

An examination of the impact of the NMW on earnings, the bite and wage differentials (15-4)

A report to the Low Pay Commission

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The present analysis uses data from the Annual Survey of Hours and Earnings, Great Britain coverage, 2004-2014, the Annual Business Survey, Great Britain coverage, 2004-2013, and the Labour Force Survey, 2004-2013. Access to the data was granted by the Office for National Statistics via the ONS Virtual Microdata Laboratory. This work contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.



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Executive Summary

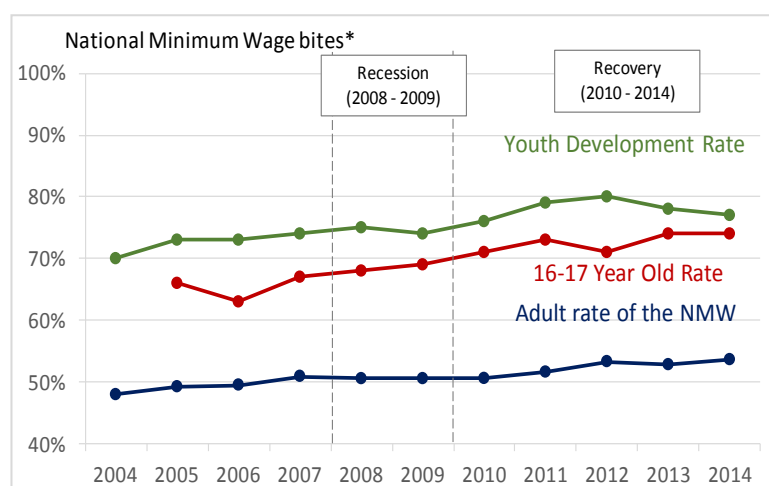
London Economics were commissioned by the Low Pay Commission to undertake an in-depth analysis of the impact of the National Minimum Wage (NMW) on earnings, the bite¹ and wage differentials. In particular, there were two substantial phases of research:

- The **first phase** involved a descriptive analysis to establish an understanding of how the bite (relative to various points on the earnings distribution) has changed over time as a consequence of changes in the NMW, and how the bite varies by key variables such as industry, geographical location, size of firm, sector (private or public) and the age of the individual.
- The **second phase** consisted of an econometric analysis.
 - The *first part* of this phase explored the impact of the NMW on earnings and wage differentials, using a *difference-in-differences* (DID) approach. In doing so, the research built on the work of Dickens, Riley and Wilkinson (2012), providing a significant extension of their work by focusing on the effects of the NMW during and following the 2008-09 recession. A number of sensitivity analyses were also considered, including a triple difference-in-differences approach, and an assessment of spillover effects for those individuals marginally further up the earnings distribution.
 - The *second part* of this phase investigated whether wages and differentials reflect skills and productivity differences by sector, using *fixed effects* estimation. The analysis focused on the potential effects of the NMW in narrowing (or widening) any existing productivity-wage differential across age groups. This built on previous research carried out by Dickerson and McIntosh (2011, 2012) and used recent data to provide a larger data set and more insight into the impact of the NMW.

The impact of the NMW on earnings, the bite and wage differentials

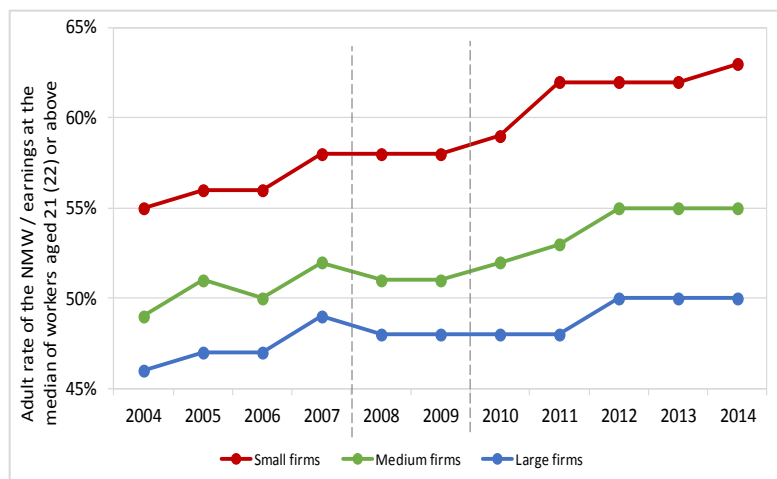
Defining the bite of the minimum wage as being the ratio of the minimum wage to the hourly median wage amongst the relevant group of workers, the analysis demonstrated that:

- The bites of the three minimum wages have been increasing over time. In contrast to the bite of the adult rate of the NMW, which has been increasing steadily across the 'pre-recession', 'recession' and 'recovery periods', the recent slowdown and freeze in the youth minimum wage rates have resulted in a slight reduction in the bite of the Youth Development rate.

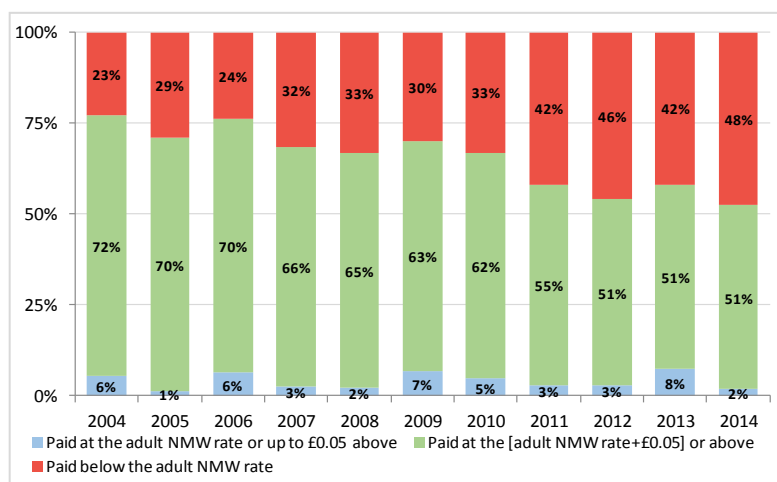


¹ The **bite** is defined as the ratio of the minimum wage to a specific point on the earnings distribution, usually the median.

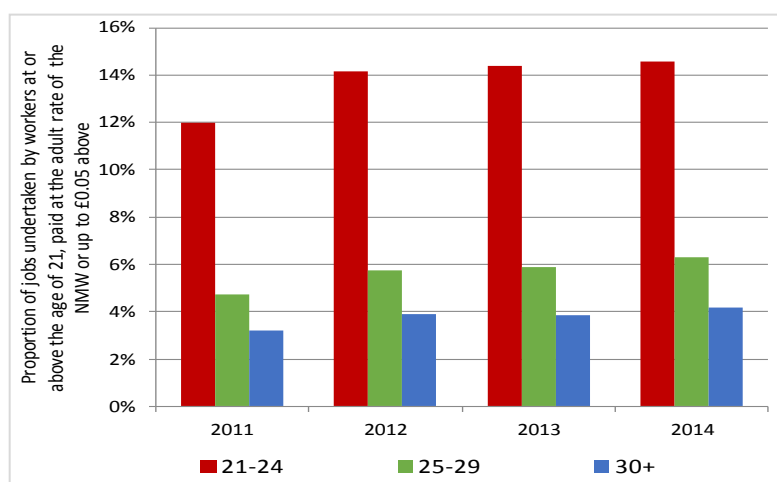
- Amongst **adult workers**, the bite of the minimum wage has increased over time irrespective of the size of the firm that the worker is employed in. However, within small firms, the bite has increased most rapidly since the ‘recovery’ (reaching **63%** in small firms compared to **55%** in medium sized firms and **50%** in large firms).



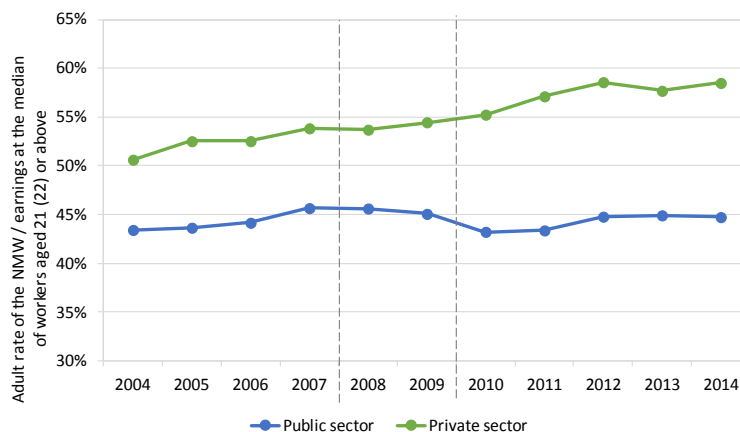
- In relation to the extent to which the adult rate of the NMW has become a *going rate* amongst **younger workers**, the analysis suggests that since 2009, a **decreasing proportion** of younger workers are paid **at least £0.05 above the adult rate of the NMW per hour**, while an **increasing proportion** are paid strictly less than the adult rate of the NMW (**48%** in 2014 compared to **30%** in 2009).



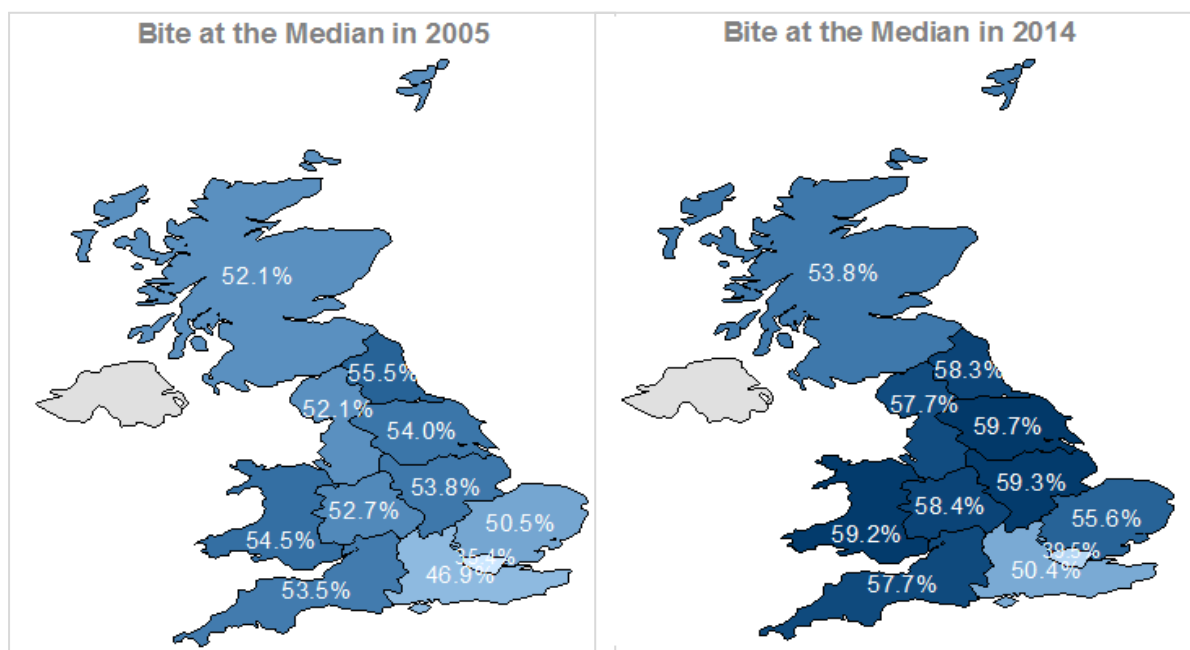
- Amongst **adults**, across all age groups, the adult rate has become **more** of a going rate irrespective of age-band. For workers aged between 21 and 24, **14.6%** earned the adult rate of the NMW in 2014 (compared to **12.0%** in 2011). For workers between the ages of 25 and 29, the comparable estimates were **6.3%** and **4.7%**, while for workers aged 30 or above, the proportions were **4.2%** and **3.2%** respectively.



- The analysis demonstrated that the bite of the adult rate of the NMW has remained relatively constant for workers employed in public sector entities (although dipping in 2010 and 2011). However, for workers in private sector organisations, the analysis indicates that despite the relatively moderate increases in the adult rate of the NMW in recent years, the bite has increased from **54.5%** in 2009 to **58.5%** in 2014.



- The bite of the adult rate of the NMW varied by geographic region. In 2005, the bite of the adult rate stood at **35.4%** in London compared to **55.5%** in the North East. The bite of the adult rate of the NMW increased in every region between 2005 and 2014 by
 - **1.7 percentage points** in Scotland.
 - **2.8 percentage points** in the North East;
 - **3.5 percentage points** in the South East;
 - **4.2 percentage points** in London;
 - **4.3 percentage points** in the South West;
 - **4.7 percentage points** in Wales;
 - **5.1 percentage points** in the East of England;
 - **5.5 percentage points** in the East Midlands;
 - **5.6 percentage points** in the North West;
 - **5.7 percentage points** in Yorkshire and the Humber; and
 - **5.7 percentage points** in the West Midlands;

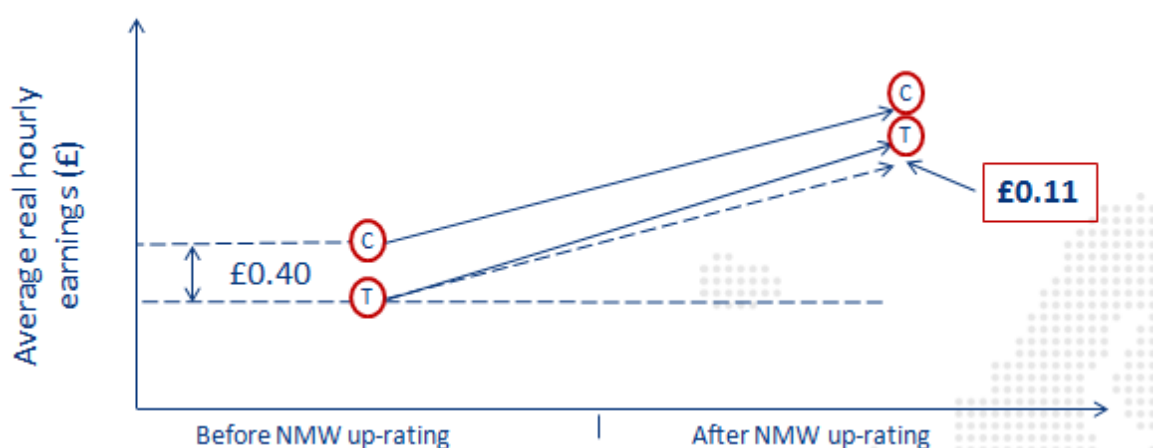


The impact of national minimum wage up-ratings

In terms of the impact of the up-rating of the adult rate of the NMW on earnings, we undertook an analysis to assess the change in the **level** of hourly earnings between workers impacted directly by the national minimum wage up-rating (i.e. the **treatment group** earning between the current adult rate of the NMW and the up-rated adult rate of the NMW), and a **control group** of workers earning at or within 10% in excess of the up-rated NMW. The analysis was replicated to consider the relative change in **wage growth** between the treatment and control groups. **Various different model specifications and sub-group analyses were tested.**

The aggregate analysis across all periods demonstrated that

- Amongst the **treatment group**, the up-rating of the adult rate of the NMW increased average hourly earnings by **£0.11** per hour compared to the **control group**. In terms of wage growth, workers in the treatment group witnessed **2 percentage point** faster wage growth as a result of the up-rating compared to the control group.



Impact of NMW up-ratings: Standard pooled DID		
	Real wages (£)	Real wage growth
After period coefficient	0.54***	0.07***
Treatment group coefficient	-0.40***	-0.07***
Impact of NMW up-rating on Treatment group	0.11***	0.02***
N	191,978	191,978

Note: ASHE 2004-2013 data; Yearly time dummies included for 2005-2014; Control variables included as in Dickens et al (2012): quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Results from year-specific models are presented in Annex, slide 41.

- The further away a worker was from the up-rated adult rate of the NMW, the greater the impact of the up-rating (**£0.12** per hour for the group of workers further away from the up-rating compared to **£0.10** per hour for the group of workers closer to the up-rating).

Splitting the annual data into a pre-recession, recession and recovery period, the analysis indicated that

- The difference in real wage growth between the treatment and control groups stood at **3 percentage points** in the pre-recession period; however, the effect of the recession (and the fact that NMW up-ratings were less than during the pre-recession period) was to reduce this difference in real wage growth (by **1 percentage point**). A similar outcome was identified in the recovery period.
- In low-paying sectors, the up-rating of the adult rate of the NMW provided workers in the treatment group with **2 percentage point** faster wage growth as a result of the uprating compared to the control group in the pre-recession period. This differential wage growth as a result of NMW up-ratings was unchanged in the recession and recovery periods.
- Workers in small firms saw the least impact of the up-rating on wage growth compared to the control group in the pre-recession period (**1.8 percentage points** compared to **1.9 percentage points** in medium sized firms and **3.3 percentage points** in large firms). During the recovery period, the relative wage growth experienced by workers in small firms following NMW up-ratings compared to the control group was essentially **zero**.

Impact of the NMW on wage and productivity differentials

Using a fixed effects approach at sector level, we also examined the impact of the NMW on earnings and productivity profiles of groups of workers with different characteristics (e.g. age) and firms with different characteristics (e.g. firm size). The main findings were as follows.

- Younger workers (aged 16-20) appeared to be **underpaid** relative to their productivity when compared to workers aged 30-49; however, these workers were **overpaid** compared to workers aged 21-29 and aged 50-59. Additional analysis of different sub-groups (in light of the introduction of the National Living Wage) suggests that 21-24 year olds are **overpaid** relative to 25-29 year olds.
- Across all periods and years, the extent to which young workers (aged 16-20) are overpaid or underpaid relative to their productivity contribution is generally reduced if more workers earn at, or close to, the NMW.
- Focussing on **low-paying sectors** only, 16-20 year olds appear to be **underpaid** relative to their productivity when compared to 21-29 year olds; however increasing the percentage of workers earning at the NMW is associated with a **narrowing** of the productivity-wage gap for workers aged 21-29.
- The impact of the NMW on productivity-wage differentials between age groups in the recession period is statistically significant, suggesting that there was a reduction in the gap between productivity and wages across all age groups within the same sector during the recession. Given productivity differences, workers aged 16-20 became **less underpaid** compared to 21-29 year olds and 30-49 year olds, and **less overpaid** compared to 50-59 year olds. However, the estimates of the impact of the NMW are relatively small and often statistically insignificant.

1 Introduction and terms of reference

London Economics were commissioned by the Low Pay Commission to undertake an in-depth analysis of the impact of the National Minimum Wage (NMW) on earnings, the bite (defined as the ratio of the minimum wage to a specific point on the earnings distribution, usually the median) and wage differentials. In particular, there were two substantial phases of research:

- The first phase (*Research Objective 1 and 2* presented in Section 2) involved a descriptive analysis to establish an understanding of how the bite (relative to various points on the earnings distribution) has changed over time in relation to changes in the NMW, and how the bite varies by key variables such as industry, geographical location, size of firm, sector (private or public) and age of individual.
- The **second phase** consists of an econometric analysis.
 - Comparing a treatment group with a number of counterfactuals, the *first part* of this phase (*Research Objective 3*) explored the impact of NMW up-ratings on wage differentials and wage growth, using a difference-in-differences (DID) approach. In doing so, the research builds on the work of Dickens, Riley and Wilkinson (2012), providing a significant extension of their work by focussing on the effects of the NMW during and following the 2008-09 recession. A number of sensitivity analyses were also considered including a triple difference-in-differences approach, as well as assessing the spillover effects associated with increments in the NMW for those individuals marginally further up the earnings distribution.
 - The *second part* of this phase (*Research Objective 4*) investigates whether wage differentials between different age groups reflect productivity differentials by sector, using fixed effects estimation. The analysis focuses on the potential effects of the NMW in narrowing (or widening) any existing productivity-wage differential between different age groups. This builds on previous research carried out by Dickerson and McIntosh (2011, 2012) and uses recent ASHE data to provide a larger data set and more insight into the impact of the NMW.

The original research objectives proposed by the Low Pay Commission are presented below.

Table 1 Research Objectives

Number	Description
RO1	Examine the impact of the minimum wage on earnings, the bite and wage differentials
RO2	Examine whether the impact of the NMW on earnings varies according to industry, geographical location, size of firm, and sector (private and public)
RO3	Investigate the extent to which the NMW has become established as the 'going rate'.
RO4	Investigate whether wages and differentials reflect skills and productivity differences by sector

In section 2, we present a range of descriptive statistics on the bite of the NMW (at both an aggregated level but also broken down according to a number of key variables), as well as the impact of NMW up-ratings on wage differentials and wage growth. In section 3, we estimate wage and productivity differentials at sectoral level across different age-groups, and assess the extent to which up-ratings in the NMW narrowed or widened these wage-productivity gaps. Section 4 concludes.

2 Impact of the NMW on earnings, the 'bite' of the minimum wage and wage differentials (RO1 – RO3)

2.1 Background and context

Since its introduction in the United Kingdom in 1999, research on the effects of the National Minimum Wage (NMW) has found that the policy has significantly increased the earnings of low-paid workers and narrowed earnings differentials at the lower end of the income distribution.

However, given recent developments in the UK labour market as a result of the 2008-09 recession, it is imperative to re-examine this consensus view to test whether it still applies under current economic conditions. The recent recession of 2008-2009 has caused a significant increase in unemployment (in particular amongst young people) and an erosion of real earnings. In consequence, the 'bite' (the ratio of the minimum wage to a specific point on the earnings distribution, usually the median) of the NMW has generally continued to increase. The Low Pay Commission has responded to these adverse labour market conditions by slowing the growth of the adult rate of the National Minimum Wage and by slowing down and freezing youth rates between October 2011 and 2013.

Therefore, there is a need to closely examine the impact of the NMW on earnings and earnings differentials, focussing on the period since the 2008-09 recession. Of particular interest is whether the effects of the NMW have been felt in particular sections of the economy compared to others (for instance, in low-paying sectors, small firms, or in different Home Nations of the United Kingdom).

Placing the current research in context, several studies have found that the minimum wage has significantly affected wages in the lower part of the hourly earnings distribution, by increasing earnings for low-paid workers and narrowing wage differentials. Research so far has used three standard methodological approaches: **difference-in-differences** estimation; **panel data** methods; and **sectoral study** approaches. Some of these analyses are summarised below.

- Dickens, Riley and Wilkinson (2012) estimate the effects of NMW up-ratings on the lowest paid workers using a *horizontal difference-in-difference* approach. They use data from the Labour Force Survey (LFS) and New Earnings Survey (NES) between 1994 and 2010, and are therefore able to examine the impact on earnings of the introduction of the NMW as well as all subsequent up-ratings. The horizontal difference-in-difference approach relies on comparing the changes in earnings of a **treatment group** (those workers with hourly earnings situated just below a forthcoming up-rating of the NMW) to a **control group** (workers with hourly earnings lying just above the forthcoming up-rating). To add robustness to their results, a model pooled over time, and vertical difference-in-difference models are also estimated.

Dickens, Riley and Wilkinson (2012) find large effects of the introduction of the NMW on the earnings of the lowest-paid workers, as well as statistically significant effects of the larger up-ratings in 2001, 2003 and 2004. However, they find that when NMW up-ratings were smaller, such as in the recent recession years, there was some evidence of wage differentials being restored. This research also explores regional variation in the effects of the NMW in the bite of the NMW. They find that the areas with the lowest wages prior to the introduction of the NMW were those that experienced the greatest reduction in earnings inequality between 1998 and 2010.

- Butcher, Dickens and Manning (2012) construct a panel dataset by segmenting the labour market by gender, age and geographical area, resulting in labour market segments with varying degrees of NMW bite. For example, the 'bite' is generally highest for women, younger workers and in lower-wage areas. Estimating a model in *first-differences*, it was possible to identify the effect of changes in the minimum wage on earnings at different points (percentiles) of the income distribution (using the fact that minimum wages are likely to have a greater effect in segments of the labour market where the bite is highest).

As expected, these authors find that the minimum wage has had the largest effect on the lowest paid workers – at the *fifth* percentile of the earnings distribution. However, they also find that the NMW increases the wage of workers at the *tenth* percentile, and find some evidence of spill-over effects at the *twenty-fifth* percentile. Hence there is some evidence that the NMW has increased wages of a significant proportion of workers - and not just for the very lowest paid workers.

- Other studies have attempted to estimate such spillovers directly. For example, Stewart (2009) used a variety of approaches - including difference-in-differences - to identify counterfactuals for different levels of the wage distribution. Stewart (2009) found some evidence of spillovers, although the results were sensitive to the assumptions used.
- A final approach to estimating the effects of the NMW on earnings has been through sectoral studies (as adopted by Machin, Manning and Rahman (2002)) to examine the effects of the introduction of the NMW on the residential care homes sector. This sector was chosen because it had a high proportion of workers that are low paid, as well as being made up predominantly of small firms. The authors found a very large reduction in the wage dispersion of the bottom half of the earnings distribution (wage compression). Before the introduction of the NMW, roughly a third of workers had been paid below the forthcoming NMW, whereas after 30% were paid exactly the NMW.

2.2 Data

The dataset used to produce the descriptive analysis of earnings is the **Annual Survey of Hours and Earnings (ASHE)**, accessed through the ONS Virtual Micro-data Laboratory facility. The ASHE is an annual survey carried out in April and based on a 1% sample of employee jobs taken from HM Revenue & Customs (HMRC) PAYE records. It provides information on earnings and hours of work, as well as other job and personal characteristics (excluding education). The information is collected directly from employers. The ASHE also contains information on region (and more granular geographic levels), occupation types and industry. The ASHE is widely regarded as the primary source of information on earnings in the United Kingdom, and allows the examination of trends in specific segments of the labour market.

The ASHE replaced the New Earnings Survey (NES) in 2004. Although the ASHE methodology was applied to all data prior to 2004, there is a significant structural break in the ASHE data with the introduction of weights in 2004. Thus, for consistency of the estimates, this study focuses on ASHE data from 2004 onwards. The present section of the study makes use of data covering the period from **2004 to 2014**, the latest available year.

2.3 Phase 1: Descriptive statistical analysis of earnings and the 'bite' of the minimum wage

2.3.1 Methodology

This component of the analysis focuses on building a detailed understanding of recent trends in earnings, the bite of the minimum wage, and wage differentials, as well as the relationship between these trends and changes in the NMW. The focus is on a comparison of the trends in the period before, during and after the 2008-09 recession.

In this phase of the analysis, we aim to build an in-depth understanding of how the earnings distribution has changed over time in relation to changes in the NMW, and how the distribution varies by:

- industry;
- geographical location;
- size of firm;
- sector (private or public); and
- age of worker.

In the overall labour market, as well as in the segments that we are interested in, we examine:

- the proportion of employees paid the NMW;
- measures of the bite of the NMW (including the ratio of the NMW to earnings at the first decile, quintile and median of the distribution (presented in the Annex)); and
- other measures of earnings differentials at the lower end of the distribution, such as the ratio of earnings at the fifth and tenth percentiles to the median.

Throughout this analysis, we also aim to shed light on the extent to which the minimum wage has become the 'going rate'. Specifically, we assess the proportion of young workers in receipt of the adult rate of the NMW (or above) despite not being eligible for the adult rate, as well as the proportion of adult workers that are paid the adult rate of the NMW².

2.3.2 Sample construction

Data cleaning

The sample used for descriptive statistical analysis is derived from the Annual Survey of Hours and Earnings, and includes workers of all ages and minimum wage rate eligibility bands.

Observations have been dropped from the dataset³ if:

- the 'low-pay calibration weight'⁴ is missing;

² The question of the extent to which the NMW rates have become the 'going rate' is of particular importance given the findings of Income Data Services (2011). They found that many large firms pay at least the adult minimum wage rate to workers under the age of 21, suggesting that for these firms the adult rate has become the 'going rate' even for younger workers. Interestingly, they also document cases in which large firms have changed their wage-setting arrangements since the 2008-09 recession by introducing rates for those under 21 which are lower than the adult minimum wage.

³ The data cleaning strategy follows that typically adopted by the Low Pay Commission for consistency.

- basic hours worked are zero or missing;
- pay is affected by absence; or
- the derived hourly earnings variable is zero or missing.

Structural breaks

Two structural breaks occur in the Annual Survey of Hours and Earnings dataset between 2004 and 2014, namely:

- Since 2006, *Special Arrangement*⁵ respondents were treated as an extra stratum, and occupations were coded using an automated system.
- In 2011, the 2010 Standard Occupational Classification (SOC 2010) replaced that from 2000 (SOC 2000).

Due to these structural breaks in the data, comparisons in the descriptive statistics pre- and post-2006 and pre- and post-2011 should be made with caution.

In relation to the descriptive analysis of the bite of the adult rate of the NMW, the total number of individual level observations ranged between 124,143 (2008) and 164,760 (2014). In relation to the Youth Development rate, the total number of observations ranged between 5,987 (2012) and 8,845 (2010), while for the 16-17 Year Old rate, the total number of observations ranged between 1,544 (2011) and 2,354 (2005)

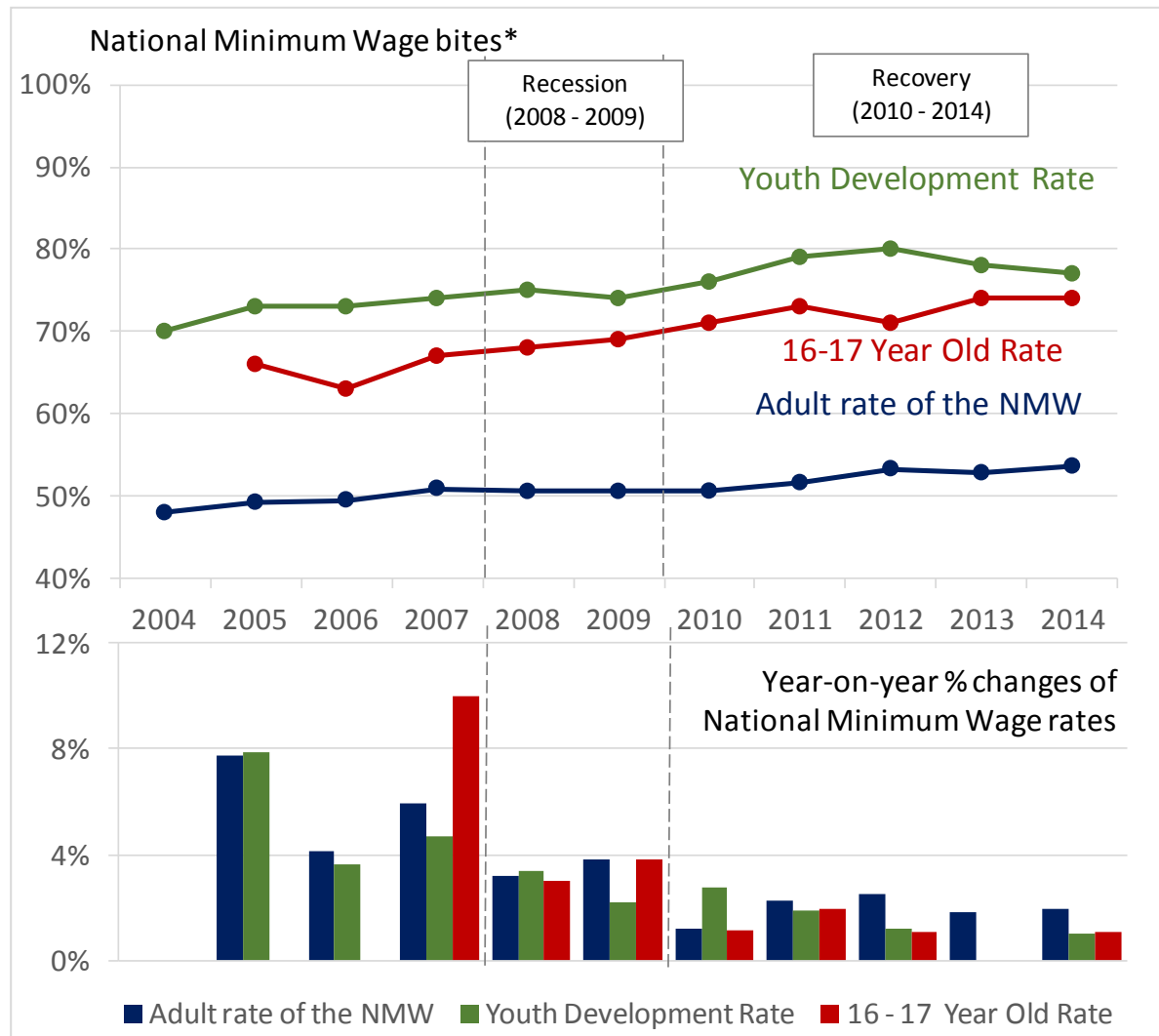
⁴ The 'low-pay calibration' weight is the weight that is applied in the ASHE that is specifically applied to earnings information when dealing with low pay observations. The rationale for adopting this particular weight is because of the fact that low pay jobs may be underrepresented in a population analysis when the 'standard' calibration is used

⁵ A number of businesses have a Special Arrangement (SA) in place with the ONS to provide their data electronically. These employers have internal systems set up to extract and return information on all relevant employees at the survey reference date. Consequently the likelihood of response for an employee of one of these businesses is higher than for employees in businesses that return paper questionnaires. For use in calculating the estimates of earnings that appear in the ASHE results, a number of weights are applied to each record in the ASHE dataset. One of these weights gives an adjustment for non-response and is determined by which category or stratum a particular record falls into. Previously, there were three strata; 1. Paper questionnaires sent out in the initial despatch in April and SAs. 2. Employees identified as changing jobs between initial sample selection and the survey reference date. 3. Employees who started jobs between the initial sample selection and the survey reference date. SAs have a response rate significantly higher than the returns from the paper questionnaires sent out in the original despatch. This meant that SA records were receiving a higher weight than they ideally ought to. Treating SAs as a separate stratum allows us to allocate more appropriate weights to them

2.3.3 Main findings

The analysis presented in Figure 1 demonstrates the fact that the bite of the adult rate of the Adult Minimum Wage rate remained relatively constant between 2004 and 2009 (increasing from approximately **48%** to **50%**). However, despite the relative slowdown in the subsequent up-ratings, the bite of the adult rate of the NMW has increased by approximately **4 percentage points** to **54%**. It is important to note that with the announcement of the living wage policy, whereby workers aged 25 or above will receive a £0.50 premium on the adult rate of the NMW, the expected bite of the Living Wage rate will stand at approximately **60%** amongst the 25+ age group.

Figure 1 National Minimum Wage bite at the Median



*Note: Each bite is calculated relative to the median earnings of the respective age group. NMW growth rates are presented for the respective ASHE year.

Source: London Economics' analysis of ASHE data 2004-2014

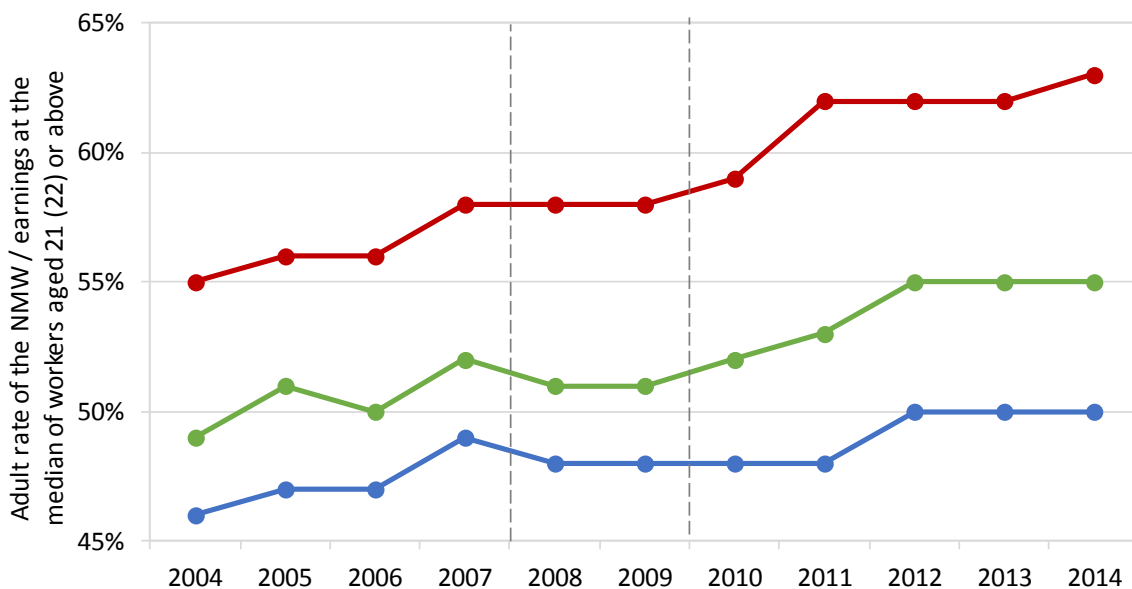
The analysis also demonstrates the bites of the **Youth Development Rate** and the **16-17 Year Old Rate**. This analysis indicates that the bite of the 16-17 Year Old Rate has increased – essentially steadily from **67%** in 2004 to almost **75%** in 2014, whilst the bite of the Youth Development Rate has increased by **8 percentage points** – from **70%** in 2004 to **78%** in 2014. Note that the slowdown and subsequent freeze in the Youth Development Rate did result in a reversal of the long term increase in the bite of this minimum wage rate (by **2 percentage points** from **80%** in 2012 to **78%** in 2014).

The evolution of the bite by firm size

Breaking down the sample of employers by firm size (Figure 2), the analysis demonstrates that the bite of the adult rate of the NMW increases as firm size decreases, which reflects the difference in affordability across firm size. To reflect change in the age of eligibility for the adult rate in 2010, the bite is calculated relative to the median earnings of workers aged 21 or above from 2010 onwards, and relative to the median earnings of workers aged 22 or above in preceding years.

In large firms (250 or more employees), the bite of the adult rate of the NMW stands at **50%**, which compares to approximately **63%** in small firms (less than 49 employees). However, of interest is the fact that the gap in the bite of the adult rate of the NMW between small and large firms has increased following the recession and subsequent recovery. In 2004, the gap in the bite of the adult rate of the NMW stood at approximately **8 percentage points**, whilst this has increased to **13 percentage points** in 2014.

Figure 2 Adult rate of the National Minimum Wage bite at the Median, by firm size



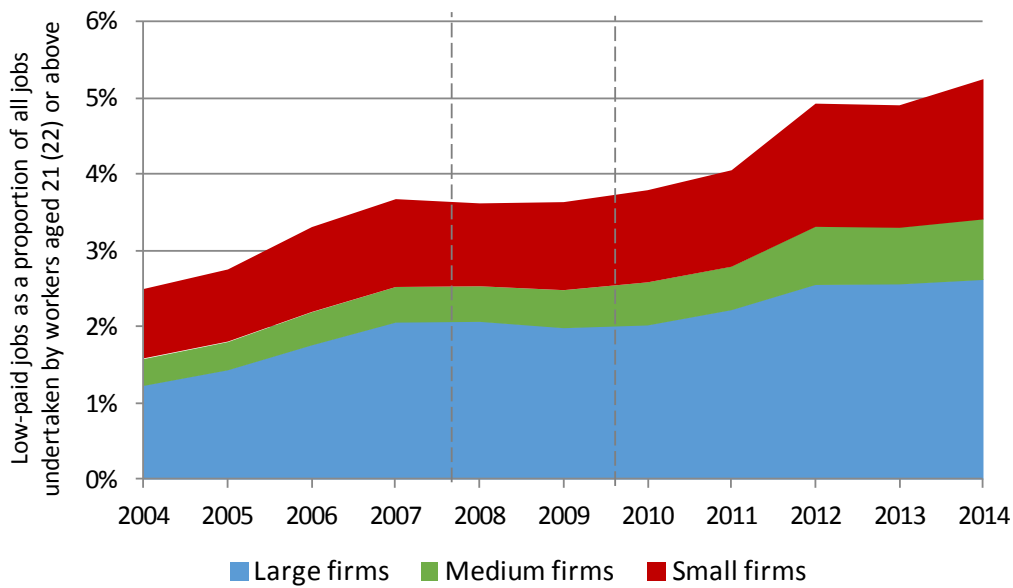
Note: Each bite is calculated relative to the median earnings of workers aged 21 (22) or above in the respective firm size

Source: London Economics' analysis of ASHE data 2004-2014

In Figure 3, we present information on the prevalence of 'low paid jobs' by firm size, where 'low-paid jobs' are classified as jobs that are paid at or within £0.05 of the adult rate of the NMW. The analysis indicates that there has been an increasing proportion of low paid jobs across the economy as a whole between 2004 and 2014 (from **2.5%** in 2004 to **5.3%** in 2014) with the prevalence of low paid jobs amongst small firms increasing correspondingly (i.e. accounting for approximately **35-36%** of all low paid jobs at the start and end of the period (compared to approximately **30%** of low paid jobs in 2008).

Combining information on the increasing bite of the adult rate of the NMW (especially amongst workers in small firms) with the increased prevalence of low paid jobs (again, especially amongst small firms) suggests that there has been a significant degree of downward pressure on wages in all firms, but in particular in relation to those firms with the fewest employees.

Figure 3 Prevalence of low-paid jobs by firm size



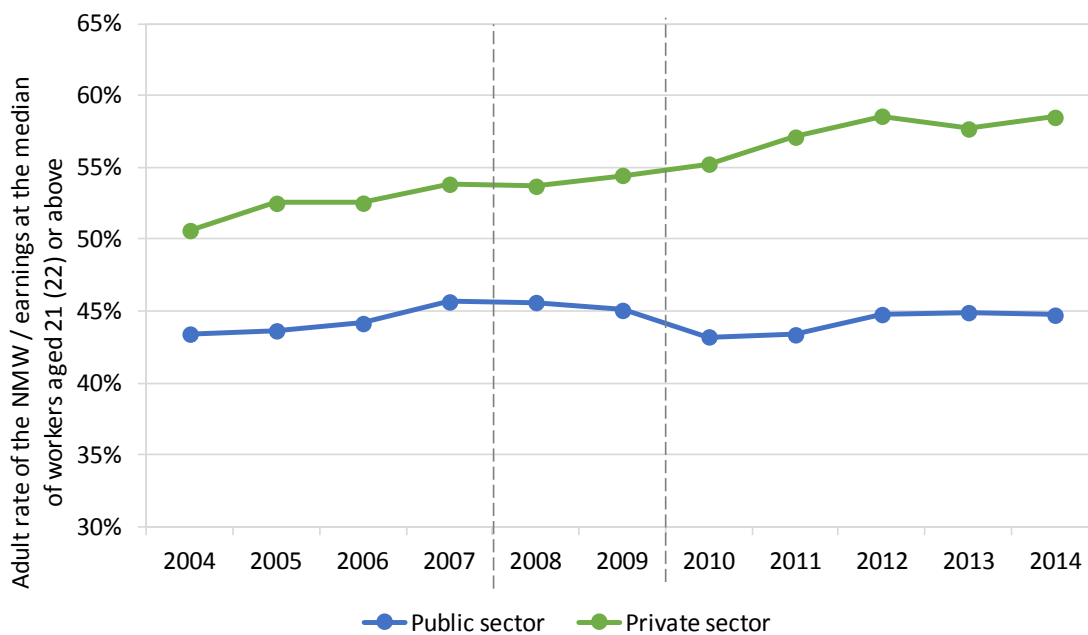
Note: Low-paid jobs are defined as jobs paid up to the adult rate of the NMW + £0.05

Source: London Economics' analysis of ASHE data 2004-2014

The evolution of the bite by sector

In terms of the sector of employment, Figure 4 contrasts workers employed in the public and private sectors. The analysis suggests that within the public sector, the bite of the minimum wage has remained approximately constant (at between 43% and 45%). However, in contrast, for workers employed within the private sector, the bite of the minimum wage has increased steadily over time, increasing from approximately 50% to 59% by 2014.

Figure 4 Bite of the adult rate of the NMW by employment sector (public/private)



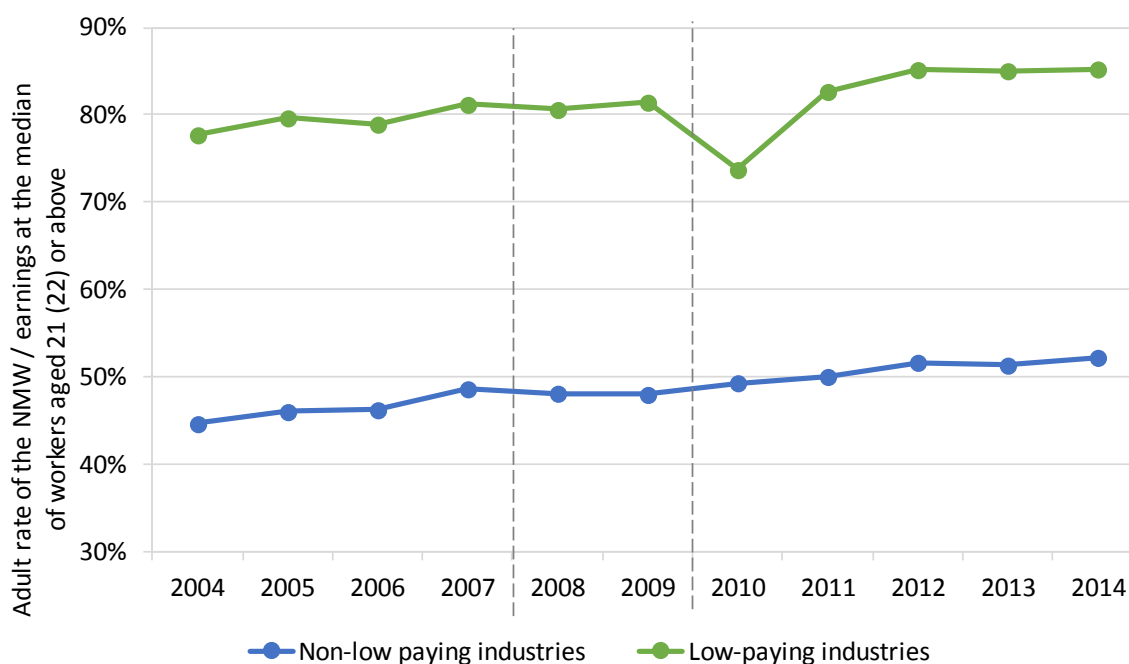
Note: Each bite is calculated relative to the median earnings of workers aged 21 (22) or above in the respective sector

Source: London Economics' analysis of ASHE data 2004-2014

The evolution of the bite by industry

The data from the ASHE has also been segmented according to whether workers are employed in 'low-paying industries' or otherwise (i.e. non low-paying industries). The analysis demonstrates that the bite of the adult rate of the NMW is significantly lower in the non low-paying industries (standing at **52%**) compared to low-paying industries (where the bite stands at approximately **85%**). Interesting however is the fact that the bite of the adult rate of the NMW has increased equally rapidly within non low-paying industries as in traditionally low-paying industries (**7 percentage points**).

Figure 5 Bite of the adult rate of the NMW by employment occupation (low-paying)



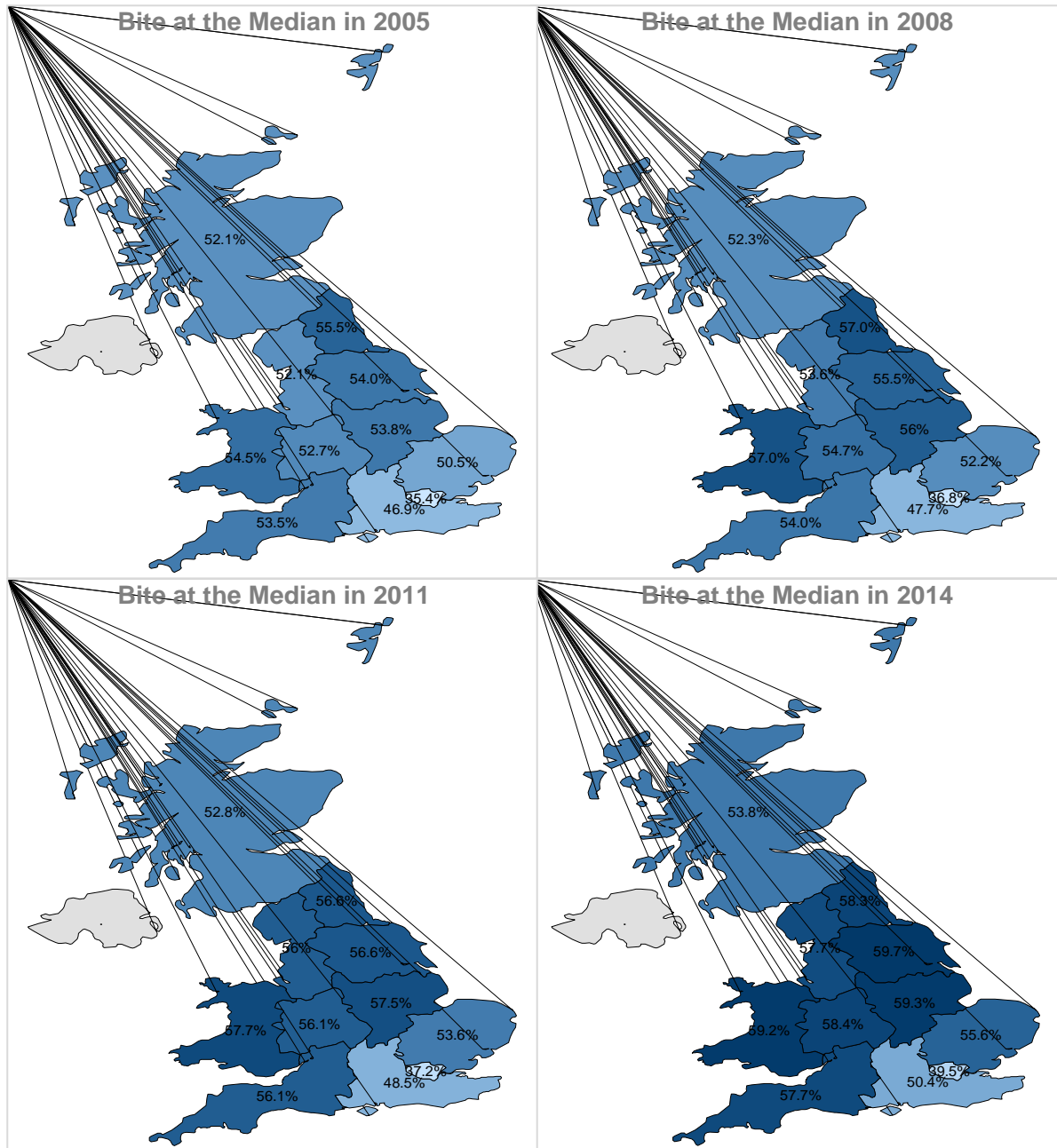
Note: Each bite is calculated relative to the median earnings of workers aged 21 (22) or above in the respective occupation class

Source: London Economics' analysis of ASHE data 2004-2014

The evolution of the bite by region

The analysis in Figure 6 presents the bite of the adult rate of the NMW amongst relevant workers in 2005, 2008, 2011 and 2014 by region. The analysis illustrates the general increase in the bite of the adult rate of the NMW over time across all regions, but also a general narrowing of the differences in the bite between those government office regions at the top and the bottom of the distribution. In particular, over the period of analysis, the increase in the bite of the adult rate of the NMW was **2.8 percentage points** in the North East; **5.6 percentage points** in the North West; **5.7 percentage points** in Yorkshire and the Humber; **5.5 percentage points** in the East Midlands; **5.7 percentage points** in the West Midlands; **4.3 percentage points** in the South West; **5.1 percentage points** in the East of England; **4.2 percentage points** in London; **3.5 percentage points** in the South East; **4.7 percentage points** in Wales; and **1.7 percentage points** in Scotland.

Figure 6 Bite of the adult rate of the NMW by region



Note: Each bite is calculated relative to the median earnings of workers aged 21 (22) or above in the respective government office region. A darker colour represents higher bite of the adult rate of the NMW at the median.

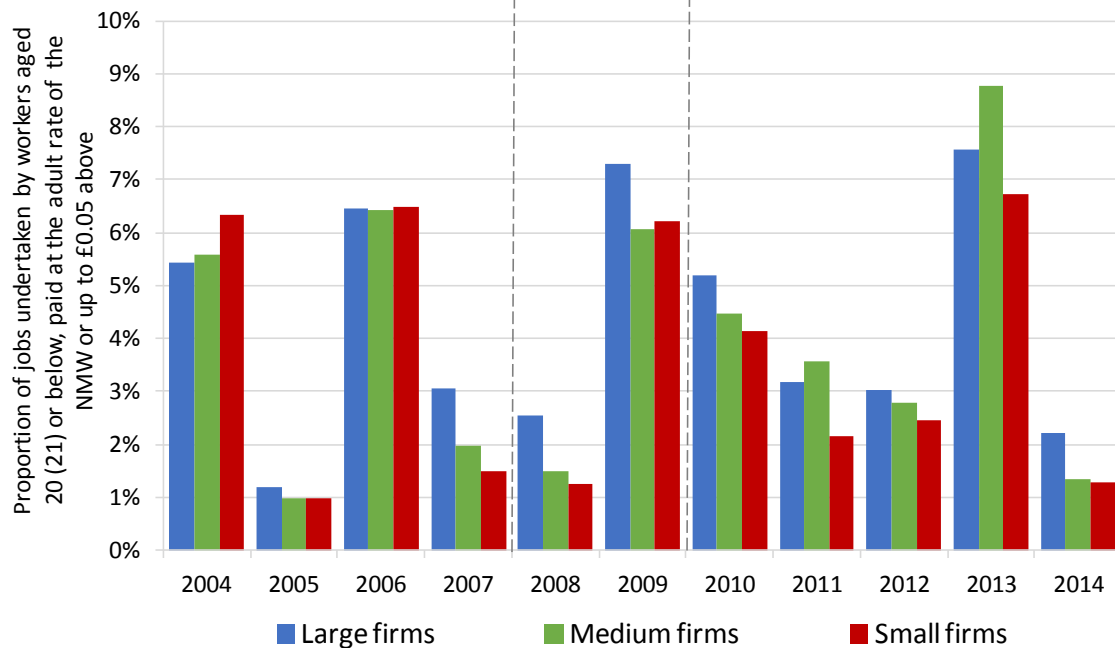
Source: London Economics' analysis of ASHE data 2004-2014

The adult rate of the NMW as the going rate for younger workers

To assess the extent to which the adult rate of the NMW has become the 'going rate' amongst younger workers, in Figure 7, we assess the proportion of workers that are in receipt of the adult rate (or up to £0.05 in excess of the adult rate) by firm size. In Figure 8, across the entire economy, we provide information on the proportion of younger workers paid below the adult rate; at the adult rate (plus £0.05); or strictly above the adult rate (plus £0.05). In Figure 9, this information is broken down by firm size.

The information in Figure 7 indicates that the proportion of younger workers paid at the adult rate of the NMW is generally greater amongst larger firms than smaller firms. Furthermore, since the onset of the recession (with the exception of 2013), the proportion of younger workers paid at the adult rate of the NMW (plus £0.05) has been gradually decreasing. Compared to 2009, approximately **7%** of younger workers in large firms and **6%** of workers in small firms were paid the adult rate of the NMW. However, these proportions have decreased to approximately **2%** and **1%** respectively in 2014. In this sense, the adult rate of the NMW has become less of a going rate amongst younger workers that are not strictly eligible to be in receipt of this wage.

Figure 7 Proportion of younger workers paid the adult rate of the NMW, by firm size

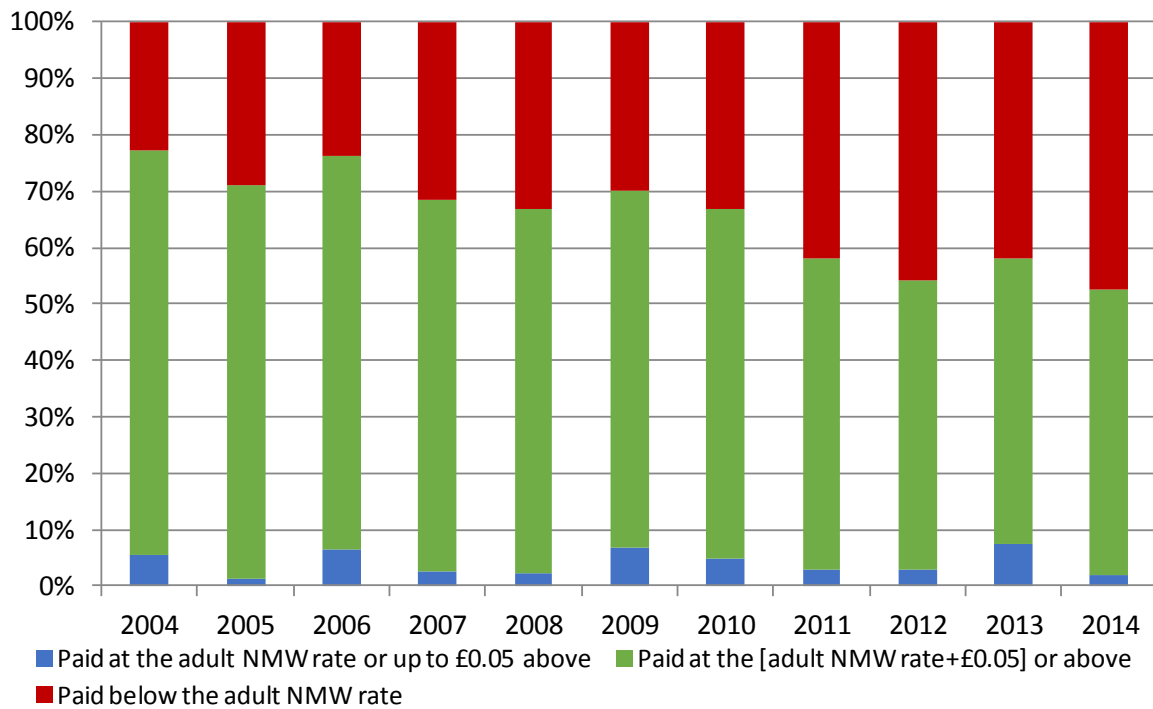


Source: London Economics' analysis of ASHE data 2004-2014

However, Figure 8 illustrates again the extent of the downward wage pressure across the entire economy. The analysis indicates that the proportion of younger workers being paid less than the adult rate of the NMW has been increasing over time. Compared to 2009, when approximately **30%** of younger workers were paid less than the adult rate of the NMW and **63%** were paid more than £0.05 in excess of the adult rate of the NMW, by 2014, approximately **48%** of younger workers were paid below the adult rate with approximately **50%** being strictly above the adult rate.

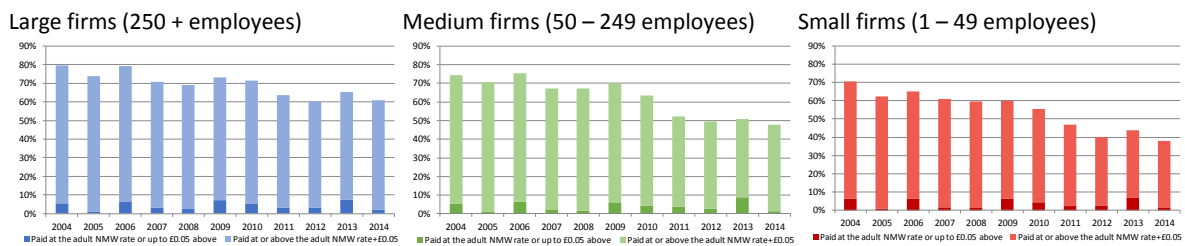
Figure 9 further reflects this outcome. Across all firm sizes, the proportion of younger workers paid strictly in excess of the adult rate of the NMW has been decreasing consistently since 2004.

Figure 8 Young workers pay relative to the adult rate of the NMW



Source: London Economics' analysis of ASHE data 2004-2014

Figure 9 The proportion of younger workers paid at least the adult rate of the NMW

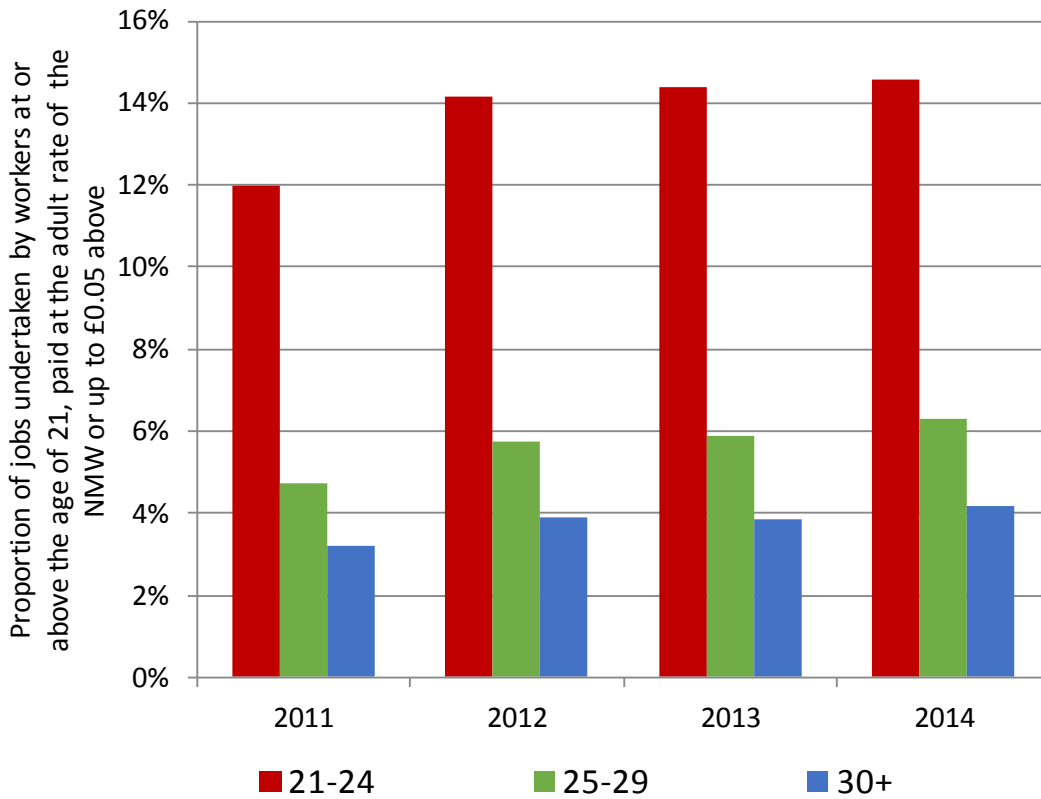


Source: London Economics' analysis of ASHE data 2004-2014

The adult rate of the NMW as the going rate for *adult* workers

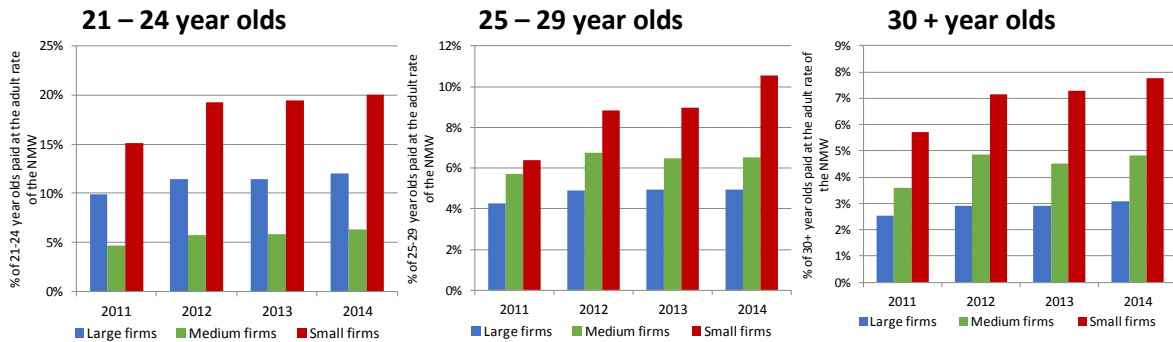
The next objective of the analysis was to assess the extent to which the adult rate of the NMW has become the going rate amongst adult workers. Using information from ASHE from March 2011 (primarily because of the change in the age threshold for eligibility for the adult rate of the NMW in October 2010), the analysis presented in Figure 10 indicates there has been an increasing proportion of adult workers in receipt of the adult rate. Specifically, amongst workers aged between 21 and 24, there has been a **2.5 percentage point** increase in the number of jobs paid at the adult rate (from **12.0%** to **14.5%**). Similarly, the proportion of jobs undertaken by 25-29 year olds paid at the minimum wage has increased from **4.5%** to **6.1%**. Amongst workers aged 30 or more, the proportion has increased from approximately **3.2%** to **4.0%**.

Figure 10 Proportion of adult workers paid the adult rate of the NMW, by age bracket



Source: London Economics' analysis of ASHE data

Figure 11 Proportion of adult workers paid the adult rate of the NMW by age bracket and firm size



Source: London Economics' analysis of ASHE data

2.4 Phase 2: Impact of the NMW up-ratings on hourly earnings – difference-in-differences analysis

To understand the impact of up-ratings in the adult rate of the NMW on the hourly earnings between the treatment and counterfactual groups, we undertook a difference-in-differences analysis. The difference-in-differences estimation also uses a dataset constructed from the individual Annual Survey of Hours and Earnings microdata⁶. ASHE data allows the use of more timely data and, therefore, a more up-to-date examination of the NMW on earnings during the post-recession period. Additionally, data on earnings are incomplete and less reliable in the LFS than in the ASHE⁷. The ASHE provides a more limited number of controls than the LFS; however, it allows for segmentation of the labour market by industry, size of firm, sector and geographical location, which ensures the research aims can be fully addressed.

2.4.1 Methodology

This component of the analysis adopts a **difference-in-differences** (DID) approach to estimate the impact of changes in the NMW on the earnings of low-wage workers. In doing so, the analysis builds on the work of Dickens, Riley and Wilkinson (2012), providing an extension of their study by 1) focussing on the effects of the NMW during and following the 2008-09 recession, and 2) performing the estimation on further segmentations of the labour market.

The standard DID approach compares the change in earnings of workers that are **directly affected by a new up-rating in the NMW** (the 'treatment' group) to the change in earnings of 'similar' workers who are not affected by the up-rating (the 'control' group). In particular, the control group consists of workers who earn between the forthcoming up-rated level of the adult rate of the NMW and up to 10% (in monetary terms) above the forthcoming up-rating of the NMW.

Model specification

Our main estimation takes the form:

$$(1) w_{it} = \beta_0 + \beta_1 D_{t+1} + \beta_2 D_{T=1} + \beta_3 D_{t+1} D_{T=1} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$$

- w_{it} is the wage outcome variable for individual i at time t (discussed in detail further below);
- D_{t+1} is a dummy variable taking value one if the minimum wage up-rating has come into effect, i.e. at time $t+1$, or the "after" period, and zero otherwise;
- $D_{T=1}$ is an indicator variable for individuals assigned to the Treatment group at time t , which takes value 1 when $NMW_t \leq w_{it} < NMW_t^*$ and 0 otherwise, where
 - NMW_t is the minimum wage rate *before* the up-rating and NMW_t^* is the upcoming minimum wage rate relative to period t , which is in effect in the *after* periods;
- X is a vector of covariates accounting for systematic differences in personal and job characteristics;
- β 's and γ 's are the coefficients to be estimated.

⁶ in contrast to Dickens, Riley and Wilkinson (2012), who use data from the NES and the LFS

⁷ In fact, when Dickens, Riley and Wilkinson (2012) estimate their model using data from the LFS, they find results that differ significantly compared to their results based on data from the NES. They attribute the findings when using the LFS to measurement error in the data on hourly earnings and small sample sizes due to the fact that earnings data is collected only in the first and fifth waves for each individual in the sample.

Recession and recovery

Strictly speaking, in this analysis, the time period in which the latest economic recession occurred does not perfectly match the commonly accepted 'GDP-led' definition of economic downturn (as used in the latest Low Pay Commission report (2015)⁸). Specifically, as the ASHE provides a snapshot of earnings from March/April each year, this analysis assumes that ASHE 2008 and ASHE 2009 estimates represent earnings during the recession period, whereas the ASHE data between 2010 and 2014 reflect the earnings achieved during the 'recovery' period.

In a difference-in-differences setting, however, we measure changes between two consecutive periods. As such, the **recession** period has been defined to capture 'before' observations from 2008 and 2009, and 'after' observations from 2009 and 2010 respectively, with the NMW up-ratings in-between occurring strictly during the recession. Similarly, 'before' period observations from 2010-2013 and 'after' period observations from 2011-2014 are considered to have occurred during the **recovery** period.

The main model specification this study follows has been modified to capture the changes of impact from the NMW up-ratings on the treatment group's earnings as follows:

$$\begin{aligned}
 (2) \ w_{it} = & \beta_0 + \beta_1 D_{t+1} \\
 & + \beta_2^{2004-2007} D_{T=1} + \beta_3^{2004-2007} D_{t+1} D_{T=1} + \\
 & + \beta_2^{2008-2009} D_{T=1} \textit{Recession} + \beta_3^{2008-2009} D_{t+1} D_{T=1} \textit{Recession} \\
 & + \beta_2^{2010-2014} D_{T=1} \textit{Recovery} + \beta_3^{2010-2014} D_{t+1} D_{T=1} \textit{Recovery} \\
 & + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon, \text{ where}
 \end{aligned}$$

- *Recession* is a dummy variable taking value 1 if the year of observations in the before period is 2008 or 2009 and the year of observation in the after period is 2009 or 2010 (0 otherwise);
- *Recovery* is a dummy variable which takes value 1 when the year of observations in the before period falls between 2010-2013 and observations from the after period are from 2011-2014 (0 otherwise).

Therefore, the $\beta_3^{2008-2009}$ and $\beta_3^{2010-2014}$ coefficient estimates capture how the impact of NMW up-rating on the treatment group has changed during the recession and recovery periods respectively, compared to that during the pre-recession period - $\beta_3^{2004-2007}$. The net average difference-in-differences estimate during the recession period is therefore $(\beta_3^{2004-2007} + \beta_3^{2008-2009})$, while in the recovery period, net average difference-in-differences estimate is represented by $(\beta_3^{2004-2007} + \beta_3^{2010-2014})$.

It should be noted that the estimation does not directly identify a *cause* for this change in impact, but simply identifies the average difference in additional impact post-NMW up-rating on the treatment group compared to the control. This difference may be at least partially caused by the smaller up-ratings of the adult rate of the NMW.

⁸ Specifically, using ONS information on quarterly changes in GDP, the UK recession occurred between 2008Q2 and 2009Q3

Wage gap

Specification (1) estimates the average impact of the minimum wage up-ratings on the treatment group, but does not take into account the variation of this effect between individuals, depending on how far away their earnings are from the future up-rating. A varied specification has also been considered to incorporate a measure of 'wage gap' in the estimation, to assess the effect of NMW up-ratings, depending on the distance between the individual's wage and the future up-rating of the NMW. The wage gap is measured as:

- $G_{it} = \ln\left(\frac{NMW_t^*}{w_{it}}\right)$, where
 - NMW_t^* is the upcoming minimum wage rate relative to period t
 - w_{it} is individual i 's nominal hourly wage

Two variants of the specification which incorporate the wage gap measure have been estimated, namely:

$$(3) w_{it} = \beta_0 + \beta_1 D_{t+1} + \beta_2 D_{T=1} + \beta_3 D_{t+1} D_{T=1} G_i + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$$

$$(4) w_{it} = \beta_0 + \beta_1 D_{t+1} + \beta_2 D_{T=1} G_i + \beta_3 D_{t+1} D_{T=1} G_i + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon$$

Specification (3) imposes a common average difference between the treatment and control groups, whereas specification (4) allows for this difference, as well as the difference in impact on the treatment group post-up-rating, to vary with the size of the individual and time-specific wage gap.

The rationale behind incorporating a wage gap measure is to take into account the effective size of the variation in the size of up-ratings over time, as well as the variation in individuals' up-ratings: the further away from the forthcoming minimum wage a worker's earnings are in the 'before' period, the more of a boost they would be expected to receive following the NMW up-rating.

Dataset construction

In the construction of the sample for difference-in-differences analysis, only individuals⁹ who are observed in ASHE for at least two consecutive years have been kept in the sample. If an individual has a record in ASHE for more than two consecutive years, the 'middle year' observations have been used twice – once as an 'after' period observation, paired with the individual's record from the previous year as a 'before' observation; and once as a 'before' observation, paired with the individual's record from the following year as an 'after' observation. The individual's earliest and latest year observations are used only once, as 'before' and 'after' observations, respectively.

Treatment and Control groups

The **treatment group** is defined as those who, during the before period, are paid between the current NMW (in effect during the 'before' period) and the forthcoming up-rated NMW (in effect during the 'after' period). The **control group** is defined as those who, at time t , are already paid at least the forthcoming up-rated NMW, but not paid more than the forthcoming minimum wage plus an increment, $NMW_{t+1} + c$. c is a constant which determines the highest wage included in

⁹ An individual is trackable over time via the personal identifier variable (piden) – a random identifier created to identify multiple occurrences of the same person within the dataset (ONS *Annual Survey of Hours and Earnings (ASHE) Dataset Notes* (2013)).

the control group. To ensure comparability with previous studies, for the main part of the analysis the increment has been selected as 10%¹⁰ above the forthcoming NMW of each respective year. An individual is therefore assigned into a group based on their earnings in the ‘before’ period, however individuals can move between groups in *different* ‘before’ periods.

Earlier studies (Bryan, Salvatori and Taylor (2013); Dickens, Riley and Wilkinson (2009)) have included the *remaining groups* of the earnings distribution that are neither part of the treatment and control groups, namely the group of workers earning below the NMW in period t , and the group of workers with earnings above the maximum within the control group. This approach results in a sample size boost without adding additional information on the groups of interest (i.e. the treatment and control groups).

However, this boost in sample size, without adding additional information on the group of interest, would be expected to generate smaller standard errors. This makes the standard errors overly precise, and might also result in the perception of a statistically significant impact (where there may be none). Moreover, one of the key assumptions for a difference-in-differences analysis – that of common characteristics between the groups of comparison – would not be valid when comparing the control group to the upper end of the earnings distribution. Therefore, imposing a restriction of a common coefficient on control variables for all groups would potentially distort the difference-in-difference estimators. To avoid these issues, the estimations presented above have been run on a sample that only includes records of individuals in the treatment or control groups, in the *before* and *after* periods in which they are observed.

‘Before’ and ‘after’ periods

The ASHE is performed around March/April each year. Therefore, each edition of the ASHE dataset represents a snapshot of the earnings distribution from about six months after the previous calendar year’s NMW up-rating (which takes effect in October each year), and six months before the forthcoming NMW up-rating of the same calendar year as the survey. Therefore, the NMW up-ratings of October each year can be seen as policy interventions that take place between two consecutive outcome snapshots – those of March/April earnings in the same calendar year (*before* the up-rating), and those of March/April earnings in the calendar year *after* the up-rating.

Outcome variables

The basic variable modelled in this section of the study is **hourly earnings**. It has been derived in accordance with the measure used by the Low Pay Commission as:

$$\text{Hourly earnings} = \frac{\text{Gross pay excluding overtime}^{11} - \text{Shift and premium payments}^{12}}{\text{Basic paid hours}^{13}}$$

Three dependent variables w_{it} have been constructed based on hourly earnings:

¹⁰ Control groups with earnings within varying increments have been used in estimations for robustness checks, as discussed later on.

¹¹ Average gross weekly earnings excluding overtime for the reference period (ONS (2013). ‘Annual Survey of Hours and Earnings (ASHE) Dataset Notes’)

¹² Additional premium payments during the pay period for shift work and night or weekend work not treated as overtime (ONS (2013). ‘Annual Survey of Hours and Earnings (ASHE) Dataset Notes’)

¹³ Basic weekly paid hours worked. Missing values of are imputed (when pay is unaffected by absence) (ONS (2013). ‘Annual Survey of Hours and Earnings (ASHE) Dataset Notes’)

- (1) levels of real hourly wages, derived as hourly earnings deflated by the Retail Price Index¹⁴
- (2) log transformation of real wages, to obtain % changes in real wages between the before and after periods
- (3) the percentage year-on-year change of real wages

Data cleaning

In addition to the data cleaning performed for phase 1 of the study, observations have been dropped from the dataset if the individual in each observation is below the eligibility age for the adult rate of the NMW in the given year. In other words, the estimation has been performed only for 'adult' workers, to avoid additional influences such as:

- the different minimum wage up-rating schedules across the three rates;
- age transitions between the before and after periods which place individuals in a different rate eligibility group; and
- smaller sample sizes of individuals eligible for the 16-17 Year Old Rate or the Youth Development Rate.

Control variables

The workforce characteristics used as control variables in all estimations performed mimic those used by Dickens, Riley and Wilkinson (2012):

- Gender
- Employment mode: full-time/part-time employment marker
- Age: Quadratic of age
- Same job: marker for workers who are in the same job as observed in the previous year of ASHE
- Cubic of real wages, deflated using the Retail Price Index
- Year dummies are also included in the estimation.

Assumptions

This DID approach relies on two **key assumptions**: firstly, that the control group are unaffected by the up-rating of the NMW; and secondly, that in the absence of the NMW, wages for the lowest earners would grow at the same rate as for those paid just above the minimum wage. The first assumption, for example, would be false if there are spillover effects of the NMW on wages for individuals whose wage at time t is already above the forthcoming NMW.

Robustness checks

Whilst neither assumption is directly testable, the robustness of the results has been ensured through a number of sensitivity analyses. Firstly, the estimation has been performed using different values for c to verify that the results are not dependent on the **choice of control group**. Secondly, **vertical DID** and **triple DID** methods have been employed as in Bryan et al. (2013) and Dickens et al. (2009, 2012). Vertical DID methods employ two additional control groups, which are

¹⁴ Annual percentage change over 12 months, All items (CZBH series) (ONS (2015). 'Consumer Price Inflation', table 37 – 'RPI: All items: 12 months % change 1948-2015').

positioned marginally higher in the wage distribution, and hence compares the difference in outcomes between the original treatment and control groups with the difference in outcomes between the new control groups (both not directly affected by the NMW up-rating). Therefore, if there is a general change in earnings at the lower end of the distribution, then vertical DID methods ensure that they will not bias the results. Triple DID methods combine the standard and vertical DID methods.

Vertical and triple difference-in-differences

Following Dickens, Riley and Wilkinson (2012), a **vertical difference-in-differences model** has been estimated, comparing the average difference in outcomes between the treatment and control groups, and between two other groups from further up the wage distribution – named the 'benchmark' treatment and 'benchmark' control groups.

The benchmark treatment group is comprised of workers earning between 10% above and 20% above the future up-rating of the adult rate of the NMW in each year, and the benchmark control group of workers earning between 20% above and 30% above the future up-rating.

The model is estimated on a pooled sample including all time periods, using the following specification:

$$(5) w_{it} = \beta_0 + \beta_1 D_{T/C=1} + \beta_2 D_{T=1} + \beta_3 D_{T/C=1} D_{T=1} + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon, \text{ where:}$$

- $D_{T/C=1}$ is a dummy variable taking value 1 if the observation is from the original treatment or control group, and 0 if it is from the benchmarking treatment or control group;
- $D_{T=1}$ is an indicator variable which takes value 1 for individuals assigned to the treatment group, either original or benchmark, and 0 for individuals from one of the control groups.

In equation (5), β_1 captures common (to the treatment and control group) differences between the groups closer to the NMW and those further up the wage distribution, β_2 measures the average difference between the treatment and control groups (regardless of where in the wage distribution), and β_3 is interpreted as the NMW up-rating treatment effect.

The **triple difference-in-differences** approach combines the classic and the vertical DID, comparing the outcomes of the two sets of treatment and control groups before and after NMW up-ratings. This approach is designed to account for spillover effects further up the earnings distribution or distributional shifts. In this study, we implement the idea of a triple DID by estimating the model in the basic specification (1) - once on the original treatment and control groups - and once on the benchmark groups. The difference in the β_3 coefficients is effectively the triple difference-in-difference estimator.

The impact of NMW up-ratings on specific segments of workers

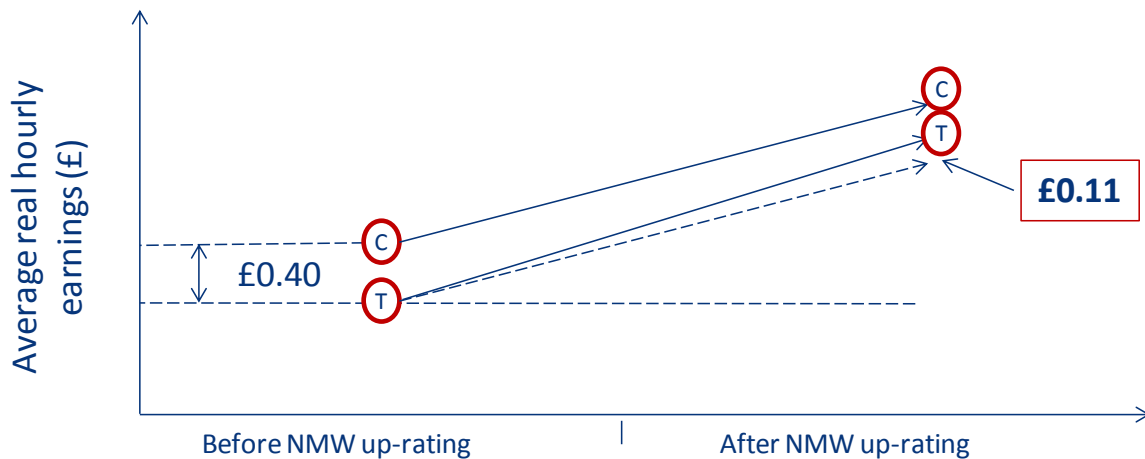
Lastly (presented in the Annex), to address Research Objective 2, we perform the estimation for specific segments of the labour market to identify the extent to which the effects of the NMW on the earnings distribution differ by the following:

- Industry and occupation – low-paying versus non-low-paying¹⁵;
- geographical location;
- size of firm;
- sector (private and public); and
- age

2.5 Main results - Pooled estimation analysis

The difference-in-differences results from the pooled sample (presented in Table 2 and in Figure 12) show that on average, in the 'before' period, the treatment group's real hourly earnings are approximately **£0.40** lower than those of the control group. Across the 'before' and 'after' period, on average, the treatment group's hourly earnings increase by **£0.11** more than the control group's hourly earnings, resulting in a partial closing of the gap in real hourly earnings between the Treatment and Control from **£0.40** down to **£0.29**.

Figure 12 Illustration of the pooled difference-in-differences estimation results



Note: Based on the results presented in Table 2 and Table 24 in A1.1.

Source: London Economics' analysis of ASHE data

In addition, the results show that the treatment group benefit from **wage growth** that is **2 percentage points** higher on average compared to that of the control group. The results from the year-on-year percentage change of real wage demonstrate that the real wage *acceleration* (i.e. the rate of change of wage growth) of the treatment group has also increased to a greater extent across the two periods compared to than that of the control group.

¹⁵ Low-paying industries and occupations are defined as by the Low Pay Commission in their annual National Minimum Wage publications, and the definition slightly varies over time. Detailed definitions can be found in the LPC reports of 2007 (A5.1), 2010 (A4.1) and 2013 (Table A6.1), when new definitions were adopted. Industries which are considered low-paying currently include (based on SIC codes) the retail, hospitality, social care, employment agencies, food processing, leisure, travel and sport, cleaning, agriculture, childcare, textiles and clothing, and hairdressing industries. Low-paying occupations include certain occupational classifications (based on SOC codes) representing office work, non-food processing, storage and transport.

Table 2 Results - Full sample – Pooled difference-in-difference estimation

Coefficient	Real wages (£)	Log real wages = ln(real wage)	Y-o-y % Δ of real wages = ln[wage(t)/wage(t-1)]
	(absolute real wage growth)	(% real wage growth)	(real wage acceleration)
After period coefficient	0.54*** (0.01)	0.07*** (0.001)	0.10*** (0.001)
Treatment group coefficient	-0.40*** (0.01)	-0.07*** (0.001)	-0.01*** (0.002)
Impact of NMW up-rating on Treatment group	0.11*** (0.02)	0.02*** (0.001)	0.03*** (0.002)
Observations	191,978	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in Table 24 in A1.1.

Source: London Economics' analysis of ASHE data

Overall, the pooled estimation results provide evidence that the hourly wage gap between the treatment and the control groups has narrowed following the up-ratings of the NMW between 2004 and 2014.

Yearly estimations of the impact on real wage growth and real wage acceleration of each NMW up-rating between 2004 and 2013 have also been conducted, and are presented in Table 25, Table 26 and Table 27 in A1.1. Yearly estimations capture the variation in the impact of NMW up-ratings over time, alongside the variation in the absolute and relative NMW up-ratings. The results demonstrate that lower percentage up-ratings of the NMW between periods tend to coincide with a lower additional boost to the treatment group's earnings compared to the control group, and vice versa. There are two yearly estimations where the estimated additional real wage boost for the treatment group is not statistically significant – the change between 2006 and 2007, and 2007 and 2008; however, in general, the analysis suggests that in the earlier part of the period, the (relatively large) NMW up-ratings narrowed the earnings gap between the treatment and counterfactual groups by between **£0.10** and **£0.15**, while in the later part of the period, the (relatively smaller) up-ratings of the NMW was associated with a narrowing of the gap between the treatment and counterfactual of between **£0.07** and **£0.10** per hour in real terms.

Further analysis – assessing the impact of the distance from the forthcoming NMW

It would be expected that a NMW up-rating will impact workers differently depending on their distance from the forthcoming NMW up-rating. Specifically, individuals who earn the previous NMW would be expected to experience a greater wage boost from the up-rating of the NMW compared to workers who currently earn a (higher) wage closer to the forthcoming rate.

To begin examining the heterogeneity of the impact from NMW changes on workers directly affected by the changes, the treatment group was first split into two discrete groups:

- **T1:** workers with wages *closer* to the *current* NMW, i.e. workers with nominal earnings w_{it} , such that:

$$NMW_t \leq w_{it} < NMW_t + \frac{NMW_t^* - NMW_t}{2} ; \text{ and}$$

- **T2:** workers with wages closer to the forthcoming up-rated NMW, i.e. workers with nominal earnings w_{it} , such that:

$$NMW_t + \frac{NMW_t^* - NMW_t}{2} \leq w_{it} < NMW_t^*$$

The estimation results (presented in Table 3) demonstrated that workers in T1, as one might expect, experienced a higher additional real wage boost (£0.12 compared to £0.10); higher wage growth (by 2.3 percentage points compared to 1.7 percentage points), and higher wage acceleration compared to the control group in the after period, than workers in T2.

Table 3 Results - Full sample – Pooled difference-in-difference estimation with two treatment groups

Coefficient	Real wages (£)	Log real wages = ln(real wage)	Y-o-y % Δ of real wages = ln[wage(t)/wage(t-1)]
T1 coefficient	-0.44*** (0.01)	0.08*** (0.001)	-0.01*** (0.002)
Impact of NMW up-rating on T1	0.12*** (0.02)	0.023*** (0.002)	0.03*** (0.003)
T2 coefficient	-0.323*** (0.0160)	-0.0582*** (0.00138)	-0.00768*** (0.00248)
Impact of NMW up-rating on T2	0.10*** (0.02)	0.017*** (0.002)	0.0230*** (0.003)
Observations	191,978	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Treatment group with wages closer to the adult NMW includes workers whose earnings in the ‘before’ period fall in the first half of the gap between the adult rate of the NMW and its future up-rating. Treatment group with wages closer to the forthcoming adult NMW includes workers whose earnings in the ‘before’ period fall in the second half of the gap between the adult rate of the NMW and its future up-rating. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in Table 28 in A1.1.

Source: London Economics’ analysis of ASHE data

Incorporating the wage gap into the estimation

Incorporating the wage gap (i.e. the distance between the earnings of each individual in the treatment group and the forthcoming NMW), allows for the impact of the up-rating to have an effect which varies with the distance of wages from the forthcoming NMW. Following Dickens, Riley and Wilkinson (2012), we estimated two versions of the wage gap interaction model:

$$(1) y_{it} = \beta_0 + \beta_1 \text{after} + \beta_2 T + \beta_3 \text{after} \times T \times \text{wgap}$$

$$(2) y_{it} = \beta_0 + \beta_1 \text{after} + \beta_2 T \times \text{wgap} + \beta_3 \text{after} \times T \times \text{wgap} ,$$

where the wage gap $G_{it} = \ln\left(\frac{NMW_t^*}{w_{it}}\right)$, i.e. G_{it} represents the percentage distance from the forthcoming NMW rate, relative to individual i ’s wage in period t . The results from both models are presented in Table 4 below.

Table 4 Results - Full sample – Pooled wage gap difference-in-difference estimation

Coefficient	Wage gap equation (1)		Wage gap equation (2)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
After period coefficient	0.07***(0.001)	0.10*** (0.001)	0.07*** (0.0007)	0.10***(0.001)
Treatment group coefficient	-0.06*** (0.001)	-0.001 (0.001)	-	-
Treatment group x wage gap interaction	-	-	-2.20*** (0.03)	-0.27*** (0.07)
Impact of NMW up-rating and wage gap on Treatment group	0.03 (0.04)	0.78*** (0.07)	0.78*** (0.05)	1.03*** (0.09)
Observations	191,978	126,855	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01; The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in Table 29 in A1.1.

Source: London Economics’ analysis of ASHE data2004-2014

The positive effect of the NMW up-rating on earnings of the Treatment group compared to the control group is confirmed. Additionally, the greater the wage gap, the greater the wage increase that the workers in the Treatment group experience.

Pre-recession, recession and recovery period analysis

The main analysis has been replicated to assess whether there has been any differential impact of the NMW up-rating depending on whether the up-rating took place pre-recession (2004-2008), during the recession (2008-2009) or during the recovery period (2009-2014). The findings presented in Table 5 suggest during the pre-recession period, the growth in average real hourly earnings of the treatment group increased by approximately **3 percentage points more** than for the control group; however, during the recession and subsequent recovery, real wage growth for the treatment group was dampened to some extent relative to the control group (although the coefficient referring to the recessionary period is statistically insignificant). Specifically, although wage growth amongst the treatment group remained greater than for the control group, the impact of the NMW up-ratings during the recovery period reduced the difference in real earnings growth between the treatment and control groups by approximately **1 percentage point**.

Table 5 Results - Full sample – Recession and recovery pooled difference-in-difference estimations

Coefficient	Standard specification (1)		Wage gap equation (2)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.03*** (0.002)	0.03*** (0.004)	0.77*** (0.05)	1.00*** (0.11)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.01 (0.003)	-0.01 (0.01)	0.47*** (0.18)	0.44 (0.30)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.01*** (0.003)	-0.01* (0.004)	-0.15 (0.12)	0.13 (0.21)
Observations	191,978	126,855	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. ^ Treatment group coefficients represent the coefficients of the Treatment group indicator in equation (1), and the coefficients of the interaction between the Treatment group indicator and the wage gap in equation (2). The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in Table 30 in A1.1.

Source: London Economics' analysis of ASHE data

Low-paying industries and occupations analysis

The analysis also considers the impact of up-ratings of the adult rate of the NMW on workers in low-paying industries and occupations. Adopting the same model specification as previously, and adopting the Low Pay Commission's standard classification of industries and occupations identified as low paid, the analysis indicates that during the pre-recession period, the NMW up-rating resulted in workers in low-paying industries in the treatment group achieving a **1.5 percentage point** boost to real earnings growth compared to the control group. Furthermore, during the recession and recovery period, despite the increases in the adult rate of the NMW declining in absolute terms relative to pre-recession levels, the rate of real earnings growth for the treatment group was not dampened relative to the control group (i.e. remaining at approximately **1.5 percentage points**).

However, the results are marginally different when considering low-paying occupations rather than low-paying industries. In the pre-recession period, the analysis again indicates that the NMW up-rating resulted in low-paid workers in the treatment group achieving a **1.4 percentage point** boost to real earnings growth compared to low-paid workers in the control group. Interestingly, during the recession (2008-2009), real earnings growth increased even more for these workers in relative terms (by an additional **1 percentage point**), whilst in the recovery period, relative real wage growth has been dampened (by approximately **0.7 percentage points** compared to the pre-recession period).

Table 6 Results - Low-paying industries and occupations

Coefficient	Low-paying industries		Low-paying occupations	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.015*** (0.003)	0.024*** (-0.013)	0.014*** (0.002)	0.021*** (0.004)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	0.004 (0.005)	-0.013 (0.010)	0.010** (0.005)	0.001 (0.008)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	0.003 (0.004)	0.003 (0.008)	-0.007** (0.003)	-0.005 (0.005)
Observations	46,045	26,019	81,368	55,871

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in 0 in A1.1.

Source: London Economics' analysis of ASHE data

Firm size analysis

Building on the analysis presented in section 2.3.3, in Table 7, we present the same analysis broken down by firm size (in terms of number of employees). The analysis indicates that during the pre-recession period the impact of the NMW up-rating had a positive effect on the real earnings growth of the treatment group relative to the counterfactual, but interestingly, the impact increased as firm size increased. Compared to a **1.8 percentage point** boost achieved by treatment group workers in small firms, the comparable earnings boost associated with the up-rating stood at **3.3 percentage points** in large firms. However, the impact of the NMW up-ratings had a differential effect during the recessionary period (as well as the recovery period). Specifically, the analysis suggests that for treatment workers employed in large firms, the impact of the NMW up-rating narrowed the wage growth gap between the two groups (by **0.9 percentage points**). Furthermore, during the recovery period between 2009 and 2014, the analysis suggests that the up-ratings of the NMW again narrowed the gap in the wage growth achieved by workers in the treatment group relative to the counterfactual, with the effect being greater for those employed in small firms compared to large firms (**1.7 percentage points** compared to **1.2 percentage points**).

Table 7 Results – Firm size

Coefficient	Small firms (1-49 employees)		Medium firms (50-249 employees)		Large firms (250+ employees)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0182*** (0.004)	0.026*** (0.007)	0.019*** (0.005)	0.030*** (0.010)	0.033*** (0.002)	0.034*** (0.004)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	0.005 (0.007)	0.018 (0.013)	-0.007 (0.009)	-0.024 (0.017)	-0.009** (0.004)	-0.017** (0.007)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.0176*** (0.005)	-0.020** (0.009)	-0.002 (0.006)	-0.004 (0.012)	-0.012*** (0.003)	-0.003 (0.006)
Observations	42,892	27,839	22,288	14,461	126,690	84,494

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in O in A1.1.

Source: London Economics' analysis of ASHE data

Job switchers

Finally in this section, in Table 8, we consider the impact of NMW up-ratings on workers depending on whether they remained in the same job or switched jobs over the period before and after the increase in the NMW. Unsurprisingly, the analysis indicates that for those individuals who switched jobs during the period, the up-rating of the NMW had a statistically significant larger impact on wage growth compared to the counterfactual group. Specifically, the analysis indicates that compared to a wage growth differential between workers remaining in the same position and the control group standing at **2.0 percentage points** during the pre-recession period, the comparable estimate amongst job-switchers was **5.0 percentage points**. Although there was no

statistically significant change in the impact of the NMW up-rating for either group during the recessionary period, during the recovery period, the analysis indicates that the relative rate of wage growth amongst job-switchers was *narrowed* at twice the rate of workers remaining in the same jobs (**2.4 percentage points** compared to **1.2 percentage points**), though the NMW treatment effect still remained considerably larger amongst job-switchers.

Table 8 Results – Job switchers versus employees on the same job

Coefficient	Same job as previous year	Switched job from previous year
	Log real wages	Log real wages
After period coefficient	0.051*** (0.001)	0.155*** (0.00335)
Treatment group coefficient	-0.0808*** (0.001)	-0.078*** (0.006)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.020*** (0.002)	0.050*** (0.008)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.004 (0.003)	-0.022 (0.014)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.012*** (0.002)	-0.024** (0.010)
Observations	171,470	20,508

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in O in A1.1.

Source: London Economics' analysis of ASHE data

2.5.1 Further segmentation analysis

In Table 9, we present information on the impact of the up-rating in the adult rate of the NMW depending on whether the worker is employed in the public or private sector, as well as by Home Nation of workplace location (Table 10) and age-band of employee (Table 11). In particular, in relation to age-band of employee, we have disaggregated the analysis to consider workers aged between 21 and 24, 25 and 29, and 30 or above, to reflect the changes being introduced in 2016 in relation to the Living Wage policy.

Analysis by sector (public versus private)

The analysis of the impact of the NMW up-rating on relative wage growth between the treatment and control groups of workers employed in the public versus private sectors suggests that there were very different effects across the sectors. Specifically, the impact of NMW upratings in the pre-recession period resulted in a **9 percentage point** relative increase in wage growth in the public sector compared to a **2 percentage point** increase in the private sector. However, in the recession, the estimates indicate that the NMW up-rating had less of an effect in the public sector, with relative wage growth between the treatment and control groups **3.2 percentage points** lower than in the pre-recession period (though still positive and greater than for employees in the private sector). In contrast, in the recovery period, the analysis indicates that the impact of the NMW up-rating on differential wage growth between the treatment and control groups was reduced amongst workers in the private sector only (by **1 percentage point**).

Table 9 Results - public versus private sectors

Coefficient	Public sector		Private sector	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0898*** (0.0077)	0.127*** (0.0142)	0.0210*** (0.00191)	0.0252*** (0.00364)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.0322** (0.0147)	-0.0501** (0.0233)	-0.00330 (0.00338)	-0.00477 (0.00606)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	0.00141 (0.0116)	-0.0225 (0.0187)	-0.0102*** (0.00248)	-0.00359 (0.00445)
Observations	23,228	15,824	158,122	103,894

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in O in A1.1.

Source: London Economics’ analysis of ASHE data

Regional analysis

In the analysis by Home Nation, the findings suggest that in the pre-recession period, the wage growth boost associated with the up-rating of the NMW achieved by workers in the treatment group in England stood at **2.7 percentage points** compared to **2.6 percentage points** in Wales and **1.5 percentage points** in Scotland.

Table 10 Results – Impact of NMW uprating by Home Nation

Coefficient	England		Wales		Scotland	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0278*** (0.00210)	0.0339*** (0.00394)	0.0259*** (0.00681)	0.0165 (0.0121)	0.0175*** (0.00575)	0.0148 (0.0105)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.00625* (0.00374)	-0.00923 (0.00654)	-0.0260** (0.0119)	-0.0162 (0.0196)	0.0167 (0.0107)	0.0159 (0.0184)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.0143*** (0.00275)	-0.0107** (0.00483)	-0.0140 (0.00895)	0.00221 (0.0148)	-0.00694 (0.00784)	0.00305 (0.0134)
Observations	161,274	106,419	11,789	7,984	18,915	12,452

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in O in A1.1.

Source: London Economics’ analysis of ASHE data

During the recessionary period, the analysis further demonstrates that the impact of the up-rating has a relatively limited effect on wage growth differentials between the treatment and counterfactual groups in England; however, in Wales, the total effect of the NMW up-rating on wage growth between the treatment and control groups was effectively **zero**. Although statistically insignificantly different from zero, the impact of the NMW up-rating on workers in Scotland in the treatment group, if anything, was to increase the gap in relative wage growth between the two groups. In the 'recovery' period, the analysis indicates that the impact of the NMW up-rating in England on relative wage growth between the treatment and counterfactual groups was approximately halved.

Analysis by age groups

When assessing the impact of up-ratings of the adult rate of the NMW on workers of different age, the sample was split into those employees aged between 21 and 24, 25 and 29 and 30 and above. The analysis demonstrates that the up-rating of the NMW had a positive effect on real wage growth amongst all workers in the treatment groups relative to their counterfactual irrespective of age. However, the impact did vary by age, with workers aged between 21 and 24 achieving a **4.8 percentage points** relative wage boost relative to their control group, compared to **2.4 percentage points** for those aged 25-29 and **5.2 percentage points** amongst those aged 30 or above.

However, amongst 21-24 year olds, the analysis also demonstrated that during the recession period (and in the recovery period), the impact of the NMW up-rating on the real wage growth gap between the treatment and control groups was effectively zero. This is in comparison with workers aged between 25 and 29, where although there was a statistically insignificant change in the impact of the NMW up-rating between the treatment and control groups in the recessionary period compared to the pre-recession period, during the recovery period the impact of the NMW up-rating on relative wage growth was reduced by **1.2 percentage points**. Amongst workers aged 30 or above, there was no statistically significant change in the impact of the NMW up-rating during either the recession or recovery periods compared to the pre-recession period.

Table 11 Results – Impact of NMW uprating by worker age banding

Coefficient	21-24 year olds		25-29 year olds		30+ year olds	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0480*** (0.0065)	0.0331*** (0.00631)	0.0243*** (0.00207)	0.0650*** (0.0161)	0.0522*** (0.0116)	0.0270*** (0.00379)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.0363*** (0.0111)	-0.0245** (0.0109)	-0.00297 (0.00373)	-0.0357 (0.0261)	-0.0248 (0.0190)	-0.00571 (0.00633)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.0420*** (0.0076)	-0.0271*** (0.0079)	-0.0117*** (0.00279)	-0.0568*** (0.0178)	-0.0211 (0.0136)	-0.00422 (0.00474)
Observations	19,632	22,279	150,067	8,249	13,689	104,917

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in O in A1.1.

Source: London Economics' analysis of ASHE data

2.6 Robustness checks

Using alternative control groups

As part of the analysis, we also considered whether the up-rating in the NMW had any consequential impact on workers with earnings higher up the earnings distribution compared to the original control group (who were comprised of workers with earnings between the forthcoming up-rating of the NMW and 10% above the up-rating).

Specifically, although we generate a number of alternative control groups, taking an example (3rd column), the alternative control group consists of workers that are between 10% and 20% above the forthcoming up-rating of the NMW. Technically, this group should be entirely unaffected by the up-rating of the NMW (as with the original control group). The analysis demonstrates that during the pre-recession period, the treatment group posted a **2.7 percentage point** relative increase in real wage growth compared to the original counterfactual, whilst also posting a **4.0 percentage point** relative increase in real wage growth compared to the alternative control group.

Table 12 Results – Alternative control groups

Coefficient	Original Control: £/hr between up-rated NMW - 10% above	£/hr between 10% - 15% above up-rated NMW	£/hr between 10% -20% above up-rated NMW	£/hr between up-rated NMW – earnings at 5 th percentile~	£/hr between up-rated NMW – earnings at 10 th percentile~
	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages
After period coefficient	0.065*** (0.000744)	0.056*** (0.00110)	0.052*** (0.000761)	0.069*** (0.000855)	0.064*** (0.000613)
Treatment group coefficient	-0.082*** (0.00142)	-0.148*** (0.00163)	-0.170*** (0.00142)	-0.076*** (0.00147)	-0.114*** (0.00136)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.027*** (0.00190)	0.035*** (0.00211)	0.040*** (0.00190)	0.024*** (0.00196)	0.031*** (0.00186)
<i>Change</i> in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.005 (0.00339)	-0.004 (0.00357)	-0.006* (0.00338)	-0.004 (0.00346)	-0.007** (0.00340)
<i>Change</i> in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.013*** (0.00249)	-0.011*** (0.00262)	-0.013*** (0.00248)	-0.014*** (0.00255)	-0.014*** (0.00250)
Observations	191,978	120,282	184,254	160,678	263,840

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 * of the distribution above the up-rated NMW. The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are available in 0 in A1.1.

Source: London Economics' analysis of ASHE data 2004-2014

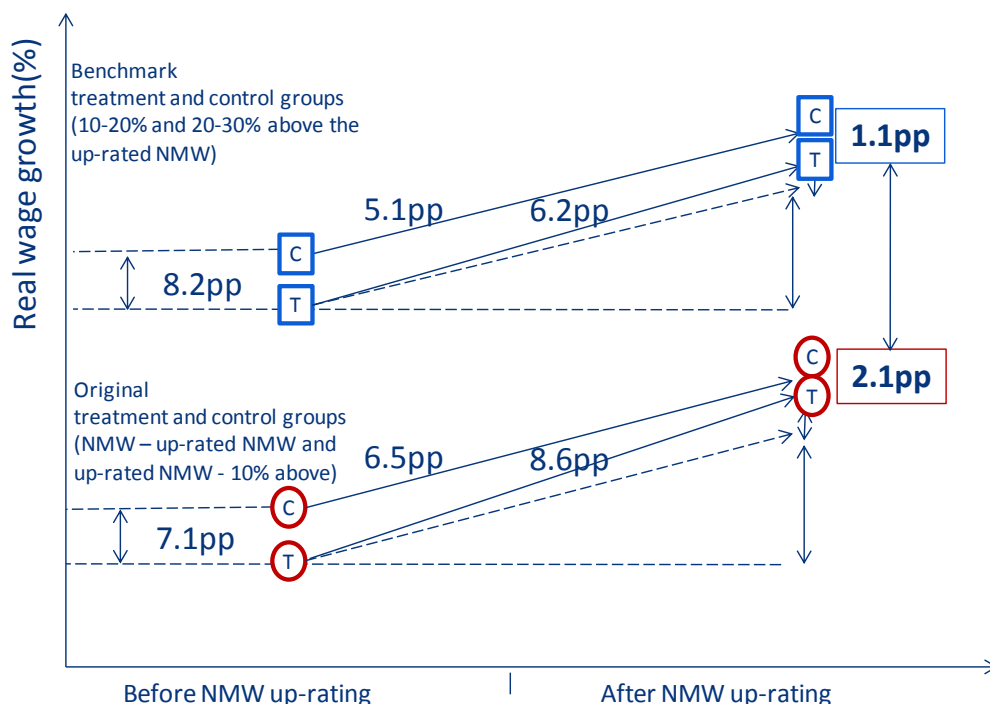
Combining these pieces of information, this suggests that the real wage growth amongst the original control group (between the up-rated of the NMW and 10% above) was greater than amongst workers contained within the alternative control group (between 10% and 20% above the up-rated NMW). This suggests that although not directly affected by the up-rating of the NMW, those workers in the original control group did experience some wage growth spillovers as a result of the up-rating of the NMW.

Although there was a limited change in the impact of the NMW uprating on relative wage growth during the recession, the analysis suggests that the impact of the up-rating on the relative levels of wage growth during the recovery was depressed; however, of note is the fact that the effects appear to be relatively uniform. In other words, although the relative rate of wage growth between the treatment group and the original control group was estimated to be approximately **1.4 percentage points** (as opposed to **2.7 percentage points** during the pre-recession period), the relative rate of wage growth between the treatment group and the alternative control group was estimated to be approximately **2.7 percentage points** (as opposed to **4.0 percentage points** during the pre-recession period). This suggests that the spillover effects associated with the up-rating of the NMW appeared to persist over the entire period.

Vertical and triple difference-in-difference analysis

In addition to the robustness specifications using alternative control groups, vertical and triple difference-in-differences models have also been estimated. The vertical difference-in-difference specification tests the changes in the wage distribution at its lower end. Essentially, it estimates how the difference in wage-related outcomes of the **original** treatment versus those of the original control group compare to the difference in outcomes between a **benchmark** treatment and control, slightly higher up the wage distribution. The results (summarised in Table 13) indicate that the relative earnings growth between the **original** treatment and control groups stood at **2.1 percentage points**, while the relative earnings growth between the **benchmark** treatment and control groups stood at **1.1 percentage points**. Differencing the benchmark difference-in-differences estimate from the original difference-in-differences estimate results in a net positive result. This suggests that despite neither the benchmark treatment nor control groups being directly affected by the NMW up-rating, the wage growth of workers further down the earnings distribution increased at a faster rate than individuals marginally further up the earnings distribution following the up-rating of the NMW.

Figure 13 Illustration of the triple difference-in-differences estimation results



Note: Based on the results presented in Table 13 and Table 35 in A1.1.

Source: London Economics' analysis of ASHE data

Table 13 Results - Full sample – Vertical and triple difference-in-difference estimations

Vertical DID			Triple DID		
Coefficient	Original and benchmark treatment and control		Coefficient	Original treatment and control	Benchmark treatment and control
	(% real wage growth)			(% real wage growth)	(% real wage growth)
Original treatment/control groups coefficient	-0.160*** (0.0005)		After period coefficient	0.065*** (0.0007)	0.051*** (0.0007)
Treatment groups coefficient	-0.076*** (0.0005)		Treatment group coefficient	-0.071*** (0.0009)	-0.082*** (0.0007)
Impact of NMW up-rating on original treatment group	0.017*** (0.0008)		Impact of NMW up-rating on Treatment group	0.021*** (0.0013)	0.011*** (0.001)
Observations	439,278		Observations	191,978	247,300

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage. Full results are presented in Table 35 in A1.1

Source: London Economics' analysis of ASHE data

3 Impact of the NMW on wage and productivity differentials (RO4)

3.1 Background and context

Since the onset of the recent recession, the recoveries in output and employment in the United Kingdom have been markedly different. In contrast to previous recessions, the reduction in employment has been smaller than the fall in output. Moreover, employment recovered more strongly than output. Therefore, labour productivity (measured by output per worker) has been sluggish and remained below pre-crisis levels. This has important implications for real wages, which have been falling since the recession and it is widely agreed that productivity growth is the 'only sustainable source of real income growth in the long term'.¹⁶

Over the same period (i.e. between 2008 and 2014), the National Minimum Wage (NMW) rates have continued to rise, with the adult rate of the NMW increasing by **13.4%**, the Youth Development Rate by **7.5%** and 16-17 Year Old Rate by **7.4%**.¹⁷ Given these developments, a number of studies have investigated the impact of the NMW on age-earnings and age-productivity profiles. For example:

- Dickerson and McIntosh (2011) tested the hypothesis that the introduction of the NMW and subsequent changes over time would affect the productivity-wage gap more for young workers than older workers, since a higher proportion of young workers are affected by the NMW. However, they find no evidence that the NMW increased productivity-wage gaps for younger workers relative to older workers.¹⁸
- Dickerson and McIntosh (2012) examined whether there are gaps between wages and productivity for different age groups at a sector-level and the extent to which these differences changed over the recession period. They find that wage differentials between age groups *narrowed slightly* following the recession but productivity differences between age groups had *widened*. This suggests that younger workers' wages had increased by more than their productivity contribution would warrant. However, productivity coefficients were not statistically significant.
- Lanot and Sousounis (2013) investigate the effect of the NMW on the potential substitution between workers of different ages in the low-paying sectors based on changes to their relative average wages. Their results suggest that wages in low paying sectors have increased more in line with legal obligations than in line with productivity growth.

The approach taken in this chapter builds on the work by Dickerson and McIntosh (2011, 2012), who use a **fixed effects** approach to estimate the effect of changes in the NMW on any existing gap between productivity and wages at a sector level.

¹⁶ Economic and Fiscal Outlook – December 2013, Office for Budget Responsibility, page 67.

¹⁷ The calculations are based on the adult rate of £5.73, the Youth Development Rate of £4.77 and the 16-17 Year Old Rate of £3.53 in 2008 and the rates of £6.50, £5.13 and £3.79 (respectively) in force at the time of reporting. It should also be noted that the entitlement age for the adult rate of the NMW dropped from 22 to 21 in October 2010 and there was also a freeze in the two youth rates in 2011.

¹⁸ If anything, there is evidence that productivity differences narrowed between young and old workers following the introduction of the National Minimum Wage, but there was no significant change in earnings differentials across age groups.

At sector level, this chapter advances our knowledge of the impact of the NMW on earnings and productivity profiles of groups of workers with different characteristics (e.g. age) and firms with different characteristics (e.g. firm size) in two main ways.

- Firstly, the existing evidence has focussed on the introduction of the NMW and the period up to 2008, with the most recent studies only using data for a year or two following the most recent recession. However, the analysis presented here uses data up to 2013 and examines whether there has been a change in the impact of the NMW over the recession the recovery period.
- Secondly, as an extension to the work carried out by Dickerson and McIntosh (2011, 2012), additional variables of interest are included in the estimation and alternative specifications are considered. For example, the proportions of medium and large firms in a given sector are used to examine whether there are productivity and wage differences across firm size.

3.2 Methodology

In order to understand the impact of the NMW correctly, variation in wages and productivity due to changes in the NMW over time need to be identified for a given sector. This is best done using a fixed effects specification, as it controls for unobserved characteristics that may be correlated with the explanatory and dependent variables and are constant across time.

Under this specification, the model can be derived from the Cobb-Douglas specification and represented by the following equation:

$\log y_{it} = \beta_0 + X_{it}'\beta + NMW_t * X_{it}'\gamma + \varepsilon_{it}$, where:

- y_{it} is the dependent variable for sector i in year t ;
- X_{it} is the set of independent variables, which includes workforce characteristics expressed as a proportion of the sector's workforce;
- NMW_t measures the percentage of workers in each sector i paid at or close to (above or below 5%) the NMW in year t .¹⁹ This variable is **interacted** with each independent variable;
- β_0 is the constant, β and γ are vector coefficients of interest; and
- ε_{it} is the error term.

Three outcomes of interest are considered: (i) Productivity, (ii) Wage rate and (iii) the productivity-wage gap, which is defined by the difference between (i) and (ii). For each outcome of interest, the estimating equation is run separately.

Hence, for a given workforce characteristic, the corresponding β coefficient reveals the impact on productivity, wages or their difference, while the γ interaction coefficient captures the impact on these outcomes when more workers are paid the NMW. Taking age groups as an example, γ will show whether productivity and wage differences between age groups narrow or widen as more workers are paid the NMW.

¹⁹ Taking into account the age and hence, the appropriate rate for each worker in a given year.

3.3 Data

Data coverage

For the purposes of this analysis, the following datasets are used:

- Labour Force Survey (2003 to 2014)
- Annual Business Inquiry/Annual Business Survey (2004 to 2013)
- Business Register and Employment Survey (2009 to 2013)
- Annual Survey of Hours and Earnings (2003 to 2014)

Ideally, any analysis would be undertaken at individual level; however, the main data issue with carrying out this analysis is the lack of individual-level data on productivity. Therefore, all data is aggregated to a sector level for which productivity data can be obtained using the Annual Business Survey (ABS) and the Business Register and Employment Survey (BRES).²⁰ In other words, the unit of observation in the analysis is the sector (industry).

Productivity

Productivity is measured by dividing gross value added (GVA) by total employment (i.e. GVA per capita). GVA at market prices is used from the ABS, which measures a firm's sales excluding payments made by the firm for non-labour inputs, while the level of employment for each firm is derived from the BRES. Net capital expenditure for each firm is also used from the ABS to control for its impact on productivity and as a proxy for capital stock, which forms a part of the Cobb-Douglas specification used to derive the estimating equation. Average productivity and net capital expenditure per head are used at the sector level.

Wages

Wage information for an individual is available in the Annual Survey of Hours and Earnings (ASHE)²¹. For all earnings that are not affected by absence, an hourly pay rate is calculated *excluding* overtime, premium and shift payments. An average wage rate is used to aggregate up to sector level. To control for the impact of inflation, GVA at market prices, net capital expenditure and the wage rate are expressed in real terms, using the Retail Price Index (RPI) as the price deflator.²²

Workforce characteristics

Workforce characteristics at a sector level are also constructed using the ASHE, as well as the Labour Force Survey (LFS)²³. ASHE data is used to determine the proportion of workers who fall into defined age categories in a given sector. For consistency and comparability with previous studies, the following age categories are used: 16-20, 21-29²⁴, 30-49 and 50-59 year olds. The proportions of the workforce broken down by gender, working part-time, and in the private sector are also included as additional controls. As an extension to previous studies, the split by employer

²⁰ The ABS and BRES was previously formed by the Annual Business Inquiry (ABI) – (ABI/I) Part 1 was replaced by the BRES and (ABI/II) Part 2 by the ABS in 2009. BRES is the main source for employee statistics and provides employment estimates at different geographical and industrial levels. ABS contains detailed financial information on companies covering two-thirds of the UK economy. It is intended to be a census of larger companies (250 or more employees) and a stratified sample of smaller firms.

²¹ The ASHE is an annual survey carried out in April each year and based on a 1% sample of employee jobs taken from HM Revenue & Customs (HMRC) PAYE records. It provides information on earnings, hours of work as well as other job and personal characteristics, directly obtained from employers.

²² Sector-specific producer prices are also used to test the robustness of the results (See section 3.4.6 for further details).

²³ The LFS is the official survey in the UK recording labour market outcomes in each quarter with around 100,000 respondents per quarter. At most, each respondent in the survey is tracked over five consecutive quarters.

²⁴ In light of the recent introduction of the National Living Wage, we have also split 21-29 year olds into separate groups of 21-24 year olds and 25-29 year olds.

size in a given sector is also used to examine whether there are productivity and wage differences within sectors across firm sizes. The ASHE variable “*idbrnemp*” is used to determine firm size and is split into three bands; namely, small (1 to 49 employees), medium (50 to 249 employees) and large (250+ employees).

The ASHE does not provide information on the highest qualification held by respondents. Therefore, the LFS is used to construct variables to estimate the qualification distribution of workers in a given sector. In particular, individuals falling into the following detailed groupings are considered; (i) Degree or equivalent, (ii) Higher education, (iii) GCE, A-level or equivalent, (iv) GCSE grades A*-C or equivalent, (v) Other qualifications and (vi) No qualification.

National Minimum Wage 'spike'

The incidence of the NMW is measured by the percentage of workers in a given sector earning at most 5% above or below the appropriate NMW rate.²⁵ The resulting variable (referred to as the ‘NMW spike’ hereafter) is interacted with all workforce characteristics in each estimating equation.

Weighting

All explanatory variables are aggregated up to produce population estimates at a sector level using the respective weights provided in the ASHE and LFS. Hence, all proportions estimate population distributions.

Sector-level classification

A consistent identifier is required to construct a sector-level dataset combining all four datasets (ABS, BRES, ASHE and LFS) at sector-level and across time. For the analysis undertaken, the 2007 Standard Industrial Classification of Economic Activities (SIC) is used. There are a number of data issues and limitations with this approach. In particular:

- Prior to 2009, the ABS, BRES, ASHE and LFS datasets utilise the 2003 SIC sector disaggregation. Therefore, weighted tables²⁶ mapping all SIC 2003 codes to SIC 2007 codes are used to produce a consistent sector identifier for all years in the scope of the study.
- **The ABS covers the non-financial business economy only.** Hence, some sectors are not included in the analysis. Namely, sectors in financial intermediation, administration and defence.
- The LFS does not provide a breakdown further than the 2-digit SIC 2003 level (prior to 2009) for sectors in construction, retail and wholesale trade. Hence, the distribution at the 2-digit level is used to represent the distribution of qualifications at the 3 and 4-digit levels.

The sectors included in the analysis are determined by the number of observations reported in the ASHE at the 2, 3, or 4-digit sector level. As a *rule of thumb*, a ‘sector’ has to represent at least 0.1% of aggregate employment in a given year (equivalent to approximately 300 observations per year in the ASHE). If this is achieved at the 4-digit level, the ‘sector’ is included in the analysis. For sectors failing to meet this condition, the 3-digit level is considered and then the 2-digit level. This

²⁵ Taking into consideration the age and hence, the eligible rate for each worker, as well as the change in the entitlement age from 22 to 21 year olds for the adult rate of the National Minimum Wage in October 2010.

²⁶ This data is available from the Office of National Statistics (ONS). For the analysis in this section, the employment weights are used to convert SIC 2003 to SIC 2007.

process provides an unbalanced panel dataset covering **120 sectors** over the period from 2004 to 2013.

3.4 Main results

This section presents the main results of the fixed effects estimations investigating the effects of the NMW on productivity, wages, and the productivity-wage gap within sectors for different age groups. The results for other workforce characteristics are discussed briefly, but these analyses and associated results are presented in full in Annex 3.

The main analysis is repeated by considering:

- Low-paying sectors only²⁷; and
- Pre-recession, recession and recovery periods separately;

Moreover, a number of robustness checks are performed on the full sample to test the stability and sensitivity of estimated coefficients. Additional estimations are also run using different age groupings corresponding to the qualifying ages for the various minimum wage rates, as well as a split of 21-24 and 25-29 year old workers in light of the upcoming National Living Wage. These results are presented in the Annex.

3.4.1 Descriptive statistics

Before proceeding to the empirical results, Table 14 below provides mean values for all variables used in the analysis for all sectors, with a further breakdown for low-paying industries only, as well as a breakdown for all sectors during the pre-recession, recession and recovery periods.

Comparing the sample of *low-paying* sectors with *all* sectors reveals expected differences in productivity, wages and workforce characteristics. In particular, low-paying sectors are associated with lower productivity and wages when compared to all sectors. Moreover, they are associated with a higher proportion of younger workers, less qualified workers, more female and part-time workers. The percentage of workers earning within 5% of the NMW rates is also expectedly higher for low-paying sectors at **14.1%** compared to **6.1%** for all sectors.

Since the recession in 2008, average real productivity and wage levels have remained largely unchanged. However, the percentage of workers around the NMW 'spike' has increased from **4.6%** to **7.6%** over the period of interest. Most of the workforce characteristics remain stable over time with a noticeable shift in the proportion of other individuals in possession of formally recognised qualifications to degree-level or equivalent.

²⁷ As identified by the Low Pay Commission in 2014.

Table 14 Descriptive statistics

Variable	All sectors	Low-paying sectors	Pre-recession (2004-2007)	Recession (2008-2009)	Recovery (2010-2013)
Productivity (Log real GVA per capita)	3.67	3.19	3.53	3.76	3.76
Wages (Log real wages)	2.46	2.17	2.38	2.50	2.51
Real net capital expenditure	1.02	0.53	0.97	1.03	1.07
NMW 'spike' (%)	6.08	14.10	4.57	6.03	7.57
<i>Proportion of:</i>					
16-20 year olds	0.07	0.14	0.07	0.07	0.06
21-29 year olds	0.20	0.24	0.20	0.20	0.20
30-49 year olds	0.53	0.45	0.53	0.53	0.53
50-59 year olds	0.20	0.17	0.20	0.19	0.20
Small firms	0.26	0.25	0.26	0.26	0.26
Medium firms	0.17	0.13	0.16	0.16	0.17
Large firms	0.57	0.61	0.58	0.58	0.57
Degree or equivalent	0.22	0.12	0.19	0.21	0.24
Higher education	0.09	0.07	0.09	0.09	0.09
GCE, A-level or equivalent	0.25	0.26	0.25	0.25	0.26
GCSE grades A*-C or equivalent	0.23	0.28	0.23	0.23	0.23
Other qualification	0.12	0.15	0.14	0.13	0.11
No qualification	0.08	0.11	0.10	0.09	0.07
Female	0.40	0.55	0.41	0.40	0.39
Part-time	0.21	0.38	0.20	0.21	0.21
Private sector	0.87	0.90	0.86	0.87	0.88

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

3.4.2 Full sample

Table 15 reports the results for the age coefficients from the fixed effects specification using the full sample of all sectors and years.²⁸ Assuming the NMW 'spike' is equal to zero, all age-productivity coefficients are positive which suggests that older workers (aged 21 or higher) are associated with higher levels of productivity compared to 16-20 year old workers within the same sector. For example, a one percentage point rise in the proportion of workers aged 30-49 in a sector is associated with an average increase of **0.41%** in productivity, relative to a similar sized change in the proportion of workers aged 16-20.

Looking at the wage equation (middle panel in Table 15), average wages are also estimated to be higher for all age groups relative to the youngest group (16-20 year olds), with statistically significant coefficients for all older age groups. For example, a one percentage point increase in the proportion of workers aged 30-49 in a sector is associated with a **0.89%** increase in real wages, compared to workers aged 16-20 and this impact is statistically significant at the 1% significance level.

In terms of the productivity-wage gap (right panel in Table 15), the direction of the productivity-wage gap coefficient (assuming the interaction terms are zero) reveals the extent to which the

²⁸ To avoid multi-collinearity amongst the age group variables, the proportion of 16-20 year olds is excluded from the estimations; hence, all age coefficients measure the effect relative to 16-20 year olds. Similarly, for firm size, the proportion of small firms and for qualifications, the proportion of workers with a highest qualification of a degree or equivalent are omitted from the estimating equations.

reference group (i.e. 16-20 year olds) are underpaid or overpaid relative to their productivity contribution to a given age group included in the estimation. To interpret the productivity-wage gap coefficients, a **minus** sign implies that 16-20 year olds are **underpaid** given their productivity relative to the particular age group under consideration, while a **plus** sign implies that 16-20 year olds are **overpaid** given their productivity.

Hence, the estimated coefficients suggest that workers aged 16-20 are **overpaid** relative to their productivity contribution when compared to 21-29 and 50-59 year olds, as the gain in real productivity exceeds the increase in real wages (**0.17** and **0.21** respectively). On the other hand, the equivalent coefficient for workers aged 30-49 is negative, suggesting that workers aged 16-20 are **underpaid** relative to their productivity contribution (**-0.48**).

Table 15 Results - Full sample – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	1.13 (0.98)	0.97*** (0.25)	0.17 (1.02)
	30-49	0.41 (0.81)	0.89*** (0.20)	-0.48 (0.81)
	50-59	1.44 (1.07)	1.24*** (0.29)	0.21 (1.05)
NMW 'spike' interaction terms (γ)	21-29	-0.001 (0.07)	-0.0001 (0.02)	-0.001 (0.07)
	30-49	0.03 (0.05)	0.02 (0.02)	0.01 (0.05)
	50-59	-0.04 (0.06)	-0.02 (0.03)	-0.02 (0.06)
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in 0 in Annex 3.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Turning to the NMW 'spike' interaction terms, productivity-wage differentials narrow between 16-20 and 21-29 year olds as a higher percentage of workers earn close to the NMW (i.e. a negative coefficient compared to positive coefficient when the NMW spike is assumed to be zero). More specifically, within the same sector, a percentage-point increase in the proportion of (any aged) workers earning at the NMW is associated with a reduction in the productivity-wage differential for 21-29 year olds relative to 16-20 year olds (-0.001). In other words, 16-20 year olds become less overpaid relative to workers aged 21-29. A similar phenomenon occurs in respect to the productivity-wage gap that exists between 16-20 year olds and 50-59 year olds. In contrast, increases in the proportion of workers paid the NMW are associated with larger productivity and wage differences for workers aged 30-49 relative to 16-20 year olds. In other words, 16-20 year olds become less underpaid relative to 30-49 year olds. However, all interaction coefficients are relatively small and statistically insignificant.

The results for the other workforce characteristics are shown in Table 39 in Annex 3. In brief, the firm size variables show that sectors with a higher proportion of medium and large firms have higher productivity and wages, with the productivity effect being slightly larger. Looking at the productivity-wage gaps, the analysis suggests that workers in small firms are overpaid given their productivity compared to workers in medium or large firms. As more workers earn at or around the NMW within sectors, the gap between productivity and wages becomes smaller between small and large firms.

An increasing proportion of female workers within sectors is associated with lower productivity and lower wages, however, taken together, suggests that female workers are underpaid compared to men given their productivity contribution. Moreover, as the percentage of workers earning at the NMW increases, they become further underpaid.

3.4.3 Low-paying industries

A larger proportion of workers earn close to, or at the National Minimum Wage in low-paying sectors (as shown by the mean values in Table 14). Hence, examining the impact of the NMW on the relationship between productivity and wages in these sectors may reveal stronger minimum wage effects.

The results in Table 16 show that the age-productivity profile follows an 'inverted-U' shape with older workers associated with higher productivity than 16-20 year olds, reaching a maximum when workers are aged 30-49. As with the aggregate analysis, average wages are also estimated to be higher for all age groups relative to the youngest group (16-20 year olds), with statistically significant coefficients for the 21-29 and 30-49 age groups. A one percentage point increase in the proportion of workers aged 30-49 in a sector is associated with a **0.94%** increase in real wages, compared to workers aged 16-20 and this impact is statistically significant at the 5% significance level.

Similar to the results covering all sectors, increases in the percentage of workers earning at the NMW have little to no impact on wage differentials within sectors by age as all interaction coefficients are close to zero and have relatively large standard errors (see the middle panel of results in Table 16).

Table 16 Results - Low-paying sectors only – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	0.74 (1.20)	1.41** (0.52)	-0.66 (1.14)
	30-49	1.75 (1.33)	0.94** (0.44)	0.81 (1.24)
	50-59	1.17 (1.48)	0.90 (0.57)	0.26 (1.41)
NMW 'spike' interaction terms (γ)	21-29	0.07 (0.07)	-0.02 (0.02)	0.08 (0.07)
	30-49	-0.002 (0.04)	-0.001 (0.02)	-0.001 (0.04)
	50-59	0.01 (0.10)	-0.0003 (0.04)	0.01 (0.09)
Observations		313	313	313

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 40 in Annex 3.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Combining these outcomes, the estimated age productivity-wage gap coefficients reveal that the younger workers (aged 16-20) appear to be **underpaid** relative to productivity contribution compared to workers aged 21-29 in low-paying industries, but **overpaid** relative to their productivity when compared to older workers (30-49 and 50-59) in low-paying industries.

In terms of the NMW-spike interaction term, for workers aged 21-29, the estimate is relatively large, suggesting that the productivity-wage gap narrows by 0.08% per percentage point increase in the proportion of workers earning at the NMW. In other words, younger workers aged 16-20 become less underpaid relative to 21-29 year olds. However, as before, all reported age coefficients are not statistically significant.

Briefly considering some other characteristics, the results (presented in Table 40) show that larger proportions of medium and large firms within sectors are associated with higher productivity and wages. As before, the productivity effect is larger than the wage effect suggesting that workers in small firms are **overpaid** relative to their productivity contribution relative to workers in medium or large firms. However, increases in the percentage of workers earning at the NMW marginally reduces the extent to which workers in small firms are overpaid. Similar to the full sample results, a higher proportion of female workers within a sector is associated with lower productivity and wages, with the productivity effect being more negative. That is, there is a negative productivity-wage gap suggesting that female workers are underpaid relative to their productivity.

Therefore, when the analysis is restricted to low-paying sectors only, **there is limited statistical evidence to suggest the NMW has any impact on productivity differentials across age groups**. The estimated interaction coefficients are small with relatively large standard errors; and hence can be viewed as being equivalent to zero. Moreover, **the NMW does not appear to impact on productivity-wage differentials**.

3.4.4 Pre-recession, recession and recovery period analysis

With additional years of data, the analysis in this section extends the work by Dickerson and McIntosh (2012) investigating the impact of the recession and the subsequent recovery phase on the age-productivity and age-earnings profiles. The extent to which the impact of the NMW varies across these periods is also of interest. This is achieved by splitting the sample into three periods and performing the analysis for each period separately. In particular, the following periods are considered: (i) 'Pre-recession' period from 2004 to 2007, (ii) 'Recession' period from 2008 to 2009 and (iii) 'Recovery' period from 2010 to 2013.

Pre-recession

Beginning with the pre-recession period, the wage equation in Table 17 shows that the youngest workers were linked with the lowest wages and these wage differentials were statistically significant compared to older age groups (although the impact is not increasing with age). There is also statistical evidence (at the 5% significance level) suggesting that the wage differential within sectors for 21-29 year olds (relative to 16-20 year olds) was reduced from **1.07%** by **0.06%** for each percentage point increase in the proportion of workers earning at the NMW during this period.

The empirical results for the productivity-wage gap equation imply that 16-20 year olds were **underpaid** relative to their productivity when compared to *all* older age groups within the same sector; however, this gap in productivity and wages becomes smaller with increases in age. Hence, an increase in the proportion of the oldest group of workers (aged 50-59) relative to 16-20 year olds is associated with higher productivity as well as a corresponding increase in wages in the pre-recession period. This result combined with a percentage point increase in the proportion of workers earning at the NMW suggests that the NMW spike widens the productivity-wage gap between 16-20 and 50-59 year olds (meaning that 16-20 year olds are now relatively overpaid compared to 50-59 year olds). More specifically, the interaction coefficient of 0.31% for a percentage point increase in the NMW spike more than offsets the original coefficient of -0.05% (assuming no workers earn at the NMW) and this impact is statistically significant at the 5% level.

Table 17 Results – Pre-recession period (2004-2007) – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	-0.34 (1.90)	1.07*** (0.33)	-1.41 (1.94)
	30-49	-0.35 (1.20)	0.79*** (0.23)	-1.14 (1.18)
	50-59	0.89 (2.34)	0.94*** (0.33)	-0.05 (2.40)
NMW 'spike' interaction terms (γ)	21-29	0.02 (0.13)	-0.06** (0.03)	0.09 (0.13)
	30-49	0.03 (0.11)	0.01 (0.02)	0.02 (0.11)
	50-59	0.27* (0.16)	-0.04 (0.04)	0.31** (0.15)
Observations		430	430	430

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 41 in Annex 3.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Recession

Turning to the recession period, the estimated coefficients in Table 18 are more erratic due to the smaller sample size in this period. The productivity-wage gap coefficients in this period (right panel in Table 18) suggest that workers aged 16-20 are **underpaid** given their productivity contribution in comparison with workers aged 21-49; whereas, they are **overpaid** relative to their productivity when viewed alongside workers aged 50-59. However, increasing the percentage of workers being paid the NMW is associated with a decrease in differentials between productivity and wages for all age groups. Moreover, these results are statistically significant for all age groups (although the level of significance varies across the age groups).

Table 18 Results – Recession period (2008-2009) – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	0.05 (2.00)	0.68 (0.53)	-0.63 (2.08)
	30-49	-0.01 (1.84)	0.92** (0.44)	-0.93 (1.85)
	50-59	3.13 (2.30)	0.71 (0.61)	2.42 (2.34)
NMW 'spike' interaction terms (γ)	21-29	0.37 (0.24)	-0.08 (0.06)	0.45* (0.24)
	30-49	0.35*** (0.13)	-0.002 (0.04)	0.35*** (0.14)
	50-59	-0.41* (0.24)	0.01 (0.06)	-0.41* (0.23)
Observations		210	210	210

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 42 in Annex 3.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

As observed in the full sample analysis, this reduction in the productivity-wage gap due to an increase in the percentage of workers earning the NMW is mainly driven by changes in

productivity differentials as opposed to wage differentials. The NMW ‘spike’ interaction terms are effectively zero in the wage equation.

Recovery period

The estimated coefficients for the age variables in the recovery period are presented in Table 19 below. Looking at both productivity and wage equations, the results seem to be at odds with the analysis presented above. Specifically, an increase in the proportion of older workers (relative to 16-20 year olds) is associated with lower productivity as well as lower wages in a given sector. In relation to the wage-productivity estimates, the analysis suggests that 16-20 year olds are **underpaid** relative to 30-59 year olds.

Turning to the NMW ‘spike’ interaction terms, coefficients for 21-29 and 50-59 year olds suggest that both productivity differentials and wage differentials narrow as the bite of the NMW increases within sectors, whereas the reverse is true for 30-49 year olds relative to 16-20 year olds. However, all interaction coefficients are statistically insignificant. Considering the productivity-wage gap estimation, during the recovery, the analysis suggests that younger workers are relatively underpaid relative to 30-49 year olds and 50-59 year olds. The analysis also indicates that the interaction terms are relatively small when compared to the pre-recession and recession periods.

Table 19 Results – Recovery period (2010-2013) – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW ‘spike’ is 0 (β)	21-29	-0.67 (1.33)	-0.75** (0.35)	0.07 (1.40)
	30-49	-0.54 (0.92)	-0.04 (0.36)	-0.51 (0.95)
	50-59	-1.44 (1.16)	-0.22 (0.41)	-1.22 (1.22)
NMW ‘spike’ interaction terms (γ)	21-29	0.07 (0.06)	0.02 (0.02)	0.04 (0.06)
	30-49	-0.03 (0.05)	-0.01 (0.02)	-0.02 (0.06)
	50-59	0.09 (0.06)	0.02 (0.03)	0.08 (0.07)
Observations		442	442	442

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 43 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

Therefore, the results presented in this section are reasonably variable over time when the sample is split into pre-recession, recession and recovery periods. Given there is also a lack of time series variation within sectors due to the split in the sample, the conclusions are indicative only.

3.4.5 Summary results

In the pre-recession period, there is evidence of a **narrowing wage gap** for 50-59 year olds as the proportion of workers being paid the NMW increases. Young workers (aged 16-20) appear to be **underpaid relative to their productivity** compared to older workers within the same sector and this productivity-wage gap becomes **smaller** for 21-49 year olds workers if more workers earn the NMW. In contrast, for 50-59 year olds, a percentage point increase in the proportion of workers being paid the NMW **widens** the productivity-wage gap in a given sector.

The impact of the NMW on productivity-wage differentials between age groups in the recession period is **statistically significant**, suggesting that there is **a reduction in the gap between productivity and wages across all age groups within the same sector**. This is mainly driven by changes in productivity differentials as opposed to wage differentials.

The results in the recovery period are at odds with the earlier periods, suggesting that workers aged 21 or older are associated with lower productivity and wages compared to 16-20 year olds. However, all reported coefficients are not statistically significant. The NMW ‘spike’ interaction terms suggest that 16-20 year olds are **less underpaid** relative to their productivity contribution when compared with 50-59 year olds as the proportion of workers in receipt of the NMW increases (i.e. a contraction in the productivity-wage gap). In contrast, they are further overpaid (underpaid) given their productivity relative to 21-29 (30-49) year olds as the percentage of workers earning the NMW increases within a sector. However, these interaction coefficients are **relatively small and statistically insignificant**.

3.4.6 Robustness checks

In this section, the robustness of the full sample results is tested by making changes in the fixed effects specification. For brevity and comparability, age coefficients in the productivity-wage gap estimations are reported only. Full estimation results are presented in Annex 3.

Excluding the capital measure

Real net capital expenditure per head is included in the estimations to control for its impact on productivity and as a proxy for the capital stock, which is required in the Cobb-Douglas specification. Therefore, the estimations are re-run excluding net capital expenditure to check for its significance on the statistical relationship between age, productivity and wages. Table 20 reports the results of the productivity-wage gap estimation from the full sample (reported in Table 15) alongside those under the changed specification excluding the capital measure.

A simple comparison shows that there are very minor changes in the results. Therefore, the inclusion or exclusion of the real net capital measure appears to have little influence on the age-earnings and age-productivity profiles. Moreover, if anything, the NMW ‘spike’ interaction terms move closer to zero.

Table 20 Robustness check - Excluding the capital measure – Age coefficients

Coefficient	Age group	Productivity-wage gap	
		Main results	Robustness check – Excluding the capital measure
Coefficient assuming NMW ‘spike’ is 0 (β)	21-29	0.17 (1.02)	0.13 (1.04)
	30-49	-0.48 (0.81)	-0.39 (0.82)
	50-59	0.21 (1.05)	0.21 (1.07)
NMW ‘spike’ interaction terms (γ)	21-29	-0.001 (0.07)	0.002 (0.07)
	30-49	0.01 (0.05)	-0.001 (0.05)
	50-59	-0.02 (0.06)	-0.003 (0.06)
Observations		1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 44 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

Sector-specific price deflators

The impact of price inflation is likely to vary across sectors, hence as a robustness check, sector-specific Producer Price Indices are used to deflate the measures of productivity, wages and net capital expenditure.²⁹ The estimated coefficients (from the productivity-wage gap estimation) under this changed specification are shown in Table 21 in the right panel with the equivalent results from the main specification in the left panel.

Similar to the previous robustness check excluding the capital measure, the estimated coefficients are virtually identical when sector-specific price deflators are used. Hence, the results are unaffected by potential variation in the impact of price inflation across sectors.

Table 21 Robustness check - Sector-specific price deflators – Age coefficients

Coefficient	Age group	Productivity-wage gap	
		Main results	Robustness check – Sector-specific price deflators
Coefficient assuming NMW ‘spike’ is 0 (β)	21-29	0.17 (1.02)	0.16 (1.02)
	30-49	-0.48 (0.81)	-0.49 (0.82)
	50-59	0.21 (1.05)	0.20 (1.05)
NMW ‘spike’ interaction terms (γ)	21-29	-0.001 (0.07)	-0.001 (0.07)
	30-49	0.01 (0.05)	0.01 (0.05)
	50-59	-0.02 (0.06)	-0.02 (0.06)
Observations		1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 45 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

Using a full-time equivalent (FTE) measure of employment

The variables of GVA per capita and net capital expenditure per head included in the estimations in the previous sections are constructed using the reported head count as the measure of employment in the denominator. As a robustness check, a FTE measure of employment is constructed assuming a part-time worker is equivalent to half a full-time worker and used to derive new measures for GVA per capita and net capital expenditure per head. Table 22 compares the productivity-wage gap coefficients under this specification with those from section 3.4.2.

Table 22 Robustness check - FTE measure of employment – Age coefficients

Coefficient	Age group	Productivity-wage gap	
		Main results	Robustness check – FTE measure of employment
Coefficient assuming NMW ‘spike’ is 0 (β)	21-29	0.17 (1.02)	2.19* (1.25)
	30-49	-0.48 (0.81)	0.41 (0.98)
	50-59	0.21 (1.05)	0.69 (1.43)
NMW ‘spike’ interaction terms (γ)	21-29	-0.001 (0.07)	-0.06 (0.09)
	30-49	0.01 (0.05)	-0.002 (0.07)
	50-59	-0.02 (0.06)	0.0004 (0.10)
Observations		1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 46 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

²⁹ Using publically available datasets from ONS, Eurostat, BIS and Defra, sector-specific Producer Price indices are available for 53 of the 120 sectors in the analysis. In the other cases, RPI was used.

The estimated coefficients assuming the NMW ‘spike’ is equal to zero have changed markedly (mainly driven by changes to productivity differentials – see Table 46) when a FTE measure of employment is used as the denominator for the measures of productivity and net capital expenditure. The reported coefficients (right panel in Table 22) suggest that 16-20 year olds are overpaid relative to their productivity when compared with *all* older workers (as opposed to 21-29 and 50-59 year olds only reported in the main results). However, the extent to which 16-20 year olds are overpaid relative to their productivity is considerably larger and statistically significant (at the 10% significance level) in the case of 21-29 year olds only.

There is little change in the NMW interaction coefficients and they remain close to zero. Therefore, the impact of the NMW on productivity-wage differentials is not affected by the change in the measures of productivity and net capital expenditure.

Alternative wage measure

The sensitivity and stability of estimated coefficients in the wage equation is also checked by repeating the analysis using the ASHE variable “*hexo*”, which measures the hourly wage rate excluding over-time pay. The results using this alternative wage measure are shown in Table 23 below and demonstrate no substantial change (estimates in right panel) when compared to the results from the preferred specification (estimates in left panel – also in Table 15).

Table 23 Robustness check - Alternative wages measure – Age coefficients

Coefficient	Age group	Productivity-wage gap	
		Main results	Robustness check – Alternative wages measure
Coefficient assuming NMW ‘spike’ is 0 (β)	21-29	0.17 (1.02)	0.16 (1.02)
	30-49	-0.48 (0.81)	-0.49 (0.82)
	50-59	0.21 (1.05)	0.18 (1.05)
NMW ‘spike’ interaction terms (γ)	21-29	-0.001 (0.07)	-0.002 (0.07)
	30-49	0.01 (0.05)	0.01 (0.05)
	50-59	-0.02 (0.06)	-0.02 (0.06)
Observations		1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * p < 0.10, ** p < 0.05, *** p < 0.01. Full results are available in Table 47 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

In summary, the empirical results presented in this section highlight the stability of estimated coefficients under slight changes to the preferred specification. There is some variation in productivity differentials when the FTE equivalent measure of employment is used; however the outcome only changes for 30-49 year olds. That is, 16-20 year olds appear to be overpaid relative to their productivity contribution in comparison to 30-49 year olds; whereas, in the main specification, 16-20 year olds were underpaid relative to their productivity. However, the coefficients remain statistically insignificant.

The effect of the NMW on productivity, wages, and the productivity-wage gap between age groups within sectors remains small and statistically insignificant under all the robustness checks.

4 Overall conclusions

The change in the bite of the national minimum wage over time

Having undertaken a detailed analysis of the Annual Survey of Hours and Earnings, the analysis suggests that:

- Despite the smaller increases in up-ratings in recent years, the bite of the three minimum wages is **increasing** over time.
- The bite of the adult rate of the NMW is **highest** in small firms, with the gap in the bite **widening** between small and large firms.
- Since 2009, a **decreasing proportion** of **younger workers** are paid **at** the adult rate of the NMW, while an **increasing proportion** are paid strictly less than the adult rate of the NMW.
- For adults, the adult rate of the NMW has become **more** of a going rate.
- The bite of the adult rate of the NMW has remained relatively constant for workers employed in public sector entities; however, for workers in private sector organisations, the bite has increased.
- The bite of the adult rate of the NMW increased in every region between 2005 and 2014, with the smallest increases occurring in Scotland and the North East of England, and the largest increases occurring in the West Midlands and Yorkshire and the Humber.

The impact of up-ratings of the adult rate of the NMW

- The up-rating of the adult rate of the NMW increased average hourly earnings by **£0.11p** per hour for those directly affected by the up-rating (the treatment group) compared to those with earnings just above the up-rated adult rate of the NMW (the control group). In terms of wage growth, workers in the treatment group witnessed **2 percentage point** faster wage growth as a result of the uprating compared to the control group.
- The further away a worker was from the up-rated adult rate of the NMW, the greater the impact of the up-rating (**£0.12p** per hour for the group of workers further way from the up-rating compared to **£0.10p** per hour for the group of workers closer to the up-rating).

Splitting the data into a 'pre-recession', 'recession' and 'recovery period', the analysis indicated that:

- The difference in real wage growth between the treatment and control groups stood at **3 percentage points** in the pre-recession period; however, the effect of the recession (and the fact that NMW up-ratings were less than during the pre-recession period) was to reduce this difference in wage growth rates (by **1 percentage point**). A similar outcome was identified in the recovery period.
- In low-paying sectors, the up-rating of the adult rate of the NMW provided workers in the treatment group with **2 percentage point** faster wage growth as a result of the uprating compared to the control group in the pre-recession period. This differential wage growth as a result of NMW up-ratings was unchanged in the recession and recovery periods.
- Workers in small firms saw the least impact of the up-rating on wage growth compared to the control group in the pre-recession period (**1.8 percentage points** compared to **1.9 percentage points** in medium sized firms and **3.3 percentage points** in large firms). During the recovery period, the relative impact of the uprating on wage growth experienced by workers in small firms following NMW up-ratings was essentially **zero**.

Productivity and wage differentials

- Younger workers (aged 16-20) appeared to be **underpaid** relative to their productivity when compared to workers aged 30-49; however, **overpaid** compared to workers aged 21-29 and aged 50-59. In light of the introduction of the National Living Wage, additional analysis suggests that 21-24 year olds are **overpaid** relative to 25-29 year olds.
- The impact of the NMW on productivity-wage differentials between age groups in the recession period was statistically significant, suggesting that there was a reduction in the gap between productivity and wages across all age groups within the same sector during the recession. Given productivity differences, workers aged 16-20 became **less underpaid** compared to 21-29 year olds and 30-49 year olds, and **less overpaid** compared to 50-59 year olds.
- In **low-paying sectors** only, 16-20 year olds appear to be **underpaid** relative to their productivity when compared to 21-29 year olds. Increasing the percentage of workers earning at the NMW is associated with a **narrowing** of the productivity-wage gap for workers aged 21-29.

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ANNEXES

Annex 1 Additional analysis

Analysis separating 21-29 year olds into two groups based on eligibility for the upcoming National Living Wage.

A1.1 Full results

Table 24 Results - Full sample – Pooled difference-in-difference estimation

Coefficient	Real wages (£)	Log real wages = ln(real wage)	Y-o-y % Δ of real wages = ln[wage(t)/wage(t-1)]
	(absolute real wage growth)	(% real wage growth)	(real wage acceleration)
After period coefficient	0.541*** (0.00859)	0.0648*** (0.000741)	0.0950*** (0.00121)
Treatment group coefficient	-0.399*** (0.0107)	-0.0706*** (0.000927)	-0.00710*** (0.00167)
Impact of NMW up-rating on Treatment group	0.113*** (0.0152)	0.0209*** (0.00131)	0.0255*** (0.00222)
D2005	0.290*** (0.0196)	0.0613*** (0.00169)	-
D2006	0.491*** (0.0197)	0.0987*** (0.00170)	-0.0160*** (0.00273)
D2007	0.655*** (0.0199)	0.130*** (0.00172)	-0.0247*** (0.00274)
D2008	0.831*** (0.0200)	0.162*** (0.00173)	-0.0163*** (0.00276)
D2009	1.255*** (0.0196)	0.231*** (0.00169)	0.0238*** (0.00275)
D2010	0.970*** (0.0191)	0.188*** (0.00165)	-0.0872*** (0.00267)
D2011	1.138*** (0.0190)	0.214*** (0.00164)	-0.0350*** (0.00264)
D2012	1.351*** (0.0190)	0.249*** (0.00164)	-0.0202*** (0.00262)
D2013	1.472*** (0.0185)	0.269*** (0.00160)	-0.0310*** (0.00257)
D2014	1.615*** (0.0215)	0.289*** (0.00186)	-0.0315*** (0.00279)
Gender	-0.0860*** (0.00787)	-0.00698*** (0.000680)	0.000107 (0.00113)
Full-time/ part-time indicator	-0.0227*** (0.00749)	-0.00710*** (0.000646)	0.00415*** (0.00107)
Age squared	-3.67e-05*** (3.01e-06)	-5.02e-06*** (2.60e-07)	-6.48e-06*** (4.27e-07)
Same-job as previous year	0.284*** (0.00957)	0.0345*** (0.000826)	0.0125*** (0.00173)
Real earnings (cubed)	4.35e-06*** (1.10e-08)	4.26e-08*** (9.47e-10)	4.13e-08*** (1.27e-09)
Constant	4.845*** (0.0257)	1.582*** (0.00222)	0.00773** (0.00379)
Observations	191,978	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 25 Results - Full sample – yearly difference-in-difference estimations on *real wages*

Coefficient	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009	2009 - 2010	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014
	Real wages	Real wages	Real wages	Real wages	Real wages	Real wages	Real wages	Real wages	Real wages	Real wages
After period coefficient	0.821*** (0.0236)	0.746*** (0.0270)	0.658*** (0.0228)	0.716*** (0.0332)	0.960*** (0.0236)	0.228*** (0.0178)	0.589*** (0.0169)	0.586*** (0.0131)	0.502*** (0.0122)	0.673*** (0.0172)
Treatment group coefficient	-0.452*** (0.0264)	-0.341*** (0.0349)	-0.441*** (0.0248)	-0.368*** (0.0456)	-0.377*** (0.0326)	-0.354*** (0.0241)	-0.369*** (0.0236)	-0.354*** (0.0178)	-0.352*** (0.0198)	-0.416*** (0.0201)
Impact of NMW up-rating on Treatment group	0.129*** (0.0372)	0.115** (0.0493)	0.0512 (0.0349)	0.0640 (0.0645)	0.119** (0.0461)	0.0786** (0.0340)	0.100*** (0.0333)	0.140*** (0.0251)	0.0892*** (0.0279)	0.0723** (0.0283)
Gender	-0.0784*** (0.0217)	-0.142*** (0.0268)	-0.110*** (0.0203)	-0.158*** (0.0335)	-0.0627*** (0.0234)	-0.0171 (0.0171)	-0.0504*** (0.0164)	-0.0144 (0.0124)	0.00600 (0.0121)	-0.0475*** (0.0150)
Full-time/ part-time indicator	-0.0395* (0.0202)	0.00135 (0.0249)	-0.00579 (0.0191)	-0.0157 (0.0311)	0.00177 (0.0221)	-0.0448*** (0.0162)	-0.0809*** (0.0157)	-0.0609*** (0.0120)	-0.0389*** (0.0117)	-0.0313** (0.0145)
Age squared	-0.0001** (0.0000)	-0.0000*** (0.0000)	-0.0001*** (0.0000)	-0.0001*** 0.0000	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)
Same-job as previous year	0.262*** (0.0244)	0.268*** (0.0308)	0.0379*** (0.00272)	0.284*** (0.0399)	0.254*** (0.0272)	0.167*** (0.0202)	0.261*** (0.0214)	0.244*** (0.0157)	0.221*** (0.0155)	0.325*** (0.0191)
Real earnings (cubed)	0.000106*** (0.0000)	-0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.000149*** (0.0000)	0.000144*** (0.0000)	0.000324*** (0.0000)	0.000731*** (0.0000)	0.000709*** (0.0000)	0.0000*** (0.0000)
Constant	4.920*** (0.0557)	5.169*** (0.0698)	1.690*** (0.00606)	5.621*** (0.0881)	5.621*** (0.0605)	6.051*** (0.0455)	5.841*** (0.0439)	5.778*** (0.0333)	5.959*** (0.0319)	6.197*** (0.0405)
Observations	19,118	16,190	17,006	15,074	15,686	18,818	20,898	20,880	21,176	27,132

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 26 Results - Full sample – yearly difference-in-difference estimations *log real wages*

Coefficient	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009	2009 - 2010	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014
	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages
After period coefficient	0.127*** (0.00288)	0.110*** (0.00263)	0.0941*** (0.00262)	0.0959*** (0.00257)	0.137*** (0.00233)	0.0225*** (0.00196)	0.0811*** (0.00191)	0.0862*** (0.00165)	0.0705*** (0.00149)	0.0842*** (0.00178)
Treatment group coefficient	-0.0952*** (0.00322)	-0.0673*** (0.00340)	-0.0849*** (0.00285)	-0.0673*** (0.00352)	-0.0673*** (0.00321)	-0.0595*** (0.00264)	-0.0644*** (0.00266)	-0.0623*** (0.00223)	-0.0594*** (0.00243)	-0.0654*** (0.00208)
Impact of NMW up-rating on Treatment group	0.0321*** (0.00454)	0.0223*** (0.00480)	0.0203*** (0.00401)	0.0168*** (0.00498)	0.0232*** (0.00453)	0.0101*** (0.00373)	0.0160*** (0.00376)	0.0253*** (0.00315)	0.0160*** (0.00342)	0.0142*** (0.00292)
Gender	-0.00772*** (0.00265)	-0.0131*** (0.00261)	-0.0115*** (0.00233)	-0.0107*** (0.00259)	-0.00499** (0.00230)	-0.00211 (0.00188)	-0.00666*** (0.00185)	-0.00151 (0.00156)	0.00101 (0.00149)	-0.00409*** (0.00155)
Full-time/ part-time indicator	-0.0105*** (0.00247)	-0.00621** (0.00242)	-0.00601*** (0.00220)	-0.00929*** (0.00240)	-0.00420* (0.00218)	-0.00816*** (0.00178)	-0.0127*** (0.00177)	-0.00962*** (0.00151)	-0.00634*** (0.00144)	-0.00462*** (0.00150)
Age squared	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)
Same-job as previous year	0.0375*** (0.00298)	0.0355*** (0.00300)	0.0379*** (0.00272)	0.0372*** (0.00308)	0.0284*** (0.00267)	0.0232*** (0.00222)	0.0321*** (0.00242)	0.0327*** (0.00197)	0.0287*** (0.00191)	0.0373*** (0.00197)
Real earnings (cubed)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)
Constant	1.598*** (0.00680)	1.645*** (0.00680)	1.690*** (0.00606)	1.720*** (0.00680)	1.744*** (0.00596)	1.807*** (0.00500)	1.780*** (0.00496)	1.777*** (0.00418)	1.809*** (0.00392)	1.835*** (0.00419)
Observations	19,118	16,190	17,006	15,074	15,686	18,818	20,898	20,880	21,176	27,132

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 27 Results - Full sample – yearly difference-in-difference estimations on year-on-year % change of real wages

Coefficient	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009	2009 - 2010	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014
	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages	Y-o-y % Δ of real wages
After period coefficient	-	0.0833*** (0.00434)	0.0896*** (0.00419)	0.108*** (0.00403)	0.117*** (0.00334)	-0.0226*** (0.00365)	0.145*** (0.00302)	0.103*** (0.00298)	0.0713*** (0.00268)	0.0920*** (0.00273)
Treatment group coefficient	-	-0.0122** (0.00593)	-0.00235 (0.00475)	0.0107* (0.00572)	-0.0156*** (0.00485)	-0.00881 (0.00568)	-0.00293 (0.00463)	-0.0127*** (0.00452)	-0.00702 (0.00478)	-0.00449 (0.00362)
Impact of NMW up-rating on Treatment group	-	0.0383*** (0.00815)	0.0253*** (0.00657)	-0.000897 (0.00791)	0.0403*** (0.00663)	0.0194*** (0.00750)	0.0163*** (0.00621)	0.0415*** (0.00596)	0.0271*** (0.00640)	0.0157*** (0.00462)
Gender	-	-0.000384 (0.00447)	-0.00168 (0.00387)	-0.00274 (0.00419)	0.00633* (0.00343)	0.0126*** (0.00366)	0.000418 (0.00304)	0.00735** (0.00293)	0.000852 (0.00274)	-0.000594 (0.00238)
Full-time/ part-time indicator	-	0.0119*** (0.00410)	0.00376 (0.00359)	0.00707* (0.00383)	0.00704** (0.00318)	0.00459 (0.00346)	-0.00325 (0.00287)	-0.00324 (0.00280)	0.00413 (0.00263)	0.000650 (0.00231)
Age squared	-	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000*** (0.0000)
Same-job as previous year	-	-0.0158** (0.00616)	-0.00701 (0.00554)	0.00642 (0.00618)	0.00306 (0.00496)	0.00416 (0.00574)	0.0175*** (0.00514)	0.000792 (0.00463)	0.00650 (0.00437)	0.0364*** (0.00361)
Real earnings (cubed)	-	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)
Constant	-	0.0319*** (0.0119)	0.00313 (0.0104)	-0.0134 (0.0114)	-0.0134 (0.00910)	0.0127 (0.0103)	-0.0754*** (0.00866)	-0.0321*** (0.00818)	-0.0205*** (0.00752)	-0.0406*** (0.00670)
Observations	-	11,056	12,162	10,837	11,442	11,918	15,044	14,643	16,115	22,481

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 28 Results - Full sample – Pooled difference-in-difference estimation with two treatment groups

Coefficient	Real wages (£)	Log real wages = ln(real wage)	Y-o-y % Δ of real wages = ln[wage(t)/wage(t-1)]
	(absolute real wage growth)	(% real wage growth)	(real wage acceleration)
After period coefficient	0.540*** (0.00859)	0.0647*** (0.000741)	0.0951*** (0.00121)
T1 (Treatment group with wages further away from the up-rated NMW) coefficient	-0.442*** (0.0127)	-0.0777*** (0.00109)	-0.00677*** (0.00201)
Impact of NMW up-rating on T1 (workers in the Treatment group with wages further away from the up-rated NMW)	0.119*** (0.0180)	0.0229*** (0.00155)	0.0269*** (0.00266)
T2 (Treatment group with wages closer to the up-rated NMW) coefficient	-0.323*** (0.0160)	-0.0582*** (0.00138)	-0.00768*** (0.00248)
Impact of NMW up-rating on T2 (workers in the Treatment group with wages closer to the up-rated NMW)	0.104*** (0.0226)	0.0174*** (0.00195)	0.0230*** (0.00332)
D2005	0.287*** (0.0196)	0.0607*** (0.00169)	-
D2006	0.489*** (0.0197)	0.0985*** (0.00170)	-0.0159*** (0.00274)
D2007	0.655*** (0.0199)	0.130*** (0.00172)	-0.0247*** (0.00275)
D2008	0.829*** (0.0200)	0.162*** (0.00173)	-0.0163*** (0.00277)
D2009	1.259*** (0.0196)	0.231*** (0.00169)	0.0238*** (0.00277)
D2010	0.978*** (0.0192)	0.189*** (0.00165)	-0.0874*** (0.00268)
D2011	1.144*** (0.0190)	0.215*** (0.00164)	-0.0352*** (0.00265)
D2012	1.355*** (0.0190)	0.249*** (0.00164)	-0.0203*** (0.00263)
D2013	1.478*** (0.0185)	0.270*** (0.00160)	-0.0311*** (0.00258)
D2014	1.623*** (0.0215)	0.290*** (0.00186)	-0.0318*** (0.00280)
Gender	-0.0875*** (0.00787)	-0.00720*** (0.000679)	0.000142 (0.00113)
Full-time/ part-time indicator	-0.0218*** (0.00749)	-0.00696*** (0.000646)	0.00413*** (0.00107)
Age squared	-3.69e-05*** (3.01e-06)	-5.05e-06*** (2.60e-07)	-6.47e-06*** (4.27e-07)
Same-job as previous year	0.286*** (0.00957)	0.0348*** (0.00348)	0.0125*** (0.00173)
Real earnings (cubed)	4.35e-06*** (1.10e-08)	4.26e-08*** (9.47e-10)	4.13e-08*** (1.27e-09)
Constant	4.842*** (0.0257)	1.581*** (0.00222)	0.00781** (0.00379)
Observations	191,978	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 29 Results - Full sample – Pooled wage gap difference-in-difference estimation

Coefficient	Wage gap equation (1)		Wage gap equation (2)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
After period coefficient	0.0705*** (0.000682)	0.0977*** (0.00112)	0.0684*** (0.000694)	0.0965*** (0.00115)
Treatment group coefficient	-0.0605*** (0.000760)	-0.000643 (0.00133)	-	-
Treatment group x Wage gap interaction coefficient	-	-	-2.199*** (0.0321)	-0.274*** (0.0719)
Impact of NMW up-rating and wage gap on Treatment group	0.03 (0.04)	0.78*** (0.07)	0.78*** (0.05)	1.03*** (0.09)
D2005	0.0629*** (0.00171)	-	0.0463*** (0.00176)	-
D2006	0.0993*** (0.00170)	-0.0144*** (0.00275)	0.0839*** (0.00172)	-0.0132*** (0.00276)
D2007	0.132*** (0.00173)	-0.0255*** (0.00275)	0.112*** (0.00178)	-0.0256*** (0.00275)
D2008	0.163*** (0.00173)	-0.0141*** (0.00277)	0.141*** (0.00178)	-0.0141*** (0.00277)
D2009	0.232*** (0.00169)	0.0257*** (0.00276)	0.208*** (0.00175)	0.0254*** (0.00276)
D2010	0.189*** (0.00165)	-0.0846*** (0.00268)	0.166*** (0.00171)	-0.0848*** (0.00268)
D2011	0.215*** (0.00164)	-0.0330*** (0.00265)	0.192*** (0.00170)	-0.0331*** (0.00265)
D2012	0.250*** (0.00164)	-0.0177*** (0.00263)	0.227*** (0.00171)	-0.0180*** (0.00263)
D2013	0.269*** (0.00160)	-0.0292*** (0.00258)	0.245*** (0.00166)	-0.0292*** (0.00258)
D2014	0.291*** (0.00185)	-0.0282*** (0.00279)	0.264*** (0.00190)	-0.0282*** (0.00279)
Gender	-0.00696*** (0.000680)	0.000227 (0.00113)	-0.00701*** (0.000683)	0.000160 (0.00113)
Full-time/ part-time indicator	-0.00717*** (0.000647)	0.00409*** (0.00107)	-0.00831*** (0.000649)	0.00423*** (0.00107)
Age squared	-5.03e-06*** (2.60e-07)	-6.52e-06*** (4.27e-07)	-4.84e-06*** (2.61e-07)	-6.51e-06*** (4.27e-07)
Same-job as previous year	0.0344*** (0.000827)	0.0124*** (0.00173)	0.0337*** (0.000830)	0.0125*** (0.00173)
Real earnings (cubed)	4.26e-08*** (9.48e-10)	4.13e-08*** (1.27e-09)	4.26e-08*** (9.52e-10)	4.13e-08*** (1.27e-09)
Constant	1.578*** (0.00221)	0.00444 (0.00377)	1.596*** (0.00227)	0.00535 (0.00378)
Observations	191,978	126,855	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 30 Recession and recovery pooled difference-in-difference estimations (full sample)

Coefficient	Standard specification (1)		Wage gap equation (2)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
After period coefficient	0.0653*** (0.000744)	0.0949*** (0.00121)	0.0671*** (0.000710)	0.0964*** (0.00117)
Treatment group (x Wage gap interaction)^ coefficient pre-recession (2004 -2008)	-0.0824*** (0.00142)	-0.00786*** (0.00278)	-1.890*** (0.0354)	-0.241*** (0.0871)
<i>Change</i> in Treatment group (x Wage gap interaction)^ recession (2008-2009)	0.0141*** (0.00252)	-0.00155 (0.00457)	-1.443*** (0.130)	-0.322 (0.228)
<i>Change</i> in Treatment group (x Wage gap interaction)^ recovery (2010-2014)	0.0210*** (0.00190)	0.00222 (0.00350)	-1.518*** (0.0868)	-0.0109 (0.162)
Impact of NMW up-rating (and wage gap)^ on Treatment group pre-recession (2004 -2008)	0.0274*** (0.00190)	0.0307*** (0.00356)	0.766*** (0.0485)	0.959*** (0.111)
<i>Change</i> in impact of NMW up-rating on Treatment group (and wage gap)^ during recession (2008-2009)	-0.00476 (0.00339)	-0.00734 (0.00593)	0.467*** (0.180)	0.442 (0.303)
<i>Change</i> in impact of NMW up-rating (and wage gap)^ on Treatment group during recovery (2010-2014)	-0.0134*** (0.00249)	-0.00795* (0.00437)	-0.150 (0.119)	0.131 (0.205)
D2005	0.0590*** (0.00172)	-	0.0491*** (0.00179)	-
D2006	0.0971*** (0.00172)	-0.0163*** (0.00174)	0.0870*** (0.00174)	-0.0133*** (0.00276)
D2007	0.128*** (0.00176)	-0.0253*** (0.00277)	0.116*** (0.00181)	-0.0253*** (0.00276)
D2008	0.158*** (0.00182)	-0.0164*** (0.00286)	0.150*** (0.00186)	-0.0134*** (0.00284)
D2009	0.225*** (0.00181)	0.0249*** (0.00290)	0.217*** (0.00182)	0.0255*** (0.00284)
D2010	0.181*** (0.00176)	-0.0866*** (0.00279)	0.175*** (0.00178)	-0.0849*** (0.00274)
D2011	0.207*** (0.00174)	-0.0348*** (0.00276)	0.204*** (0.00177)	-0.0333*** (0.00271)
D2012	0.242*** (0.00173)	0.238*** (0.00176)	-0.0199*** (0.00273)	-0.0182*** (0.00267)
D2013	0.262*** (0.00172)	0.257*** (0.00174)	-0.0309*** (0.00270)	-0.0293*** (0.00265)
D2014	0.283*** (0.00196)	-0.0307*** (0.00294)	0.278*** (0.00199)	-0.0286*** (0.00289)
Gender	-0.00691*** (0.00068)	0.000104 (0.00113)	-0.00730*** (0.0007)	0.000163 (0.00113)
Full-time/ part-time indicator	-0.00714*** (0.00065)	0.00415*** (0.00107)	-0.00775*** (0.0007)	0.00422*** (0.00107)
Age squared	-4.97e-06*** (2.60e-07)	-6.49e-06*** (4.27e-07)	-4.99e-06*** (2.61e-07)	-6.50e-06*** (4.27e-07)
Same-job as previous year	0.0345*** (0.0008)	0.0126*** (0.00173)	0.0343*** (0.00083)	0.0125*** (0.00173)
Real earnings (cubed)	4.26e-08*** (9.47e-10)	4.13e-08*** (1.27e-09)	4.26e-08*** (9.50e-10)	4.13e-08*** (1.27e-09)
Constant	1.586*** (0.00226)	0.00756** (0.00382)	1.589*** (0.00229)	0.00542 (0.00379)
Observations	191,978	126,855	191,978	126,855

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. ^ Treatment group coefficients represent the coefficients of the Treatment group indicator in equation (1), and the coefficients of the interaction between the Treatment group indicator and the wage gap in equation (2) The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 31 Results - Low-paying industries and occupations

Coefficient	Low-paying industries		Low-paying occupations	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
After period coefficient	0.0422*** (0.00132)	0.0712*** (0.00259)	0.0420*** (0.000873)	0.0637*** (0.00141)
Treatment group coefficient pre-recession (2004 -2008)	-0.0776*** (0.00173)	-0.00689* (0.00389)	-0.0761*** (0.00173)	0.000506 (0.00332)
Change in Treatment group coefficient during recession (2008-2009)	0.0111*** (0.00355)	0.00267 (0.00748)	0.0107*** (0.00314)	-0.00385 (0.00573)
Change in Treatment group coefficient during recovery (2010-2014)	0.0180*** (0.00297)	0.0144*** (0.00218)	0.000569 (0.00607)	-0.00359 (0.00403)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0153*** (0.00249)	0.0244*** (0.00544)	0.0142*** (0.00230)	0.0205*** (0.00427)
Change in impact of NMW up-rating on Treatment group during recession (2008-2009)	0.00437 (0.00516)	-0.0129 (0.0103)	0.0102** (0.00467)	0.00107 (0.00806)
Change in impact of NMW up-rating on Treatment group during recovery (2010-2014)	0.00339 (0.00402)	0.00260 (0.00779)	-0.00685** (0.00280)	-0.00489 (0.00498)
D2005	0.0530***(0.00204)	-	0.0509***(0.00218)	-
D2006	0.0960***(0.00202)	-0.0172*** (0.00360)	0.0966***(0.00217)	-0.00578*(0.00337)
D2007	0.134***(0.00247)	-0.0151*** (0.00445)	0.130***(0.00222)	-0.0223*** (0.00342)
D2008	0.159***(0.00262)	-0.0162*** (0.00471)	0.160***(0.00230)	-0.0138*** (0.00352)
D2009	0.226***(0.00256)	0.0262*** (0.00479)	0.225***(0.00228)	0.0214*** (0.00357)
D2010	0.185***(0.00275)	-0.0833*** (0.00507)	0.194***(0.00288)	-0.0877*** (0.00475)
D2011	0.211***(0.00271)	-0.0282*** (0.00492)	0.210***(0.00211)	-0.0342*** (0.00325)
D2012	0.242***(0.00272)	-0.0211*** (0.00484)	0.244***(0.00210)	-0.0221*** (0.00321)
D2013	0.262***(0.00266)	-0.0283*** (0.00473)	0.263***(0.00208)	-0.0343*** (0.00319)
D2014	0.278***(0.00337)	-0.0360*** (0.00550)	0.290***(0.00230)	-0.0309*** (0.00342)
Gender	-0.00495***(0.00111)	0.00567** (0.00223)	-0.00792*** (0.00083)	-0.000237 (0.00136)
Full-time/ part-time indicator	-0.00680*** (0.00108)	0.00521** (0.00218)	9.58e-05 (0.000747)	0.00398*** (0.00122)
Age squared	-4.46e-06*** (4.24e-07)	-5.96e-06*** (8.37e-07)	-3.03e-06*** (3.04e-07)	-4.25e-06*** (4.92e-07)
Same-job as previous year	0.00969*** (0.00132)	-0.0285*** (0.00335)	0.0111*** (0.000987)	-0.0152*** (0.00206)
Real earnings (cubed)	3.51e-08*** (8.06e-10)	3.46e-08*** (1.22e-09)	7.85e-06*** (1.17e-07)	6.10e-05*** (7.54e-07)
Constant	1.608*** (0.00333)	0.0471*** (0.00673)	1.598*** (0.00282)	0.0281*** (0.00465)
Observations	46,045	26,019	81,368	55,871

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. ^ Treatment group coefficients represent the coefficients of the Treatment group indicator in equation (1), and the coefficients of the interaction between the Treatment group indicator and the wage gap in equation (2) The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 32 Results – Firm size

Coefficient	Small firms (1-49 employees)		Medium firms (50-249 employees)		Large firms (250+ employees)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
After period coefficient	0.0587*** (0.00165)	0.0917*** (0.00287)	0.0607*** (0.00200)	0.0884*** (0.00352)	0.0675*** (0.000904)	0.0963*** (0.00143)
Treatment group coefficient pre-recession (2004 -2008)	-0.0830*** (0.00288)	-0.00710 (0.00597)	-0.0794*** (0.00385)	-0.00493 (0.00812)	-0.0819*** (0.00179)	-0.00924*** (0.00339)
Change in Treatment group coefficient during recession (2008-2009)	0.0133*** (0.00512)	-0.0221** (0.00995)	0.00729 (0.00661)	-0.00851 (0.0132)	0.0154*** (0.00318)	0.00821 (0.00555)
Change in Treatment group coefficient during recovery (2010-2014)	0.0245*** (0.00375)	0.00512 (0.00734)	0.0179*** (0.00484)	-0.00175 (0.00972)	0.0194*** (0.00244)	0.00164 (0.00436)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.0182*** (0.00379)	0.0187*** (0.00510)	0.0327*** (0.00240)	0.0257*** (0.00744)	0.0302*** (0.0103)	0.0335*** (0.00438)
Change in impact of NMW up-rating on Treatment group during recession (2008-2009)	0.00527 (0.00680)	0.0176 (0.0126)	-0.00733 (0.00879)	-0.0244 (0.0169)	-0.00864** (0.00430)	-0.0167** (0.00728)
Change in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.0176*** (0.00484)	-0.0197** (0.00891)	-0.00220 (0.00630)	-0.00355 (0.0120)	-0.0122*** (0.00323)	-0.00343 (0.00551)
D2005	0.0593*** (0.00358)	-	0.0588*** (0.00474)	-	0.0592*** (0.00213)	-
D2006	0.103*** (0.00359)	-0.0163*** (0.00600)	0.0991*** (0.00472)	-0.00351 (0.00799)	0.0945*** (0.00211)	-0.0184*** (0.00330)
D2007	0.137*** (0.00372)	-0.0267*** (0.00616)	0.127*** (0.00491)	-0.0108 (0.00822)	0.124*** (0.00215)	-0.0274*** (0.00331)
D2008	0.171*** (0.00391)	-0.0147** (0.00647)	0.167*** (0.00511)	0.00138 (0.00857)	0.152*** (0.00223)	-0.0201*** (0.00341)
D2009	0.229*** (0.00389)	0.0212*** (0.00662)	0.230*** (0.00501)	0.0323*** (0.00859)	0.222*** (0.00221)	0.0243*** (0.00345)
D2010	0.184*** (0.00372)	-0.0907*** (0.00630)	0.185*** (0.00479)	-0.0778*** (0.00811)	0.179*** (0.00216)	-0.0876*** (0.00335)
D2011	0.207*** (0.00366)	-0.0436*** (0.00615)	0.212*** (0.00471)	-0.0266*** (0.00793)	0.206*** (0.00215)	-0.0337*** (0.00332)
D2012	0.252*** (0.00367)	-0.0104* (0.00610)	0.245*** (0.00466)	-0.0123 (0.00776)	0.239*** (0.00214)	-0.0249*** (0.00328)
D2013	0.266*** (0.00365)	-0.0353*** (0.00608)	0.266*** (0.00462)	-0.0202*** (0.00768)	0.259*** (0.00211)	-0.0320*** (0.00324)
D2014	0.291*** (0.00418)	-0.0310*** (0.00658)	0.284*** (0.00519)	-0.0232*** (0.00827)	0.280*** (0.00243)	-0.0328*** (0.00354)
Gender	-0.0102*** (0.00140)	4.42e-05 (0.00248)	-0.00532*** (0.00169)	0.000903 (0.00302)	-0.00595*** (0.000859)	0.000164 (0.00140)

Coefficient	Small firms (1-49 employees)		Medium firms (50-249 employees)		Large firms (250+ employees)	
	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages	Log real wages	Y-o-y % Δ of real wages
Full-time/ part-time indicator	-0.000891 (0.00139)	0.0171*** (0.00245)	-0.00396** (0.00170)	0.00427 (0.00302)	-0.0111*** (0.000806)	-0.000677 (0.00130)
Age squared	-3.22e-06*** (5.22e-07)	-6.06e-06*** (9.12e-07)	-5.53e-06*** (6.71e-07)	-7.42e-06*** (1.18e-06)	-5.36e-06*** (3.31e-07)	-6.38e-06*** (5.28e-07)
Same-job as previous year	0.0306*** (0.00184)	0.0117*** (0.00416)	0.0344*** (0.00209)	0.0195*** (0.00457)	0.0347*** (0.00101)	0.0103*** (0.00206)
Real earnings (cubed)	1.01e-07*** (3.15e-09)	1.00e-07*** (4.47e-09)	1.23e-05*** (2.18e-07)	1.84e-05*** (4.96e-07)	3.67e-08*** (9.97e-10)	3.54e-08*** (1.31e-09)
Constant	1.578*** (0.00470)	-0.00990 (0.00853)	1.572*** (0.00587)	-0.0115 (0.0104)	1.595*** (0.00284)	0.0188*** (0.00466)
Observations	42,892	27,839	22,288	14,461	126,690	84,494

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 33 Results – Job switchers versus employees on the same job

Coefficient	Same job as previous year	Switched job from previous year
	Log real wages	Log real wages
After period coefficient	0.0509*** (0.000710)	0.155*** (0.00335)
Treatment group coefficient	-0.0808*** (0.00139)	-0.0776*** (0.00574)
Change in Treatment group coefficient during recession (2008-2009)	0.0143*** (0.00245)	0.0189* (0.0102)
Change in Treatment group coefficient during recovery (2010-2014)	0.0205*** (0.00185)	0.0215*** (0.00767)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.020*** (0.00185)	0.0502*** (0.00766)
Change in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.00369 (0.00330)	-0.0216 (0.0137)
Change in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.0117*** (0.00243)	-0.0239** (0.00999)
D2005	0.0560*** (0.00692)	0.0560*** (0.00692)
D2006	0.0946*** (0.00689)	0.0946*** (0.00689)
D2007	0.130*** (0.00715)	0.130*** (0.00715)
D2008	0.160*** (0.00745)	0.160*** (0.00745)
D2009	0.218*** (0.00769)	0.218*** (0.00769)
D2010	0.182*** (0.00756)	0.182*** (0.00756)
D2011	0.207*** (0.00723)	0.207*** (0.00723)
D2012	0.240*** (0.00714)	0.240*** (0.00714)
D2013	0.255*** (0.00707)	0.255*** (0.00707)
D2014	0.273*** (0.00819)	0.273*** (0.00819)
Gender	-0.00933*** (0.00277)	-0.00933*** (0.00277)
Full-time/ part-time indicator	-0.0366*** (0.00272)	-0.0366*** (0.00272)
Age squared	-1.47e-05*** (1.32e-06)	-1.47e-05*** (1.32e-06)
Same-job as previous year	3.89e-08*** (1.34e-09)	3.89e-08*** (1.34e-09)
Real earnings (cubed)	1.687*** (0.00789)	1.687*** (0.00789)
Observations	171,470	20,508

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 34 Robustness checks – Alternative control groups

Coefficient	Original Control: £/hr between up-rated NMW - 10% above	£/hr between 10% - 15% above up-rated NMW	£/hr between 10% -20% above up-rated NMW	£/hr between up-rated NMW – earnings at 5 th percentile*	£/hr between up-rated NMW – earnings at 10 th percentile*
	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages
After period coefficient	0.065*** (0.000744)	0.056*** (0.00110)	0.052*** (0.000761)	0.069*** (0.000855)	0.064*** (0.000613)
Treatment group coefficient	-0.082*** (0.00142)	-0.148*** (0.00163)	-0.170*** (0.00142)	-0.076*** (0.00147)	-0.114*** (0.00136)
Change in Treatment group coefficient during recession (2008-2009)	0.0141*** (0.00252)	0.00775*** (0.00275)	0.00960*** (0.00251)	0.0187*** (0.00259)	0.0207*** (0.00248)
Change in Treatment group coefficient during recovery (2010-2014)	0.0210*** (0.00190)	0.0171*** (0.00212)	0.0178*** (0.00189)	0.0292*** (0.00196)	0.0340*** (0.00185)
Impact of NMW up-rating on Treatment group pre-recession (2004 -2008)	0.027*** (0.00190)	0.035*** (0.00211)	0.040*** (0.00190)	0.024*** (0.00196)	0.031*** (0.00186)
Change in impact of NMW up-rating on Treatment group during recession (2008-2009)	-0.005 (0.00339)	-0.004 (0.00357)	-0.006* (0.00338)	-0.004 (0.00346)	-0.007** (0.00340)
Change in impact of NMW up-rating on Treatment group during recovery (2010-2014)	-0.013*** (0.00249)	-0.011*** (0.00262)	-0.013*** (0.00248)	-0.014*** (0.00255)	-0.014*** (0.00250)
D2005	0.0590*** (0.00172)	0.0607*** (0.00213)	0.0575*** (0.00171)	0.0596*** (0.00181)	0.0554*** (0.00143)
D2006	0.0971*** (0.00172)	0.0994*** (0.00209)	0.0977*** (0.00169)	0.0978*** (0.00180)	0.0938*** (0.00143)
D2007	0.128*** (0.00176)	0.128*** (0.00219)	0.125*** (0.00175)	0.127*** (0.00187)	0.120*** (0.00147)
D2008	0.158*** (0.00182)	0.164*** (0.00239)	0.161*** (0.00184)	0.154*** (0.00197)	0.148*** (0.00152)
D2009	0.225*** (0.00181)	0.233*** (0.00239)	0.230*** (0.00183)	0.219*** (0.00196)	0.215*** (0.00150)
D2010	0.181*** (0.00176)	0.188*** (0.00233)	0.187*** (0.00178)	0.175*** (0.00191)	0.170*** (0.00147)
D2011	0.207*** (0.00174)	0.214*** (0.00229)	0.212*** (0.00176)	0.200*** (0.00189)	0.195*** (0.00145)
D2012	0.242*** (0.00173)	0.246*** (0.00227)	0.242*** (0.00175)	0.234*** (0.00190)	0.224*** (0.00146)
D2013	0.262*** (0.00172)	0.266*** (0.00223)	0.263*** (0.00172)	0.252*** (0.00188)	0.242*** (0.00145)
D2014	0.283*** (0.00196)	0.285*** (0.00252)	0.284*** (0.00197)	0.275*** (0.00217)	0.263*** (0.00169)
Gender	-0.00691*** (0.000679)	-0.00530*** (0.000863)	-0.00604*** (0.000679)	-0.00679*** (0.000752)	-0.00800*** (0.000588)
Full-time/ part-time indicator	-0.00714*** (0.000646)	-0.00616*** (0.000833)	-0.00656*** (0.000660)	-0.00699*** (0.000715)	-0.00960*** (0.000561)

Coefficient	Original Control: £/hr between up-rated NMW - 10% above	£/hr between 10% - 15% above up-rated NMW	£/hr between 10% -20% above up-rated NMW	£/hr between up-rated NMW – earnings at 5 th percentile*	£/hr between up-rated NMW – earnings at 10 th percentile*
	Log real wages	Log real wages	Log real wages	Log real wages	Log real wages
Age squared	-4.97e-06*** (2.60e-07)	-5.19e-06*** (3.35e-07)	-5.32e-06*** (2.69e-07)	-5.04e-06*** (2.87e-07)	-4.97e-06*** (2.28e-07)
Same-job as previous year	0.0345*** (0.000826)	0.0343*** (0.00106)	0.0298*** (0.000851)	0.0362*** (0.000902)	0.0308*** (0.000725)
Real earnings (cubed)	4.26e-08*** (9.47e-10)	1.08e-07*** (3.20e-09)	1.12e-07*** (3.12e-09)	4.25e-08*** (9.57e-10)	4.30e-08*** (9.63e-10)
Constant	1.586*** (0.00226)	1.647*** (0.00287)	1.678*** (0.00223)	1.578*** (0.00246)	1.631*** (0.00190)
Observations	191,978	120,282	184,254	160,678	263,840

Note: * p < 0.10, ** p < 0.05, *** p < 0.01 *

* of the distribution above the up-rated NMW. The Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Table 35 Results - Full sample – Vertical and triple difference-in-difference estimations

Vertical DID			Triple DID	
Coefficient	Log real wages = Ln (real wage)	Coefficient	Original treatment and control	Benchmark treatment and control
	(% real wage growth)		(% real wage growth)	(% real wage growth)
Original treatment/control groups coefficient	-0.160*** (0.000519)	After period coefficient	0.0648*** (0.000741)	0.0514*** (0.000717)
Treatment groups coefficient	-0.0764*** (0.000522)	Treatment group coefficient	-0.0706*** (0.000927)	-0.0821*** (0.000702)
Impact of NMW up- rating on original treatment group	0.0167*** (0.000831)	Impact of NMW up- rating on Treatment group	0.0209*** (0.00131)	0.0114*** (0.000991)
D2005	0.0850*** (0.00110)	D2005	0.0613*** (0.00169)	0.0505*** (0.00142)
D2006	0.124*** (0.00111)	D2006	0.0987*** (0.00170)	0.0923*** (0.00144)
D2007	0.154*** (0.00112)	D2007	0.130*** (0.00172)	0.118*** (0.00146)
D2008	0.186*** (0.00113)	D2008	0.162*** (0.00173)	0.154*** (0.00147)
D2009	0.252*** (0.00110)	D2009	0.231*** (0.00169)	0.222*** (0.00143)
D2010	0.212*** (0.00108)	D2010	0.188*** (0.00165)	0.181*** (0.00140)
D2011	0.239*** (0.00107)	D2011	0.214*** (0.00164)	0.209*** (0.00139)
D2012	0.269*** (0.00107)	D2012	0.249*** (0.00164)	0.234*** (0.00138)
D2013	0.288*** (0.00105)	D2013	0.269*** (0.00160)	0.257*** (0.00137)
D2014	0.340*** (0.00117)	D2014	0.289*** (0.00186)	0.278*** (0.00160)
Gender	-0.00680*** (0.000441)	Gender	-0.00698*** (0.000680)	-0.00690*** (0.000554)
Full-time/ part-time indicator	-0.00714*** (0.000430)	Full-time/ part-time indicator	-0.00710*** (0.000646)	-0.00534*** (0.000551)
Age squared	-4.65e-06*** (1.76e-07)	Age squared	-5.02e-06*** (2.60e-07)	-5.11e-06*** (2.28e-07)
Same-job as previous year	0.0161*** (0.000558)	Same-job as previous year	0.0345*** (0.000826)	0.0193*** (0.000736)
Real earnings (cubed)	2.17e-09*** (5.07e-11)	Real earnings (cubed)	4.26e-08*** (9.47e-10)	2.04e-09*** (0)
Constant	1.770*** (0.00144)	Constant	1.582*** (0.00222)	1.696*** (0.00184)
Observations	439,278	Observations	191,978	247,300

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Model includes yearly time dummies for 2005-2014; Control variables included: quadratic in age, indicator of whether in same job as last year, and a cubic in the real wage.

Source: London Economics' analysis of ASHE data

Annex 2 Research Objective 4 – Additional analysis

Alternative National Minimum Wage (NMW) rates were designed based on the average productivity of low skilled workers. Therefore, given the different entitlement ages to the various NMW rates, there should be differences in productivity across these ages. In this section, the impact of the NMW on productivity-wage differentials between age groups is examined by:

- Separating the age groups such that they correspond to the current entitlement ages for the alternative NMW rates; and
- Separating 21-24 year olds from 25-29 year olds given the introduction of the National Living Wage³⁰

All other explanatory variables are also included in the specification. As before, age coefficients are the focus of the analysis and full estimation results are contained in Annex 3.

A2.1 Analysis using age groups corresponding to the entitlement ages for NMW rates

Table 36 shows the results separating workers based on their eligibility for the 16-17 Year Old Rate, the Youth Development Rate (18-20 year olds) and the adult rate of the NMW (21-59). Under this setting, the proportion of 16-17 year olds is excluded from the estimation to avoid multi-collinearity and hence, becomes the reference group in this analysis.

The productivity equation (right panel) suggests that older workers are associated with higher productivity within sectors, as may be expected. Increases in the proportion of workers earning at or close to the NMW reduces these productivity differentials. For example, when no worker earns at the NMW ‘spike’, a percentage point increase in the proportion of workers aged 21-59 is associated with a 0.84% rise in productivity in a given sector, relative to 16-17 year olds. However, if within the same sector, the percentage of workers earning at or close to the NMW increases, this productivity differential is reduced by 0.03% per percentage point.

Table 36 Results – Age groups corresponding to the entitlement ages for NMW rates – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW ‘spike’ is 0 (β)	18-20	0.29 (1.50)	-0.37 (0.43)	0.66 (1.49)
	21-59	0.84 (1.13)	0.75** (0.36)	0.09 (1.19)
NMW ‘spike’ interaction terms (γ)	18-20	-0.09 (0.10)	0.004 (0.02)	-0.09 (0.10)
	21-59	-0.03 (0.07)	0.004 (0.01)	-0.03 (0.07)
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 48 in Annex 3.

Source: London Economics’ analysis of ABS, BRES, LFS and ASHE data

³⁰ The National Living Wage of £7.20 per hour will come into force in April 2016 and the qualifying age is 25 or higher.

Turning to the wage equation (middle panel), 18-20 year olds are associated with lower wages, although this result is not statistically significant and 21-59 year olds are linked to higher wages, as one may expect, and this wage differential is statistically significant at the 5% level. Similar to the main results presented above, there is effectively no impact on wage differentials due to changes in the bite of the NMW.

Taken together, these results suggest that 16-17 year olds are overpaid relative to their productivity contribution when compared with workers eligible for the Youth Development Rate. However, the productivity-wage gap between these age groups narrows with increases in the proportion of workers earning the NMW. The productivity-wage gap is smaller for workers eligible for the adult rate of the NMW (aged 21-59) when compared to those aged 16-17. Moreover, the NMW interaction term for this age group suggests that, if anything, the productivity-wage gap becomes smaller as more individuals earn at the NMW.

A2.2 Analysis separating 21-29 year olds based on eligibility for the upcoming National Living Wage

The National Living Wage is being introduced in April 2016 and effectively becomes a new minimum wage rate for individuals over the age of 25. Hence, the analysis is repeated by separating the group of 21-29 year olds into 21-24 and 25-29 year olds. The results are shown in Table 37.

Table 37 Results – Separating 21-29 year olds based on eligibility for the upcoming National Living Wage – Age coefficients

Coefficient	Age group	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-24	-0.07 (1.41)	0.93*** (0.35)	-1.00 (1.38)
	25-29	2.04 (1.29)	1.00*** (0.28)	1.05 (1.32)
	30-49	0.30 (0.81)	0.87*** (0.20)	-0.58 (0.81)
	50-59	1.36 (1.06)	1.22*** (0.29)	0.14 (1.04)
NMW 'spike' interaction terms (γ)	21-24	0.09 (0.09)	0.02 (0.02)	0.07 (0.09)
	25-29	-0.10 (0.09)	-0.02 (0.02)	-0.07 (0.09)
	30-49	0.04 (0.05)	0.02 (0.02)	0.02 (0.05)
	50-59	-0.03 (0.07)	-0.02 (0.03)	-0.01 (0.06)
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Full results are available in Table 49 in Annex 3.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Across all periods and sectors, the results suggest that young workers aged 16-20 are underpaid relative to their productivity contribution when compared to 21-24 year olds, but overpaid when compared to 25-29 year olds, i.e. 21-24 year olds are overpaid relative to their productivity when compared to 25-29 year olds. An increase in the proportion of workers earning the NMW narrows the productivity-wage gap for both age groups relative to 16-20 year olds. However, all NMW interaction coefficients are statistically insignificant.

As the National Living Wage will increase the number of workers affected by the minimum wage, it suggests, if anything, that the productivity-wage gap within sectors will narrow between these groups of workers.

Annex 3 Research Objective 4 – Full results

Table 38 Variable description

Variable	Description
21-29	Proportion of workers aged 21-29 in a sector
30-49	Proportion of workers aged 30-49 in a sector
50-59	Proportion of workers aged 50-59 in a sector
Medium	Proportion of medium-sized firms in a sector
Large	Proportion of large-sized firms in a sector
Higher education	Proportion of workers with highest qualification equal to higher education in a sector
A-levels	Proportion of workers with highest qualification equal to GCE, A-level or equivalent in a sector
GCSEs	Proportion of workers with highest qualification equal to GCSE grades A*-C or equivalent in a sector
Other qualification	Proportion of workers with highest qualification equal to other qualifications in a sector
No qualification	Proportion of workers with no qualification in a sector
Female	Proportion of female workers in a sector
Part-time	Proportion of part-time workers in a sector
Private	Proportion of private-sector workers in a sector
Net capex	Log real net capital expenditure per head

Table 39 Results – Full sample

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	1.13 (0.98)	0.97*** (0.25)	0.17 (1.02)
	30-49	0.41 (0.81)	0.89*** (0.20)	-0.48 (0.81)
	50-59	1.44 (1.07)	1.24*** (0.29)	0.21 (1.05)
	Medium	0.68 (0.59)	0.63*** (0.16)	0.05 (0.54)
	Large	0.33 (0.32)	0.22*** (0.08)	0.11 (0.30)
	Higher education	-0.15 (1.01)	-0.36* (0.19)	0.21 (0.94)
	A-levels	0.19 (0.49)	-0.46*** (0.15)	0.65 (0.50)
	GCSEs	0.37 (0.59)	-0.22 (0.15)	0.60 (0.58)
	Other qualification	-0.97 (0.63)	-0.57*** (0.16)	-0.40 (0.63)
	No qualification	-1.04* (0.62)	-1.13*** (0.16)	0.09 (0.59)
	Female	-0.41 (0.59)	-0.12 (0.17)	-0.29 (0.58)
	Part-time	-0.16 (0.53)	-0.18 (0.15)	0.02 (0.50)
	Private	0.22 (0.57)	-0.26* (0.16)	0.48 (0.54)
	Net capex	0.09*** (0.03)	0.01* (0.01)	0.08*** (0.03)
NMW 'spike' interaction terms (γ)	21-29	-0.001 (0.07)	-0.0001 (0.02)	-0.001 (0.07)
	30-49	0.03 (0.05)	0.02 (0.02)	0.01 (0.05)
	50-59	-0.04 (0.06)	-0.02 (0.03)	-0.02 (0.06)
	Medium	-0.01 (0.04)	-0.01 (0.01)	0.0004 (0.04)
	Large	-0.03 (0.02)	-0.0003 (0.004)	-0.03 (0.02)
	Higher education	-0.06 (0.08)	0.02 (0.02)	-0.08 (0.08)
	A-levels	-0.01 (0.04)	0.03** (0.01)	-0.04 (0.04)
	GCSEs	-0.03 (0.03)	0.001 (0.01)	-0.03 (0.03)
	Other qualification	0.00 (0.04)	0.02 (0.02)	-0.02 (0.04)
	No qualification	0.01 (0.06)	0.03 (0.02)	-0.02 (0.06)
	Female	-0.03 (0.02)	-0.01 (0.01)	-0.02 (0.02)
	Part-time	0.01 (0.02)	-0.005 (0.01)	0.02 (0.02)
	Private	0.04 (0.06)	-0.01 (0.01)	0.05 (0.06)
	Net capex	-0.001 (0.002)	-0.0003 (0.001)	-0.0006 (0.002)
Constant	2.54** (1.18)	1.92*** (0.28)	0.62 (1.17)	
Observations	1,082	1,082	1,082	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 40 Results – Low-paying sectors only

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	0.74 (1.20)	1.41** (0.52)	-0.66 (1.14)
	30-49	1.75 (1.33)	0.94** (0.44)	0.81 (1.24)
	50-59	1.17 (1.48)	0.90 (0.57)	0.26 (1.41)
	Medium	2.27*** (0.82)	0.87*** (0.30)	1.40* (0.80)
	Large	0.91* (0.47)	0.09 (0.12)	0.82* (0.45)
	Higher education	-2.86** (1.27)	-0.40 (0.55)	-2.46** (1.19)
	A-levels	0.35 (0.96)	-0.25 (0.32)	0.60 (0.85)
	GCSEs	-0.76 (0.99)	-0.002 (0.36)	-0.76 (0.99)
	Other qualification	-0.02 (1.03)	0.04 (0.38)	-0.07 (1.04)
	No qualification	-2.71*** (0.89)	-1.20*** (0.38)	-1.52* (0.84)
	Female	-1.24** (0.51)	-0.35 (0.26)	-0.88 (0.58)
	Part-time	1.61*** (0.50)	-0.05 (0.20)	1.66 (0.55)
	Private	-0.65 (0.63)	-0.54*** (0.17)	-0.11 (0.58)
	Net capex	0.12*** (0.04)	-0.02** (0.01)	0.14 (0.04)
NMW 'spike' interaction terms (γ)	21-29	0.07 (0.07)	-0.02 (0.02)	0.08 (0.07)
	30-49	-0.002 (0.05)	-0.001 (0.02)	-0.001 (0.04)
	50-59	0.01 (0.10)	-0.0003 (0.04)	0.01 (0.09)
	Medium	-0.06 (0.04)	-0.02 (0.01)	-0.04 (0.04)
	Large	-0.02 (0.02)	0.001 (0.01)	-0.03 (0.02)
	Higher education	0.13* (0.07)	0.04 (0.03)	0.09 (0.06)
	A-levels	-0.01 (0.05)	0.03 (0.02)	-0.04 (0.04)
	GCSEs	0.08 (0.05)	-0.001 (0.02)	0.08 (0.05)
	Other qualification	-0.01 (0.06)	0.01 (0.02)	-0.03 (0.05)
	No qualification	0.10** (0.05)	0.02 (0.02)	0.08* (0.04)
	Female	-0.003 (0.03)	-0.01 (0.008)	0.01 (0.02)
	Part-time	-0.03* (0.02)	-0.004 (0.006)	-0.03 (0.02)
	Private	-0.02 (0.03)	-0.001 (0.007)	-0.02 (0.03)
	Net capex	-0.002 (0.002)	0.0004 (0.001)	-0.003 (0.002)
Constant	2.36** (1.05)	1.97*** (0.33)	0.38 (1.00)	
Observations	313	313	313	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 41 Results – Pre-recession period (2004-2007)

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	-0.34 (1.90)	1.07*** (0.33)	-1.41 (1.94)
	30-49	-0.35 (1.20)	0.79*** (0.23)	-1.14 (1.18)
	50-59	0.89 (2.35)	0.94*** (0.33)	-0.05 (2.40)
	Medium	-0.89 (1.66)	-0.09 (0.23)	-0.8 (1.59)
	Large	0.1 (0.37)	-0.11 (0.13)	0.21 (0.39)
	Higher education	1.02 (1.80)	0.20 (0.25)	0.83 (1.71)
	A-levels	0.09 (0.83)	-0.23 (0.15)	0.33 (0.89)
	GCSEs	-0.74 (0.91)	0.09 (0.16)	-0.83 (0.94)
	Other qualification	-1.53 (0.92)	-0.51** (0.22)	-1.02 (0.93)
	No qualification	0.27 (1.26)	-0.42* (0.22)	0.69 (1.25)
	Female	-1.32 (1.09)	-0.18 (0.20)	-1.14 (1.12)
	Part-time	-0.02 (0.49)	0.03 (0.20)	-0.06 (0.49)
	Private	0.36 (0.60)	-0.09 (0.16)	0.45 (0.65)
	Net capex	-0.01 (0.05)	-0.002 (0.01)	-0.01 (0.04)
NMW 'spike' interaction terms (γ)	21-29	0.02 (0.13)	-0.06** (0.03)	0.09 (0.13)
	30-49	0.03 (0.11)	0.01 (0.02)	0.02 (0.11)
	50-59	0.27* (0.16)	-0.04 (0.04)	0.31** (0.15)
	Medium	0.02 (0.14)	0.01 (0.03)	0.02 (0.13)
	Large	-0.06** (0.02)	-0.002 (0.01)	-0.05** (0.02)
	Higher education	-0.33 (0.28)	-0.06 (0.05)	-0.27 (0.26)
	A-levels	-0.04 (0.10)	-0.01 (0.02)	-0.03 (0.10)
	GCSEs	-0.05 (0.13)	-0.03 (0.03)	-0.02 (0.12)
	Other qualification	0 (0.08)	0.04 (0.03)	-0.03 (0.08)
	No qualification	-0.01 (0.14)	-0.03 (0.02)	0.02 (0.14)
	Female	0.05 (0.04)	0.02* (0.01)	0.03 (0.04)
	Part-time	0.1 (0.06)	-0.004 (0.02)	0.10* (0.06)
	Private	-0.07 (0.08)	0.02 (0.01)	-0.09 (0.08)
	Net capex	0.01 (0.005)	0.0004 (0.001)	0.005 (0.01)
Constant	4.05*** (1.49)	1.88*** (0.32)	2.17 (1.50)	
Observations	430	430	430	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 42 Results – Recession period (2008-2009)

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	0.05 (2.00)	0.68 (0.53)	-0.63 (2.08)
	30-49	-0.01 (1.84)	0.92** (0.44)	-0.93 (1.85)
	50-59	3.13 (2.30)	0.71 (0.61)	2.42 (2.35)
	Medium	-0.49 (1.20)	0.68** (0.27)	-1.17 (1.24)
	Large	-0.14 (0.64)	0.40* (0.20)	-0.54 (0.66)
	Higher education	0.97 (1.77)	-0.88 (0.64)	1.85 (1.78)
	A-levels	1.31* (0.67)	-0.002 (0.28)	1.31* (0.72)
	GCSEs	-1.13 (1.39)	0.23 (0.34)	-1.36 (1.40)
	Other qualification	1.48 (1.15)	-0.87* (0.45)	2.35* (1.22)
	No qualification	-0.96 (1.70)	0.08 (0.48)	-1.04 (1.80)
	Female	-0.52 (1.05)	-0.35 (0.53)	-0.17 (1.13)
	Part-time	0.41 (1.41)	-0.25 (0.57)	0.66 (1.55)
	Private	0.78 (1.58)	0.39 (0.54)	0.39 (1.67)
	Net capex	0.04 (0.05)	-0.001 (0.03)	0.04 (0.06)
	NMW 'spike' interaction terms (γ)	21-29	0.37 (0.24)	-0.08 (0.06)
30-49		0.35*** (0.13)	-0.002 (0.04)	0.35*** (0.14)
50-59		-0.41* (0.24)	0.01 (0.06)	-0.41* (0.23)
Medium		0.02 (0.16)	0.01 (0.03)	0.01 (0.16)
Large		0.01 (0.07)	0.01 (0.02)	0.002 (0.07)
Higher education		-0.14 (0.20)	0.10 (0.06)	-0.24 (0.19)
A-levels		-0.12 (0.08)	0.001 (0.03)	-0.12 (0.08)
GCSEs		0.08 (0.13)	0.04 (0.03)	0.04 (0.12)
Other qualification		-0.17 (0.17)	0.06 (0.05)	-0.23 (0.17)
No qualification		-0.12 (0.26)	-0.06 (0.07)	-0.06 (0.26)
Female		0.04 (0.08)	-0.01 (0.03)	0.05 (0.08)
Part-time		0.03 (0.07)	0.01 (0.03)	0.03 (0.08)
Private		-0.20* (0.11)	-0.01 (0.03)	-0.19 (0.12)
Net capex		0.01 (0.005)	0.002 (0.001)	0.003 (0.01)
Constant		2.50 (1.85)	1.39** (0.60)	1.11 (1.96)
Observations	210	210	210	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 43 Results – Recovery period (2010-2013)

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	-0.67 (1.33)	-0.75** (0.35)	0.07 (1.40)
	30-49	-0.54 (0.92)	-0.04 (0.36)	-0.51 (0.95)
	50-59	-1.44 (1.16)	-0.22 (0.41)	-1.22 (1.22)
	Medium	-0.28 (0.68)	-0.23 (0.24)	-0.05 (0.75)
	Large	0.05 (0.36)	0.01 (0.16)	0.03 (0.41)
	Higher education	0.93 (0.66)	0.02 (0.15)	0.91 (0.69)
	A-levels	0.1 (0.39)	-0.11 (0.21)	0.2 (0.47)
	GCSEs	-0.63 (0.47)	-0.11 (0.17)	-0.52 (0.53)
	Other qualification	-0.69 (0.57)	0.06 (0.24)	-0.75 (0.67)
	No qualification	0.27 (0.90)	0.05 (0.24)	0.22 (0.94)
	Female	-0.45 (0.67)	0.09 (0.19)	-0.54 (0.77)
	Part-time	-1.46** (0.67)	-0.57** (0.24)	-0.9 (0.79)
	Private	-0.69 (0.57)	0.05 (0.14)	-0.74 (0.63)
	Net capex	0.06*** (0.02)	0.01 (0.01)	0.06** (0.03)
NMW 'spike' interaction terms (γ)	21-29	0.07 (0.06)	0.02 (0.02)	0.04 (0.06)
	30-49	-0.03 (0.05)	-0.01 (0.02)	-0.02 (0.06)
	50-59	0.09 (0.06)	0.02 (0.03)	0.08 (0.07)
	Medium	0.01 (0.04)	-0.01 (0.02)	0.02 (0.05)
	Large	-0.01 (0.02)	-0.001 (0.01)	-0.01 (0.02)
	Higher education	-0.12** (0.06)	-0.004 (0.02)	-0.12* (0.07)
	A-levels	-0.04 (0.03)	-0.003 (0.02)	-0.04 (0.04)
	GCSEs	0.01 (0.04)	-0.02 (0.02)	0.03 (0.05)
	Other qualification	0.06 (0.05)	-0.02 (0.03)	0.08 (0.06)
	No qualification	-0.08 (0.07)	0.02 (0.02)	-0.09 (0.08)
	Female	0.01 (0.03)	-0.02* (0.01)	0.03 (0.03)
	Part-time	0.02 (0.02)	0.01 (0.01)	0.01 (0.03)
	Private	-0.01 (0.04)	0.01 (0.01)	-0.02 (0.04)
	Net capex	-0.0001 (0.002)	-0.0002 (0.0005)	0.0001 (0.002)
Constant	5.69*** (1.11)	2.88*** (0.45)	2.82** (1.23)	
Observations	442	442	442	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 44 Robustness check – Excluding capital measure

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	1.09 (1.01)	0.96*** (0.25)	0.13 (1.04)
	30-49	0.51 (0.82)	0.90*** (0.20)	-0.39 (0.82)
	50-59	1.45 (1.09)	1.23*** (0.29)	0.21 (1.07)
	Medium	0.77 (0.58)	0.65*** (0.16)	0.13 (0.54)
	Large	0.29 (0.32)	0.22*** (0.08)	0.07 (0.29)
	Higher education	-0.16 (1.03)	-0.36* (0.19)	0.21 (0.96)
	A-levels	0.15 (0.49)	-0.46*** (0.15)	0.61 (0.50)
	GCSEs	0.41 (0.58)	-0.21 (0.15)	0.62 (0.57)
	Other qualification	-1.13* (0.65)	-0.59*** (0.16)	-0.54 (0.65)
	No qualification	-1.25* (0.64)	-1.16*** (0.16)	-0.09 (0.61)
	Female	-0.36 (0.60)	-0.11 (0.17)	-0.25 (0.59)
	Part-time	-0.21 (0.52)	-0.20 (0.15)	-0.02 (0.49)
	Private	0.20 (0.57)	-0.26* (0.16)	0.46 (0.54)
	NMW 'spike' interaction terms (γ)	21-29	0.002 (0.07)	0.0003 (0.02)
30-49		0.01 (0.05)	0.02 (0.02)	-0.001 (0.05)
50-59		-0.02 (0.06)	-0.02 (0.03)	-0.003 (0.06)
Medium		-0.01 (0.04)	-0.01 (0.01)	-0.004 (0.04)
Large		-0.03 (0.02)	-0.001 (0.004)	-0.03* (0.02)
Higher education		-0.05 (0.08)	0.02 (0.02)	-0.08 (0.08)
A-levels		-0.01 (0.04)	0.03** (0.01)	-0.04 (0.04)
GCSEs		-0.02 (0.03)	0.0004 (0.01)	-0.02 (0.03)
Other qualification		0.01 (0.04)	0.02 (0.02)	-0.01 (0.04)
No qualification		0.01 (0.06)	0.03* (0.02)	-0.01 (0.06)
Female		-0.03 (0.02)	-0.01 (0.01)	-0.02 (0.02)
Part-time		0.01 (0.02)	-0.005 (0.01)	0.01 (0.02)
Private		0.04 (0.06)	-0.01 (0.01)	0.05 (0.06)
Constant		2.66** (1.20)	1.94*** (0.28)	0.72 (1.19)
Observations	1,082	1,082	1,082	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 45 Robustness check – Sector-specific price deflators

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	1.22 (0.99)	1.07*** (0.26)	0.16 (1.02)
	30-49	0.5 (0.79)	0.99*** (0.22)	-0.49 (0.82)
	50-59	1.54 (1.06)	1.34*** (0.29)	0.20 (1.05)
	Medium	0.66 (0.59)	0.61*** (0.16)	0.05 (0.55)
	Large	0.31 (0.32)	0.20*** (0.08)	0.11 (0.30)
	Higher education	-0.13 (1.01)	-0.34* (0.20)	0.21 (0.94)
	A-levels	0.17 (0.49)	-0.48*** (0.14)	0.65 (0.50)
	GCSEs	0.38 (0.59)	-0.22 (0.15)	0.60 (0.58)
	Other qualification	-0.94 (0.63)	-0.53*** (0.16)	-0.41 (0.63)
	No qualification	-1.07* (0.63)	-1.16*** (0.16)	0.09 (0.59)
	Female	-0.33 (0.60)	-0.03 (0.18)	-0.30 (0.58)
	Part-time	-0.19 (0.53)	-0.21 (0.16)	0.02 (0.50)
	Private	0.19 (0.58)	-0.29* (0.16)	0.49 (0.54)
	Net capex	0.09*** (0.03)	0.02* (0.01)	0.08*** (0.03)
NMW 'spike' interaction terms (γ)	21-29	0 (0.07)	-0.001 (0.02)	-0.001 (0.07)
	30-49	0.03 (0.05)	0.02 (0.02)	0.01 (0.05)
	50-59	-0.04 (0.06)	-0.02 (0.03)	-0.02 (0.06)
	Medium	-0.01 (0.04)	-0.01 (0.01)	0.0003 (0.04)
	Large	-0.03 (0.02)	0 (0.004)	-0.03 (0.02)
	Higher education	-0.06 (0.08)	0.02 (0.02)	-0.08 (0.08)
	A-levels	-0.01 (0.04)	0.03** (0.01)	-0.04 (0.04)
	GCSEs	-0.03 (0.03)	-0.001 (0.01)	-0.03 (0.03)
	Other qualification	-0.01 (0.04)	0.01 (0.02)	-0.02 (0.04)
	No qualification	0.02 (0.06)	0.03** (0.02)	-0.02 (0.06)
	Female	-0.03 (0.02)	-0.01 (0.01)	-0.02 (0.02)
	Part-time	0.01 (0.02)	-0.003 (0.01)	0.02 (0.02)
	Private	0.04 (0.06)	-0.01 (0.01)	0.05 (0.06)
	Net capex	-0.001 (0.002)	-0.0004 (0.0005)	-0.001 (0.002)
Constant	2.48** (1.17)	1.85*** (0.28)	0.63 (1.17)	
Observations	1,082	1,082	1,082	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 46 Robustness check – Using FTE measure of employment

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	3.12** (1.23)	0.94*** (0.25)	2.19* (1.25)
	30-49	1.29 (0.99)	0.89*** (0.20)	0.41 (0.98)
	50-59	1.92 (1.43)	1.23*** (0.29)	0.69 (1.43)
	Medium	0.7 (0.90)	0.64*** (0.16)	0.06 (0.91)
	Large	0.44 (0.47)	0.22*** (0.08)	0.22 (0.45)
	Higher education	-0.41 (1.14)	-0.36** (0.19)	-0.05 (1.09)
	A-levels	0.1 (0.59)	-0.46* (0.15)	0.55 (0.61)
	GCSEs	-0.36 (0.74)	-0.21 (0.15)	-0.15 (0.74)
	Other qualification	-1.18* (0.69)	-0.57*** (0.16)	-0.61 (0.69)
	No qualification	0.7 (1.06)	-1.15*** (0.16)	1.85* (1.04)
	Female	-0.85 (0.62)	-0.11 (0.17)	-0.75 (0.62)
	Part-time	0.9 (0.69)	-0.2 (0.16)	1.11 (0.69)
	Private	0.82 (0.58)	-0.27* (0.16)	1.09* (0.59)
	Net capex	0.47*** (0.15)	0.01 (0.01)	0.46*** (0.15)
NMW 'spike' interaction terms (γ)	21-29	-0.06 (0.09)	0.001 (0.02)	-0.06 (0.09)
	30-49	0.01 (0.07)	0.02 (0.02)	-0.002 (0.07)
	50-59	-0.02 (0.10)	-0.02 (0.03)	0.0004 (0.10)
	Medium	0.03 (0.07)	-0.01 (0.01)	0.04 (0.07)
	Large	-0.03 (0.03)	-0.0004 (0.004)	-0.03 (0.03)
	Higher education	0.02 (0.11)	0.02 (0.02)	-0.0004 (0.11)
	A-levels	0.01 (0.06)	0.03** (0.02)	-0.02 (0.06)
	GCSEs	0.06 (0.07)	-0.001 (0.02)	0.06 (0.07)
	Other qualification	-0.02 (0.07)	0.02 (0.02)	-0.04 (0.07)
	No qualification	-0.05 (0.11)	0.03* (0.02)	-0.08 (0.11)
	Female	-0.02 (0.03)	-0.01 (0.01)	-0.01 (0.03)
	Part-time	-0.03 (0.03)	-0.004 (0.01)	-0.03 (0.04)
	Private	0.04 (0.08)	-0.01 (0.01)	0.05 (0.08)
	Net capex	-0.02** (0.01)	0.0001 (0.001)	-0.02** (0.01)
Constant	3.06** (1.28)	1.92*** (0.28)	1.14 (1.29)	
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 47 Robustness check – Alternative wage measure

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-29	1.13 (0.98)	0.97*** (0.26)	0.16 (1.02)
	30-49	0.41 (0.81)	0.89*** (0.20)	-0.49 (0.82)
	50-59	1.44 (1.07)	1.26*** (0.29)	0.18 (1.05)
	Medium	0.68 (0.59)	0.64*** (0.16)	0.04 (0.55)
	Large	0.33 (0.32)	0.24*** (0.08)	0.1 (0.30)
	Higher education	-0.15 (1.01)	-0.37* (0.19)	0.22 (0.94)
	A-levels	0.19 (0.49)	-0.45*** (0.15)	0.64 (0.50)
	GCSEs	0.37 (0.59)	-0.22 (0.15)	0.6 (0.58)
	Other qualification	-0.97 (0.63)	-0.55*** (0.16)	-0.43 (0.63)
	No qualification	-1.04* (0.62)	-1.12*** (0.16)	0.08 (0.59)
	Female	-0.41 (0.59)	-0.13 (0.17)	-0.28 (0.58)
	Part-time	-0.16 (0.53)	-0.17 (0.15)	0.01 (0.50)
	Private	0.22 (0.57)	-0.26* (0.16)	0.49 (0.54)
	Net capex	0.09*** (0.03)	0.01* (0.01)	0.08*** (0.03)
NMW 'spike' interaction terms (γ)	21-29	-0.001 (0.07)	0.001 (0.02)	-0.002 (0.07)
	30-49	0.03 (0.05)	0.02 (0.02)	0.01 (0.05)
	50-59	-0.04 (0.06)	-0.02 (0.03)	-0.02 (0.06)
	Medium	-0.01 (0.04)	-0.01 (0.01)	0.0002 (0.04)
	Large	-0.03 (0.02)	-0.001 (0.004)	-0.03 (0.02)
	Higher education	-0.06 (0.08)	0.02 (0.02)	-0.07 (0.08)
	A-levels	-0.01 (0.04)	0.03** (0.01)	-0.04 (0.04)
	GCSEs	-0.03 (0.03)	-0.0002 (0.01)	-0.03 (0.03)
	Other qualification	0.00005 (0.04)	0.02 (0.02)	-0.02 (0.04)
	No qualification	0.01 (0.06)	0.02 (0.02)	-0.02 (0.06)
	Female	-0.03 (0.02)	-0.01 (0.01)	-0.02 (0.02)
	Part-time	0.01 (0.02)	-0.004 (0.01)	0.01 (0.02)
	Private	0.04 (0.06)	-0.01 (0.01)	0.05 (0.06)
	Net capex	-0.001 (0.002)	-0.0004 (0.001)	-0.001 (0.002)
Constant	2.54** (1.18)	1.92*** (0.28)	0.62 (1.17)	
Observations	1,082	1,082	1,082	

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 48 Results – Age groups corresponding to the entitlement ages for NMW rates

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	18-20	0.29 (1.50)	-0.37 (0.44)	0.66 (1.49)
	21-59	0.84 (1.13)	0.75** (0.36)	0.09 (1.19)
	Medium	0.62 (0.60)	0.62*** (0.16)	-0.004 (0.56)
	Large	0.26 (0.31)	0.22*** (0.08)	0.05 (0.29)
	Higher education	-0.40 (1.01)	-0.38* (0.20)	-0.02 (0.94)
	A-levels	0.04 (0.48)	-0.46*** (0.17)	0.5 (0.49)
	GCSEs	0.31 (0.60)	-0.22 (0.16)	0.53 (0.58)
	Other qualification	-1.08* (0.62)	-0.61*** (0.15)	-0.47 (0.62)
	No qualification	-1.15* (0.61)	-1.13*** (0.17)	-0.02 (0.57)
	Female	-0.33 (0.59)	-0.1 (0.17)	-0.23 (0.58)
	Part-time	-0.25 (0.54)	-0.19 (0.15)	-0.06 (0.51)
	Private	0.21 (0.55)	-0.27* (0.15)	0.48 (0.52)
	Net capex	0.09*** (0.03)	0.01* (0.01)	0.08*** (0.03)
	NMW 'spike' interaction terms (γ)	18-20	-0.09 (0.010)	0.004 (0.02)
21-59		-0.03 (0.07)	0.004 (0.01)	-0.03 (0.07)
Medium		-0.001 (0.04)	-0.01 (0.01)	0.01 (0.04)
Large		-0.02 (0.02)	-0.001 (0.004)	-0.02 (0.02)
Higher education		-0.01 (0.10)	0.02 (0.02)	-0.03 (0.09)
A-levels		0.02 (0.04)	0.03* (0.02)	-0.01 (0.04)
GCSEs		-0.02 (0.04)	-0.001 (0.01)	-0.02 (0.03)
Other qualification		0.01 (0.04)	0.02 (0.02)	-0.01 (0.04)
No qualification		0.02 (0.06)	0.02 (0.02)	-0.004 (0.06)
Female		-0.03 (0.02)	-0.01* (0.01)	-0.02 (0.02)
Part-time		0.02 (0.02)	-0.01 (0.01)	0.02 (0.02)
Private		0.06 (0.07)	-0.01 (0.01)	0.06 (0.07)
Net capex		-0.001 (0.002)	-0.0004 (0.001)	-0.0003 (0.002)
Constant		2.62* (1.47)	2.16*** (0.39)	0.46 (1.52)
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 49 Results – Separating 21-29 year olds based on eligibility for the upcoming National Living Wage

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-24	-0.07 (1.41)	0.93*** (0.35)	-1.00 (1.38)
	25-29	2.04 (1.29)	1.00*** (0.28)	1.05 (1.32)
	30-49	0.30 (0.81)	0.87*** (0.20)	-0.58 (0.82)
	50-59	1.36 (1.06)	1.22*** (0.29)	0.14 (1.04)
	Medium	0.72 (0.56)	0.63*** (0.16)	0.09 (0.52)
	Large	0.37 (0.33)	0.22*** (0.08)	0.15 (0.30)
	Higher education	-0.19 (1.00)	-0.35* (0.19)	0.16 (0.94)
	A-levels	0.23 (0.49)	-0.45*** (0.15)	0.67 (0.50)
	GCSEs	0.4 (0.59)	-0.23 (0.15)	0.64 (0.58)
	Other qualification	-0.98 (0.63)	-0.57*** (0.16)	-0.4 (0.63)
	No qualification	-1.04* (0.62)	-1.13*** (0.16)	0.09 (0.59)
	Female	-0.44 (0.60)	-0.13 (0.17)	-0.31 (0.59)
	Part-time	-0.13 (0.54)	-0.17 (0.15)	0.04 (0.51)
	Private	0.22 (0.57)	-0.26* (0.16)	0.48 (0.54)
	Net capex	0.09*** (0.03)	0.01* (0.01)	0.08*** (0.03)
NMW 'spike' interaction terms (γ)	21-24	0.09 (0.09)	0.02 (0.02)	0.07 (0.09)
	25-29	-0.1 (0.09)	-0.02 (0.02)	-0.07 (0.09)
	30-49	0.04 (0.05)	0.02 (0.02)	0.02 (0.06)
	50-59	-0.03 (0.07)	-0.02 (0.03)	-0.01 (0.06)
	Medium	-0.01 (0.04)	-0.01 (0.01)	-0.003 (0.04)
	Large	-0.03* (0.02)	-0.001 (0.004)	-0.03* (0.02)
	Higher education	-0.06 (0.08)	0.02 (0.02)	-0.08 (0.08)
	A-levels	-0.02 (0.04)	0.03** (0.01)	-0.05 (0.04)
	GCSEs	-0.03 (0.03)	0.0002 (0.01)	-0.03 (0.03)
	Other qualification	-0.001 (0.04)	0.02 (0.02)	-0.02 (0.04)
	No qualification	0.01 (0.06)	0.02 (0.02)	-0.02 (0.06)
	Female	-0.03 (0.02)	-0.01 (0.01)	-0.02 (0.02)
	Part-time	0.01 (0.02)	-0.01 (0.01)	0.01 (0.02)
	Private	0.04 (0.06)	-0.01 (0.01)	0.05 (0.06)
	Net capex	-0.001 (0.002)	-0.0003 (0.001)	-0.001 (0.002)
Constant		2.57** (1.18)	1.94*** (0.28)	0.63 (1.17)
Observations		1,082	1,082	1,082

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data

Table 50 Results – Separating 21-29 year olds based on eligibility for the upcoming National Living Wage - Low-paying sectors only

Coefficient	Variable	Productivity (Log real GVA per capita)	Wages (Log real wages)	Productivity-wage gap
Coefficient assuming NMW 'spike' is 0 (β)	21-24	-1.50 (1.25)	1.90** (0.73)	-0.41 (1.24)
	25-29	-0.17 (1.92)	0.81 (0.50)	-0.98 (1.90)
	30-49	1.65 (1.34)	0.90** (0.43)	0.75 (1.25)
	50-59	1.26 (1.51)	0.94 (0.59)	0.32 (1.42)
	Medium	2.21** (0.88)	0.85*** (0.30)	1.36 (0.85)
	Large	0.86 (0.47)	0.07 (0.11)	0.79* (0.45)
	Higher education	-2.79 (1.29)	-0.38 (0.53)	-2.41* (1.21)
	A-levels	0.39 (0.92)	-0.25 (0.33)	0.64 (0.81)
	GCSEs	-0.87 (1.00)	-0.04 (0.37)	-0.83 (1.00)
	Other qualification	-0.03 (1.03)	0.04 (0.36)	-0.07 (1.05)
	No qualification	-2.68*** (0.84)	-1.20*** (0.39)	-1.48* (0.79)
	Female	-1.36** (0.51)	-0.41* (0.24)	-0.95 (0.58)
	Part-time	1.66*** (0.53)	-0.04 (0.20)	1.70*** (0.56)
	Private	-0.65 (0.64)	-0.54*** (0.17)	-0.11 (0.59)
	Net capex	0.11*** (0.03)	-0.03*** (0.01)	0.13*** (0.04)
NMW 'spike' interaction terms (γ)	21-24	0.08 (0.08)	-0.02 (0.03)	0.10 (0.08)
	25-29	0.06 (0.11)	-0.01 (0.03)	0.07 (0.11)
	30-49	0.006 (0.05)	0.001 (0.02)	0.005 (0.04)
	50-59	0.01 (0.10)	-0.02 (0.01)	0.01 (0.09)
	Medium	-0.06 (0.04)	-0.02 (0.01)	-0.04 (0.04)
	Large	-0.02 (0.02)	0.001 (0.005)	-0.03 (0.02)
	Higher education	0.12 (0.07)	0.03 (0.03)	0.08 (0.06)
	A-levels	-0.02 (0.04)	0.03 (0.02)	-0.05 (0.04)
	GCSEs	0.08 (0.05)	-0.001 (0.02)	0.08 (0.05)
	Other qualification	-0.01 (0.06)	0.02 (0.02)	-0.03 (0.05)
	No qualification	0.10** (0.05)	0.02 (0.02)	0.08* (0.04)
	Female	-0.003 (0.02)	-0.01 (0.01)	0.005 (0.02)
	Part-time	-0.04* (0.02)	-0.004 (0.01)	-0.03 (0.02)
	Private	-0.02 (0.03)	-0.002 (0.01)	-0.02 (0.03)
	Net capex	-0.002 (0.002)	0.001 (0.001)	-0.002 (0.002)
Constant		2.52** (1.07)	2.06*** (0.30)	0.45 (1.03)
Observations		313	313	313

Note: Reported standard errors in parentheses are clustered by sector. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year dummies are also included in the estimations.

Source: London Economics' analysis of ABS, BRES, LFS and ASHE data



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