The impact of the National Living Wage introduction on firms' pay and contractual arrangements

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Copy-edited by Rachel Lumpkin

Published by **The Institute for Fiscal Studies**

ISBN 978-1-80103-203-2

The authors gratefully acknowledge the support of the Low Pay Commission (grant number PS23127), British Academy (SRG2223\230175), and of the Economic and Social Research Council through the Centre for the Microeconomic Analysis of Public Policy at IFS (ES/T014334/1). G. Giupponi additionally gratefully acknowledges the support of Bocconi University, UniCredit Foundation and PRIN 2022 PNRR (CUP J53D23015280001). This work was undertaken in the Office for National Statistics (ONS) Secure Research Service using data from ONS and other owners and does not imply the endorsement of the ONS or other data owners.

Executive summary

Minimum wages have become an increasingly popular policy for governments looking to support workers on low pay, bolstered by evidence that they lead to increases in wages without reducing employment. But relatively little is known about how firms adjust their organisational and pay structures in response to rising minimum wages, despite worries around narrowing pay differentials and shifts towards less secure contract types. In this report, we examine the impact of the 2016 introduction of the National Living Wage (NLW), a new and higher minimum wage for workers aged 25 and over in the UK, on firms' wage distributions, pay practices and use of alternative contractual arrangements.

Key findings

1. The NLW led to wage increases for low-paid workers, up to £2 per hour above the minimum level. These 'spillovers' suggest that firms raised wages for workers not directly affected by the NLW, partly maintaining pay differentials between workers.

2. Incumbent workers (tenure of at least one year) were more likely to benefit from spillovers than new starters. Spillovers were smaller in firms with the highest shares of workers earning minimum wage, and larger in public-sector firms.

3. In addition to raising the overall wage bill, the NLW led to pay compression among low-wage workers. Despite this, we find no evidence that large firms adjusted their organisational structure (measured in terms of the mix of occupations) in response to the higher minimum wage.

4. We do, however, find evidence of a change in pay practices. Comparing firms heavily exposed to the NLW with those less exposed, we find that the NLW induced firms not already using incentive pay and payment by the hour to implement these methods to compensate low-wage workers, resulting in an increase of 3.4 percentage points (ppt) in the probability of workers in these firms receiving incentive pay. This is consistent with attempts to mitigate weakening incentives to progress caused by pay compression.

5. We do not find any effect of the NLW introduction on firms' use of agency workers or subcontractors, even among firms that might be most able to use them. In fact, the share of large firms' employment costs spent on outsourcing – agency workers and subcontractors – did not change dramatically between 2012 and 2019.

6. There were no impacts on the survival rates of large firms, or on firm-level employment. Therefore, our analysis of existing firms' responses to the NLW likely captures the most important effects.

1. Introduction

The introduction of the National Living Wage (NLW) in 2016 marked the beginning of a series of ambitious increases in the level of the UK minimum wage, bringing UK policy closer to the international frontier. In 2024, the NLW is expected to meet the government target set at two-thirds of the median wage, and it has been extended to apply to all workers aged 21 or over. These repeated expansions to the reach of the NLW have made it the flagship policy aimed at supporting workers on low pay in the UK. But the level of the minimum wage set by the government is not the only factor influencing the ultimate impacts on workers as well as on economic performance; the way that firms respond to the policy is also critical.

Much of the analysis of minimum-wage policies, both in the UK and abroad, has focused on the wage and employment effects of minimum wages. In general, this research has found that minimum wages increase wages with limited effects on employment. But much less is known about how firms adjust their organisational and pay structures in response to the minimum wage. Qualitative evidence suggests that employers are worried about the NLW narrowing pay differentials between low-paid workers, or having to incur significant additional costs to maintain current differentials (Low Pay Commission, 2023). The extent to which firms adjust their pay and organisational structures will play an important role in determining the outcomes of those earning at or near to the minimum wage.

This report offers an assessment of how firms changed their pay and contractual practices in response to the higher wage bills and pay compression generated by the NLW introduction. First, we document the extent to which the NLW affected the distribution of wages within firms. We then examine whether firms adjusted their occupational structure in response, by looking at the prevalence of high- and low-paid occupations. We consider the extent to which firms made use of payment by the hour and incentive pay in order to incentivise workers. We also look at whether firms changed their use of alternative contractual arrangements, agency workers and subcontractors, in response to the rise in the minimum wage. Finally, we examine whether the NLW had impacts on firm-level employment or the likelihood of a firm closing.

This report proceeds as follows. Section 2 describes the NLW policy and existing research. Section 3 outlines our methodology. Sections 4–7 present our results, and Section 8 concludes.

2. Background

The NLW was a new, higher minimum wage for adults aged 25 and over, introduced in April 2016. It was set at £7.20 per hour, a 7.5% increase from its previous level of £6.70 set in October 2015, and an 11% increase compared to the £6.50 rate the previous April.[1] This significantly increased the 'coverage' of the minimum wage in the UK, with 7.2% of jobs paid the age-relevant minimum wage in 2016 compared to 5.4% in 2015 (Low Pay Commission, 2024). Since then, there have been further real-terms increases in the NLW. In April 2019, the NLW was paid at £8.21, which was 18% higher than in April 2015 after accounting for inflation. As a result, the 'bite' of the NLW, the ratio of the minimum wage to the median wage, was 7.3ppt higher at 60% (Giupponi et al., 2024).

These significant increases were backed by growing evidence that minimum wages did little to harm employment but increased the wages of low-paid workers.[2] In fact, since the pioneering work of Card and Krueger (1995), many other countries such as Germany and Hungary, as well as many US states, have introduced or increased minimum wages. Given the revived popularity of the minimum wage as a policy lever, more research has explored beyond the impacts on overall wages and employment, and there is now an established literature on the effect of minimum wages on the market-level wage distribution (Autor, Manning and Smith, 2016; Cengiz et al., 2019). This has found that increases in the minimum wage have not only affected those earning below the new minimum, but there have been 'spillovers' – increases in wages for workers earning slightly higher wages. For the NLW, Giupponi et al. (2024) find spillover effects up to £1.50 per hour above the new minimum at the market level.

These findings suggest that employers' responses to minimum wages, in particular how they set wages of workers earning above the minimum, can have important implications for the overall impact of the policy on top of the direct effect. Despite this, there has been little research to date on the extent to which minimum wages affect the distribution of wages within firms. Forsythe (2023) and Gopalan et al. (2021) find that increases in the minimum wage in US states led firms to increase wages for workers earning above the minimum, while Giupponi and Machin (2023) find that the NLW generated spillovers in the residential care home sector. In this report, we shed light on the impact of the NLW on the wage distribution of large firms, covering the majority of UK employees.

1 Inflation was close to zero at this time and so nominal and CPI-adjusted real increases are the same.
2 See Manning (2021) for a summary of the literature on employment effects of the minimum wage.

Adjusting the wages they offer to employees is not the only way that firms might respond to higher minimum wages. A smaller but growing body of research has examined other margins of adjustment for firms, including prices (Aaronson and French, 2007; Harasztosi and Lindner, 2019), profitability (Draca, Machin and van Reenen, 2011), productivity (Riley and Bondibene, 2017; Mayneris, Poncet and Zhang, 2018) and firm value (Bell and Machin, 2018). The evidence on other adjustment channels, such as pay and contractual arrangements, is relatively scarce though, in large part due to a lack of available data.

In this report, we provide an assessment of the effect of the NLW on firms' choice of pay practices and contractual arrangements. To the best of our knowledge, there is no previous work that has examined the impact of minimum wages on firms' use of incentive pay. In previous research concerning contractual arrangements, Datta, Giupponi and Machin (2019) have shown that the NLW increased usage of zero-hours contracts in the adult social care sector, but in this report we use firm-level data to explore the impact on utilisation of agency workers and subcontractors across all large firms.

3. Empirical approach

Data

This work draws on data from three sources: the Annual Survey of Hours and Earnings (ASHE), the Annual Business Survey (ABS) and the Business Structure Database (BSD).

The ASHE is a large-scale survey of employees, which provides high-quality employer-reported data on wages, hours worked, occupation and basic demographic characteristics. It is a panel dataset, meaning that the same set of employees is followed over time, and it covers approximately 1% of public- and private-sector employees in the United Kingdom.[3] We use data for Great Britain, combined with weights so that job totals match those observed in the Labour Force Survey.

The ABS is an annual survey of non-financial businesses in the UK, with near-universal coverage of firms with 250 or more employees. It provides detailed information on firms' employment costs, purchases, capital expenditure, profits, and other business and financial statistics. Data are collected at the reporting unit level. Most firms consist of a single reporting unit, but larger firms can be split into multiple reporting units based on divisional structure, geography or other reporting structures. We cannot distinguish between different reporting units in the ASHE, so limit our sample to firms with a single reporting unit.

The BSD is an annual snapshot of administrative firm data, which contains the universe of firms that are registered for VAT or pay at least one member of staff through the PAYE tax system. It contains basic information including industry classifications, the firm's starting date and numbers of employees.

We use data covering the period 2012 to 2019. This means our analysis begins after the labour market had stabilised following the global financial crisis in 2007–08, and ends before the onset of the COVID-19 pandemic.

[3] While the ASHE aims to cover 1% of employee jobs, the actual yield has recently been significantly below that. During our period of data, it actually covers more like two-thirds of a per cent (Forth et al., 2024).

Identifying the impact of the NLW

We attempt to isolate the impact of the minimum wage from wider trends by comparing firms more and less exposed to the NLW introduction. Firms with a greater proportion of workers earning the minimum wage will generally see their wage bills rise by more for a given increase in the minimum wage than those with fewer minimum-wage workers. We would therefore expect these firms to respond more to a rise in the minimum wage.

Our basic strategy involves comparing changes in outcomes before and after the NLW introduction between firms that were more affected by the NLW and those less affected. This set-up is known as a difference-in-differences framework, and relies on the assumption that the outcome of interest would have evolved similarly in the two groups of firms absent the NLW introduction. Our basic regression takes the form:

$$Y_{jt} = \beta Exposure_j * POST_t + \alpha_j + \theta_t + \varepsilon_{jt}, \quad (1)$$

where Y_{jt} is the outcome of interest for firm j observed at time t. α_j are firm fixed effects, θ_t are year fixed effects, $Exposure_j$ is an indicator for highly exposed firms and $POST_t$ is an indicator for post-NLW years (2016 or later). The coefficient β is our parameter of interest, capturing the change in the outcome variable in highly exposed firms after the NLW introduction, relative to the change in less-exposed firms.

We also use an event study version of the model above, which plots the differences each year rather than just pre- or post-NLW introduction. This has the advantage of allowing us to assess whether the evolution of our outcomes was similar for highly exposed and less-exposed firms prior to the NLW introduction. In order for our estimates to capture the impact of the NLW, we require that the outcome would have evolved similarly among both types of firms without the policy change. The event study version of equation (1) is given as

$$Y_{jt} = \sum_{\tau \neq 2015} \beta_\tau Exposure_j * I[\tau = t] + \alpha_j + \theta_t + \varepsilon_{jt}, \quad (2)$$

where $I[\cdot]$ is an indicator variable. We often also add further controls to help refine our estimates, such as controlling for industry-level trends or firm characteristics.

Calculating exposure to the NLW

Our measure of exposure is the firm-level coverage of the 2016 NLW. We define this as the proportion of the firm's employees with hourly wages below the 2016 NLW in 2015. Therefore, calculating firm-level coverage exactly requires information on the wages of all employees of a firm, something the ASHE data lack because the ASHE covers only a 1% sample of employees. We can calculate coverage based on the workers we observe, as in the following equation:

$$Coverage_j = \frac{\text{number of observed workers earning} < \text{2016 NLW}}{\text{number of observed workers}}. \quad (3)$$

This will not be precise for firms where we only observe a few workers, so we only perform this calculation for firms for which we observe at least 20 employees in the ASHE data, which limits us to very large firms – generally those with at least 2,000 employees. Setting a lower threshold for firm size in order to estimate coverage would allow us to include more firms, but it would also mean less accurate measurement and hence attenuation of our estimated effects.

In order to achieve a larger and more representative sample for our analysis without greatly sacrificing the accuracy of our exposure measure, we instead adopt a novel approach to impute firm-level coverage for a much larger set of firms. This involves using the very large firms for whom we observe at least 20 observations in the ASHE and calculating their coverage, and then relating that coverage to characteristics of those firms that we observe in the ABS such as average pay, industry and employment. We then use a least absolute shrinkage and selection operator (LASSO) regression to select the most relevant predictors, and use the selected model to predict firm-level coverage for all firms in the ABS. Appendix A outlines this imputation procedure in detail and assesses its accuracy. We use our imputation for our analysis of firms' pay practices, contractual arrangements and survival and employment (Sections 5–7). Our analysis of firms' wage distributions requires data on the wages of individual employees, and so for that we use coverage calculated directly in the ASHE.

4. How has the NLW affected firms' pay and occupational structures?

We start by documenting how the NLW has affected the distribution of wages within firms. The introduction of the NLW in April 2016 required firms to pay workers aged 25 and over a minimum of £7.20 per hour. In order to comply, firms had to increase pay for workers earning less than this. But minimum wages may also prompt firms to make wider changes to their pay structure. For example, firms may wish to increase the wages of workers earning just above the minimum wage in order to preserve pay differentials between these workers and minimum-wage workers.

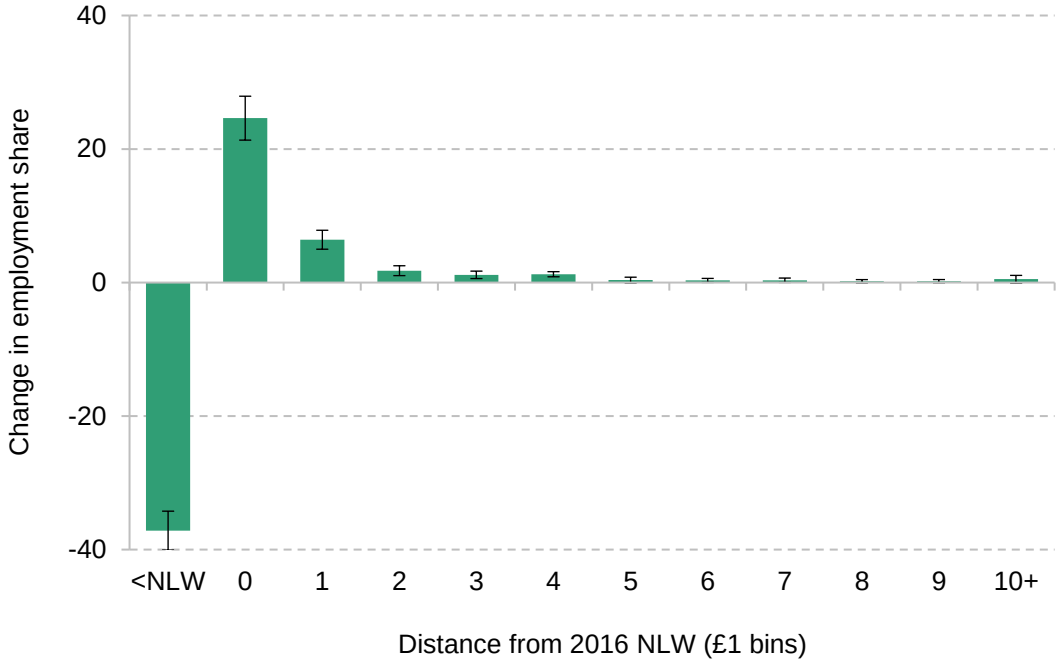
To assess changes in the firm-level wage distribution, we employ a bunching approach where the outcome variable is the share of employment in each of 12 wage bins (Cengiz et al., 2019; Giupponi et al., 2024). We calculate these employment shares using wage information in the ASHE, for a sample of large firms (more than 20 observations in 2015). Wage bins are defined relative to the 2016 NLW, in real (CPI-adjusted) terms.

Figure 1(a) plots the average change in the share of firms' workforces paid at each wage level, comparing the years before the NLW introduction (April 2012 to April 2015) with those after (April 2016 to April 2019). The chart is based on a sample of large firms for whom the coverage of the NLW introduction was at least 20%, meaning those firms that faced a significant cost shock when the NLW was introduced. We restrict the sample to large firms because in the UK we only have worker-level wage data on a subset of firms' employees, meaning we can only infer the wage distributions of large firms with confidence. Although large firms make up only a small proportion of the total number of firms, they account for a significant proportion of total employment. As a result, our sample covers 46% of employees in Great Britain, with one-fifth of these in firms that were heavily exposed to the NLW introduction.

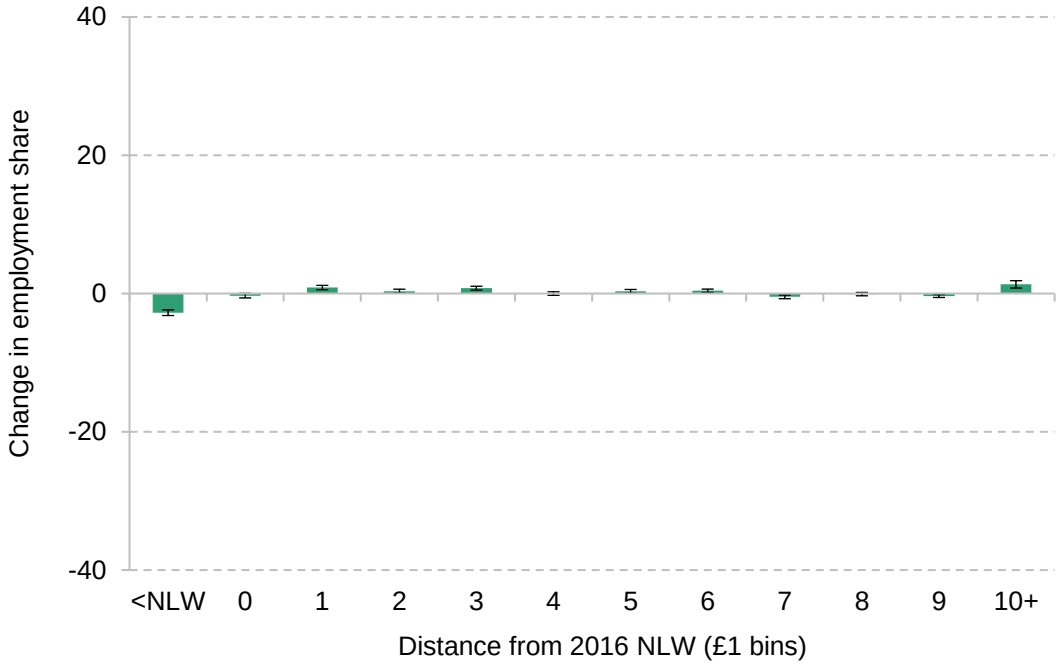
Among firms heavily exposed to the NLW introduction, we see that there was a sharp reduction in the share of employees paid below the 2016 NLW (in real terms), while there was a large increase in the share of employees paid at the 2016 NLW itself, along with smaller rises in the shares paid £1 and £2 above that minimum. There are no detectable changes at higher wage

Figure 1. Change in within-firm employment share by wage bin, pre- and post-NLW (ppt)

(a) Heavily exposed firms



(b) Less-exposed firms



Note: Sample of large firms (at least 20 observations in the ASHE 2015) corresponding to 46% of all worker–year observations. Pre-NLW refers to 2012–15 and post-NLW refers to 2016–19. Panel (a) is based on a sample of firms where NLW coverage in 2016 was at least 20% (19% of our sample). Panel (b) is based on a sample of firms with coverage below 20% (81% of our sample). Error bars show 95% confidence intervals. The *x*-axis measures distance to the 2016 NLW in 2016 prices (CPI).

Source: Authors' calculations using the ASHE, 2012–19.

levels. Figure 1(b) repeats the same analysis, but uses a sample of large firms for whom NLW coverage was less than 20% – the effects here are muted throughout the wage distribution. The lack of effects on higher earners and less-exposed firms is a good indicator that our empirical strategy is measuring changes due to the NLW itself, as we would not expect the policy to have large effects on workers earning much more than the NLW or on firms with few minimum-wage workers.

The patterns observed are consistent with the NLW generating substantial within-firm wage compression at the bottom of the income distribution. Workers earning less than the minimum wage benefited from increases in their earnings, but for the most part this resulted in more workers paid at the NLW. Increases in the £1 and £2 bins suggest that firms do raise the wages of some workers above the minimum, likely in order to mitigate narrowing pay differentials. These spillovers are much smaller than the direct effects further down however, meaning that the net effect is significant compression.[4]

We have also explored the extent to which changes in firms' wage distributions differ for different types of workers and firms. Figure B.1 in Appendix B shows the difference between high- and low-coverage firms for all workers (panel (a)), and then separately for incumbents (at least one year's tenure; panel (b)) and new starters (less than one year's tenure; panel (c)). We see that spillover effects were slightly larger among incumbent employees than among new hires. This result echoes findings at the market level (across all workers rather than within firms) by Cengiz et al. (2021) and suggests that spillovers may reflect relative pay concerns within the firm (Dube, Giuliano and Leonard, 2019) rather than search or bargaining frictions (Flinn, 2006). Table 1 shows the association between changes in the employment share in four wage bins and the coverage (measured continuously) of the 2016 NLW. As before, we observe a sharp reduction in the share of the workforce paid below the minimum wage, and a corresponding increase in the share paid up to £2.99 above the minimum. We detect no change in the share of the workforce paid £3 or more above the minimum wage. The table also shows specifications where we allow for different associations between different types of firms. We see that spillovers are relatively smaller amongst the most heavily exposed firms – those where the 2016 NLW coverage was at least 40%. Spillovers were bigger among public-sector firms. There is no evidence that unionised firms saw bigger spillovers than non-unionised ones.

[4] Subsequent increases in the NLW between 2017 and 2019 mean that the real distance between the current NLW and its 2016 level is positive rather than zero (although less than one). This means that spillovers after 2016 may be overstated slightly.

Table 1. Association between coverage and change in employment shares

	Below NLW	£0–£0.99 above NLW	£1–£2.99 above NLW	£3+ above NLW
Overall				
Coverage × POST	−0.00727***	0.00616***	0.00119***	−0.0000766
	(0.000285)	(0.000335)	(0.000280)	(0.000194)
By coverage				
5–20% × POST	−0.0706***	0.0141*	0.0417***	0.0148**
	(0.00628)	(0.00788)	(0.00778)	(0.00703)
20–40% × POST	−0.236***	0.136***	0.0859***	0.0142
	(0.0165)	(0.0235)	(0.0209)	(0.0140)
40%+ × POST	−0.400***	0.333***	0.0704***	−0.00315
	(0.0187)	(0.0234)	(0.0154)	(0.0119)
By public v. private sector				
Coverage × POST	−0.00763***	0.000737	0.00612***	0.000769
	(0.000524)	(0.000900)	(0.000843)	(0.000968)
Coverage × POST × Private	0.000383	0.00570***	−0.00519***	−0.000886
	(0.000646)	(0.000959)	(0.000867)	(0.001000)
By whether unionised				
Coverage × POST	−0.00715***	0.00607***	0.00112***	−0.0000381
	(0.000309)	(0.000344)	(0.000262)	(0.000199)
Coverage × POST × Unionised	−0.000899*	0.000639	0.000502	−0.000242
	(0.000515)	(0.000644)	(0.000557)	(0.000326)
Number of firms	6,032	6,032	6,032	6,032

Note: Sample of large firms (at least 20 observations in the ASHE 2015). Percentage point changes. Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by p). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Source: Authors' calculations using the ASHE 2012–19.

Another way to measure pay differentials within firms is to use wage ratios. Wage ratios are a measure of wage inequality between workers at different points in the firm's wage distribution. Table 2 shows estimates for the effect of the NLW introduction on wage ratios within firms with differing levels of exposure to the NLW, relative to the least-exposed firms (those with less than 5% coverage).

Table 2. Change in within-firm wage ratios relative to 'least-exposed' firms (<5% coverage)

Firm coverage	Outcome		
	90:10 ratio	50:10 ratio	90:50 ratio
5–20% Coverage × POST	−0.161***	−0.085***	0.011
	(0.044)	(0.018)	(0.026)
20–40% Coverage × POST	−0.253***	−0.060***	−0.101*
	(0.073)	(0.018)	(0.055)
40–100% Coverage × POST	−0.089	0.017	−0.082*
	(0.062)	(0.018)	(0.043)
Observations	6,032	6,032	6,032

Note: Sample of large firms (at least 20 observations in the ASHE 2015). Changes in levels. Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by p). *p < 0.10; **p < 0.05; ***p < 0.01.

Source: Authors' calculations using the ASHE 2012–19.

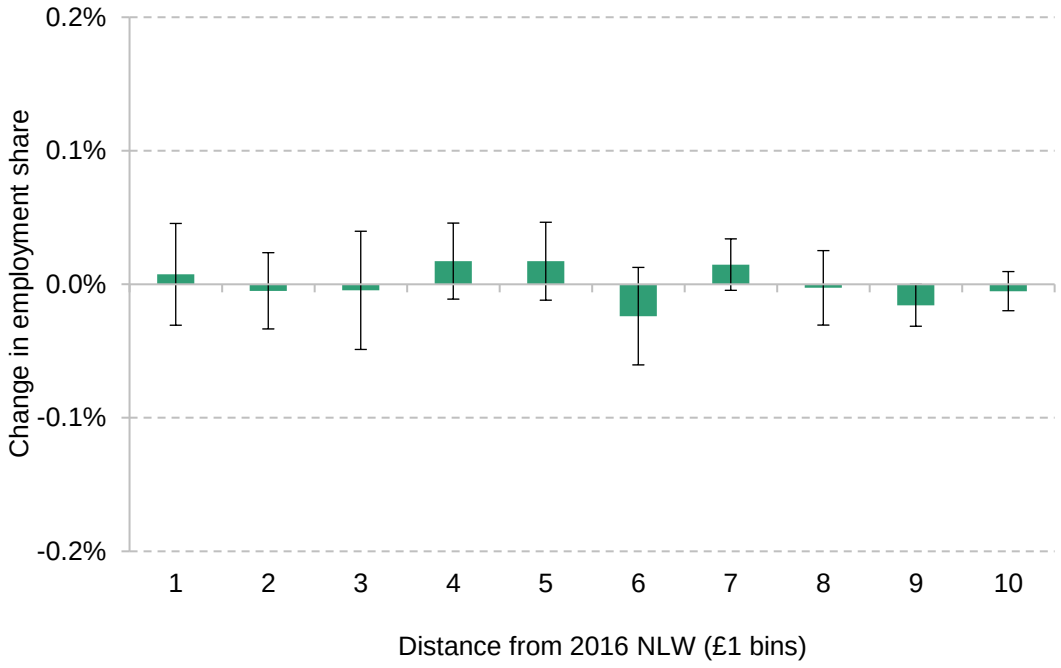
We find that the NLW led to declines in the 90:10 and 50:10 ratios for less-exposed (5–20% coverage) and moderately exposed (20–40% coverage) firms, but not for highly exposed firms (40–100% coverage). This is because the majority of workers in the highly exposed firms earn at or near to the minimum wage, and so there are limited differentials to be reduced. There is evidence of a fall in the 90:50 ratio for the moderately and highly exposed firms, showing that effects can extend far up the wage distribution in firms with many minimum-wage workers.

So far, we have considered the impact of the introduction of the NLW on within-firm wage distributions. We now turn to firms' occupational structures. Survey evidence for the UK suggests that some firms have responded to wage compression by changing their organisational structures and cutting back on rungs on the job ladder above the minimum to maintain pay differentials between staff levels (Low Pay Commission, 2020). In order to capture changes in occupational structure, we group occupations into deciles (tenths) based on the nationwide median wage in that occupation before the introduction of the NLW. We then use the share of employment in each of these occupation–wage groups as a proxy for the occupational structure of the firm. We can then use these occupation–wage deciles in the same way that we used wage bins in the wage analysis, comparing changes in each decile between firms more and less exposed to the NLW introduction.

In Figure 2, we see that there is no significant association between the coverage of the 2016 NLW and changes in the employment of various occupation deciles after 2016. This implies that the NLW did not lead to changes in firms' structure measured in this way. This finding is in

accordance with Forsythe (2023), who finds that US firms did not change occupational structure in response to changes in the minimum wage. That said, we cannot rule out the possibility of more subtle changes – wage hierarchies are difficult to observe in survey data containing only a subset of employees, and the removal of grades on a pay scale may not show up in occupational changes in the data.

Figure 2. Association between NLW coverage (continuous) and change in employment share by occupation–wage decile



Note: Sample of large firms (at least 20 observations in the ASHE 2015) corresponding to 46% of all worker–year observations in the ASHE. Error bars show 95% confidence intervals. Occupation–wage decile based on pre-NLW median wage for each three-digit SOC code.

Source: Authors' calculations using the ASHE 2012–19.

In this section, we have considered the effects of the NLW on within-firm wage distributions and organisational structures. We find that the NLW led to significant pay compression, with small spillovers up to £2 per hour above the 2016 NLW. This was the case among all types of firms we considered, although there were small differences in the extent of spillovers between firms more and less affected by the policy, as well as between public- and private-sector firms. We find no effect on firms' occupational structures, suggesting that any changes in firms' job ladders must be subtle enough not to be detected by our occupation-based measure.

In the next two sections, we consider alternative margins along which firms may respond to the NLW introduction: the use of hourly or incentive pay and the use of outsourcing.

5. Have firms adjusted their pay practices in response?

One worry about narrowing pay differentials is that it reduces incentives for low-paid workers to progress, or lowers morale among higher-paid workers. Preserving differentials throughout the wage distribution when there are increases in the minimum wage can be very costly, and in the previous section we saw that firms did so only partially in response to the NLW rises between 2016 and 2019. One option for firms to incentivise effort could be to change the employment contracts they offer, making more use of paying workers by the hour or using incentive pay.[5] In this section, we present analysis showing how the introduction of the NLW in 2016 changed the use of these two types of payment. We consider three different outcomes: receipt of any incentive pay, incentive pay as a share of total pay and being paid by the hour. Box 1 details the exact definitions used. These measures come from the pay information in the ASHE, and we use our imputed measure of coverage to provide a measure of coverage for a greater number of employees.

Box 1. Our measures of pay practices

In this analysis, we consider three outcomes, defined as follows.

- **Receipt of incentive pay.** Indicator variable for whether worker received any incentive payments. Incentive payments include profit sharing, productivity or performance-related pay, other bonuses or commission.
- **Incentive pay as a share of total pay.** Amount of incentive pay as a proportion of total pay. Incentive pay is defined the same as above.
- **Payment by the hour.** Indicator variable for whether worker was paid based on an hourly rate. Workers not paid by the hour likely receive a salary.

[5] In addition to acting as an incentive mechanism, payment by the hour could also be used by firms to reduce the number of hours their employees work, or may be helpful in ensuring compliance. Figure B.2 in Appendix B shows that the NLW led to reductions in total hours worked by workers earning below the minimum, and increases in hours worked just above, but no changes for workers earning more than £1 above the NLW. Overall, we do not find that the NLW led firms to reduce the total number of hours worked.

Table 3 shows the share of workers receiving either incentive pay or being paid by the hour. First, considering the share receiving incentive pay, we find that around 5% of all workers received some incentive pay as part of their total pay, with those in low-coverage firms less likely than those in high-coverage firms. The patterns look very similar if we just consider workers earning up to £5 over the 2016 NLW. For payment by the hour, we see that it is far more prevalent than incentive pay, and it is more pronounced among lower-paid workers. We also note that workers in high-coverage firms are much more likely to be paid by the hour than workers in low-coverage firms.

To assess whether firms changed their use of incentive pay and payment by the hour, we compare whether there have been differential changes between firms more and less exposed to the NLW introduction since 2016. As pay compression has largely occurred at the bottom of firms' wage distributions, we conduct the analysis on a sample of workers earning up to £5 above the 2016 NLW (2016 prices) in order to reduce noise from changes further up the distribution. Table 4 shows our estimates for the impact of the NLW on firms' use of the three payment types, estimated using equation (1).

Table 3. Share of workers receiving incentive pay or paid by the hour in 2015

	All workers		Workers paid up to NLW + £5	
	Did not receive (%)	Received (%)	Did not receive (%)	Received (%)
Incentive pay				
All	94.27	5.73	94.32	5.26
High coverage	93.09	6.91	93.57	6.43
Low coverage	94.58	5.42	94.74	5.26
Payment by the hour				
All	61.46	38.54	45.20	54.80
High coverage	31.62	68.38	24.53	75.47
Low coverage	69.27	30.73	56.89	43.11

Note: Sample of workers in firms for whom we have a direct or imputed measure of coverage.

Source: Authors' calculations using the ABS 2015 and the ASHE 2012–19.

Table 4. Impact of NLW introduction on firms' use of incentive pay and payment by the hour, workers earning up to 2016 NLW + £5

	Incentive pay	Incentive pay share	Paid by hour
All			
High coverage × POST	0.0329*	0.000985	0.00287
	(0.0174)	(0.00112)	(0.0116)
Observations	454,383	450,696	454,383
No pre-reform use			
High coverage × POST	0.0338**	0.00269***	0.0914***
	(0.0145)	(0.000968)	(0.0276)
Observations	147,408	145,897	43,391
Some pre-reform use			
High coverage × POST	0.0281	−0.0000617	0.00788
	(0.0186)	(0.00100)	(0.0120)
Observations	304,101	301,974	408,118

Note: Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by p). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. For some firms, we cannot establish pre-reform use and so the sum of observations for 'no use' and 'some use' is less than for 'all'.

Source: Authors' calculations using the ABS 2015 and the ASHE 2012–19.

The first row shows results for the impact of the NLW on workers in all types of firms. For each of our outcomes, we do not find a statistically significant change (at the 5% level). This suggests that, among all workers, the NLW does not lead to increases in the share of workers receiving incentive pay, the amount of incentive pay received, or the share of workers being paid by the hour. But there may be differences between different firms' abilities to increase usage of these types of contracts. Some firms may have already used incentive pay and payment by the hour in situations where it was applicable, and so had little scope to use these more in response to the NLW introduction.

We test whether these types of differences exist by splitting our sample in two. For each outcome, we look at the impacts of the NLW on firms that did not use the payment type before the NLW introduction and on firms that did use the payment type before the NLW introduction.[6] We see that among firms that did not use incentive pay before the NLW introduction, the NLW led to a 3.4ppt increase in the proportion of workers receiving some incentive pay and a 0.3ppt increase in the value of incentive pay as a share of total pay. We also find that the NLW led to a 9.1ppt increase in the share of workers paid by the hour in firms that did not previously pay workers based on an hourly rate. By contrast, we do not find that firms that were already using incentive pay or payment by the hour changed their use of these because of the NLW introduction. This is consistent with such firms having little room to increase their usage, whereas firms not using these payment types were able to adopt them to help incentivise workers.

Table B.1 in Appendix B shows the estimates for the impacts on higher-earning workers, those earning more than £5 above the 2016 NLW. We do not find significant changes in incentive pay among firms not already using these practices, which supports the idea that firms adopted these practices as a way to deal with wage compression among low-paid workers. We still find a large and significant increase in payment by the hour though, suggesting that this might be driven by other factors, such as the ability to have more control on hours worked.

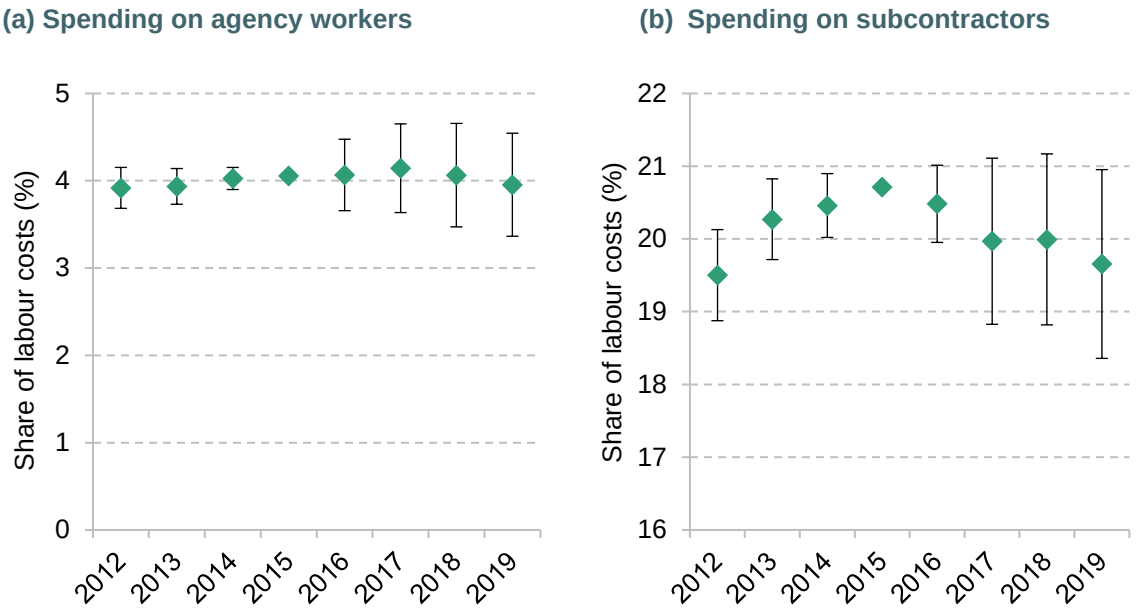
[6] As we approximate whether firms used each payment type based on a subset of employees, smaller firms are more likely to be misclassified. We add additional controls for firm size before and after the NLW in order to stop this biasing our results.

6. How has the NLW affected firms' use of alternative contractual arrangements?

The NLW required many firms to significantly increase their wage bill simply in order to comply, with even greater spending required to preserve pay differentials between low-paid workers. One option for firms looking to make savings when the minimum wage is increased is to make use of alternative contractual arrangements, and to outsource tasks to workers outside the firm. Employing agency workers – employees of an agency that can be hired on a temporary basis by other firms – allows firms to avoid committing in advance to paying employees for a certain number of hours each week or month at the minimum wage. Using subcontractors instead of hiring employees allows firms to bypass paying the minimum wage altogether, because subcontractors are classed as self-employed workers and are thus not covered by minimum-wage legislation. In this section, we explore the extent to which this happened in response to the NLW, combining information on firms' spending on agency workers and firms' spending on subcontractors in the ABS with our measures of coverage (either using the ASHE or imputed).

Figures 3(a) and (b) show, respectively, how firms' spending on agency workers and subcontractors – as a share of their total spending on workers (the cost of their employees plus agency workers or subcontractors) – evolved between 2012 and 2019, for a sample of large firms (generally those with more than 250 employees) for whom we have data every year. The average spend on agency workers in this sample was around 4% of total employment costs, while for subcontractors it was around 20%. Therefore, around one-quarter of the labour costs of these large firms came from paying external workers to do tasks rather than workers employed by the firm. These shares remained relatively constant over our sample period, although spending on subcontractors did rise by 1ppt between 2012 and 2015, falling away after that.

Figure 3. Share of spending on outsourcing, 2012–19



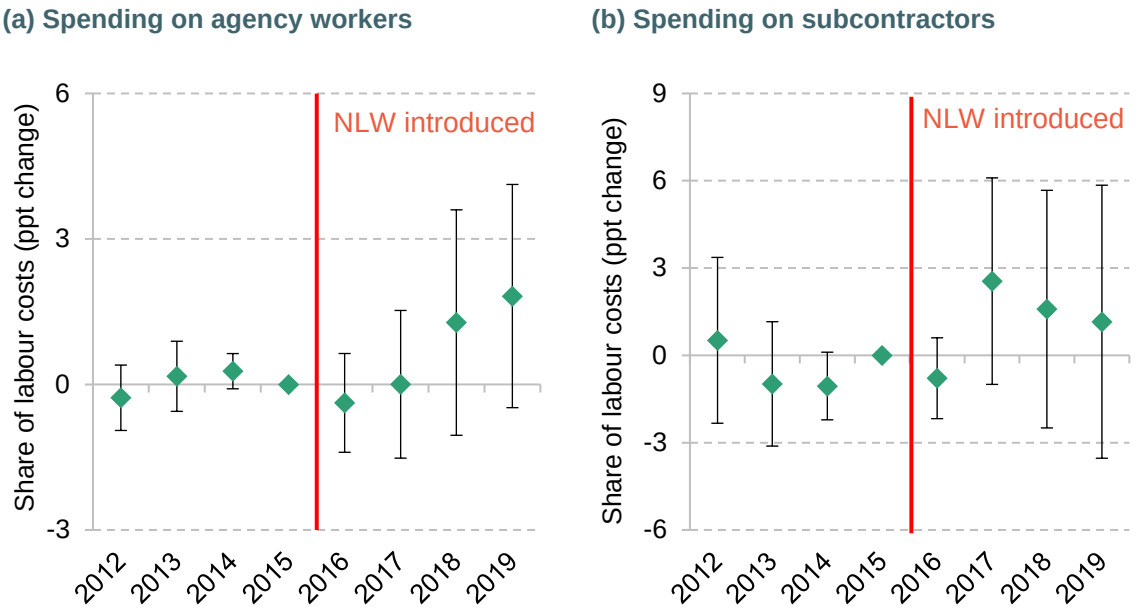
Note: Based on a balanced panel of large firms, weighted by employment costs. Spending as a share of total salaries and spending on agency and subcontractors. Error bars show 95% confidence intervals.

Source: Authors' calculations using the ABS 2012–19.

Our finding of relative stability in the share of firms' spending on agency workers and subcontractors over time is at odds with Judge and Slaughter (2023), who find that use of these contractual arrangements rose significantly during the 2010s. One reason for this could be that our sample is based only on large firms, for which we have reliable data. But another reason for the discrepancy could be that our measures of spending are based on firm balance sheet data from the ABS, whereas their measures use workers' responses to the UK Labour Force Survey. Increased awareness of different contract types may have contributed to the rise in the proportion of workers reporting being an agency worker or subcontractor. While workers may not know exactly who their pay packet comes from, or the different definitions of contract types, it is much more likely that firms are aware and record it accurately on their balance sheets. Therefore, this type of effect is unlikely to play a role in the trends presented here.

We use our usual strategy to assess whether firms changed their use of agency workers and subcontractors in response to the 2016 NLW, comparing changes in highly exposed and less-exposed firms before and after the introduction. Figures 4(a) and (b) present event studies for spending on agency workers and subcontractors, respectively, where each dot represents a coefficient estimate of the difference in spending on outsourcing in high-coverage firms relative to low-coverage firms, relative to 2015. As usual, high-coverage firms are defined as those with at least 20% of employees earning below the 2016 NLW in 2015.

Figure 4. Impact of NLW on firms' contractual arrangements, 2012–19



Note: Estimates weighted by employment costs. Spending as a share of total salaries and spending on agency and subcontractors. Error bars show 95% confidence intervals.

Source: Authors' calculations using the ABS 2012–19 and the ASHE 2015.

In the years before the NLW introduction, the coefficients are close to zero and not statistically significant, suggesting that trends were similar for firms more and less affected by the NLW. This is reassuring and gives us confidence that we can interpret differences between these firms after the NLW introduction as causal. For agency workers, the change in spending between 2015 and 2019 was 1.8ppt higher in high-coverage firms compared with low-coverage firms. Similarly, we observe that spending on subcontractors fell by slightly less in high-coverage firms. These changes are not statistically significant at standard levels, although the *p*-value for the 2019 estimate of the impact on spending on agency workers is close to the 10% significance threshold, at 0.12.

As with firms' adoption of alternative pay practices, it is likely that some firms may have higher propensity to use alternative contractual arrangements than others, and this could mean that there are impacts on a subset of firms that do not appear when examining all firms. Therefore, we conduct heterogeneity analysis where we allow for the NLW to have different impacts on different types of firms. Table 5 shows estimates, allowing for differential impacts on firms that had used that type of contractual arrangement before (column 2), firms that had used these arrangements more than other firms in the same industry (column 3), and those in industries that used these arrangements more (column 4). One might imagine that firms that had used agency workers or subcontractors previously, and particularly those that used them intensively, may be better set up to outsource a larger share of tasks in response to an increase in the minimum wage.

Similarly, firms in industries that tend to outsource more may have more tasks that can be outsourced easily, which could allow them to make bigger adjustments after the NLW introduction. Despite this, we do not see strong evidence that these types of firms responded differently to the 2016 NLW than other types of firms. All but one of the interactions between our coefficient of interest (High coverage × POST) and indicators for these types of firms are not statistically significant at the 5% level.

Table 5. Impact of NLW introduction on firms use of incentive pay and payment by the hour, workers earning up to 2016 NLW + £5

	Baseline	Firm previously used	High pre-NLW firm use	High pre-NLW industry use
Spending on agency workers				
High coverage × POST	0.550	−0.778*	0.586	−0.718
	(0.786)	(0.448)	(1.359)	(0.594)
× Firm used before		1.477*		
		(0.855)		
× High firm use			−0.169	
			(1.270)	
× High industry use				2.699*
				(1.404)
Spending on subcontractors				
High coverage × POST	1.333	0.269	0.238	2.264
	(1.448)	(0.674)	(1.118)	(1.481)
× Firm used before		1.451		
		(1.272)		
× High firm use			1.596	
			(1.126)	
× High industry use				−3.373**
				(1.520)
Observations	83,976	83,976	83,976	83,975

Note: Coefficients indicate percentage point changes. Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by *p*). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Source: Authors' calculations using the ABS 2012–19 and the ASHE 2015.

This section has employed novel data on firms' spending on agency workers and subcontractors to explore whether firms used alternative contractual arrangements to deal with the cost shock presented by the NLW introduction. We do not find evidence that firms changed their utilisation of either agency workers or subcontractors, even among firms that we might consider more likely to do so *ex ante*. It is important to highlight that this analysis is based on large firms (generally those with at least 250 employees) because we require a measure of NLW coverage – either measured directly or imputed (see Appendix A). As a result, the findings here are only relevant for these types of firms, although these firms do account for the majority of UK employment. While we do not find any statistically significant effect, the estimates are not highly precise. More detailed data on firms' wage structures would allow us to obtain more precise estimates of minimum-wage coverage and have greater confidence in our conclusions, while improved sample coverage of smaller firms will be necessary in order to assess potential impacts on these types of firms.

7. How has the NLW affected firm survival and firm employment?

In the analysis discussed so far, we have focused on how existing firms respond to changes in the minimum wage. But one potential outcome of a significant increase in the national minimum wage is that firms are forced to close because of the higher costs. This could affect our results, because our estimates of outcomes in the years after the NLW introduction are based on a sample consisting only of firms that remained open. If the firms that closed were systemically different to those that remained open, then our estimates could be picking up compositional changes in the sample of firms, rather than firm responses to the change in the minimum wage. A similar issue could arise when we look at worker-level outcomes if firms made large changes to the size of their workforce. In this section, we test what impact the NLW had on firm survival and firm-level employment in large firms. We draw on the administrative information on firms and their employment in the BSD, for those firms for which we have measures of NLW coverage.

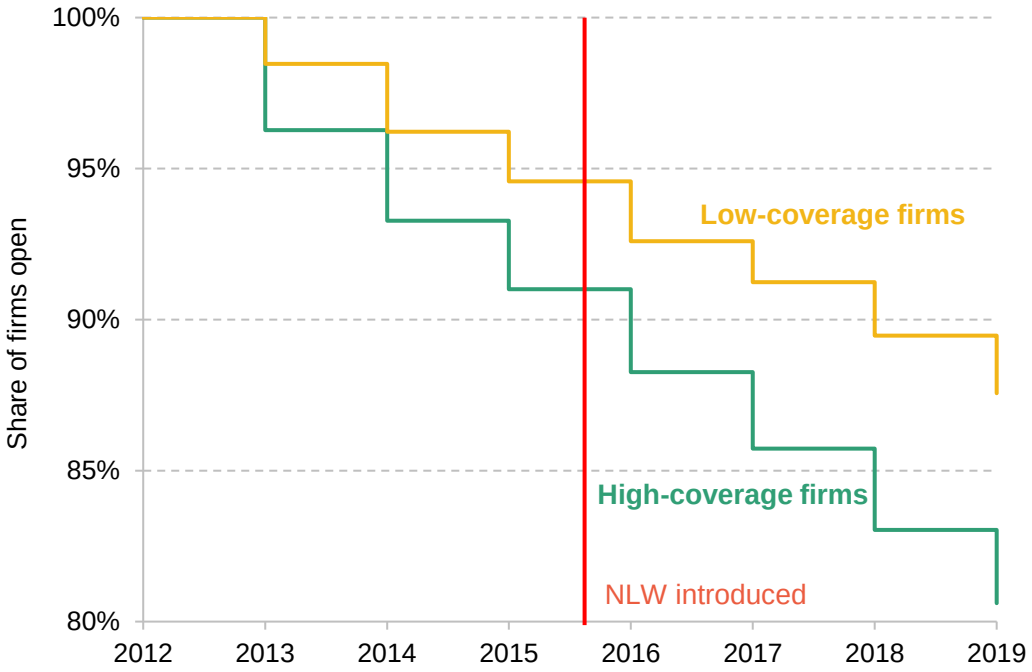
Firm survival

In order to assess the impact of the NLW on firm survival, we look at a sample of large firms (more than 250 employees) that were open in 2012. Figure 5 shows the survival rate of these firms up to 2019, split by the coverage of the 2016 NLW. We use information on firms from 2011 in order to assign them as either high- or low-coverage firms, because more recent information is not always available for firms that closed in 2013.[7]

A smaller proportion of high-coverage firms remained open in 2019 than low-coverage firms (82% compared to 88%). But this is a consequence of a higher rate of closure throughout our sample period, both in the years leading up to the NLW introduction and in the years afterwards. This suggests that it wasn't the NLW introduction that led firms to close. Instead, some other features of high-coverage firms are likely resulting in a higher likelihood of closing each year.

[7] The ABS, the source of our information for the imputation, collects data over the year following the year of interest. Therefore, using data any later than ABS 2011 for our imputation would require firms to be open in our sample period and directly affect our results. For this reason, we use the ABS 2011 here.

Figure 5. Firm survival rate, by firm-level coverage of the 2016 NLW



Note: Coverage of the 2016 NLW imputed based on firm information from 2011.

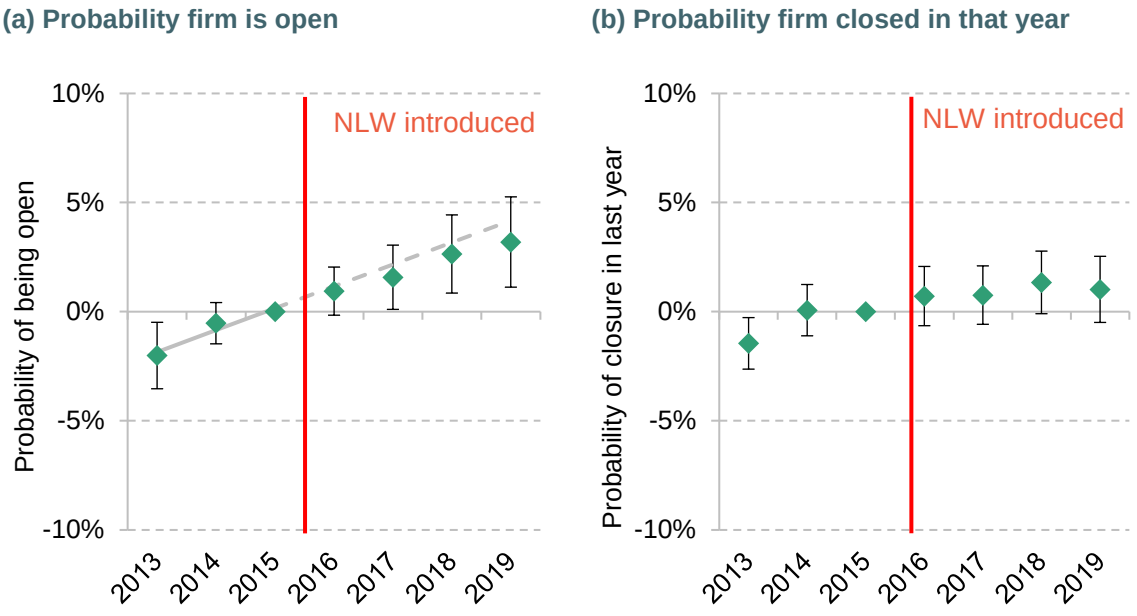
Source: Authors' calculations using the BSD 2012–19, the ABS 2011 and the ASHE 2015.

This difference is not explained by the basic firm-level information available in our data, such as firm age, industry and number of employees

Figure 6(a) shows the impact of the NLW more clearly, by plotting event study estimates of the impact of the NLW on the probability of a firm being open. We include controls for firm age, industry and employment. As in Figure 5, we find that there are persistent differences in the probability of being open between high- and low-coverage firms prior to the NLW introduction, shown by the fact that the estimates trend upwards. This continues after the introduction, although the slope is slightly shallower, shown by the fact that the points lie below the dotted grey line. This suggests that the NLW may have slightly increased the likelihood that firms close, although 95% confidence intervals lie relatively close to the line.

Instead of the probability of being open in a given year, Figure 6(b) plots the event study for the probability of a firm closing in the past year. For both high- and low-coverage firms, the rate of closure was roughly the same each year between 2012 and 2019, even though that rate was higher for high-coverage firms than low-coverage firms. Taking both pieces of evidence into account, it does not seem that the NLW has had significant impacts on the rates of survival of the large firms that we have analysed in the earlier sections of this report.

Figure 6. Impact of NLW on firm survival, 2012–19



Note: Error bars show 95% confidence intervals. Estimates include controls for industry, firm age and employment.

Source: Authors' calculations using the BSD 2012–19, the ABS 2011 and the ASHE 2015.

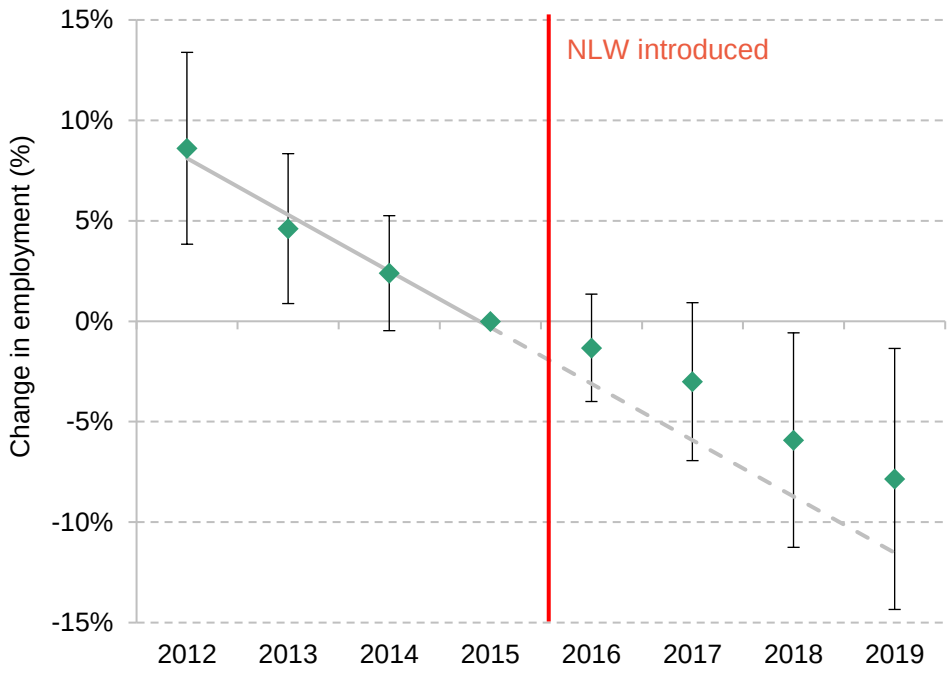
Firm employment

We use a similar sample to explore whether the NLW led to any changes in firm-level employment.[8] The main difference is that we restrict our sample to those large firms that were open throughout our period of interest, 2012 to 2019. Having established that the NLW has not led to higher numbers of closures, we use the same set of firms each year so that our sample composition remains the same.

Figure 7 shows event study estimates for changes in firm-level employment. The estimates show a downward trend between 2012 and 2019, reflecting the fact that employment was falling by more among high-coverage firms than among low-coverage firms. But there do not seem to be any differences between the trend after the NLW introduction compared with before the NLW introduction, shown by the fact that the estimates are close to the grey line, which projects the pre-NLW trend forwards. This suggests that the NLW also did not lead to significant changes in firm-level employment among large firms.

[8] We use ABS 2010 information to impute firm-level coverage, because the use of later years leads to selection bias. This selection likely leads to differential mean reversion between high- and low-coverage firms, which biases our results.

Figure 7. Impact of NLW on firm-level employment, 2012–19



Note: Error bars show 95% confidence intervals.

Source: Authors' calculations using the BSD 2012–19, the ABS 2010 and the ASHE 2015.

Given that the analysis in this report has concentrated on the impacts of large firms – those with more than 250 employees – it seems reasonable that even a significant cost shock such as the introduction of the NLW did not lead to changes in firm survival or employment. This suggests that our methodology of looking at existing firms' responses to the NLW introduction is likely to capture the majority of the impact of the NLW through changes to pay and contractual arrangements, at least for this set of firms.

8. Conclusions

This report has offered an assessment of the impact of the NLW introduction on firms' internal pay, occupational and contractual structures. We find that workers earning up to £2 above the new minimum saw increases in their wages, highlighting that within-firm spillovers are an important driver of the spillovers already documented at the market level. Despite this, the NLW still led to significant pay compression among low-paid workers, which could negatively impact workers' incentives to progress. However, we do not find any evidence that firms made changes to their occupational structure as a way to deal with this.

We present the first evidence on the impact of minimum wages on firms' use of incentive pay and payment by the hour. We find that firms that did not previously use these pay practices increased their usage in response to the NLW introduction, while there was no impact on firms already using them. This highlights that firms looked to other methods to encourage workers in the face of narrowing pay differentials between those on low pay, but the majority of large firms already use these payment types so their role may be limited.

We also use novel data on firms' spending on agency workers and subcontractors to assess whether firms turned to alternative contractual arrangements as a way to either deal with higher employment costs or bypass the minimum wage entirely. We do not find evidence that firms heavily exposed to the NLW increased their usage of either contract type after the introduction. Agency work and self-employment are subject to lower job security and weaker career progression, so the lack of response here is likely positive for workers' long-term welfare.

While the analysis here sheds light on wider firm responses to minimum wages, the paucity of data in this area still presents a challenge to researchers. Analysis of the impact on UK firms' wage distributions can only be done for large firms, and while our imputation allows us to expand the sample for analysing pay practices and outsourcing, it is still mostly limited to firms with more than 250 employees. Although our sample of large firms is representative of the firms that hire the majority of UK workers, smaller firms may be less able to deal with the effects of the minimum wage, and so the null results presented here may not extend to them.

Appendix A. Details on imputation of exposure to the NLW

The lack of data on the full wage distribution of firms in the UK makes it difficult to work out how exposed different firms are to increases in the minimum wage. A typical way to measure exposure is to compute a firm's coverage – that is, the share of a firm's workforce paid below the minimum wage just before its introduction or increase. The ASHE, the main source of wage data for the UK, is only a 1% sample of employees, so we can only use it to calculate coverage of the NLW for very large firms (generally at least 2,000 employees) for whom we can observe a sufficient number of employees. Previous work looking at the impact of minimum wages on firm-level outcomes has used average earnings as a proxy for exposure (Draca, Machin and Van Reenen, 2011), but this is a less accurate measure of the impact of the minimum wage on a firm's wage bill. Here, we describe a novel procedure combining ASHE and ABS data to impute coverage of the NLW for a much larger set of firms.

Our methodology involves using firm-level characteristics in a second dataset, the ABS, matched to the ASHE, in order to predict the coverage that we measure in the ASHE. We then extend that prediction to the larger set of firms in the ABS. The basic procedure we follow is outlined below.

- Calculate firm-level coverage of the NLW in the ASHE 2015 for firms with at least 20 observations.
- For firms in the ASHE that we can match to the ABS, estimate the prediction model using variables in the ABS as predictors of coverage calculated in the ASHE.
- Impute coverage for all firms in the ABS using firm-level characteristics in the ABS as inputs for the prediction model.

Computing coverage using ASHE data

We begin by computing the coverage of the NLW for very large firms in the ASHE 2015, specifically those for which we observe at least 20 employees. As the ASHE is a 1% sample of employees, this implies firms with at least 2,000 employees. With this number of employees, we can be more confident that the coverage we compute is accurate. We calculate coverage as the share of observed employees earning less than the 2016 NLW in the ASHE 2015, as shown in the following equation:

$$Coverage_j = \frac{\text{number of observed workers earning} < \text{2016 NLW}}{\text{number of observed workers}} \quad \text{(A.1)}$$

Predicting exposure using the ASHE–ABS linkage

In order to recover predictors of firm-level coverage, we use the ASHE–ABS linkage to estimate a model of the following form, where $Coverage_j$ is the coverage estimated using the ASHE and the regressors are observed in the ABS:

$$Coverage_j = f(X_j)'\lambda + v_j. \quad \text{(A.2)}$$

The potential predictors that we include (X_j) are: average earnings (linear and quadratic); industry; region; region interacted with industry; average earnings (linear and quadratic) interacted with industry; employment count (linear and quadratic); ratio of employment costs to other costs; ratio of social security payments to gross wages; legal status; whether multiple local units; whether conducted R&D. We estimate λ using a LASSO to select relevant predictors.

In order to test the importance of each of our predictors of coverage, we run our LASSO using a subset of predictors. Table A.1 shows the impact on the R^2 of adding progressively more predictors to our model. The R^2 captures the fraction of variation in coverage that our predictors explain. Almost half of the variation is explained by firms' average earnings (48%), but adding in controls for industry and region significantly increases the explanatory power of our model (71%). This suggests that our prediction model is likely to capture more of the variation in exposure than average earnings alone would.

Table A.1. LASSO model fit, adding more predictors

	ASHE coverage					
Average earnings	×	×	×	×	×	×
Industry fixed effects		×	×	×	×	×
Region fixed effects			×	×	×	×
Industry × Region fixed effects				×	×	×
Industry × Average earnings					×	×
Legal status, R&D, employment, social security						×
R^2	0.480	0.589	0.602	0.673	0.709	0.736

Note: Sample of 528 firms with at least 20 observations in the ASHE 2015 that can be matched to the ABS 2015. Includes quadratic terms for average earnings and employment.

Source: Authors' calculations using the ABS 2015 and the ASHE 2015.

Imputing exposure for firms in ABS

As a last step, we use firm-level characteristics in the ABS and the estimated λ to predict coverage for all other firms in the ABS (other than those for which we already have a measure of coverage from the ASHE). These are generally smaller firms than those we use in the ASHE.

Accuracy of imputation

We use split-sample validation to test the accuracy of our model. This involves running the LASSO on 75% of our linked ASHE–ABS sample, and then predicting coverage for the remaining 25%. The first row of Table A.2 shows the proportion of firms correctly assigned as high coverage using either a 20% or 10% threshold. The LASSO predicts coverage to a high degree of accuracy, correctly identifying 87% of firms when using the higher cut-off. The second row shows the share of high-coverage firms that are correctly identified if instead we predict coverage solely using average earnings. Using this method, less than 80% of firms are assigned correctly based on a 20% threshold, indicating that the LASSO predictor performs much better.

Table A.2. Split-sample validation, full predictors compared to average earnings

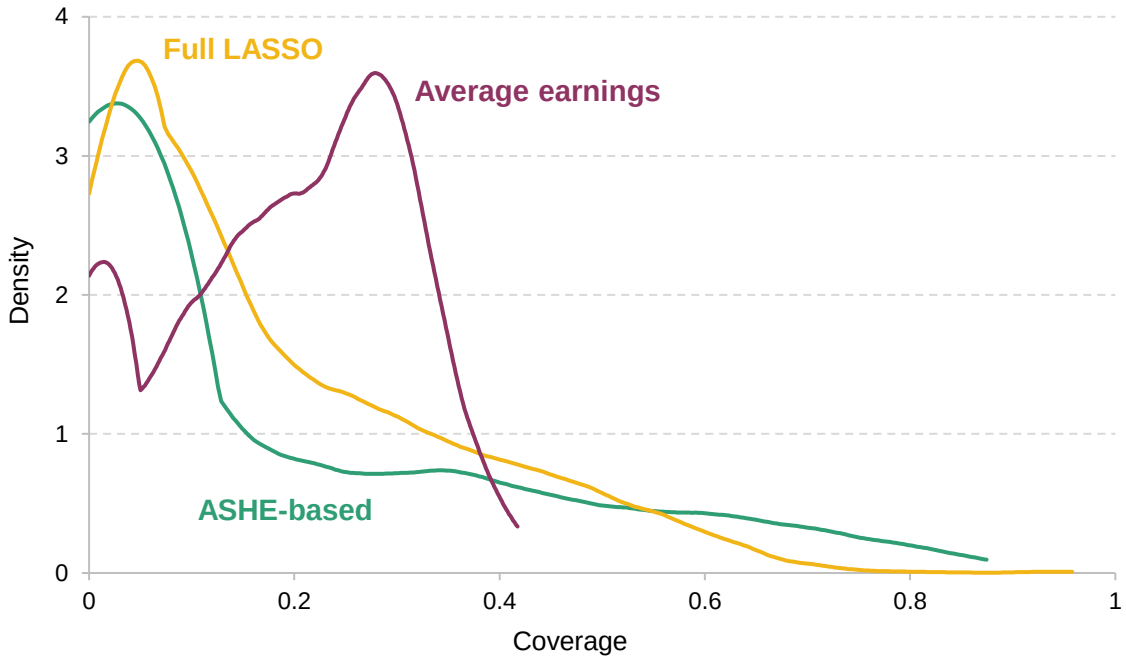
	High coverage ≥ 20%: correctly assigned	High coverage ≥ 10%: correctly assigned
LASSO with all predictors	87.4%	81.5%
Average earnings	77.8%	67.4%

Note: Sample of large firms observed in both the ASHE 2015 and the ABS 2015. 'LASSO with all predictors' shows the proportion of firms correctly predicted as high coverage based on our LASSO with all predictors. 'Average earnings' shows the proportion of firms correctly predicted by regressing coverage on average earnings.

Source: Authors' calculations using the ABS 2015 and the ASHE 2015.

We can also compare the distribution of imputed coverage with the distribution of coverage we observe in the ASHE. Figure A.1 shows that the distribution we predict looks much closer to the ASHE distribution than if we used average earnings to predict coverage instead. Still, our LASSO is unable to replicate the proportion of firms with zero coverage that we observe in the actual data.

Figure A.1. Density of ASHE-based and imputed coverage (matched firms)



Note: Sample of large firms observed in both the ASHE 2015 and the ABS 2015. 'ASHE-based' shows distribution of coverage calculated directly in the ASHE. 'Full LASSO' shows the distribution of coverage estimated by our LASSO with all predictors. 'Average earnings' shows distribution of coverage estimated by regressing coverage on average earnings.

Source: Authors' calculations using the ABS 2015 and the ASHE 2015.

Advantages of imputation

Table A.3 shows the number (and proportion) of firms in the ABS for which we have an estimate of coverage based directly on ASHE wage data, and the number for which we have an estimate using our imputation. The imputation greatly expands our sample. We can predict coverage for almost all ABS firms in 2015, and because the ABS repeatedly samples bigger firms, we have coverage predictions for at least 7,000 (15%) of firms in all other years of our period of interest.

This not only helps the precision of our estimates, but it also makes our sample more representative of the general firm population. This is because we can only calculate coverage in the ASHE for extremely large firms, generally those with at least 2,000 employees. The imputation therefore also helps give our findings greater external validity.

Table A.3. Sample sizes using the ASHE alone versus with ABS imputation

Year	Coverage estimated in ASHE		+ Imputation with 2015 ABS	
	No. of firms	% of firms	No. of firms	% of firms
2012	627	1%	7,223	15%
2013	626	1%	7,461	16%
2014	634	1%	12,512	26%
2015	640	1%	34,206	77%
2016	642	1%	12,708	29%
2017	634	1%	9,324	21%
2018	619	1%	9,289	21%
2019	618	2%	8,674	25%
All	5,040	1%	101,397	29%

Note: Numbers and shares of firms in the ABS for which we have a measure of coverage using that method.

Source: Authors' calculations using the ABS 2015 and the ASHE 2015.

Robustness

One concern with our approach is that because we estimate relationships between our predictors and coverage based on a sample of large firms, our imputation is using the wrong relationships when extrapolating to smaller firms. The extent of this issue is untestable, as we cannot accurately calculate coverage for smaller firms in the ASHE. But, to gauge the severity of this concern, we use equation (A.3) to estimate the wage response to ASHE-based and imputed coverage across firms of different sizes. In order to capture the wage effects of the minimum wage, we restrict the analysis to workers whose wages are up to £3 above the NLW.

$$\ln(Wage_{ijt}) = \beta Coverage_j * POST_t + \sigma_j + \gamma_t + \varepsilon_{jt}. \quad \text{(A.3)}$$

Table A.4 shows the wage responses we estimate. We find that the response is highly stable across the different imputation methods and firm sizes. This suggests that our imputation is performing well at identifying high- and low-coverage firms among smaller firms.[9]

[9] Results are robust to using different wage thresholds and a discrete measure of coverage.

Table A.4. Wage response estimates by coverage imputation and firm size, workers earning up to NLW + £3

	Hourly wage (logarithm)				
	(1)	(2)	(3)	(4)	(5)
Coverage × POST	0.115***	0.116***	0.110***	0.110***	0.108***
	(0.00736)	(0.00861)	(0.00717)	(0.0124)	(0.00855)
Coverage measure	ASHE + LASSO	ASHE	LASSO	LASSO	LASSO
Firm size	Any	≥2,000	<2,000	[1,000, 2,000)	<1,000
Observations	422,136	303,547	118,589	43,973	74,616

Note: Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by p). *p < 0.10; **p < 0.05; ***p < 0.01.

Source: Authors' calculations using the ABS 2015 and the ASHE 2015.

Extensions

In this appendix, we have described the imputation we use to produce the results presented in the report. But we have extended our methodology in several ways, helping to validate our baseline procedure and also highlighting the flexibility of this approach for future research. These include:

1. Imputing coverage for firms in ABS 2013–14

While our baseline approach just uses ABS 2015 data to predict coverage, this method does the same for firms in ABS 2013 and 2014, allowing us to have a coverage prediction for a larger number of small firms (because the ABS is a random sample, and not a panel, of smaller firms). The distribution of imputed coverage remains similar to the ASHE-based distribution when we do this. While this significantly increases sample size, there are no data (e.g. on pay practices or outsourcing) for most of these smaller firms after the NLW, limiting the usefulness of this extension for our analysis.

2. Imputing wage bill gap

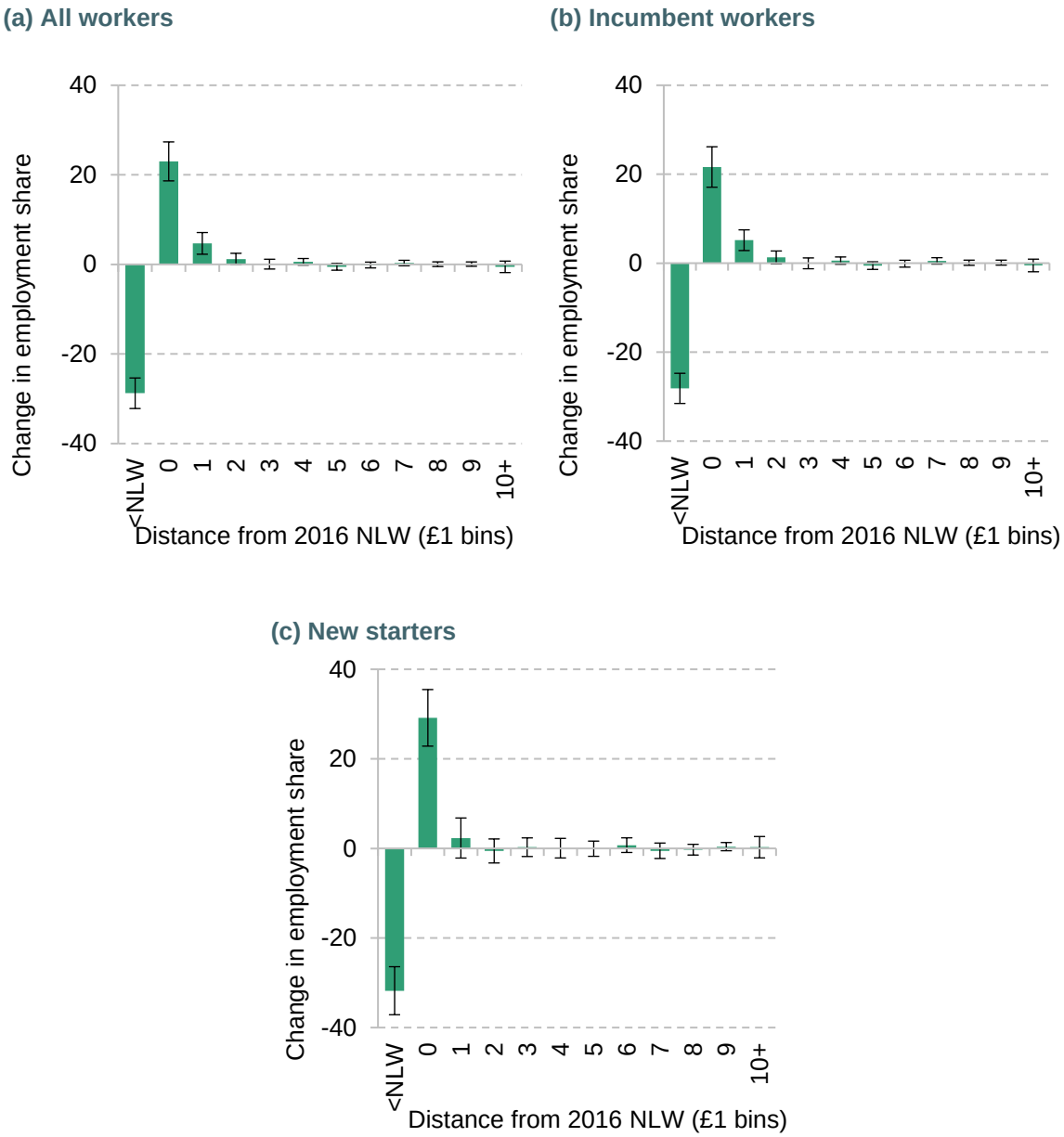
This method uses the wage bill gap (GAP) measure of exposure to the NLW rather than the coverage measure we have used throughout this report. The GAP is defined as the percentage increase in a firm's wage bill required to bring all workers earning below the NLW up to the NLW. We perform the same exercise as outlined above, and find that the GAP prediction is slightly less accurate than the coverage one, but our LASSO model still significantly outperforms solely using average earnings.

3. Imputing probability of firm having high coverage

Instead of predicting exposure (coverage or GAP) and then assigning firms as heavily or less exposed, this method directly imputes the likelihood of being highly exposed. To do this, we run the same LASSO prediction model but use a binary indicator for high/low exposure as the dependent variable. We then assign firms with a probability of more than 0.5 as heavily exposed. This method assigns 85% of ASHE–ABS firms correctly when using a 20% high-coverage threshold, almost as accurate as when imputing coverage directly. One disadvantage of this method is that it cannot be used more flexibly, as can be done with a continuous measure of each firm's exposure as our baseline offers.

Appendix B. Additional charts and table

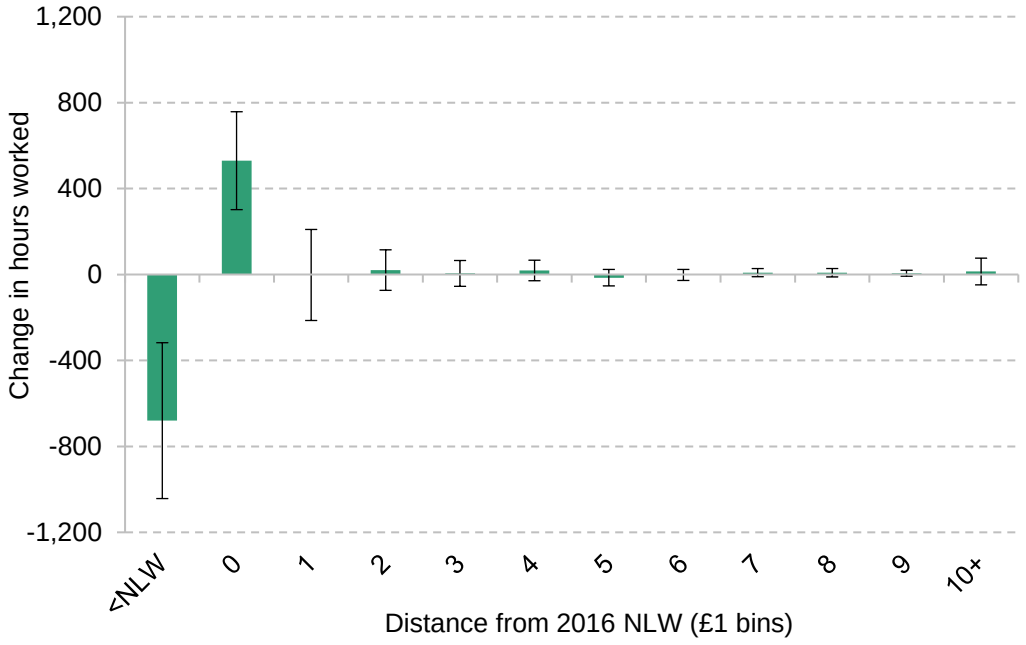
Figure B.1. Change in within-firm employment share by wage bin, pre- and post-NLW (ppt)



Note: Sample of large firms (at least 20 observations in the ASHE 2015) corresponding to 46% of all worker–year observations. Pre-NLW refers to 2012–15 and post-NLW refers to 2016–19. Error bars show 95% confidence intervals. The *x*-axis measures distance to the 2016 NLW in 2016 prices (CPI).

Source: Authors' calculations using the ASHE 2012–19.

Figure B.2. Change in total hours worked, by wage bin



Note: Sample of large firms (at least 20 observations in the ASHE 2015) corresponding to 46% of all worker–year observations in the ASHE. Error bars show 95% confidence intervals. The *x*-axis measures distance to the 2016 NLW in 2016 prices (CPI).

Source: Authors' calculations using the ASHE 2012–19.

Table B.1. Impact of NLW introduction on firms' use of incentive pay and payment by the hour – workers earning more than 2016 NLW + £5

	Incentive pay	Incentive pay share	Paid by hour
No pre-reform use			
High coverage × POST	0.00908	0.00205*	0.0763**
	(0.00630)	(0.00107)	(0.0389)
Observations	147,331	146,173	96,517
Some pre-reform use			
High coverage × POST	0.0306**	0.00285	0.0181
	(0.0121)	(0.00225)	(0.0241)
Observations	238,064	236,062	288,878

Note: Standard errors shown in parentheses. Asterisks indicate whether the results are statistically significant at different critical values (denoted by *p*). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. For some firms, we cannot establish pre-reform use and so the sum of observations for 'no use' and 'some use' is less than for 'all'.

Source: Authors' calculations using the ABS 2015 and the ASHE 2012–19.

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