

Article

# Public and private sector earnings in the UK: 2017

The results of statistical models that explore the relationship between mean hourly earnings and a range of independent variables, based on Annual Survey of Hours and Earnings (ASHE) 2017 provisional results data.

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# 1 . Main points

- After controlling for various individual and job characteristics, on average there is a positive earnings (including pensions) differential in favour of the public sector.
- The positive differential in favour of the public sector is mainly concentrated on low-skilled workers and on workers in smaller organisations when the organisation size is considered.
- High-skilled employees in the public sector tend to have lower earnings than their counterparts employed in the knowledge-intensive services and primary sectors in the private sector.
- Relatively low-paid employees have the largest earnings advantage from employment in the public sector; for high-paid employees, the gap still exists in favour of the public sector for those working in smaller organisations, however, employment in the large private sector organisations has a positive impact on the earnings of those employees.

## 2 . Things you need to know about this release

The headline figures of median and mean earnings for the public and private sector are published in [Annual Survey of Hours and Earnings: 2017 provisional and 2016 revised results](#). Direct comparison between these sectors can be difficult for many reasons.

The composition of the public and private sectors is different. They consist of different industries, occupations and employees with different education, experience and skill levels. For example, the human capital of private and public sector differs. In the public sector, a higher proportion of employees have a degree-level education or higher. Additionally, jobs in the private sector vary significantly compared with the public sector. The private sector has some of the lowest paid workers, but also has some of the highest paid, whereas in the public sector, wages are spread more evenly across the distribution. It is therefore difficult to make direct comparisons between the two sectors using a simple mean (or median) earnings, without considering a range of factors associated with a person's earnings, such as job type, employee characteristics and job location<sup>1</sup>. Regression modelling can be used to account as far as possible for the differences between the sectors. For more information on regression analysis and its limitations, see the Quality and methodology section.

Another reason why public-private earnings comparison is not straightforward is that employee compensation consists of more than just wages. An employee's reward package may include additional monetary benefits, such as bonuses and pensions, and non-monetary benefits, such as company cars, uniforms, health insurance and workplace quality of life. These benefits are not included in gross pay. This analysis focuses on gross pay and pensions because pension contribution is a significant part of an employee's remuneration. It also represents a major cost to public and private sector employers.

### Data sources and regression modelling

The primary source of data is the Annual Survey of Hours and Earnings (ASHE) for all employees whose earnings in April were not affected by absence and were paid adult rates.

There are several important points to note about this analysis and the approach used in the regression model (further information on the regression methodology and definitions is given in the Quality and methodology section), which are detailed in this section.

The ASHE dataset does not include all factors that affect pay such as education, employee ability or motivation.

The ASHE dataset only covers the earnings of paid employees in the UK and does not include data on self-employed earnings (who are often some of the highest paid workers, as well as some of the lowest paid workers).

Three variables are estimated using regression analysis: hourly earnings, hourly total reward including pensions and hourly total reward including pensions and salary sacrifice.

The ASHE survey asks how much the employer and the employee contributed to the pension if the employee belonged to a workplace pension scheme. We used this information and defined “total reward” as the sum of hourly earnings plus hourly employer pension contribution<sup>2</sup>. This can also be seen as the sum of current and deferred earnings.

Employers can contribute to a pension on behalf of an employee through a process called “salary sacrifice”. Where such arrangements exist, the member and employer both benefit from lower National Insurance payments. Therefore, employer contributions levels can be affected by salary sacrifice arrangements, whereby higher contributions are made by the employer with the member in return accepting a lower rate of pay. [ASHE 2017 survey](#) questions 5e and 5g ask whether employee pensions contributions were made through a salary sacrifice arrangement. Additionally, we estimated a third measure of earnings where the employees made their pension contributions through salary sacrifice. For more information on how this is calculated, see the Quality and methodology section.

It should be noted that, whilst these estimates provide a more complete analysis of earnings differentials, the true value of pensions may be underestimated<sup>3</sup>. For defined benefit schemes, actual cost to the employer is based on a series of factors upon retirement, such as:

- career average earnings
- inflation rates
- retirement age
- pension tenure
- life expectancies
- accrual rates
- lump sum factor

Therefore, to calculate the true value of defined benefit scheme pensions requires a series of assumptions about individuals and pension plans – something that is not possible using the ASHE dataset nor is it possible to do so using a single source of data.

When modelling total reward using regression analysis, we included a variable indicating whether the employees receive any benefits in kind (see [2017 ASHE questionnaire](#) – Question 6c) to control for the effects of fringe benefits on earnings<sup>4</sup>.

Overtime paid at a higher rate would increase an employee’s hourly earnings whereas working unpaid overtime would effectively reduce hourly earnings. The standard ASHE measure of hourly earnings does not include overtime because excluding overtime gives a more like-for-like (in terms of working pattern) comparison between workers. However, overtime payments can be an important consideration in the analysis of “total reward” as sometimes people actively seek out jobs with overtime due to the opportunity to increase their total pay. Overtime payments and total hours worked by employees are included in ASHE, so we adjusted the hourly earnings for overtime payments in this article.

Bonus payments can also be a significant part of the employee remuneration. In this article, a bonus adjustment is made to hourly earnings in the ASHE dataset using the Average Weekly Earnings series (published monthly based on the Monthly Wages and Salaries Survey), to better account for the timing of bonus payments throughout the year. Estimates in this article are not therefore directly comparable with those published in ASHE provisional results 2017, which do not make this adjustment for the timing of bonus payments.

For consistency over time, employees of those banks classified to the public sector in 2008 have been treated as if they were in the private sector throughout.

## Notes for: Things you need to know about this release

1. Analysis of earning differentials should also consider non-random sorting of individuals between sectors as they may have different characteristics (both observed and unobserved) that cause them to select themselves into different sectors and these characteristics may be significantly correlated with their earnings.
2. Note that ASHE (Q-6b) only asks whether the employee was a member of any pension scheme run or facilitated by the organisation he or she works for, however, the individual may belong to another (private) pension scheme.
3. The true value of the pensions can also be overestimated as employees could lose money in a defined contribution (DC) scheme with poor investment strategy or in an unfavourable economic climate.
4. The expected sign of this variable is negative after controlling for personal and job characteristics affecting earnings, however, in cases where the benefits increase the productivity of employees, the sign of the variable can be positive as earnings have a positive relationship with productivity.

## 3 . Factors affecting earnings – descriptive analysis

This section will consider a number of factors that are available in the Annual Survey of Hours and Earnings (ASHE) dataset and are considered in the earnings models presented in this article. Simple averages are considered to gain an initial insight into earnings differences amongst individuals with different characteristics, such as age and gender and job-related characteristics, such as public or private sector, industry groups in the private sector, occupational group, region of employment, job tenure, job status, and size of employer.

### Pensions and salary sacrifice

Pension contributions make up a significant proportion of employee remuneration, therefore it is important to consider this in any analysis of earnings. The composition of pension entitlement varies significantly between sectors.

Table 1 shows that 93% of employees in the public sector belong to a defined benefit pension scheme, whereas in the private sector, only 13% of employees belong to a defined benefit scheme. Pension enrolment also differs greatly between sectors, with 33% of private sector employees not belonging to any workplace pension scheme. In the public sector, only 11 % of employees do not belong to a pension scheme. This figure may decline in years to come with the introduction of auto-enrolment. For more information, see [workplace pensions](#).

Table 2 shows that in 2014 contribution rates for employees and employers tended to be higher in the public sector, where participations rates were also relatively high and the majority of schemes were defined benefit. Note that these are the latest published estimates, which are available in the [Median Contribution Rates to Workplace Pensions by Pension Type and Sector dataset](#). For more on contribution rates, see [Pensions short stories: Employees eligible for automatic enrolment: contributions to workplace pensions, 2005 to 2014](#).

**Table 1: Proportion of employees with workplace pensions: by type of pension, UK, 2017**

	Percentages		
	All employees <sup>1</sup>	Public sector	Private sector
Occupational defined benefit	39	93	13
Occupational defined contribution	32	5	45
Group personal pension <sup>3</sup>	22	1	31
Group stakeholder pension	6	<1	9
Unknown pension type	2	1	2
<b>Not in a pension scheme<sup>2</sup></b>	<b>29</b>	<b>11</b>	<b>33</b>

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. All employees with a workplace pensions.
2. As a percentage of all employees aged 16 to 64.
3. Data for Group Self-invested personal pensions (GSIPP) are included within the category Group Personal Pensions (GPP).
4. Percentages may not sum up to 100 due to rounding.
5. Data for 2017 are provisional.

**Table 2: Median employer and employee contribution rates to workplace pensions by pension type and sector, 2014, Great Britain**

	Percentages	
	Employer	Employee
<b>Public Sector</b>		
Occupational defined benefit	14	7
Occupational defined contribution	10	3
Group personal pensions	14	6
Pension type unknown	14	7
<b>Private Sector</b>		
Occupational defined benefit	14	7
Occupational defined contribution	3	1
Group personal pensions	4	2
Pension type unknown	3	2

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Table 3 displays the proportion of employees who have a salary sacrifice arrangement. It shows that private sector employees are more likely to have a salary sacrifice arrangement than those in the public sector.

**Table 3: Proportion of employees with a salary sacrifice scheme, UK, 2017**

	Percentages		
	Not known	In salary sacrifice scheme	Not in salary sacrifice scheme
Private sector	29	27	44
Public sector	11	8	81

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

## Individual characteristics

### Age

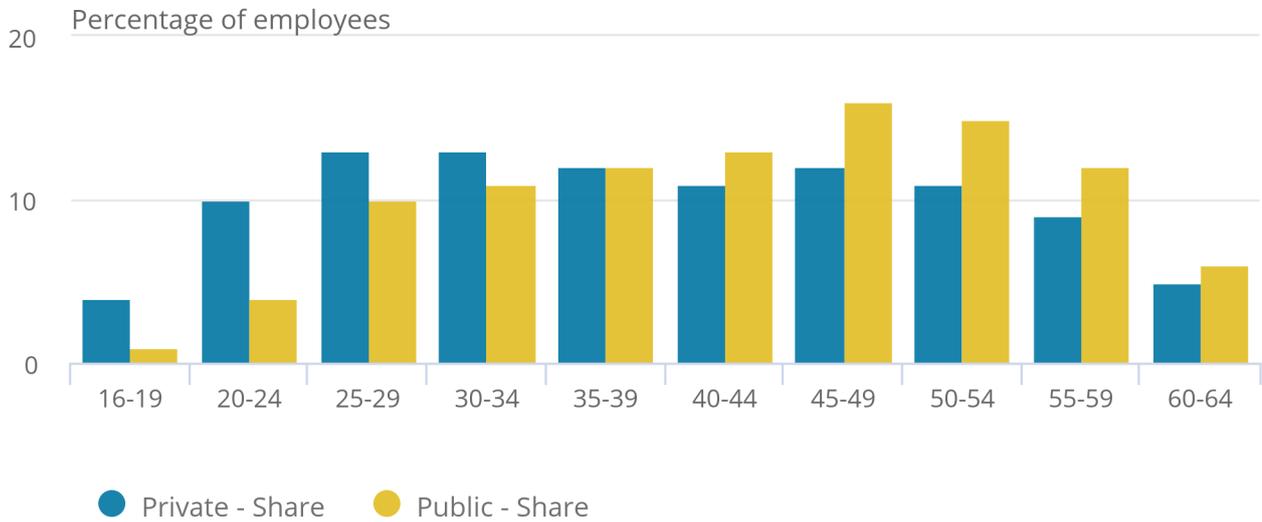
Age is an important factor affecting earnings, as this tends to be a proxy for experience and the build-up of skills over time. Figure 1a shows that the distribution of jobs held within the private sector is more skewed towards the younger age groups, while the distribution of the jobs held within the public sector is more skewed towards the older age groups.

Figure 1b also shows current average hourly earnings for different age groups in the public and private sectors. Average hourly earnings regardless of sector rise sharply at younger age groups as job-related skills and experience are rewarded. Peaking in both sectors at ages 40 to 44 years, the average private sector earnings levels (excluding pensions) remain slightly higher than the public sector between the ages 35 to 39 and 55 to 59 years. In both sectors average earnings begin to decline at ages 50 to 54 years, with average earnings declining faster in the private sector.

Average hourly earnings (including pensions) for all employees also rise sharply with age. On average, public sector earnings (including pensions) remain above the private sector at every age group.

**Figure 1a: Share of all employees by age and sector, UK, 2017**

Figure 1a: Share of all employees by age and sector, UK, 2017



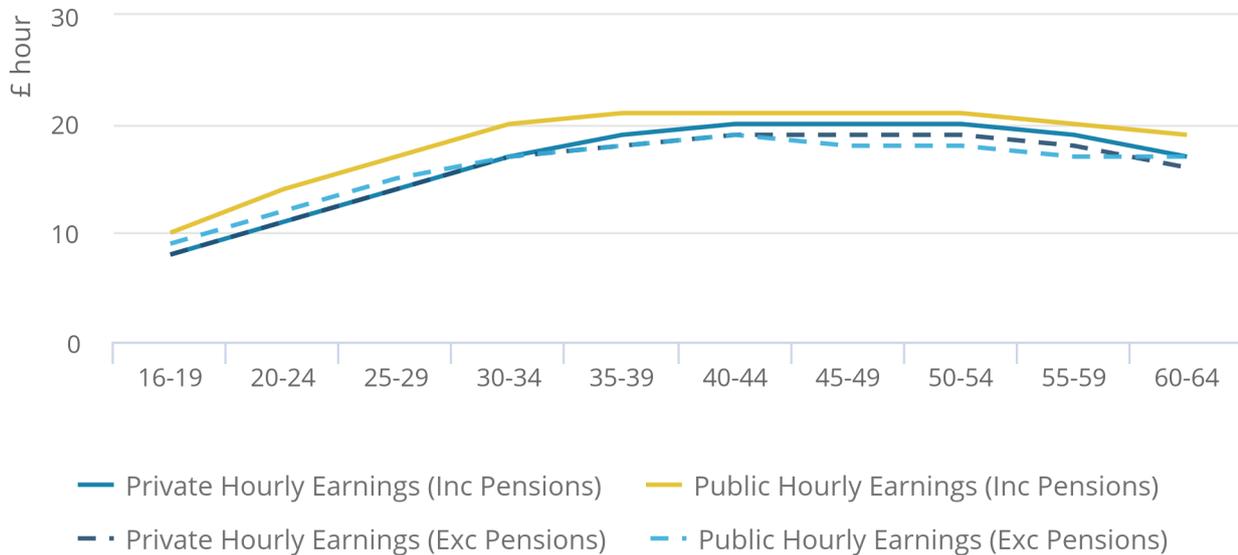
**Source: Office for National Statistics, Annual Survey of Hours and Earnings**

**Notes:**

1. Data for 2017 are provisional

**Figure 1b: Mean Hourly Earnings (Inc Pensions) of all employees by age and sector, UK, 2017**

Figure 1b: Mean Hourly Earnings (Inc Pensions) of all employees by age and sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

## Gender

Table 4 shows the proportion of men and women differs between the two sectors. In the public sector, around two-thirds of employees are women, whereas in the private sector only 42% of employees are women.

There are also differences in “total reward” between sectors. Our estimates using ASHE 2017 survey data show that women earn less than men on average in both sectors. In the public sector, adding pensions to mean hourly earnings increases average earnings by around £3 for men and £2 for women. In the private sector, including pensions increases average hourly earnings by around £1 for men.

**Table 4: Average earnings per hour by gender and sector, UK, 2017**

mean hourly earnings (£)								
	Female	Male	Female (Includes pensions)	Male (Includes pensions)	Female (Includes pensions and salary sacrifice)	Male (Includes pensions and salary sacrifice)	Female share %	Male share %
Private	14	18	14	19	15	19	42	58
Public	16	20	18	23	18	23	67	33

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional

## Occupation (skill) group

Earnings are likely to increase as the skill level of the job increases. Thus, differences in earnings by sector may be partly explained by compositional differences in the share of employees at each skill level. The ASHE survey does not include employees' educational attainment or other skill-related attributes, however, it records the occupation of employees using the [Standard Occupational Classification 2010: SOC 2010](#), which provides an indication of the types of job undertaken.

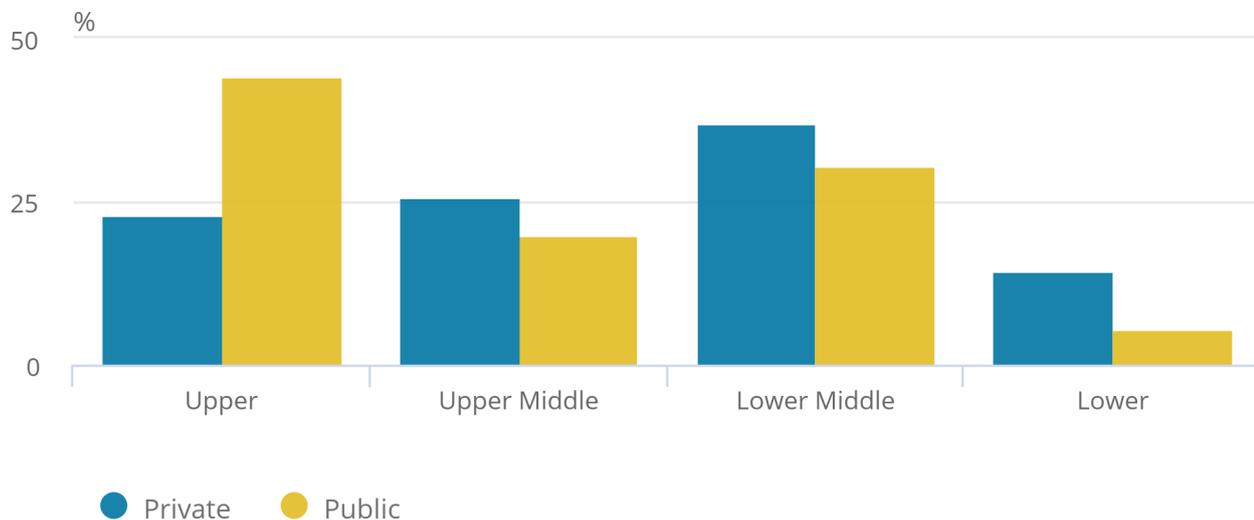
SOC 2010 allocates jobs to occupations, based on a description that considers the level of qualification and the type of tasks to be carried out. This makes SOC occupations a good proxy measure for skill levels. Therefore, for this analysis skill is defined solely by occupation and is grouped into four broad skill levels using SOC 2010.

Professional or upper-skill group jobs include occupations such as scientists, IT engineers, and health and educational professionals, while elementary occupations or lower-skill group occupations include farm workers, window cleaners, waiters, waitresses and processing operatives. The Quality and methodology section provides more detail of occupations in each skill group.

Figure 2 shows that a larger proportion of public sector employees are in the professional and upper middle-skilled group (63%) compared with the private sector (49%).

**Figure 2: Occupational (skill) share of employee jobs by sector, UK, 2017**

Figure 2: Occupational (skill) share of employee jobs by sector, UK, 2017



**Source:** Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

1. Data for 2017 are provisional.

Table 5 shows the mean, median and standard deviations of hourly earnings (including pensions) of disaggregated occupations by sector. Mean hourly earnings for different occupations is relatively similar across most sectors. However, the medians and the standard deviations<sup>1</sup> suggest that the private sector has a more dispersed earnings distribution than the public sector, indicating that the differential between top and bottom earners is much larger in the private sector.

The biggest difference in standard deviations is observed in the “managers, directors and senior officials” occupations, where standard deviation is around £28 in the private sector compared with around £17 in the public sector. This could be due to the factors affecting earnings such as age, however, jobs within the same occupational group can vary significantly in terms of the associated level of educational qualification, skills or responsibility and may not be distributed evenly between the public and private sectors. For example, jobs in a narrowly defined occupational category of “teaching and educational professionals” includes all teaching professionals such as university lecturers, secondary education teaching professionals or nursery teachers and the distribution of these jobs between the public and private sectors are not perfectly balanced.

Even within a more narrowly defined occupation such as “solicitors” there can be a range of different types of skills, specialisation and productivity levels of workers. For example, a lawyer working in a multinational law firm in London may have a different specialisation (hence different labour productivity levels affecting their earnings) to a lawyer working in a small local law firm, but both will have the same narrowly defined occupational classification.

**Table 5: Mean and median hourly earnings (includes pensions) by occupation groups, UK, 2017**

	Public Sector			Private Sector		
	Mean hourly earnings £	Median hourly earnings £	Standard Deviation £	Mean hourly earnings £	Median hourly earnings £	Standard Deviation £
Managers, directors and senior officials	30	27	17	30	22	28
Professional occupations	25	23	13	26	23	18
Associate professions	20	18	12	22	18	20
Administration and secretarial	14	13	6	14	12	8
Skilled trades	15	13	6	14	13	10
Caring, leisure and other occupations	12	11	5	10	9	5
Sales occupations	16	14	6	11	9	6
Process, plant and machine	17	14	8	12	11	5
Elementary occupations	11	10	5	10	8	5

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.
2. The standard deviation is a statistic indicating how the values for a group are spread from the mean. A low standard deviation means that most of the values are very close to the mean. A high standard deviation means that the values are spread out.

## Job-related characteristics

### Industry composition

Our previous publications have undertaken analysis of the earnings in the public and private sectors in a broad manner, that is, each sector was treated as a whole. However, the private sector is very diverse consisting of different types of industries with different working conditions, skills, productivity levels and job contents of the seemingly similar occupations.

Table 6a shows the mean, median and standard deviations of earnings for aggregated industry groups in the private sector and for the public and private sectors as a whole. It suggests that average earnings in the private sector vary considerably between different industry groups. For example, in knowledge-intensive services sectors, the mean hourly earnings (including pensions) are £12 higher than mean hourly earnings in the less knowledge-intensive services sectors.

Table 6a also shows that average hourly earnings in the private sector as a whole are lower than the public sector. Table 6b suggests that one of the reasons for this is that the relatively high share (around 40%) of the employees in the private sector are working in the relatively less-skilled and low-productivity services sectors (less-knowledge intensive services sectors) and this pulls down the average earnings of the private sector as a whole. This reflects the fact that many of the lower-skilled jobs have been outsourced from the public sector to the private sector.

Additionally, several studies have shown that in many countries there are large and persistent earnings differentials for seemingly similar workers and jobs across industries.

Various explanations have been offered for this phenomenon. These include:

- compensating differences for some unmeasured undesirable aspects of the working conditions in some industries, such as unpleasant and unsafe working conditions in some industries such as mining
- unobserved quality of the workers (when unobserved quality of the labour force is not randomly distributed among industries)
- on-the-job training or industry experience may not be randomly distributed among industries
- labour market imperfections such as market power of the firm, discrimination, rent sharing, non-profit maximising firms and labour supply elasticity

**Table 6a: Mean and median hourly earnings (includes pensions) by industry groups, UK, 2017**

	Mean hourly earnings £	Median hourly earnings £	Standard Deviation
Primary Industries	20	15	17
Manufacturing	18	15	14
Construction	17	15	11
Less Knowledge Intensive Services	14	10	14
Knowledge Intensive Services	26	20	22
Public Sector (ALL)	20	17	12
Private Sector (ALL)	17	13	17

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional

2. Less knowledge-intensive services include: Private sector Wholesale and retail trade; repair of motor vehicles; transport and storage; accommodation and food services; administrative services, education, human health and social work activities and other service activities.

3. Knowledge intensive services include: Private sector Information and communication, financial and insurance and real estate activities

4. Primary Services include: Private sector agriculture forestry and fishing, mining and quarrying, and utility services.

**Table 6b: Skill composition of industries, UK, 2017**

	<b>Construction</b>	<b>Knowledge Intensive Services</b>	<b>Less Knowledge Intensive Services</b>	<b>Manufacturing</b>	<b>Primary Industries</b>	<b>Public Sector</b>
Lower	8%	2%	20%	11%	15%	5%
Lower Middle	24%	23%	45%	30%	32%	31%
Upper Middle	44%	29%	20%	35%	29%	20%
Upper	24%	46%	15%	24%	23%	44%
<b>% of total workforce</b>	<b>4</b>	<b>14</b>	<b>43</b>	<b>10</b>	<b>2</b>	<b>26</b>

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional
2. Less knowledge-intensive services include: Private sector Wholesale and retail trade; repair of motor vehicles; transport and storage; accommodation and food services; administrative services, education, human health and social work activities and other service activities.
3. Knowledge intensive services include: Private sector Information and communication, financial and insurance and real estate activities
4. Primary Services include: Private sector agriculture forestry and fishing, mining and quarrying, and utility services.

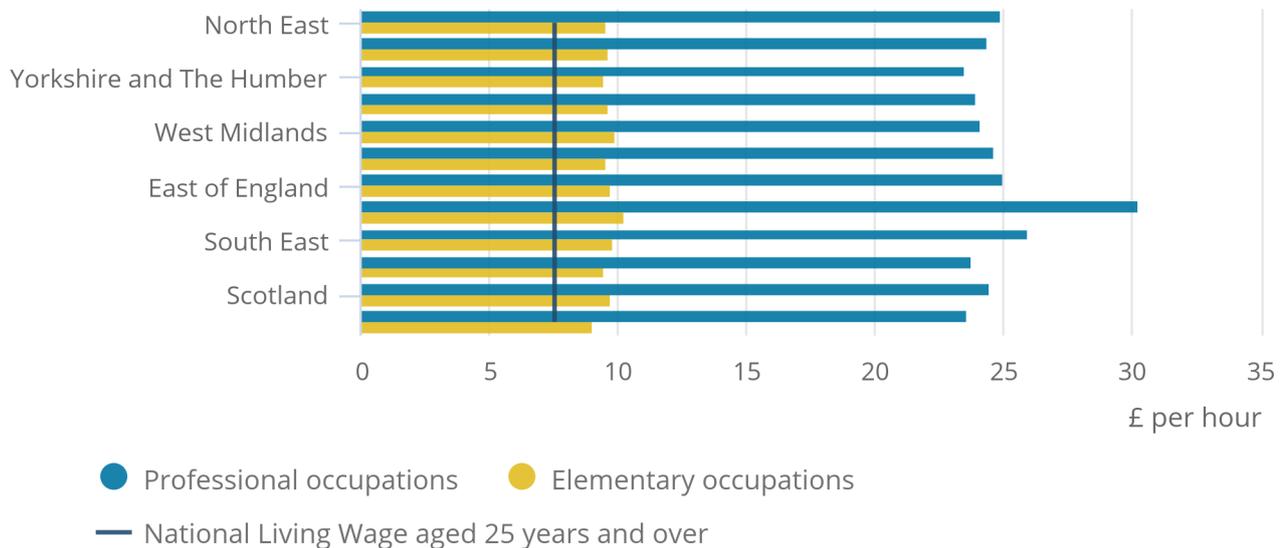
## Location

Geographic location is another factor that can influence earnings. Local labour market conditions and cost of living can be among the geographic factors affecting wages.

Figure 3 shows the mean hourly earnings including pensions for employees in selected occupation groups – professional occupations and elementary occupations. Average earnings of the employees in the elementary occupations were broadly similar across the regions, however, professionals in London earned on average around £7 more than in Northern Ireland in 2017.

**Figure 3: Mean hourly earnings (includes pensions) by region for elementary and professional occupations, and National Living Wage, UK regions and countries, 2017**

Figure 3: Mean hourly earnings (includes pensions) by region for elementary and professional occupations, and National Living Wage, UK regions and countries, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

## Organisation size

Many empirical studies have shown a strong and positive relationship between employer size and earnings.

Theoretical reasons for why large firms are able to pay more include economies of scale, such as:

- technical economies – cost savings as a result of mass production techniques or specialisation of labour
- purchasing economies – bulk buying
- administrative savings
- financial savings – can borrow money more cheaply than small firms
- risk bearing economies

However, firms can also become too large and suffer from diseconomies of scale.

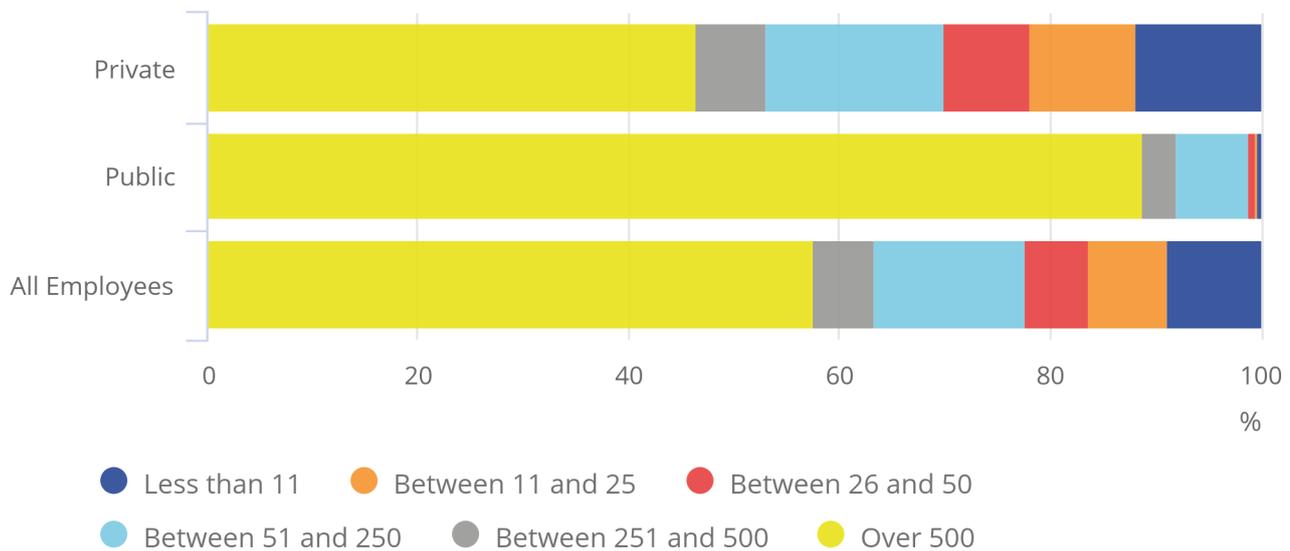
Other explanations include:

- higher labour productivity due to better capital investment and capital-skill complementarity, therefore, the workers can be paid higher according to their productivity
- market power and sharing their excess profits with their workers
- unionisation of the workforce
- substitute high monitoring costs with wage premia
- better training for workers (resulting in more productive workers)
- better hiring practices – can hire more qualified workers
- internal labour markets to increase the stability of their workforce

Figure 4 shows that in 2017, nearly 60% of all employee jobs were in organisations with over 500 employees, with noticeable differences between the private and public sector. In the public sector, around 90% of employee jobs are in organisations with over 500 employees, whereas this is just 46% in the private sector. Nearly half of the employee jobs in the private sector are in organisations with less than 250 employees, whereas in the public sector, only 7% of employee jobs are in organisations with under 250 employees.

**Figure 4: Percentage of employee jobs by size of organisation and by sector, UK, 2017**

Figure 4: Percentage of employee jobs by size of organisation and by sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

Table 7 shows that without controlling for the factors affecting earnings, on average employees in large organisations tend to earn more than employees in small organisations. Average earnings of public sector employees are closer to the earnings of private sector employees in larger organisations.

**Table 7: Mean hourly earnings by organisation size, UK, 2017**

<b>Organisation Size</b>	<b>Mean hourly earnings £</b>	<b>Mean hourly earnings (Includes pensions) £</b>	<b>Mean hourly earnings (Includes pensions and salary sacrifice) £</b>
<b>Private Sector</b>			
Less than 11	14	14	14
Between 11 and 25	15	15	15
Between 26 and 50	16	16	16
Between 51 and 250	17	18	18
Between 251 and 500	19	20	20
Over 500	17	18	18
Public	17	20	20

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Public sector as a whole (includes all sizes).
2. Data for 2017 are provisional.

## Other factors

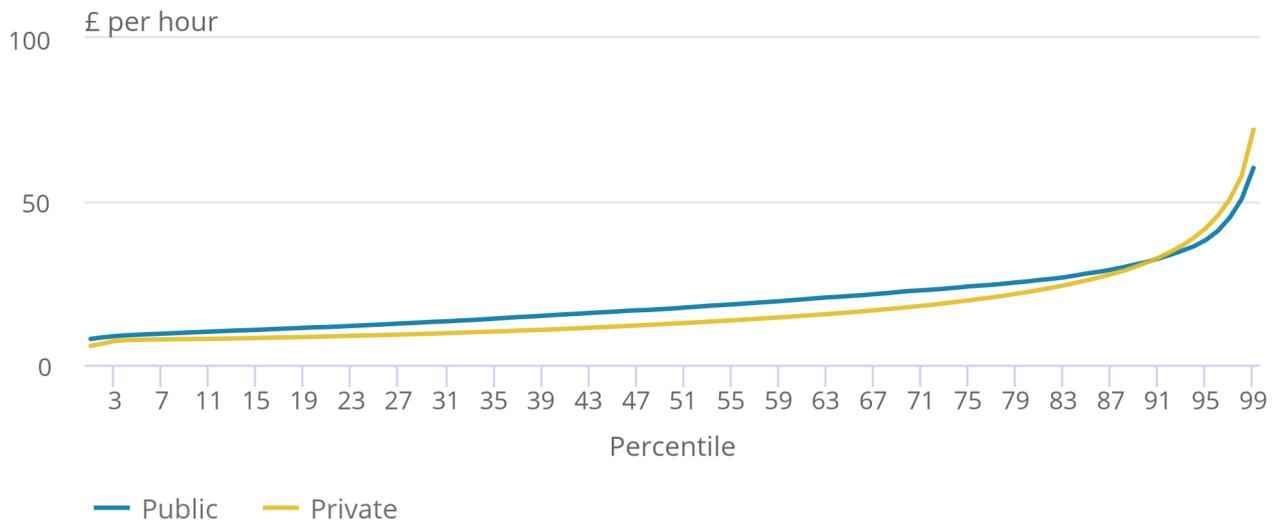
Other job-related factors such as full- or part-time or temporary status of the job can also affect the earnings of an employee. The regression analysis controls for those factors available in the ASHE dataset (for more information, see regression model specifications in the Regression analysis modelling earnings differences section).

## Distribution of earnings

Figure 5 shows that mean hourly earnings (including pensions) were generally higher for public sector employees across the earnings distributions, apart from the top 10% where employees in the private sector earn more. Mean hourly public sector earnings exceeded private sector earnings by between £0 to £5 per hour until the 91st percentile of the earning distribution. At this point, both mean public and private sector earnings (including pensions) were around £32 per hour. In April 2017, private sector employees at the 99th percentile of earnings were paid around £12 per hour more than employees at the 99th percentile of hourly earnings in the public sector.

**Figure 5: Distribution of hourly earnings (includes pensions) in the public and private sector, UK, 2017**

Figure 5: Distribution of hourly earnings (includes pensions) in the public and private sector, UK, 2017



**Source:** Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

1. Data for 2017 are provisional.
2. Only data between the first and 99th hourly earnings percentile have been used.

**Notes for: Factors affecting earnings – descriptive analysis**

1. When the median is lower than mean, the distribution is skewed to the left with a tail stretching toward the right (high values), so a long tail of low values (on the left) pulls the mean down. The standard deviation is a statistic indicating how the values for a group are spread from the mean. A low standard deviation means that most of the values are very close to the mean. A high standard deviation means that the values are spread out.

## 4 . Regression analysis modelling earnings differences

The previous section considered one characteristic at a time to compare average earnings between the private and public sectors. This creates a partial picture of the earnings as employees have multiple personal and job characteristics that can impact on their earnings. Regression modelling can be used to account for some of these differences by including controls for them. The technical notes provide more detail on regression analysis. This regression analysis estimates the earnings difference between types of individuals when controlling for the modelled factors.

# Regression model specifications

## Dependent variables

- Log of bonus-adjusted hourly earnings.
- Log of bonus-adjusted hourly earnings including pensions (employer contribution).
- Log of bonus-adjusted hourly earnings including pensions (employer contribution) and salary sacrifice (if employee pension contributions made through salary sacrifice).
- For more information, see the Quality and methodology section.

## Control variables

The regressions use the following control variables to take account of measurable factors that influence earnings:

- sex – there is a difference in the distribution of men and women in the public and private sector
- age and age squared – the relationship between earnings and age is non-linear (see the Quality and methodology section)
- occupational classifications – four broad occupational groupings based on skill level: upper, upper middle, lower middle and lower (for detailed descriptions of these see the Quality and methodology section)
- region (region of job location) – this term may capture the impact of industry and labour market structures (for example, shortages for an occupation may be different in a different region and industry in the region) in the regions on earnings
- organisation size – private sector firms are split by six firm size groups and the public sector is treated as one size group; from a statistical point of view, as over 90% (as shown in Figure 4) of those working in the public sector are also in large organisations, just the inclusion of organisation size can lead to issues of collinearity and have an impact on the precision of the estimate of the public and private sector pay differential
- full- or part-time status – studies show that earnings differentials between these two groups of employees can still exist after controls for job and individual characteristic affecting earnings are considered; the reasons include systematic observed and unobserved characteristics of the two groups, different accumulation of human capital and employers' fixed labour costs
- permanent or temporary status – studies show that after controlling for individual and job characteristics, workers on permanent contracts can earn more than workers on fixed-term contracts with similar observable characteristics affecting earnings
- job tenure – less or equal to 6 months, 6 to 12 months, 1 year to 2 years, 2 to 5 years, 5 to 10 years, 10 to 20 years and over 20 years – job tenure is a proxy for organisation-specific experience, which can impact on earnings
- benefits in kind – dummy variable to control for any other benefits received by an employee that may affect employee level of earnings; for example, employees can agree to forego a part of their salary in exchange for a benefit, such as a company car or health insurance

## Interaction terms

We use the following interaction terms to reflect where the impact of one determinant of earnings is affected by the level of another variable:

- sex multiplied by age and sex multiplied by age squared – the potential work experience proxied by age for males and females is different, that is, women experience more career interruptions than males
- occupation multiplied by age and occupation multiplied by age squared – the return to work experience may be different for different occupations, for example, professional occupations compared with elementary occupations
- occupational group multiplied by organisation size – the effect of organisation size may differ for different occupation classifications as according to internal labour markets theory, larger firms offer more opportunities to workers and a suitable occupational match, therefore, on average, workers in larger firms are employed in better matches and earn higher wages; conditional on wages, they are less likely to separate from the firm, but more likely to switch occupations within the firm, while the wage premium is higher for workers with longer tenure
- occupational group multiplied by region – industry and labour market structures that impact on earnings may differ between regions

For more information on how to interpret the coefficients of interacted variables, see the Quality and methodology section.

## Regression model without organisation size

There are arguments for and against including organisation size in the regression model. The argument for including it is that there is clear evidence from the private sector that employees in large organisations on average earn more than employees in small organisations for similar jobs. The previous section has outlined the potential reasons for this. If organisation size impacts on earnings, then it should be controlled for in the model as the aim of the regression model is to calculate public sector earnings differentials after all other influencing factors have been controlled for.

However, another view is held that public sector employees should earn the same as private sector employees, irrespective of organisation size. In this case, it would be useful to see the results without organisation size included.

In the model without the organisation size, all the variables are the same as defined previously, except for the firm size variable. Instead of splitting the private sector by firm size, we split the private sector by five industry groups as discussed in [Section 3](#). This model has the following interaction term:

Occupational group multiplied by industry sector – the effect of industry may differ for different occupation groups, for example, labour supply and demand for the same occupations or incentive conditions may differ between industries.

The [Analysis of factors affecting earnings using the Annual Survey of Hours and Earnings linear regression dataset](#) gives the coefficients generated by the linear regression model and provides metadata for the variable names and model specifications. The Quality and methodology section explains how to interpret these results.

## Results 1 – Regression analysis including organisation size

Given that we have split private sector firms into six different size groups, and that earnings vary significantly across private sector firms of different size, it is useful to compare the modelled private sector wages in organisations of different sizes with those in the public sector.

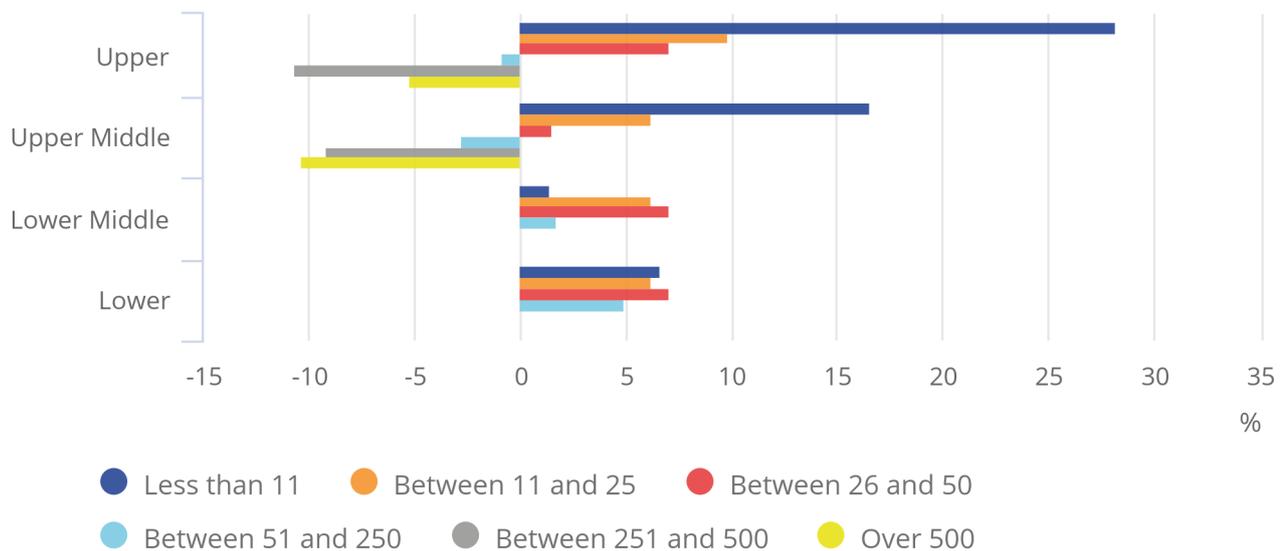
Since the impact of organisation size in the private sector can also vary according to occupational groups (as modelled by the interaction term “occupational group multiplied by organisation size”), we present the comparison for each of our categories of occupation. Figures 6a to 6d show the percentage difference in average hourly earnings of employees working in the public sector compared with employees working in different sized private sector organisations for four occupational groups and for different definitions of earnings.

The results are for the linear model, which interacts occupation with sector and firm size. The results in Figures 6a to 6d are obtained by using the estimated coefficients from the individual effects of occupational groups, firm size and the interaction effect between occupational groups and firm size. For more information on how results are calculated, see the Quality and methodology section.

Figure 6a suggests that employees with lower and lower-middle skills working in the public sector on average earn more than similarly-skilled employees in the private sector regardless of the size of their organisation. However, employees in upper-middle and upper skill groups in firms with over 50 employees on average tend to earn more in the private sector than employees in the same skill groups in the public sector. For example, upper-skilled workers in firms with 251 to 500 employees earn on average 11% more than their public-sector counterparts.

**Figure 6a: Average percentage difference in mean hourly earnings (excludes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017**

Figure 6a: Average percentage difference in mean hourly earnings (excludes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

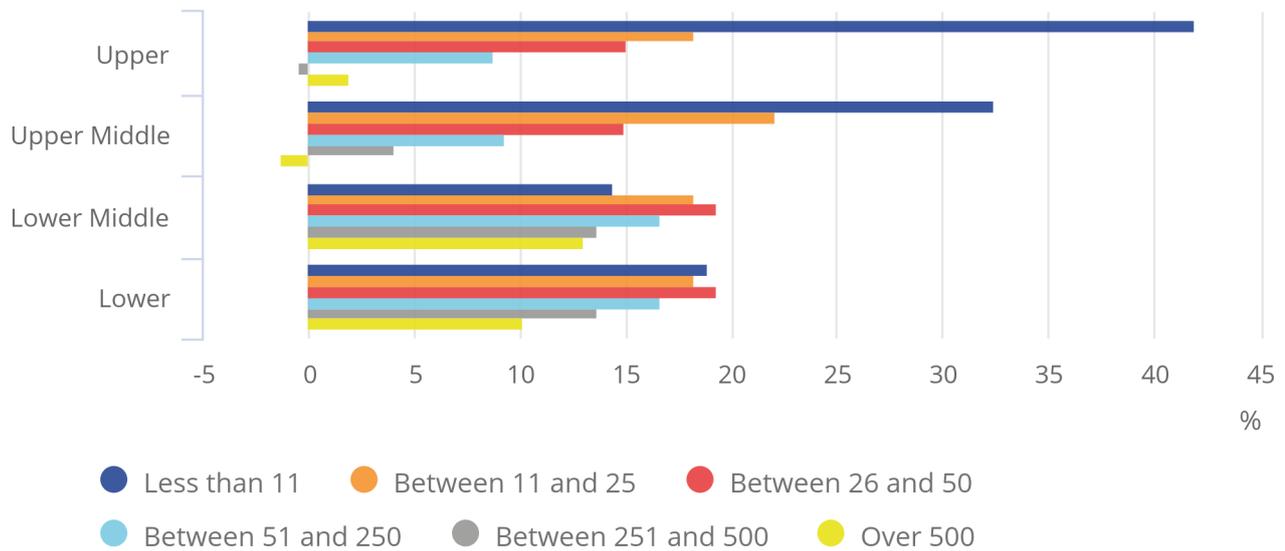
Notes:

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.

Figures 6b and 6c show that the public sector receives a larger remuneration package on average in almost every occupation grouping, regardless of private sector company size, when pensions (Figure 6b) and both pensions and salary sacrifice (Figure 6c) are included in the hourly earnings. The exceptions are for employees in the upper-middle occupations working for firms with over 500 employees and employees in upper-skilled occupations in firms with 251 to 500 employees. They earn slightly more on average than their public-sector counterparts when pensions are included in the hourly earnings. The biggest difference between public and private sector total remuneration, is found for upper-skilled occupations in smaller firms, where the public sector employees earn on average 42% more than private sector employees in firms with less than 11 employees.

**Figure 6b: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017**

Figure 6b: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017



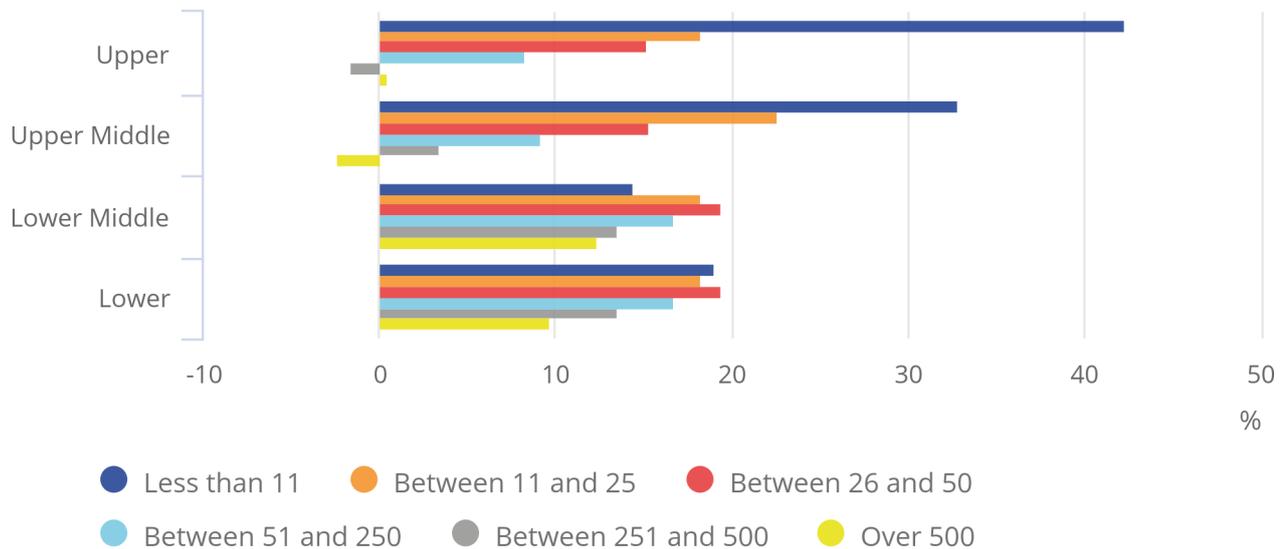
**Source: Office for National Statistics, Annual Survey of Hours and Earnings**

**Notes:**

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.

**Figure 6c: Average percentage difference in mean hourly earnings (includes pensions and salary sacrifice) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017**

Figure 6c: Average percentage difference in mean hourly earnings (includes pensions and salary sacrifice) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017



**Source:** Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

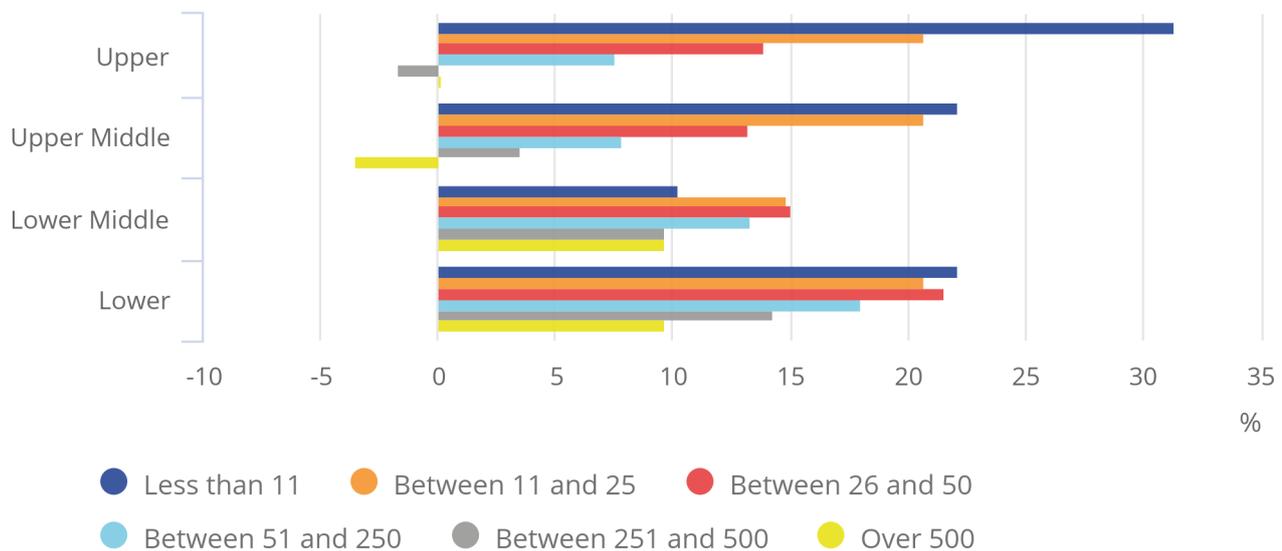
1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.

Differences in private and public sector earnings (including pensions) can be difficult to interpret because 32% of private sector workers do not belong to a pension scheme run or facilitated by their employer, whereas this figure is only 11% in the public sector. To carry out a like-for-like comparison between the two sectors, one more regression has been run looking at only those with pensions.

Figure 6d shows that when examining only those who belong to a workplace pension scheme, the differences between the public and private sector are still largely in favour of the public sector. However, the total remuneration differences are less than before between the public sector workers and those with upper-middle and upper skills working in small organisations. For example, those in upper-skilled occupations in the public sector earn on average 31% more than their private-sector counterparts in firms with less than 11 employees. Only employees in the upper-middle-skilled occupations working for firms with over 500 employees and employees in upper-skilled occupations in firms with 251 to 500 employees earn slightly more on average than their public-sector counterparts when comparing those in a pension scheme.

**Figure 6d: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017**

Figure 6d: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and firm size, private sector compared with public sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.
3. Data include employees belonging to employer run or facilitated pension schemes only.

**Analysis of other factors**

**Job tenure**

Figure 7 compares the earnings differential of the job tenure groups with those who have been in their job for six months or less for both with and without pensions. It suggests that the longer a person is in a job, the more they earn, even after accounting for all other individual and job-related factors such as gender, occupation, industry and region. These results are calculated using the estimated coefficients produced in the regression model.

The model also suggests that each subsequent group earns more than the previous group, with those in the same job for 20 years or more earning 25% more than those newly started in a job.

**Figure 7: Average hourly earnings by tenure group, UK, 2017**

Figure 7: Average hourly earnings by tenure group, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

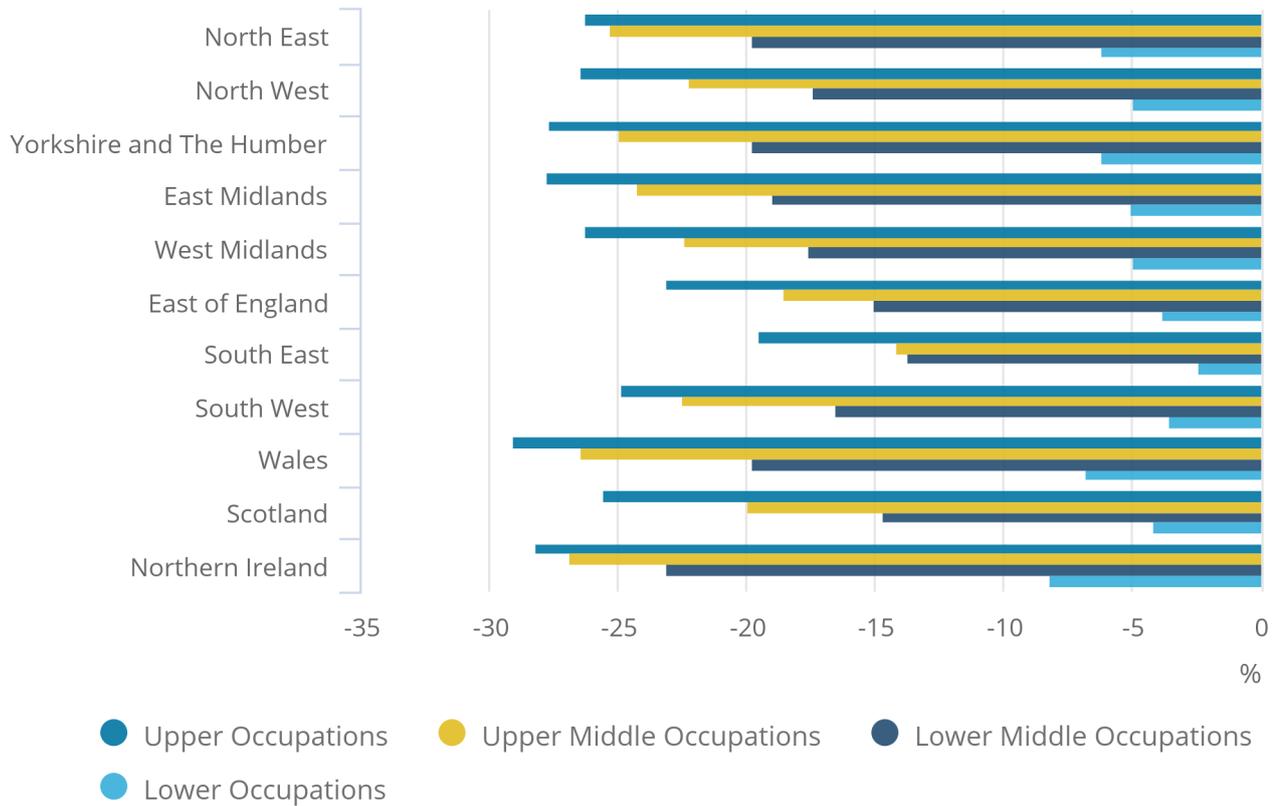
- 1. Data for 2017 are provisional.

**Location**

The [Annual Survey of Hours and Earnings \(ASHE\) 2017](#) estimates and Figure 3 suggest that employees in every occupational group working in London earn more than similar employees located in other regions and countries of the UK. Figure 8 shows that this was still the case after controlling for various individual and job characteristics affecting earnings, with the higher-skilled occupations having the largest earnings differential. For example, after controlling for the factors affecting earnings, employees in upper-skilled occupations in the UK regions and countries (except the South East) earn around 25% (including pensions) less than their counterparts working in London. Employees working in the South East have the second-highest earnings in every occupational group in the UK.

**Figure 8: Average percentage difference in mean hourly earnings (includes pensions) of employees located in UK regions and countries to earnings of employees in the same occupational groups located in London, 2017**

Figure 8: Average percentage difference in mean hourly earnings (includes pensions) of employees located in UK regions and countries to earnings of employees in the same occupational groups located in London, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

1. Data for 2017 are provisional.

The regression output for each of the previous estimates is available in the datasets, including for previous years.

**Other factors**

Controlling for all factors affecting earnings, for the model that includes pension contributions, part-time workers in 2017 earned 9% less than full-time workers when controlling for other factors and temporary workers earned 2% less than permanent workers. In the model that excludes pension contributions, part-time workers earned 8% less than full-time workers and temporary workers earned 1% less than permanent employees.

## Results 2 – Regression analysis excluding organisation size

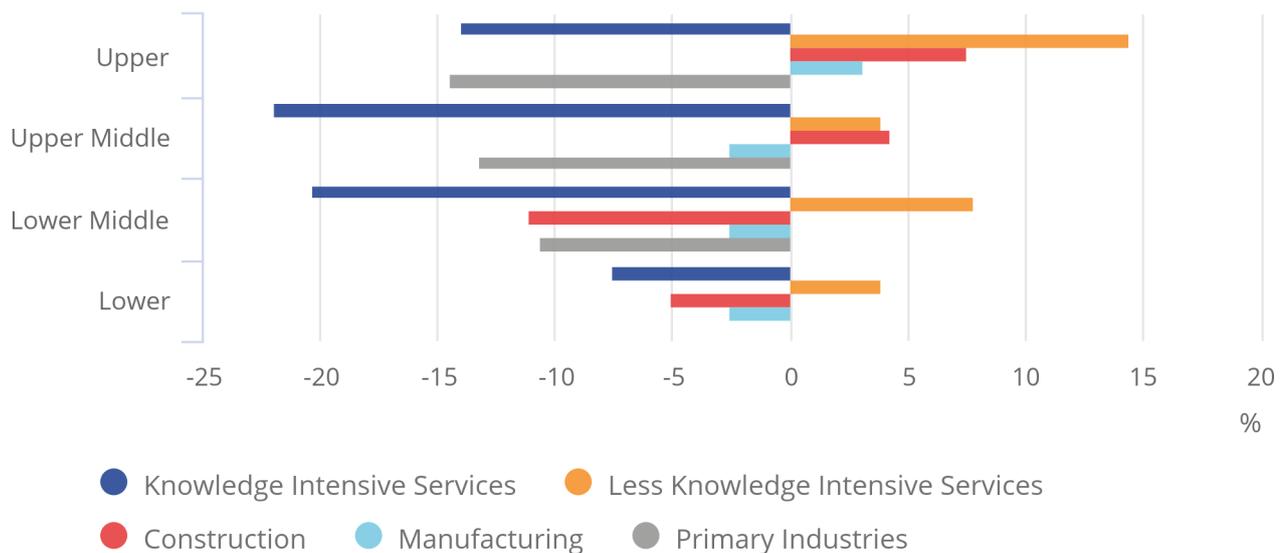
Figures 9a and 9b show the percentage difference in average hourly earnings of employees working in the public sector compared with employees working in different private sector industry groups for four occupational groups.

The results are for the linear model, which interacts occupational groups with different industry groups. The results are obtained by using the estimated coefficients from the individual effects of occupational groups, industry groups and the interaction effect between the two groups.

Figure 9a suggests that employees in all the occupational groups working in knowledge-intensive services and primary industries in the private sector tend to earn more than their public-sector counterparts, with the largest difference occurring for the upper-middle-skilled occupations. For all the occupational groups, private sector employees earn on average less than their public-sector counterparts if they are working in less knowledge-intensive services sectors, with the largest difference occurring for the upper-skilled occupational groups.

**Figure 9a: Average percentage difference in mean hourly earnings (excludes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017**

Figure 9a: Average percentage difference in mean hourly earnings (excludes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

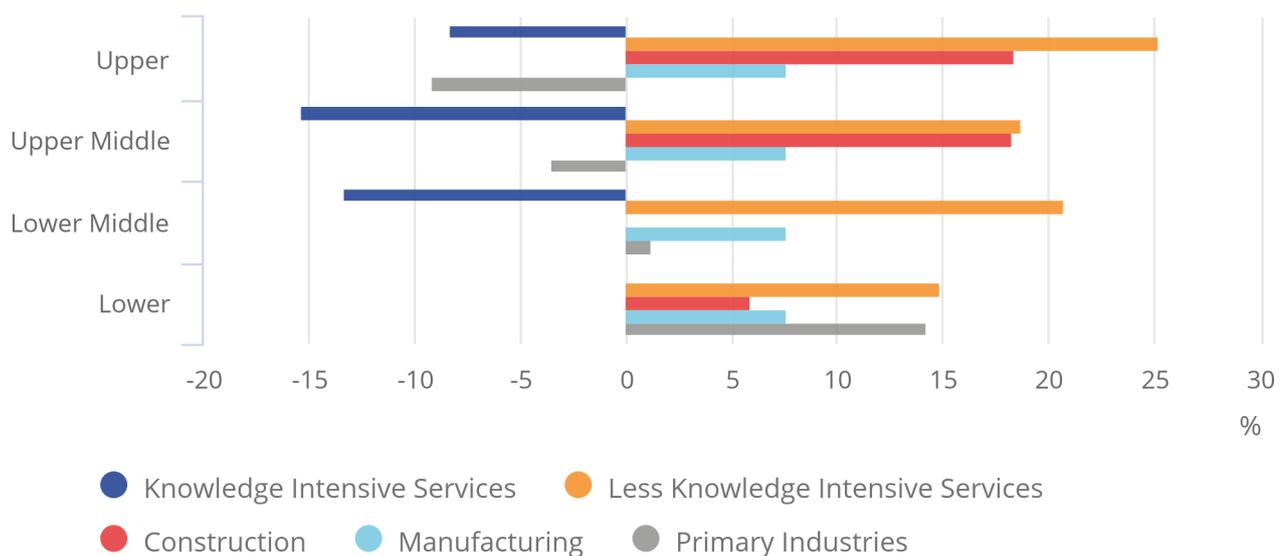
**Notes:**

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.

Figure 9b shows that when pensions are included in the earnings, employees in the lower-middle and upper-skilled occupational groups in the knowledge-intensive services sectors still earn more than their public-sector counterparts. However, there was no difference in earnings for those in the lower-skilled occupational groups in the knowledge-intensive services sectors between the public sector and the private sector. For all the workers in the less knowledge-intensive services sectors, the differences shown in Figure 9a become larger when the pensions are included in the earnings.

**Figure 9b: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017**

Figure 9b: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017



Source: Office for National Statistics, Annual Survey of Hours and Earnings

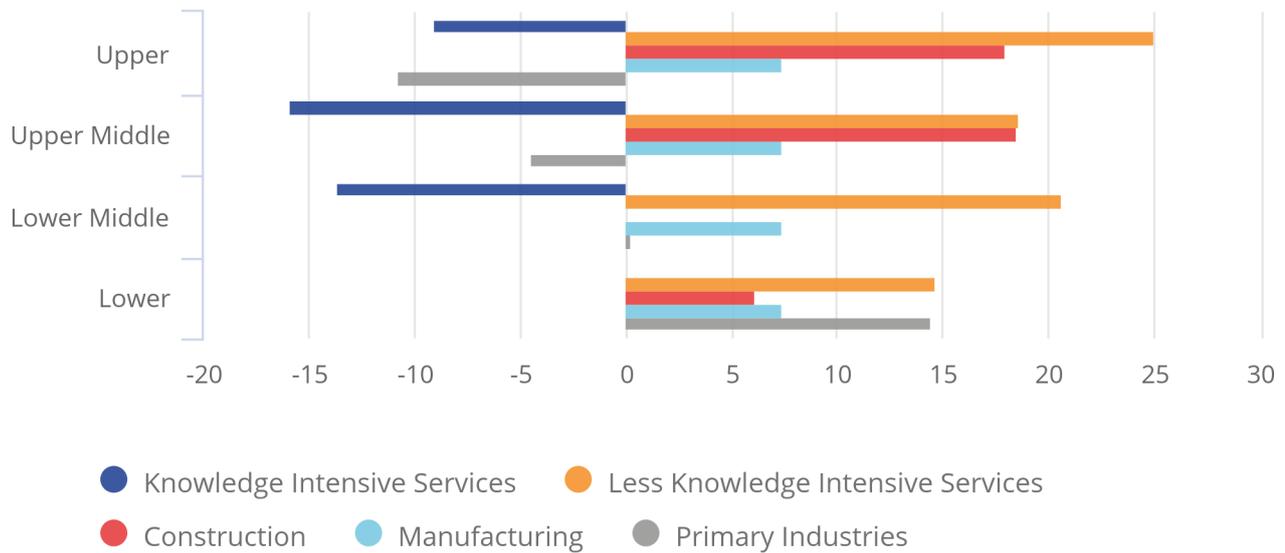
**Notes:**

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.

This analysis suggests that, excluding pensions, public sector workers in the knowledge-intensive services sectors earn on average less than those in the private sector. On the other hand, private sector employees in the less knowledge-intensive services sectors earn on average less than public sector employees; however, these differences increase on average when pensions are included in earnings.

**Figure 9c: Average percentage difference in mean hourly earnings (includes pensions and salary sacrifice) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017**

Figure 9c: Average percentage difference in mean hourly earnings (includes pensions and salary sacrifice) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017



**Source: Office for National Statistics, Annual Survey of Hours and Earnings**

**Notes:**

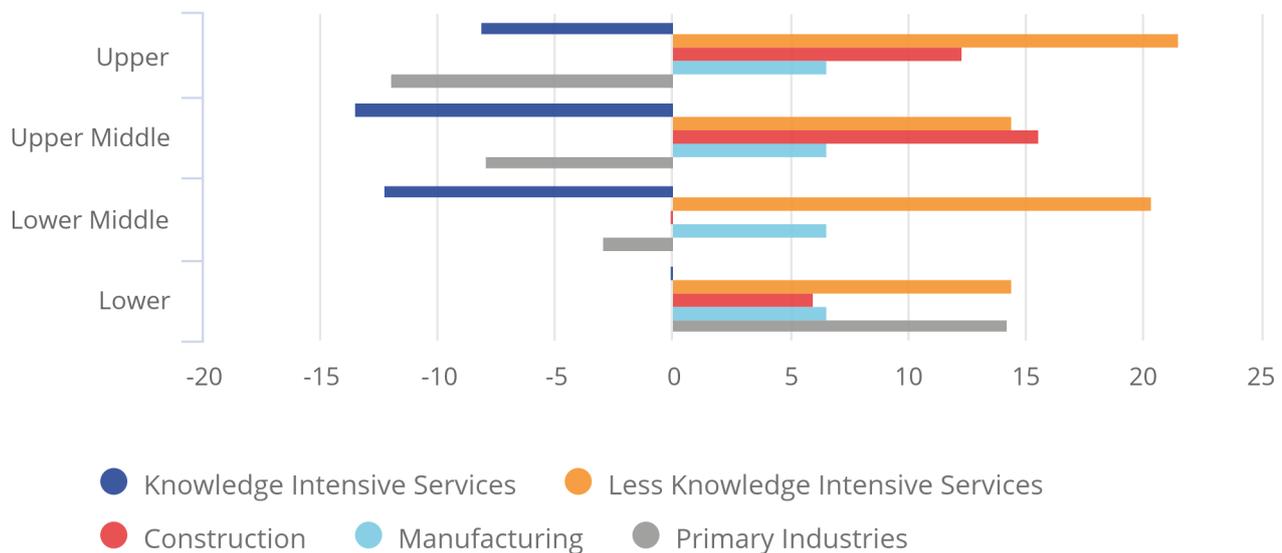
1. Bars show the percentage by which public-sector earnings higher than private-sector.
2. Data for 2017 are provisional.

As detailed in the Results 1 section, which included organisation size, to carry out a like-for-like comparison between the two sectors without the organisation size, one more regression has been run looking at only those who belong to a workplace pension scheme.

Figure 9d shows when examining only those who belong to a workplace pension scheme, the differences in earnings between the public and private sector are still largely in favour of the employees in the knowledge-intensive services sectors. For all the workers in the less knowledge-intensive services sectors, the differences shown in Figures 9b and 9c become smaller when we compare employees with pensions only.

**Figure 9d: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017**

Figure 9d: Average percentage difference in mean hourly earnings (includes pensions) of employees, by occupational group and industry, private sector compared with public sector, UK, 2017



**Source:** Office for National Statistics, Annual Survey of Hours and Earnings

**Notes:**

1. Bars show the percentage by which public sector earnings are higher or lower than private sector earnings.
2. Data for 2017 are provisional.
3. Data include employees belonging to employer run or facilitated pension schemes only.

The regression output for each of the previous estimates is available in the datasets, including for previous years.

### Results 3 – Quantile regressions

The linear regression model considers the difference in the mean earnings of public and private sector workers. This does not take account of the fact that the distribution of pay tends to be narrower in the public sector than the private sector, as shown in Table 6a, and so does not give a complete picture. It is possible to use quantile regression methods to estimate the difference in the median pay of public and private sector workers, as well as the difference at each percentile, for example, the fifth or tenth percentile. This is useful as it indicates if the pay gap is different at different points of the pay distribution, effects which cannot be captured by mean regressions.

It should be noted that estimates across different quantiles of the income distribution compare the average hourly pay for a certain distribution of the public sector workforce with the average pay for a certain distribution of the private sector workforce. For example, if we observe a positive public sector premium at the lower end of the distribution, this does not necessarily imply that if an individual in this part of the income distribution working in the public sector was to move to the private sector, they would earn a lower hourly pay.

Instead, it implies that individuals in the lower end of the public sector income distribution – conditional on observed characteristics – on average earn an hourly premium compared with the individuals in the lower end of the private sector income distribution. The pay gap between private and public sector workers has been estimated for the second, fifth and tenth percentiles, the median and the 75th, 90th, 95th and 98th percentiles using the quantile regression model both excluding and including organisation size.

Table 8a shows that that the earnings differential between public and private sector employment varies substantially along the earnings distribution, with relatively low-paid employees having the largest earnings advantage from employment in the public sector. For high-paid employees, the gap still exists in favour of the public sector for those working in smaller organisations, however, employment in the large private sector organisations has a positive impact on the earnings of those employees.

Without controlling for the organization size, Table 8b shows that employees working in the less knowledge-intensive services sectors have a negative earnings differential at all levels of the earnings distribution, with the differential being the largest for the employees at the lower end of the distribution. Employees in knowledge-intensive services and primary industries generally benefit more from working in the private sector if they are earning above the median. In the knowledge-intensive services, the negative earnings differentials for those earning below the median are relatively small.

**Table 8a: Average difference in hourly earnings (includes pensions) between public and private sector workers of different company sizes**

Company Size	Percentage difference to the Public Sector							
	2nd	5th	10th	50th	75th	90th	95th	98th
Less than 11	-25	-25	-25	-19	-15	-11	-6	0
Between 11 and 25	-19	-20	-20	-17	-14	-10	-7	-6
Between 26 and 50	-17	-18	-18	-15	-12	-8	-6	-6
Between 51 and 250	-14	-16	-16	-12	-8	-3	0	0
Between 251 and 500	-12	-14	-15	-9	-3	3	8	11
Over 500	-13	-15	-15	-8	-1	5	10	14

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

**Table 8b: Average difference in hourly earnings (includes pensions) between public and private sector workers in different industries**

Percentage difference to the Public Sector	Percentile							
	2nd	5th	10th	50th	75th	90th	95th	98th
Construction	-17	-16	-14	-11	-8	-6	0	0
Knowledge Intensive Services	-5	-4	-2	9	17	25	29	37
Less Knowledge Intensive Services	-17	-19	-20	-18	-15	-11	-8	-3
Manufacturing	-14	-15	-16	-10	-5	0	0	5
Primary Industries	-14	-15	-14	0	7	14	16	21

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

## Concluding remarks

The analysis in this article finds that after controlling for various individual and job characteristics, on average there is a positive earnings differential in favour of the public sector. The positive differential in favour of the public sector is mainly concentrated on low-skilled workers and on workers in smaller organisations, when the organisation size is considered.

Without controlling for the organisation size, the public sector also has a positive wage differential on average, however, high-skilled employees in the public sector tend to have lower earnings than their counterparts employed in the knowledge-intensive services and primary sectors in the private sector.

Quantile regression analysis provides a more complete picture of the distribution of the public-private sector earnings differential than the estimates of the mean earnings differentials. The analysis shows that the earnings differential between public and private sector employment varies substantially along the earnings distribution, with relatively low-paid employees having the largest earnings advantage from employment in the public sector. For high-paid employees, the gap still exists in favour of the public sector for those working in smaller organisations; however, employment in the large private sector organisations has a positive impact on the earnings of those employees.

Without controlling for the organisation size, employees working in the less knowledge-intensive services sectors have a negative earnings differential at all levels of the earnings distribution, with the differential being the largest for the employees at the lower end of the distribution.

However, the earnings differentials are not fully explained by employees' observable individual or job characteristics included in the regression models. The literature provides some theoretical explanations to account for these, such as monopolistic power of governments in the provision of public services, which may result in non-competitive wage settlements, different objectives of government (for example, political or income distribution) and private sector (for example, profit maximising) or differences in wage bargaining powers.

Alternatively, the regression estimates can be misleading for various technical reasons. These include data limitations, sampling bias, omitted variables, non-sampling errors, and self-selection issues. For a detailed explanation of the technical issues, please see the Quality and methodology section.

## 5 . Quality and methodology

### Survey details

The Annual Survey of Hours and Earnings (ASHE) is based on a 1% sample of employee jobs taken from HM Revenue and Customs Pay As You Earn (PAYE) records. Information on earnings and hours is obtained from employers and treated confidentially. ASHE does not cover the self-employed, nor does it cover employees not paid during the reference period. The [Annual Survey of Hours and Earnings Quality and Methodology Information report](#) contains important information on:

- the strengths and limitations of the data and how it compares with related data
- uses and users of the data
- how the output was created
- the quality of the output: including the accuracy of the data

### Classification of SOC 2010

The [Standard Occupational Classification 2010: SOC 2010](#) separates the labour market into nine major groups, based on criteria such as the qualifications, skills and experience associated with each job.

These nine major groups can be combined further into four skill groups (levels one through to four, where level one indicates relatively low skill requirements and level four indicates relatively high skill requirements). Table 9 describes some of the important features of each skill group.

**Table 9: Skill groups and share of employees by skill groups by Standard Occupational Classification (SOC) 2010, UK, April 2017**

Skill Group	Proportion of women, ASHE 2017	Proportion of men, ASHE 2017	Typical occupations
Lower	12	12	Labourers (e.g agriculture, construction) , cleaners and basic admin workers
Lower Middle	26	45	Secretaries, carers, hairdressers, cashiers, machine operatives, transport drivers
Upper	30	27	Skilled trade workers, associate professionals and technical occupations
Upper Middle	32	16	Professionals (e.g teachers, doctors, scientists, engineers, managers, directors)

Source: Office for National Statistics, Annual Survey of Hours and Earnings

Notes:

1. Data for 2017 are provisional.

In March 2012, the 2011 ASHE estimates were published on a SOC 2010 basis (they had previously been published on a SOC 2000 basis). Since the SOC forms part of the methodology by which ASHE data are weighted to produce estimates for the UK, this release marked the start of a new time series and therefore care should be taken when making comparisons with earlier years.

Similarly, methodological changes in 2004 and 2006 also resulted in discontinuities in the ASHE time series. On 28 February 2014, we published a [methodological note](#) explaining the impact of the change in Standard Occupational Classification on the estimates of public and private sector pay.

## Relevance

The earnings information in ASHE relates to gross pay before tax, National Insurance or other deductions and excludes payments in kind. With the exception of annual earnings, the results are restricted to earnings relating to the survey pay period and so exclude payments of arrears from another period made during the survey period; any payments due as a result of a pay settlement but not yet paid at the time of the survey will also be excluded.

Most of the published ASHE analyses (that is, excluding annual earnings) relate to employees on adult rates whose earnings for the survey pay period were not affected by absence. They do not include the earnings of those who did not work a full week and whose earnings were reduced for other reasons, such as sickness. Also, they do not include the earnings of employees not on adult rates of pay, most of whom will be young people. More information on the earnings of young people and part-time employees is available in the main survey results. Full-time employees are defined as those who work more than 30 paid hours per week or those in teaching professions working 25 paid hours or more per week.

## Sampling error

ASHE aims to provide high-quality statistics on the structure of earnings for various industrial, geographical, occupational and age-related breakdowns. However, the quality of these statistics varies depending on various sources of error.

Sampling error results from differences between a target population and a sample of that population. Sampling error varies partly according to the sample size for any particular breakdown or “domain”.

## Non-sampling error

ASHE statistics are also subject to non-sampling errors. For example, there are known differences between the coverage of the ASHE sample and the target population (that is, all employee jobs). Jobs that are not registered on PAYE schemes are not surveyed. These jobs are known to be different to the PAYE population in the sense that they typically have low levels of pay. Consequently, ASHE estimates of average pay are likely to be biased upwards with respect to the actual average pay of the employee population.

Non-response bias may also affect ASHE estimates. This may happen if the jobs for which respondents do not provide information are different to the jobs for which respondents do provide information. For ASHE, this is likely to be a downward bias on earnings estimates since non-response is known to affect high-paying occupations more than low-paying occupations.

[Further information about the quality of ASHE](#), including a more detailed discussion of coverage and non-response errors, is available on our archive website.

## Re-weighting of the Labour Force Survey

Returned data from ASHE are weighted to UK population totals from the Labour Force Survey (LFS). The LFS itself has recently been reweighted, using revised UK and subnational population estimates consistent with the 2011 Census and updated population projections. We have found there to be negligible impact of this on the ASHE results. Further information on the [LFS reweighting](#) can be found on our LFS user guidance pages

## Statistical notes

The dependent variable is expressed in log form. If the distribution of a variable has a positive skew, taking a natural logarithm of the variable sometimes helps fitting the variable into a model. Also, when a change in the dependent variable is related with percentage change in an independent variable, or the other way around, the relationship is better modelled by taking the natural log of either or both the variables.

### Definitions of earnings used in the regression analysis

Hourly earnings equals (gross weekly earnings for the reference period divided by total paid hours worked during the reference period)

Where:

Gross weekly earnings for the reference period equals basic weekly earnings plus incentive pay paid in this period relating to the pay period plus additional premium payments during the pay period for shift work and night or weekend work not treated as overtime plus weekly overtime pay for the pay period plus pay received in the pay period for other reasons.

Total paid hours worked during the reference period equals basic weekly paid hours worked plus weekly paid overtime hours worked during the reference period.

Hourly earnings including pensions equals (gross weekly earnings divided by weekly total paid hours worked) plus hourly employer pension contributions.

Pensions are provided in ASHE in the form of weekly employer and employee contributions. To get an hourly amount, weekly employer pension contributions are divided by total paid weekly hours.

Hourly earnings including pensions and salary sacrifice equals hourly earnings including pensions plus hourly employee pension contributions if they are made through salary sacrifice.

In the salary sacrifice scheme, the salary sacrificed is recorded in employee pensions contributions. To get a value for earnings including pensions and salary sacrifice, both employee and employer pension contributions are added to gross pay as an hourly amount<sup>1</sup>.

All earnings variables have been adjusted to account for bonus payments using data from the Average Weekly Earnings (AWE) series. Using AWE data, we have calculated an average bonus amount, as a percentage of average earnings for each (Standard Industrial Classification 2007: SIC 2007 two digit) industry in both the public and private sector. Hourly earnings from ASHE are then multiplied by this bonus percentage to get bonus-adjusted hourly earnings.

### Taylor series approximations

When accounting for the age of employees in the regression model, we have incorporated a variable for both age and age squared; this is due to the Taylor series approximations. Taylor series approximations tell us that for many smooth functions, they can be approximated by a polynomial, so including terms like  $x^2$  or  $x^3$  let us estimate the coefficients for the approximation for a known or unknown non-linear function of , or in this case age.

## Interaction terms

As well as the suite of independent variables observed in the model, a number of interaction terms are included. These are added to account for the assumption that some characteristics interact with one another.

The presence of a significant interaction indicates that the effect of the first independent variable (1) on the dependent variable (Y) is different at different values of a second independent variable (2). It is tested by adding a term to the model in which the two independent variables are multiplied, as follows:

$$Y = A + 1*1 + 2*2 + 3*1*2$$

Adding an interaction term to a model drastically changes the interpretation of all the coefficients. If there were no interaction term, 1 would be interpreted as the unique effect on the Y (in this case earnings). But the interaction means that the effect of 1 on Y is different for different values of 2. So, the unique effect of 1 is not limited to 1, but also depends on the values of 3 and 2.

The unique effect of 1 is represented by everything that is multiplied by 1 in the model, as follows:

$$1 + 3*2. 1 \text{ is now interpreted as the unique effect of 1 on Y only when } 2=0.$$

When interpreting the outputs of the model, care needs to be taken with the coefficients of variables. When the independent variables are in their original state and the dependent variable is in its log-transformed state (a log-linear model) each one unit increase in the independent variable multiplies the expected value of Y by ( $\exp^*$ ).

For small values of  $\beta$ , approximately  $\exp^* \approx 1 + \beta$ . We can use this for the following approximation for a quick interpretation of the coefficients: ( $100 * \beta$ ) is the expected percentage change in Y for a unit increase in the independent variable. For example, for  $\beta = .06$ ,  $\exp^{*.06} \approx 1.06$ , so a one unit change in the independent variable corresponds to (approximately) an expected increase in Y of 6%.

## Regression analysis and its limitations

In analysis that looks at the relationship between two variables, it can be tempting to infer that one variable is directly related to the other. For example, a conclusion such as “the average earnings of the employees in the public sector is higher than the average earnings of the employees in the private sector” would only be justified if we could show that there were no other important differences between the two groups of employees that might affect the findings, such as differences in skills or job characteristics.

Regression analysis allows us to do this by holding constant all the variables in the model while measuring the size and strength of the relationship between two specific variables. If the regression results show a significant relationship between the two groups, then this means that two people who are identical in every way apart from their employment sector would indeed have different average earnings. This implies a direct relationship between earnings and employment sector, even when the other variables included in the analysis are considered. Therefore, the main benefit of regression analysis is that it provides a better method than analysis looking at the relationship between only two variables at a time of identifying those factors that can influence the earnings of an individual.

However, every analytical method has its limitations and regression analysis is no exception. The following sections summarise some important considerations which should be borne in mind in terms of the statistical assumptions underlying the techniques used here and the types of inference that can be drawn from the findings.

## **The explanatory power of the models**

The explanatory power of the regression models (that is, the amount of variance in earnings that has been explained by the model) used in this analysis is around 55%.

It is important to note that the explanatory power of the model can be influenced by leaving out important factors, both observable and non-observable, which contribute to earnings, such as training on the job, other observable variables not included in ASHE such as education, or individual motivation or productivity, which can only be observed by the employer.

## **Omitted variable bias**

In an ideal world, a regression model should include all the relevant variables that are associated with the outcome (that is, the variable being analysed such as earnings). In reality, however, we either cannot observe all the potential factors affecting earnings (such as the productivity of the employee) or are limited by whatever information is collected in the survey data used in the regression analysis.

If a relevant factor is not included in the model, this may result in the effects of the variables that have been included being mis-estimated. When the omitted variables are correlated with the included variables in the model, the coefficient estimates of those variables will be biased and inconsistent. However, the estimated coefficients are less affected by omitted variables when these are not correlated with the included variables (that is, the estimates will be unbiased and consistent). In the latter case, the only problem will be an increase in the estimated standard deviations of the coefficients, which are likely to give misleading conclusions about the statistical significance of the estimated parameters.

## **Causality**

Regression analysis based on cross-sectional observational data cannot establish with certainty whether relationships found between the independent and dependent variables are causal. For example, the usual assumption is that individual characteristics, such as occupation, are independent variables that may affect earnings (viewed here as a dependent variable). However, variables such as occupational choice could be jointly determined with earnings (that is, some of the association between occupational choice and earnings may be caused by the impact of earnings on occupational choice).

## **Self-selection**

A non-random selection of workers into different sectors may also affect the outcome of the regression results. A self-selection bias will affect the outcome if the characteristics of the people that cause them to select themselves into a group are different and these characteristics are correlated with earnings.

## **Multi-collinearity dependence (or correlations) among the variables**

If two or more independent variables in the regression model are highly correlated with each other, the reliability of the model as a whole is not reduced but the individual regression coefficients cannot be estimated precisely. This means that the analysis may not give valid results either about individual independent variables, or about which independent variables are redundant with respect to others. This problem becomes increasingly important as the size of correlations between the independent variables (that is, multi-collinearity) increases.

## Measurement issues

The analysis compared the aggregate average earnings of a group such as occupations or industries between the public and private sectors. However, the jobs, skills and responsibilities in these groups can be very diverse and the distribution of these jobs between the public and private sectors may not be balanced. For example, jobs in a narrowly defined occupational category of “teaching and educational professionals” includes all teaching professionals such as university lecturers, secondary education teaching professionals or nursery teachers and the distribution of these jobs between the public and private sectors is not perfectly balanced.

Even within a more narrowly defined occupation such as “solicitors” there can be a range of different types of skills, specialisation and productivity levels of workers. For example, a lawyer working in a multinational law firm in London may have a different specialisation (so different labour productivity levels affecting their earnings) to a lawyer working in a small local law firm, but both will have the same narrowly defined occupational classification.

## Notes for: Quality and methodology

1. Note that the employer contribution can be overestimated as the total amount may include employee contributions.

## 6 . Acknowledgments

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