

Exploring the gender pay gap and its contributing factors 2018

1 General Report

The Office for National Statistics (ONS) collects quarterly household surveys known as The Labour Force Survey (LFS) which cover a range of subjects including their employment and income. We analysed data from the LFS for the period of July-September 2018 to examine the gender pay gap and the main factors causing this inequality. This inequality is unlawful across the UK under the Equality Act 2010 (2). The ONS projected the gender pay gap to be 17.9% in 2018. From our data, we found the gender pay gap to be slightly lower than expected at 17.6%, with men's median hourly wage being £13.33 and women's median hourly wage being £10.98. Three possible explanations have been offered for this difference: unequally shared caring responsibilities and part-time roles; women choosing to work in lower paid roles; and a higher number of men in senior roles. Firstly, from our analysis we did find evidence that childcare was distributed unevenly and generally a higher proportion of women worked part-time:

- 29.7% of working women worked part-time whilst 12.2% of working men worked part-time.
- As displayed in figure 8, for men and women who have a child under the age of five 37% of females are in part-time work compared with only 10% of males.
- Around 9% of women report being inactive in the workforce citing family reasons whereas only approximately 1% of men report family reasons as the reason for not working.

Secondly, we found inconclusive evidence to support the claim that women choose lower paying roles. By gross average weekly pay, the second lowest paying occupation sector, 'Caring, Leisure and Other service occupations', had the largest proportion of female workers at 82%. Furthermore, figure 5 illuminates that three out of the four lowest paid sectors have a larger proportion of women. In contrast, we observed that two of the higher paying professions, 'Professional Occupations' and 'Associate Professionals and Technical Occupations', were divided relatively evenly amongst genders. Finally, it was suggested that a larger proportion of males in senior roles contributed to the gender pay gap. Our data found that the split between male and female managers was 60:40 whilst the proportion of males and females in supervisor roles was around 50% each. Although these differences in proportions are not huge, it was found that when assessing the impact of becoming a manager, average weekly pay increased by 18% for a male manager whereas a female manager received an average increase of 13%. It was also found that for every age category, men's median hourly wage was higher than women's, as displayed in figure 1. This trend was consistent for different levels of education. For example, for those educated to degree level there was found to be a pay gap of 16.8% in favour of men. So, when exploring the reasons for pay inequality in the UK it was found that the main factors causing this disparity were: the uneven responsibilities women had in caring for family members, and that, although the proportion of women in senior roles was not dramatically lower, women in these roles were compensated less than their male counterparts.

2 Data

The data used in this report was taken from the Labour Force Survey (July to September 2018), conducted by the Office for National Statistics. This survey is the largest household study in the UK and should have provided the most complete data set for our analysis. The data was collected by interviewers using either computer assisted questionnaires or over the telephone. A sample of households were selected at random from the Royal Mail's Postcode Address File to complete this survey (5). The data provided us with information about 55,326 people, these each had 52 variables covering a range of categories including: household characteristics, employment status, education and earnings. We found some of these variables to be irrelevant to our analysis. For example: accommodation details and housing tenure which we considered to be results of pay level rather than contributing factors. We did not use data entries for unemployed people apart from those that gave the reason they were not looking for work. This was because we cannot compare a pay gap between those who are unemployed. However, we were interested in evaluating the reasons given for choosing not to work. There are large amounts of missing data in many variables. We decided against imputing our outcome variable and instead treated the set of data which included earnings as a smaller data set. A large amount of missing data may cause bias, and this was a major limitation of our analysis. However, we did not find patterns in variables which had missing earnings data, so we assumed that our data was missing at random. Our analysis focus was on differences between gender. Gross weekly pay had 82.8% missing data and both genders had similar amounts of missing data. Thus, there should have been no gender bias in our analysis of earnings. We also have structural missing data, for example- questions relating to unemployment and children were not applicable for some respondents. This has been recorded in the original data and so is not a problem.

3 Gender Pay Gap

Throughout this report, we have used the definition of gender pay gap to be- the percentage difference between men and women's median hourly earnings, relative to men's median pay (excluding overtime), as defined by the ONS. Our data found that there was a 17.6% gender pay gap in the UK, with men's median hourly wage being £13.33 and women's median hourly wage being £10.98. We looked for details which may explain this disparity. Firstly, we examined differences between men and women working in part-time and full-time jobs. From our data sample 29.7% of women worked part time hours compared to 12.2% of men. Men's median hourly wage in part-time jobs was 10.8% lower than for women, contradicting the belief that men earn more than women. Women earned a median hourly wage of £9.23 whilst men earned £8.33 in part-time work. However, this was not the case when looking at people in full time work. Men earned a higher median hourly wage of £14.02 whilst women earned £12.16, a 3.3% decrease. From figure 1, we see that as age increases, median hourly wage also rises until the age of 50 for men and

45 for women. The escalation in wage is plausible, because as people's experience and proficiency in their respective jobs increases, they would be compensated by a rise in wages. Over the period, in which men's and women's wages rose, the average rate of increase for men was £1.14 per hour for every 5 year increase in age and was £0.87 for women. After the age of 50, men's median hourly wages started to decrease at an average rate of £1.11 for every 5 year increase. For women, after the age of 45, the average rate of decrease in the median hourly wage for women was £0.59 for every 5 year increment. However, at every age category the median hourly pay was greater for men than for women. We also investigated whether the gender pay gap remained in specific sectors of occupation. As displayed in figure 2, median hourly pay was higher for men in each of the 9 sectors listed in the data, and so there was a gender pay gap throughout employment sectors. We found the sector with the largest pay gap was 'Skilled Trades Occupations', which included jobs such as farmers, painters and decorators and electricians. This gap was found to be 25.7% and the second largest pay gap was in 'Process, Plant And Machine Operatives' with a pay gap of 20.2%. On the other hand, we found the smallest pay gap to be in jobs listed under 'Caring, Leisure And Other Service Occupations' which included jobs such as teaching assistants, veterinary nurses and travel agents. This pay gap was much smaller at 4.52%. Therefore, there is evidence here to suggest that pay gap could be explained by occupation. We also explored how the gender pay gap differs by education level (figure 3) Again, from figure 3, we can see that median hourly wage for men was greater than that of women at every education level. The largest pay gap between males and females was 23.2% for people whose highest education qualification was GCE A level or equivalent, whilst the smallest gap was for people who held no qualifications, with a pay gap of 9.9%. However, the pay gap between males and females who hold a 'Degree or equivalent' was 16.8%, so there is no evidence of a linear increase in that rate of the pay gap as the level of education increases.

4 Explanations for the Gender Pay Gap

One explanation given for the gender pay gap is that caring responsibilities and part time roles are shared unequally between men and women. To investigate this, we used the technical definition of part time-work (less than 35 hours) (6) and presumed that the majority of caring responsibilities are for children. We discovered that overall substantially more women are in part time roles. Of working women, 29.7% worked part time hours compared to 12.2% of men. This inequality is only intensified when combined with caring responsibilities. We found that, for women with children aged 0 to 4 years this percentage increases to 37.1%, with a further increase to 38.5% for women with children between 5 and 16 years old. In comparison, only 10.2% of men with children younger than 5 years old were working part time hours. Not only are women with young children more likely to partake in part time roles, but they are also more likely to give up work altogether. We found that 49.6% of women with a child under 5 years old were not in any form of employment, in comparison to 13.9% of men, however this would not directly impact gender pay gap. So there was evidence that women take an unequal role in the caring responsibilities of children, which can be seen in figure 8. Overall, 1.09% of men reported being inactive in the workforce due to family reasons in comparison to 8.8% of women. This may suggest that caring responsibilities of elderly relatives and older children is also unequally shared between men and women. However, we would need more information to fully support this conclusion. A further explanation given for the gender pay gap is that women choose to work in low paid sectors. Some sectors had a significant gender disparity, those with the greatest disparity, consisting of more males include 'Process, Plant and Machine Operatives' with 11.7% female employees and 'Skilled Trades Occupations' with 9.15% females. Conversely, the field with the highest proportion of females was 'Caring, Leisure and Other Service Occupations' at 81.8%. However, a variety of societal factors and personal choices could explain these disparities. We can see from figure 5, that there were overwhelmingly more women represented in the lower paid sectors. The 'Caring, Leisure and Other Service Occupations' which had the highest representation of women was the second lowest paying sector. On the other hand, the highest paying sector 'Managers, Directors and Senior Officials' had only 35.5% female representation. However, two higher paying sectors 'Professional Occupations' and 'Associate Professional and Technical Occupations' had women and men represented almost equally with 50.2% and 45.1% female employees respectively. It has also been suggested that the gender pay gap is caused by there being more men than women in senior roles. We found that there were more men in manager roles with 59.3%, whilst supervisor roles had quite an even gender proportion of women at 49.2%. A breakdown of these proportions are shown in figure 6. These figures implied that there were not huge differences in the proportion of women and men in senior roles, which suggested that this was not a significant factor contributing towards gender pay gap. However, when looking into specific managerial roles our analysis showed that the proportion of 'Chief executives and Senior officials' had a high proportion of men at 73.8%. In this sector, we had no reported remuneration data, and consequently does not impact our gender pay gap calculation. It was reported that CEOs in 2018 were paid an average annual salary of £589,920 (3) which was higher than any of our reported values and so would result in a larger pay gap than calculated.

5 Model of Gross Weekly Pay

5.1 Model selection

In order to find the variables associated with gross weekly pay, we used a linear model with a logarithmic transformation. We chose a linear model due to the continuous nature of the outcome variable and its simplicity in comparison to a gamma model, which displayed similar results. The logarithmic transformation stabilised the variance as a result of many outliers and right skewed data. We chose to use gross weekly pay instead of gross hourly pay as our dependent variable to minimise missing data. Considering the 2018 national minimum wage, the lowest minimum wage was £3.50 for apprentices. (1) We decided to allow observations which were slightly below the lowest minimum wage, but

to exclude anything below £3 per hour. This was to prevent our analysis being impacted by illegal pay, errors, and very extreme cases. Because of the large number of variables, we chose to start by building three smaller models which focused on socio-demographics, employment and all other variables. We firstly removed all variables which were not significant in the smaller models at a 95% confidence using p-values and ANOVA tests. We found many employment factors with perfect collinearity, so in each case we chose to use the factor which encompassed the major groups rather than the detailed ones as to not over complicate the model. When combined, this resulted in an initial complete model. Similarly, we used a mixture of p-values and ANOVA tests to remove variables which became insignificant. However, in this case, when removing a variable, we also compared the old and new models using AIC. We kept the variable if the AIC in the new model increased by more than 5 points. We then added significant interaction terms. Since the focus of our analysis is the gender pay gap, we added terms which significantly interacted with the gender variable at 95% confidence. We concluded that there were five significant interactions. Using an ANOVA test we compared the models with and without interactions and concluded the latter was significantly better. Our final model is as follows, where μ is the mean gross weekly pay.

$$\begin{aligned} \log(\mu_{hijklmno}) = & \beta + \beta_1 Sex_h + \beta_2 Age + \beta_3 Age^2 + \beta_4 Region_i + \beta_5 Ethnicity_j + \beta_6 NumberChildren5to16 \\ & + \beta_7 MaritalStatus_k + \beta_8 MainJobUnit_l + \beta_9 NotPermanent + \beta_{10} PartTime \\ & + \beta_{11} TotalUsualHours + \beta_{12} Sector_m + \beta_{13} ManagerialStatus_n + \beta_{14} SecondJob \\ & + \beta_{15} HighestQualification_o + \beta_{16} BadHealth + \gamma_1 (Sex * Age)_h + \gamma_2 (Sex * NumberChildren5to16)_h \\ & + \gamma_3 (Sex * PartTime)_h + \gamma_4 (Sex * TotalUsualHours)_h + \gamma_5 (Sex * ManagerialStatus)_{hn} \end{aligned}$$

$h = \text{Male, Female}$ $Sex_{Male} = 0$
 $i = \text{Yorkshire, NorthWest, EastMidlands, WestMidlands, EastAnglia, SouthEast, SouthWest, Wales, Scotland, NI, North}$ $Region_{North} = 0$
 $j = \text{Mixed, Indian, Pakistani, Bangladeshi, Chinese, Other Asian, Black, Other, British}$ $Ethnicity_{British} = 0$
 $k = \text{Single, Married/CivilPartnership, Divorced/Widowed}$ $MaritalStatus_{Single} = 0$
 $l = \text{Manager/Director/SeniorOfficial, Professional, AssociateProfessional/Technical, Administrative/Secretarial, SkilledTrades, Caring/Leisure/Service, Sales/CustomerService, Process/Plant/MachineOperatives, Elementary}$ $MainJobUnit_{Elementary} = 0$
 $m = \text{Private, Public}$ $Sector_{Private} = 0$
 $n = \text{NotManager, ForemanorSupervisor, Manager}$ $ManagerialStatus_{NotManager} = 0$
 $o = \text{Degree, HigherEducation, GCEAlevel, GCSE, Other, None}$ $HighestQualification_{None} = 0$

5.2 Model Checking

We used a wide range of methods to check the validity of our model. We looked at plots displaying Residual vs Fitted, Normal Q-Q, Scale-Location and Residuals vs Leverage. They all displayed a good fit apart from the Normal Q-Q plot. The Residual vs Fitted and the Scale-Location plots both appeared random with the first centered around 0 and the Residual vs Leverage plot displayed no points with influence above Cook's distance. However, the Normal Q-Q plot (figure 7), showed non-normality for the highest and lowest theoretical quantiles. This would suggest that our model cannot explain gross weekly pay for very high and low earners. This was also apparent in the binned residual plot with strong outliers only present in the highest and lowest expected values.

6 Model Results

Using our final model we found the following results: a woman (of average: age, number of children and total usual hours of work) working full time in a non-managerial position makes 7% (95% CI: -33%, +18%) less than her male counterpart and this number rises for full-time female managers who earn 11% (-39, +17) less. This supports the claim that the pay gap was still present in the UK even when controlling for job type and education level for example. Furthermore, the interaction between gender and age was negative at -0.19% (-0.33, -0.05) implying the gender gap increases with age. Finally, the negative interaction term of -2% (-4, 0) between gender and children aged 5-16 indicated that women with children aged 5-16 earned less than their male equivalent. However, the highest coefficient between the interaction variables was whether the person worked part-time. This coefficient was 48% (38, 58) suggesting that a female who works part-time earns more than her male counterpart. There were other factors which influenced gross weekly pay more than gender. For example, ethnicity affected gross weekly pay quite strongly. British people were paid higher than all other nationalities whilst people from Bangladesh were comparatively paid 23% (-35, -12) less per week. The type of job also played an important role in gross weekly pay. The lowest paid jobs were first "Elementary Occupations" then "Caring Leisure and Other Service occupations". The two highest paid areas were "Manager, Directors and Senior Officials", who made 52% (46, 59) more than people in "Elementary occupations, and, "Professional Occupations" were the highest with a 61% (55, 67) increase. However, in our preliminary analysis we found that "Manager, Director or Senior Official" earned more on average than someone in a "Professional Occupation". This difference could be due to the "Manager" variable not being included. Other important factors include education level with "Degree or equivalent" earning the most with a 30% (24%, 35%) increase in weekly salary compared to someone with no qualifications. Unsurprisingly, full-time workers

earned 37% (31, 42) more than part-time workers. Distinct regions also earned different salaries with the highest incomes in South East and the lowest in Midlands with a 16% fall. Since London is located within the South East this result was expected. Another component of the model was age which had a quadratic relationship with gross weekly pay. Every year gross weekly pay increased by 5% (4, 6) but the quadratic component was negative at -0.055% (-0.06,-0.05) suggesting an eventual decline.

6.1 Model Explanations for Gender Pay Gap

Our model showed that, *ceteris paribus*, a woman with a child aged between 5 and 16 could expect to receive 2.21%(1.16,3.25) less gross weekly pay than her male counterpart. This suggests that caring responsibilities explain considerable portions of the gender pay gap. We would expect managerial positions to cause an increase in wages and subsequently increase the gender pay gap since there was a higher proportion of males. In addition to this, we also found a significant interaction term in our model indicating that female managers were paid less than male managers. We found that, all else equal, a male becoming a manager is associated with an 18.5%(16.6,20.4) increase in gross weekly pay, whilst a female manager sees an increase of 12.7%(-5.52,34.34). This implies that if proportions of male and females in managerial positions were equal this would still contribute to the gender pay gap. The model also shed light on alternative explanations for the gender pay gap, shown by an interaction between age and sex. Men saw an increase in their gross weekly pay of 5.29%(5.0,5.58) per year increase in age while women saw a smaller increase of 5.09%(4.51,5.66). It is unclear why this was true, it is possible that this is a result of years away from the workplace to raise children. Women may also be less likely to ask for pay rises causing a slower salary increase (4). The Equality Act 2010 legally protects people from gender discrimination in the workplace(2). From our model, we found that gender alone was a significant variable, implying that with all other variables kept the same, gender will still impact gross weekly pay. We predicted gross weekly pay for both males and females ranging from 16 to 65, based on an average respondent from the survey using a reference of either the mean value or the most common category for our predictions (figure 4). These predictions showed significant differences between males and females. This does suggest evidence of illegal discrimination, but further analysis would be needed to confirm. Alternatively, there exist explanations for gender pay gap which were not adequately represented by the survey.

7 Conclusion

7.1 Strengths and Limitations

Overall, our data set was detailed and provided us with enough variables to explore explanations behind the gender pay gap. The survey design of simple random sampling minimised bias and the given weights allowed us to accurately represent the population of the UK, however a stratified sampling method may have given better representation of small subgroups. The large data set gave us a good range of outcomes and exposures- increasing the precision of our predictions and reliability of our model. The biggest limitation of the model was missing data in remuneration variables. Despite having 55,247 original entries, in total we only deemed 9,078 entries usable with 4% of this data missing due to explanatory variables. A limitation of our model is that it should not be used to make predictions for very high or low earners due to poor fit. Furthermore, our model is not necessarily generalisable to other countries making extrapolation difficult. To increase the reliability of our results we would need a larger number of responses for our outcome- gross weekly pay. To further our analysis, a point of interest would be the data from previous years for comparison, specifically to observe the trend in the pay gap across time. It would also be interesting to see differences if we had surveyed gender as a non-binary variable. Finally, comparing findings between heterosexual and homosexual relationships could reveal some information about women's career choices or their choice to not work.

7.2 Overall conclusion

In conclusion, we found a gender pay gap of 17.6% in the UK between July and September 2018. We found that men consistently earned more than women, with the exception of part-time workers where women had a higher median wage. The size of the gender pay gap varied over different attributes including: education, occupation, and age. There was generally a larger pay gap for more highly educated individuals, although the increases are not linear. The largest gap was between those who achieved GCE A levels whilst the lowest gap was between individuals with no qualifications. We found that the gender pay gap also varied by employment sector which had the largest pay gap in 'Skilled Trades Occupations' whilst the smallest pay gap was seen in 'Caring Leisure, and Other Service Occupations'. We also found that the pay gap showed a quadratic trend with age increasing up until the age of 45 with a gradual decrease after this. Overall our analysis found that the main causes of gender pay gap can be attributed to three reasons: the unequal divide of caring responsibilities and part-time roles; the pay increases of managerial roles; and the impact of age on pay by gender. Overall of working women 29.7% were in part-time roles in comparison to 12.2% of men. We found this is largely due to child caring responsibilities. Women with children were much more likely to work in part-time roles or give up work all together. Of working women with children aged 5 to 16, 38.5% were working a part-time role. This would generally decrease the income of women under these conditions. Our model supported this conclusion, as it found having a child between ages 5 to 16, and its interaction between gender to be significant variables. From our data summaries we found that there was a higher proportion of men in managerial positions, which would increase the gender pay gap. Additionally, our model found that gender and managerial status interacted meaning that female managers were paid less than male managers. Finally we found from our summaries that earnings increase with age, and that this increase is consistently higher for men than for women. Our model also supported this finding a significant interaction between age and gender. Overall, there is also some inconclusive evidence suggesting illegal discrimination.

References

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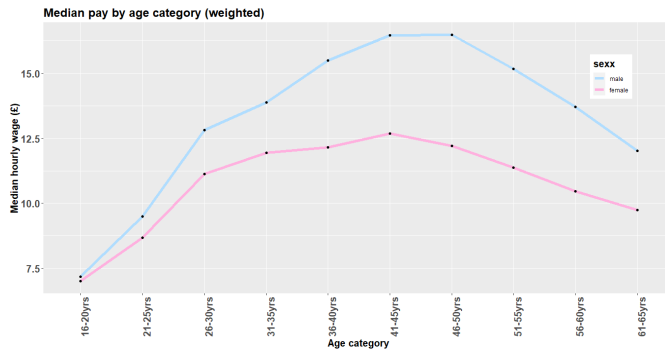


Figure 1

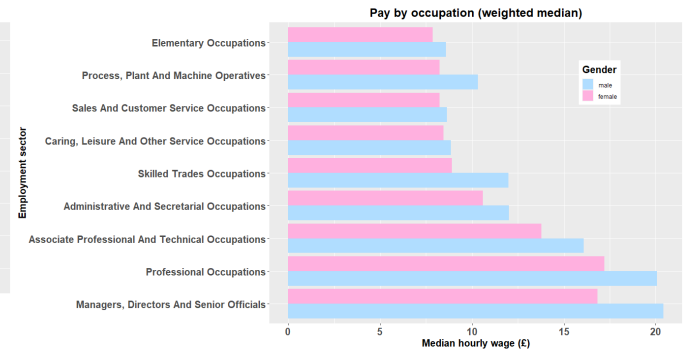


Figure 2

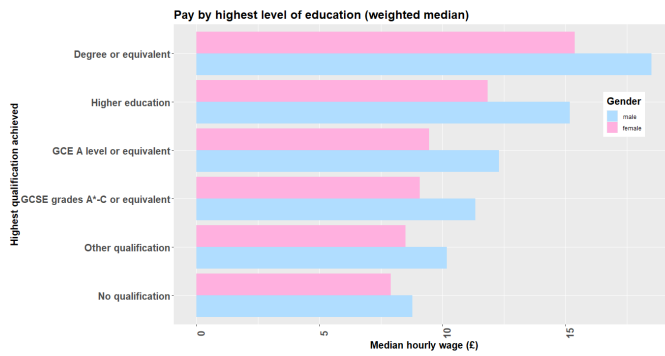


Figure 3

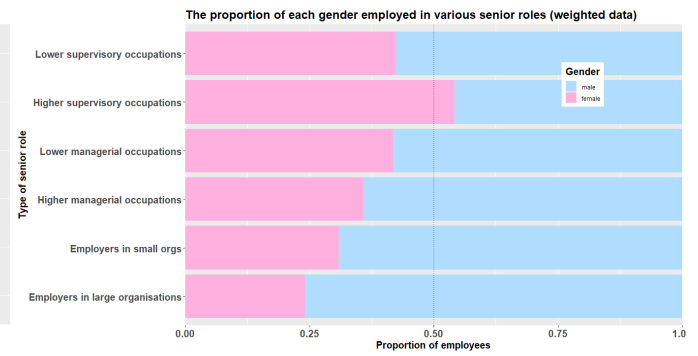


Figure 4

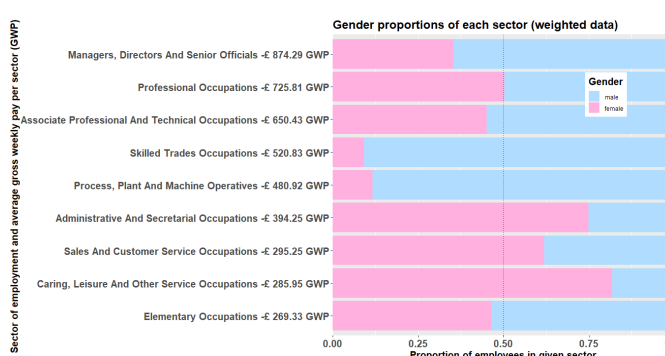


Figure 5

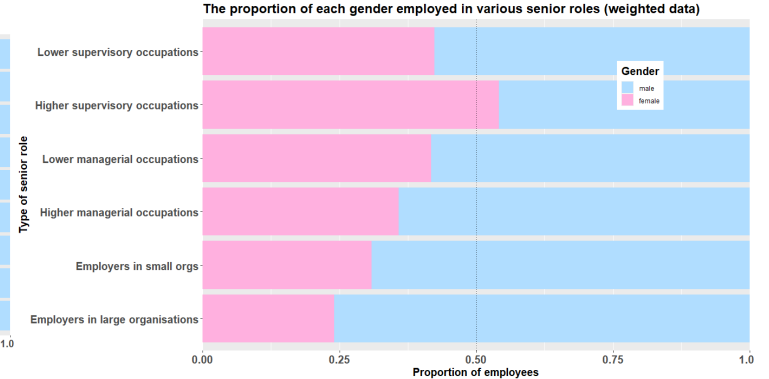


Figure 6

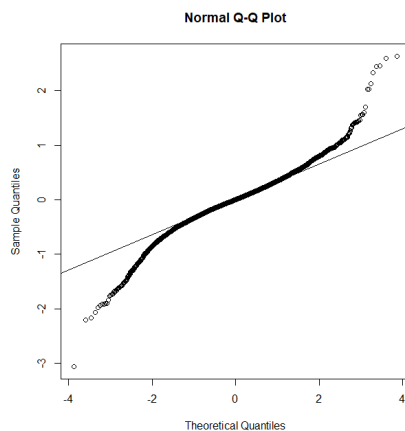


Figure 7

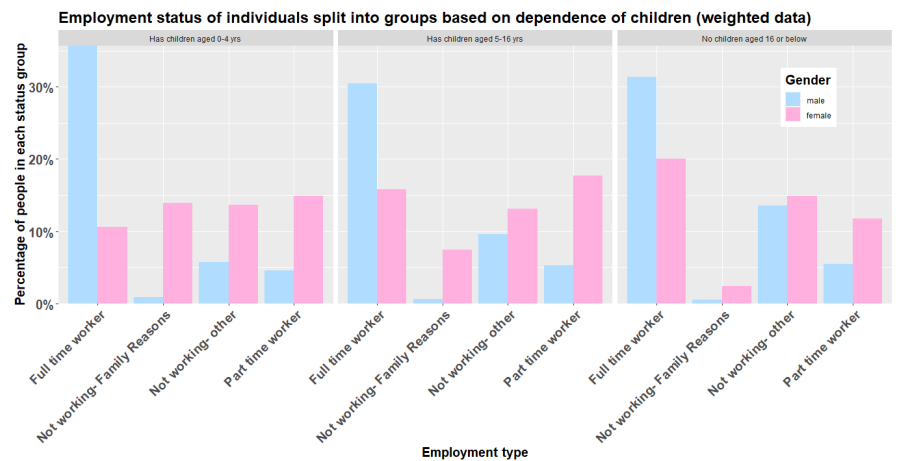


Figure 8