Briefing Paper No. 4 September 2017

How Do Gender Pay Gap Decompositions Work : Answers from the Scottish Pay Gap Project

In view of the need for a clear explanation of the pay gap components, we developed this briefing paper for non-economists and those new to the pay gap issues. We thank *Close the Gap* for consultancy funds related to this briefing. We are grateful to David Bayliss for help with the project on the pay gap during 2015/6.

Key points

- The gender pay gap in the UK decreased from 22% in 2004 to 19% in 2013/14.
- Oaxaca decomposition method allows us to study detailed components of the gender pay gap (Oaxaca and Ransom, 1994).
- Pay gap is explained by differing effects of X variables by men and women, ie., endowment effects.
- Although men and women are engaged in similar jobs, the reward can differ by sex over time in particular. Pay gap is further explained by this differing reward effects to men and women.
- There are factors that are advantageous to women's pay, ie., protective factors.

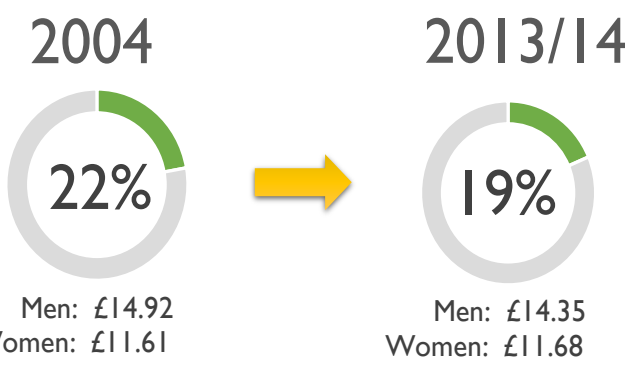
Overview

This briefing paper will present and explain:

- The gender pay gap trend in the UK and Scotland from 2004 to 2013/14
- Components of pay gap decompositions
- How to interpret pay gap decomposition results

1. UK Pay Gap at a Glance

Figure 1. UK Gender Pay Gap



Source: British Household Panel Survey (BHPS), 2004; Understanding Society sample, also known as UK Household Longitudinal Study (UKHLS), 2013/2014. The population sampled is employees aged 16-65, hours 5+ per week; wage rates are gross ie before tax. The population of employees has had those who reported extreme wage rates removed. Unless otherwise stated, this is the reference population throughout this paper.

As shown above, the total gender pay gap fell from 22% in 2004 to 19% over a decade later. After adjusting for inflation, in 2013/14, women on average earned £11.68 per hour, which is 19%, or £2.67 less than their male counterparts.

So, how does the gender pay gap work? What are the factors that drive this gender pay gap? Are there any factors that help women bring higher wages? Most importantly, how do we obtain detailed components of gender pay gap?

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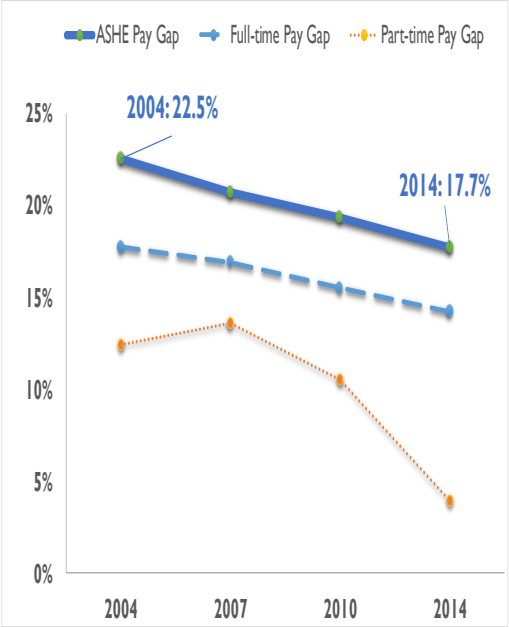
Validation

Figure 2. UK Gender Pay Gap Using ASHE Data



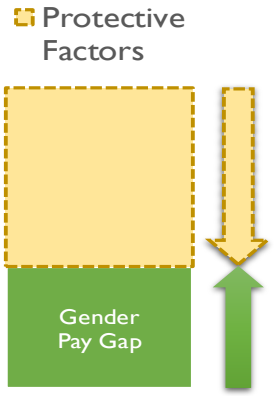
Source: Annual Survey of Hours and Earnings (ASHE) online data 1997-2015 Time Series -tcm77-424470.xls, table 6. Annual inflation not adjusted. Part-time corresponds to 30 hours a week (25 hours for teaching) or less. The ASHE figures relate to employees on adult rates of pay, whose earnings for the survey pay period were not affected by absence. Annual estimates are provided for the tax year, and only earnings of employees on adult rates of pay who have been in the same job for more than a year are included.

The ASHE data shows marginally smaller gender pay gap for 2014 as measurements are different from those in BHPS/UKHLS in Figure 1. The pay gap trend was downward as seen in BHPS/UKHLS data. ASHE data is drawn from an annual 1% sample of jobs taken from HM Revenue and Customs' Pay As You Earn (PAYE) records.

Offsetting Nature of the Pay Gap

Gender Pay gap can be widened by a number of drivers. Some factors are advantageous to women, reducing the pay gap. We call them protective factors. As such, drivers and protective factors of the gender pay gap offset each other.

Figure 3. Protective Factors



UK Pay Gap Decompositions

Figure 4. Drivers of UK Gender Pay Gap Decompositions

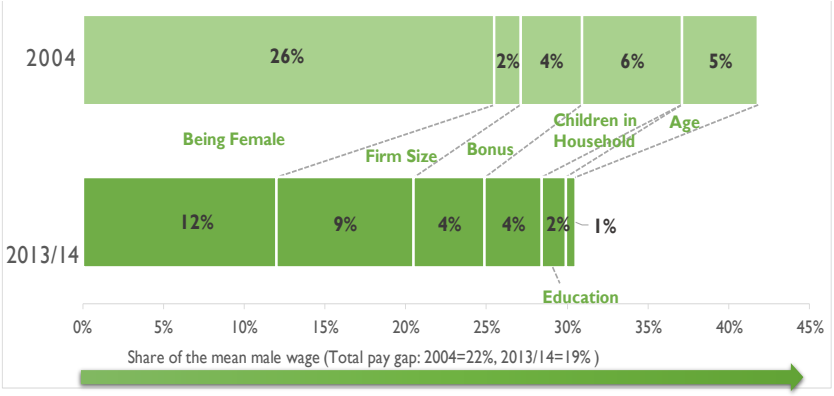


Figure 4 illustrates the gender pay gap factors which contribute to widening the gap and show by what proportion these have changed over a ten-year period. The above key findings based on Figure 4 are in pay-gap units, each being a % of the male average wage (see details in Table 3, page 6).

The main difference in the UK pay gap over time is a reduction in the female residual (shown as Being Female), ie., the amount of wages that women lose, on average, relative to men after controlling for the various explanatory variables such as age, sector etc. This can also be defined as the penalty for being a woman.

The female residual for 2004 was approximately 25.5% of the mean male wage of £14.92 (0.255*£14.92=£3.80) whereas in 2013/2014 it has reduced to approximately 12% of the male mean wage of £14.35 (0.12*£14.35=£1.73).

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UK Pay Gap Decompositions (continued)

Figure 5. Protective Factors of UK Gender Pay Gap Decompositions

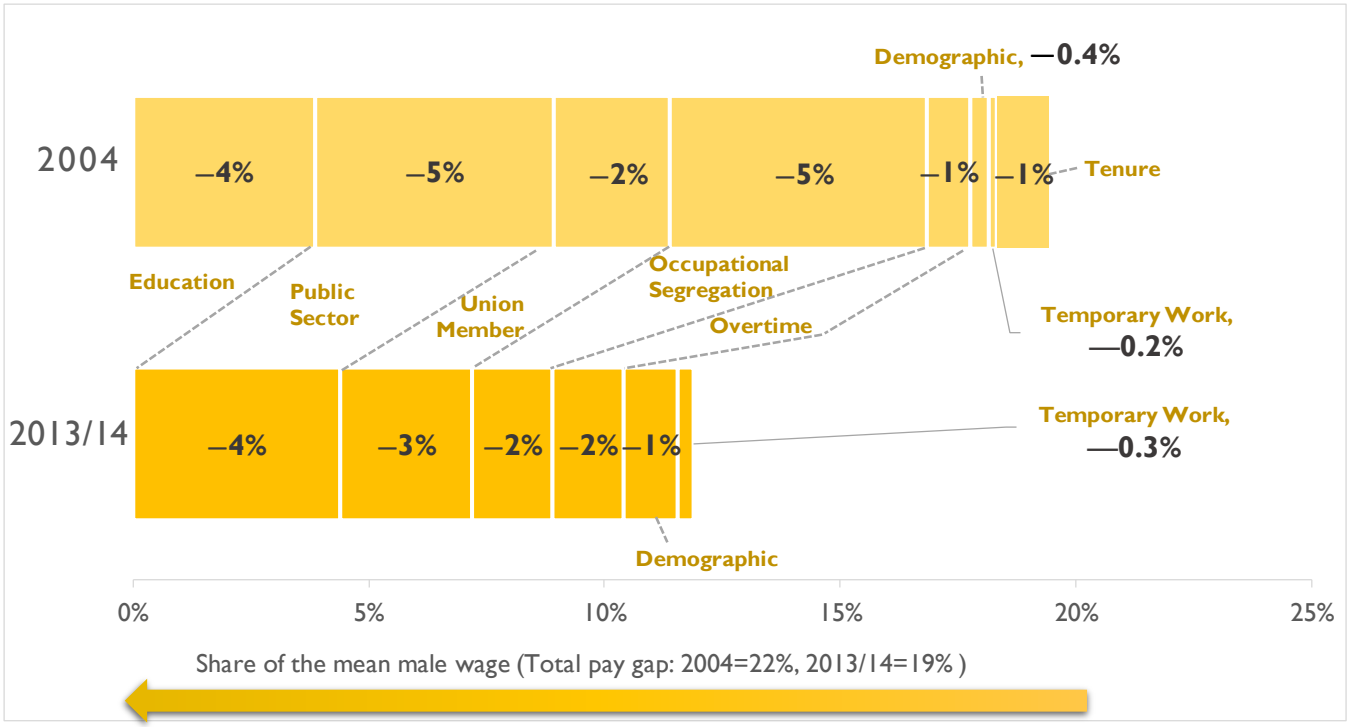

Figure 5 shows the each protective factor in pay gap units. The negative (-) sign indicates it contributes to decreasing the gender pay gap (see the direction of the yellow arrow).

The main difference in the UK pay gap over time is the role of education. Although education helped women to earn 4% of the mean male wage in 2004, the protective effects of education were not seen in 2013/14.

Public sector employment and union membership continued to be protective over the given period although the effect size of the public sector was down about 1% in 2013/14.

We see in Figure 5 that occupational segregation, ie., how men and women are rewarded differently when they work in jobs and sectors which are dominated by people of the male gender, continued to be a protective factor in 2013/14. This means that the reward factor is particularly large and protective for women in male-dominated jobs. This can also reflect a negative wage differential experienced by men working in female-dominated jobs. The effect size was down from approximately 5% to about 2% of the mean male wage over a ten-year period.

In the next section, we will introduce the pay gap decomposition method and examine components of pay gap decompositions. Then, we will show Scottish pay gap decomposition results and explore how decomposition components are summed to produce drivers and protective factors of the pay gap.

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Example, Part 1

UK, 2013/14	Endowment Effects
Education	
O-level or GCSE	-0.002
A-level	0.008
Higher education	-0.018
Institutional	
Union member	-0.008
Public sector	-0.023
Firm Size	
Medium firm	0.001
Large firm	0.004
Temporary work	0.000
Overtime	-0.015
Bonus Ever	0.014
Tenure in job	0.000
Occupational Segregation	0.112
. . .	
Total Endowments Effects	**0.070**

Endowments effects account for 43% (0.070/total gender pay gap in log 0.164) of the pay gap. The largest endowment effect was in occupation, estimated as 0.112, driving the gender pay gap. By contrast, higher levels of education (-0.018) is contributing to *reducing* the pay gap. As such, higher education is protective of women's wage.

2. Components of Pay-Gap Decompositions

The decomposition approach (Oaxaca and Ransom, 1994) allows us to study detailed breakdown of the two key pay gap components: **Endowment Effects** and **Reward Effects**.

Endowment Effects

The term 'endowments' refers to the male and female levels of the various explanatory variables (X variables) – age, sector, education levels and having a bonus, for example. Sector can be important, if women are more prevalent in the public sector. These sets of X variables show differing characteristics by gender ($X_m — X_f$, where *m* is male, *f* is female) and this each male-female difference is multiplied by men's slope coefficient β_m. The total endowment effects are the sum(∑) of the term, $(Xm — Xf)*\beta_m$ for each explanatory variable.

Equation 1. Oaxaca Decomposition Method (Oaxaca and Ransom, 1994).

Endowment Effects | Reward Effects

$$\bar{y}_m - \bar{y}_f = \beta_{0m} - \beta_{0f} + \Sigma(\bar{X}_m - \bar{X}_f)\beta_m + \Sigma(\beta_m - \beta_f)\bar{X}_f$$

This effect shows that male wages are higher if the effect size for men is larger than that for women ($X_m > X_f$). In this term, we assume men and women have same slopes for these particular endowments, thus there is no wage reward structure favouring a particular gender ($\beta_m — \beta_f = 0$, $\beta_m = \beta_f$, reward effects=0, Equation 1).

In the case of a bonus, for example, if more men receive bonus payments, men's endowment effects become greater due to the larger proportion of men receiving bonuses, which results in higher wages for men. Here, we assume both men and women receive same rates of bonuses.

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Example, Part 2

UK, 2013/14	Reward Effects
Education	
O-level or GCSE	-0.005
A-level	0.008
Higher education	0.020
Institutional	
Union member	-0.017
Public sector	-0.016
Firm Size	
Medium firm	0.045
Large firm	0.025
Temporary work	-0.003
Overtime	0.001
Bonus Ever	0.025
Tenure in job	0.000
Occupational Segregation	-0.128
. . .	
Total Reward Effects	**-0.013**

*** Unexplained component**

Constant (Being Female) :	Female Residual
Total Female Residual	**0.106**

Reward effects and female residual further contribute to 57% of the pay gap. It is noticeable that the constant term reflecting an unexplained gender differential is still the largest single component in the UK pay gap decomposition (see Table 3, page 6).

Reward Effects

In the endowment effects, we assumed there were no slope differences by sex. In reality, however, the bonus payments rate for women may be lower ($\beta_m > \beta_f$) even though the same proportion of women has bonus entitlements as that of men ($X_m = X_f$). The reward effects take into account this additional amount that men/women get if there is a differential in rewards by sex given the value of the X explanatory variables for women, X_f.

Equation 1. Oaxaca Decomposition Method (Oaxaca and Ransom, 1994).

Endowment Effects — Reward Effects

$$\bar{y}_m - \bar{y}_f = \beta_{0m} - \beta_{0f} + \Sigma(\bar{X}_m - \bar{X}_f)\beta_m + \Sigma(\beta_m - \beta_f)\bar{X}_f$$

Here we write: $(\beta_m - \beta_f)^* X_f$. Here, $(\beta_m - \beta_f)$ refers to the male-female rewards differential (=slope difference, also known as coefficient differential). Multiplying through, we find that if men get higher rewards [for having a bonus at all] then they again get higher wages than women.

Consider higher education. If men and women have the same level of higher education (ie the same % of men and of women have higher education, $X_m = X_f$, Equation 1) then the first term disappears ($X_m - X_f = 0$, endowment effects=0). Although there is no gender difference arising from characteristics, in some years women may receive higher rewards than men ($\beta_m < \beta_f$) due to higher education. This appears as a 'reward' differential, which is beneficial for women.

Female Residual

The 'female residual' is a difference of the constant terms ($\beta_{0m} - \beta_{0f}$). It is the amount of wages that women lose, on average, relative to men after controlling for all the X variables. This is unexplained component of pay gap decompositions after examining endowments effects or reward effects.

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Components of Pay-Gap Decompositions (continued)

Table 3. UK Gender Pay Gap Decompositions

UK, 2013/14 Men's wage (mean): £14.35	Endowment Effects: E	Reward Effects: R	Decomposition E+R+F	A: (%)	↕	Gender Pay Gap B: £2.67	C: % of £14.35
Education							
O-level or GCSE	-0.002	-0.005	-0.007	-(4%)	↓	**-£0.10**	**-1%**
A-level	0.008	0.008	0.016	(10%)		**£0.26**	**2%**
Higher education	-0.018	0.020	0.003	(2%)		**£0.05**	**0.3%**
Institutional							
Union member	-0.008	-0.017	-0.025	-(15%)	↓	**-£0.41**	**-3%**
Public sector	-0.023	-0.016	-0.039	-(24%)	↓	**-£0.64**	**-4%**
Firm Size							
Medium firm	0.001	0.045	0.046	(28%)		**£0.76**	**5%**
Large firm	0.004	0.025	0.029	(18%)		**£0.48**	**3%**
Temporary work	0.000	-0.003	-0.003	-(2%)	↓	**-£0.05**	**-0.3%**
Overtime	-0.015	0.001	-0.014	-(8%)	↓	**-£0.22**	**-2%**
Bonus Ever	0.015	0.025	0.039	(24%)		**£0.64**	**4%**
Tenure in job	0.000	0.000	0.000	(0%)			
Occupational Segregation	0.112	-0.128	-0.016	-(9%)	↓	**-£0.25**	**-2%**
Children in Household							
Have toddler aged 0-4	0.001	-0.001	0.000	(0%)		**-£0.01**	**-0.1%**
Have children aged 5-16	0.000	0.031	0.031	(19%)		**£0.51**	**4%**
Demographics							
Young age	-0.004	-0.020	-0.024	-(15%)	↓	**-£0.40**	**-3%**
Older age	-0.004	0.033	0.029	(18%)		**£0.48**	**3%**
Limiting illness	0.001	-0.011	-0.010	-(6%)	↓	**-£0.16**	**-1%**
Constant (Female Residual, F)			0.106	(65%)		**£1.73**	**12%**
Total	**0.070**	**-0.013**	**0.164**	**(100%)**		**£2.67**	**19%**

Regression with all its specificity and the care we take in measurement (take using logarithms as an example), can tease out the two types of bias and help us to add up the two components again. For each explanatory variable, there is an endowment term and a slope-related reward term. The two terms are summed together. In all the sum of all the factors is the pay gap itself. The protective factors are shown in arrows, which are found to reduce or narrow the pay gap.

Table 3 shows the total pay gap of 19% [calculated from (Male wage-Female wage, £2.67) divided by male wage=(£14.35—£11.68)/£14.35=0.186, Figure 1]. We can also estimate the share of each variable in pound terms (e.g., higher education, £0.05 (B)=share of the total decomposition, 2% (A)*£2.67). Finally, the last column in Table 3 displays the share of each explanatory variable's contribution to the total pay gap of 19% (C=A*0.186), which is the share of the mean male wage of £14.35.

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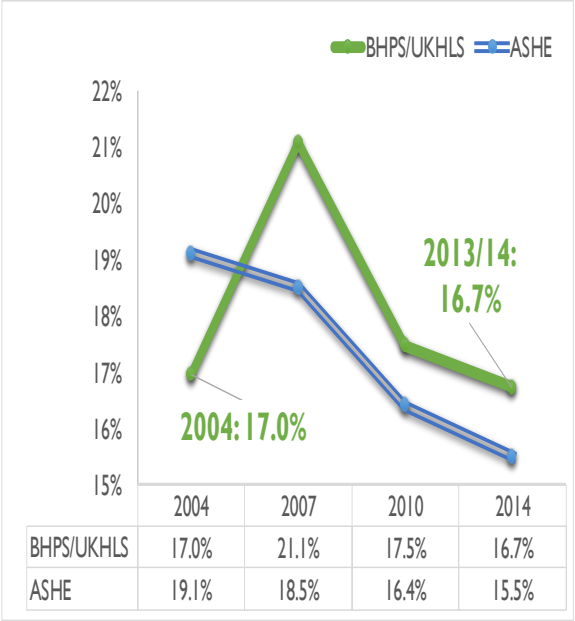
3. Scottish Pay Gap

Research suggests that there are regional pay gap differences within the UK (Olsen et al., 2013) and a lack of Scottish-specific data in this research area has been noted. This briefing paper aims to present the aspects of our research which compared the factors driving the UK gender pay gap in 2004 to 2013/2014 and considered the differences between the UK and the Scottish pay gaps in 2013/2014.

When we used BHPS and UKHLS data, the pay gap was estimated at the17% range between 2004 and 2013/14 although there was a sharp increase during 2007. Compared to the UK, the pay gap in Scotland was 2% narrower in 2013/14 (Mean male wage: £13.69, mean female wage: £11.40 based on BHPS/UKHLS data).

Figure 6. Scotland Gender Pay Gap by Data Sources



	2004	2007	2010	2014
BHPS/UKHLS	17.0%	21.1%	17.5%	16.7%
ASHE	19.1%	18.5%	16.4%	15.5%

Note: The pay gap estimated from BHPS and UKHLS adjusted annual inflation. Other details of measurements are stated in Figure 1 and 2.

Scottish Pay Gap Decompositions

Figure 7. Drivers of Scotland Gender Pay Gap Decompositions

Figure 7 shows the share of the total decomposition and the share to the mean male wage. To illustrate the sum of endowment and reward effects, we report the figures in log scale. The biggest causal factor in Scotland is simply being female, and it has become worse between 2004 and 2013/14. In pound terms, the contribution to the total decomposition, 164% (calculated from log scale 0.235/ total 0.143, recall column A in Table 3, page 6) represents approximately £3.76 per hour [164%*(£13.69-£11.40)] in 2013/14, which is a huge gender difference with no explanation at all. The amount was merely £1.58 in 2004. Being in a medium or large firm and bonus payments were also part of the nexus of conditions contributing to the gender pay gap in Scotland.

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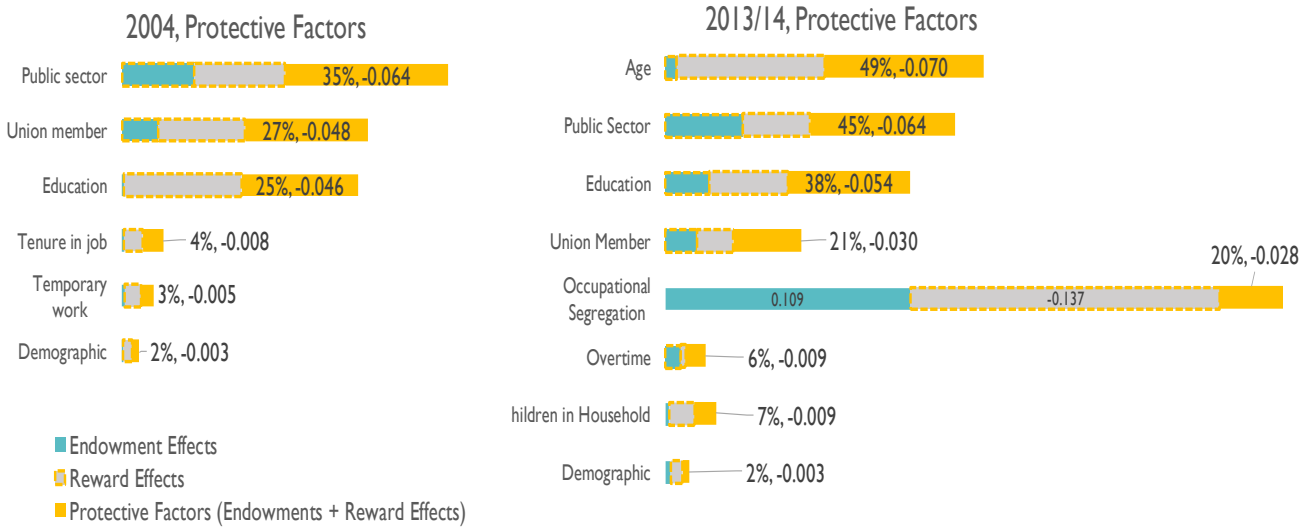
Scottish Pay Gap Decompositions (continued)

In terms of two effects in 2013/14, reward effects make up a significant proportion of drivers whereas endowment effects were very small (see the size of endowment and reward effects) with the exception of occupational segregation.

Figure 8 shows protective factors in the gender pay gap. Again, the impact of protective factors are the sum of both endowments and reward effects. The net effects are shown in yellow. Here, a majority of reward effects display female advantages as shown in dotted lines.

Figure 8. Protective Factors of Scotland Gender Pay Gap Decompositions



During both periods, institutional factors such as public sector employment and union membership have been protective against the higher pay gap.

It is important to note here the contrasting impact of occupational sex segregation. Firstly, the endowment effects of occupational segregation during 2013/14 in Figure 8 (0.109) shows that it has a direct causal impact that raises the gender pay gap, i.e. those working in male-dominated jobs are paid more. Secondly, the reward effects (-0.137) show an offsetting (protective) marginal effect for women in male-dominated jobs. As the latter female-protective reward effects are greater than the former endowment effects, the net of these two effects (-0.028) was a ***protective factor*** in 2013/14. This can also reflect men's disadvantage working in female-dominated jobs. This can be considered a major change: the net occupational segregation effect (0.034) ***drove*** the pay gap in 2004 with the endowment effects of 0.114, larger than the reward effects of –0.080 (Figure 7).

In the background, improvements in women's education levels on average have helped the pay gap to improve in Scotland. Not only are more women getting higher levels of education, they also get more pay rewards in 2013/4 than in 2004 for a given level of formal education.

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About Data Used

The research used data from the British Household Panel Survey (BHPS)'s sample from 2004 to 2009 and the Understanding Society (also known as UKHLS)'s main sample from 2010/11 to 2013/14.

We used microdata from the UK Data Service based on multistage random sampling with weighted results so that the sample used matches the UK or Scotland society (as appropriate). In 2009/10-2014/5, BHPS cases form a subset of UKHLS cases. The annual Understanding Society survey and the earlier British Household Panel Survey involve representative national samples of households with all the households' members' details. Core sample members are followed year-on-year even as they create new households. The sample sizes of the cross-sectional data in 2004-9 (BHPS) are smaller than those in 2010/11-2013/4 (UKHLS). Survey interviews for BHPS were spread out over all 12 months of that year. The cross sectional series samples in UKHLS were conducted over a 24-month period, hence the style 2010/11 reflecting all calendar months of those years. Changes in the sample were considerable over the long period considered here. We have used a series of cross-sectional weightings to compensate for large regional and ethnic booster samples that were added to the data from 2009/10 onward.

About Methods

In the regression based tables we use the logarithm of wages as the dependent variable. This was to address skewness in wage distribution. It also has the convenient property that a small change in the log is equivalent to the corresponding % change in the actual £ wage. A 0.05 log wage change is approximately 5% real wage rise ($\exp^{0.05}$=1.05), for example. In the decomposition regression models, a set of X variable (explanatory variables) is entered. We use the letter k to indicate the number of explanatory variables, e.g. 20. If there are 20 variables (k=20), we will have 40 components plus the constant term, because there are up to 20 endowment differentials and up to 20 rewards differentials.

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Conclusion

The gender pay gap in the UK narrowed by 3% points over the 10 year period. There has been less of a decline in gender pay gaps over time in Scotland, compared with the UK as a whole. The differences in wages across firm size and bonus payments contributed to increasing the pay gap to some extent.

However, the single largest driver of the pay gap during the given period was female residual, the un-explained component of the gender pay gap. This is the amount which women lost simply by virtue of being a woman in the UK/Scotland even after controlling for all other reasonable explanatory variables.

It was also observed that union membership and public sector employment continued to be strong protective factors of the gender pay gap in the UK and Scotland. The recent data based on 2013/14 also revealed the helpful effects of occupational segregation, influencing to reduce the pay gap both in the UK and Scotland. This was due to the reward effects that favoured women's wage growth for a given endowment. The larger reward effects were found to offset the smaller endowment effects, which resulted from a characteristics differential that favoured men.

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Glossary

- **Decomposition** — A breakdown of the factors behind an outcome into several component parts.
- **Endowment** — The amount of quality or ability (call this X) possessed by someone. For example, an individual's endowment attributable to education can be 6, 10 or 13 years.
- **Pay Gap** — The relative size of the male-female gap in average wages. We divide the gap by average male wages.
- **Protective Factor** — One of the elements of a decomposition which has a negative effect on a bad outcome. Thus the gender pay gap being deemed bad (unfair or unjustifiable), we seek protective factors which are good, and these have an inverse effect on the pay gap.
- **Regression** — A modelling approach used by statisticians. This approach allows for several independent factors, called the X variables (explanatory variables), and one outcome variable, the dependent variable, called the Y variable. A basic equation can be written as: $Y=\beta_0+\beta_1X_1+\beta_2X_2+...$
- **Occupational (sex) Segregation** — Men working alongside men, and women working alongside women. It involves a division of labour by sex. We generated a segregation measure by calculating the male ratio in occupations X 10, where 9 displaying highly male -dominant occupations.
- **Log Wage** — Logarithmic transformations are used to transform a highly skewed variable, such as wage. Consider $(2x2x2x2x2)=2^5=32$. Here, 2 is the base and 5 is an exponent or power. This can be written as $5=\log_2 32$. We used natural logarithm (written as "ln") that uses base of $e\approx2.71828$ in this paper. In 2013/14, the UK mean male wage was estimated as £14.35. In log wage, it is expressed as ln 2.66. We can also convert log scale to £ by exponentiating the log wage, 2.66. In sum, £14.35=ln 2.66=$\exp^{2.66}$.
- **Slope** — A measure of how much something (call this Y) responds to something else (call this X). Here, Y is the wage and X is a set of explanatory variables, such as education, age, etc. In the equation, slopes with no explanatory variables in the model can be expressed as β_0 and slopes for each explanatory variable can be shown as β_1 for education (the share of wage increase/decrease by levels of education), β_2 for age (the share of wage increase by additional year of age) and so on.

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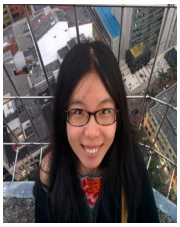

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