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IZA DP No. 13289

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ABSTRACT

A Short History of the Gender Wage Gap in Britain*

After shrinking dramatically during World War Two the gender wage gap (GWG) narrowed again in the early 1970s due to the Equal Pay Act. The GWG has closed across birth cohorts at all points in the adult life-cycle but remains. Within birth cohort it rises to middle age before falling again. Among those born in 1958, the raw GWG was 16 percentage points among workers aged 23, rising to 35 percentage points at 42. Among those born in 1970 the gaps were 9 and 31 percentage points at age 26 and age 42 respectively. Differences in men's and women's work experience in mid-life account for much but not all of the raw gap in both cohorts. The GWG is a little larger early in the life cycle when accounting for non-random selection into employment but selection plays no role later in life. Policy options for closing the remaining gap are considered.

JEL Classification: J16, J2, J3

Keywords: gender wage gap, labour force participation, birth cohorts, employment selection, sample attrition

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1. Introduction

Women's experience in the British labour market has transformed in in the 75 years since the end of the Second World War. Over seven-in-ten women are in the labour force today, accounting for nearly half the workforce. They are spending longer in employment and commensurately less time in exclusively caring roles. Motherhood has ceased to be incompatible with paid work. Women have been outperforming men academically for several decades. Yet the labour market experiences of men and women remain distinct. Women continue to be concentrated in services and the public sector and in occupations characterised by caring. They account for over four-fifths of part-time workers and remain under-represented in the top occupations and in leadership roles. Despite some convergence in men's and women's wages a sizeable gap remains. Britain is no different to most other modern Western economies in these respects. The average gap between mean male and female hourly earnings in the EU28 in 2017 was 16.0%, the UK's, at 20.8%, was the fourth highest (Eurostat 2019).

The disadvantages women continue to experience in the labour market relative to men, are the subject of vigorous debate. Some maintain that different employment patterns for men and women reflect differences in men's and women's preferences. Others emphasise the additional constraints women face in the labour market due to discrimination by employers and co-workers, and societal expectations regarding caring roles at home which limit geographical and career mobility, potentially undermining women's bargaining power vis-à-vis employers.

This paper examines change over time in men's and women's wages – the gender wage gap (GWG).[1] Section Two reports trends in the raw GWG, labour force participation and educational attainment by gender, and fertility. Section Three reviews recent micro-econometric studies of the raw GWG and covariate-adjusted gaps comparing the differential pay of "like" men and women with similar human capital. Section Four reflects on the role public policy has played in tackling the position of women in the labour market. Section Five presents new estimates of the GWG within and across birth cohorts using data for those born in 1958 and 1970 through to the second decade of the 21st Century. The raw ratio of women's median hourly wages relative to men's is adjusted to allow for differences in men's and women's human capital (covariate adjusted). We also adjust the GWG to account for effects of non-random selection into employment (selection-adjusted) and attrition from the surveys (attrition-adjusted). In the final section of the paper we review policy options for closing the remaining gap.

2. Trends in the Raw Gender Wage Gap, Labour Force Participation, Educational Attainment, Fertility and Selection into Employment

2.1 RAW GENDER WAGE GAP

[1] We adopt the official description of the difference between men's and women's pay as a gender gap. Our data only allow us to treat biological sex and social gender as indistinguishable.

Table 1: Raw Gap Between Female and Male Mean Hourly Earnings As a Proportion of Male Hourly Earnings (except column 2 which uses weekly earnings)

Year	*Col. 1* Full-time Manual Employees	*Col. 2* Full-time Manual Employees (Weekly)	*Col. 3* All employees	*Col. 4* Full-time employees	*Col. 5* Part-time employees
1921	0.53	-	-	-	-
1931	0.53	-	-	-	-
1941	0.46	0.56	-	-	-
1951	0.38	0.45	-	-	-
1961	0.40	0.50	-	-	-
1971	0.40	0.48	-	0.37	-
1976	0.30	0.40	-	0.27	-
1981	0.31	0.39	-	0.27	-
1991	-	0.37	-	0.22	-
2001	-	-	0.25	0.20	0.10
2011	-	-	0.19	0.16	0.09
2018	-	-	0.17	0.14	0.08

Notes: Column 1 derived from Joshi et al. 1985 Table 6. Column 2 based on Department of Employment Labour Statistics for average gross weekly earnings in series 0063011938to2018meantimeseries.xls. Columns 3-5 based on New Earnings Survey/Annual Survey of Hours and Earnings mean gender pay gap series 006331nesandashegenderpaygaptimeseries.xls. Until 1981 based on men aged 21+ and women aged 18+, then those on 'adult rates'.

Real wages have been rising "ever since the eighteenth century" (Joshi et al, 1985: S152) but the gap between men's and women's hourly pay remains. The earliest statistics, for full-time manual workers, suggested women were paid roughly half the hourly rate of men in the early 20th Century (Table 1). The gap in hourly pay among full-time manual workers closed by 11 percentage points during World War Two (from 51% in 1939 to 40% in 1945) but then remained static for a quarter century when it closed by another 10 percentage points. This abrupt change in the early 1970s coincided with the introduction of the Equal Pay Act.

The GWG has continued to decline since 1980, but convergence has slowed, as in other developed countries (Kunze, 2017). As column 4 of Table 1 indicates, the raw GWG among full-time workers fell 7 percentage points in the quarter century to 2001 and a further 6 percentage points in the seventeen years through to 2018. By 2018, the raw gap in mean hourly earnings was 14 percentage points among full-timers and 8 percentage points among part-timer workers.[2] At the current convergence rate for all employees (column 3) women will not achieve equal pay for another four decades.

[2] The overall pay gap in column 3 is not the average of the gaps within full and part-timers (which are shown in columns 4 and 5) because it compares all men and all women, whereas women are much more heavily represented among part-timers. The penalty for part-time employment is greater among men than it is among women.

Change in the raw GWG accompanied other big changes in women's labour market participation, education and fertility. We present descriptive evidence on these changes below and consider the role they have played more formally in Section Five.

2.2 ACTIVITY AND EMPLOYMENT RATES

Table 2: Women's Labour Market Activity Rates

Census Year	*Col 1* All	*Col 2* All – LFS	*Col 3* Married	*Col 4* Married - LFS	*Col 5* Single/Divorced/ Widowed	*Col 6* Single/Divorced/ Widowed – LFS
1871	34.5					
1891	33.5					
1911	32.5					
1931	31.6		10.9		66.7	
1951	36.3		23.2		70.0	
1961	41.0		31.6		73.3	
1971	51.5		45.9		72.7	
1981	57.7		54.0		68.9	
1991	64.0	69.0	62.3	68.0	66.6	72.4
2001	67.9	70.1		69.0		71.7
2011	73.6	72.1		70.3		74.3
2019		77.3		75.6		79.0

Notes: (1) Census figures for England and Wales 1871-1931 (GB 1951-1981) relate to women 20-64 (Joshi et al. 1985 Table 1). (2) The 1991, 2001 and 2011 figures in columns 1, 3 and 5 are derived from NOMIS economic activity series S08, ST028 and DC6107EW respectively relating to women in England and Wales aged 16-64. (3) Labour Force Survey figures (LFS) relate to women aged 20-64, derived from the annual survey in 1991 and the April to June quarterly surveys in 2001, 2011 and 2019. In 2011 and 2019; Married includes civil partnership. Own calculations. (4) No adjustment is made for the limited comparability of Censuses with each other and with surveys (Joshi and Owen (1987 and Owen and Joshi (1987)

Roughly one-third of women were economically active before World War Two, a fraction that had been roughly constant for the best part of a century, but activity rates almost doubled between the 1930s and 1980s (Table 2). The Pre-War labour force was characterised by a high degree of sex segregation of occupations and industries (Hakim 1979; Hatton and Bailey, 1988). Labour market activity rates were always high among women who were single, divorced or widowed (column 5). The main growth was amongst married women.

Married women born before World War One re-entered the labour market in the 1950s in mid-life after their children reached teenage years. By then, most had previous employment experience, even if not currently employed. For those born before 1920 the occasion for employment interruption had been marriage, while for the women born later breaks in employment were mainly upon motherhood. By the mid-1960s nearly all non-student women had had some experience of employment (Hunt 1968). By 1980 the proportion currently working had risen to 63% and the proportion ever-worked had risen to 98% (Martin and Roberts, 1984).

Table 3: Percentage of women aged 20-64 in Full-time and Part-time Work

Year	*Col 1* Full-time	*Col 2* Full-time (LFS)	*Col 3* Part-time	*Col 4* Part-time (LFS)	*Col 5* Unemployed	*Col 6* Unemployed (LFS)	*Col 7* All active	*Col 8* All active (LFS)
1951	30.3		5.2		0.8		36.3	
1961	29.8		10.2		1.0		41.0	
1971	29.0		20.2		2.3		51.5	
1981	31.6		22.4		3.7		57.7	
1991	34.0	37.5	22.2	27.7	4.0	3.9	64.8	69.0
2001	38.0	38.7	26.0	28.8	2.6	2.6	67.9	70.1
2011	40.2	39.9	29.3	27.6	4.2	4.6	73.6	72.1
2019		45.8		28.9		2.6		77.3

Notes: (1) Figures through to 1981 are taken from Joshi et al. 1985 Table 4. (2) The 1991, 2001 and 2011 figures in columns 1, 3, 5 and 7 are derived from NOMIS economic activity series S08, ST028 and DC6107EW respectively and relate to women in England and Wales. The figures for full-time and part-time exclude the self-employed and women on a government scheme in 1991, and full-time students in 2001 but these women are included in the all active figure in column 7. (3) LFS figures as Table 2.

Most returners took up part-time work: it increased four-fold in the three decades after the War (Table 3). By contrast, there was no growth at all in women's full-time employment before the 1980s, after which the rate of growth in part-time employment slowed and full-time jobs accounted for most of the upward trend.

Since the 1970s the rise in women's activity rates has been matched by increased inactivity among men with low earnings potential (Faggio and Nickell, 2003; Haldane et al., 2019) leading to a gradual convergence in women's and men's employment rates. The outflow of low earning men implies increased positive selection of men into employment, whereas rising participation rates among women imply fewer disparities between the characteristics of women in and out of work. Since around 2000 low earning men have been working fewer hours, increasingly taking part-time jobs (Blundell et al, 2018).

The gender gap in past experience has also diminished across birth cohorts. Among the 42-year olds born in 1958 and surveyed in 2000, employed men had 56 months (median) more experience than women, while the gap was 52 months among the non-employed. Among the 42-year olds born in 1970 and surveyed in 2012 these gaps had fallen to 34 and 11 months respectively. Non-employed women were becoming increasingly similar to their employed counterparts, at least at mid-life (and thus, less different to men).

2.3 EDUCATIONAL ATTAINMENT

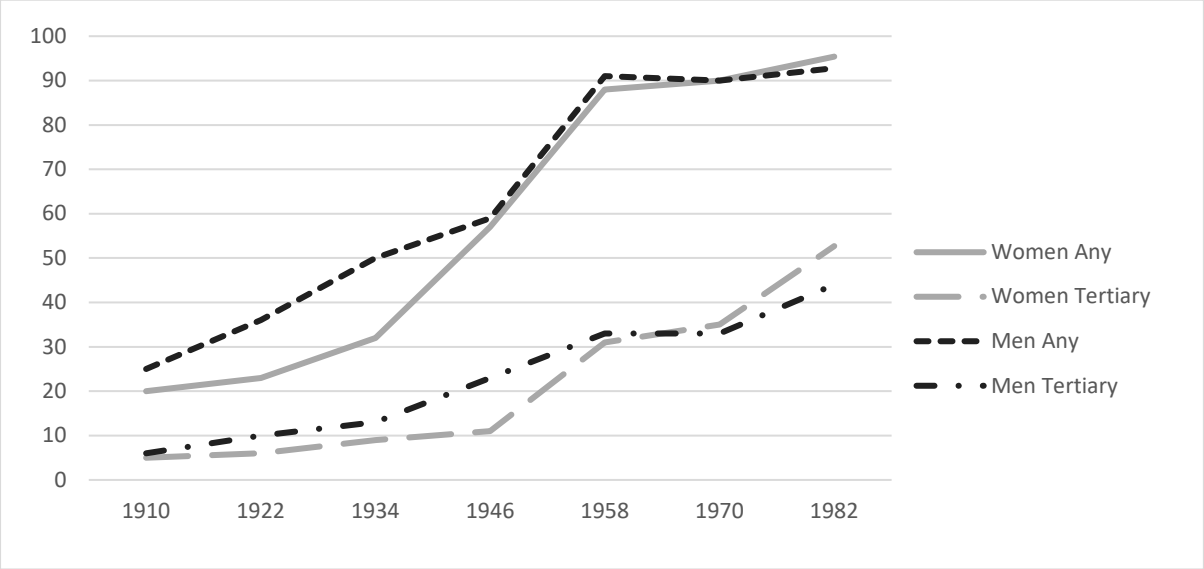
Among the generation born before the First World War entering the labour force in the inter-war period around a fifth of women and a quarter of men had some qualifications. About one-in-twenty had some tertiary education (Figure 1). Among the generation born at the end of the Second World War women matched men in terms of basic qualifications, but men were twice as likely as women to reach the tertiary level. Qualifications for both sexes continued to grow with the extension of secondary education post-war and the expansion of university education. Women began to outperform men in tertiary education from the late 1990s (Figure 1) and, more recently, in GCSEs (Machin and McNally, 2005). Among women born in

the 1980s, 45 percent had a degree or higher qualification by age 33 (Roantree and Vira, 2018:).

Although women's educational attainment is strongly associated with the propensity to enter the labour market (Blundell et al 2018 for 1978-2015) the growth in women's educational attainment did not play an important role in the increase in women's employment rates in the 1950s to 1970s (Joshi et al., 1985). But in the 1980s and 1990s, employment rates rose more quickly among mothers with qualifications compared to those without (Macran et al., 1996).

The improvement in women's educational attainment relative to men's is apparent in other countries too and is part of what Goldin (2014) terms the "grand gender convergence" in which women have come to look "more like men" (p.1094), implying that the influence of positive selection into employment among women may have declined over time.

Figure 1: Percentage of Men and Women in their Early 30s with Qualifications, by cohort



Notes: (1) Any = any formal qualifications, academic or vocational (including tertiary). Tertiary = qualifications normally gained after age 18, degrees and diplomas. (2) Sources: Census of Great Britain Qualified Manpower Tables, 1971 and 1981; General Household Survey from Rake (2000) Fig 2.1; Cohort studies from Makepeace et al. (2003), appendix to Ch 2; and our analysis of LFS

2.4 FERTILITY

Between the 1880s and 1930s fertility halved to around 2 births per woman. It began rising again after World War Two, peaking at a little below 3 in mid-60s (Joshi et al., 1985). It dropped again in the second half of the 1960s, as in other industrial countries, and continued falling until the late 1970s stabilising since at a little under 2 (Office for National Statistics, 2019). Much of the fall in fertility since the baby boom was driven by delayed first births (Knipe 2016). Fertility control was facilitated by the advent of modern contraceptives and the legalisation of abortion in 1968. Their use was associated with enhanced education, improved labour market opportunities and an emerging assertion of female autonomy. Younger adults with higher qualifications were increasingly likely to postpone parenthood, or avoid it altogether, compared with less qualified women and men (Kneale and Joshi, 2008).

The initial increase in female employment between 1951 and 1971 occurred *despite* the booming numbers of children, whereas in the 1970s and 1980s female employment rose whilst fertility fell. Since then rising employment rates have been associated with an increase in the number of (as yet) childless women, but also in the participation of mothers, notably speedier returns to work after childbirth. The employment rate of lone mothers, which had fallen below that of partnered mothers in the 1980s, began to catch up in the first decade of the 2000s (Roantree and Vira, 2018), propelled by a reversal of expectations in the tax and benefit system about single parents' employment, and facilitated by the increased availability of subsidized childcare. While the presence of dependent children was the major source of women's labour force non-participation until the 1990s, by the twenty-first century mothers and other adult women had similar employment rates. Indeed, from 2007, women aged 16-64 with children had employment rates exceeding those of women (Vizard, 2019).

3. Review of Micro-econometric Analyses of the Gender Wage Gap

Men and women differ in human capital attributes that may affect both their propensity to enter work, the sort of job they do, and their productivity levels in that job but they may also encounter differential rates of reward for a given attribute or in a given labour market situation. The residual gap which remains after adjusting for covariates is often treated as if it captured gender discrimination although, in fact, it may relate to a range of factors not observed by the analyst. We briefly summarise results from previous UK studies that adjust the GWG for human capital.

Figure 2 presents results from 8 analyses conducted on micro survey household data since 1971 which provide covariate-adjusted GWGs for employees of all ages.[3] First, the raw GWG was falling markedly between the 1970s and 1990s (as we saw in Table One), but convergence slowed in the 2000s. Second, although the covariates used to adjust the raw GWG vary somewhat across studies, adjusted GWGs are usually around half the size.

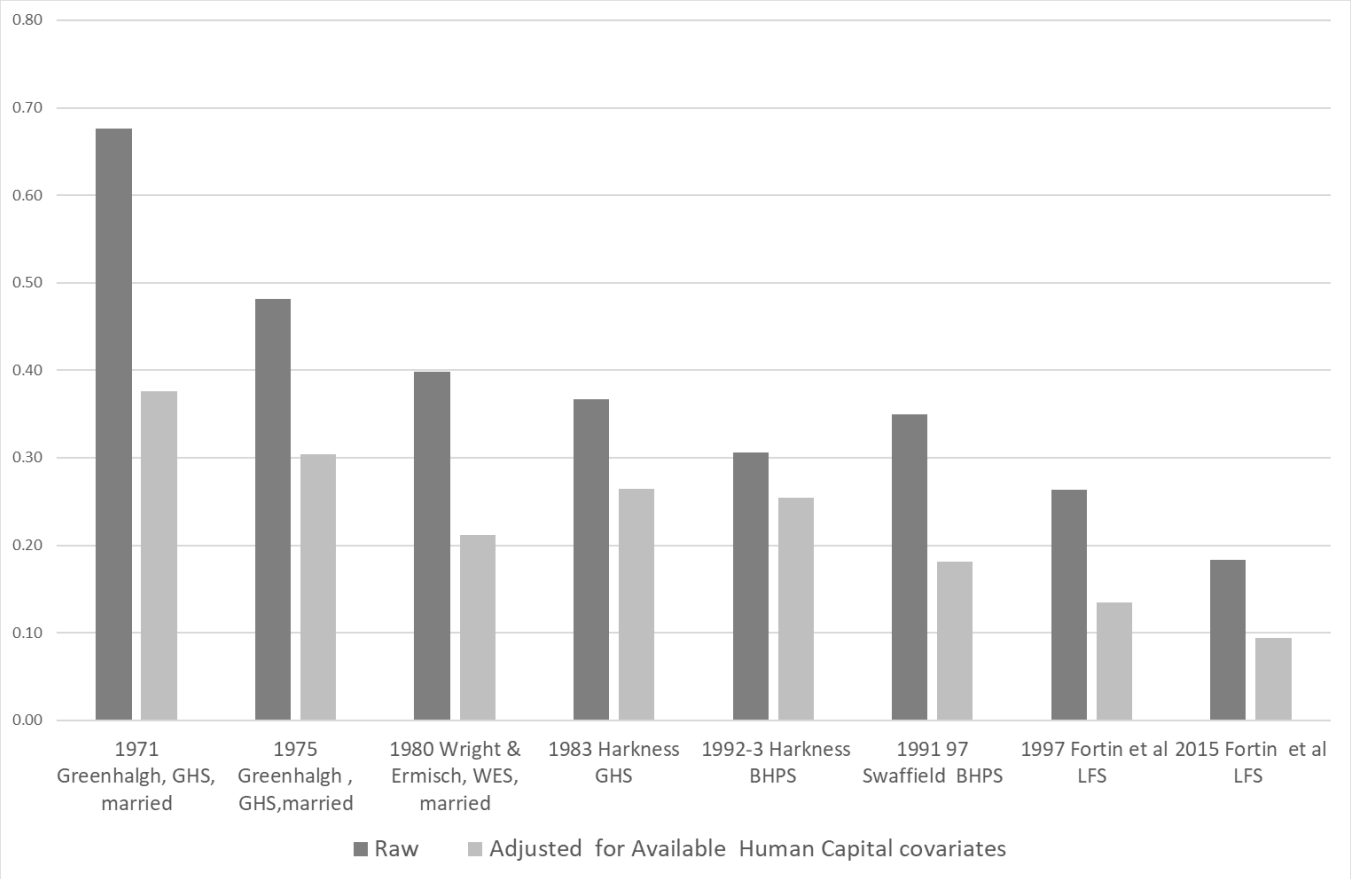
Third, in contrast to the finding for the US by Blau and Kahn (2017) that the proportion of the wage gap attributable to human capital fell over time, the proportion of the raw gap accounted for by human capital has remained fairly constant since the mid-1990s indicating that a substantial part of the gap is still accounted for by the earnings-enhancing traits of male employees relative to female employees (a point we return to in Section Five).

Fourth, the decline in the raw GWG between 1971 and 1974 shown by Greenhalgh (1980) might reflect the imminent introduction of Equal Pay Act, but the closing of the GWG in her analysis was mainly due to improved education among wives relative to husbands, rather than a reduction in unequal treatment. Among Greenhalgh's smaller sample of single workers (not shown) there was by contrast a marked equalisation of rewards between those dates.
The persisting unexplained gap has motivated researchers to go beyond traditional human capital models to explain the gap. Studies often include information on occupation, industry and job type but these arguably capture channels through which unequal treatment of like human capital occurs. Studies suggest roles for labour market discrimination (particularly in

[3] Appendix Table A1 presents further details. The review is confined to studies estimating the GWG for employees of all ages rather than subsets of the population, and models which do not include job characteristics among covariates.

hiring and promotion), gender preferences in job search, gendered non-cognitive skills, compensating wage differentials for flexible hours schedules and the differential impact of employers' monopsony wage-setting powers on women whose bargaining power can be limited by caring duties. (For a review of these studies see Blau and Kahn, 2017). Childrearing primarily affects the size of the GWG through its impact on work experience (Joshi et. al., 2019). Although having children matters for the GWG (Costa Dias et al., 2018), GWGs persist among those who have never had children and among full-time workers (Joshi et al., 2019; Manning and Swaffield, 2008).

Figure 2: Log gender wage gaps in selected UK studies adjusting for human capital



As Section Two indicates, education, employment participation and family building have all been changing over time in ways that could impact the size of the GWG. There is therefore value in estimating changes in the size of the GWG among male and female employees who are observationally equivalent and in adjusting for non-random selection into employment. In the paper closest in spirit to the analyses in Section Five, Neuburger et al. (2011) estimate trends in the GWG for men and women from three birth cohorts (1946, 1958 and 1970) up to their 30s and 40s. Comparing the GWG among employees and the gap in potential earnings, which includes imputed earnings for the non-employed, reveals positive selection into employment among women when compared with men. However, positive selection into employment decreased across cohort suggesting that "cross-cohort improvement in women's labour market position is underestimated in changes in relative pay for the working population" (p. 272). This finding is consistent with Blundell et al.'s (2007) estimates for the

period 1978-1998, albeit using different data and methodologies. A fuller discussion is presented in Section Five and in the Appendix.

4. The Role of Labour Market Policies

Changes in labour market policy have contributed to improvements in women's relative position in the labour market in the post-War period. These policy changes may have a direct causal impact on behaviours and attitudes, but it is also likely they reflect and reinforce the gradual spread of changing gender norms (Esping-Andersen and Billari, 2016). Some of the key policy interventions since the 1970s are listed in Table 5. A number of policies have had an indirect, often substantial, impact on women's position in the labour market. As noted above, expansion in the public education system has fuelled women's educational attainment, increasing their potential earnings and thus the relative value of employment compared with time out of the labour force. Modern contraception and rights to abortion have given women more choice regarding whether to have children and, if so, when to have them. Here we focus more narrowly on labour market interventions.

Labour market policies have directly addressed issues of discrimination and the returns women can expect from the labour market. Chief among these is the Equal Pay Act of 1970 which, according to Zabalza and Tzannatos (1985) was directly responsible for the rise in women's relative pay in the 1970s. These and other authors point to the timing of changes in wage relativities and the way the legislation was reflected in collective bargaining agreements to argue that the change in relativities "was due to the Equal Pay Act of 1970, which outlawed the use of separate rates of pay for men and women from January 1976 onward". Zabalza and Tzannatos (1985) note that, even though the Act did not come into force until 1976 its effect was felt as early as 1971 as unions and employers adjusted wages through collective bargaining in anticipation of the Act.[4] Joshi et al. (1985) suggest the Act reduced the GWG by about 15% while Zabalza and Tzannatos (1985) suggest an effect nearer to 19%. This change in pay relativities occurred with no detrimental impact of demand for women's labour, suggesting women had been being paid below their marginal product.

Table 4: Policies Affecting the Gender Wage Gap

Date	*Law/Policy*	*Intention*	*Impact*
1970 (into effect January 1976)	Equal Pay Act	To equalise pay between men and women engaged in the same work, or work of equal value	Substantially closed the hourly GWG between 1970 and 1977 (Zabalza and Tzannatos (1985)
1975	Sex Discrimination Act	Unlawful for employer to treat women less favourably than men; required equal	Set up the Equal Opportunities Commission (from 2006 part of the Equality and

[4] It is possible that similar legislation passed in the absence of strong sectoral unionisation may not have had the same impact, and that the impact of the EPA may also have been magnified by incomes policies in force at the time limiting pay rises for higher earners. A recent review argues "litigation and collective bargaining are best regarded as complements, in the sense that litigation is unlikely to be effective in advancing an equality agenda in the absence of well-functioning arrangements for collective wage determination" (Deakin et al., 2015: 382).

		treatment of married v single women	Human Rights Commission)
1975	Employment Protection Act (with subsequent acts in 1978, 1980, 1982)	Introduced statutory paid maternity leave and right of reinstatement after unpaid leave	Contributed to increase in women's employment rates (Gregg et al., 2007)
1983	Equal Pay Amendment Act - Implementation of work of equal value Directive[5]	To equalise pay between men and women engaged in work of equal value	Still required female employee to compare herself with male employee in same establishment. Initially perceived to have done little to advance pay equity (Hepple et al., 2000). But mass litigation began in the 1990s with more grounds for legal claims and, from the 2000s, the entry of no-win no-fee firms (Deakin et al., 2015)
1986	Social Security Act – replaced Family Income Supplement with Family Credit	To extend in-work benefits available to families with children where at least one person is working 24 hours or more. Subsequent extension through Working Family Tax Credit	Contributed to increased employment rates among women, especially single parents (Brewer et al., 2006)
1999	Statutory National Minimum Wage	To set hourly wage minima for adult and younger workers	Reduced the GWG at the lower end of the wage distribution (Robinson, 2002) but not further up the distribution (Dickens and Manning, 2004)
1999	National Childcare Strategy	Roll out of free nursery education.	Successful in offering free places for 3-4 year olds but very patchy provision otherwise (Waldfogel and Garnhan, 2007). Policy critiqued as effort to create a "reserve army" of mothers (Grover, 2005)
2000	Part-time Workers' Regulations	Unlawful to discriminate against part-timers on pay/conditions	Little impact on part-time pay penalty (Manning and Petrongolo, 2008; Bell (2011)
2003	Right to Request Flexible Working	Employer had duty to consider applications to work flexibly	Literature focuses on individual and workplace performance and job

[5] In 1982 European Court of Justice ruled Britain had failed to fulfil its obligations under Treaty of Rome with respect to equal pay for work of equal value.

			attitudes (de Menezes and Kelliher, 2011) and work intensification (Kelliher and Anderson, 2010) but does not consider wages.
2010	Equalities Act	To consolidate anti-discrimination law. Includes compulsory gender wage reports from 2013	Covers employers of 250+ employees. Yet to be evaluated.
2015	Shared Parental Leave	Legal right for parents to share maternity leave entitlement	Yet to be evaluated but unlikely to promote co-parenting as currently implemented (Atkinson, 2017)
2017	Childcare for working parents	30 hours free childcare per week for children aged 3-4 years	Offering free full-time childcare increases mothers' labour supply but free part-time childcare only has marginal effects (Brewer et al. (2020)

The introduction of a statutory national minimum wage in 1999 disproportionately benefited women who were more likely to be low paid, especially part-timers (Dex et al., 2000). Its introduction led to some narrowing of the GWG at the bottom of the wage distribution (Robinson, 2002), but had little impact on the GWG further up the distribution (Dickens and Manning, 2004). Again, this occurred with little or no impact on demand for women's employment.

Policies encouraging women's increased participation in the labour market include in-work welfare payments aimed at "making work pay" for those with low earnings potential, increasing conditionality around receipt of out-of-work benefits and lowering the relative value of those benefits compared to in-work support. These policies are often credited with increasing participation rates among lone mothers albeit at the potential expense of mothers' wellbeing (Bryson, 2005).

Parental leave policies assist women (and, to some extent, men) in combining family and career responsibilities. Paid maternity leave and subsequent policy changes increasing its generosity and lowering qualification barriers contributed to increasing participation among mothers with young children between 1974 and 2000 (Gregg et al., 2007). Those with the highest potential earnings responded most to maternity leave legislation in the early 1980s, with those in the middle of the potential earnings distribution responding in the late 1980s and early 1990s (Gregg et al., 2007).

There are, nevertheless, clear limitations to existing policy. Equal pay claims under the EPA rely upon the woman identifying a man in the same workplace engaged in work of equal value. The absence of male comparators on the same site (and difficulties establishing their pay) prevent claims being taken. This is problematic if there is discrimination in hiring or

promotions which perpetuates segmentation in the labour market. Even where there are grounds for a claim, the emotional and psychological costs of taking it to a tribunal can be considerable. The maternity leave legislation has not affected the participation rates of mothers with the lowest earnings potential (Gregg et al., 2007). Furthermore correspondence studies continue to reveal discrimination against women in hiring, particularly in male-dominated professions, as indicated by lower call-back rates from identical CVs which are randomly allocated gender (Jackson, 2009; Azmat and Petrongolo, 2014). Another obstacle to female careers, especially in male dominated workplaces, is sexual harassment (McLaughlin et al., 2017). We return to the challenges faced by policy in Section Six.

5. Trends in the Gender Wage Gap from the 1958 National Child Development Study and 1970 British Cohort Study

In this section we examine trends in GWGs for two birth cohorts (see University College, London, various dates, for full documentation). The first is the 1958 National Child Development Study (NCDS) whose cohort members we follow through to 2013 when they were aged 55. The second is the 1970 British Cohort Study (BCS) whose cohort members we follow through to 2012 when they were aged 42. We present raw gaps, expressed in terms of the female/male ratio in median hourly earnings, and covariate adjusted gaps, where the covariates are confined to human capital attributes. [6] We also present GWG estimates that account for selection into employment by men and women and adjust estimates for sample attrition.

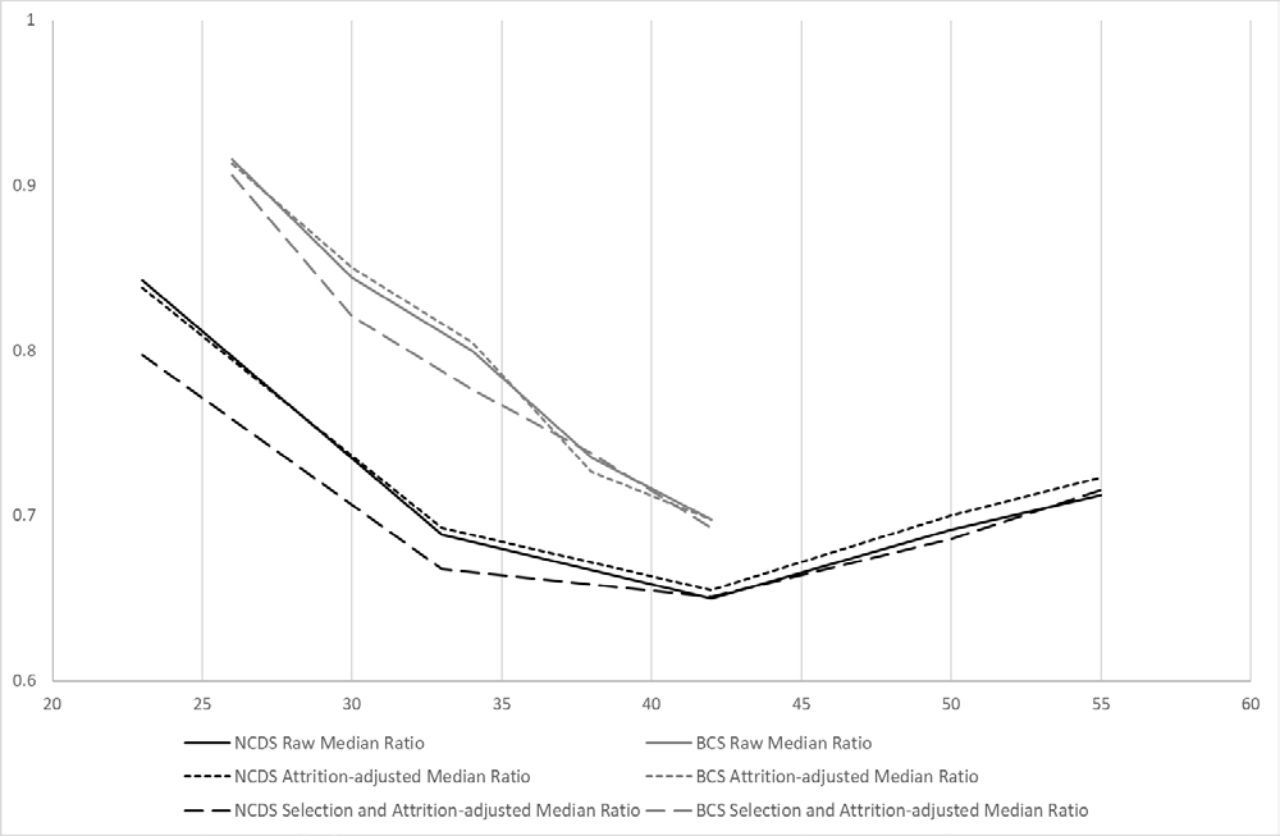
There are various ways in which one can adjust for selection into employment (see Appendix Section A2). We adopt an approach similar to Neuburger et al. (2011) whereby we adjust men's and women's wages to account for non-random selection into employment by imputing a wage for four types of individual: those in employment without a wage observation; the self-employed; the unemployed; and the economically inactive. These imputed wages come from nearest neighbour wage 'donors' defined as those in the waged employment group at the same sweep from the same sex who are nearest in their propensity for waged employment to the non-waged individual. The nearest neighbours are identified through propensity score matching where the propensity for waged employment is estimated for each individual for each survey sweep. The probits for the (0,1) being in waged employment at the time of the survey sweep are run separately for men and women so that nearest neighbours who are 'donors' of their wage to the non-waged are drawn from the same sex. The covariates used to match those without wages and those with wages are listed in Appendix Table A3. We enforce common support by dropping cases whose propensity for waged employment falls below the lowest probability for the waged employee sample at that sweep (Appendix Table A4). We also adjust for sample attrition by weighting the separate male and female wage equations by the inverse probability of responding to each sweep (see Appendix Section A4 which also describes the covariates used in the attrition models).

[6] We use real gross hourly pay deflated by the RPI to January 2000 prices. The value of the GWG inferred from the ratio of medians is very similar to that obtained by the ratio at the geometric mean which we have also derived in analysing mean log pay.

Figure 3 presents the ratio of female-to-male median hourly earnings over the ages surveyed in NCDS and BCS. Three series are presented: the raw GWG; the raw GWG adjusting for survey attrition; and the raw GWG adjusting for both survey attrition and non-random selection into employment. Four findings emerge. First, the GWG grows until cohort members reach mid-life. The black solid line shows that for employees born in 1958 the raw GWG is around 16 percentage points at age 23, doubling to 31 percentage points by age 33, reaching its maximum (35 percentage points) at age 42 before falling back to reach 29 percentage points by age 55.

Second, the solid grey line for the 1970 birth cohort follows a similar pattern through to age 42 (the last year we observe them). However, the line always lies above the black solid line for the 1958 birth cohort indicating that the GWG is smaller in the later birth cohort across all ages through to age 42. The raw GWG for the 1970 birth cohort is 9 percentage points at age 26, rising to 16 percentage points by age 30, 20 percentage points at age 34, 26 percentage points at age 38 and 31 percentage points at age 42.

Figure 3: Female-to-male ratios of median observed and potential pay, by survey



Third, adjusting for sample attrition makes very little difference to the size of these raw GWGs in either birth cohort or across the life-cycle.

Fourth, comparing the dashed lines with the solid lines in Figure 2, these raw GWGs are underestimated early in adulthood if one fails to account for non-random selection into employment. The GWG is around 4 percentage points larger at age 23 in the NCDS when selection-adjusted. Similarly, the potential GWG is around 3 percentage points larger at age 30 for BCS cohort members than the GWG between employees. However, adjusting for

selection into employment makes no difference to the size of the GWG later in life. (The underlying median hourly earnings for employees and the 'donor' earnings attached to those without a wage are presented, by cohort sweep and gender in Appendix Table A5 and Figures A1a-A2b).

Figure 4: Female-to-male ratios of median pay, covariate-adjusted by survey

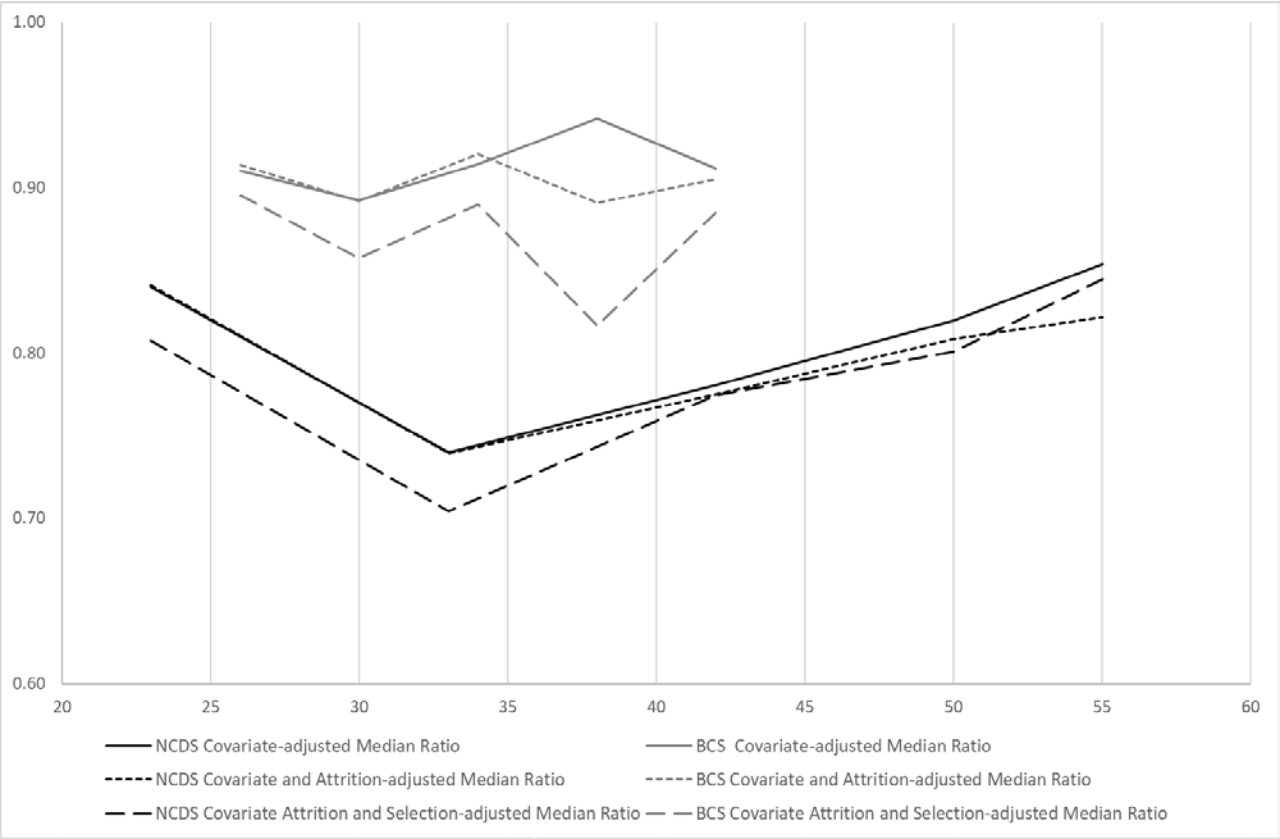


Figure 4 is similar to Figure 3 but presents covariate-adjusted ratios in female-to-male median hourly earnings instead of raw ratios. One again there are three lines for each birth cohort: the solid lines indicate the ratio before adjusting for sample attrition and selection into employment; the dotted lines adjust for attrition; and the dashed lines adjust for both attrition and selection into employment.

Focusing on the 1958 birth cohort first (the black lines) it is apparent that the GWG over the life-course is similar in shape to the raw gap presented in Figure 3, in that it grows initially before closing later in life, but accounting for human capital results in a much smaller gap from age 33 onwards. Human capital differences between men and women close the gap by 5 percentage points at age 33, then by 13-14 percentage points from age 42 onwards. Men possess human capital advantages which, by age 55, account for around half the raw GWG. The picture is similar if one adjusts for attrition and selection into employment.

Turning to the cohort born in 1970, the covariate-adjusted GWG looks rather different to the raw gap in Figure 3. As in the case of the 1958 cohort, human capital differences account for a sizeable part of the raw GWG once cohort members reach their 30s. The human capital adjustment closes the GWG by around 5 percentage points by age 30, rising to 20 percentage points in their late 30s and early 40s. These human capital differences between men and

women become more important over the life-cycle such that the remaining gap is roughly constant at 10-15 percentage points when they are in their 30s and early 40s. The picture is similar when one accounts for sample attrition and selection into employment, although estimates do diverge at age 38.[7]

Comparing the two cohorts, we see that the component of the wage gap not explained by human capital has shrunk, while at least in mid-life the proportion of the wage gap associated with human capital has grown. This is despite the narrowing of educational attainments and the work experience between cohorts described in Section Two. The gaps in human capital which remain are associated with more of the smaller wage gap in mid-life. The level of the covariate-adjusted gap for 42-year olds in 2012 is comparable to the recent estimates for such gaps for all ages summarised in Section Three. Together they confirm that gender differences in pay, though reflecting differences across cohort in human capital, also leave a gap to be explained, and tackled by other sorts of policy.

6: Policy Implications

Our new estimates in Section Five confirm that there has been convergence in the GWG across birth cohorts born in 1958 and 1970, and that this convergence is apparent at all points in the life-cycle. Estimates are similar when adjusting for sample attrition and selection into employment. At its current rate of convergence (based on column 3 in Table 1) the GWG would not close for another four decades. The gap has been closed dramatically in the past through policy interventions, raising the question: should there be further policy intervention to close the GWG and, if so, what form should it take?

Covariate-adjusted estimates of the GWG in the literature shed some light on the degree to which women face discrimination in the labour market. Simply labelling residual earnings differences as 'discrimination' is not sufficient when considering policy responses to wage gaps. Evidence from correspondence studies suggests discriminatory practices do exist. This form of discrimination, whether taste-based or statistical, reinforces gender-based labour market segmentation since hiring discrimination is particularly apparent in male-dominated segments of the labour market. There is therefore room for new policy initiatives to tackle discriminatory employer behaviour in hiring practices.

It is harder to establish the degree to which discrimination plays a role in determining wage differences between men and women in 'like' jobs. Such discrimination is, of course, illegal, but the law is not easy to enforce, partly because, in the absence of a formal job evaluation scheme, it can be difficult to identify when men and women are undertaking similar work or work of equal value. It can also be difficult for women to mount legal challenges to discriminatory practices without the support of a trade union. We can infer from the number of such legal cases, and the size of the settlements, that discriminatory pay practices remain widespread (Deakin et al., 2015). Whether the GWG can be substantially closed by facilitating legal challenges is a moot point.

[7] These differences may be due to the quality of some of the data collected at age 38 since this was a telephone survey, whereas other surveys from age 30 onwards were conducted face-to-face.

An alternative strategy is to require transparency in the way employers pay men and women. It can affect employers' practices because those seen to be presiding over large GWGs are liable to suffer reputational damage in the eyes of consumers, investors and potential employees. There is evidence from other countries that pay transparency laws have helped reduce the GWG in Denmark (Bennedsen et al., 2018) and Switzerland (Vaccaro, 2017). A similar provision which required employers of 250 or more workers to report raw mean wages of men and women came into effect in 2013 in the UK (see Table 4). Although it has yet to be evaluated, the UK government is currently considering whether to extend the pay reporting requirements to smaller employers.[8]

One important obstacle to women's progression in the labour market is segmentation along gender lines. This occurs across industries, firms, occupations and contract types, and can affect both raw and covariate adjusted gaps. For example, women make up over four-fifths of part-time workers in the UK. Since experience in part-time work has no impact on subsequent earnings growth (Joshi et al., 2019) this contributes substantially to the GWG. Using data from the late 1990s on men and women employed full-time at both 33 and 42 years old, Dex et al. (2000) simulate a scenario in which women would be paid the same as men holding the current occupational distribution constant and a scenario in which women are redistributed such that their occupational distribution mirrors that of men. While occupational segregation plays a role in explaining this GWG the bulk of it is accounted for by differential pay *within* occupation. Economists have returned to this issue recently, drawing attention to substantial GWGs within occupation, some of which emerge when women trade flexible hours schedules for better pay (Goldin, 2014). This may be treated as a difference in gender preferences, since women often seek flexibility to assist with caring responsibilities. But this begs wider questions: why do women so often take on the primary carer role and, when they do, why should they have to concede a compensating wage differential for flexible working?

Social norms governing gender roles have been changing, as noted earlier, and governments have tried to encourage men to take on their share of caring responsibilities through shared care provisions. These have been partially successful. However, there are clear limitations to strengthening provisions supporting women in their caring roles, even if governments are motivated by a desire to assist parents in combining paid and unpaid labour: a recent study for the United States (Bailey et al., 2019) indicates that leave entitlements can have deleterious effects on women's relative wage growth if they reinforce work experience disparities between men and women.

The focus on parenthood as a source of GWGs is understandable: in Britain women suffer a wage penalty on becoming mothers whereas men appear to benefit from a fatherhood premium (Costa Dias et al., 2018; Joshi et al., 2019), and the fraction of gender wage penalties due to parenthood is rising in countries like Denmark (Kleven et al., 2018). But the GWG is not all about children: a GWG is apparent at the start of young people's careers where it is little affected by human capital differences, and it is apparent among those who never have children suggesting actual caring responsibilities are not the sole cause of the GWG. It is possible, of course, that women suffer due to employers' expectations regarding domestic

[8] https://www.equalpayportal.co.uk/gender-pay-gap-reporting/

commitments, but even women who work full-time throughout their lives receive lower lifetime earnings than their male counterparts (Joshi et al., 2019).

In 2017 women were better represented than men in professional occupations but they are still outnumbered nearly 2:1 by men in top managerial and directorship roles (McGuinness, 2018). The GWG within workplaces falls as the proportion of managers who are female rises. In Britain the GWG disappears when around nine-in-ten managers are female, a scenario that obtains in around 12 percent of British workplaces (Theodoropolous et al., 2019). The current empirical literature on quotas for top executives cautions against a simple policy response since studies find few positive spill-overs of executive quotas on female representation and female wages lower down the corporate hierarchy (Bertrand et al., 2018). However, the job of workplace managers and supervisors is different from board-level management and, arguably, has a more direct impact on the wages of non-managerial staff at the workplace (via pay and promotion). Theodoropoulos et al. (2019) show that female managers improve the lot of the women below them in the corporate hierarchy. There may therefore be value in reviewing ways in which women can be sustained in more secure contracts and promoted to positions of authority within the firm, whether that is via quotas or other means.

It is also possible that women in positions of authority in the workplace can tackle unfair workplace culture creating zero tolerance of sexual harassment and bullying. If these practices contribute to maintaining the GWG then increasing the share of females in managerial roles via quotas or other policies might help close the GWG, though women leaders are themselves sometimes vulnerable (Folke et al 2020). Workplace culture could be addressed more generally by overhauling the system for resolving disputes, or at least making mandatory the guidance to employers on preventing workplace harassment and bullying (EHRC 2020). Complainants (and whistle-blowers) should have access to support and legal advice before or on resort to a tribunal. Non-disclosure agreements should not be allowed to cover up illegal discrimination, though they often currently do (Women and Equalities Committee, 2019).

In this paper we have focused on the GWG at the median and mean, but it can and does differ in different parts of the wage distribution (Harkness, 1996; Fortin et al., 2017). The increasing "bite" of the statutory national minimum wage in Britain will disproportionately affect women. A simple, transparent and easily enforceable statutory instrument, minimum wages, can be a powerful tool for redressing GWGs at the lower end of the wage distribution. To date, the minimum wage has been an effective means of redressing pay relativities without dampening demand for low-waged labour, suggesting that many women in the labour market continue to be systematically undervalued. If evaluations of the latest changes to the minimum wage and National Living Wage come to similar conclusions perhaps the best means of ensuring rapid convergence in the GWG will be through direct interventions in wage setting, supported by extensions via collective bargaining, as occurred with the implementation of the Equal Pay Act some 45 years ago.

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Appendix

A1: Previous Micro-econometric studies

Appendix Table A1: Log gender gaps in selected UK studies adjusting for (some) human capital

Author	**Data**	**Date of survey**	**Gender gaps Male - Female**		**Comments and Covariates**
			Raw	Human Capital Adjusted	
Greenhalgh (1980)	General Household Survey GHS	1971	0.676	0.376	Estimates for married sample. Controls: Education, Age, Region, Industry, age of oldest child, health, 'colour'. No actual work history
	GHS	1975	0.481	0.304	
Wright and Ermisch (1991)	Women and Employment Survey	1980	0.398	0.212	Married couples only. Education and instrument for actual work history. Wives under 60. Estimates before selection adjustment (little difference made to gaps)
Harkness (1996)	GHS	1983	0.367	0.264	Combined models comparing full and part-time women separately with all men. Otherwise controls are education and age. Ages 16-64 No work history
	British Household Panel Study	1992-93	0.306	0.254	As above but including work history.
Swaffield (2007)	British Household Panel Study	1991-97	.350	.181	GLS model. Education, work and non-work history, parental background, current work part-time
Fortin et al (2017)	Labour Force Survey LFS	1997	0.263	0.134	Wages at mean, not logged, ages 25-64. ' HC model' includes top pay centiles, education, Region, family demographics, tenure in job but not complete work history.
		2015	0.183	0.094	

A2: Accounting for Selection into Employment When Estimating the Gender Wage Gap (GWG): Methods and Evidence

Over the post-war era, the utility attached to women's employment compared to home life has changed. There has been greater societal acceptance of women's employment role and recognition of the need for shared parenting (Scott and Clery, 2013). New technologies have increased the efficiency of home production, reducing the time needed to undertake home-based tasks. The relative value of work has also changed for women now that their educational attainment outstrips that of men (see Section 2.3 of the main paper). These trends, together with a falling population of young children since around 1970, imply rising (falling) utility of paid (home) work for women, leading to an increase in women's employment rates. In addition, the policy interventions discussed in Section Four may have raised the costs of discrimination in the labour market, such that women are more likely to face wage offers reflecting their productivity than they did in the past. The growth in employment rates among women, particularly those with higher qualifications, is consistent with greater utility attaching to women's employment compared with non-employment and is also consistent with reduced discrimination against women.

Selection into employment may vary over time and by age group, imparting different biases to a GWG based solely on those in employment. This can occur simply because the participation rate varies over time, or else because different types of women refrain from the labour market. When interpreting trends in the GWG one needs to account for the changing composition of women (and men) in and out of employment. If the attributes of those in employment have changed over time, gender differences in these changing attributes may disguise the underlying rate of change in the GWG.

The implications of the changes described above for our ability to interpret the rate of convergence in the GWG are uncertain a priori. One possibility is that, as the fraction of women in employment tends towards 1, a greater proportion of women with low earnings potential join the labour market at the margin, pulling down observed wages for women, potentially reducing the degree of selection bias. But there are alternative scenarios. Assuming employers are heterogeneous in their propensity to discriminate against women on grounds of taste, then as women's employment participation rises, so a higher percentage will face discriminatory employers, thus reducing women's relative wages. A similar pattern might be predicted based solely on statistical discrimination associated with the costs of discerning individual productivity. However, if anti-discrimination legislation makes it more costly for employers to discriminate against women, this might imply an increase in women's relative wages at any given level of relative female employment.

Positive selection of women into employment appears unlikely in the early post-war period for two reasons. First, the level of education of adult women in the 1950s (born before World War Two), and to some extent those of labour force age in the 1960s and 1970s, was so low, that positive selection of the female labour force would have had a limited effect. Second, to the extent that some women had higher earning potential than others (perhaps captured by social class linked to homogamy), and since the sole breadwinner family was the norm to which many people aspired, women of high earning potential may have been expected to maintain a 'respectable' role in their home and thus eschew labour market participation.

Empirically, although there are no micro datasets to estimate participation functions or quantify the extent of selection bias in wages, there is evidence from the birth cohort studies that it was wives of working-class husbands who led the way into the (mainly part-time) employment opportunities opening up in the early 1950s. These class differentials narrowed in the 1960s when the mothers of the 1958 cohort were making their returns to employment, and had all but disappeared by 1980 (Joshi, 1985). This implies a reduction in the extent of negative selection into employment between the 1940s and 1980.

There are four different approaches to account for non-random selection into employment. The first is to assume selection into employment can be captured by observed information available to the analyst. The second is to use methods which seek to account for selection into employment based, at least in part, on information that is not observed by the analyst. A third approach is to bound estimates. A fourth is to estimate GWGs for sub-groups who appear similar a priori. All these approaches rely on fairly strong assumptions about the nature of selection.

The first approach entails the imputation of potential earnings for those not in employment. Analysts use a range of methods to impute earnings. In longitudinal data they may impute wages within individuals over time by extrapolating from the wages they have during periods of employment. In other cases, analysts recover predicted wages from wage equations based on Mincerian human capital equations, imputing the out-of-sample predictions to the non-employed. Others "match" non-employed people to "like" employees who appear to be a match based on human capital traits such that the employees are 'donors' of their wages to their matched counterparts in the non-employed population. (This is the approach we adopt).

In the second approach analysts, recognising that selection into employment may be based on unobserved traits, use a Heckman two-step procedure, where stage one is a participation equation which generates a selection term that is then carried over into stage two – the wage equation – to adjust for non-random selection into employment. Technically, a difficulty arises in distinguishing between the two equations (the participation and wage equations) since the analyst requires an exclusion restriction, that is, a variable or set of variables which predict employment participation but can be reasonably excluded from a wage equation on the grounds that their sole influence on wages arises from their effect on labour market participation. One such set of instruments might be family formation and, in particular, the age and number of children at home. However, this exclusion restriction is often criticised on the grounds that, firstly, family formation decisions are endogenous with respect to potential earnings (Adda et al., 2017) and, secondly, family formation may have a direct impact on wages which is not absorbed in the participation decision.

The third approach is to bound the estimates of the GWG by estimating lower and upper bounds based on quantiles of the wage distribution (Manski, 1989). Assumptions are made about the relative potential wages of workers and non-workers to estimate these bounds, often in conjunction with the use of instruments to account for non-random employment selection.

The fourth approach is adopted in a parallel well-established literature which tends to focus on homogeneous sub-populations instead of estimating selection into employment. For

example, analysts often estimate wages for full-timers only based on the assumption that they will share high levels of work motivation which may drive both high levels of labour market attachment and higher earnings. Biases associated with unobserved high work motivation are thus conditioned out through the decision to focus solely on this non-random subset of employees. The limitation of focusing on sub-samples, such as full-time employees, is that one cannot extrapolate to the population from which they are drawn. This is a problem when much of the growth in female employment between the Second World War and the early 1980s has been in part-time employment.

There are few studies on the nature of selection into employment and its implications for interpreting trends in the GWG. They are summarised in Appendix Table A2. Three are for the United States, four for Britain, and one is a cross-country study. Results are not consistent within or across country, due in part to different estimation methods deployed.

Using longitudinal data for the United States from the Panel Survey of Income Dynamics (PSID) for 1979, 1989 and 1998, Blau and Kahn (2006) replace the missing potential wages of non-participants in the labour market with wages observed within four-year windows when the individual was last or next in employment. Using this methodology, they argue that convergence in the raw GWG among full-time employees was slightly overstated in the 1980s and understated in the 1990s.[9]

Using cross-sectional data from the United States Current Population Survey for 1975-79 and 1995-99 Mulligan and Rubinstein (2008) adjust for selection into employment using the Heckman two-step procedure, relying on the presence of young children in the household as an instrument.[10] They find little convergence in the regression-adjusted GWG having accounted for increasingly positive selection into employment among women in the United States (the selection term was large and negative for the 1975-79 sample but becomes large and positive for 1995-99). Jacobsen et al. (2015) extend Mulligan and Rubinstein's analysis to cover a half century through to 2013. They find similar results to Mulligan and Rubinstein for the period where both studies overlap, but also show strong positive selection into employment in the 2000s suggesting that convergence in the GWG is partially accounted for by selection. However, their use of marital status as an exclusion restriction is suspect if one believes it has a direct impact on earnings over and above that associated with its impact on participation.

Gomulka and Stern (1986 and 1990) were the first to adjust wage equations for selection into employment in the UK across multiple years, but their primary focus was the determinants of married women entering employment, rather than trends in wages so they do not report the impact of selection into employment on trends in the GWG. However, using a Heckman two-step procedure they identify positive selection into employment among married women in the 1970s and early 1980s.

[9] Using a similar methodology Olivetti and Petrongolo (2008) found the inclusion of potential wages for non-employed individuals had only a small effect on the size of GWGs in countries like the USA and UK with high rates of female employment, but bigger effects in southern European countries where female participation rates were lower.

[10] Neuburger (2010: 57) critiques Mulligan and Rubinstein's identification strategy.

Appendix Table A2: The Impact of Employment Selection on Trends in the Gender Wage Gap

Authors	*Data*	*Method*	*Findings*
Blau and Kahn 2006	US, PSID, 1979, 1989, 1998	Within-person wage imputed in 4-year window	1980s: positive selection of women into employment overstates convergence in GWG. 1990s: negative selection of women into employment understates rate of convergence
Blundell et al. 2007	UK, FES 1978-1998	Bounds and partial instrument (out-of-work benefits)	GWG in potential earnings has fallen for less-qualified 25 year olds but not for other age/education groups. Gender differential in potential earnings has been greater than that for observed wages.
Wright and Ermisch, 1991	UK, 1980 Women and Employment Survey	Heckman 2 step include marriage and children	Small negative selection in sample confined to married persons, where wife aged 16-59 (Positive selection among all women into fulltime work)
Gomulka and Stern, 1986, 1990	UK, FES 1970-1983, married women	Heckman 2 step	Positive selection in eight of the 10 years
Jacobsen, J., Khamis, M. and Yuksel, M. (2015)	US, CPS, 1964-2013	Heckman 2-step selection model using marital status as exclusion restriction	Changes in female selection into employment (positive selection in early 1960s; small negative effect until late 1980s; switches to positive selection in 1990s and 2000s)
Mulligan and Rubinstein 2008	US, full-time workers, CPS, 1975-1979 and 1995-1999	Heckman 2-step selection model with young children interacted with marital status as the exclusion restriction	Changes in female selection into employment (negative in the 1970s, positive in the 1990s) account for most of the convergence in the GWG.
Neuburger et al. 2011	GB, 1972-2004, NSHD, NCDS and BCS	Imputation based on nearest neighbour matching	Positive selection into employment among women in three birth cohorts, ages up to 42/3, weakening over time and with age. Leads to understatement of the rate of convergence in the GWG for people in their twenties and thirties.
Olivetti and Petrongolo 2008	14 OECD countries, ECHPS, 1994-2001	Within-person imputed wage from most recent job	Positive selection into employment among women resulting in under-estimate of size of GWG in countries with low female employment

Notes:

(1) Abbreviations. FES=Family Expenditure Survey. PSID=Panel Survey of Income Dynamics. CPS=Current Population Survey. NSHD=1946 National Survey of Health and Development. NCDS=1958 National Child Development Survey. BCS=1970 British Cohort Survey. ECHPS: European Community Household Panel Survey.

Blundell et al. (2007) were the first to examine the sensitivity of trends in the GWG in the UK to selection into employment. Using a bounding methodology combined with a partial exclusion restriction based on variance over time in benefit entitlements they found that, over the two decades through to 1998, changes in the composition of women entering the labour force masked some of the improvement in women's relative earnings.

Neuburger et al. (2011) estimate trends in the GWG for men and women in three birth cohorts born in 1946, 1958 and 1970 for survey respondents in their 20s, 30s and 40s. They rerun their estimates taking account of the "potential earnings" of those who do not provide a wage to account for non-random selection into employment. They impute potential earnings for men and women who are not in employment using earnings provided by donor respondents in employment whose probability of non-employment is estimated to be the nearest to those non-employed individuals. They find substantial cross-cohort increases in women's median pay relative to men's, but a growing GWG within cohort as employees age through to their early 40s.[11] A comparison of the GWG among employees and the gap in potential earnings, which includes imputed earnings for the non-employed, reveals positive selection into employment among women when compared with men. However, as female employment rates increased across cohorts, wage biases associated with positive selection into employment decreased. They suggest that "cross-cohort improvement in women's labour market position is underestimated in changes in relative pay for the working population" (p. 272), consistent with Blundell et al.'s (2007) estimates for the period 1978-1998, albeit using different data and methodologies.

A3: Implementation of our Method to Account for Selection into Employment

Our methodology for imputing median earnings to the non-waged is described in the main text. Here we provide additional supporting information. Table A3 provides a description of the variables used in the matching exercise. Table A4 presents the number of cases with no common support and number of cases with imputed wages. Table A5 presents the median hourly earnings for employees and the imputed median hourly earnings for the non-waged, by category. Figures A1a-A2b plot those median earnings by cohort and by sex relative to the median earnings for employees of the same sex at each sweep.

Appendix Table A3: Variables used in matching

In waged employment	Dummy = 1 if cohort member in employment with valid hourly wage
Part time worker	Dummy = 1 if self-defined part-time worker (<30 hours per week)
Work experience	
Full-time experience	Months in self defined full-time paid employment since age 16
Full-time experience squared	Months in self defined full-time paid employment since age 16 - squared
Part-time experience	Months in self defined part-time paid employment since age 16
Part-time experience squared	Months in self defined part-time paid employment since age 16 - squared

[11] They note that these findings mirror those from quasi-cohort cross-sectional studies using the General Household Survey and the New Earnings Survey (Harkness, 2005; Manning and Swaffield, 2008).

Highest qualification	
NVQ Level 1	Dummy = 1 if highest qualification is NVQ level 1 or equivalent
NVQ Level 2	Dummy = 1 if highest qualification is NVQ level 2 or equivalent
NVQ Level 3	Dummy = 1 if highest qualification is NVQ level 3 or equivalent
NVQ Level 4	Dummy = 1 if highest qualification is NVQ level 4 or equivalent
NVQ Level 5	Dummy = 1 if highest qualification is NVQ level 5 or equivalent
Missing	Dummy = 1 if information on highest qualification is missing
Test Scores	
Maths score	Standardised maths test score taken at age 10 (1970 cohort) or 11 (1958 cohort)
Missing maths score	Dummy = 1 if maths score missing
Reading score	Standardised reading test score taken at age 10 (1970 cohort) or 11 (1958 cohort)
Missing reading score	Dummy = 1 if reading score missing
Region	
London or SE	Dummy = 1 if living in London or the South East at time of survey
Presence of Children	
Children in household	Dummy = 1 if a child in the household by the time of the survey
Young child	Dummy = 1 if a child aged under 5 in the household at the time of the survey
More than 1 child	Dummy = 1 if more than one child in the household at the time of the survey
Social class of first job	
I	Dummy = 1 if first job in RG class I
II	Dummy = 1 if first job in RG class II
III NM	Dummy = 1 if first job in RG class III Non-Manual
III M	Dummy = 1 if first job in RG class III Manual
IV	Dummy = 1 if first job in RG class IV
V	Dummy = 1 if first job in RG class V
Missing	Dummy = 1 if information on occupation of first job is missing
Fathers social class	
I	Dummy = 1 if at birth father's job in RG class I
II	Dummy = 1 if at birth father's job in RG class II
III NM	Dummy = 1 if at birth father's job in RG class III Non-Manual
III M	Dummy = 1 if at birth father's job in RG class III Manual
IV	Dummy = 1 if at birth father's job in RG class IV
V	Dummy = 1 if at birth father's job in RG class V
Missing	Dummy = 1 if information at birth on father's job is missing
Age of parents	
Mother's age	Mother's age last birthday in years at birth sweep
Mother's age missing	Dummy = 1 if information missing
Father's age	Father's/ husband's age at birth sweep
Father's age missing	Dummy = 1 if information missing
Age mother left education	
Left before 16	Dummy = 1 if age left was less than 16
Left aged 16 or 17	Dummy = 1 if age left was 16 or 17
Left at 18 or more	Dummy = 1 if age left was 18 or more
Missing	Dummy = 1 if information missing
Age father left education	
Left before 16	Dummy = 1 if age left was less than 16
Left aged 16 or 17	Dummy = 1 if age left was 16 or 17
Left at 18 or more	Dummy = 1 if age left was 18 or more
Missing	Dummy = 1 if information missing
Number of siblings at age 16	
Only child	Dummy = 1 if had no siblings at age 16
One sibling	Dummy = 1 if had one sibling at age 16
Two or three siblings	Dummy = 1 if had two or three siblings at age 16
Four or more siblings	Dummy = 1 if had four or more sibling at age 16

Appendix Table A4: Number of cases with no support and number of cases with imputed wage

	Unemployed		Inactive		Employees with unknown earnings		Self employed	
	Men	Women	Men	Women	Men	Women	Men	Women
	Number of cases with No Support							
NCDS								
Age 23	4	0	9	45	0	3	0	2
Age 33	2	5	2	11	1	0	2	0
Age 42	4	0	22	35	2	1	3	0
Age 50	13	6	51	84	0	2	2	1
Age 55	3	2	15	154	2	2	1	1
BCS								
Age 26	7	5	5	4	2	0	0	0
Age 30	15	3	46	13	0	0	4	1
Age 34	3	1	5	9	0	1	4	2
Age 38	3	7	7	23	2	0	0	0
Age 42	19	1	48	42	0	0	0	0
	Number of Cases with an Imputed Wage							
NCDS								
Age 23	752	455	324	1744	417	274	397	99
Age 33	334	113	196	1724	405	416	888	389
Age 42	160	91	351	1096	446	581	988	426
Age 50	152	76	338	779	411	479	958	378
Age 55	149	102	450	814	345	527	1020	421
BCS								
Age 26	256	93	287	974	217	253	411	181
Age 30	227	119	266	1388	417	448	608	262
Age 34	116	73	213	1203	317	421	656	298
Age 38	126	70	199	897	662	725	747	398
Age 42	143	74	232	892	173	174	902	506

Appendix Table A5: Median Hourly Earnings (£ at 2000 prices) for Employees and Imputed Median Hourly Earnings for Non-Waged

Cohort sweep at age	Employed with Wage		Unemployed only		Non-employed only		Working but wage unknown		Self-employed		All	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
NCDS 1981 (Age 23)	5.57	4.69	5.18	4.02	5.15	3.81	5.52	4.65	5.59	4.45	5.51	4.40
NCDS 1991 (Age 33)	8.80	6.06	6.72	5.45	6.81	4.99	8.49	5.42	8.31	5.75	8.50	5.60
NCDS 2000 (Age 42)	10.08	6.55	7.90	4.79	7.34	5.32	8.72	5.77	9.33	6.48	9.58	6.19
NCDS 2008 (Age 50)	11.00	7.61	8.02	6.30	8.02	6.09	10.37	6.73	10.53	7.35	10.49	7.20
NCDS 2013 (Age 55)	9.92	7.07	8.78	5.49	8.88	6.16	8.26	6.67	9.53	7.22	9.54	6.78
BCS 1996 (Age 26)	7.49	6.86	6.27	7.04	6.57	5.87	7.32	6.73	7.04	6.08	7.32	6.58
BCS 2000 (Age 30)	8.49	7.17	6.48	6.01	6.28	5.15	7.78	6.68	7.93	6.96	8.21	6.71
BCS 2004 (Age 34)	10.32	8.25	7.22	6.33	6.57	5.70	9.55	7.44	9.36	8.14	9.88	7.64
BCS 2008 (Age 38)	10.87	7.98	8.71	6.99	7.45	6.34	10.14	7.52	9.95	8.51	10.31	7.59
BCS 2012 (Age 42)	10.44	7.28	7.63	5.69	7.07	5.79	8.96	7.29	9.89	7.82	9.95	6.92

Figure A1a: Imputed Wages Relative to Employee Wages: NCDS, Men

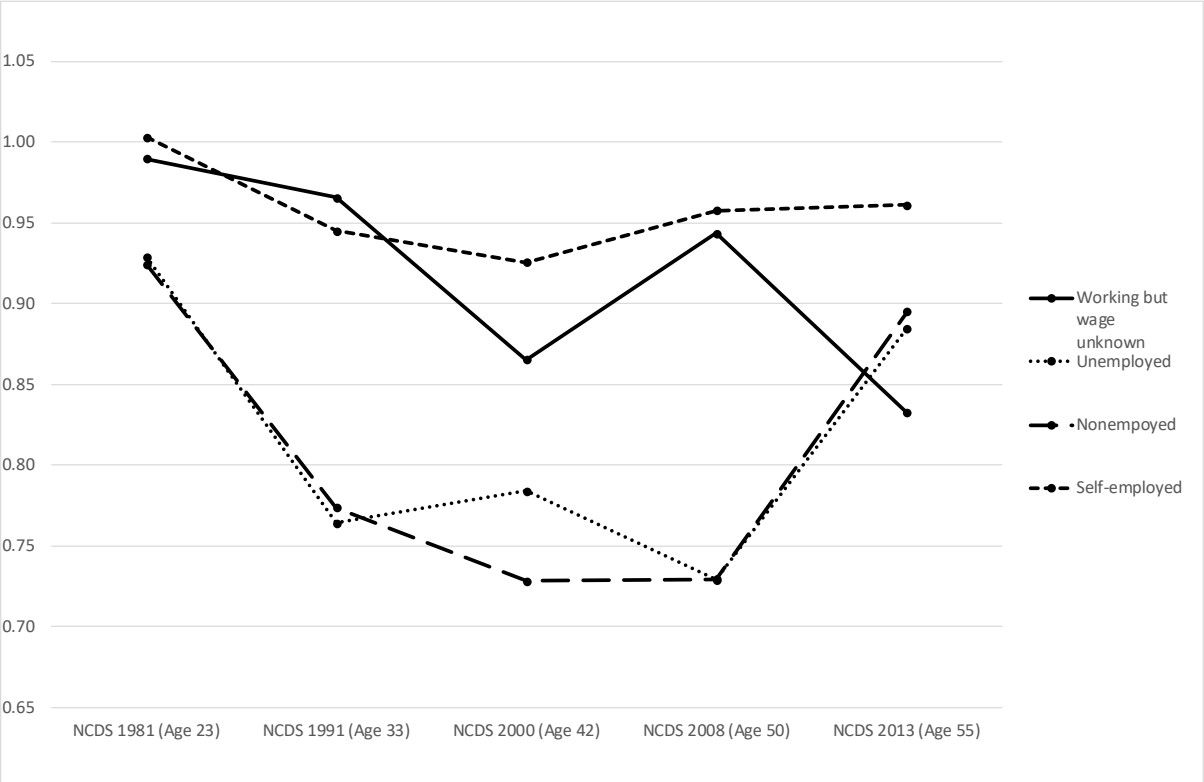


Figure A1b: Imputed Wages Relative to Employee Wages: NCDS, Women

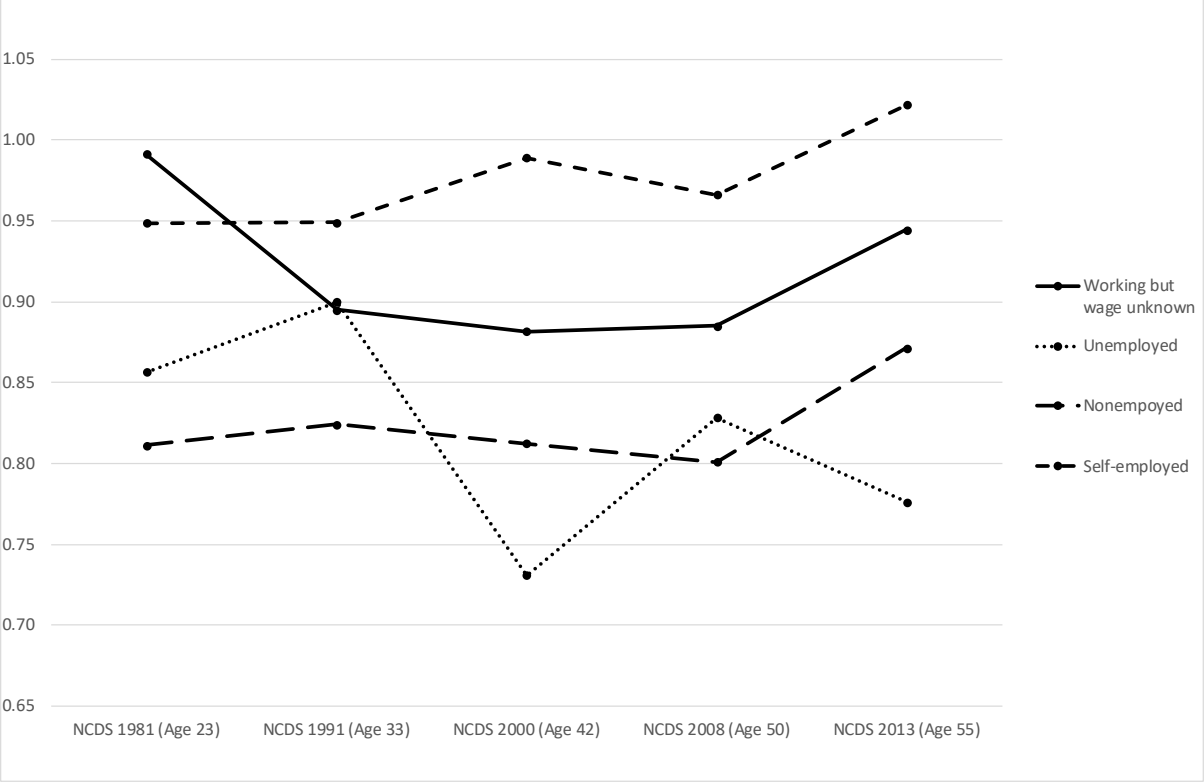


Figure A2a: Imputed Wages Relative to Employee Wages: BCS, Men

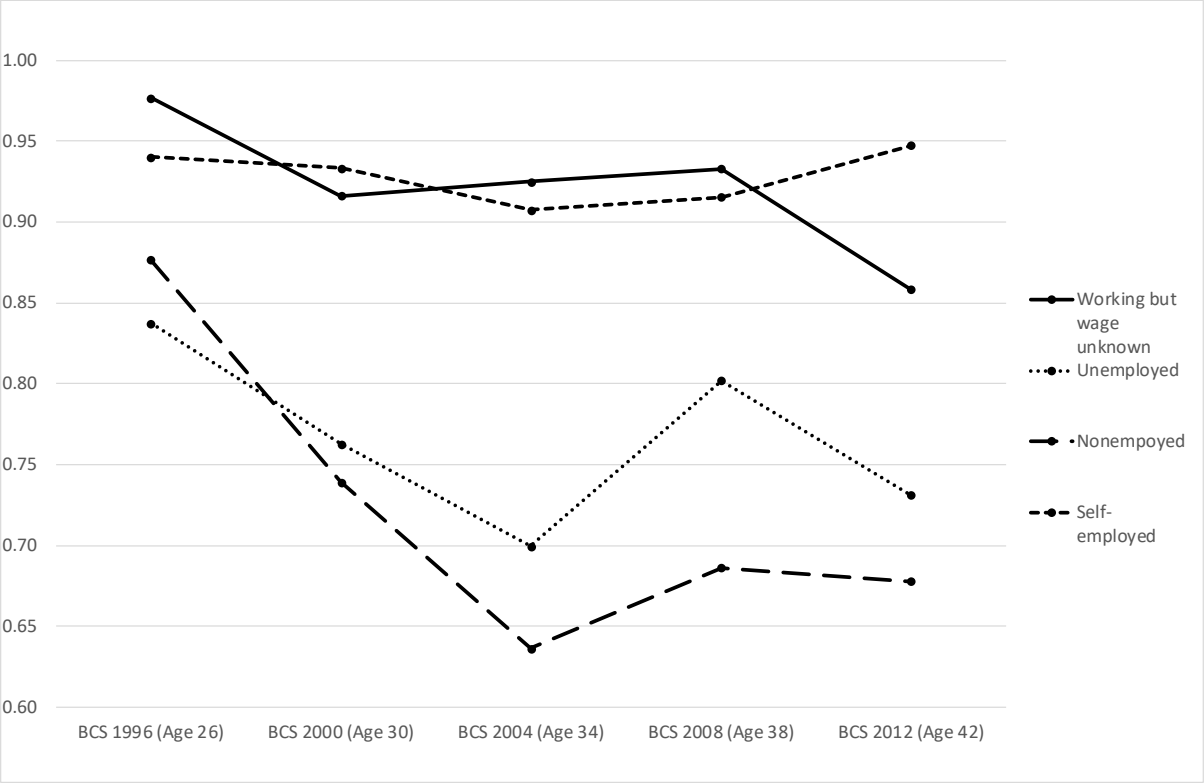
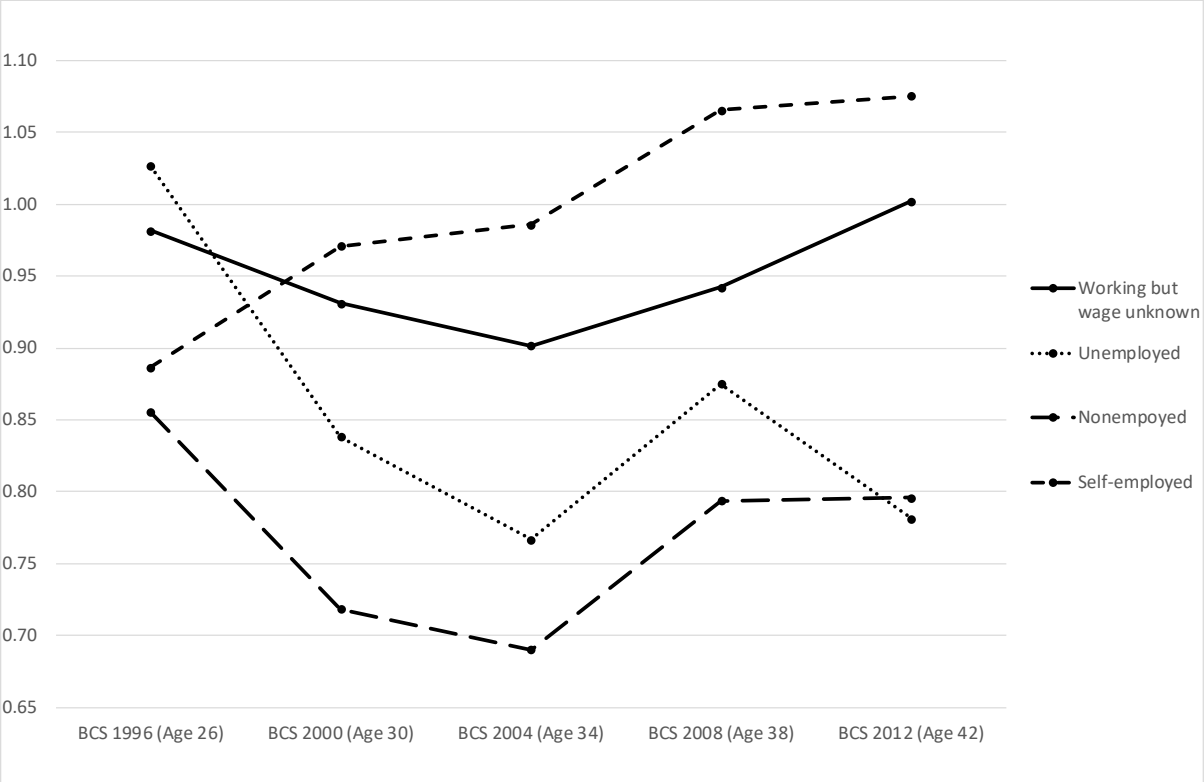


Figure A2b: Imputed Wages Relative to Employee Wages: BCS, Women



A4: Methodology for Adjusting for Sample Attrition

Appendix Table A6: Number of Respondents and Non-Respondents by Cohort, Sweep and Gender

	Respondents			Non-respondents		
	Men	Women	Total	Men	Women	Total
NCDS	6,267	6,270	12,537	1,716	1,328	3,044
Age 23	5,634	5,835	11,469	2,193	1,652	3,845
Age 33	5,626	5,793	11,419	2,142	1,689	3,831
Age 42	4,644	4,890	9,534	2,967	2,459	5,426
Age 50	4,822	4,968	9,790	2,715	2,324	5,039
Age 55	4,433	4,704	9,137	2,968	2,508	5,476
BCS						
Age 26	4,103	4,900	9,003	3,819	2,588	6,407
Age 30	5,471	5,790	11,261	2,418	1,665	4,083
Age 34	4,627	5,038	9,665	3,038	2,260	5,298
Age 38	4,204	4,665	8,869	3,387	2,562	5,949
Age 42	4,724	5,110	9,834	2,889	2,167	5,056

Appendix Table A6 indicates there is substantial sample attrition across both birth cohorts. Adjustments for sample attrition involved estimating a logistic model of the probability of responding to a survey sweep and taking the inverse of the predicted probability of response. There were separate models for each survey sweep by gender. For each sweep the response variable takes the value 1 when the outcome of the interview was productive for the given person; and 0 if the interview was productive at age 10/11, but not the given sweep. Cohort members who died or emigrated were not included in the target sample for that sweep. When there was missing data for covariates, missing dummies were included. For continuous variables, the values of covariates were assigned the mean of known values for each sweep and gender. For each model the values of weights which were below the 1st percentile and above 99th percentile, were replaced to the 1st and 99th percentile respectively.

These probability weights were then applied to the models of selection and covariate adjustment discussed in Section A2 and A5 respectively to give estimates of the gender wage gap that are adjusted for attrition and selection; attrition and covariates; and attrition selection, and covariates.

Based on the information available we use slightly different variables from the NCDS and BCS in these models. Tables A7a and A7b provide a description of the variables used. For models using data from the NCDS, the pseudo R-Squared varies from 0.05 to 0.07. For models using data from the BCS, the pseudo R-Squared varies from 0.06 to 0.09.

Appendix Table A7a: Variables used in NCDS models adjusting for sample attrition

Present in age 16 sweep	Dummy = 1 if cohort member was present

Birthweight	Weight in ounces
Missing birthweight	Dummy = 1 if birthweight missing
Older siblings	Number of older siblings at age 16
Missing older sibling	Dummy = 1 if information on older siblings is missing
Younger siblings	Number of younger siblings at age 16
Missing younger sibling	Dummy = 1 if information on younger siblings is missing
Test Scores	
Maths score	Standardised maths test score taken at age 11
Missing maths score	Dummy = 1 if maths score missing
Reading score	Standardised reading test score taken at age 11
Missing reading score	Dummy = 1 if reading score missing
Rutter score	
Normal	Dummy = 1 if between 1 and 9
High	Dummy = 1 if 10 or more
Smoking	
Non-smoker	Dummy = 1 if non-smoker by age 16
Smoker	Dummy = 1 if ever smoked up to age 16
Drinking alcohol	
None	Dummy = 1 if had not drunk alcohol by age 16
Past week	Dummy = 1 if had drunk alcohol in past week at age 16
Past month	Dummy = 1 if had drunk alcohol in past month at age 16
Past year	Dummy = 1 if had drunk alcohol in past year at age 16
Mother’s characteristics	
Mother's age	Mother's age last birthday in years at birth sweep
Mother's age missing	Dummy = 1 if information missing
Mother’s marital status	
Married	Dummy = 1 if married or stable union at birth
Not married	Dummy = 1 if not married at birth
Mother’s smoking	
Non-smoker	Dummy = 1 if non-smoker during pregnancy
Stopped smoking	Dummy = 1 if stopped smoking during pregnancy
Smoker	Dummy = 1 if smoker during pregnancy
Breastfeeding	
None	Dummy=1 if did not breastfeed
Up to 1 month	Dummy=1 if breastfed for up to 1 month
More than 1 month	Dummy=1 if breastfed for more than 1 month
Fathers social class	
I	Dummy = 1 if at birth father's job in RG class I
II	Dummy = 1 if at birth father's job in RG class II
III NM	Dummy = 1 if at birth father's job in RG class III Non-Manual
III M	Dummy = 1 if at birth father's job in RG class III Manual
IV	Dummy = 1 if at birth father's job in RG class IV
V	Dummy = 1 if at birth father's job in RG class V
Missing	Dummy = 1 if information at birth on father's job is missing
Housing tenure at birth	
Owner occupied	Dummy = 1 if owner occupied
Council rented	Dummy = 1 if council rented
Private rented	Dummy = 1 if private rented
Rent free	Dummy = 1 if rent free
Other	Dummy = 1 if other
Persons per room - age 7	
1 or fewer	Dummy = 1 if 1 or fewer
1 to 1.5	Dummy = 1 if more than 1 up to 1.5
1.5 to 2	Dummy = 1 if more than 1.5 up to 2
More than 2	Dummy = 1 if more than 2

Region	Dummies = 1 if region living in at birth was: North; North West; East and West Riding; North Midlands; Midlands; East; South East; South; South West; Wales; Scotland.

Appendix Table A7b: Variables used in BCS models adjusting for sample attrition

Present in birth sweep	Dummy = 1 if cohort member was present
Present in age 16 sweep	Dummy = 1 if cohort member was present
Birthweight	Weight in grams
Missing birthweight	Dummy = 1 if birthweight missing
Older siblings	Number of older siblings at age 16
Missing older sibling	Dummy = 1 if information on older siblings is missing
Younger siblings	Number of younger siblings at age 16
Missing younger sibling	Dummy = 1 if information on younger siblings is missing
Test Scores	
Maths score	Standardised maths test score taken at age 10
Missing maths score	Dummy = 1 if maths score missing
Reading score	Standardised reading test score taken at age 10
Missing reading score	Dummy = 1 if reading score missing
Rutter score	
Normal	Dummy = 1 if between 1 and 9
High	Dummy = 1 if 10 or more
Smoking	
Never smoker	Dummy = 1 if never smoked by age 16
Ex-smoker	Dummy = 1 if previously smoked, but non-smoker at age 16
Smoker	Dummy = 1 if smoker at age 16
Drinking alcohol	
None in last week	Dummy = 1 if had not drunk alcohol in the last week (at age 16)
Once in last week	Dummy = 1 if had drunk alcohol once in the last week (at age 16)
2 -3 times in last week	Dummy = 1 if had drunk alcohol 2-3 times in the last week (at age 16)
Most days	Dummy = 1 if had drunk alcohol most days in the last week (at age 16)
Mother's characteristics	
Mother's age	Mother's age last birthday in years at birth sweep
Mother's age missing	Dummy = 1 if information missing
Mother's marital status	
Married	Dummy = 1 if married at birth
Not married	Dummy = 1 if single, divorced, widowed, separated at birth
Mother's smoking	
Non-smoker	Dummy = 1 if non-smoker during pregnancy
Stopped smoking	Dummy = 1 if stopped smoking during pregnancy
Smoker	Dummy = 1 if smoker during pregnancy
Breastfeeding	
None	Dummy=1 if did not breastfeed
Up to 1 month	Dummy=1 if breastfed for up to 1 month
1-3 months	Dummy=1 if breastfed for between 1 and 3 months
More than 3 months	Dummy=1 if breastfed for more than 3 months
Fathers social class	
I	Dummy = 1 if at birth father's job in RG class I
II	Dummy = 1 if at birth father's job in RG class II
III NM	Dummy = 1 if at birth father's job in RG class III Non-Manual
III M	Dummy = 1 if at birth father's job in RG class III Manual
IV	Dummy = 1 if at birth father's job in RG class IV
V	Dummy = 1 if at birth father's job in RG class V
Missing	Dummy = 1 if information at birth on father's job is missing
Housing tenure at age 5	
Owner occupied	Dummy = 1 if owner occupied
Being bought	Dummy = 1 if housing being bought
Council rented	Dummy = 1 if council rented

Private rent unfurnished	Dummy = 1 if private rented unfurnished
Private rent furnished	Dummy = 1 if private rented furnished
Rent free	Dummy = 1 if rent free
Tied to occupation	Dummy = 1 if tied to occupation
Other	Dummy = 1 if other
Persons per room - age 5	Ratio of people in household to number of rooms.
Missing person per room	Dummy = 1 if information missing
Region	Dummies = 1 if region living in at birth was: North; Yorkshire and Humberside; East Midlands; East Anglia; South East; South West; West Midlands; North West; Wales; Scotland; Northern Ireland.

A5: Co-variate Adjusted Gender Wage Gaps

We calculate covariate adjusted gender wage gaps by estimating a quantile regression model at the median by gender for each sweep. We then recover predicted wages for the sample of females, based on their characteristics, under a female-only model and under the male-only model. We express the gap between these two predictions as a ratio of the median wages obtained under female-only model, relative to the median wages obtained under the male-only model. To account for selection into employment we perform the same exercise, but this time combining both observed and imputed wages. Table A8 provides a list of the variables used in the quantile regression models. For models using data from the NCDS, the pseudo R-Squared varies from 0.04 to 0.20. For models using data from the BCS, the pseudo R-Squared varies from 0.01 to 0.19. The BCS data at age 26 were collected using a postal questionnaire and here the pseudo R-squared is particularly low (0.01 and 0.02 for male and female equations respectively). Excluding that sweep the lowest pseudo R-squared is 0.08.

Appendix Table A8: Variables used in covariate adjustment

Work experience	
Full-time experience	Months in self defined full-time paid employment since age 16
Full-time experience squared	Months in self defined full-time paid employment since age 16 - squared
Part-time experience	Months in self defined part-time paid employment since age 16
Part-time experience squared	Months in self defined part-time paid employment since age 16 - squared
Highest qualification	
NVQ Level 1	Dummy = 1 if highest qualification is NVQ level 1 or equivalent
NVQ Level 2	Dummy = 1 if highest qualification is NVQ level 2 or equivalent
NVQ Level 3	Dummy = 1 if highest qualification is NVQ level 3 or equivalent
NVQ Level 4	Dummy = 1 if highest qualification is NVQ level 4 or equivalent
NVQ Level 5	Dummy = 1 if highest qualification is NVQ level 5 or equivalent
Missing	Dummy = 1 if information on highest qualification is missing
Test Scores	
Maths score	Standardised maths test score taken at age 10 (1970 cohort) or 11 (1958 cohort)
Missing maths score	Dummy = 1 if maths score missing
Reading score	Standardised reading test score taken at age 10 (1970 cohort) or 11 (1958 cohort)
Missing reading score	Dummy = 1 if reading score missing
Region	
London or SE	Dummy = 1 if living in London or the South East at time of survey

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