

# Are Women Doing It For Themselves? Female Managers and the Gender Wage Gap

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## ABSTRACT

Using matched employer-employee data for Britain from the 2004 and 2011 Workplace Employment Relations Surveys (WERS), we find a raw gender wage gap in hourly wages of around 0.18-0.21 log points. The regression-adjusted gap is around half that. However, the gender wage gap declines substantially with an increasing share of female managers in the workplace. The gap is no longer statistically significant when around 90 percent of workplace managers are women, a scenario that obtains in around one in ten workplaces. The gap closes because women's wages rise with the share of female managers in the workplace while men's wages fall. Instrumental variables estimates suggest the share of female managers in the workplace has a causal impact in reducing the gender wage gap. The role of female managers in closing the gender wage gap is more pronounced when employees are paid for performance, consistent with the proposition that women are more likely to be paid equitably when managers have discretion in the way they reward performance and those managers are women. These findings suggest a stronger presence of women in managerial positions can help tackle the gender wage gap.

Keywords: gender wage gap; female managers; performance pay

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## 1. INTRODUCTION

In the last few decades, there has been what Claudia Goldin (2014) described as “a grand gender convergence” in human capital, with women now outperforming men in educational attainment and closing the gap in labour market experience. These trends are common across much of the developed world (Olivetti and Petrongolo 2016; Kleven and Landais 2018). Yet a gender wage gap persists, with women earning substantially less than men. The gap has been closing but the rate of convergence is slow (Blau and Kahn 2017; Kunze 2018). In Britain the raw gender wage gap in median hourly pay was 17.3% in 2019, at a time when the employment gap was eight percentage points (Devine and Foley, 2020).

Women have made advances across the occupational distribution so that they are now better represented than men in professional occupations (Devine and Foley, 2020). However, concerns remain about their ability to breach what has been termed the “glass ceiling” limiting access to managerial positions, and the associated implications for the overall labour market situation of women (Bertrand 2018). Men outnumber women by a ratio of almost 2:1 in the top occupations (Managers, directors and senior officials) (Devine and Foley, 2020).

Some argue these persistent differences in the occupational distribution of men and women reflect fundamental differences in their preferences (Bender *et al.* 2005; Lordan and Pischke 2016, 2019) while others maintain that the segregation is linked primarily to constraints women face, such as those due to societal expectations around family caring and what is deemed “appropriate” for men and women (Craig *et al.* 1982). These constraints often lead to women engaging in part-time employment which comes with a sizeable pay penalty (Manning and Petrongolo 2008). Women

may also face direct and indirect discrimination in the labour market preventing them from entering particular occupations, or creating obstacles to wage progression that men may not face. For example, Kunze and Miller (2017) find women are less likely to be promoted than men.

A growing body of work using matched employer-employee data moves beyond occupational gender segregation to examine the effects of gender segregation within and across workplaces. These studies find the gender wage gap differs greatly across workplaces (Groshen 1991; Carrington and Troske 1995; Bayard *et al.* 2003; Bruns 2019). In particular, the gender wage gap differs systematically with the share of females at the level of the workplace and the share of females in each occupation within the workplace, including the respondent's own occupation.

There are various reasons why the gender composition of workplaces, and the gender composition of jobs within a workplace, can influence wages and thus the gender wage gap. First, we might expect the gender wage gap to diminish where women make up a high percentage of the decision-makers at the workplace. This may arise if, with women well-represented at management level, managerial decision-making has particular regard to the interests of women. It is conceivable, for instance, that workplaces will be better placed to challenge gender-based discrimination when women are in positions of authority capable of making decisions and bring in policies and practices that have regard to gender. Second, gender composition can affect gender norms at the workplace, and thus the jobs available to women at the workplace, the wage they can command in those jobs and the extent to which the workplace can accommodate women's job preferences, such as those relating to flexible work schedules. Third, gender composition may affect wage bargaining at the workplace. For example, women may be more successful in arguing their case for performance-

related pay rises if female managers are more capable than male managers of recognizing their contribution, or they are more willing to do so.

In order to contribute to the literature on the role of gender composition at the workplace on the size of the gender wage gap we exploit nationally representative matched employer-employee data for Britain in 2004 and 2011 in the Workplace Employment Relations Surveys (WERS) (DTI, 2014; DBIS, 2015). We begin with descriptive analyses of the gender share in occupations within the workplace and estimate their association with the size of the gender wage gap by interacting those female share variables with a gender dummy. We estimate ordinary least squares (OLS) regressions for log hourly wages and workplace fixed-effects models that net out unobserved traits of workplaces that might be linked to both gender composition and employee wages. We supplement these analyses with workplace-level panel (first-difference) analyses estimating the association between change in the workplace share of female managers and change in the workplace gender wage gap.

Our main contributions to the literature are twofold. First, we estimate the causal impact of female managers (and non-managers) on the size of the gender wage gap at the workplace using two instruments. The first instrument draws on the idea that women have a comparative advantage in service-producing sectors, resulting in a concentration of female employment in those industries where “people” skills are typically valued over “brawn” skills; in other words, in those which have a higher level of interaction with the general public. Since we expect no systematic variation in wage rates between goods-producing and service-producing industries all other things equal, we use the extent to which a workplace’s industry-sector is ‘service-focused’ as an instrument for the

share of women in employment at that workplace. Our measure of being ‘service-focused’ is the share of the industry output that is accounted for by final consumption (consumption by individuals and households) as opposed to intermediate consumption (consumption by other businesses). Our second instrument focuses on the share of women in management at the workplace and draws on the idea that some occupational career paths are more egalitarian than others. We argue that there is occupation-level variation in the opportunity costs to child-raising, which in turn is likely to have a differential effect on male and female career paths, given the traditional household division of labour. This, in turn, results in gender differences in promotion probabilities by occupation, something we capture using longitudinal employee data from the Quarterly Labour Force Survey (QLFS). These probabilities are used to identify occupations in which men are, on average, more likely than women to be promoted to managerial positions (and vice versa). Since many managers are hired via promotion rather than from the external labour market (Lyness and Judiesch, 1999), a workplace whose core non-managerial workforce is drawn from a less egalitarian occupation will have fewer women in managerial positions than one in which the core non-managerial workforce is drawn from a more egalitarian occupation. We thus use gender-differences in promotion probabilities at national level in the workplace’s core non-managerial occupation as an instrument for the share of managers at the workplace that are female. These two instruments provide a source of exogenous variation to the share of female employees in the workplace.

Our second contribution is to examine one of the key mechanisms by which we think the share female managers may influence the size of the gender wage gap, namely through performance-related payments. Our dataset is one of the few in the literature to observe the methods that are used to determine pay levels at the workplace. We use these data to identify workplaces in which

there is extensive use of performance-related payments rather than time-based pay, and examine heterogeneity in the impact of the gender composition of management across pay regimes where managers thus appear to have more or less discretion to determine the pay of individual employees.

We find a substantial gender wage gap in Britain in 2004 and 2011. The raw gap in hourly wages is around 0.18-0.21 log points. The regression-adjusted gap is roughly half that. However, we show the gender wage gap declines substantially with the increasing share of female managers in the workplace. This is the case in 2004 and in 2011. The gender wage gap is no longer statistically significant once around 90 per cent of workplace managers are women, a scenario that obtains in around one in ten workplaces. The gap closes because women's wages rise with the share of female managers in the workplace while men's wages fall. These baseline results are robust to a range of sensitivity analyses including fully-interacted models by gender, alterations to model specifications, coefficient stability tests, the removal of managerial employees from the wage estimation, and changes to the definition of managers to include supervisors. Similar results are found when we run workplace fixed-effects and panel first difference estimates. The instrumental variables estimates confirm that the effect of the share female managers in reducing the size of the gender wage gap is a causal impact. Finally, we confirm that the share of female managers plays a greater role in closing the gender wage gap when the workplace has a pay-for-performance scheme, suggesting women are more likely to be paid equitably when managers have discretion in the way they reward performance and those managers are women. These findings suggest a stronger presence of women in managerial positions can help tackle the gender wage gap.

The remainder of the paper proceeds as follows. Section 2 provides a background on how the gender composition of workplaces may affect the gender wage gap and reviews the relevant literature. Section 3 presents the data and our empirical strategy, whereas Section 4 outlines the results. Section 5 concludes.

## 2. GENDER COMPOSITION AND THE GENDER WAGE GAP

The gender composition of workplaces may affect the wages of men and women for a variety of reasons. A higher share female can affect gender norms at the workplace (Akerlof and Kranton, 2010) in ways that favour women in terms of the jobs available to them, the wage they can command in those jobs and the extent to which the workplace accommodates women's job preferences, such as those relating to flexible work schedules. If managers have limited knowledge about the actual productivity of their employees, women may suffer statistical discrimination where men have stereotypical views of women's relative talents (Lazear and Rosen 1990; Flabbi *et al.* 2019). Alternatively, if men have a distaste for working with women, this may also lead to prejudicial outcomes in terms of pay and promotion, either via managerial decisions or as the result of co-worker tastes (Becker 1957). Women may be less likely to suffer these forms of discrimination at the workplace – whether it is directly in relation to differential pay, or indirectly through procedures for promoting and rewarding staff – where those who are making the decisions are women.

The growing literature on the effects of gender segregation on the gender wage gap has paid close attention to worker sorting within and across workplaces. Using German data, Ludsteck (2014) examines the role of non-random sorting of workers, recovering effects of female shares at

workplace, occupational and workplace-occupation job cell. Utilising the panel component of the data to account for selection on fixed unobserved traits, he confirms the finding in earlier studies that an increasing share of women in a job cell results in lower wages for those in that job cell.<sup>1</sup> The effects are greater for women, resulting in an increase in the gender wage gap. However, accounting for selection into occupations, workplaces and job cells reduces the size of the share-female effect on wages substantially and, in the case of men, renders it statistically non-significant. The implication is that much of the female job cell share effect arises due to selection effects, with women working in job cells dominated by men having above-average unobserved individual ability.

The focus on job cells (those working in the same occupation within the same workplace) is perhaps driven by the expectation that this is where one is most likely to observe co-worker taste-based discrimination. If men have distaste for working with women, prejudiced men may have an incentive to restrict women's access to jobs undertaken predominantly by men. If they are unsuccessful, men may seek a compensating wage differential for working alongside women. But this presupposes that men experience a disutility from working alongside women, whereas the literature indicates it is women who have a disutility from working alongside men: women are less satisfied in male-dominated jobs (Usui 2008; Lordan and Pischke 2019) and male domination of occupations increases women's likelihood of quitting a job (Hunt 2016).<sup>2</sup> If this finding carries

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<sup>1</sup> Ludsteck (2014: 362-364) reviews the earlier studies.

<sup>2</sup> In an earlier version of their paper using the WERS data used here Lordan and Pischke (2016, Table 9) confirm that both the share of males in the occupation and the share of males at the workplace are negatively associated with women's job satisfaction having conditioned, *inter alia*, on hourly wages. They also find that the share of males in the workplace is negatively and significantly correlated with men's job satisfaction, but this negative coefficient is only half the size found for women, and the share of males in the occupation is non-significant, suggesting that men's distaste for working alongside other men is lower than women's. This is not what one would expect if men experienced disutility from working alongside women.



over to the workplace environment, the implication is that women might derive greater utility from working in a female-dominated environment. If so, it is possible that women may pay a compensating wage differential for working in a workplace with fewer men, in the same way that Goldin argues they pay a compensating wage differential for access to flexible working schedules (Goldin 2014). This might lead to a higher gender wage gap than might otherwise be observed.

Mumford and Smith (2007, 2009) investigated the role of gender segregation at workplace and occupation-level in explaining the size of the gender wage gap in Britain using forerunners to the data used in this paper. In their first paper analysing WERS 1998 they find that a sizeable part of the raw gender wage gap is accounted for by workplace gender segregation, whereas the impact of occupational segregation is much smaller. The inclusion of the segregation measures reduces the penalty of being a woman by about one-third from 18 to 11 percentage points. In their follow up paper (Mumford and Smith 2009) using WERS 2004 they show that workplace gender segregation is associated with a larger gender wage gap among both full-time and part-time employees. However, they do not consider the effects of segregation in managerial and non-managerial occupations and they do not investigate the pay determination mechanisms underpinning the gender wage gap.

The effects of workplace gender composition may be particularly pronounced when one focuses on the gender composition of those in positions of authority. For instance, a higher share of females in the managerial ranks may challenge the association between leadership and masculinity (Koenig *et al.* 2011), potentially paving the way for career advancement for women. Alternatively, women may be better-placed than men to judge accurately the work performance of female colleagues and

reward them accordingly (Aigner and Cain 1977). One might therefore expect the gender wage gap to diminish (rise) as the share female (male) in managerial positions rises. However, some suggest women in positions of authority engage in discriminatory behaviours towards other women in what has been termed a “queen bee” syndrome. In these settings, women who have achieved career success in male-dominated fields block other women from advancing (Staines *et al.* 1974; Bagues *et al.* 2017).<sup>3</sup>

Studies examining the effects of increasing female representation at board level within companies have found gains for women in senior executive positions. For example, Matsa and Miller’s (2011) study of corporate board members and top executives in a large panel of publicly traded US companies from 1979 to 2009 finds that increases in female board representation are followed in later years by greater female representation at the CEO and top executive level and a smaller gender wage gap among top executives. However, other studies suggest that any spillover effects of female board-level representation may not extend to beyond the C-suite. Bertrand *et al.* (2019) is the first study that examines the effect of mandated gender quotas on the gender wage gap. In December 2003 the Norwegian government passed a law requiring forty percent representation of each gender on the board of directors of public limited liability companies. Using linked administrative employer-employee data for the years 1986-2014 they find that women appointed to these boards after the reform were more qualified than women appointed prior to the reform, and that the gender wage gap fell markedly. They do not find robust evidence, however, that the reform benefited women employed lower down the hierarchy in these companies.

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<sup>3</sup> Similar effects are found elsewhere. For example, evidence from the French criminal justice system indicates that the leniency in sentencing shown to female criminals relative to male criminals is less evident when female judges are presiding because they are more harsh in their sentencing of women than male judges (Philippe 2020).

Other studies focusing on a broader set of organisations and managerial positions have found evidence of positive spillovers. In the only study for Britain, Stojmenovska (2017) uses the WERS 2004-2011 panel to show that a rising share of women in management at the workplace is associated with a falling gender wage gap among non-managerial employees, something we return to below. For the United States Tate and Yang (2015) find that firms with more women in leadership roles have a smaller gender wage gap, and that women in these roles offer equal pay to newly hired employees further down the hierarchy. Using longitudinal linked employer-employee data for Portugal over the period 1987-2000 Cardoso and Winter-Ebmer (2010) show that an increase in the share of females in a workplace reduces the wages of both men and women, with the effect being more pronounced for women. However, they also show that women's wages rise relative to men's when a workplace switches to being female-led. This happens because women's wages rise and men's fall when compared to what they would have been in a male-led firm, with a female boss reducing the gender wage gap by 1.5 percent. Looking at the share of females in the workplace they find that the advantage of female leadership for women gets smaller as the share of females at the workplace grows whereas for men the disadvantage of female leadership grows with a rising percentage female.

Cardoso and Winter-Ebmer (2010: 155) interpret their results in terms of female leaders' ability to "mentor and protect female co-workers...[thus] increase[ing] the latter's promotion chances and thus their expected wage".<sup>4</sup> Further support for this interpretation comes from Kunze and Miller's

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<sup>4</sup> Compelling evidence regarding the importance of mentoring comes from Ginther *et al.*'s (2020) randomised control trial in which they find women randomly assigned into a mentoring workshop to support women in research careers increased the likelihood of a woman remaining in academia and in receiving tenure in a highly-ranked economics institution.

(2017) study on female representation in corporate leadership in Norway. They find greater female representation among the higher occupational ranks in the workplace narrows the gender gap in promotion rates at lower ranks, a spill-over effect they say “will occur if higher-ranking women serve as mentors, role models, and advocates for their lower ranking co-workers” (pp. 23-24). However, they also find a negative spill-over on women’s promotion probabilities from an increasing share of women among one’s peers which, they suggest, may arise due to “greater competition (and less cooperation) among peers of the same sex...or from women in lower ranks facing greater competition for scarce sex-specific resources such as mentors and sponsors” (p. 29).<sup>5</sup>

Other studies using longitudinal data point to the importance of worker sorting as the underlying mechanism. Gagliarducci and Paserman (2015) use longitudinal linked employer-employee data from West Germany and find that the share of females among top management is associated with lower wages for both male and female employees. But once they control for workplace fixed effects and workplace specific time trends the above correlation disappears. They argue that their results are consistent with female managers sorting into workplaces that are smaller, less productive and more female friendly. Using longitudinal linked employer-employee data for Sweden, Hensvik (2014) confirms that the gender wage gap falls in female-led firms, but the result is driven by worker sorting as opposed to the treatment of similarly productive women and men: female managers recruit high-wage women rather than paying their existing women more relative to equivalent men. Finally, using a linked employer-employee panel from the Italian manufacturing sector Flabbi *et al.* (2019) identify differential impacts of female leadership on the

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<sup>5</sup> Other studies showing that an increase in the share of female managers is associated with a narrowing of the gender wage gap include Hirsch (2013) and Lucifora and Vignani (2016).

gender wage gap in different parts of the wage distribution. These arise because female leadership has a positive impact at the top of the female wage distribution and a negative impact at the bottom, whereas it has the opposite symmetric effect on the male wage distribution. They suggest that their findings are consistent with statistical discrimination, with female managers better able to assess female productivity than male managers.

We contribute to this literature in two ways using nationally-representative matched employer-employee data for Britain. First, we present evidence of a robust, causal impact of the share of female managers in reducing the size of the gender wage gap. This happens because men's wages fall and women's wages rise with an increase in the share of female managers at the workplace. Second, we show this effect is more pronounced for employees whose pay is partly dependent on their performance, consistent with the proposition that women are more likely to be paid equitably when managers have discretion in the way they reward performance and those managers are women. These findings suggest a stronger presence of women in managerial positions can help tackle the gender wage gap.

### 3. DATA AND ESTIMATION

We pool two matched employer-employee data sets for 2004 and 2011 from the British Workplace Employment Relations Survey (WERS).<sup>6</sup> The surveys match workplace-level questions asked of senior managers with questionnaires issued to 25 randomly selected employees in each workplace, or to all employees in workplaces with fewer than 25.<sup>7</sup> This match makes it a very rich dataset,

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<sup>6</sup> Separate estimates by year provided similar results.

<sup>7</sup> The management questionnaire response rate in 2004 (2011) was 64% (46%) while the employee questionnaire response rate in 2004 (2011) was 60% (54%).

offering workplace-level and firm-level control variables that are not typically available in household or employee-only surveys, and an array of workplace and employee-level characteristics that would not typically be found in linked employer-employee datasets derived from administrative sources. The employer survey provides information of the gender composition of each occupational group in the workplace (after having asked the employer to categorise the workforce into the nine Major Groups of the UK's Standard Occupational Classification (2000)).<sup>8</sup> We thus have data on gender segregation among managers and non-managers at the workplace, in conjunction with wage data from a random sample of its employees.

Employees were asked “*How much do you get paid for your job here, before tax and other deductions are taken out? If your pay before tax changes from week to week because of overtime, or because you work different hours each week, think about what you earn on average*”. In the 2011 WERS survey respondents report within 14 bands representing income ranging from “less than £60 per week/£3,120 per year” to “£1,051 or more per week/£54,061 per year”.<sup>9</sup>

Since wages are only observed within ranges, we use mid-points across the ranges. The highest band is open-ended so we top-code it equal to 1.5 times its lower bound. We also know the respondents' usual weekly working hours including overtime (a continuous measure). Our dependent variable is the log hourly wage which is constructed by dividing the mid-point of the

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<sup>8</sup> These nine groups are: Managers and senior officials; Professional occupations; Associate professional and technical occupations; Administrative and secretarial occupations; Skilled trades; Personal service occupations; Sales and customer service occupations; Process, plant and machine operatives; and Elementary occupations. Managers were provided with an Employee Profile Questionnaire (EPQ) to complete ahead of their face-to-face interview; the EPQ included examples to assist them with categorisation.

<sup>9</sup> In WERS 2004 the corresponding pay bands ranged from “less than £50 per week/£2,600 per year” to “£871 or more per week/£45,241 per year”.

weekly earnings interval by working hours per week.<sup>10</sup> Our baseline specification (results shown in Table 1) is the following:

$$\begin{aligned}
 \log y_{i(j)} &\equiv \log \left( \frac{w_{i(j)}}{h_{i(j)}} \right) \\
 &= \beta_0 + \beta_1 \xi_{i(j)} + \beta_2 \text{ShFemManag}_j + \beta_3 \xi_{i(j)} * \text{ShFemManag}_j \\
 &\quad + \beta_4 \text{ShFemNonManag}_j + \beta_5 \xi_{i(j)} * \text{ShFemNonManag}_j + \beta'_6 \mathbf{X}_{i(j)} + \beta'_7 \mathbf{W}_j \\
 &\quad + \beta_8 \text{Yr}_{2004} + \varepsilon_{i(j)},
 \end{aligned}$$

where  $i$  indexes individuals and  $j$  indexes workplaces.  $\xi_{i(j)}$  is a dummy variable taking the value of 1 if worker  $i$  in workplace  $j$  is female, 0 otherwise.  $\text{ShFemManag}_j$  is the share of female managers among all managers in the workplace and  $\xi_{i(j)} * \text{ShFemManag}_j$  is an interaction term between the female dummy variable and the share of female managers in the workplace.  $\text{ShFemNonManag}_j$  is the share of female non-managers in the workplace among all non-managers and  $\xi_{i(j)} * \text{ShFemNonManag}_j$  is an interaction term between the female dummy variable and the share of female non-managers in the workplace.

The share of female managers and share of female non-managers are interacted with the gender dummy in order to identify whether the association between these two variables and wages differ between male and female employees. The parameter on the gender dummy ( $\beta_1$ ) indicates the gender wage gap in a male-dominated workplace; the parameter on share of female managers ( $\beta_2$ ) (or non-managers,  $\beta_4$ ) shows the impact on male pay of an increasing share of female managers

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<sup>10</sup> Bryson *et al.* (2018: 141) demonstrate the validity of the aforementioned mid-point imputation procedures using continuous hourly wage data provided in the UK's Annual Survey of Hours and Earnings (ASHE). Their investigations show that the mid-point is a valid estimate of the mean wage within each of the WERS hourly-wage intervals when actual hourly wages are known ( $r=0.99$ ).

(or non-managers). The parameters of the respective interaction terms ( $\beta_3$  and  $\beta_5$ ) show the effect on the gender wage gap of an increasing share of female managers (or non-managers).

$\mathbf{X}_{i(j)}$  is a vector of observed individual covariates,  $\mathbf{W}_j$  is a vector of observed workplace covariates,  $Yr_{2004}$  is a dummy variable taking the value of 1 if the observation comes from the 2004 cross section and  $\varepsilon_{i(j)}$  is the disturbance term. We estimate this model using OLS, but for robustness of the functional form we also report some results from an interval regression model.

The vector  $\mathbf{X}_{i(j)}$  includes the following controls: age, age squared/100, married or living with a partner, having dependent children in the age group 0-18, having a disability (long term illness or health problem that affects the amount or type of one can do), member of an ethnic minority group, seven educational qualification dummies (omitted category: no academic qualification), having a vocational qualification, tenure, tenure squared/100, being a union member, having a permanent or a temporary job (omitted category, fixed period job with an agreed end date), and 25 occupational dummies (the two-digit level of the 2000 edition of the UK's Standard Occupational Classification).

The vector  $\mathbf{W}_j$  includes the following controls: log size of the workplace (number of employees), if the workplace is one of a number of different workplaces in the UK belonging to the same organisation, or is a single independent workplace not belonging to another body (omitted category: sole UK workplace of a foreign organisation), private sector workplace, foreign-owned workplace, the share of employees who are trade union members, the share of employees age 50 or over, the share of employees between ages 18 and 21, the shares of eight occupational groups (omitted



category: share of routine/unskilled occupations), 34 industry dummies (two digit level of the 2003 edition of the UK's Standard Industry Classification), and nine region dummies (omitted category: Yorkshire and Humberside).

The average employee works in a workplace where forty-nine percent of employees are female, but there is considerable variation around this mean (Appendix Figure A1). We remark briefly on the role played by the female share in the workplace in estimating the gender wage gap, but we focus primarily on two separate indicators measuring the number of female managers as a share of all managers at the workplace and the number of female non-managerial employees as a share of all non-managers.<sup>11</sup> The mean share of female managers at the workplace is 36%, while the mean share of female non-managers is 50%. About 28% of employees work in workplaces where the majority (>50%) of managers are women (Appendix Figure A2).<sup>12</sup> Managers are defined here as those occupying SOC(2000) Major Group 1 (Managers and senior officials). We also estimate a variant in which the managerial group is defined to include Professional employees (SOC(2000) Major Group 2), in an attempt to capture employees who are likely to hold senior supervisory positions.<sup>13</sup> Finally, we also test the sensitivity of our results to using a direct estimate of the gender composition of supervisors at the workplace.

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<sup>11</sup> A more detailed specification in which we separated non-managerial employees into those belonging to the sampled employees' own occupation and those in other non-managerial occupations did not add further insights.

<sup>12</sup> Appendix Figure A3 presents the share of female non-managers distribution in the workforce by gender.

<sup>13</sup> Data from the employee survey indicate that 75% of employees in SOC(2000) Major Group 1 (Managers and senior officials) and 44% of employees in SOC(2000) Major Group 2 (Professionals) are responsible for overseeing the work of other employees on a day-to-day basis. The share of employees with such supervisory responsibilities is less than 35% in SOC(2000) Major Groups 3-9.

Because some control variables have missing observations, we recode missing observations to their mean values and add a dummy variable to identify those observations.<sup>14</sup> We keep workplaces with 10 or more employees, and employees who have worked a positive numbers of hours and provide wage information. We drop observations with missing information on share females. Our final sample consists of 39,966 workers clustered in 3,236 workplaces across the private and public sectors.

To correct for sample design and any observable non-response bias our analyses use employee level weights provided with the survey data (Forth and Freeth, 2014). Standard errors account for the clustering of employee observations within workplaces. Descriptive statistics of all the variables used in the analysis are reported separately for females and males in Appendix Table A1.

With these data we are able to replicate the cross-sectional estimates of the gender wage gap that dominate the literature, and to estimate the association between the gender wage gap and the share of female managers at the workplace. However, estimates of the influence of female shares in management on the gender wage gap could be biased if unobserved factors influence both wages and the share of females in management. For example, it is possible that discriminatory employers offer particularly low wages to women and are less likely to promote women to managerial positions, inducing a positive correlation between women's wages and the share of women in managerial roles. If these discriminatory employer preferences are unobserved, as they are in our case, this would lead to a potential upward bias in the interaction between the female dummy and the share female managers in our wages models.

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<sup>14</sup> These controls are the share of employees who are trade union members, the share of employees age 50 or over and the share of employees between ages 18 to 21 years old.

To address this possibility, we undertake workplace fixed-effects models which account for unobserved workplace traits common to all employees in a workplace, and which may thus be associated with the gender composition of the workplace and the wages paid to its employees at a given point in time.

Unlike Hensvik (2014) and Ludsteck (2014) we are unable to account for unobserved traits of employees because we do not have repeated observations at the employee level – as would arise if they were followed over time. However, we do track a random sub-sample of workplaces over time, permitting workplace-level panel analyses for 963 workplace observations where we have matched employer-employee data in 2004 and for the same workplaces in 2011.<sup>15</sup> We use this balanced panel to analyse the association between *changes* in the gender gap between men's and women's mean average workplace wages and *changes* in the female share of women in managerial and non-managerial positions within the workplace between 2004 and 2011, whilst accounting for time-varying changes in the characteristics of the stock of male and female employees at the workplace. An association between changes in the gender wage gap in mean wages and changes in female shares within workplaces, after controlling for time-varying differences in employee characteristics by gender, would thus provide some assurance that any role of female managers in closing the gender wage gap is not due solely to the sorting of workers across workplaces.

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<sup>15</sup> Sample sizes are smaller because only a random sub-sample of workplaces were issued for panel follow-up. The analysis is confined to those workplaces that provided employee respondents in both 2004 and 2011 where data were not missing. The data do not permit panel analyses at individual worker level because the survey did not attempt to collect unique identifiers that would enable individual workers to be matched over time.

The panel analysis is performed in two steps. In the first step we construct the average raw male-female log hourly wage differential from the employee level sample in each workplace. We then merge these raw gender wage gaps to the workplace panel sample using the unique workplace identifier. It is this male-female log hourly wage differential that is the dependent variable for our panel regression which takes the following form:

$$\Delta(\overline{W}_M - \overline{W}_F)_{jt} = \delta_1 \Delta ShFemManag_{jt} + \delta_2 \Delta ShFemNonManag_{jt} + \delta_3' \Delta \mathbf{W}_{jt} + \delta_4' \Delta \mathbf{X}_{jt} + \Delta v_{jt},$$

where  $j$  indexes workplaces and  $t$  indexes time.  $\Delta ShFemManag_{jt}$  is the change in the share of female managers between the two time periods and  $\Delta ShFemNonManag_{jt}$  is the corresponding change in the share of female non-managers.  $\Delta \mathbf{W}_{jt}$  captures change in observed workplace controls as outlined above,  $\Delta \mathbf{X}_{jt}$  captures change in observed individual characteristics averaged at the workplace level and  $\Delta v_{jt}$  shows change in the disturbance term. A subsequent specification then replaces these individual characteristics averaged at the workplace level ( $\Delta \mathbf{W}_{jt}$ ) with separate female and male characteristics, also averaged at the workplace level. By estimating influences on the change in the mean workplace-level residual gender wage gap, the analysis captures change net of observed compositional change in the workplace's employees.

These estimates still do not account for the possibility that wages could endogenously drive appointment to managerial positions. Women may be more likely to apply for management jobs when wages are low, if their labour market opportunities are more restricted than those of men. To account for the potential endogeneity of the share of female managers and share of female non-managers in the workplace, we use an instrumental variables strategy. In the absence of an

exogenous policy shift which might provide for a natural experiment, we utilise two instruments based on features of the workplace itself.

The first instrument draws on the idea that women have a comparative advantage in service-producing sectors, resulting in a concentration of female employment in those sectors. Ngai and Petrongolo (2017) outline a model for production of goods and services which involves a combination of male and female work, but in which the production of services is relatively less intensive in the use of “brawn” skills than the production of goods, and relatively more intensive in the use of “brain” skills. They argue that, as men are better endowed with “brawn” skills than women, men have a natural comparative advantage in producing goods, whilst women have a natural comparative advantage in producing services. Lordan and Pischke (2019) further develop these ideas, proposing a third category of “people” skills. They argue that women value jobs – typical in the service sector – that are relatively high on “people” content and low on “brawn”, thus providing a further rationale for an unequal distribution of men and women across different sectors of the economy.

For these reasons we expect women to be more heavily represented in industries where “people” skills are typically valued over “brawn” skills; in other words, in those which have a higher level of interaction with the general public. Since we expect no systematic variation in wage rates between goods-producing and service-producing industries all other things equal, we use the extent to which a workplace’s industry-sector is ‘service-focused’ as an instrument for the share of women in employment at that workplace.

To derive this indicator we take data from the UK Supply and Use Tables (Office for National Statistics, 2018). Using these tables, we compute - for each of 85 industry sectors – the share of industry output that is accounted for by final consumption (that is, consumption by individuals and households) as opposed to intermediate consumption (that is, consumption by other businesses). To give some indication of the variation the share is 3% in SIC(2007) Division 28 (Manufacture of machinery and equipment), 19% in Division 64 (Financial Services), 76% in Group 49.1/49.2 (Rail transport) and 98% in Division 86 (Human health activities).<sup>16</sup> This indicator is matched onto each workplace in our sample using information from the employer on the industry sector in which the workplace is operating.

The second instrument focuses on the share of women in management at the workplace and draws on the idea that some occupational career paths are more egalitarian than others. Adda *et al.* (2017), for example, draw attention to occupation-level variation in the rate at which skills depreciate when out of work. In their model, occupations dominated by abstract skills require constant updating to keep pace with changes in information technology, products or processes, whilst the skills required in routine occupations change at a slower pace. This framework points to occupation-level variation in the opportunity costs to child-raising, which in turn is likely to have a differential effect on male and female career paths, given the traditional household division of labour. Our conjecture is that, since many managers are hired via promotion rather than from the external labour market (Lyness and Judiesch 1999), a workplace whose core non-managerial workforce is drawn from a less egalitarian occupation (i.e. one in which interruptions are more damaging to career prospects) will have fewer women in managerial positions than one in which

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<sup>16</sup> The exclusion restriction cannot be tested but the variable has a small and statistically non-significant standardised beta coefficient when entered directly into our wage equation (beta= -0.027; t= -1.40).

the core non-managerial workforce is drawn from a more egalitarian occupation. We utilise this notion by using longitudinal employee data to estimate gender-specific promotion probabilities by occupation. These probabilities are used to identify occupations in which men are, on average, more likely than women to be promoted to managerial positions (and vice versa). We identify the gender-difference in promotion probabilities at national level in the workplace's core non-managerial occupation, and use this as an instrument for the share of managers at the workplace that are female.<sup>17</sup>

We use data from the employer to identify the specific occupation of the largest group of non-managerial employees at the workplace (classified at the Minor Group or three-digit level of the UK's Standard Occupational Classification (78 groups)), and then use data from the UK's Five-Quarter Longitudinal Labour Force Survey (LFS) to identify the percentage of employees in each SOC Minor Group in Quarter 1 who have been promoted to SOC Major Group 1 (Managers and senior officials) by Quarter 5 (12 months later). We use LFS data pertaining to the year of the WERS survey (2004 or 2011 as appropriate). We compute promotion probabilities separately for men and women, then compute the difference in these probabilities. Occupations with a higher value are those in which men are more likely to be promoted to managerial positions than women. The median three-digit occupation has a value of 0.03, indicating that the share of men promoted to managerial positions annually is three percentage points higher than the equivalent share of women (inter-quartile range: -0.06 to 0.09). To provide a tractable illustration, we have computed

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<sup>17</sup> In doing so, we take the identity of the core occupation as exogenous. Having conditioned on the share of employees in the workplace in that core occupation, and employee-specific human capital, there are no theoretical grounds to suspect that gender-differences in promotion probabilities at national level in the core occupation will affect employee wages at the workplace, other than through its impact on the share of women managers at the workplace. Again, the variable has a small and statistically non-significant standardised beta coefficient ( $\beta = 0.010$ ;  $t = 1.42$ ) if entered directly into the wage equation.

the same probabilities for each SOC Major Group (one-digit) and present these values for illustrative purposes in Appendix Table A6.

We use our chosen instruments to generate fitted values for the shares of female managers and female non-managers in each workplace, and then use these fitted values (and their interactions with the exogenous female dummy) as instrumental variables in the usual 2SLS approach.

Having identified the size of the gender wage gap and how it varies with the share of female managers, both in cross-section and panel data, and having established whether the effects are robust to treating the share of female managers as potentially endogenous, we consider one mechanism by which female managers may influence the gender wage gap, namely their ability to reward employees for their performance. Where employees are rewarded for their individual performance, the gender of managers determining those rewards may affect the size of the gender wage gap. As noted above, women may be better-placed than men to judge accurately the work performance of female colleagues and reward them accordingly. Alternatively, if there is gender-bias in the way performance is rewarded, having a higher share of females in managerial positions may help redress that bias by rewarding employees more equitably.<sup>18</sup> To test this proposition we construct a dummy variable taking the value of 1 if the respondent manager said that 60% or more of the non-managerial employees at this workplace are paid under performance pay, 0 otherwise. About 28% of the workplaces operated such schemes, covering one third of employees in the population. To establish whether the share female managers performs differently in the presence

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<sup>18</sup> A further possibility is that women perform better when managed by women, thus raising their relative returns when performance-based pay is available. There is experimental evidence in education to indicate that women attain higher test scores when their professors are women (Carrell *et al.* 2010).



and absence of performance pay we interact the performance pay variable with a female dummy and the female share of managers. We incorporate a similar interaction with the female share of non-managers. OLS and workplace fixed effects estimates for these models are presented.

#### 4. RESULTS

The raw gender wage gap was 0.21 log points in 2004 and 0.18 log points in 2011. The adjusted gender wage gap controlling for individual and workplace characteristics falls to 0.13 log points in 2004 and to 0.10 log points in 2011 (Appendix Table A2). The female dummy is highly statistically significant throughout and the models with controls account for over two-fifths of the variance in log hourly pay. Since the coefficients are not markedly different in the two years we pool the data for 2004 and 2011 in the remainder of our analyses. The raw gender wage gap in the pooled data is 0.19 log points, with the adjusted gap falling to 0.11 log points or 11.3 percent (columns 5 and 6 of Appendix Table A2).

[INSERT TABLE 1]

Our focus is on how this gender wage gap varies with the share of female managers and of non-managers in the workplace. Baseline OLS estimates of this effect are presented in column 1 of Table 1.<sup>19</sup> Men's wages fall with the share female, whether that share is in managerial or non-managerial occupations. However, the interaction with the female dummy is only statistically significant in the case of the share of female managers: the interaction is positive and statistically significant. A one standard deviation increase in the share of female managers is associated with

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<sup>19</sup> Appendix Table A3 reports coefficients from the full model.

a 4 percentage point decline in the gender wage gap ( $0.114 \times 0.355 = 4.05$ ). Results are very similar using interval regression to account for the banded wages data (column 2).<sup>20</sup>

Figure 1 shows the marginal effects of the share of female non-managers and of managers on men's and women's wages from the OLS in Table 1 column 1, together with the 95 percent confidence intervals for those estimates. In Panel A we see that both men's and women's wages fall with an increase in the share of females in non-managerial occupations, which is consistent with the literature which uses the percent female at the workplace as a measure of gender segregation. In contrast, Panel B shows that, while men's wages also fall with the rising share of females among managers, women's wages are rising in the share female in managerial positions. The net effect is captured in Figure 2 which shows the gender wage gap falling as the share of female managers rises. When nearly all managers – around nine-in-ten – are women the gender wage gap is no longer statistically significant.

[INSERT FIGURES 1 AND 2]

We run some sensitivity tests to see how robust the OLS results in Table 1 column 1 are to the treatment of managers. These tests are presented in Appendix Table A4. The association between the share of females in managerial occupations and women's wages might be explained by female managers using their authority to upwardly adjust their own wages. This is not what is driving the results: if we drop managers from the estimation sample (Table A4, column 1) results are similar to those presented above. The association might also be sensitive to our definition of managers. In

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<sup>20</sup> Further investigation showed no evidence of non-linearities.

column 2 of Table A4, we expand our definition of managers to include employees in SOC(2000) Major Group 2 (Professionals), since over two-fifths of employees in this group hold supervisory responsibilities. The coefficient of this new interaction term increases in magnitude compared to the interaction coefficient reported in Table 1 column 1 and remains highly statistically significant. In column 3 of Table A4 we replace the share of female managers with a direct estimate of the share of female supervisors at the workplace.<sup>21</sup> Once again, the coefficient is large and statistically significant, and is of the same magnitude (0.12 log points) to that for the share of female managers in column 1. In column 4 we incorporate both the share of female managers and the share of female supervisors. Their interactions with the female dummy are both positive and statistically significant, indicating that a higher share of females in positions of authority and responsibility, whether as managers or supervisors, is associated with a lower gender wage gap.<sup>22</sup>

When we incorporate workplace fixed effects in Table 1 column 3 the coefficients indicate how the within-workplace difference between men's and women's wages varies according to the share of female managers.<sup>23</sup> The workplace-level covariates fall out of this model as workplace fixed

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<sup>21</sup> In the employee questionnaire employees were asked “*Do you supervise any other employees? A supervisor, foreman or manager is responsible for overseeing the work of other employees on a day-to-day basis*” Yes/No. We keep employees who answered affirmatively to this question and use those data to compute the share of female supervisors among all supervisors in the workplace.

<sup>22</sup> We conducted two further sets of robustness checks on our model specification. First, we interacted the female dummy with all the other control variables in the model (fully interacted model) to establish whether the extra controls impact on the coefficient of the interaction between share of female managers and being female. The interaction coefficient drops from 0.114 to 0.081 but remains highly statistically significant (see column 5 in Appendix Table A4). Second, we ran a more parsimonious model excluding some variables which might be thought to be jointly determined with individuals' potential earnings, namely having dependent children in the age group 0-18, having a permanent or a temporary job and the occupation dummies at the two-digit level. As seen in column 6 of Table A4, the removal of these variables does not materially affect our results, though the size of the interaction between the share of female managers and being female increases.

<sup>23</sup> Around one quarter of workplaces in our sample do not contribute to these fixed-effects estimates as they have no within-workplace gender variance. Specifically, there are 1,010 workplaces where all managers are from a single sex (629 all-male and 381 all-female, accounting for 7,165 and 4,080 sampled employees respectively). Also, 113 workplaces with 1,051 sampled employees are from a single sex. The latter subset comprises 87 workplaces (with 815

effects wipe out constant workplace characteristics, but the interaction between the share of female managers and the female dummy remains positive, statistically significant and of similar magnitude to the OLS estimate, while the interaction with the share of female non-managers remains statistically non-significant. This suggests fixed unobserved workplace characteristics do little to mask the association between a higher share of female managers and closure of the gender wage gap.<sup>24</sup>

[INSERT TABLE 2]

In Table 2 we turn to the workplace-level panel analysis, in which we regress changes in the share of female managers and of non-managers on changes in the average gender wage gap. An increase in the share of managers who are female is associated with a reduction in the size of the average wage gap within workplaces between 2004 and 2011. In column 1, we control for changes in the characteristics of the average employee at the workplace; here, the magnitude of the coefficient implies that a one standard deviation increase in share female managers decreases the log male-female wage differential by 12.3 percentage points. In column 2 we replace the average employee characteristics with separate female and male averaged workplace characteristics. The share of female managers coefficient decreases in magnitude by around half suggesting that female managers may affect the wage gap through hiring and firing policies which change the composition

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sampled employees) in which all employees are female and 26 workplaces (with 236 sampled employees) in which all employees are male.

<sup>24</sup> We also use Oster's (2019) method to test the robustness of our cross-sectional estimates to plausible assumptions regarding unobserved selection bias. We do so using her STATA routine PSACALC to establish the sensitivity of the interaction term to rescaling the explanatory power of the model assuming that observed and unobserved variables play an equal role into selection of the interaction term. Rescaling by a factor of 1.25 increases the coefficient on the interaction term in Table 1 column 1 from 0.114 to 5.762 while the coefficient on the interaction in Table 1 column 3 rises from 0.137 to 10.993. Rescaling by a factor of 1.5 raises the size of the coefficients even more indicating that our results do not appear to be driven by omitted variables bias.

of the male and female workforce - perhaps recruiting women with higher earnings potential (which is what Hensvik (2014) found for Sweden). However, there remains an effect of female managers on the wage gap after accounting for the compositional changes that we observe in our data: the interaction coefficient in column 2 remains negative and statistically significant, with a one standard deviation shift in the share female managers now decreasing the wage gap by 5.1 percentage points after accounting for compositional changes.

[INSERT TABLE 3]

Next we turn to our IV estimates. Here we instrument the share female managers and share female non-managers with the share of industry output that is accounted for by household consumption rather than intermediate business consumption, and the gender-difference in promotion probabilities for the workplace's core non-managerial occupation. Table A5 in the Appendix reports the first stage estimates. Both instruments are strong predictors of the endogenous variables. As outlined in Section 3, we anticipated the household consumption expenditure variable to be positive and significant for both share female managers and non-managers, whereas the gender differential in promotion probabilities was expected to be negative and significant only for the share female managers. This is precisely what we find.

Our IV estimates of female shares on wages are presented in Table 3. The positive and statistically significant interaction between the female dummy and the female share of managers confirms that an increasing share of female managers increases women's wages relative to those of men. In contrast, the share female non-managers significantly lowers women's wages compared with

men's. The coefficients for the interactions between being female and the female share of managers and non-managers are larger in our IV estimates than in the corresponding OLS estimates presented in Table 1 column 1, and the IV estimates are less precisely estimated.<sup>25</sup>

One potential mechanism by which the share of female managers may affect the gender wage gap is through female managers using their discretion to rewarding their staff differently to male managers. To investigate this issue we construct a dummy variable taking the value of 1 if the human resources manager said that the majority (strictly, 60% or more) of the non-managerial employees at this workplace are paid for performance, as opposed to being paid solely on the basis of hours worked. Just under one-quarter (23%) of workplaces had such a performance pay regime, covering around one-third (30%) of all employees. Table 4 confirms that a higher share of female managers has a more pronounced effect on the gender wage gap in workplaces where most of the non-managerial employees are subject to performance-related pay. This is apparent from the positive and statistically significant triple interaction between being female, the share of female managers and performance pay. We also include a triple interaction with female share of non-managers as well as all the double interactions and simple controls in order to interpret these coefficients correctly. The size of the coefficient is very similar in the OLS and workplace fixed effects models (columns 1 and 2 respectively), indicating that the effect is not confounded by

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<sup>25</sup> The F-statistics for the instruments are both above 20 (Appendix Table A5) so the instruments are not weak. It is possible that measurement error is biasing the OLS estimates downwards. To check for measurement error we first remove the 38 workplaces where the respondent reported firm-level rather than workplace-level figures for the female shares. These account for 502 employee observations. When removing those observations both OLS and IV results remain almost the same (the OLS estimate for share of female managers drops by 0.8 percent from 0.114 to 0.113, and the IV estimates reduces by 1.9 percent from 0.309 to 0.303 and remains statistically significant at the 1% level). We also removed smaller workplaces with less than twenty employees since small miscalculations in the number of female managers or non-managers could translate into large errors in the construction of the female share variables. The OLS estimate for share of female managers drops by 28.1 percent from to (0.114 to 0.082) and the respective IV estimate increases by 15.5 percent from (0.309 to 0.357). Measurement error does not therefore appear to be an issue.

unobserved fixed workplace traits.<sup>26</sup> The finding is consistent with the sort of statistical discrimination which Flabbi *et al.* (2019) point to in their study of female leadership in Italian manufacturing.

[INSERT TABLE 4 AND FIGURE 3]

The implications of the OLS model for the gender wage gap are presented in Figure 3. Panel A shows how men's and women's wages vary as the share of female managers rises among those employees in workplaces where fixed rates of pay predominate, while Panel B presents the same information for those in workplaces with extensive performance-related pay. Among those working in fixed pay regimes, men's wages fall with a rising share of female managers, while women's wages rise such that the gender wage gap is no longer statistically significant when 90 percent of managers are female. Among employees working in performance-pay regimes, the gender wage gap is considerable in the presence of a high share of male managers. However, the decline in men's wages and the rise in women's wages with the share of female employees is particularly pronounced, such that the gender wage gap is no longer statistically significant once 60 percent of managers in the workplace are women. Strikingly, the female wage profile is above the male wage profile for those paid for individual performance when the share of female managers exceeds 80 percent; the differences between the wage profiles are not statistically significant at this point, however. This evidence is consistent with female managers using their discretion to

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<sup>26</sup> Since we have no credible way to instrument for performance pay in addition to the share of female managers and share of female non-managers, performance pay is treated as if it were exogenous. In a previous study using WERS Manning and Saidi (2010) concluded that the presence of a performance-pay system at the workplace made little difference to the size of the gender wage gap. However, they did not consider within-workplace variance in individual employees' exposure to performance-related pay, nor its interaction with the share of female managers at the workplace.

reward individual performance in a way that is more equitable for women.<sup>27</sup> Alternatively female managers, as per their male counterparts, may favour employees of the same sex when choosing who to reward and by how much.

## 5. CONCLUSION

Using matched employer-employee data for Britain in 2004 and 2011 we estimate a raw gender wage gap of around 0.19 log points which falls to around 0.11 log points controlling for individual and workplace characteristics. However, the gender wage gap declines substantially with the increasing share of female managers in the workplace. The gap closes because women's wages rise with the share of female managers in the workplace while men's wages fall. Instrumental variables estimates suggest the share of female managers in the workplace has a causal impact in reducing the gender wage gap. The role of female managers in closing the gender wage gap is more pronounced when employees are paid for performance, consistent with the proposition that women are more likely to be paid equitably when managers have discretion in the way they reward performance and those managers are women. These findings suggest a stronger presence of women in managerial positions can help tackle the gender wage gap.

Although our estimates are consistent with the proposition that the share of female managers may have a causal impact on the gender wage gap we are unable to discount potential bias arising from unobserved individual ability. However, our findings are consistent with earlier studies indicating women in managerial positions can close the gender wage gap by facilitating women's career progression and by tackling discriminatory practices.

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<sup>27</sup> It is also possible that women exert greater effort if they feel those efforts are more likely to be rewarded more fairly when female managers determine performance-related rewards.



It is notable that much of the decline in the gender wage gap with the increase in the share of female managers arises due to a worsening in men's positions, not only in relative but also in absolute terms. This is worthy of further investigation but may be due to a reallocation of limited resources from men to women when the share of female managers rises.

From a policy perspective, it seems having more women in decision-making positions (managers and supervisors) has a causal impact in reducing the gender wage gap. Raising female board-level representation via quotas has not improved the lot of women lower down the corporate hierarchy (Bertrand *et al.* 2019), but there may be value intervening at workplace-level nevertheless for two reasons. First, 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). Second, there are means other than quotas to encourage greater female representation at managerial level.

Studies show that transparency requirements, under which firms are required to report their mean gender wage gap, have changed corporate behaviour (Bennedsen *et al.* 2018 for Denmark and Vaccaro 2017 for Switzerland) perhaps because firms fear the reputational damage associated with doing the wrong thing. Gender wage gap reporting regulations were introduced in the UK in 2017 under the umbrella of the Equality Act, covering all businesses with 250 or more employees, but do not require businesses to report the gender composition of managerial positions. At the same time, transparency over female representation at board level appears to have done much to improve the gender balance at the very top of listed companies in the UK (FTSE Women Leaders 2019). If

the broader set of firms covered by the gender wage gap reporting regulations were required to report the percent female in managerial roles – in addition to pay information currently required – this might encourage greater employment of women managers, thereby providing further impetus to efforts to close the pay gap between men and women within the workplace.

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Table 1: Baseline Estimates

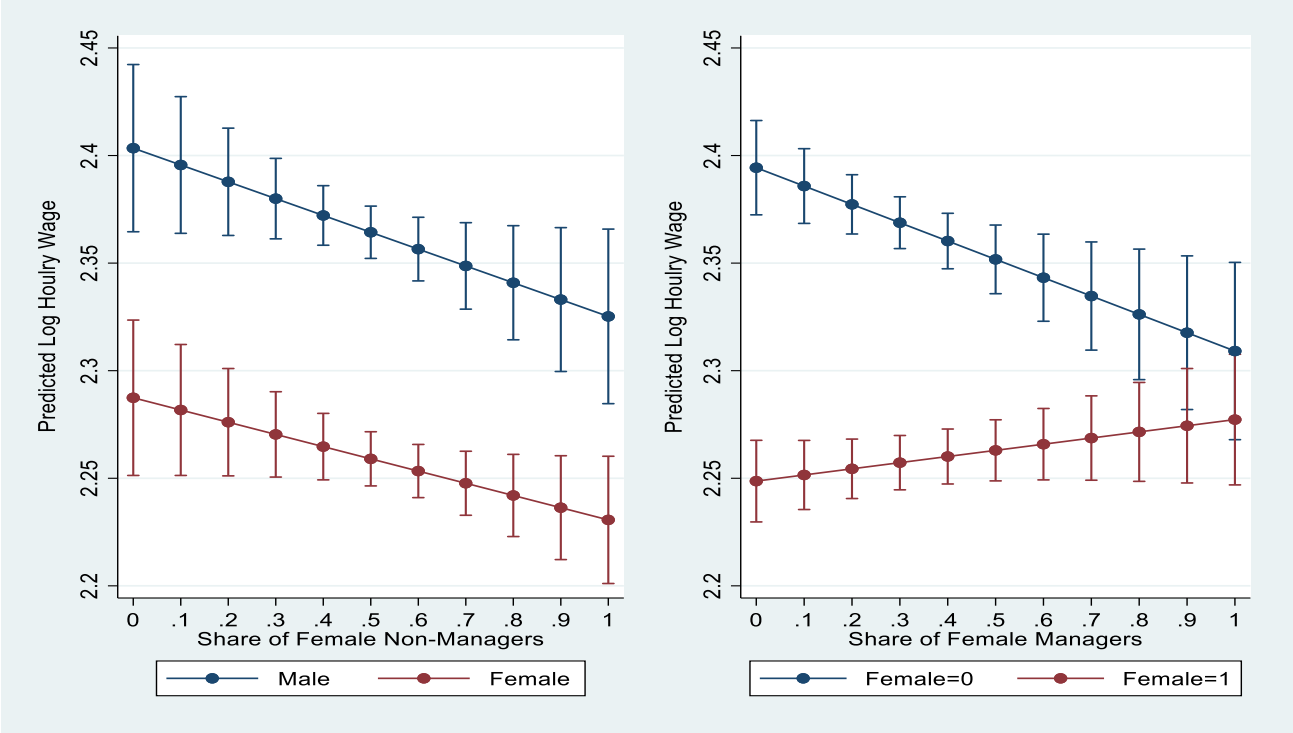
	(1) OLS	(2) Interval regression	(3) OLS Workplace FE
Female	-0.156*** (0.021)	-0.153*** (0.021)	-0.138*** (0.023)
Female Share Managers	-0.085***	-0.092***	

	(0.029)	(0.030)	
Female Share Managers*Female	0.114***	0.110***	0.137***
	(0.033)	(0.033)	(0.036)
Female Share Non-Managers	-0.078**	-0.100**	
	(0.039)	(0.039)	
Female Share Non-Managers*Female	0.021	0.010	-0.031
	(0.040)	(0.039)	(0.043)
Constant	1.708***	1.591***	1.861***
	(0.072)	(0.073)	(0.046)
Observations	39966	39966	39966
Adjusted R <sup>2</sup>	0.452		0.502
Log pseudolikelihood		-359.415	

Notes. The dependent variable in columns 1 and 3 is the log hourly wage. In column 2, the dependent variables are a lower and an upper log hourly wage bound respectively. For reasons of brevity we report the estimates for the variables on interest only (results on all controls for column 1 are reported in Table A3). The rest of the controls are: age, age squared/100, married or living with a partner, having dependent children in the age group 0-18, having a disability (long term illness or health problem that affects the amount or type of one can do), member of an ethnic minority group, seven educational qualification dummies (omitted category: no academic qualification), a vocational qualification, tenure, tenure squared/100, being a current union member, having a permanent or a temporary job (omitted category, fixed period job with an agreed end date), 25 occupational dummies, log size of the workplace (number of employees), if the workplace is one of a number of different workplaces in the UK belonging to the same organisation, or is a single independent workplace not belonging to another body (omitted category: sole UK workplace of a foreign organisation), private sector workplace, foreign-owned workplace, the share of employees who are trade union members, the share of employees who are aged 50 or over, the share of employees aged 18-21, the shares of eight occupational groups (omitted category: share of routine/unskilled occupations), 34 industry dummies, 9 region dummies, and dummies for variables with missing observations: share female managers, share female non-managers, share of employees who are trade union members, the share of employees in the age group 50 plus, and the share of employees in the age group 18-21. We have replaced missing observations for those variables with their mean values. Standard errors are in parentheses and are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . The sum of the female share of managers coefficient and of the female share managers\*female coefficient is significantly different from zero at the 10% level (coef=0.029, p.val=0.064).

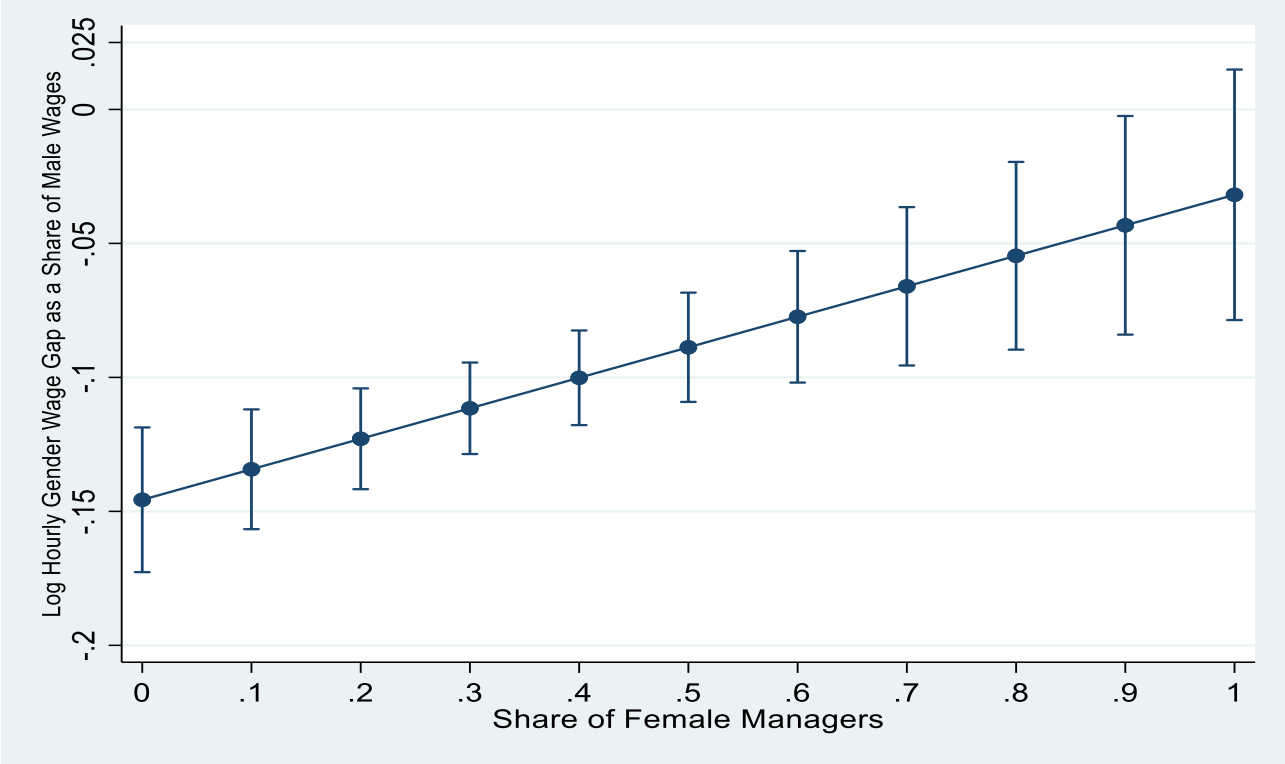
Figure 1: The Impact of Share Female Managers and Non-Managers on the Gender Wage Gap





Notes. Both panels show the marginal effects of the share of female managers and of non-managers on male and female wage profiles as obtained from Table 1, column 1. The vertical lines are the 95 percent confidence intervals.

Figure 2: Share Female Managers and the Decline in the Gender Wage Gap



Notes. This figure shows the closing of the gender wage gap as the share of female managers increases. The estimates are obtained from Table 1, column 1.

Table 2: Change in Gender Wage Gap: Workplace Panel (First-Difference) Analysis

	(1) $\Delta(\overline{W_M} - \overline{W_F})_{jt}$	(2) $\Delta(\overline{W_M} - \overline{W_F})_{jt}$
Female Share Managers	-0.398*** (0.132)	-0.178* (0.107)
Female Share Non-Managers	0.399 (0.244)	0.131 (0.165)
Constant	-0.668 (1.365)	0.771 (0.807)
Observations	963	963
Adjusted $R^2$	0.294	0.589

Notes. The dependent variable is the raw gender wage gap (male wage minus female wage) as obtained from the individual level questionnaires. We then merge the raw gender wage to the panel data using the individual workplace identifier. The workplace control variables are those as outlined in the Notes of Table 1. In column 1 we also include all the individual level controls as outlined in the Notes of Table 1 but averaged at the workplace level. In column 2 we replace the individual level averaged workplace controls with separate male and female individual averaged workplace controls. For reasons of brevity we report only the coefficients for the variables of interest. Estimates for the other controls are available upon request. Standard errors are in parentheses and are clustered at the workplace level. Estimates are weighted using workplace level panel weights that account for workplaces that did not provide employee level data in one or in both survey years. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 3: Instrumental Variables estimates

	(1) All employees	(2) All employees except Managers (SOC1)
Female	-0.125*** (0.022)	-0.117*** (0.022)
Female Share Managers	-0.323* (0.167)	-0.302 (0.185)
Female Share Managers*Female	0.309*** (0.095)	0.366*** (0.097)
Female Share Non-Managers	0.054 (0.183)	-0.002 (0.206)
Female Share Non-Managers*Female	-0.197** (0.084)	-0.245*** (0.086)
Observations	39966	36381
Adjusted $R^2$	0.452	0.431

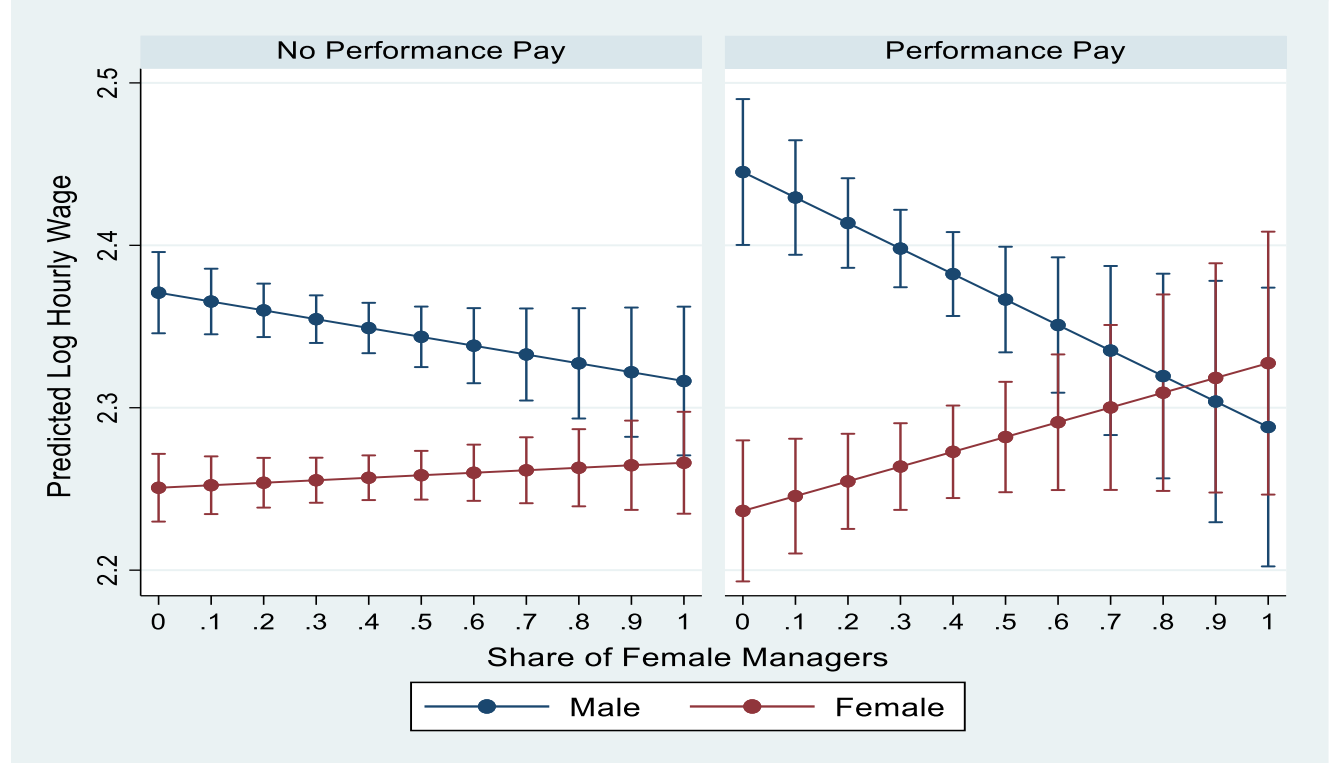
Notes. For reasons of brevity we report only the coefficients for the variables of interest (a full set of coefficients is available on request). All controls are the same as outlined in the Notes of Table 1. Standard errors in parentheses are clustered at the workplace level. The first stage results for the instruments are reported in Table A5. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 4: Performance Pay Results

VARIABLES	(1) OLS	(2) OLS Workplace FE
Female	-0.132*** (0.021)	-0.105*** (0.024)
Female Share Managers	-0.054* (0.032)	
Female Share Managers * Female	0.070* (0.036)	0.097** (0.039)
Performance Pay	0.104*** (0.028)	
Female * Performance Pay	-0.063 (0.046)	-0.108** (0.054)
Performance Pay * Female Share Managers	-0.103 (0.068)	
Female * Performance Pay * Female Share Managers	0.178** (0.082)	0.165* (0.091)
Female Share Non-Managers	-0.061 (0.039)	
Female Share Non-Managers*Female	0.024 (0.040)	-0.047 (0.044)
Performance Pay * Female Share Non-Managers	-0.060 (0.072)	
Female * Performance Pay * Female Share Non-Managers	-0.051 (0.098)	0.045 (0.114)
Constant	1.684*** (0.072)	1.860*** (0.089)
Observations	39966	39966
Adjusted $R^2$	0.453	0.502

Notes. Performance pay is a dummy variable taking the value of 1 if the respondent manager said that 60% or more of the non-managerial employees at this workplace are paid under performance pay, 0 otherwise. About one quarter of the workplaces offered such schemes that covered one third of the employees. For reasons of brevity we report only the coefficients for the variables of interest. All the other controls are the same as outlined in the Notes of Table 1 and their estimates are available upon request. Standard errors in parentheses and are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Figure 3: The Impact of Share Female Managers and of Performance Pay on the Gender Wage Gap



Notes. Both panels show the marginal effects of the share of female managers and of non-managers on male and female wage profiles as obtained in Table 4, column 1. The vertical lines are the 95 percent confidence intervals.

## APPENDIX

Table A1: Descriptive Statistics

Variable	Females		Males	
	Mean	St. dev.	Mean	St. dev.
Log hourly wage	2.223	0.610	2.415	0.651
Share female managers	0.472	0.306	0.243	0.239
Share female non-managers	0.652	0.306	0.361	0.248
Age	40.301	12.117	41.341	12.112
Age sq/100	17.710	9.829	18.558	10.097
Married/cohabiting	0.660	0.474	0.689	0.463
Dependent children	0.341	0.474	0.387	0.487
Disability/health problem	0.103	0.304	0.105	0.307
Ethnic minority	0.072	0.259	0.079	0.270
GCSE grades D-G/CSE gr. 2-5	0.245	0.430	0.273	0.445
GCSE grades A-C, GCE 'O'-level	0.598	0.490	0.530	0.499
1 GCE 'A'-levels grades A-E	0.113	0.316	0.103	0.304
2 or more GCE 'A'-levels grades A-E	0.252	0.434	0.249	0.432
First degree (BSC, BA, Bed, HND)	0.259	0.438	0.287	0.452
Higher degree (MSc, MA, MBA, PhD)	0.078	0.268	0.090	0.287
Other academic qualification	0.258	0.437	0.234	0.423
Vocational/professional qualification	0.572	0.495	0.563	0.496
Tenure	5.226	3.556	5.516	3.596
Tenure sq/100	0.400	0.396	0.434	0.404
Union member	0.316	0.465	0.327	0.469
Permanent job	0.921	0.270	0.930	0.256
Temporary job	0.041	0.198	0.037	0.188
Manager and senior administrator	0.092	0.290	0.156	0.363
Professional	0.111	0.314	0.134	0.341
Associate professional and technical	0.168	0.374	0.147	0.354
Clerical and secretarial	0.246	0.431	0.080	0.271
Craft and skilled service	0.011	0.106	0.116	0.320
Personal and protective service	0.124	0.330	0.028	0.166
Sales	0.103	0.305	0.038	0.191
Operative and assembly	0.023	0.149	0.133	0.340
Log number of employees	4.882	1.681	5.087	1.575
Part of a larger organisation	0.773	0.419	0.759	0.428
Single independent workplace	0.208	0.406	0.210	0.407
Private sector workplace	0.663	0.473	0.803	0.398
Foreign workplace	0.101	0.301	0.180	0.384
Trade union density	0.247	0.279	0.273	0.308
Performance pay	0.246	0.431	0.306	0.461
Share of employees aged 50+	0.232	0.145	0.233	0.140

*Continued*

*Continued*

	Females		Males	
	Mean	St. dev.	Mean	St. dev.
Share of employees aged 18-21	0.062	0.098	0.047	0.079
Share managers/senior administrators	0.096	0.104	0.103	0.102
Share professional staff	0.167	0.222	0.128	0.210
Share technical staff	0.112	0.188	0.111	0.187
Share sales staff	0.140	0.282	0.099	0.216
Share operative staff	0.041	0.147	0.144	0.260
Share clerical staff	0.179	0.225	0.139	0.185
Share craft staff	0.033	0.099	0.100	0.186
Share personal service staff	0.117	0.243	0.028	0.119
Manufacturing	0.077	0.266	0.226	0.418
Utilities (electricity, water, gas)	0.002	0.049	0.005	0.073
Construction	0.013	0.114	0.059	0.236
Wholesale	0.137	0.344	0.122	0.328
Hotels and restaurants	0.042	0.202	0.035	0.183
Transportation and communication	0.037	0.188	0.112	0.315
Financial sector	0.060	0.237	0.054	0.226
Other businesses	0.143	0.350	0.172	0.377
Public administration	0.077	0.266	0.064	0.246
Education	0.159	0.366	0.059	0.236
Health	0.216	0.412	0.055	0.228
North	0.049	0.216	0.058	0.234
North West	0.129	0.336	0.131	0.338
East Midlands	0.068	0.252	0.075	0.264
West Midlands	0.087	0.281	0.078	0.269
East Anglia	0.038	0.191	0.042	0.201
South East	0.311	0.463	0.308	0.462
South West	0.082	0.274	0.079	0.269
Wales	0.042	0.200	0.036	0.186
Scotland	0.104	0.305	0.107	0.309
Instrumental variable: Household consumption expenditure as share of final demand in the industry sector	0.594	0.003	0.382	0.003
Instrumental variable: National male-female difference in promotion rates to managerial positions for employees in the workplace's largest occupation	0.004	0.000	0.004	0.000
Observations (employees)	21624		18342	
Observations (workplaces)	3019		2900	

Notes. Estimates are weighted using individual level weights.

Table A2: The Raw and Regression Adjusted Gender Wage Gap

VARIABLES	(1) 2004 Raw	(2) 2004 Adjusted	(3) 2011 Raw	(4) 2011 Adjusted	(5) Pooled Raw	(6) Pooled Adjusted
Female	-0.206*** (0.014)	-0.129*** (0.010)	-0.182*** (0.019)	-0.096*** (0.014)	-0.194*** (0.012)	-0.113*** (0.009)
Constant	2.291*** (0.015)	1.513*** (0.086)	2.545*** (0.021)	1.597*** (0.108)	2.551*** (0.019)	1.656*** (0.069)
Observations	20,697	20,697	19,269	19,269	39,966	39,966
R-squared	0.030	0.442	0.019	0.426	0.066	0.452
Adjusted $R^2$	0.030	0.439	0.019	0.423	0.066	0.451

Notes. For reasons of brevity we report only the coefficients for the female dummy variable. All the other controls are the same as outlined in the Notes of Table 1 and their estimates are available upon request. Standard errors in parentheses are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table A3. Full Estimates as in Table 1, Column 1

VARIABLES	(1) Full Estimates
Female	-0.156*** (0.021)
Female Share Managers	-0.085*** (0.029)
Female Share Managers*Female	0.114*** (0.033)
Female Share Non-Managers	-0.078** (0.039)
Female Share Non-Managers*Female	0.021 (0.040)
Age	0.024*** (0.002)
Age sq/100	-0.025*** (0.003)
Married/cohabiting	0.040*** (0.007)
Dependent children	0.020*** (0.007)
Disability/ health problem	-0.038*** (0.009)
Ethnic minority	-0.059*** (0.014)
GCSE grades D-G/cse gr.2-5	-0.007 (0.008)
GCSE grades A-C, GCE 'O'-level	0.038*** (0.008)
1 GCE 'A'-levels grades A-E	0.025** (0.011)
2 or more CSE 'A' levels grades A-E	0.077*** (0.010)
First degree (BSc, BA, Bed, HND)	0.106*** (0.009)
Higher degree (MSc, MA, MBA, PhD)	0.107*** (0.015)
Other academic qualification	0.030*** (0.008)
Vocational/professional qualification	0.043*** (0.007)
Tenure	0.007 (0.004)
Tenure sq/100	0.058 (0.040)
Union member	0.028*** (0.008)
Permanent job	0.100*** (0.018)
Temporary job	0.132*** (0.025)
Log number of employees	0.027*** (0.003)
Part of a larger organisation	-0.121*** (0.036)
Single independent workplace	-0.146*** (0.037)
Private sector workplace	0.020 (0.013)
Foreign workplace	0.048*** (0.015)

*Continued*



*Continued*

	Full Estimates
North	0.016 (0.020)
North West	-0.004 (0.017)
East Midlands	-0.018 (0.019)
West Midlands	-0.001 (0.017)
East Anglia	-0.012 (0.024)
South East	0.119*** (0.014)
South West	-0.025 (0.018)
Wales	-0.030 (0.019)
Scotland	0.032* (0.017)
Trade union density	0.057*** (0.019)
Share of employees aged 50+	-0.101*** (0.033)
Share of employees aged 18-21	-0.248*** (0.054)
Share managers/senior administrators	0.628*** (0.056)
Share Professional staff	0.361*** (0.032)
Share technical staff	0.340*** (0.034)
Share sales staff	0.062* (0.032)
Share operative staff	0.059* (0.031)
Share clerical staff	0.196*** (0.033)
Share craft staff	0.110*** (0.041)
Share personal service staff	0.142*** (0.033)
dummy for missing union density	0.001 (0.012)
dummy for missing age 50 and over	0.043 (0.041)
dummy for missing age 18 to 21	-0.052 (0.042)
Constant	1.708*** (0.072)
Observations	39,966
R-squared	0.454
Adjusted R <sup>2</sup>	0.452

Notes. Other controls that we do not report their coefficients due to space constraints are 25 occupation and 34 industry dummies, both constructed at the 2-digit level. Standard errors in parentheses are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table A4: Sensitivity Checks

	(1) Without SOC1 (i.e. exclude managers)	(2) Share Female Managers & Share Female Professionals	(3) % Female Supervisors	(4) % Female Supervisors and % Female Managers	(5) Fully Interacted Linear Model	(6) Parsimonious controls
Female	-0.156*** (0.020)	-0.145*** (0.021)	-0.162*** (0.014)	-0.176*** (0.015)	0.547*** (0.135)	-0.145*** (0.021)
Female Share Managers	-0.073** (0.031)			-0.073** (0.029)	-0.064** (0.029)	-0.130*** (0.032)
Female Share Managers*Female	0.106*** (0.035)			0.079** (0.032)	0.081** (0.032)	0.161*** (0.036)
Female Share Non-Managers	-0.093** (0.041)				-0.077* (0.042)	-0.017 (0.042)
Female Share Non-Managers*Female	0.034 (0.040)				0.022 (0.052)	-0.097** (0.042)
Female Share Managers & Professionals		-0.118*** (0.029)				
Female Share Managers & Professionals * Female		0.170*** (0.033)				
Female Share Non-Managers & Non- Professionals		-0.011 (0.036)				
Female Share Non-Managers & Non- Professionals*Female		-0.053 (0.038)				
Female Share Supervisors			-0.101*** (0.022)	-0.078*** (0.023)		
Female Share Supervisors*Female			0.121*** (0.025)	0.091*** (0.028)		
Constant	1.741*** (0.080)	1.694*** (0.070)	1.693*** (0.069)	1.694*** (0.070)	1.345*** (0.099)	1.085*** (0.070)
Observations	36381	39966	39966	39966	39,966	39,966
Adjusted $R^2$	0.431	0.452	0.452	0.452	0.458	0.387

Notes. For reasons of brevity we report only the coefficients for the variables of interest. All the other controls are the same as outlined in the Notes of Table 1 and their estimates are available upon request. Column 1 presents the female share interactions from a fully interacted linear model. Note the positive and statistically significant main effect for the female dummy is not easily interpretable since it captures the correlation between being female and log hourly wages when all other right-hand side variables are set to zero. Column 2 removes the following controls: having dependent children in the age group 0-18, having a permanent or a temporary job and the occupation dummies at the two-digit level. Column 3 returns to the Column 1 specification but drops managers from the sample. Column 4 expands our definition of managers to include employees in SOC(2000) Major Group 2 (Professionals), since over two-fifths of employees in this group hold supervisory responsibilities. Column 5 controls for share female supervisors and its interaction with the female dummy and does not control for share female managers and share female non-managers and their respective interactions with the female dummy. Column 5 includes share female supervisors and share female managers and their interactions with the female dummy. Standard errors are in parentheses and are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table A5: First-Stage Regressions for Instrumental Variables Estimates

	(1) Share Female Managers	(2) Share Female Non- Managers
Instrumental variable: Household consumption expenditure as share of final demand in the industry sector	0.330*** (6.361)	0.343*** (7.213)
Instrumental variable: National male-female difference in promotion rates to managerial positions for employees in the workplace's largest occupation	-0.053** (-2.054)	0.002 (0.089)
Observations	3,236	3,236
Adjusted $R^2$	0.336	0.649
F-test of excluded instruments F(2,3235):	22.25	26.27
Prob>F	<0.01	<0.01

Notes. Standardised beta coefficients (t-statistics in parentheses). These regressions are estimated on workplace level data as the dependent variables are workplace level variables. In column 1 the dependent variable is the endogenous share female managers variable. In column 2 the dependent variable is the share female non-managers variable. Workplace control variables are as outlined in the Notes of Table 1. Estimates are weighted using workplace-level weights. Levels of significance: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table A6: National Male-Female Difference in Promotion Rates to Managerial Positions for Employees in Each SOC Major Group

SOC Major Group	Percentage of employees promoted to SOC1: Managers & senior officials		Difference
	Male employees	Female employees	Male-Female
2: Professionals	1.6%	0.8%	0.8%
3: Associate professional and technical	2.9%	2.3%	0.6%
4: Administrative and secretarial	1.9%	1.2%	0.7%
5: Skilled trades	0.4%	0.0%	0.4%
6: Caring, leisure and other personal service	1.2%	0.2%	1.0%
7: Sales and customer service	2.2%	0.9%	1.2%
8: Process, plant and machine operatives	0.3%	0.0%	0.3%
9: Elementary occupations	0.9%	0.6%	0.3%

Notes. Estimates are derived from the Longitudinal Five-Quarter Labour Force Surveys of 2004/5 and 2011/12. Estimates refer to the percentage of employees in each SOC Major Group at Quarter 1 who have been promoted to SOC Major Group 1 (Managers and senior officials) by Quarter 5.

Figure A1: Distribution of Employees by Overall Female Share in their Workplace, By Gender of Employee, (Pooled 2004-2011)

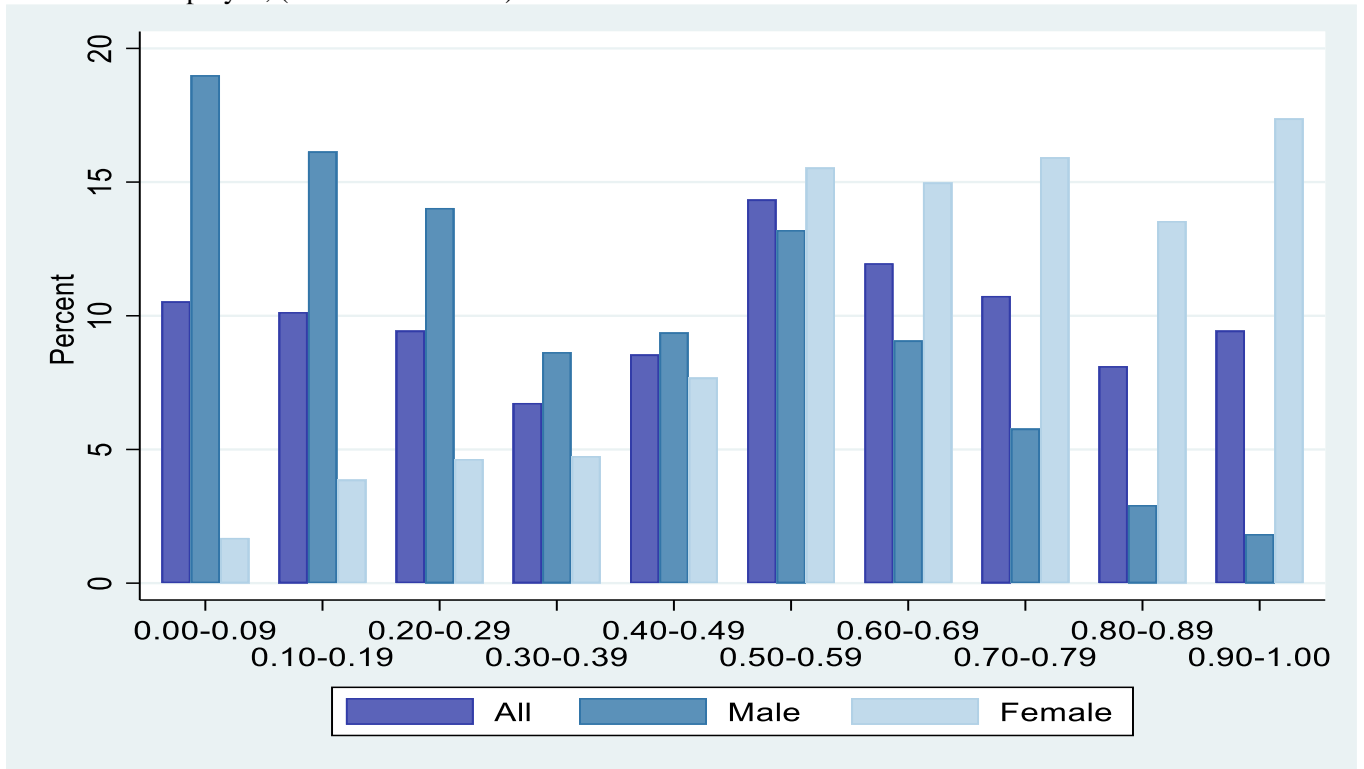


Figure A2: Distribution of Employees by Female Share Among Managers in their Workplace, by Gender of Employee, (Pooled 2004-2011)

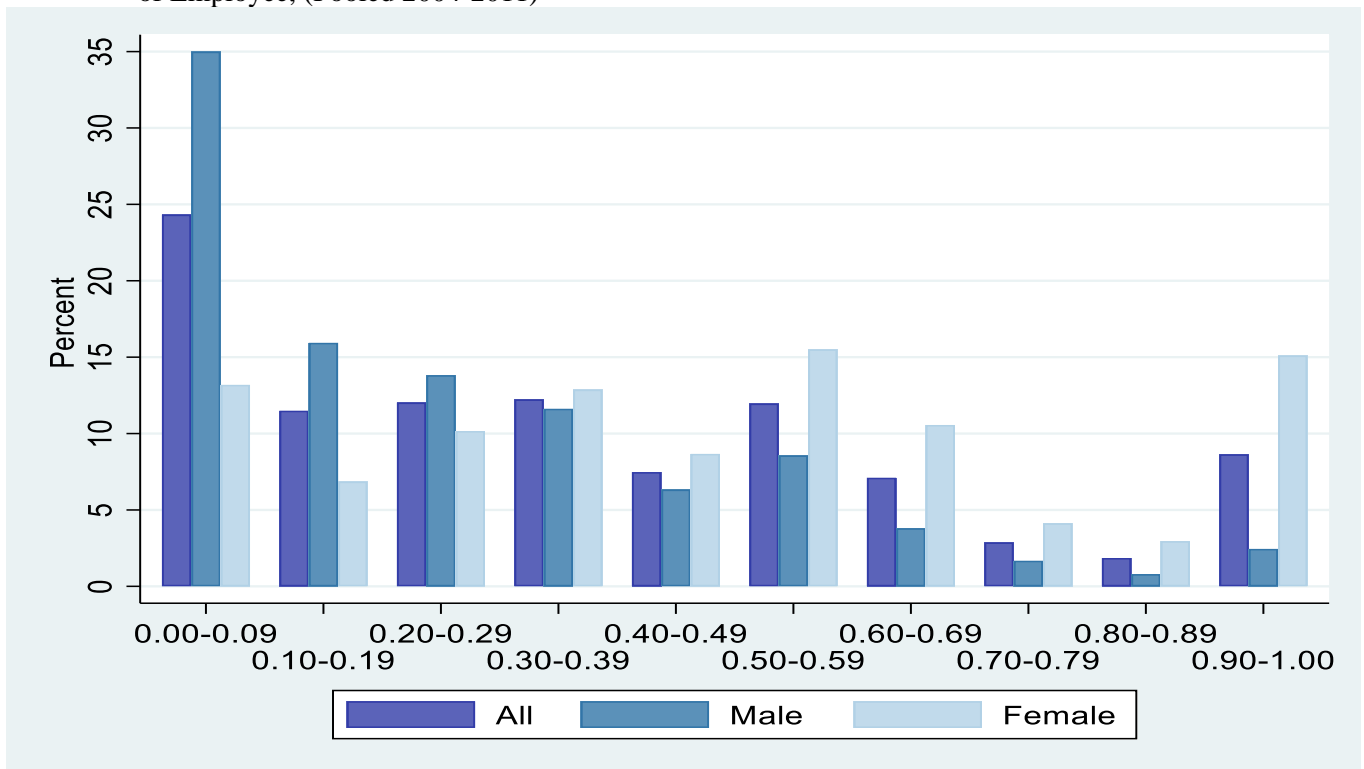


Figure A3: Distribution of Employees by Female Share Among Non-Managers in their Workplace, by Gender of Employee, (Pooled 2004-2011)

