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Are Women Doing It for Themselves? Female Managers and the Gender Wage Gap*

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Abstract

Using linked employer-employee data for Britain, we find a robust association between the share of female managers in the workplace and the size of the gender wage gap. In workplace fixed-effects estimates, the gap is eradicated when more than 60% of workplace managers are women, a scenario that obtains in around one fifth of all workplaces. The association between the share of female managers and the gender wage gap is more pronounced when workplace managers set pay at the workplace, and where employees are paid for performance. These findings are consistent with the proposition that women are more likely to be paid equitably when managers have discretion in the way they set pay or reward performance and those managers are women. They suggest that a stronger presence of women in managerial positions can help tackle the gender wage gap.

I. Introduction

In the last few decades, there has been what Goldin (2014) described as 'a grand gender convergence' in human capital, with women now outperforming men in educational

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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, 2017). 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).

A growing body of work using linked employer-employee data has moved beyond differences in human capital to examine the effects of gender segregation within and across workplaces (Groshen, 1991; Carrington and Troske, 1995; Bayard *et al.*, 2003; Bruns, 2019). These studies find that the gender wage gap differs systematically with the share of females at 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 jobs within a workplace can influence wages and thus the gender wage gap. Our focus in this paper is the role of female managers. If women are well-represented at management level, managerial decision-making may have greater regard to the interests of women, challenging gender-based discrimination within the workplace and introducing policies and practices that enable women to compete on a level playing field. The gender composition of managerial positions may also 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. Furthermore, the gender composition of managers may affect wage bargaining at the workplace. For example, women may be more successful in arguing their case for performance-related pay (PRP) 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 rich (and nationally representative) linked employer-employee data for Britain – taken from the 2004 and 2011 Workplace Employment Relations Surveys (WERS) (Department of Trade and Industry, 2014; Department for Business Innovation and Skills, 2015).

Our first contribution is to use an array of estimation techniques to capture a robust association between the shares of women in managerial positions at the workplace and the size of the gender wage gap. These include cross-sectional specifications which control for workplace fixed effects, and workplace-level panel specifications which additionally control for time-varying workplace observables.

Our second contribution is to examine two key mechanisms by which female managers may influence the size of the gender wage gap, namely through setting pay at the workplace and by presiding over performance-related payments. Our dataset is one of the few in the literature to observe the methods that are used to determine pay at the workplace. We use these data to examine heterogeneity in the impact of the gender composition of management across pay regimes where managers appear to have varied amounts of discretion to determine the pay of individual employees. In doing so, we address a notable gap in the literature, since few existing studies of management composition

and the gender wage gap have been able to examine pay setting mechanisms in any detail.

We find a substantial gender wage gap in Britain in 2004 and 2011. The raw gap in hourly wages is around 0.21 log points. The regression-adjusted gap is marginally lower. However, we show that the size of the gender wage gap is negatively associated with the share of female managers in the workplace. In workplace fixed-effects estimates, the gap is effectively eradicated when more than 60% of workplace managers are women, a scenario that obtains in around one fifth of all workplaces. The gap closes because women's wages are positively associated with the share of female managers, while men's wages are negatively associated with it.

These baseline results are robust to a range of sensitivity analyses including: fully interacted models by gender; tests for coefficient stability; and the removal of managerial employees from the wage estimation – although this last test produces weaker effects. We then show that the association between the share of female managers and the gender wage gap is more pronounced when the workplace managers are responsible for setting pay at the workplace, and where the workplace has a PRP scheme, suggesting women are more likely to be paid equitably when managers have discretion in the way they reward employee performance, and those managers are women. These findings suggest a stronger presence of women in managerial positions can help tackle the gender wage gap by shifting the distribution of rewards in favour of female subordinates.

The remainder of the paper proceeds as follows. Section 2 considers how the gender composition of workplaces may affect the gender wage gap and reviews the relevant literature. Section 3 presents our analysis of the association between the share of female managers and the gender wage gap. Section 4 examines the role of wage setting mechanisms. Section 5 concludes.

II. Gender composition and the gender wage gap

The gender composition of workplaces may affect the wages of men and women through many routes. A higher share of female employees can affect gender norms at the workplace (Akerlof and Kranton, 2010) in ways that benefit women in terms of job opportunities, wage offers and the extent to which job preferences, such as those relating to flexible work schedules are accommodated. 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.

Mumford and Smith (2007, 2009) investigated the role of gender segregation 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 data from the 1998 WERS, they find that around one third of the raw gender wage gap is accounted for by gender

segregation at the workplace level. In their follow-up paper (Mumford and Smith, 2009) using the 2004 WERS, they show that workplace gender segregation contributes to the 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, women are often denied career-enhancing opportunities where men are 'gate-keepers' to those opportunities. Examining data from submissions to three large international conferences in economics, Hospido and Sanz (2021) find that all-female authored papers are significantly less likely to be accepted. They find that this gap is due to male reviewers, it is only true for less well-known female authors, and it is larger in fields dominated by males. 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 as the share female in managerial positions rises. However, some suggest that 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).[1]

Studies examining the effects of increasing female representation at senior levels within companies have tended to focus on those at the very top of the organization. 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.[2] However, other studies suggest that any spillover effects of female board-level representation may not extend beyond the C-suite. Bertrand *et al.* (2019) examined the effect of a law in Norway requiring at least 40% representation of each gender on the board of directors of public limited liability companies. They found 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 in senior positions fell markedly. They did not find robust evidence, however, that the reform reduced the gender wage gap for women employed lower down the hierarchy in these companies. This may be because of

[1] 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 harsher in their sentencing to women than male judges are (Philippe, 2020). However, Egan *et al.* (2022) provide contrary evidence on the treatment of mistakes in a corporate setting; in their study of misconduct by financial advisors, the greater propensity for female advisors to be punished for mistakes dissipates at firms with a greater percentage of female managers and executives.

[2] See also Fortin *et al.* (2017), who find that the under-representation of women among the very highest earners accounts for a substantial share of the aggregate gender wage gap.

board members' limited reach into the individualized discussions that set pay for such employees.[3]

Other studies focusing on a broader set of organizations and managerial positions have found some evidence of positive spillovers. Tate and Yang (2015) find that US 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, Cardoso and Winter-Ebmer (2010) 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, with a female boss reducing the gender wage gap by 1.5%.

Cardoso and Winter-Ebmer (2010: 155) interpret their results in terms of female leaders' ability to 'mentor and protect female co-workers . . . [thus] increas[ing] the latter's promotion chances and thus their expected wage'.[4] Further support for this interpretation comes from De Paola and Scoppa (2015). Using data for promotions to associate and full professors in Italian universities across two academic disciplines (economics and chemistry), they find that female candidates are significantly less likely to get promoted when the committee is entirely composed of males; they find no gender differential in promotions when the composition of the committee is gender balanced. In a similar vein, Kunze and Miller's (2017) study on female representation in corporate leadership in Norway finds that greater female representation among the higher occupational ranks in the workplace narrows the gender gap in promotion rates at lower ranks, a spillover 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 spillover 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).[5]

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.

While a number of these studies highlight various mechanisms through which female managers may affect the gender wage gap, none examined pay setting mechanisms in any detail, despite the importance of pay determination processes in shaping final wage outcomes. Below we identify two scenarios in which workplace managers have a direct impact on wage setting at the workplace, thus providing them with an opportunity to

[3]Maida and Weber (2022) use data from a staggered reform that introduced a gender quota for the members of boards of directors in companies listed with the Italian stock exchange. They find small and imprecisely estimated effects on the share of female managers in the top of the firm-specific earnings distribution.

[4]Compelling evidence regarding the importance of mentoring comes from Ginther *et al.'s* (2020) randomized 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.

[5]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 Vigani (2022).

affect the size of any gender wage gap directly through the pay awards they make. First, we distinguish between workplaces where workplace managers have authority to set pay directly, or through individual negotiation with employees; that is, without collective bargaining with trade unions. We hypothesize that local managers will have less influence on wages in unionized settings but, in the absence of unions, a higher percentage of female managers will reduce any gender wage gap because female decision-makers are less likely than male managers to countenance discriminatory practices that operate to the detriment of women.

Second, we distinguish between workplaces that offer PRP to reward individual performance and those that do not. PRP systems offer managers the opportunity to shape pay outcomes between men and women by restricting access to bonus schemes, assigning employees to more or less lucrative job assignments or by varying rewards between individual employees within the same job.[6]

Some studies have investigated the role of PRP on male and female earnings, typically finding that the returns are very similar. Booth and Frank (1999), for instance, use data from the British Household Panel Survey and find no statistically significant difference in the coefficient on PRP between men and women. Manning and Saidi (2010), using data from the 1998 and 2004 WERS, reach the same conclusion. However, no previous studies, to our knowledge, have investigated the interaction of PRP with the gender composition of decision-makers in the workplace. We hypothesize that, where a workplace has a higher percentage of female managers, those managers may use individual PRP systems to rectify any pay penalties women might face when management roles are dominated by men.

III. Female managers and the gender wage gap

Baseline estimates

We begin by estimating the relationship between female managers and the gender wage gap. To do so, we pool two linked employer-employee data sets for 2004 and 2011 from the British WERS series. WERS is a nationally representative survey of workplaces in Britain with five or more employees, covering all industries except for agriculture, forestry, fishing, mining, and quarrying. At each wave, the employer survey collects data from a face-to-face interview with the human resource manager at the workplace, including data on the composition of the workforce, workplace management practices, and workplace demographic characteristics such as ownership status. Each wave also has a linked survey of employees within participating workplaces, in which data on individual employees' wages, human capital, and other characteristics are collected from questionnaires issued to 25 randomly selected employees in each workplace, or to all employees in workplaces with fewer than 25.[7] While each wave of the survey generates

[6]Illustrations are provided by the legal case of female, local council workers whose successful pay discrimination claim was based on having been excluded from bonus systems offered to employees in male-dominated roles (Pidd, 2010), and the legal case of a female city banker whose successful claim for equal pay was based, in part, on having received bonuses equating to less than 15% of those given to a male comparator (Moss, 2019).
[7]The employer survey response rate in 2004 was 64% (46% in 2011) while the employee survey response rate was 60% (54% in 2011).

a cross-sectionally representative sample of workplaces and their employees, a subset of workplaces from each wave are followed up at the next to form a two-wave, workplace-level panel (the employee observations from these workplaces cannot be linked over time, however).

The survey generates a rich dataset, 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 on the gender composition of each occupational group in the workplace (having asked the employer to categorize the workforce into the nine Major Groups of the UK's *Standard Occupational Classification (2000)*).[8] 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 employee survey, respondents report within 14 bands representing earnings ranging from 'less than £60 per week/£3,120 per year' to '£1,051 or more per week/£54,061 per year'.[9] 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. Our dependent variable is the log hourly wage which is constructed by dividing the mid-point of the weekly earnings interval by the respondent's usual weekly working hours including overtime (a continuous measure).[10] Our baseline specification (results shown in Table 1) is the following:

$$\begin{aligned}\log y_{i(j)} \equiv \log\left(\frac{w_{i(j)}}{h_{i(j)}}\right) = \beta_0 + \beta_1 F_{i(j)} + \beta_2' \sum_{\gamma\in\Gamma} \text{ShFemManag}_j \\ + \beta_3' F_{i(j)} * \sum_{\gamma\in\Gamma} \text{ShFemManag}_j + \beta_4 \text{ShFemNonManag}_j \\ + \beta_5 F_{i(j)} * \text{ShFemNonManag}_j + \beta_6' \boldsymbol{X}_{i(j)} + \beta_7' \boldsymbol{W}_j + \beta_8 \text{Yr}_{2004} + \varepsilon_{i(j)} \qquad (1)\end{aligned}$$

where i indexes individuals and j indexes workplaces. $F_{i(j)}$ is a dummy variable taking the value of 1 if worker i in workplace j is female, 0 otherwise. ShFemManag_j is the share of female managers among all managers in the workplace in deciles where

[8]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 categorization.

[9]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'.

[10]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). They use ASHE to estimate the mean hourly wage of all employees within each hourly wage interval observed in the WERS 2011 dataset. The correlation between this wage measure and the one obtained from the simpler, mid-point approach described in the text is 0.99.

TABLE 1
Baseline estimates

	(1) *OLS without controls*	*(2)* *OLS with controls*	*(3)* *Interval regression*	*(4)* *Fully Interacted*	*(5)* *OLS Workplace FE*
Female	−0.073**	−0.135***	−0.112***	0.242**	−0.181***
	(0.032)	(0.026)	(0.024)	(0.104)	(0.027)
Share female managers: 0%–10.0%	Ref	Ref.	Ref.	Ref.	
Share female managers: 10.1%–20.0%	0.187***	0.066**	0.052**	0.053*	
	(0.044)	(0.032)	(0.025)	(0.032)	
Share female managers: 20.1%–30.0%	0.167**	0.108**	0.065*	0.105**	
	(0.076)	(0.049)	(0.039)	(0.047)	
Share female managers: 30.1%–40.0%	−0.027	−0.031	−0.025	−0.029	
	(0.044)	(0.033)	(0.028)	(0.033)	
Share female managers: 40.1%–50.0%	−0.134**	−0.116***	−0.088***	−0.109***	
	(0.054)	(0.039)	(0.031)	(0.039)	
Share female managers: 50.1%–60.0%	−0.013	−0.110**	−0.072*	−0.108**	
	(0.063)	(0.044)	(0.037)	(0.043)	
Share female managers: 60.1%–70.0%	−0.208***	−0.160***	−0.125***	−0.151***	
	(0.080)	(0.050)	(0.040)	(0.049)	
Share female managers: 70.1%–90%	−0.299***	−0.170***	−0.107*	−0.146**	
	(0.077)	(0.065)	(0.061)	(0.065)	
Share female managers: 90.1%–100%	−0.369***	−0.205***	−0.148***	−0.182***	
	(0.071)	(0.048)	(0.042)	(0.047)	
(Shr. fem. Mngrs.: 10.1%–20.0%)*Female	0.011	0.011	0.018	0.044	0.0001
	(0.049)	(0.039)	(0.033)	(0.038)	(0.040)
(Shr. fem. Mngrs.: 20.1%–30.0%)*Female	0.050	−0.040	−0.017	−0.019	−0.010
	(0.054)	(0.040)	(0.033)	(0.038)	(0.042)
(Shr. fem. Mngrs.: 30.1%–40.0%)*Female	0.147***	0.044	0.036	0.053	0.043
	(0.042)	(0.036)	(0.032)	(0.036)	(0.039)
(Shr. fem. Mngrs.: 40.1%–50.0%)*Female	0.207***	0.086**	0.068**	0.093**	0.100***
	(0.046)	(0.037)	(0.031)	(0.037)	(0.035)
(Shr. fem. Mngrs.: 50.1%–60.0%)*Female	0.279***	0.150***	0.114***	0.169***	0.111**
	(0.063)	(0.047)	(0.040)	(0.046)	(0.046)

(Continued)

TABLE 1
(Continued)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
(Shr. fem. Mngrs.: 60.1%–70.0%)*Female	0.355***	0.170***	0.142***	0.172***	0.167***
	(0.068)	(0.051)	(0.042)	(0.051)	(0.060)
(Shr. fem. Mngrs.: 70.1%–90.0%)*Female	0.439***	0.213***	0.155***	0.198***	0.219***
	(0.074)	(0.061)	(0.058)	(0.064)	(0.045)
(Shr. fem. Mngrs.: 90.1%–100%)*Female	0.319***	0.148***	0.097**	0.125***	0.159***
	(0.064)	(0.046)	(0.041)	(0.046)	(0.045)
Number of observations (employees)	37,401	37,401	37,401	37,401	37,401
Number of workplaces	3,358	3,358	3,358	3,358	3,358
Employee controls	No	Yes	Yes	Yes	Yes
Workplace controls	No	Yes	Yes	Yes	No
Workplace fixed effects	No	No	No	No	Yes
Adjusted R^2	0.094	0.315		0.322	0.454
Log pseudolikelihood			−376.576		

Notes: The dependent variable in columns 1, 2, 4 and 5 is the log hourly wage. In column 3, the dependent variables are a lower and an upper log hourly wage bound respectively. Column 1 includes as regressors the variables displayed, along with the share of female non-managers and its interaction with the female dummy, and a year dummy for survey year 2004. The omitted category of share of female managers is between 0% and 10%. We merge the 70% to 90% of share of female managers categories as the 80% to 90% share of female managers has much fewer observations compared to the other deciles (580 observations). Columns 2–5 add various sets of control variables as indicated at the base of the table: these are listed in the text. For brevity, we report the estimates for the variables of interest only; results for all the controls in column 2 are reported in Table S2. SEs are in parentheses and are clustered at the workplace level. Estimates are weighted using employee-level weights. In column 5 all interaction coefficients between share of female managers and female are jointly statistically significant $F(8,3357) = 4.48$, $P = 0.0000$. Levels of significance: $^{*}P < 0.1$, $^{**}P < 0.05$, $^{***}P < 0.01$.

$\Gamma = \{10.1\%–20\%, 20.1\%–30.0\%, 30.1\%–40\%, 40.1\%–50\%, 50.1\%–60\%, 60.1\%–70.0\%, 70.1\%–90\%, 90.1\%–100\%\}$ and $F_{i(j)} * \text{ShFemManang}_j$ is an interaction term between the female dummy variable and the share of female managers in the workplace. ShFemNonManang_j is the share of female non-managers in the workplace among all non-managers and $F_{i(j)} * \text{ShFemNonManang}_j$ is the associated interaction term with the female dummy variable.[11]

The share of female managers (in deciles) and share of female non-managers are interacted with the gender dummy to identify whether the association between these two variables and wages differ between male and female employees. The parameter on the gender dummy β_1 indicates the gender wage gap in a male-dominated workplace; the vector of parameters on the decile shares of female managers β_2' shows the associations between an increasing share of female managers and male earnings. The vector of parameters of the interaction terms β_3' between share of female managers in deciles and the female dummy shows the associations between an increasing share of female managers and the gender wage gap.

The parameter β_4 shows the association between an increasing share of female non-managers and male earnings. The parameter of the interaction term between share of female non-managers β_5 and the female dummy shows the association between an increasing share of female non-managers and the gender wage gap.

$\boldsymbol{X}_{i(j)}$ is a vector of observed individual covariates, $\boldsymbol{W}_j$ 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 Ordinary Least Squares (OLS), but for robustness of the functional form we also report some results from an interval regression model (Stewart, 1983).

The vector $\boldsymbol{X}_{i(j)}$ includes the following controls: seven employee age-group dummies (omitted category: less than 20 years old); 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; and seven educational qualification dummies (omitted category: no academic qualification).

The vector $\boldsymbol{W}_j$ includes the following controls: seven workplace employment-size dummies (omitted category: 5–9 employees); if the workplace is one of a number of different workplaces in the UK belonging to the same organization or is a single independent workplace not belonging to another body (omitted category: sole UK workplace of a foreign organization); and nine dummies identifying the geographic location of the workplace (omitted category: Yorkshire and Humberside).

The average employee works in a workplace where 49% of employees are female. 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. The mean share of female managers at the workplace is 36%, while the mean share of female non-managers is 50%. Approximately

[11]The share of female non-managers is entered as a linear term. When entered categorically (as deciles or as quartiles), the pattern of the coefficients of the interaction terms between the share of female managers and the female dummy is very similar and the model fit is only marginally improved (results upon request). However, in these two specifications the models experience multi-collinearity. Thus, the linear term is preferred.

30% of employees work in workplaces where the majority (>50%) of managers are women. Such workplaces are found in all sectors of the economy but are most likely to be found in the Education and Health sectors, where more than half of all employees work in an establishment where the majority of managers are women.

We keep employees for whom we observe information on wages and usual, weekly working hours. We drop observations with missing information on other individual and workplace-level variables entering the analysis. Our final sample consists of 37,401 workers clustered in 3,358 workplaces across the private and public sectors.[12]

Our analyses use employee-level weights provided with the survey data to correct for sample selection probabilities at both levels (workplace-level and employee-level) and any observable non-response bias (Forth and Freeth, 2014), thereby ensuring that our results are representative of all employees in the survey population. 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 Table S1.

With these data we replicate the cross-sectional estimates of the gender wage gap that dominate the literature and estimate the association between the gender wage gap and the share of female managers at the workplace. The raw gender wage gap was 0.213 log points in 2004 and 0.216 log points in 2011. The adjusted gender wage gap controlling for employee and workplace characteristics falls to 0.202 log points in 2004 and to 0.186 log points in 2011 (Table A1). The female dummy is highly statistically significant throughout and the models with employee and workplace controls account for over one-quarter of the variance in log hourly pay. Since the coefficients are not markedly different in the two years, we pool the employee data for 2004 and 2011 in our subsequent analyses. The raw gender wage gap in the pooled data is 0.214 log points, with the adjusted gap falling to 0.195 log points or 21.5% (columns 5 and 6 of Table A1).

Our focus is on how this gender wage gap varies with the share of female managers in the workplace. Baseline OLS estimates of this effect are presented in Table 1.[13] As noted earlier, we adopt a flexible specification using indicators for each decile of the share of female managers. The first column of Table 1 reports a specification with no controls; wages vary substantially as a result of the interaction of employee gender and share of female managers. Column 2 adds the employee and workplace controls discussed above. The coefficients on the variables of interest reduce in magnitude by around half, but a strong association remains between managerial gender and wages. Men's wages are negatively associated with the share of female managers. In contrast, women's wages are positively associated with the share of female managers.

The coefficients on the interaction terms indicate that the gender wage gap is reduced to a statistically significant extent when at least 40% of managers at the workplace are

[12]The pooled sample of employees from the 2004 and 2011 WERS comprises a total of 44,432 employees clustered in 3,656 workplaces. We lose around 2,500 employee observations due to missing information from the employer on the share of female managers, around 2,500 observations due to missing information from the employee on earnings or hours worked, and around 1,600 observations due to missing data from the employer or employee on our control variables.

[13]Table S2 in reports coefficients from the full model. The pattern of coefficients across the control variables are in line with expectations: wages rise through to middle-age and then fall close to retirement; wages are lower for those with disabilities/health problems and for those from ethnic minority groups; wages are higher for those with better educational qualifications, higher in larger workplaces and highest in the South East.

women ($\beta'_{3(40.1\%-50.0\%)} = 0.086$; SE = 0.037) and, indeed, the size of the gender wage gap is no longer statistically significant from zero at that point ($\beta_1 + \beta'_{3(40.1\%-50.0\%)} = -0.049$; SE = 0.040). Results are similar using interval regression to account for the banded wages data (column 3), with the gender wage penalty from male management again ceasing to be statistically significant once at least 40% of managers are women.

We conduct two basic robustness checks on our model specification. First, we interact the female dummy with all the other control variables in the model (a fully interacted model) to establish whether the coefficients on the interaction between share of female managers and being female are affected by any misspecification that might arise from estimating average coefficients across genders for our various control variables. The interaction coefficients from this fully interacted model – shown in Table 1 column 4 – are similar in magnitude to those in our baseline specification (column 2).

Second, we undertake a multiple imputation estimation in which we impute missing values on the control variables, raising the estimation sample from 37,401 employees to 44,432 employees. This specification – shown in Table S3 – yields results that are very close to those reported in our baseline specification.

Expanding the set of observables

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 not accounted for, this would lead to a potential upward bias in the interaction between the female dummy and the share of female managers in our wage models.

Our baseline specification is deliberately parsimonious and excludes variables which might be jointly determined with individuals' potential earnings. However, we estimate alternative specifications which expand the set of workplace controls. We omit the presentation of most of these specifications from the main body of the paper for reasons of brevity, but the results are shown in Table S4.

Column 1 in Table S4 replicates column 1 of Table 1 for convenience. Column 2 adds 11 industry dummies that identify the industry sector in which the workplace operates (Section level of the UK's *Standard Industrial Classification (2007)*) and whether the workplace belongs to the private or public sector. These are intended to control for interindustry wage differentials and private/public sector pay differentials (Murphy *et al.*, 2020) which may be correlated with the gender composition of employment (and particularly the gender composition of management) (see Gannon *et al.*, 2007; Murphy *et al.*, 2020).

Column 3 identifies various elements of workplace culture: we include dummies for whether the workplace has an equal opportunities policy, whether it operates a variety of flexible working arrangements (seven dummies identifying provision for working at home, reduced working hours, job sharing, flexitime, changes to shift patterns and compressed hours and term-time only working), and whether it has provision to assist with caring responsibilities (eight dummies identifying the provision of extra-statutory maternity and paternity pay, paid parental leave, paid leave for elder-care, paid emergency

leave, workplace nursery, and financial help with childcare and eldercare). These variables identify workplace amenities for which women may be willing to pay a compensating wage differential. Mas and Pallais (2017), for example, find that women are more likely to select flexible work arrangements than men, and place a higher value on working from home and avoiding irregular work schedules.

The third and final set of variables added in Column 4 of Table S4 identifies the country of origin of the workplace's parent organization (27 country dummies). These are intended to control for country-level variation in gender role attitudes, which may have implications for male/female wage differentials and the structure of the workforce due to both the transmission of workplace culture and the expatriation of employees from the headquarters. Fortin (2005) documents considerable national variation in women's employment, which she links to differences in attitudes to men's and women's roles in society.

We add these three sets of additional controls to our baseline specification in a sequential manner. Each additional set of controls is jointly statistically significant, but their inclusion does not have a substantive impact on the main coefficients of interest. The coefficients on the interaction terms between the share of female managers in each decile and being female as shown in column 1 remain of similar magnitude and are estimated with a similar degree of precision.

Returning to Table 1, in column 5 we estimate a workplace fixed-effects model which accounts 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. The coefficients now indicate how the within-workplace difference between men's and women's wages varies according to the share of female managers.[14] The workplace-level covariates are absorbed by the fixed effects, but the interactions between the share of female managers and the female dummy variable remain of similar magnitude to our baseline OLS specification. As in the baseline specification, the interacted coefficients become statistically significant from zero once more than 40% of managers are female ($\beta'_{3(40.1\%-50.0\%)} = 0.100$; SE $= 0.035$). In this workplace fixed-effects specification, the gender wage penalty becomes statistically non-significant once the share of female managers exceeds 50% (see Figure 1). The gender wage gap is effectively eradicated once the share of female managers exceeds 60%; the share of female managers exceeds this level in around one fifth (20%) of all workplaces.

In the OLS specification, the gender wage penalty becomes statistically non-significant once the share of female managers exceeds 40% (see above). This indicates that fixed, unobserved workplace characteristics are leading to a small over-statement of the impact of female managers in that specification. However, the broad conclusions derived from that model are unchanged in the fixed-effects model: an increasing share of female managers at the workplace is associated with a smaller gender wage gap. Moreover,

[14]Around one third of workplaces in our sample do not contribute to these fixed-effects estimates as they have no within-workplace gender variance. Specifically, there are 1,200 workplaces where all managers are from a single sex (742 all-male and 458 all-female, accounting for 7,205 and 4,181 sampled employees, respectively). Also, 153 workplaces with 1,069 sampled employees are from a single sex. The latter subset comprises 112 workplaces (with 787 sampled employees) in which all employees are female and 41 workplaces (with 282 sampled employees) in which all employees are male.

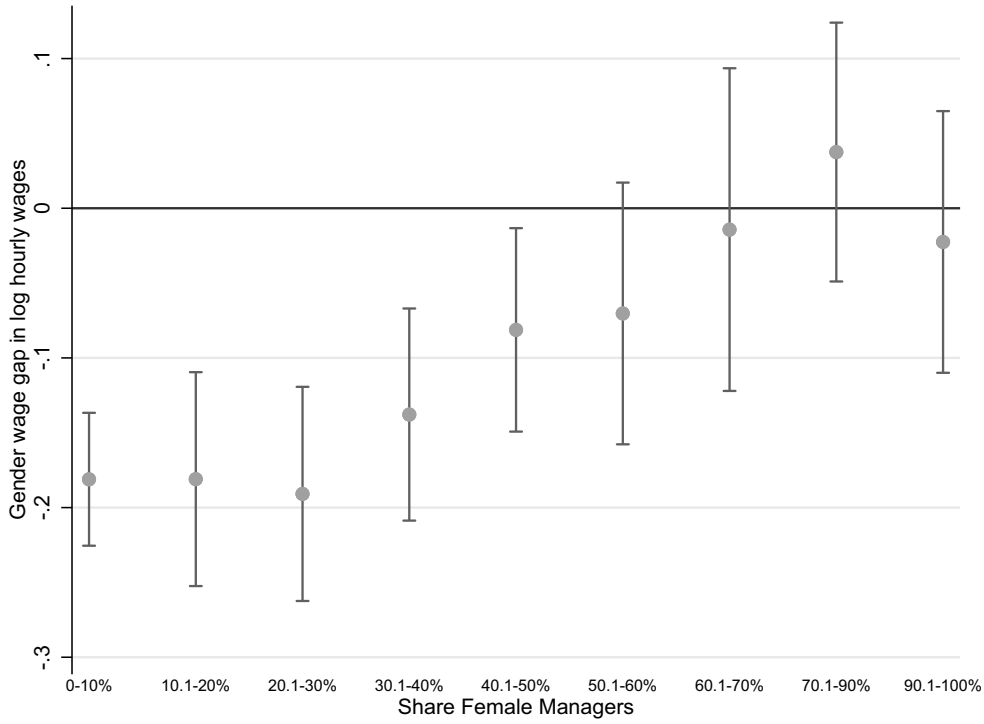

Figure 1. Mean gender wage gap in log hourly wage and share of female managers*female in deciles. *Note*: The dots are the point estimates recovered from the net effect of the share of female manager interactions in Table 1, column 5. The vertical lines are the 90% confidence intervals. Adjacent coefficients on the interaction terms are not statistically significant from each other; test statistics are available on request

the association is broadly linear: none of the adjacent coefficients plotted in Figure 1 are statistically significant from one another. While prominent policy initiatives have set targets for female representation in managerial positions – such as the 25% voluntary target set for board-level positions in UK listed companies set by the government-backed *Davies Review* (Department for Business Innovation and Skills, 2011) – we find no substantial step changes in the effects that we estimate at the workplace level.

Sensitivity to the definition of managers

We run sensitivity tests to examine how the results in Table 1 column 5 vary with the definition of managers. These tests are presented in Table 2 (where the first column simply replicates Table 1 column 5 for convenience).

First, we expand the definition of 'managers'. The definition used in Table 1 covers occupations whose tasks consist of 'the direction and coordination of the functioning of organisations and businesses' (Major Group 1 of the *Standard Occupational Classification (2000)*). It may include general managers and departmental managers. However, this group may exclude some with supervisory responsibilities who work outside the top managerial jobs in the workplace but who nevertheless have supervisory responsibilities which gives them influence over subordinates' wages. So, in column 2 of Table 2, we expand our

TABLE 2
Sensitivity checks for workplace fixed-effects model

	(1) *Managers=SOC1*	*(2)* *Managers= SOC1 + SOC2*	*(3)* *Column (1) without SOC1*	*(4)* *Column (1) without SOC1 + SOC2*
Female	−0.181***	−0.148***	−0.147***	−0.101***
	(0.027)	(0.028)	(0.026)	(0.026)
Share female managers: 0%–10.0%	Ref.	Ref.	Ref.	Ref.
(Share female managers: 10.1%–20.0%)*Female	0.000	0.019	−0.003	−0.001
	(0.040)	(0.045)	(0.037)	(0.034)
(Share female managers: 20.1%–30.0%)*Female	−0.010	0.029	−0.042	−0.044
	(0.042)	(0.038)	(0.042)	(0.038)
(Share female managers: 30.1%–40.0%)*Female	0.043	0.002	−0.003	−0.038
	(0.039)	(0.041)	(0.040)	(0.041)
(Share female managers: 40.1%–50.0%)*Female	0.100***	0.144***	0.062*	0.076**
	(0.035)	(0.036)	(0.037)	(0.038)
(Share female managers: 50.1%–60.0%)*Female	0.111**	0.145***	0.044	0.053
	(0.046)	(0.043)	(0.050)	(0.046)
(Share female managers: 60.1%–70.0%)*Female	0.167***	0.211***	0.120*	0.151***
	(0.060)	(0.052)	(0.062)	(0.055)
(Share female managers: 70.1%–90.0%)*Female	0.219***	0.225***	0.109**	0.185***
	(0.045)	(0.043)	(0.047)	(0.047)
(Share female managers: 90.1%–100%)*Female	0.159***	0.272***	0.061	0.130***
	(0.045)	(0.043)	(0.048)	(0.043)
Number of observations (employees)	37,401	37,401	33,837	28,052
Number of workplaces	3,358	3,358	3,330	3,304
Employee controls	Yes	Yes	Yes	Yes
Workplace fixed effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.454	0.455	0.450	0.430

Notes: For brevity we report only the coefficients for the variables of interest. Column 1 replicates column 5 of Table 1, defining managers as SOC Major Group 1; column 2 expands out the definition of managers to SOC Major Group 2 (professional employees). Column 3 uses the specification in column 1 but drops SOC Major Group 1 from the estimation sample. Column 4 uses the specification from column 2 but drops SOC Major Groups 1 and 2 from the estimation sample. Standard errors are in parentheses and are clustered at the workplace level. Estimates are weighted using employee-level weights. Levels of significance:
*$P < 0.1$, **$P < 0.05$, ***$P < 0.01$.

definition of managers to include employees in Major Group 2 (Professionals), since over two fifths of employees in this group hold supervisory responsibilities. The coefficients on the deciles of this new interaction term increase in magnitude compared to the interaction coefficients reported in Table 1, column 1, and remain highly statistically significant. In this specification, the association between the share of female managers and the gender wage gap becomes statistically significant once 40% of managers are female.

The association between the share of females in managerial occupations and women's wages might be explained, in part, by female managers using their authority to upwardly adjust their own wages. Indeed, Bertrand *et al.* (2019) find that increases in female board-level representation are associated with a marked reduction in the gender wage gap in senior positions but find limited evidence of changes in the gender wage gap lower down the corporate hierarchy. Our results show a somewhat different picture. If we drop managers from our estimation samples (Table 2, columns 3 and 4), the estimated coefficients on the interaction terms decrease in magnitude, in some cases by more than 50%. This indicates that female managers gain proportionately more from increased representation in decision-making positions than do women in non-managerial roles. However, most of the coefficients that were previously positive and statistically significant remain so in the non-managerial samples.[15] We do therefore find evidence of spillovers to non-managerial positions in our data.

Sensitivity to selection on unobservables

The estimates of the association between the female share in management and the gender wage gap shown in Table 1, column 5, could be biased if unobserved employee characteristics – such as unobserved productivity – influence both wages and employees' choice of workplace.

Unlike Hensvik (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 examine the robustness of the results in Table 1, column 5, to selection on unobservables by using Oster's test of coefficient stability (2019).

Oster's test relies on the observation that omitted variable bias is proportional to coefficient movements after the inclusion of observed controls, scaled by the change in *R-squared* when such controls are included. We follow Oster (2019) in estimating bias-adjusted coefficients under the assumption of equal selection on observed and unobserved variables ($\delta = 1$) and under the assumption that a hypothetical regression containing a full set of observed and unobserved controls would produce an *R-squared* of 1.3 times that of the model in column 5 of Table 1 ($R_{\max} = 1.3$). The results from Oster's test are presented in Table S5. The bias-adjusted coefficients are smaller in magnitude than

[15]The interaction coefficient between the share of female managers and the female dummy is no longer statistically different from zero in column 3 when more than 90% of managers are women, however it is also not statistically different from the interaction coefficient between 70.1% and 90.0% of female managers and the female dummy; the same interaction coefficient remains statistically significant in column 4. There is thus some suggestion in column 3 that having a very high share of female managers may offer limited returns to female non-managers, but the evidence is inconclusive and only appears under a more restrictive definition of managers.

those presented in column 5 of Table 1 – typically by a factor of one half. The only interaction term to remain statistically significantly different from zero is that indicating a share of female managers between 70% and 90% ($\beta'_{3(70.1\%-90\%)} = 0.127$; SE = 0.057), although the coefficient on the interaction term for a share of female managers above 90% lies just outside the bounds of statistical significance ($\beta'_{3(90.1\%-100\%)} = 0.081$; SE = 0.052). Oster's delta indicates that, for most terms, the relative degree of selection on employee and workplace unobservables would need to be at least 1.8 times the degree of selection on observables in order to render $\beta = 0$. These results suggest that our results are somewhat sensitive to omitted variable bias. However, a high share of female managers (70%–90%) remains associated with a smaller gender wage gap once the potential effects of omitted variable bias are taken into account using Oster's (2019) method.

We also examine the sensitivity of our results to time-varying workplace unobservables by estimating workplace-level panel models to examine the links between the share of female managers and the gender wage gap within workplaces, after netting out fixed differences across workplaces over time, as well as time-varying workplace observables. In our workplace-level panel estimation, we track a random subsample of workplaces over time, permitting workplace-level panel analyses for 401 workplaces where we have linked employer-employee data in 2004 and for the same workplaces in 2011. We use this balanced panel of workplaces, observed at two separate time points, to analyse the association between the gender wage gap at workplace level and the female share of women in managerial positions within the workplace, after controlling for other time-varying workplace observables (e.g. workplace size) and after netting out time-invariant workplace fixed effects.

The workplace 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 this raw gender wage gap 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 workplace fixed-effects panel regression which takes the following form:

$$\begin{aligned}\left(\overline{W_M} - \overline{W_F}\right)_{jt} - \overline{\left(\overline{W_M} - \overline{W_F}\right)_j} = \delta'_1 &\left(\sum_{\gamma\in\Gamma}\text{ShFemManag}_{jt} - \sum_{\gamma\in\Gamma}\overline{\text{ShaFemManag}}_{jt}\right) \\ &+ \delta_2\left(\text{ShFemNonManag}_{jt} - \overline{\text{ShFemNonManag}}_j\right) \\ &+ \delta'_3\left(\mathbf{W}_{jt} - \overline{\mathbf{W}}_j\right) + \delta'_4\left(\boldsymbol{X}_{jt} - \overline{\boldsymbol{X}_{jt}}\right) + \left(v_{jt} - \overline{v_j}\right) \qquad (2)\end{aligned}$$

where j indexes workplaces and t indexes time. ShFemManag_{jt} is the change in the share of female managers among all managers in the workplace in deciles where $\Gamma = \{10.1\%–20\%, 20.1\%–30.0\%, 30.1\%–40\%, 40.1\%–50\%, 50.1\%–60\%, 60.1\%–70.0\%, 70.1\%–90\%, 90.1\%–100\%\}$ and $\text{ShFemNonManag}_{jt}$ is the change in the share of female non-managers. $\boldsymbol{W}_{jt}$ captures observed workplace controls as outlined above, $\boldsymbol{X}_{jt}$ captures observed individual characteristics averaged at the workplace level and v_{jt} represents the disturbance term. An alternative specification replaces these individual characteristics

TABLE 3
Share of female managers and the gender wage gap: workplace panel level analysis

	(1) Individual controls averaged at the workplace level	*(2) Female and male controls averaged at the workplace level*
Share female managers: 0%–10.0%	Ref.	Ref.
Share female managers: 10.1%–20.0%	0.088	0.076
	(0.138)	(0.146)
Share female managers: 20.1%–30.0%	0.175	0.209
	(0.201)	(0.173)
Share female managers: 30.1%–40.0%	−0.058	−0.028
	(0.147)	(0.132)
Share female managers: 40.1%–50.0%	−0.289**	−0.209
	(0.132)	(0.128)
Share female managers: 50.1%–60.0%	−0.390**	−0.354*
	(0.187)	(0.210)
Share female managers: 60.1%–70.0%	−0.445**	−0.360*
	(0.173)	(0.199)
Share female managers: 70.1%–90%	−0.651**	−0.521**
	(0.298)	(0.263)
Share female managers: 90.1%–100%	−0.351*	−0.342*
	(0.193)	(0.198)
Number of observations (workplaces*year)	802	802
Number of workplaces	401	401
Adjusted R^2	0.359	0.372

Notes: The dependent variable is the raw workplace-level gender wage gap (average log hourly male wage at the workplace minus average log hourly female wage at the workplace, as estimated from the employee-level data). The workplace control variables are those used in Table 1 except the region dummies as they drop out in the fixed-effects specification due to no workplace change across regions between the two surveys. Column 1 also includes all employee characteristics used in Table 1 but averaged at the workplace level. In column 2 we replace those averaged employee characteristics with separate male and female controls averaged at the workplace level. For brevity we report only the coefficients for the variables of interest. Estimates for the other controls are available upon request. SEs 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:
*$P < 0.1$, **$P < 0.05$, ***$P < 0.01$.

averaged at the workplace level ($\boldsymbol{X}_{jt}$) with separate female and male characteristics, also averaged at the workplace level. By estimating influences on the mean workplace-level residual gender wage gap, the analysis captures change net of observed compositional change in the workplace's employees.

The results of the workplace-level panel analysis are presented in Table 3. In column 1, we control for the characteristics of the average employee at the workplace. As in earlier specifications, the share of female managers begins to have a statistically significant association with the size of the gender wage gap once this share reaches around 40%. In column 2 we replace the average employee characteristics with separate female and male averaged workplace characteristics. The coefficients on the shares of female managers decrease in magnitude by around one fifth, on average, suggesting that female managers may affect the wage gap through hiring and firing policies which change the composition

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 association between the share of female managers and the size of the gender wage gap after accounting for the compositional changes that we observe in our data: here the share of female managers starts to be associated with a smaller gender wage gap once female managers are in the majority.

While we are unable to account for gender differences in time-varying unobservable employee characteristics in this specification (e.g. improvements in unobserved aspects of employee productivity), we judge that these are likely to be positively correlated with the time-varying proxies for human capital we observe. An association between the gap in men's and women's mean wages and the share of female managers within workplaces, after controlling for time-varying differences in employee characteristics by gender, thereby provides further assurance that any role of female managers in closing the gender wage gap is not due solely to the sorting of workers across workplaces.

IV. The role of wage-setting mechanisms

Having identified a robust association between the gender wage gap and the share of female managers at the workplace, both in cross-section and panel data, we consider two mechanisms by which female managers may influence the gender wage gap. Our focus is on the role played by wage setting.

One potential way in which female managers may affect the gender wage gap is by using their influence in periodic decisions over the wages paid to different workers within the workplace. This influence is likely to be greater when managers make unilateral decisions over wages or decide wage increases through direct negotiation with individual employees. Conversely, it is likely to be less when managers' decision-making power in wage-setting is circumscribed by trade unions through the process of collective bargaining, or via an Independent Pay Review Body (Pay Review Bodies set pay for around 2.5 million public sector workers in England and Wales – see Powell and Booth (2021)). Managerial latitude is likely to be circumscribed in these settings because unions tend to favour a single rate for the job and automatic progression, while Pay Review Bodies' recommendations apply to whole occupations irrespective of gender.

To investigate this issue, we use a question from the WERS employer survey which asks managers how pay is determined for employees at the workplace. We construct a dummy variable taking the value of 1 if the human resources manager said that wages at the workplace were set through negotiation with individual employees, or unilaterally by managers at the workplace or a higher level in the organization, and zero when there are negotiations with trade unions or pay is set via an Independent Pay Review Body. The variable thus identifies situations in which managers are more likely to have power over wage outcomes. This applies in 87% of workplaces covering 76% of all employees. We add this variable to the fixed-effects model from column 5 of Table 1 and construct the triple interaction between being female, the share of female managers and the presence of managerially set pay. In doing so, we replace the deciles of share of female managers with a linear term to reduce the complexity of the interactions.

TABLE 4
Log hourly wages when management set pay at individual, workplace or organization level

	(1) *OLS Workplace FE*
Female	−0.172***
	(0.038)
Management Set Pay at Individual, Workplace or Organization Level	Fully absorbed by FE
Share female managers	Fully absorbed by FE
Share female managers * Female	0.126
	(0.083)
Share female managers	Fully absorbed by FE
Female * Management Set Pay at Individual, Workplace or Organization Level	−0.046
	(0.037)
Management Set Pay at Individual, Workplace or Organization Level * Share female managers	Fully absorbed by FE
Female * Management Set Pay at Individual, Workplace or Organization Level * Share female managers	0.149*
	(0.086)
Number of observations (employees)	37,401
Number of workplaces	3,358
Employee controls	Yes
Workplace fixed effects	Yes
Adjusted R^2	0.454

Notes: Management Set Pay at Individual, Workplace or Organization Level is a dummy variable taking the value of 1 if the human resources manager said that wages at the workplace were set through negotiation with individual employees, or unilaterally by managers at the workplace or a higher level in the organization, and zero when there are negotiations with trade unions, or pay is set via an Independent Pay Review Body. For brevity we report only the coefficients for the variables of interest. All the other controls are the same as in column 2 of Table 1 and their estimates are available upon request. SEs 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 4 confirms that the association between the share of female managers and the size of the gender wage gap is more pronounced in workplaces where managers have power in general wage setting. In workplaces where pay is subject to negotiation with unions or an Independent Pay Review Body, the interaction between being female and the share of female managers is positive but not statistically different from zero ($\beta = 0.126$, SE $= 0.083$). The elasticity is larger and statistically different from zero in the presence of managerially set pay ($\beta = 0.149$, SE $= 0.086$).

The distinction between collectively agreed and unilaterally determined (or individually negotiated) wages characterizes the wage determination process only in general terms, however. In Table 5, we move beyond general wage-setting to identify circumstances in which there is a discretionary, variable element to pay setting, i.e. the presence of a PRP scheme. PRP schemes introduce a discretionary, variable element to pay setting in which bonuses are either issued selectively and/or vary in their monetary value between different workers. In the presence of such a scheme, the gender of managers may determine who receives those rewards, or it may affect the size of the

TABLE 5
Log hourly wages and performance-related pay (PRP)

Variables	*(1)* *OLS workplace FE*	*(2)* *OLS workplace FE*
Female	−0.149***	−0.172***
	(0.027)	(0.028)
Share female managers	Fully absorbed by FE	Fully absorbed by FE
Share female managers * Female	0.159***	0.166***
	(0.046)	(0.048)
PRP	Fully absorbed by FE	0.319***
		(0.048)
Female * PRP	−0.156***	−0.225***
	(0.037)	(0.075)
PRP * Share female managers	Fully absorbed by FE	−0.294**
		(0.132)
Female * PRP * Share female managers	0.256***	0.382**
	(0.080)	(0.178)
Number of observations (employees)	37,401	18,298
Number of workplaces	3,358	1,802
Employee controls	Yes	Yes
Workplace fixed effects	Yes	Yes
Adjusted R^2	0.454	0.381

Notes: In column 1, PRP is a dummy variable taking the value of 1 if the respondent manager said that 40% or more of the non-managerial employees at this workplace receive payment by result or merit pay, 0 otherwise. In column 2, PRP is a dummy variable taking the value of 1 if the employee is in receipt of performance pay (i.e. the employee declared in the employee questionnaire that she/he receives payment based on individual performance or output) and the workplace human resource manager said that there is either individual performance related pay or merit pay in the establishment, 0 otherwise. Column 2 is estimated using the 2011 sample only as receipt of individual performance related pay is not available in 2004. For brevity we report only the coefficients for the variables of interest. All controls are the same as in column 2 of Table 1 and their estimates are available upon request. SEs are in parentheses and are clustered at the workplace level. Estimates are weighted using employee level weights. Levels of significance:
$^{*}P < 0.1$, $^{**}P < 0.05$, $^{***}P < 0.01$.

rewards given to different employees; the size of the gender wage gap may be affected in either case.[16]

In Table 5, column 1, we use workplace-level data from the 2004 and 2011 employer surveys to distinguish between workplaces that operate PRP schemes and those that do not. A PRP scheme is defined to include either 'merit pay', where the variable element is determined by a subjective assessment of the employee's performance by a supervisor or manager, or 'payment-by-results', where the variable element is determined by the amount of work done or its value (as in the case of sales commission). We construct a dummy variable taking the value of 1 if the human resources manager said that 40% or more of the non-managerial employees at the workplace are paid for performance in either of these ways, as opposed to being paid solely on the basis of hours worked. We set a threshold of at least 40% to identify workplaces where a substantial proportion of

[16]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).

all managerial employees are covered by the PRP scheme.[17] This variable is interacted with the share of female managers and the female employee dummy in a workplace-level, fixed-effects model that also includes our standard controls. Table 5 (column 1) confirms that a higher share of female managers is associated with a narrowing of the gender wage gap in workplaces where a substantial proportion of the non-managerial employees are subject to PRP. In workplaces without PRP, women's wages are improved relative to men's by 0.159 log points (SE = 0.046) when comparing a workplace with no female managers to one in which all managers are female; in workplaces that operate PRP, this elasticity increases by 0.256 log points (SE = 0.080).

The workplace-level indicator used in Table 5, column 1, does not distinguish between individuals who are in receipt of PRP and those who are not in workplaces where PRP is used. So, in Table 5 column 2, we utilize a question which appeared only in the 2011 employee survey to separately identify individual employees in receipt of performance pay from those on fixed pay in workplaces where any PRP scheme is in operation. In this specification, among fixed pay workers, women's wages are improved relative to men's by 0.166 log points (SE = 0.048) when comparing a workplace with no female managers to one in which all managers are female. Among PRP workers, an equivalent shift in the share of female managers is associated with an increase in female wages of 0.382 log points (SE = 0.178) and a decrease in male wages of 0.294 log points (SE = 0.132) – a net difference of 0.676 log points in favour of women. The availability of PRP appears to provide an important route through which female managers can affect the gender wage gap.

This managerial influence may be manifest in different ways. Under merit pay, managers may choose who is covered by the scheme, and/or they may influence the size of the reward through their subjective performance assessments; under payment-by-results, managers may choose who is covered, and/or they may influence rewards through differential assignment of tasks (e.g. assigning one worker to the easier sales tasks, which are more likely to generate a commission). In our data, the influence of female managers does not appear to be restricted to one form of PRP: in extended versions of the specifications reported in Table 5, in which we differentiate between workplaces operating merit pay schemes and those operating payment-by-results schemes, the estimated interaction terms for the two different forms of PRP were not statistically different from one another.

Although we cannot determine why or how PRP acts as a mechanism for closing the gender wage gap in the presence of a higher share of female managers, our evidence is consistent with a model of statistical discrimination in which female managers use their discretion to reward individual performance within the workplace in a way that is more equitable for women (see also Flabbi *et al.*, 2019). But it is also possible that women exert greater effort if they feel those efforts are more likely to be rewarded more fairly when

[17]The survey measures the share of non-managerial employees covered by PRP in seven categories: 0%, 1–19%, 20–39%, 40–59%, 60–79%, 80–99% and 100%. Our threshold of 40% is chosen as being close to a majority. Manning and Saidi (2010) use a different indicator of PRP coverage, based on a question in the 2004 WERS which asks which occupations at the workplace are covered by PRP. This variable is not included in the 2011 WERS.

female managers determine performance-related rewards. Our data are unable to speak to these specific alternatives, and so they are left for further research.

V. Conclusion

Using linked employer-employee data for Britain in 2004 and 2011 we estimate a raw gender wage gap of around 0.21 log points which falls marginally after controlling for individual and workplace characteristics. However, the gender wage gap is substantially smaller in workplaces with a higher share of female managers. The gap closes because women's wages are positively associated with the share of female managers in the workplace, while men's wages are negatively associated with it. This negative association between the size of the gender wage gap and the share of female managers in the workplace is apparent using a range of estimation techniques. It is robust to changes in the set of conditioning variables, such as the inclusion of variables capturing workplace culture; to the removal of managers from the wage estimation; to alternative ways of defining managers by adding professional staff with supervisory responsibilities; to different model specifications; and to the inclusion of workplace fixed effects. Similar results are obtained using workplace panel data to estimate the association between changes in the share of female managers and changes in the mean gender wage gap within workplaces.

Our results are in line with Cardoso and Winter-Ebmer's (2010) study using longitudinal linked employer-employee data for Portugal, which shows that the gender wage gap falls when a workplace switches to being female-led. They are also in line with workplace-level studies for Germany (Hirsch, 2013) and the United States (Tate and Yang, 2015) which find positive spillover effects from female managers down to women at the lower end of the hierarchy.

Existing research into the mechanisms through which an increasing share of female managers may affect the gender wage gap have tended to focus on the effects that female managers may have on gender segregation within the firm. For instance, Kunze and Miller (2017) find that greater female representation in senior positions narrows the gender gap in promotion rates at lower ranks; Hensvik (2014) finds an effect on the quality of women recruited into the firm. However, none of these existing studies examine in any detail the importance of pay determination processes in shaping final wage outcomes.

We hypothesized that the role of female managers in closing the gender wage gap would be more pronounced when managers have control over pay-setting, and 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 set pay or reward performance and those managers are women. This hypothesis is supported in our data. A higher share of female managers has a stronger association with the size of the gender wage gap in workplaces where managers have responsibility for wage setting. This association is even stronger when there is a discretionary, variable element to pay setting via PRP.

All of this is consistent with the proposition that the gender composition of decision-makers in the workplace plays an important role in determining the size of the gender

wage gap and indicates that a stronger presence of women in managerial positions can help tackle the gender wage gap by altering the distribution of rewards within the workplace.

Although our estimates indicate that the share of female managers is associated with the size of the gender wage gap, we cannot definitively rule out the possibility that both the share of female managers in the workplace and the relative pay received by men and women are jointly determined by time-varying omitted variables. Nor can we rule out the possibility that the role played by wage setting mechanisms may be biased due to gender-based selection into or out of workplaces with different pay structures.[18] However, our findings appear robust to selection on unobservables and 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.

It is notable that the negative association between the size of the gender wage gap and the share of female managers arises in part due to a worsening in men's positions, not only an improvement in women's wages. 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) may reduce 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; Maida and Weber, 2022), 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.*, 2022 for Denmark) 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 percentage of women 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.

[18]There is a sizeable literature suggesting women (men) are less (more) likely to sort into jobs offering performance pay due to their preferences for risk and competition. However, much of this literature is experimental and contrasts to field-based studies – including Manning and Saidi's (2010) study using data from the 1998 and 2004 WERS – suggesting there is no gender-based differential selection into performance pay workplaces.

Appendix A

TABLE A1

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	−0.213***	−0.202***	−0.216***	−0.186***	−0.214***	−0.195***
	(0.015)	(0.012)	(0.019)	(0.015)	(0.012)	(0.010)
Number of observations (employees)	19,103	19,103	18,298	18,298	37,401	37,401
Number of workplaces	1,556	1,556	1,802	1,802	3,358	3,358
Employee controls	No	Yes	No	Yes	No	Yes
Workplace controls	No	Yes	No	Yes	No	Yes
Year dummy	No	No	No	No	Yes	Yes
Adjusted R^2	0.031	0.290	0.026	0.270	0.067	0.305

Notes: For brevity we report only the coefficients for the female dummy variable. Controls are those used in Table 1, column 2, and described in the text. Standard errors are in parentheses and are clustered at the workplace level. Estimates are weighted using individual level weights. Levels of significance:
$^{*}P < 0.1$, $^{**}P < 0.05$, $^{***}P < 0.01$.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Tables