Gender Disparities in Promotions and Exiting in UK Russell Group Universities

by

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Abstract

A theoretical model of promotion and exits is presented incorporating statistical discrimination and bias, with both leading to a lower likelihood of promotion and a higher probability of exiting academia earlier for women. Using UK panel data, we confirm the model's predictions that women academics are considerably under-represented in higher academic grades, and especially that gender gaps are largest at Full Professor level (e.g., we show that, cet. par., women took some 8.5 years more than men to achieve Associate Professor and then a further 6.1 years more to secure a Full Professorship). The policy implications of the results suggest that UK universities should emphasise the importance of organisational culture, evaluation practices and institutional procedures when hiring and promoting both men and women.

Conflict of Interest
The authors declare that there exists no competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

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I. Introduction

Women are under-represented in higher, better-paid positions in academia in general, including the UK (e.g., Ginther, Kahn, and McCloskey, 2018). This could suggest that there are either innate (e.g., genetic) differences between men and women in the ability to be a successful researcher or there are innate differences in interests and lifestyle preferences (e.g., Gonzalez Ramos, et. al., 2015; Santos et. aal., 2021) that account for women being underrepresented in more senior grades, although our reading of the extant literature instead mainly implies that women are either (perceived as being) less research productive than men and/or that bias results in a lower likelihood of promotion. Of course, bias can lead to lower productivity if women are not afforded the same overall opportunities to publish, and consequently lower promotion opportunities, and therefore the relationship between productivity and gender bias is at least in part endogenous.

The lower likelihood of promotion has led to many studies of the 'leaky pipeline' (going back to Berrymen, 1983), whereby women both exit academia faster than men and, through bias in the promotion process, become under-represented in higher grades relative to the number of women initially entering the Higher Education (HE) sector. However, these studies generally adopt a less rigorous approach, and in particular do not formally model the interaction between productivity and gender bias and how this impacts on promotion. While recent literature has advanced our understanding, gaps persist, particularly in the integration of theoretical models with empirical data. Therefore, in this study we, firstly, develop a theoretical model that shows how, for academics with comparable productivity, statistical discrimination and bias more generally can lead to gender gaps in promotion (and exiting) at each academic grade, including why such gaps are largest at Full Professor level. That is, in the model, having controlled for productivity-enhancing characteristics (such as age and experience), comparable women and men should have the same productivity and therefore if there are differences in academic grade (and/or the probability of exiting) then this is due to differences in, for example, perceived productivity, the likelihood of getting (sufficient) outside or 'matched' internal offers, or differences in the opportunities and costs of investing in productivity-enhancing activities across genders. That is, both individual and institutional choices/practices suggest that 'bias' restricts the career paths of women relative to men.

Secondly, from an empirical perspective, and unlike nearly all UK-based studies which use cross-sectional data (e.g. Blackaby, Booth, & Frank , 2005; Mumford, and Sechel,, 2020) we use confidential panel data made available by the UK Higher Education Statistical Agency (HESA) on the population of UK academics covering 2004/05 to 2019/20 to provide new, and more extensive, evidence on gender differences in promotions and exiting with findings that are consistent with our theoretical model, together with an analysis of the underlying influences determining differential exiting and promotion patterns. The empirical model contains a wide range of relevant covariates but individual research productivity is not available and therefore the implications of not being able to control for this are discussed, referencing what other studies with access to productivity data have found. Essentially, the extant literature suggests that most of the gender-gap in (pay and) promotions and exiting cannot be explained *by controlling for* research productivity.

The next section reviews the literature on the sources of bias to substantiate the development of a model that explains such bias. Section III discusses the data source and the econometrics methods used to estimate models of survival in academia, the probability of being assigned to a particular academic grade, and the mean predicted time to promotion. The empirical results obtained are presented in Section IV, and the paper ends with a summary and conclusions.

II. The ‘leaky pipeline’ and sources of bias

The term ‘leaky pipeline’ has been used for nearly four decades in recognition of the general observation that women tend to leave academia at a faster rate than men while over time females have a lower likelihood of promotion to higher grades (Wickware, 1997; Maggian, Montinari, & Nicolò, 2020). Consequently, there are fewer women available at each further stage of the promotion ladder, even assuming the bar for promotion was gender-neutral. Moreover, as Das and Joubert (2023, p.1) observe ‘… assuming innate differences in productivity and preferences are small across genders, large aggregate pay gaps must reflect discrimination and inefficiency in compensation, in job assignment (hires, promotions, retention) or, upstream, in the production of human capital’. And as stated in the introduction, the relationship between productivity and gender bias is at least in part endogenous.

Leaving aside this potential endogeneity problem it would still be preferable to add productivity (or instruments for this variable) as a control when modelling outcomes. This is not possible using the HESA panel dataset, and therefore the issue that must be confronted is whether controlling for research productivity in empirical work ‘explains away’ gender-gaps. Santos and Dang Van Phu (2019) conducted a survey in 2013 of 2,270 UK academics from all disciplines at Russell Group universities and estimated models determining academic rank that both included and excluded controls for research productivity. They found the latter to be a strong determinant of rank, but it did not explain much of the gender-gap.

Data for other countries provides comparable results. Brower and James (2020) found that in New Zealand “… a man’s odds of being ranked professor or Associate Professor are more than double a woman’s with similar research score, age, field, and university” (p.1) and including/excluding research productivity did not affect their results. Ginther and Kahn (2021, Table 1) showed that adding productivity controls made very little difference to the gender impact on promotion to Associate Professor for economists in the U.S. (reduced the gender gap from 18.5 per cent to 15 per cent). For Italy, Filandri and Pasqua (2021) present results across 14 academic disciplines that the probability of promotion to Associate (Full Professor) was 6.5 (16) per cent lower for women without any productivity controls, and 8 (17) per cent with controls. Marini & Meschitti (2018), who also considered promotions to Full Professor in Italy for a range of academic disciplines, found men were around 24 per cent more likely than women to be promoted, when both sub-groups considered had similar research productivity (referred to by the authors as "parity of scientific production" p. 989). Corsi et. al. (2019) limited their study to just Italian economists, finding a very large negative gender impact in achieving Full Professor when controlling for productivity. Taking a different approach with the data for Italy, De Paola et al. (2017) showed that after controlling for productivity (and other relevant covariates), women were about 4 per cent less likely to apply for promotion.

Ginther et al. (2018) in their review confirm that in many studies, even after controlling for productivity, women are significantly less likely to be granted tenure or to take more time to do so. Concerning the underlying reasons for the existence of these gender gaps in promotion and exiting, there is an extensive literature showing women are not given the same opportunities to produce high quality research as men. It is grouped into demand- and supply-side factors. Regarding the former, statistical discrimination is considered, followed by supply-side bias constraints that can act as barriers to increasing (research) productivity. Such barriers reinforce and are reinforced by the effect of statistical discrimination and in general lead to women being more likely to underinvest in productivity enhancing behaviour, since through bias they face higher costs for advancing in their career. This not only leads to less likelihood of promotion for women, but also a higher probability of women exiting academia earlier.

Modelling gender gaps in promotion and exiting

The primary purpose of our model is to show that the priors we have derived from our evaluation of the extant literature are logically consistent, with the model later taken to the data to show that it is also empirically consistent. Therefore, to disentangle the endogeneity effect between productivity and gender bias on promotion and/or exiting, we use a standard gravity model (comprising both demand- and supply-side equations) to examine the flow of academics from state 0 to state 1 (Assistant and post-doc researchers to Associate Professor), and then from state 1 to state 2 (Associate to Full Professor), where the distinction between actual and 'perceived' productivities plays a crucial role (see below). We assume representative workers with the same productivity-enhancing characteristics (including investments in productivity) have the same level of actual productivity for each academic grade ($P_{\mathrm{k}}^{m} = P_{\mathrm{k}}^{f}$, where P is research productivity, k is a particular academic grade 0, 1, or 2, and m, f represents males and females, respectively), but universities find it hard to measure this with certainty, especially for women (e.g., Altbach, 2015). Thus, perceived female productivity is often underestimated relative to that for men (in the statistical discrimination literature it is based on an average expected lower productivity for women and this average often receives a higher weighting than any individual productivity information – see Lippens et al., 2020 and Charles & Guryan, 2011.

It is assumed that promotion from state 0 to 1 and then from 1 to 2 are independent, and this is justified by the processes adopted by universities in the UK that applications for promotion typically occur at discrete points in time, and the decision to promote is largely based on (research) performance since the last promotion (see Hesli & Lee, 2011). If $P_{\mathrm{k}}^{m} \neq P_{\mathrm{k}}^{f}$, then *cet. par*. universities will promote to grade k+1 individuals with higher productivity; however if $P_{\mathrm{k}}^{m} = P_{\mathrm{k}}^{f}$, this means in the model that men and women should be paid the same wage, w, once they are in each state, thus $w_{k}^{m} = w_{k}^{f}$ (and $w_0 < w_1 < w_2$). We justify this as follows: once appointed (or promoted) to a particular grade, most individuals are usually placed at or near the bottom of the pay scale, securing annual pay increases in line with national pay awards as well as automatic incremental increases until the top of the scale is achieved (initially being appointed at a higher point than the bottom of the scale due to productivity differences, can occur, as can above automatic increases, and increases above the pay scale ceiling, occurring if progression panels deem performance is 'above average'[1]). For Professors, who are on spot salaries, pay increases are also dealt with by progression panels who may award higher pay linked to performance. Thus, for representative workers with the same productivity-enhancing characteristics, $w_k^m > w_k^f$ implies (as stated in the introduction) differences in such factors as perceived productivity, or the likelihood of getting (sufficient) outside or 'matched' internal offers (and thus differences in the ability to negotiate higher pay and/or differences in risk-taking).

As noted above, the difference between actual (denoted *P*) and perceived (denoted P^*) productivity plays a crucial role in the model. Axiomatic is the constraint that $P_0 < P_1 < P_2$ and $P_0^* < P_1^* < P_2^*$, while the relationship between *P* and P^* is:

$$P_{k+1}^{*j} = P_{k+1}^j + \varepsilon_{k+1}^j; \qquad \varepsilon_{k+1}^j \geq 0; \quad k = 0, 1; \quad j = m, f \tag{1}$$

Here ε is consistent with the argument in the statistical discrimination literature that information on an individual's productivity is limited and imprecise; Equation (1) prescribes that there is a tendency to overvalue actual research productivity (which is often the case for an individual when applying for promotion and particularly for men who rate and cite their work more highly, cf. King, et al., 2017), such that lack of information biases upwards expectations of productivity so that $P_{k+1}^* > P_{k+1}$. Further, it is assumed that:

$$\varepsilon_{k+1}^m > \varepsilon_{k+1}^f \Rightarrow P_{k+1}^{*m} > P_{k+1}^{*f} \tag{2}$$

where ε can take on any value, as long as $|\varepsilon_{k+1}^m| > |\varepsilon_{k+1}^f|$, such that there is a skew to the right that is greater for men (e.g., average evidence suggests mean productivity is higher for men). Equation (2) is a different to the orthodox approach to statistical discrimination; however, the

[1] It is also possible in a very small number of cases that academics appointed from outside academia may earn above average' salaries to maintain previous salary levels. This exception has little impact on our underlying approach that if $P_k^m = P_k^f$, then generally $w_k^m = w_k^f$.

first part of Equation (2) is equivalent to using a standard approach that the weighting derived from the average productivity of women is too low relative to that applied to men (hence our continuing to use the term 'statistical discrimination'). Or ε in Equation (1) might be interpreted as the impact of the deliberations by a promotions (appointments) committee, where statistical bias results in a higher weight given to men.

Next, we present formally our gravitational model approach to examine the flow of academics from state 0 to state 1, and then from state 1 to state 2. Both a static (outcomes in any state *k*) and a dynamic (changes from state *k* to *k*+1) approach is taken; with the dynamic approach being emphasised in the main text below. On the demand-side, the flow (F_d) of promoted academics by universities is directly proportional to the product of the *perceived* productivities in each position and inversely proportional to the distance between salaries – the latter being the cost for the universities to promote academics in each state. This flow is given by:

$$F^j_{d(k+1)} = g^j_{d(k+1)} \frac{P^{*j}_k P^{*j}_{k+1}}{w^j_{k+1} - w^j_k} \qquad (3)$$

with $g^j_{d(k+1)}$ representing the net productivity returns on the (university) demand for each gender j at state *k*+1. Note, $g^j_{d(k+1)}$ is 'set' by the university-employer with differences (if any) between women and men resulting from statistical discrimination (bias), rather than actual differences in productivity. Additionally, exiting from academia is presumed to have no impact on the demand-side (Equation 3) since it is assumed there are no redundancies instituted by Russell Group UK research-intensive universities (while there may occasionally be cut-backs in (net) staff numbers, these are invariably met by not replacing staff i.e., through 'natural' wastage).

Similarly, from the supply-side, the flow (F_s) of available academics looking to be promoted is directly proportional to the product of the salaries in each state k and inversely proportional to the cost of promotion (c^j_{k+1},) from one state to another. The flow F_s is specified as:

$$F^j_{s(k+1)} = g^j_{s(k+1)} \frac{w^j_{k+1} w^j_k}{c^j_{k+1}} (1\text{-}E^j_{k+1}) \qquad (4)$$

where $g^j_{s(k+1)}$ represents the net wage returns on the academic promotion for each gender j and E^j_{k+1} is the percentage of academics exiting, with $k = 0, 1$. With state 0 as the reference situation (i.e., $P^{*m}_0 = P^{*f}_0 = 1$) in equilibrium $F^j_{s(k+1)} = F^j_{d(k+1)}$; and thus Equations (3) and (4) yield:

$$P^{*j}_{k+1} = \frac{g^j_{s(k+1)}}{g^j_{d(k+1)}} \frac{(w^j_{k+1} - w^j_k) w^j_{k+1} w^j_k}{P^{*j}_k} \frac{(1 - E^j_{k+1})}{c^j_{k+1}} \qquad (5)$$

It is assumed that $c_1 < c_2$, implying that the investment needed to be promoted to Full Professor is greater than the cost of being promoted to Associate Professor; and that $E_1 > E_2$, exiting is lower at Full Professor level. An important assumption that is also made in the dynamic model (involving a move from state *k* to *k*+1) is:

$$\frac{g_{s1}}{g_{d1}} < \frac{g_{s2}}{g_{d2}} \qquad (6)$$

That is, while the net productivity return is higher in state 2 (Professor) versus state 1 (Associate Professor), and net wage returns are also higher in state 2, the *relative* return in state 2 must be higher than the relative return in state 1 for a university to justify the promotion (since, $g_{d2} > g_{d1}$ and $g_{s2} > g_{s1}$ but there is no restriction on whether $g_{d2} \geq g_{s2}$ or $g_{d2} \leq g_{s2}$).

Using the equilibrium Equation (5), it is now possible to consider scenarios where there will be *disproportionate* gender bias when promoting staff from Associate to Full Professor. Since, for simplicity, we set $P^{*m}_0 = P^{*f}_0 = 1$ and $P^{*m}_{k+1} > P^{*f}_{k+1}$ this bias is represented by:

$$P^{*m}_1 - P^{*f}_1 < P^{*m}_2 - P^{*f}_2 \qquad (7)$$

i.e., males are perceived to be relatively more productive than women at Professor level (clearly, while Equation (2) ensures a representative male is more likely to be promoted at each stage 1 and 2 then Equation (7) is predicting that the gender gap is even larger at Full Professor level.)

<u>Scenario1</u> (supply-side): if in any state, there is no difference in relative net wage to productivity returns across genders ($\frac{g^m_{s(k+1)}}{g^m_{d(k+1)}} = \frac{g^f_{s(k+1)}}{g^f_{d(k+1)}} = \frac{g_{s(k+1)}}{g_{d(k+1)}}$; k = 0, 1), and no difference in exiting (i.e., $E^j_{k+1} = E_{k+1}$), then from Equation (5):

$$P^{*m}_{k+1} - P^{*f}_{k+1} = (w_{k+1} - w_k)w_{k+1}w_k(1 - E_{k+1})\left[\frac{g^m_{s(k+1)}}{g^m_{d(k+1)}}\frac{1}{c^m_{k+1}}\frac{1}{P^{*m}_k} - \frac{g^f_{s(k+1)}}{g^f_{d(k+1)}}\frac{1}{c^f_{k+1}}\frac{1}{P^{*f}_k}\right] \quad (8)$$

and considering Equation (6), it is possible to show (see also the supplementary appendix for the steps involved):

$$P^{*m}_1 - P^{*f}_1 < P^{*m}_2 - P^{*f}_2 \Leftrightarrow \left[c^f_1 P^{*f}_0 - c^m_1 P^{*m}_0\right] \ll \left[c^f_2 P^{*f}_1 - c^m_2 P^{*m}_1\right]$$

$$\Leftrightarrow \left[c^m_2 P^{*m}_1 - c^m_1\right] \ll \left[c^f_2 P^{*f}_1 - c^f_1\right] \quad (9)$$

since directly from Equation (5) it is possible to show – see the Supplementary Appendix – $(P^{*m}_1 > P^{*f}_1) \Leftrightarrow (c^m_1 < c^f_1)$ and $(P^{*m}_2 > P^{*f}_2) \Leftrightarrow (c^m_2 < c^f_2)$. That is, in each state women face higher investment costs. Thus, when the 'perceived' gender productivity gap is higher for Professors (Equation 7), this implies the there is a relatively higher investment cost faced by females to achieve promotion (relative to the expected productivity gap) with the relative cost to get to Full Professor substantially more than that needed to achieve a promotion to Associate Professor. (Note that, exiting does not enter into Equation (9) since there is no difference in exit rates between genders in either state 1 or 2 as $E^j_{k+1} = E_{k+1}$.)

<u>Scenario 2</u> (demand-side): although $c_1 < c_2$, when there is no gender difference in the cost of promotion from one state to another ($c^m_{k+1} = c^f_{k+1} = c_{k+1}$, for k = 0, 1) then in the static model (Equation 5) it is possible to show:

$$\frac{g^m_{s1}}{g^m_{d1}} > \frac{g^f_{s1}}{g^f_{d1}}; \quad \frac{g^m_{s2}}{g^m_{d2}} > \frac{g^f_{s2}}{g^f_{d2}} \quad (10)$$

while from Equation (9) the following can be obtained:

$$P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f} \Leftrightarrow \left[\frac{g_{s2}^f}{g_{d2}^f}\frac{1}{P_1^{*f}} - \frac{g_{s1}^f}{g_{d1}^f}\right] < \left[\frac{g_{s2}^m}{g_{d2}^m}\frac{1}{P_1^{*m}} - \frac{g_{s1}^m}{g_{d1}^m}\right] \quad \text{(10a)}$$

Equation (10) show that in both states, net wage relative to net productivity returns are higher for men; imposing Equation (6) justifies universities promoting staff to Full Professor; and Equation (10a) shows that the gender gap (in net wage relative to net productivity returns) is higher at Full Professor and thus why it is that men are more likely to get promoted from Associate to Full Professor.

Scenario 3 (exiting): If the assumptions underlying both the above scenarios are imposed (there is no difference in relative net wage to productivity returns across genders and there is no gender difference in the cost of promotion from one state to another), then it can be shown that:

$$P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f} \Leftrightarrow E_1^f - E_1^m < \left[\frac{(1-E_2^m)}{P_1^{*m}} - \frac{(1-E_2^f)}{P_1^{*f}}\right] \quad \text{(11)}$$

The static results (set out in the Supplementary Appendix) show that $E_1^f > E_1^m$ and $E_2^f > E_2^m$; women are more likely to have higher exit rates in both stages 1 and 2. Using (11) it can also be shown that $(E_2^f - E_2^m) > (E_1^f - E_1^m)$; the gender gap in exiting is larger at the Full Professor level. And using Equation (2), since $(P_k^{*j} < P_{k+1}^{*j}) \Leftrightarrow (E_k^j > E_{k+1}^j)$, this ensures that overall exiting is lowest at Full Professor level $(E_1 > E_2)$.

From the above gravity model, two main predictions are important for the empirical work below: firstly, as predicted more generally by standard discrimination models, there is a relatively higher investment cost faced by women to achieve promotion (or, equivalently, the marginal benefit of productivity-enhancing investment is lower for women); however, the model goes further than other studies by predicting that the relative cost to get to Full Professor is substantially more than that needed to achieve a promotion to Associate Professor. Consequently, women will underinvest relative to men and there will be relatively fewer female Associate and (especially) Full Professors. Secondly, women are more likely to have higher exit rates in both stages 1 and 2. The underlying causes of these predictions is bias due to statistical discrimination (cf. Equation 3) and/or women face higher costs of (tangible and intangible) investment needed to raise productivity and secure a promotion (cf. Equation 4). Note, due to a lack of data, the empirical analysis below is not able to directly estimate the gravity model e.g., it is not able to distinguish between supply- vs. demand-side factors, as we do not directly observe (perceived) productivity by either individuals and/or institutions.

III. Data and methods

Our empirical modelling makes use of a confidential panel dataset that comprises information on the population of individual staff covering 2004/05 to 2019/20 supplied annually by UK universities to the Higher Education Statistical Authority (see HESA, 2022). Observations were limited to all academic staff on a teaching and/or research contracts (i.e., omitting those on 'teaching only' contracts) employed by the 24 universities that belong to the Russell Group (RG) of research-intensive institutions (https://russellgroup.ac.uk/about/), although historical information on an individual is based on all 134 UK universities (e.g., exit here means leaving the UK HEI system, and individuals can be tracked over time if and when they change HEIs). The RG have similar approaches to promotion and progression, with an emphasis on research performance as a key determinant of outcomes, while such universities also tend to view other RG members as their main competitors in various rankings and league tables.

These data were used to estimate two types of models: exiting and time to promotion were estimated using parametric survival models, while the probability of an individual being assigned to a particular academic grade was based on an ordered probit model.[2] Both types of models control (as far as they can) for productivity-enhancing characteristics such as age (and

[2] A referee suggested that the results obtained could be sensitive to the different reputations of universities within the Russel Group sector. To take this into account we included institution dummy variables (which were also interacted with the gender variable), finding that these (interacted) dummies were not significantly different for universities that might be deemed to have the strongest reputations. By the terms of the agreement of access to the HESA data, we cannot report results that identify individual institutions.

age-squared), ethnicity, nationality, the proportion of a full-time equivalent contract worked (and its squared term), the length of time working in the university system, and controls for academic discipline (proxied by 45 cost centre dummies) and university (proxied by 23 dummies). In each of the models estimated, covariates were allowed to vary by gender sub-group. A full list of variables and their definitions, as well as mean values separately for men and women, is provided in Table A.1 in the Appendix. It is also important to note that, as alluded to above, there is no direct measure of individual (research) productivity available in the HESA dataset, as such information is not collected annually but rather is assessed periodically in a Research Assessment Exercise (RAE) and the Research Excellence Framework (see REF, 2021). The RAE/REF grade point average (GPA) results for units of assessment covering 2001, 2008 and 2014 have been merged into the HESA dataset to provide some indication of differences across units and universities (see Table S.2 in the Supplementary Appendix). Note, like many studies, we also do not have other controls in addition to productivity, such as the age of children, number of children, and marital status.[3]

Starting with exiting from HEI's, the mean predicted survival time (in years) by gender was obtained from estimating a parametric survival function where the baseline hazard is represented by the Weibull distribution:

$$h(t|\mathbf{x}_j) = \rho t^{\rho-1} e^{(\beta_0+\mathbf{x}_j\boldsymbol{\beta}_x)} \tag{12}$$

where $h(.)$ is the hazard rate at time t for the jth subject conditional on the covariates $\mathbf{x}_j$, and where ρ, β_0, and $\boldsymbol{\beta}_x$ are estimated regression coefficients. Note, in the model estimated each covariate in $\mathbf{x}_j$ was entered a second time multiplied by the dummy variable *female* (coded 1 if the jth subject was a women). Both the Cox and various parametric forms of the survival function (e.g., using an exponential, Gompertz, loglogistic, Weibull, lognormal distributions,

[3] We also do not have data on individuals who are mobile between academic and non-academic jobs, and while this may be an important factor in determining promotions and exiting, the proportion of (older) academics involved is small and so unlikely to significantly impact on the results reported here.

where appropriate with and without frailty/heterogeneity, and in proportional hazards versus accelerated failure-time versions) were estimated and comparisons of loglikelihood functions were used to select the 'best' model using the lowest value of the Akaike information criterion (AIC). Note, 2019/20 serves as the right-censoring year for this survival model of exiting.

As to promotion, this was modelled using both ordered probit (OP) models (showing the probability of an individual being assigned to a particular academic grade) and survival models (showing the mean predicted times to promotion). With respect to the OP models, a random effect (RE) approach is preferred. The latter comprises:

$$\Pr\left(y_{it} > k \middle| \boldsymbol{\kappa}, \mathbf{x}_{it,} \upsilon_i\right) = \Phi(\mathbf{x}_{it}\beta + \upsilon_i - \kappa_k) \qquad (13)$$

where y is academic grade; $\mathbf{x}$ is the vector of regressors with related β parameters (noting that there is no constant term in $\mathbf{x}$); there are $i = 1, \ldots, n$ panels (individuals); $t = 1, \ldots, n_i$; the individual-specific intercepts, υ_i, are assumed to be independent and identically distributed as $N(0,\sigma_\upsilon^2)$; and $\boldsymbol{\kappa}$ comprise here the cut-points κ_1, κ_2 since the number of possible outcomes is $K = 3$; and $\Phi(.)$ is the standard normal cumulative distribution function of the error term ϵ_{it} contained in the latent linear model $y_{it}^* = \mathbf{x}_{it}\beta + \upsilon_i + \epsilon_{it}$, where $\epsilon_{it} \sim N(0,1)$ and $\text{cov}(\epsilon_{it}, \upsilon_i) = 0$. Note, in the model estimated each covariate in $\mathbf{x}$ was entered a second time multiplied by the dummy variable *female* (coded 1 if the *i*th subject was a women). The probability of observing outcome k for response y_{it} is:

$$\Pr\left(y_{it} = k \middle| \boldsymbol{\kappa}, \mathbf{x}_{it,} \upsilon_i\right) = \Phi(\kappa_k - \mathbf{x}_{it}\beta - \upsilon_i) - \Phi(\kappa_{k-1} - \mathbf{x}_{it}\beta - \upsilon_i) \qquad (14)$$

In principle, the RE model has the additional benefit of capturing (via the υ_i) individual-specific differences that should help control for not directly observing individual productivity effects. As well as estimating an ordered probit (OP) model, parametric survival models were also estimated to obtain the mean predicted times to promotion; the 'best fit' models obtained were based on the log-normal distribution.

Figure 1 around here

In terms of the underlying data, in the 2004/05 academic year only 13.9% of Professors in Russell Group universities were women, rising to 26.6% by 2019/20, which was still considerably below the overall 44.1% of academics who were women in the last year analysed (see Figure S.1(a) in the Supplementary Appendix). In contrast, women were over-represented in academic grades below Associate Professor (comprising mostly Assistant Professors and some research assistants at post-doctoral and lower grades[4]); in 2019/20 there was almost gender parity in this sub-group. It can also be shown (Figure S.1(b) in the Supplementary Appendix) that 4.6% of women were Professors in 2004/05, raising to 8.6% by 2019/20. While the gap with male Professors narrowed slightly, men were still over twice as likely to be a Professor in 2019/20 (i.e., 18.8% versus 8.6%). More information by academic discipline is provided in Figure S.2.

The gap at Associate Professor grade has narrowed as well but the gender differential was never as large as that for Professors (20% versus 11.5% in 2004/05 compared to 16.3% versus 13.3% in 2019/20). Thus, women were much more likely to be in a grade below Associate Professor level throughout the period covered (on average nearly 80% for women compared to just under 63% for men). However, the above comparisons conflate promotion rates by gender with differences in the initial share of women at a given grade available for promotion (as well as different exit rates by gender). Thus, Figure 1 presents the proportion by gender promoted to the next grade $k + 1$ in year t relative to the proportion of academics by gender available for promotion from grade k in year $t – 1$. A ratio less than 1 means women were promoted at a lower rate than would be expected if they were given an equal chance to

[4] Because of a change in 2011/12 in the way the data codes academic grades, we cannot separate out Assistant Professors in the 'other' grades sub-group. However, using information on contract type, it is possible to confirm that there are very few (but not zero) promotions from research grades, such as Research Fellow, to Associate Professor. Note also, in the UK Russell Group system, when staff are initially recruited, they serve a period on probation (to mostly confirm their ability to publish, although also to teach to an adequate standard), and then in subsequent years they can apply for promotion to higher grades through usually an annual promotion round undertaken in their institution. Further details are provided in the supplementary appendix.

be promoted, and Figure 1 shows that for promotion to Associate Professor and especially to Full Professor, the ratio was considerably below 1 although increasing over time (cf. Figure S.1).

Lastly, and to help with interpreting the results presented in the next section, there is a discussion as to which variables are more likely to be linked with the (relatively) higher investment costs needed to achieve promotion. The first two are the age of an individual and hours worked (proxied by full-time equivalent – FTE – status). Age is usually linked to experience, and therefore older individuals might be presumed to have invested more in productivity-enhancing activities; and if those with similar ages, cet. par., have different probabilities of being promoted and/or staying in academia, this can be taken as evidence of greater barriers to promotion for these individuals. Age will also be linked to FTE status (working for longer periods in the HEI sector is, cet. par., likely to increase the probability of promotion as experience increases), and if women have a higher propensity to work fewer hours during certain periods of their career (e.g. between 32 to 46 years old when caring for younger children is more likely), this is consistent with the predictions of the model in Section II (and the arguments of Goldin, 2014) that if women face higher barriers to providing the same (quality-related) hours as men in the earlier stages of their careers, they will underinvest relative to men and, cet. par., have higher (lower) exit (promotion) rates. Staying in the HEI sector and moving between institutions is expected to increase the likelihood of being promoted (cf. Blackaby, et al., 2005, who found women were less likely to receive 'outside' offers, and therefore move, but when they did the relative value of the offer was lower than that received by men, suggesting differences in bargaining ability and/or women being relatively more risk-adverse), as is working in more than one role in a HEI in any year (e.g., a major administrative task such as Head of Department, noting as stated earlier than women often take on other administration tasks that are less likely to enhance career progression). Being on a fixed-term contract will likely reduce promotion possibilities, as will being employed by more than one HEI in any year (affecting a very small percentage of individuals) in terms of the likely impact on promotions (although the latter is likely to have the opposite effect for exiting from HEI). Since working in an academic unit that does better in the REF overall signals higher research productivity, then this is likely to increase promotion and retention rates. The larger the proportion of academics who were women (by cost centre, university, and year) presumably increases promotion and retention prospects through a lessening of the strength of cultural norms – and thus the prevalence of stereotyping and bias – operating in different academic disciplines and universities. But whether this benefits men more than women is unclear.[5]

IV. Results

Exits from academia

Table 1 reports the marginal effects separately by gender for each of the variables included in Equation (12). The unconditional (i.e., Equation 12 with no covariates) marginal effect of being a woman was –1.050 (significant at the 1% level) indicating that females survived one year less than men (alternatively, they exited on average one year earlier than men); the overall conditional marginal effect using both male and female observations was –0.412 (significant at the 1% level), showing that conditional on the $\mathbf{x}_j$, women exited some 5 months earlier than men. The separate estimates of the marginal effect of being a female in Table 1 reflects the different mean values of the $\mathbf{x}_j$ held fixed when predicting mean survival times, showing that based on their own set of characteristics women were not statistically significantly more likely to exit ahead of men.[6]

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[5] Meschitti and Marini (2023, p.17) found that "… that promotions [of women] were more likely when Full Professor ranks within academic institutions were men-dominated and Associate Professor ranks were women-dominated".

[6] Box-Stennensmeier et al. (2015:1) also used survival models to consider exiting from academia and the mean time to promotion covering social science in 19 U.S. universities, finding that '… while men were more likely than

Table 1 and Figure 2 around here

Overall, the results in Table 1 confirm that women generally do less well regarding those variables associated with higher survival rates (e.g., older age, longer hours, moving between HEIs, doing additional major administrative tasks, permanent contracts, and working in departments with relative more women present).[7] More detail on predicted survival times is provided in Figure 2 (Figure S.3 provides the background baseline hazard function for comparison). This shows the relationship between expected mean survival time and age (sub-group) by academic grade, separately by gender. Getting older increases the survival time of both men and women, up to around 53 years old for women. For Professors, the conditional survival time for men is always higher than for women and this is also true for Associate Professors (although the difference is almost zero at aged 45 years); for other grades below Associate Professor, women aged between around 32 to 56 years had higher survival times than men.[8] These results confirm one of the main predictions of the model presented in Section II: women are more likely to have higher exit rates in both stages 1 and 2 (i.e., $E_1^f > E_1^m$ and $E_2^f > E_2^m$), the gender gap is largest for Full Professors, and additionally $E_1 > E_2$. With overall higher exit rates (except for 'other' grades between 32 to 56 years old), and a tendency to retire much earlier than men (suggesting overall more dissatisfaction with academia), the results on exiting are congruent with the argument that women face both statistical discrimination and relatively higher costs when investing for promotion.

Table 2 around here

women to be promoted at the different stages of the academic career, no such difference is found when it comes to faculty retention'.

[7] Because of space constraints, detailed discussion of the results in Tables 1 – 3 (including by ethnicity, nationality and cost centres) are presented in the Supplementary Appendix.

[8] This period also overlaps with being relatively more likely to reduce their FTE status (presumably because of caring for young children), when moving outside of academia is riskier and more expensive.

Likelihood of promotions

Table 2 shows the marginal effects obtained from estimating the ordered probit model. Women (cet. par.) were overall (see the footnote to Table 2) some 6.1% less likely to be Full Professors, 4.3% less likely to be Associate Professors and some 10.4% more likely to remain in other grades (i.e., principally Assistant Professors and research assistants).[9] Factors that enhanced promotion tended to benefit men more than women achieving Full Professor, and 'pushed' women more into Associate Professor roles. This included working hours, moving HEI, working longer in in the HEI sector, undertaking a major administrative role, and working in departments with better REF outcomes. The only major exception was in relatively female dominated workplaces where women were (cet. par.) relatively more likely to be promoted to higher grades. Again, the results in this sub-section are compatible with women facing bias when investing for promotion.[10]

Figure 3 around here

Time to promotion

Promotion was also modelled using survival models, separately for those promoted to Associate Professor, and for those promoted from Associate Professor to Full Professor. The first model excludes those in the data who were already senior to the 'others' grade when first observed, while the second model excludes those never promoted to Associate Professor or who were already Professors when first observed. Firstly, a simple Cox proportional hazards regression was estimated with the *female* dummy variable as the only covariate; this produced the (smoothed) hazard functions and hazard ratios shown in Figure 3. Men were more likely to

[9] The comparable figures in Blackaby et al. (2005) were –7.4%, –10% and –13.8%, respectively. Note, their study only covered academic economists in 1999. Mumford and Sechel (2020) using data on academic economists for 2016 obtained figures of –11.0%, –1.5% and 7.2%, respectively.

[10] More detailed information on the relationship between age and the likelihood of observing outcome *k*, as well as the different gender impact of different levels of FTE status, are discussed in the Supplementary Appendix.

be promoted to both Associate and Full Professor, especially after around 15 years exposure to the 'hazard', with the hazard ratios showing that women had on average a 29.3% lower risk of promotion to Associate Professor and a 17% lower risk of promotion to Professor (conditional on having first been promoted to Associate Professor).

Table 3 around here

The results from estimating Equation (12) to obtain time to promotion (based on the marginal effect, $\partial\hat{t}/\partial x$, due to gender) are also summarised in Figure 3 based on (a) unconditional (with only *female* as a covariate) and (b) conditional (with all covariates included) parametric regressions. The unconditional (i.e., Equation 12 with no covariates) marginal effect shows that females took 4.2 years more than men to be promoted to Associate Professor, and a further 2.6 years to then get promoted to Full Professor; the overall conditional marginal effect using both male and female observations shows that women took some 8.5 years more than men to achieve Associate Professor and then a further 6.1 years more to secure a Full Professorship.[11] Table 3 reports the marginal effects separately by gender related to each of the variables included in Equation (12), and these results reflect the different mean values of the $\mathbf{x}_j$ held fixed when predicting mean survival times. Thus, there are differences in the first row of Table 3 with respect to the impact of gender on time to promotion, but generally these differences are small. The results confirm that the investments by men in productivity-enhancing activities have a much quicker pay-off than that achieved by women.

The factors that enhanced promotion, when using the survival approach, are less clear-cut in Table 3 compared to the ordered probit results. For promotion to Associate Professor (when those already at or above that grade are omitted in the estimation of Equation 12), age and undertaking major administrative tasks still tended to benefit men more than women, but

[11] Takahashi & Takahashi (2015), using Japanese data on academic economists were only able to confirm a longer wait times for promotion to Associate Professor. Mairesse et al. (2020) found no difference in promotion rates for male and female French physicists.

FTE status favoured women, and working in departments where REF outcomes were better and/or where the proportion of female academics was relatively higher were more beneficial to women. For promotion to Full Professor (conditional on already having achieved promotion to Associate Professor), most of the key variables leading to faster promotion favoured women (age, hours worked, major administrative tasks, and REF scores). This suggests that further investment in productivity-related activities were less under-valued for women who had already achieved an earlier promotion but given the longer wait times for promotion by women, the overall results are still consistent with women facing bias and overall higher investment costs.

V. Conclusions and discussion

Women remain under-represented in higher academic grades in the UK university sector. By 2019/20, less than 27% of Professors in the Russell Group universities were women, compared to the 44% average for all grades. Our theoretical model of promotion and exits incorporates statistical discrimination and bias, leading to higher investment costs for women, lower promotion likelihoods, and higher exit probabilities relative to men. The model also explains why the gender gap in promotions and exits is larger for Full Professors than for Associate Professors. The empirical models estimated largely confirmed these theoretical predictions. While many empirical studies document instances of bias, they often do not explain why such bias is greater at higher academic levels.

We addressed the role of measured productivity in explaining the ‘leaky pipeline,’ despite lacking direct measures of individual research productivity. Prior literature suggests that omitting such measures leads to only minor changes in gender bias estimates, with several studies finding that productivity differences do not explain the gender gap, and that significant gender gaps remain even after controlling for research productivity. For example, Weisshaar (2017) shows that while productivity measures account for a portion of the gender gap in tenure, a substantial share remains unexplained, indicating that gendered inequality in the tenure evaluation process contributes to the gender gap in tenure rates.

Using data from the Higher Education Statistical Authority (HESA), our analysis confirmed that exit rates decline at higher grades, women are generally more likely to exit academia before men, and female Full and Associate Professors have higher exit rates than men, with the largest gap at the Full Professor level. Women also tend to retire earlier than men. Our promotions model indicated that women were 6.2% less likely to be Full Professors, 4% less likely to be Associate Professors, and 10.2% more likely to remain in other grades. Women took an average of 8.5 years longer than men to become Associate Professors and an additional 6.1 years to become Full Professors.

The study raises important questions about how to increase the promotion rates of women, especially to Full Professor. Mitigating bias, often rooted in cultural and stereotyping factors, is crucial, as set out in the debate between the ‘difference’ model, which attributes gender disparities to cultural influences on women's career choices, and the ‘deficit’ model, which suggests systemic barriers and higher promotion thresholds for women, is significant (see Mairesse & Pezzoni, 2015, for a review).

Institutional equality, diversity, and inclusion (EDI) strategies often incorrectly focus on changing women rather than addressing structural issues (Hodgins and O’Connor, 2021). Concerns about the effectiveness of university EDI efforts are noted in studies by Beattie & Johnson (2012), Scott (2020), Ooms, Werker, & Hopp (2019), and Nielsen (2016). Proposed improvements include acknowledging gender differences in publication rates and research grant success, which disadvantage women in promotion applications (Bosquet, Combes, & García-Peñalosa, 2018).

Comprehensive institutional reforms promoting gender equality and diversity are needed. Universities should foster inclusive environments, value diverse perspectives, and provide equal opportunities for career advancement. Mentorship programs, support networks, and transparent promotion criteria can mitigate bias and ensure fair evaluations. Ultimately, achieving equity and inclusion requires collective efforts from academic institutions, policymakers, and stakeholders to dismantle systemic barriers and promote gender parity in higher education.

Our study emphasizes the need for ongoing research to refine and test models of gender gaps in academia, integrate more detailed data, and explore the effectiveness of various policy interventions. By addressing the root causes of gender disparities and implementing targeted strategies, the academic sector can make progress towards achieving their EDI goals.

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TABLES AND FIGURES

TABLE 1

Marginal effect $(\partial\hat{t}/\partial x)$ of predicted mean survival time in years, UK Russell Group universities 2004/05 to 2018/19

	males	females
Female[a]	-0.552***	-0.234
Age in years (divided by 5)	2.253***	2.379***
FTE (divided by 10)	11.187***	6.470***
Salary	0.027***	0.042***
Fixed-term contract	-3.246***	-4.578***
>1 HEI in any year	4.351***	1.942***
>1 role in any year	6.891***	5.406***
Moved	17.702***	14.592***
REF equivalent GPA	1.214***	1.274***
Proportion female (multiplied by 10)	2.054***	1.200***
Academic grade (benchmark: Professor)		
Associate Professor	-12.983***	-9.443**
Others (mostly Assistant Professors)	-8.301***	-5.638***
Function (benchmark: Teaching only)		
Research only	-12.983***	-9.443***
Teaching & research	-8.301***	-5.638***
Ethnicity (benchmark: White)		
Asian	-1.421***	-0.641***
Black	-2.245***	-2.196***
mixed	-0.743**	-0.452
other	-0.934***	-0.510
unknown	-3.178***	-3.006***
National grouping (benchmark: UK)		
USA	-4.789***	-4.397***
Canada	-5.334***	4.067***
English medium in HEI	-3.561***	-3.681***
EU pre-2004	-3.714***	-3.425***
EU accession	-3.064***	-2.904***
Muslim, Arabic countries	-4.047***	-3.360***
Rest of Africa	-4.489***	-5.191***
Central & S. America	-4.346***	-4.374***
China, HK, Taiwan, Macao	-3.686***	-3.220***
Japan, S Korea	-6.533***	-2.696***
Rest Europe	-2.588***	-3.249***
Russia, CIS	-2.972***	-2.957***
Rest Asia	-4.521***	-3.618***
RoW, not known	-5.026***	-4.224***
44 Cost centre dummies	Yes	Yes
23 university dummies	Yes	Yes
Observations	126,807	98,814
Weibull PH regression diagnostics		
Pseudo-R^2	0.49	
N	1,084,498	
N of subjects	226,269	
N that exited (censored)	121,948	
ρ	1.395***	

[a] The unconditional marginal effect (with no covariates) was -1.050*** years; the overall conditional marginal effect using both male and female observations was -0.412***. Note also, all marginal effects are based on only one (the first) observation per individual (see Cleves, Gould, & Marchenko, 2016: 311, for an explanation)

***/**/* indicate statistically significant at 1/5/10% levels (robust standard errors used)

TABLE 2

Marginal effects ($\partial\hat{p}/\partial x$) from random effects ordered probit model, UK Russell Group universities 2004/05 to 2018/19

	Professor		Associate Professor		Others (mostly Assistant Professors)	
	males	females	males	females	males	females
Female[a]	-0.071***	-0.045***	-0.039***	-0.049***	0.110***	0.094***
ln Age in years	0.453***	0.156***	0.289***	0.343***	-0.742***	-0.499***
ln FTE	0.013***	0.008***	-0.001***	0.011***	-0.014***	-0.019***
Fixed-term contract	-0.059***	-0.020***	-0.039***	-0.055***	0.098***	0.075***
Moved	0.020***	0.006***	0.009***	0.035***	-0.029***	-0.052***
>1 role in any year	0.004***	0.001**	0.003***	0.001***	-0.009***	-0.001***
ln Years in HEI	0.028***	0.010***	0.014***	0.022***	-0.042***	-0.032***
REF equivalent GPA	0.002***	0.001***	-0.001***	0.003***	-0.003***	-0.004***
Proportion female	-0.028***	-0.007***	-0.014***	-0.015***	0.042***	0.022***
Ethnicity (benchmark: White)						
Asian	-0.035***	-0.022***	0.002***	-0.051***	0.033***	0.073***
Black	-0.114***	-0.010***	-0.112***	-0.004***	0.226***	0.014***
mixed	-0.044	-0.002	-0.029	-0.003***	0.073*	0.003***
other	-0.022***	-0.026***	0.010***	-0.068***	0.012***	0.094***
unknown	-0.007	0.008	0.013	-0.009***	-0.006	0.017***
National grouping (benchmark: UK)						
USA	0.028***	0.022***	0.010***	0.047***	-0.040***	-0.069***
Canada	-0.000	0.012***	-0.001	0.029***	0.001	-0.041***
English medium in HEI	0.012***	0.005***	0.005***	0.014***	-0.017***	-0.019***
EU pre-2004	-0.002***	-0.005***	-0.001***	-0.015***	0.003***	0.021***
EU accession	-0.042***	-0.011***	-0.024***	-0.035***	0.066***	0.046***
Muslim, Arabic	-0.053***	-0.013***	-0.031***	-0.044***	0.084***	0.057***
Rest of Africa	-0.037***	-0.020***	-0.020***	-0.075***	0.057***	0.095***
Central & S. America	-0.058***	-0.010***	-0.036***	-0.030***	0.094***	0.040***
China, HK, Taiwan, etc	-0.060***	-0.013***	-0.039***	-0.043***	0.099***	0.056***
Japan, S Korea	-0.065***	0.057***	-0.044***	0.097***	0.109***	-0.154***
Rest Europe	-0.030***	-0.001***	-0.015***	-0.002***	0.045***	0.003***
Russia, CIS	-0.043***	-0.024***	-0.024***	-0.104***	0.067***	0.128***
Rest Asia	-0.036***	-0.003***	-0.020***	-0.009***	0.056***	0.012***
RoW, not known	-0.018***	-0.001**	-0.008***	-0.002**	0.026***	0.003**
Year dummies	yes	yes	yes	yes	yes	yes
44 Cost centre dummies	yes	yes	yes	yes	yes	yes
23 university dummies	yes	yes	yes	yes	yes	yes
N	1,349,909 (of which 791,615 males, 558,294 females)					
Pseudo R^2	0.605					
Log L	-319028.3					
N (panel)	276,572					
σ_u^2	8.336***					

[a] The overall conditional marginal effect using both male and female observations for Professors/AP/other was –0.061***/–0.043***/0.104***.

***/**/* indicate statistically significant at 1/5/10% levels (robust standard errors used)

TABLE 3

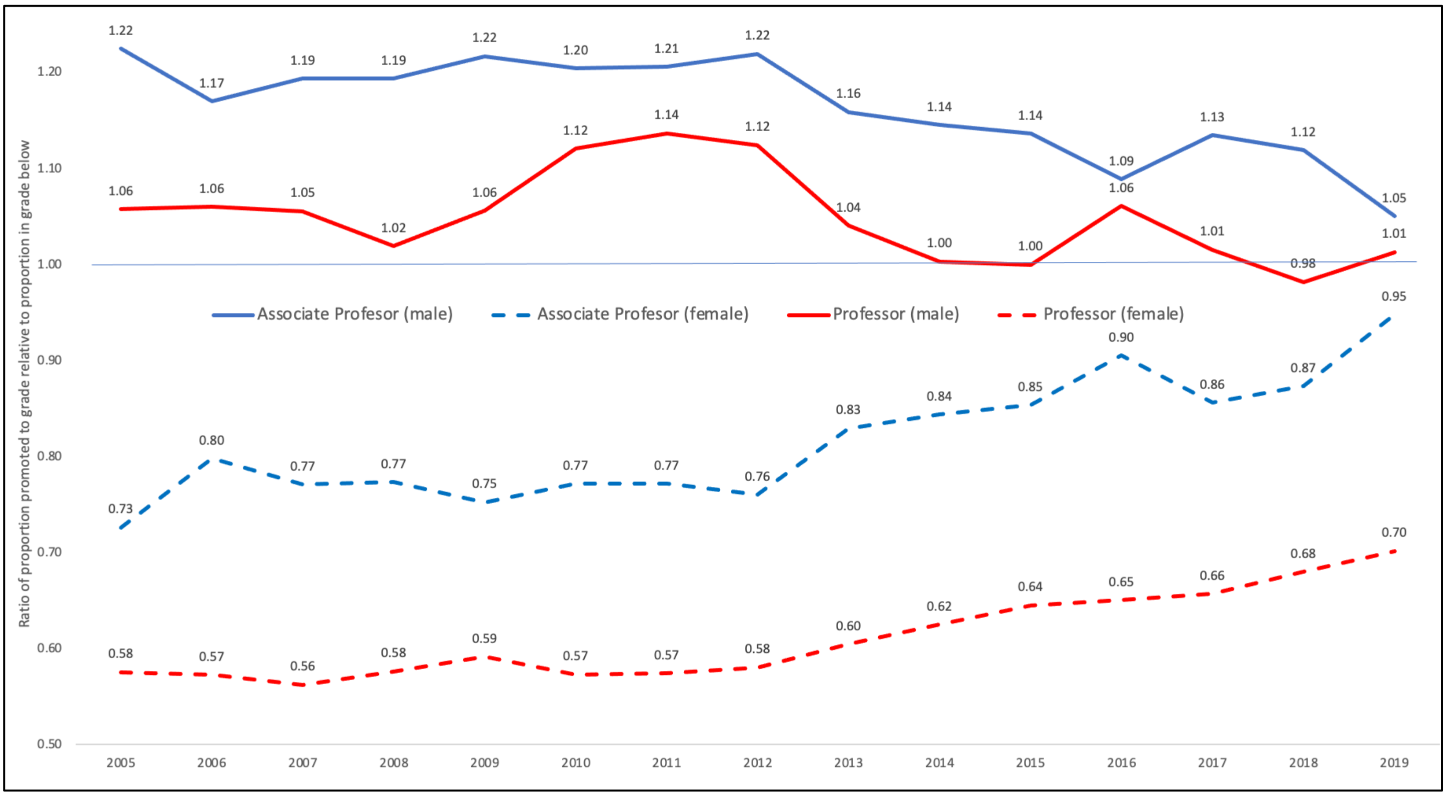
Marginal effect ($\partial\hat{t}/\partial x$) of predicted mean time in years to promotion, UK Russell Group universities 2005/06 to 2018/19

	Promotion to Associate Professor (AP)		Promotion Associate Professor to Professor	
	males	females	males	females
Female[a]	8.378***	8.584***	5.440***	7.231***
Age in years (divided by 5)	-3.889***	-3.177***	0.116	-1.565***
FTE (multiplied by 10)	-2.728***	-3.238***	-0.836*	-3.596***
Fixed-term contract	15.515***	14.206***	4.315**	6.685**
>1 HEI in any year	27.640***	30.886***	12.094***	23.379***
>1 role in any year	-21.274***	-19.311***	-11.731***	-18.232***
Moved	12.507***	14.149***	0.585	-0.507
REF equivalent GPA	-0.848	-3.149***	-1.656***	-5.035***
Proportion female	0.420	-0.253*	-0.436	-1.427
Function (benchmark: Teaching only)				
Research only	24.058***	38.267***	-8.919***	-9.443***
Teaching & research	-23.454***	-20.339***	-15.279***	-18.059***
Ethnicity (benchmark: White)				
Asian	-0.865	0.697	0.022	3.815
Black	22.069***	11.419	-0.206	5.099
mixed	-5.476**	3.675	3.738	0.833
other	0.134	5.362	-0.182	12.688*
unknown	2.046	-7.325	0.659	-1.202
National grouping (benchmark: UK)				
USA	-5.103***	-2.683	-0.417	-3.698
Canada	-0.461	-5.150	2.819	-2.118
English medium in HEI	-4.236*	-2.856	0.287	1.464
EU pre-2004	-1.572*	-0.535	-1.416**	0.617
EU accession	-0.703	15.570***	0.203	-2.140
Muslim, Arabic countries	5.054*	14.066**	3.778	-0.753
Central & S. America	8.216	8.521	1.604	39.745
China, HK, Taiwan, Macao	18.818***	27.990***	1.253	1.809
Japan, S Korea	9.784	33.665***	4.267	8.691
Rest Europe	0.618	3.800	-1.157	-2.707
Russia, CIS	18.951***	13.275*	-0.389	11.430
Rest Asia	8.992**	7.153	-3.776*	2.498
RoW, not known	-0.900	-2.088	-0.778	2.312
44 Cost centre dummies	Yes	Yes	Yes	Yes
23 university dummies	Yes	Yes	Yes	Yes
Observations	100,136	88,999	10,765	6,653
Log normal AFT regression diagnostics				
Pseudo-R^2	0.424		0.297	
N	701,655		92,842	
N of subjects	189,756		14,714	
N that promoted (censored)	14,714		4,428	
σ	0.989***		0.751***	

[a] For the promotion to Associate Professor (promotion from AP to Professor) model, the unconditional marginal effect was 4.233*** (2.563***) years; the overall conditional marginal effect using both male and female observations was 8.475*** (6.124***). Note also, all marginal effects are based on only one (the first) observation per individual (see Cleves, Gould, & Marchenko, 2016: 311, for an explanation)

***/**/* indicate statistically significant at 1/5/10% levels (robust standard errors used)

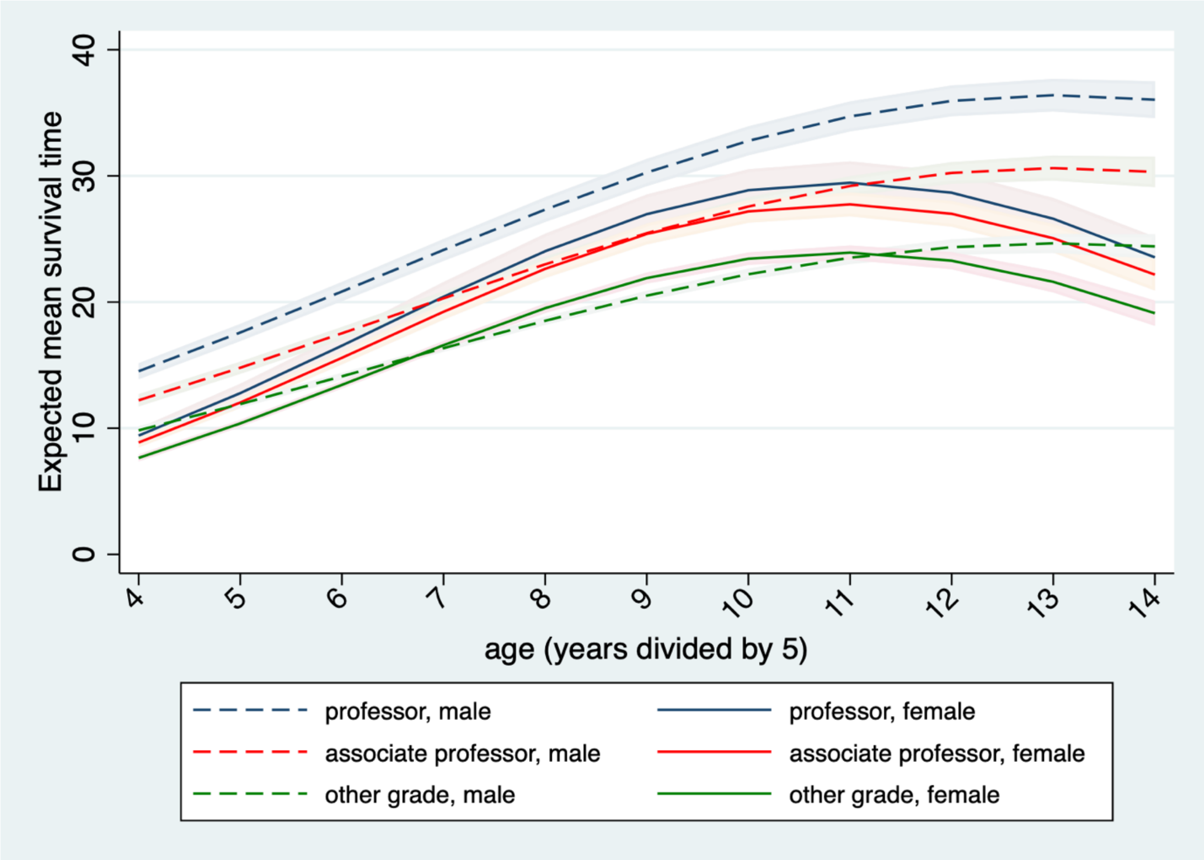
Figure 1. Academic staff promotion by grade and gender,[a] UK Russell Group universities, 2004/05 to 2019/20



[a] $\frac{Pr^j_{t,k+1}/\Sigma_j Pr^j_{t,k+1}}{N^j_{t-1,k}/\Sigma_j N^j_{t-1,k}}$ where *Pr* is the number promoted to grade *k*+1 in year *t*, for gender *j*; *N* is the number of academics in grade *k* in year *t* – 1, for gender *j*.

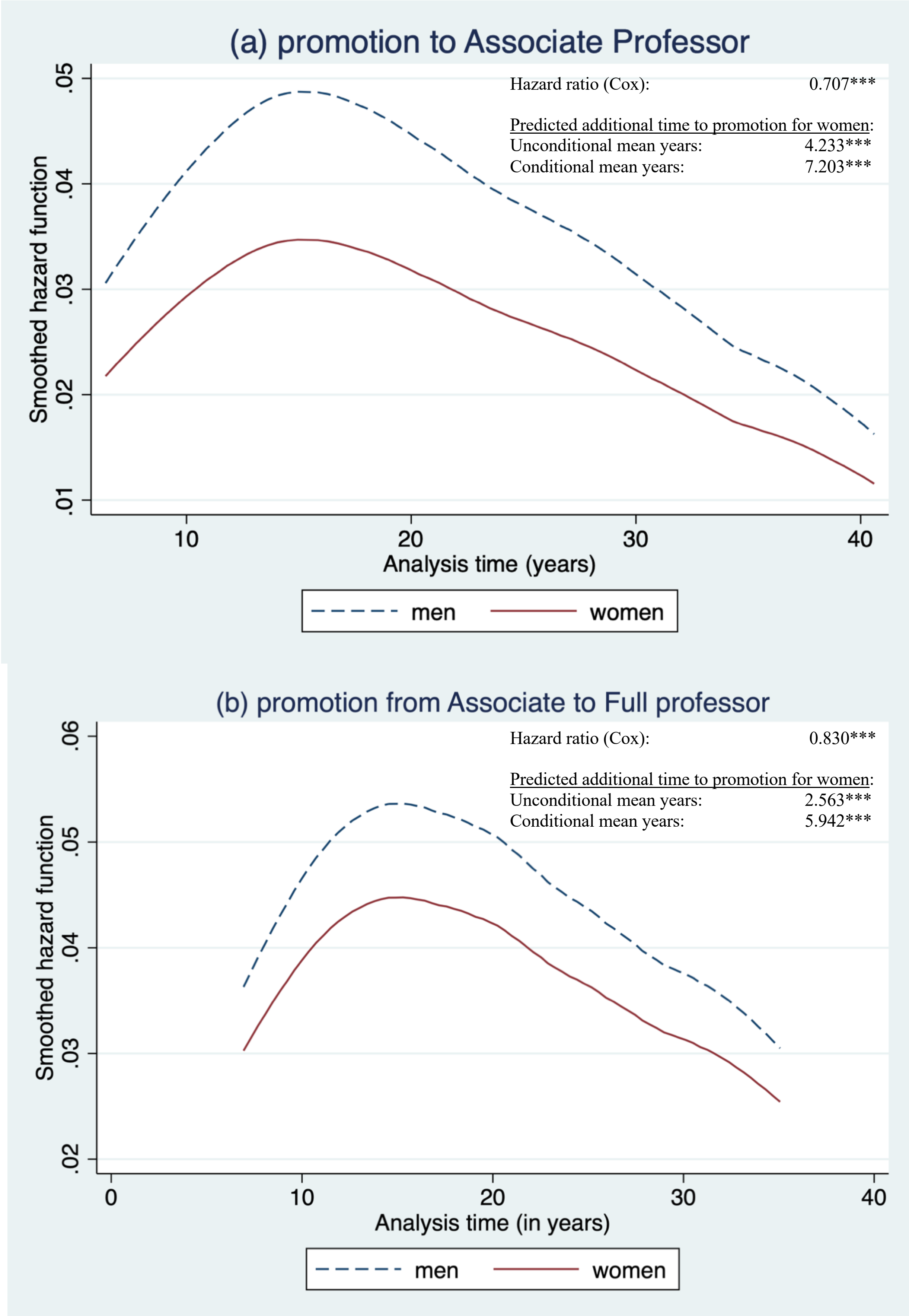
Source: data provided by HESA(2022)

Figure 2. Predicted survival time: gender and grade by age, UK Russell Group universities 2004/05 to 2018/19



Source: Equation (12)

Figure 3. Cox proportional hazards regression[a] of time taken to be promoted to Associate Professor, and Associate Professor to Professor: UK Russell Group universities, 2005/06 to 2019/20



[a] Graphs show hazards based on Cox regression with the female dummy as the only covariate (hazard ratios are also reported). The predicted additional time to promotion for women is based on (a) unconditional (with only female as a covariate) and (b) conditional (with all covariates included) parametric regressions (see Table 3); the predicted mean time reported is based on the marginal effect ($\partial\hat{t}/\partial x$) due to gender

Source: data provided by HESA(2022)

Appendix

TABLE A.1

Definitions of variables and mean values 2004/05 to 2019/20: Russell Group universities[a]

Variable[b]	Definition	Men	Women
exit	Coded 1 in year academic left UK HEIs	0.110	0.125
Academic grade/rank			
Professor	Coded 1 in year academic was a Professor	0.193	0.071
Associate Professor	Coded 1 in year academic was an Associate Professor	0.180	0.130
Others	Coded 1 in year academic was 'other' grade (Assistant Professor, researcher)	0.627	0.799
Age in years (divided by 5)[c]	Age of academic	8.306	7.801
>1 HEI in any year	Employed in more than 1 HEI (coded 1 for that year)	0.021	0.024
>1 role in any year	Undertook more than 1 role (e.g., major administrative as well as academic with salary allocated to >1 cost code) (coded 1 for that year)	0.113	0.130
FTE (divided by 10)[c]	Full-time equivalent (%) period employed in each year	8.031	7.381
Salary	FTE earnings (£'000) deflated by August CPI index (2004=1)	39.639	33.324
Fixed-term contract	Coded 1 in year academic employed on fixed-term contract	0.417	0.499
REF equivalent GPA	Grade point average awarded to unit of assessment in which academic resides in 2001, 2008 or 2014 RAE/REF (see text for details)	2.845	2.851
Moved	Coded 1 if moved institutions after 2003/04	0.154	0.158
Proportion female	Proportion of academics in year who were women, by cost centre (broad academic discipline) by university and by year	0.331	0.435
Years in HEI	Number of consecutive years employed in HE sector (for those moving institutions since 2004/05, truncated to post-2003/04 period)	1.636	1.449
Ethnicity (benchmark: White)			
Asian	Coded 1 in year academic classified as Asian	0.110	0.099
Black	Coded 1 in year academic classified as Black	0.010	0.011
mixed	Coded 1 in year academic classified as Mixed ethnicity	0.016	0.020
other	Coded 1 in year academic classified as other ethnicity	0.019	0.018
unknown	Coded 1 in year academic ethnicity unknown	0.082	0.071
Function (benchmark: Teaching only)			
Research only	Coded 1 in year academic classified as research only	0.426	0.519
Teaching & research	Coded 1 in year academic classified as research & teaching	0.454	0.284
National grouping (benchmark: UK)			
USA	Coded 1 in year legal nationality of academic classified as USA	0.026	0.028
Canada	Coded 1 in year legal nationality of academic classified as Canadian	0.009	0.011
English medium in HEI	Coded 1 in year legal nationality of academic belonged to countries where English is the medium used in HEIs (and not covered in other sub-groups)[d]	0.041	0.045
EU pre-2004	Coded 1 in year legal nationality of academic belonged to 14 EU members states before 2004 (including Monaco, Norway, and Switzerland)	0.157	0.177
EU accession	Coded 1 in year legal nationality of academic classified as part of 10 countries joining EU in 2004	0.017	0.025
Muslim, Arabic countries	Coded 1 in year legal nationality of academic classified was a country where majority of population are Muslim (and not covered in other sub-groups)[e]	0.023	0.018
Rest of Africa	Coded 1 in year legal nationality of academic belonged to African countries not covered in other sub-groups	0.001	0.001
Central & S. America	Coded 1 in year legal nationality of academic belonged to Central and South American countries not covered in other sub-groups	0.011	0.011
China, HK, Taiwan, Macao	Coded 1 in year legal nationality of academic belonged to China, Hong Kong, Taiwan, or Macao	0.034	0.026
Japan, S Korea	Coded 1 in year legal nationality of academic belonged to Japan or South Korea	0.007	0.007
Rest Europe	Coded 1 in year legal nationality of academic belonged to European country not classified elsewhere	0.009	0.010
Russia, CIS	Coded 1 in year legal nationality of academic belonged to Russia or CIS	0.006	0.005
Rest Asia	Coded 1 in year legal nationality of academic belonged to rest of Asia not classified elsewhere	0.023	0.017
RoW, not known	Coded 1 in year legal nationality of academic belonged to other country not classified elsewhere	0.017	0.019
Cost centres	44 cost centre dummies	–	–
University	23 dummies	–	–
N		797,336	564,362

[a] Data limited to academics on a teaching, research or teaching & research contract (greater than 0 FTE). Non-academics that were excluded include support staff and those on 100% administrative contracts.

[b] All variables are from the HESA annual return except the REF equivalent data which is based on results reported by the Research Assessment Exercise and Research Excellence Framework (see Supplementary Appendix for details).

[c] Also squared-terms entered Equations (13) and (14). Note in Tables 1 – 3 and S.2 the marginal effect 'solves out' the overall impact of x where x also enters as x^2.

[d] See https://le.ac.uk/study/international-students/english-language-requirements/approved-countries.

[e] See https://www.nationsonline.org/oneworld/muslim-countries.htm#maj-muslim

Supplementary Appendix (not for publication)

(a) Static model:

The intermediate steps corresponding to scenarios 1, 2 and 3 are as follows.

Scenario 1 (Supply-side):

With underlying assumptions: $\frac{g^m_{s(k+1)}}{g^m_{d(k+1)}} = \frac{g^f_{s(k+1)}}{g^f_{d(k+1)}} = \frac{g_{s(k+1)}}{g_{d(k+1)}}$ and $E^j_{k+1} = E_{k+1}$ for k = 0, 1 then from

Equation (5) we have that for k=0,1

$$P^{*m}_{k+1} > P^{*f}_{k+1} \Leftrightarrow \frac{g_{s(k+1)}}{g_{d(k+1)}} \frac{(w_{k+1} - w_k\ )w_{k+1}w_k}{P^{*m}_k} \frac{\left(1 - E_{k+1}\right)}{c^m_{k+1}}$$

$$> \frac{g_{s(k+1)}}{g_{d(k+1)}} \frac{(w_{k+1} - w_k\ )w_{k+1}w_k}{P^{*f}_k} \frac{\left(1 - E_{k+1}\right)}{c^f_{k+1}}$$

$$\Leftrightarrow \frac{1}{P^{*m}_k c^m_{k+1}} > \frac{1}{P^{*f}_k c^f_{k+1}} \Leftrightarrow P^{*f}_k c^f_{k+1} > P^{*m}_k c^m_{k+1}$$

Then if k=0 and taking into account that $P^{*m}_0 = P^{*f}_0 = 1$ it follows that

$$P^{*m}_1 > P^{*f}_1 \Leftrightarrow c^f_1 > c^m_1 \qquad \text{(A.1')}$$

and if k=1 then

$$P^{*m}_2 > P^{*f}_2 \Leftrightarrow c^m_2 P^{*m}_1 < c^f_2 P^{*f}_1 \qquad \text{(A.2')}$$

and therefore $P^{*m}_1 > P^{*f}_1$ implies

$$c^m_2 < c^f_2 \qquad \text{(A.3')}$$

Scenario 2 (Demand-side):

With underlying assumptions $c^m_{k+1} = c^f_{k+1} = c_{k+1}$ and $E^j_{k+1} = E_{k+1}$ for k = 0, 1, starting from Equation (5) we have that for k=0,1

$$P^{*m}_{k+1} > P^{*f}_{k+1} \Leftrightarrow \frac{g^m_{s(k+1)}}{g^m_{d(k+1)}} \frac{(w_{k+1} - w_k\ )w_{k+1}w_k}{P^{*m}_k} \frac{\left(1 - E_{k+1}\right)}{c_{k+1}}$$

$$> \frac{g^f_{s(k+1)}}{g^f_{d(k+1)}} \frac{(w_{k+1} - w_k\ )w_{k+1}w_k}{P^{*f}_k} \frac{\left(1 - E_{k+1}\right)}{c_{k+1}}$$

$$\Leftrightarrow \frac{g^m_{s(k+1)}}{g^m_{d(k+1)}} \frac{1}{P^{*m}_k} > \frac{g^f_{s(k+1)}}{g^f_{d(k+1)}} \frac{1}{P^{*f}_k}$$

Therefore if k=0 and taking into account that $P^{*m}_0 = P^{*f}_0 = 1$ it follows that

$$P^{*m}_1 > P^{*f}_1 \Leftrightarrow \frac{g^m_{s1}}{g^m_{d1}} > \frac{g^f_{s1}}{g^f_{d1}} \qquad \text{(A.4')}$$

and if k=1 and $P^{*m}_1 > P^{*f}_1$ we have that

$$P_2^{*m} > P_2^{*f} \Leftrightarrow \frac{\frac{g_{s2}^m}{g_{d2}^m}}{\frac{g_{s2}^f}{g_{d2}^f}} > \frac{P_k^{*m}}{P_k^{*f}} > 1 \text{ and thus } \frac{g_{s2}^m}{g_{d2}^m} > \frac{g_{s2}^f}{g_{d2}^f} \qquad \text{(A.5')}$$

<u>Scenario 3</u> (exiting):

Assuming $c_1^m = c_1^f$ and $c_2^m = c_2^f$, $\frac{g_{s1}^m}{g_{d1}^m} = \frac{g_{s1}^f}{g_{d1}^f} = \frac{g_{s1}}{g_{d1}}$; $\frac{g_{s2}^m}{g_{d2}^M} = \frac{g_{s2}^f}{g_{d2}^f} = \frac{g_{s2}}{g_{d2}}$, from Equation (5) we have that for k=0,1

$$P_{k+1}^{*m} > P_{k+1}^{*f} \Leftrightarrow \frac{g_{s(k+1)}}{g_{d(k+1)}} \frac{(w_{k+1} - w_k)w_{k+1}w_k}{P_k^{*m}} \frac{(1 - E_{k+1}^m)}{c_{k+1}} > \frac{g_{s(k+1)}}{g_{d(k+1)}} \frac{(w_{k+1} - w_k)w_{k+1}w_k}{P_k^{*f}} \frac{\left(1 - E_{k+1}^f\right)}{c_{k+1}} \Leftrightarrow \frac{(1 - E_{k+1}^m)}{P_k^{*m}} > \frac{\left(1 - E_{k+1}^f\right)}{P_k^{*f}}$$

Therefore if k=0 and taking into account that $P_0^{*m} = P_0^{*f} = 1$ it follows that

$$P_1^{*m} > P_1^{*f} \Leftrightarrow (1 - E_1^m) > \left(1 - E_1^f\right) \Leftrightarrow E_1^m < E_1^f \qquad \text{(A.6')}$$

and if k=1 and $P_1^{*m} > P_1^{*f}$ we have that

$$P_2^{*m} > P_2^{*f} \Leftrightarrow \frac{(1-E_2^m)}{\left(1-E_2^f\right)} > \frac{P_1^{*m}}{P_1^{*f}} > 1 \Leftrightarrow (1 - E_2^m) > \left(1 - E_2^f\right) \Leftrightarrow E_2^m < E_2^f \qquad \text{(A.7')}$$

(b) Dynamic model:

The intermediate steps to get to Equations (9), (10a) and (11), corresponding to scenarios 1, 2 and 3 respectively, are presented.

<u>Scenario 1</u> (Supply-side):

With underlying assumptions: $\frac{g_{s(k+1)}^m}{g_{d(k+1)}^m} = \frac{g_{s(k+1)}^f}{g_{d(k+1)}^f} = \frac{g_{s(k+1)}}{g_{d(k+1)}}$ and $E_{k+1}^j = E_{k+1}$ for $k = 0, 1$ then starting from Equation (5):

$$P_{k+1}^{*m} - P_{k+1}^{*f} = (w_{k+1} - w_k)w_{k+1}w_k(1 - E_{k+1})\left[\frac{g_{s(k+1)}^m}{g_{d(k+1)}^m}\frac{1}{c_{k+1}^m}\frac{1}{P_k^{*m}} - \frac{g_{s(k+1)}^f}{g_{d(k+1)}^f}\frac{1}{c_{k+1}^f}\frac{1}{P_k^{*f}}\right] \qquad (8)$$

Assuming $E_1 > E_2 \Leftrightarrow$(1-$E_1$)<(1-$E_2$); $\frac{g_{s1}}{g_{d1}} < \frac{g_{s2}}{g_{d2}}$, $P_0^{*f} = P_0^{*m} = 1$, and $(w_1 - w_0)w_1w_0 < (w_2 - w_1)w_2w_1$ (which is equivalent to $[(w_1 - w_0)/(w_2 - w_1) < w_2/w_0]$, i.e., the salary gap between Associate and Assistant Professor relative to the wage gap between Full and Associate Professor is smaller than the relative salary of Full Professors to that of the salary of Assistant Professors, which is supported by the empirical evidence – see Harris and Mate-Sanchez-Val, 2022) it follows that:

$$P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f} \Leftrightarrow \left[\frac{1}{c_1^m P_0^{*m}} - \frac{1}{c_1^f P_0^{*f}}\right] < \left[\frac{1}{c_2^m P_1^{*m}} - \frac{1}{c_2^f P_1^{*f}}\right]$$
$$\Leftrightarrow \left[c_1^f P_0^{*f} - c_1^m P_0^{*m}\right] \ll \left[c_2^f P_1^{*f} - c_2^m P_1^{*m}\right]$$
$$\Leftrightarrow [c_2^m P_1^{*m} - c_1^m] \ll \left[c_2^f P_1^{*f} - c_1^f\right] \qquad (9)$$

Scenario 2 (Demand-side):

Starting from Equation (5) and assuming $c_{k+1}^m = c_{k+1}^f = c_{k+1}$, for k = 0, 1, then (8) becomes

$$P_{k+1}^{*m} - P_{k+1}^{*f} = (w_{k+1} - w_k)w_{k+1}w_k(1 - E_{k+1})\frac{1}{c_{k+1}}\left[\frac{g_{s(k+1)}^m}{g_{d(k+1)}^m}\frac{1}{P_k^{*m}} - \frac{g_{s(k+1)}^f}{g_{d(k+1)}^f}\frac{1}{P_k^{*f}}\right] \qquad \text{(8a)}$$

Thus, the inequality $P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f}$ is verified iff:

$$(w_1 - w_0)w_1 w_0 \frac{1}{c_1}(1 - E_1)\left[\frac{g_{s1}^m}{g_{d1}^m}\frac{1}{P_0^{*m}} - \frac{g_{s1}^f}{g_{d1}^f}\frac{1}{P_0^{*f}}\right] < (w_2 - w_1)w_2 w_1 \frac{1}{c_2}(1 - E_2)\left[\frac{g_{s2}^m}{g_{d2}^m}\frac{1}{P_1^{*m}} - \frac{g_{s2}^f}{g_{d2}^f}\frac{1}{P_1^{*f}}\right]$$

Since $P_0^{*f} = P_0^{*m} = 1$, $c_1 < c_2$, $(w_1 - w_0)w_1 w_0 < (w_2 - w_1)w_2 w_1$, and (1-$E_1$)<(1-$E_2$) we get that:

$$1 < \frac{c_2}{c_1} < \frac{\frac{g_{s2}^m}{g_{d2}^m}\frac{1}{P_1^{*m}} - \frac{g_{s2}^f}{g_{d2}^f}\frac{1}{P_1^{*f}}}{\frac{g_{s1}^m}{g_{d1}^m}\frac{1}{P_0^{*m}} - \frac{g_{s1}^f}{g_{d1}^f}\frac{1}{P_0^{*f}}} \Leftrightarrow \left[\frac{g_{s1}^m}{g_{d1}^m}\frac{1}{P_0^{*m}} - \frac{g_{s1}^f}{g_{d1}^f}\frac{1}{P_0^{*f}}\right] < \left[\frac{g_{s2}^m}{g_{d2}^m}\frac{1}{P_1^{*m}} - \frac{g_{s2}^f}{g_{d2}^f}\frac{1}{P_1^{*f}}\right]$$

$$\Leftrightarrow \left[\frac{g_{s2}^f}{g_{d2}^f}\frac{1}{P_1^{*f}} - \frac{g_{s1}^f}{g_{d1}^f}\right] < \left[\frac{g_{s2}^m}{g_{d2}^m}\frac{1}{P_1^{*m}} - \frac{g_{s1}^m}{g_{d1}^m}\right] \quad (10a)$$

Scenario 3 (exiting):

Assuming $c_1^m = c_1^f$ and $c_2^m = c_2^f$, $\frac{g_{s1}^m}{g_{d1}^m} = \frac{g_{s1}^f}{g_{d1}^f} = \frac{g_{s1}}{g_{d1}}$; $\frac{g_{s2}^m}{g_{d2}^M} = \frac{g_{s2}^f}{g_{d2}^f} = \frac{g_{s2}}{g_{d2}}$, from Equation (8a)

$$P_{k+1}^{*m} - P_{k+1}^{*f} = (w_{k+1} - w_k)w_{k+1}w_k \frac{g_{s(k+1)}}{g_{d(k+1)}}\frac{1}{c_{k+1}}\left[\frac{(1-E_{k+1}^m)}{P_k^{*m}} - \frac{1(1-E_{k+1}^f)}{P_k^{*f}}\right] \quad (8b)$$

Thus, the inequality $P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f}$ is verified iff:

$$(w_1 - w_0)w_1 w_0 \frac{g_{s1}}{g_{d1}}\frac{1}{c_1}\left[\frac{(1 - E_1^m)}{P_0^{*m}} - \frac{(1 - E_1^f)}{P_0^{*f}}\right] < (w_2 - w_1)w_2 w_1 \frac{g_{s1}}{g_{d1}}\frac{1}{c_2}\left[\frac{(1 - E_2^m)}{P_1^{*m}} - \frac{(1 - E_2^f)}{P_1^{*f}}\right]$$

From the previous inequality, since $(w_1 - w_0)w_1 w_0 < (w_2 - w_1)w_2 w_1$; $\frac{g_{s1}}{g_{d1}} < \frac{g_{s2}}{g_{d2}}$, and $c_1 < c_2$ it follows that:

$$P_1^{*m} - P_1^{*f} < P_2^{*m} - P_2^{*f} \Leftrightarrow \left\{\frac{1}{c_1}\left[\frac{(1 - E_1^m)}{P_0^{*m}} - \frac{(1 - E_1^f)}{P_0^{*f}}\right] < \frac{1}{c_2}\left[\frac{(1 - E_2^m)}{P_1^{*m}} - \frac{(1 - E_2^f)}{P_1^{*f}}\right]\right\}$$

Since $c_1 < c_2$ the previous inequality holds if and only if :

$$\left[\frac{(1-E_1^m)}{P_0^{*m}} - \frac{(1-E_1^f)}{P_0^{*f}}\right] < \left[\frac{(1-E_2^m)}{P_1^{*m}} - \frac{(1-E_2^f)}{P_1^{*f}}\right]$$

Now since $P_0^{*m} = 1 < P_1^{*m}$ the previous inequality is equivalent to:

$$E_1^f - E_1^m < \left[\frac{(1-E_2^m)}{P_1^{*m}} - \frac{(1-E_2^f)}{P_1^{*f}}\right] \quad (11)$$

Considering the previous inequality, if $E_1^f > E_1^m$ then obviously $P_1^{*f} < P_1^{*m}$ and

$$\frac{(1 - E_2^m)}{P_1^{*m}} > \frac{(1 - E_2^f)}{P_1^{*f}}$$

which is equivalent to

$$\frac{(1 - E_2^f)}{(1 - E_2^m)} < \frac{P_1^{*f}}{P_1^{*m}} < 1$$

and thus $E_2^m < E_2^f$.

Moreover, since $P_1^{*f} < P_1^{*m}$ and $P_1^{*f} > 1$ we get that

$E_1^f - E_1^m < \frac{(1-E_2^m)}{P_1^{*m}} - \frac{\left(1-E_2^f\right)}{P_1^{*f}} < \frac{(1-E_2^m)}{P_1^{*f}} - \frac{\left(1-E_2^f\right)}{P_1^{*f}} = \frac{\left(E_2^f - E_2^m\right)}{P_1^{*f}}$ and therefore

$E_1^f - E_1^m < P_1^{*f}(E_1^f - E_1^m) < \{[(1 - E_2^m) - (1 - E_2^f)] = E_2^f - E_2^m\}$
That is, $E_1^f - E_1^m < E_2^f - E_2^m$

Table S.1: HEI's omitted from analysis[a]

10000080 Access to Music Limited
10000163 AECC University College
10000216 All Nations Christian College
10000248 Academy of Live and Recorded Arts
10000381 Arts Educational Schools
10000894 Bristol Baptist College
10000911 BCNO Limited
10000936 The British School of Osteopathy
10000939 West London College
10001386 Chicken Shed Theatre Company
10001419 Christie's Education Limited
10001546 The College of Integrated Chinese Medicine
10001653 Conservatoire for Dance and Drama
10001802 Cumbria Institute of the Arts
10001856 Darington College of Arts
10002113 East End Computing and Business College Limited
10002313 ESCP Europe Business School
10002344 European School of Osteopathy
10002681 Glasgow School of Art
10002735 Grafton College
10002901 Harper Adams University
10003138 Homerton College
10003212 Hult International Business School Ltd
10003239 ICON College of Technology and Management
10003324 The Institute of Cancer Research
10003331 Regent's University London
10003566 Kensington College of Business
10003574 Kent Institute of Art and Design
10003758 LAMDA Limited
10003798 Le Cordon Bleu Limited
10003854 Leeds Arts University
10003856 Leeds College of Music
10003945 The Liverpool Institute for Performing Arts
10003958 Liverpool School of Tropical Medicine
10004006 London Centre of Contemporary Music
10004023 London College of International Business Studies Ltd
10004035 The Film Education Training Trust Limited
10004036 London Film School Limited
10004060 London School of Business and Finance (UK) Limited
10004061 Bloomsbury Institute
10004075 London School of Theology

10004079 London Studio Centre
10004206 University of St Mark and St John
10004320 The Metanoia Institute
10004365 Millennium Performing Arts Ltd
10004450 Mountview Academy of Theatre Arts
10004511 The National Film and Television School
10004538 Nazarene Theological College
10004740 Northern College of Acupuncture
10004775 Norwich University of the Arts
10004879 Open College of the Arts
10005127 Plymouth College of Art
10005389 Ravensbourne University London
10005415 Redcliffe College
10005451 Arden University
10005470 Richmond, The American International University in London
10005523 Rose Bruford College of Theatre and Performance
10005544 Royal Academy of Dance
10005545 Royal Agricultural University
10005561 Royal Conservatoire of Scotland
10005700 SRUC
10005916 Slough Borough Council
10006093 Spurgeon's College
10006243 St Patrick's International College
10006427 University for the Creative Arts
10007048 Trinity University College
10007162 University of the Arts, London
10007361 Waverley Abbey College
10007532 Wimbledon School of Art
10007657 Writtle University College
10007761 Courtauld Institute of Art
10007765 Heythrop College
10007766 Institute of Education
10007777 Royal College of Art
10007778 Royal College of Music
10007779 The Royal Veterinary College
10007781 The School of Pharmacy
10007797 University of London (Institutes and activities)
10007809 Bell College
10007811 Bishop Grosseteste University
10007816 The Royal Central School of Speech and Drama
10007820 Grŵp Llandrillo Menai
10007824 Edinburgh College of Art

10007825	Guildhall School of Music and Drama
10007832	Newman University
10007833	Glyndŵr University
10007835	Royal Academy of Music
10007836	The Royal College of Nursing
10007837	Royal Northern College of Music
10007838	Royal Welsh College of Music and Drama
10007839	SAE Education Limited
10007912	Cliff College
10007937	GSM London
10008017	Trinity Laban Conservatoire of Music and Dance
10008071	AA School of Architecture
10008098	Study Group
10008173	University College of Estate Management
10008229	EThames Graduate School Limited
10008289	The London Institute of Banking & Finance
10008325	KLC School of Design
10008362	London School of Science and Technology Limited
10008397	Norland College
10008455	Regent College
10008574	The University of Wales (central functions)
10008816	Northern School of Contemporary Dance
10009285	Kogan Academy of Dramatic Arts
10009292	Royal Academy of Dramatic Art
10009527	Istituto Marangoni Limited
10009612	Luther King House Educational Trust
10009614	Grŵp NPTC Group
10010213	The City College
10010227	Oak Hill College
10010308	Cambridge Arts and Sciences Limited
10013109	London Bridge Business Academy
10013220	Institute of Art - London Limited
10013357	The Academy of Contemporary Music
10015506	The London College UCK
10018361	City of London College
10019178	Point Blank Music School
10019368	London College of Business Studies
10019746	ABI College Limited
10020416	Mattersey Hall
10020436	The Royal School of Needlework
10020439	Oxford Business College
10021100	Regents Theological College

10021256 The Salvation Army
10021682 Kaplan Open Learning
10022021 UK College of Business and Computing
10022047 Empire College London Limited
10022087 Futureworks
10022285 London School of Management Education
10022944 Stratford College London Limited
10023130 Nova College of Accounting and Business Ltd
10023290 West London College of Business and Management Sciences Limited
10023434 London School of Commerce & IT Limited
10023445 ICOM
10023452 The Markfield Institute of Higher Education
10023453 Matrix College of Counselling and Psychotherapy Ltd
10023454 Moorlands College
10023456 Newbold College
10023458 The Sherwood Psychotherapy Training Institute Limited
10023777 Mont Rose College of Management and Sciences
10023871 Results Consortium Limited
10024024 Central Film School London
10025197 University Centre Quayside Limited
10026921 Christ the Redeemer College
10028216 Brit College
10029682 The Islamic College
10029843 Waltham International College Limited
10030129 Nelson College London Ltd
10030391 London Churchill College Ltd
10030408 Gower College Swansea
10030776 St Mellitus College
10031982 BPP University
10032036 Amity Global Education
10032072 The Cambridge Theological Federation
10032277 The Minster Centre
10032282 The Queen's Foundation for Ecumenical Theological Education
10032288 West Dean College
10032299 Tech Music Schools
10032594 London School of Academics Ltd
10033187 Fairfield School of Business Ltd
10034324 Court Theatre Training Company Ltd
10034449 Leeds Conservatoire
10035638 Institute of Contemporary Music Performance
10037544 BIMM Limited
10037822 Tottenham Hotspur Foundation

10038763	ForMission Ltd
10039082	City and Guilds of London Art School
10039956	The University of Law
10040812	Harper Adams University
10041898	Apex College London
10041974	London College of Business Sciences
10042194	Kaplan Holborn College
10042364	Ballet West
10042500	Global Banking School Limited
10042570	Pearson College
10042737	UK Business College Ltd
10045289	St Nicholas Montessori Training Limited
10045476	Met Film School Limited
10048199	New College of the Humanities
10053279	The Sherwood Institute
10053304	Navitas UK Holdings Limited
10057951	London College of Creative Media Limited
10062810	The London School of Architecture
10066551	LCCM AU UK Limited
10067355	Dyson Technical Training Limited
10067388	The Institute of Ismaili Studies
10067853	ACM Guildford Limited
10080811	Hartpury University
10081618	The Council of the Inns of Court
10083476	The Prince's Foundation

[a] Data on 327 HEIs was made available by HESA, and the table lists the 193 excluded from the analysis since they were very specialised in what they did.

Discussion of UK HEI promotion, salary schemes in more detail

The following table sets out the salary and grades for a typical Russell Group university covering 2019/20.

35 hr week

Normal working hours rates - from 1 August 2019

Contribution Points (shaded cells, marked CP below)

Rate/hr	Spine Point	FTE Salary		
£35.4967	52	£64,604	Grade 9: CP	
£34.4654	51	£62,727	Grade 9: CP	
£33.4643	50	£60,905	Grade 9: CP	
£32.4918	49	£59,135	Grade 9: 5	
£31.5484	48	£57,418	Grade 9: 4	
£30.6319	47	£55,750	Grade 9: 3	
£29.7423	46	£54,131	Grade 9: 2	Grade 8: CP
£28.8791	45	£52,560	Grade 9: 1	Grade 8: CP
£28.0407	44	£51,034		Grade 8: CP
£27.2269	43	£49,553		Grade 8: 7
£26.4363	42	£48,114		Grade 8: 6
£25.6692	41	£46,718		Grade 8: 5
£24.9236	40	£45,361		Grade 8: 4
£24.2005	39	£44,045	Grade 7: CP	Grade 8: 3
£23.5121	38	£42,792	Grade 7: CP	Grade 8: 2
£22.8165	37	£41,526	Grade 7: CP	Grade 8: 1
£22.1549	36	£40,322	Grade 7: 7	
£21.5121	35	£39,152	Grade 7: 6	
£20.8885	34	£38,017	Grade 7: 5	
£20.2824	33	£36,914	Grade 7: 4	
£19.6951	32	£35,845	Grade 7: 3	Grade 6: CP
£19.1231	31	£34,804	Grade 7: 2	Grade 6: CP
£18.5698	30	£33,797	Grade 7: 1	Grade 6: CP
£18.0313	29	£32,817		Grade 6: 8
£17.5088	28	£31,866		Grade 6: 7
£17.0011	27	£30,942		Grade 6: 6
£16.5088	26	£30,046		Grade 6: 5
£16.0308	25	£29,176		Grade 6: 4
£15.5665	24	£28,331		Grade 6: 3
£15.1159	23	£27,511	CP	Grade 6: 2
£14.6786	22	£26,715	CP	Grade 6: 1

Associate Professor (Spine Points 45–52)

Assistant Professor, (Senior) Research Fellow, (Senior) Research Assistant (Spine Points 30–46)

(Junior) Research or Teaching Assistant (Spine Points 22–32)

Assistant Professors starting their career typically are appointed on probation at the bottom end of Grade 7 (but depending on their publications usually from their PhD may be on Spine Points 30 – 32). After being appointed to open-ended/permanent contracts post-probation they achieve annual salary increments automatically to Spine Point 36 and then move to Grade 8 (unless there are issues over their performance which may result in their staying at Grade 7). Progression to the Spine Point 43 is automatically achieved annually, with movement to Points 44-46 discretionary depending on performance. Promotion to Associate Professor (Grade 9) requires submitting an application to the promotion process operated within a university (often requiring clearing hurdles at Departmental, Faculty and then institution level). Grade 10 (with spot salary levels) is Full Professor, which again requires submitting an application to the annual promotions round. Universities typically have three levels of professor (bands 1 – 3) associated with different performance and different salary bands for each level.

Appointment of Research Fellows (which includes post-doctoral students who are paid by the institution for research – as opposed to post-docs on usually government funded grants who are not fixed-term university employees) is usually to Grade 7, but can be Grade 8; Research or Teaching Assistants are usually appointed to Grade 7. Staff on teaching only contracts are also designated as Assistant, Associate or Full Professors (teaching only).

Average GPA scores for academics in HESA database for a selection of UoA (based on 2014 UoA classification)

year	Clinical Medicine	Biological Sciences	Physics	Electrical and Electronic Engineering, Metallurgy and Materials	Economics and Econometrics	Politics and International Studies	Anthropology and Development Studies	Modern Languages and Linguistics	Philosophy	Communication, Cultural and Media Studies, Library, and Information Management
2004	2.62	2.51	2.61	2.09	2.59	2.23	1.91	1.84	2.06	1.48
2005	2.62	2.51	2.62	2.09	2.62	2.24	1.99	1.86	2.10	1.43
2006	2.62	2.50	2.63	2.13	2.63	2.26	1.98	1.86	2.13	1.46
2007	2.62	2.49	2.63	2.14	2.63	2.25	2.03	1.89	2.19	1.45
2008	2.62	2.48	2.62	2.14	2.63	2.26	2.03	1.87	2.18	1.44
2009	2.80	2.37	2.59	2.01	3.13	2.00	2.44	1.79	2.28	1.97
2010	2.78	2.37	2.60	2.08	3.11	2.00	2.39	1.86	2.35	2.01
2011	2.78	2.36	2.60	2.13	3.11	2.04	2.44	1.87	2.44	2.00
2012	2.79	2.38	2.61	2.20	3.11	2.07	2.54	1.91	2.52	2.03
2013	2.81	2.39	2.62	2.25	3.10	2.08	2.56	1.97	2.56	2.05
2014	3.20	2.96	3.14	2.32	3.10	2.69	2.78	2.47	2.84	2.50
2015	3.20	2.95	3.14	2.27	3.10	2.69	2.78	2.51	2.84	2.50
2016	3.20	2.96	3.14	2.25	3.09	2.71	2.76	2.50	2.82	2.54
2017	3.19	2.97	3.14	2.24	3.10	2.70	2.74	2.54	2.83	2.55
2018	3.19	2.98	3.14	2.17	3.08	2.71	2.71	2.56	2.84	2.56
2019	3.19	2.95	3.14	2.08	3.07	2.73	2.71	2.61	2.85	2.55

Source: RAE/REF published scores by UoA mapped into HESA database

More detail on gender-bias[12] literature

The extant literature provides many examples of women facing numerous barriers to career development constituting bias factors, such as women being asked to take on tasks less likely to enhance career progression (such as teaching, pastoral care, or course leadership with related committee work – see Barrett and Barrett, 2011; Guarino and Borden, 2017) as opposed to those that do lead to promotions (e.g., senior management and similar leadership positions – see Morley, 2014); women being more reluctant to apply for posts (Nielsen, 2016; Ceci et. al., 2014; Bosquet et. al., 2018[13]), women being perceived as more conscientious and compliant (Eswaran, 2014), and less willing to compete (Buser et. al., 2014; Booth, et. al., 2019; Nicholls, 2022). In contrast, (alpha) men are more 'pushy and ambitious' (Coate and Howson, 2016), rate and cite their work more highly (King, et. al., 2017), and when women internalise such prevailing cultural norms and stereotypes it often has negative outcomes (they are seen as 'aggressive' – Monroe, 2013).

Consequently, it has been shown females publish less often than their male counterparts[14,15,16] (Bird, 2011; Abramo et. al., 2021; Habiht et. al., 2021; Mayer and Rathmann, 2018; Huang et. al., 2020; Mairesse et. al., 2019; Sá et. al., 2020; Campbell and Simberloff, 2022; Cameron et. al., 2016),[17] submissions spend longer in peer review (Branch and Kvasnicka, 2017) and they are often held to higher standards in top journals (Card et. al, 2020; Hengel, 2022). Additionally, (lesser-known) female authors are less likely to have papers accepted at conferences (Hospido and Sanz, 2021), get asked more (hostile and patronising) questions (Dupas, et. al., 2021), and research by female authors is evaluated

[12] The term 'bias' is preferred to 'discrimination' since the latter implies a 'taste' based approach. In a system that espouses to be based on meritocracy, and given legal restraints, it seems unlikely that universities engage in 'taste' based discrimination but rather (unconscious) bias, presumably based on the prevalence of a male (white) culture. Only the term 'statistical discrimination' is retained as this is the terminology used in the literature.

[13] The latter looked at promotions of academic economists in France, finding that women "… are less likely to seek promotion, and this accounts for up to 76 percent of the promotions gap" (p. 1020).

[14] Cole & Zuckerman (1984) labelled the prevailing evidence that academic men out-publish women as the 'productivity puzzle'.

[15] There is a large literature that looks at gender differences in research productivity and what determines this. Reviewing this literature falls outside the main focus of this study, but it is worth noting that most studies find a gender gap, which increases with career length, is often linked to women publishing fewer numbers of articles and these are relatively more likely to appear in lower quality journals (or in non-journals). Squazzoni et. al. (2021) review an extensive literature that shows generally a gender-bias in publishing, although their extensive study of 145 journals indicates that "manuscripts submitted by women or co-authored by women are generally not penalized during the peer review process " (p. 7). Note, their analysis excludes desk-rejected papers, and does not control whether woman invested more time in preparing their manuscripts to prevent expected editorial bias, which might also explain lower submission rates. Indeed, Squazzoni et. al. (op. cit.) confirmed (see their Table 1) that women generally accounted for only one-third of authors and the percentage of women referees was even lower.

[16] More generally, Altbach (2015, p. 6) states 'For research-intensive universities and the academics working in them, the measurement of academic productivity is neither straightforward nor easy'. The role of journal rankings, how to weight research grants and other awards/indicators of esteem, is not uncontroversial. In the UK the Research Excellence Framework's (see, for example, REF 2021) measurement and ranking of research every 5-6 years, using various sub-panels of discipline experts, often provides rankings that vary significantly compared to the rankings a university itself predicts based on internal and external reviews of journal papers submitted to the REF; and the official REF rankings often differ widely to those that would be obtained using rankings of journals (e.g., the Association of Business School journal rankings). Indeed, Pidd & Broadbent (2015) found in comparing the REF rankings and ABS journal rankings for 1000 papers randomly selected from those submitted in REF 2014 to the Business and Management sub-panel, that only about half of the sample were awarded the same REF grade as the ABS rank (with respect to the top ranking, only 39% of those rated 4* by the ABS ranking were agreed to be 4* by the 2014 REF panel). For Norway, Nygaar and Bahgat (2018) found that different measures of the gender gap depends on different bibliometric indicators which capture different aspects of research performance.

[17] Astegiano et. al. (2019) undertook a meta-analysis of the gender productivity gap in science confirming that men published relatively more articles, but there was an even larger gender-gap when looking at group representation on scientific evaluation committees (e.g., for research positions, academic evaluations, journal editorial boards). Additionally, and stemming from the overrepresentation of men on committees (where peer recognition of a researcher's work takes place), when looking at success rates, "… men were more successful in gaining faculty or research positions…or nominations for evaluation committees… or grants… but success rate was the same for publishing research articles" (p. 7) – for the latter, noting that men submit more articles than women to journals. This led Astegiano et. al. (op. cit.) to conclude "… the fact that women have the same success rate at publishing articles as men but do not get research positions, receive grants or are proposed for evaluation committees at the same rate as men may discourage women's scientific careers. These results strongly support the idea that productivity itself may be highly affected by peer recognition and therefore by the scientific landscape in which researchers develop their careers" (p. 9).

less favourably (Krawczyk and Smyk, 2016; Jappelli et. al., 2017). Female researchers are less likely to be mentored (cf. Buch, et. al. 2011), co-author with men, have their work cited (Koffi, 2021), including self-citation (King, 2017)[18] and have comparable networks (cf. Adcroft and Taylor, 2013; Angervall et. al., 2015; Ductor et. al., 2021). In general prestige factors linked to academic advancement are more likely to be established and acquired by male academics (Coate and Howson, 2016), and consequently women are promoted at a slower rate and less often than men (Winslow and Davis, 2016). Note, not all the literature finds gender bias: Ceci, Kahn and Williams (2023) conducted a large scale meta-analysis that showed "tenure-track women are at parity with tenure-track men in three domains (grant funding, journal acceptances, and recommendation letters) and are advantaged over men in the fourth domain (hiring). For teaching ratings and salaries we found evidence of bias against women… Even in the four domains in which we failed to find evidence of sexism disadvantaging women, we nevertheless acknowledge that broad societal structural factors may still impede women's advancement in academic science" (p. 15). Ceci et. al (2014) is also an example of meta-analyses suggesting that gender-bias is much less in evidence (ceased to exist) in recent years in maths-intensive fields, and the causes of disadvantage are rooted in pre-college factors. In addition, Squazzoni et. al. (2021) found that manuscripts submitted by women to 145 journals covering a range of subject areas are generally not penalised during the peer review process, although (see their Table 1) women generally accounted for only one-third of authors and the percentage of women referees was even lower.

Differences in the likelihood of promotion also potentially occur if family commitments lower the (quality) time females allocate to research activities, especially during early career years which overlap with peak family formation years (Probert, 2005; Mason, Wolfinger, and Goulden, 2013; Aiston and Jung, 2015; Toffoletti and Starr, 2016; Winslow and Davis, 2016; Bozzon, et. al. 2017).[19] Being an academic requires a considerable time commitment (Sang et. al., 2015) leading Goldin (2014, p. 1094) to comment "…winner-take-all positions, such as … tenured professor at a university …are … positions for which considerable work hours leads to a higher chance of obtaining the reward". She goes further in arguing that "…hours of work … are worth more when given at particular moments and when the hours are more continuous" (p. 1116). That is, in a university context the 'quality' and timing of the hours worked are as important as the amount of time allocated to research activities, especially in the early stages of an academic career.

Overall, the extant literature points to a perceived lower reward for women, even when all (gender) groups have the same underlying, unobserved productivity levels leads to underinvestment (see especially Coate & Loury, 1993, for details). This reinforcing of the impact of statistical discrimination suggests that it may in fact not diminish overtime (Della Giusta & Bosworth, 2020), given, as argued by Bacevic (2021), the standards of those (predominantly male, white) individuals who make assessments (see also Lamont, 2009). More specifically, it has been argued that the criteria of excellence and meritocracy are gendered and act to the detriment of women (Fassa & Kradolfer, 2013; Van den Brink & Benschop, 2012 and 2014).

Lastly, it has also been argued that promotion and exiting from academia are dominated by differences across academic disciplines, since '… disciplines often differ in norms, culture, and standards around professional etiquette, career pathways, and academic publishing' (Durodoye Jr., et. al., 2020: 631); and once discipline is 'accounted for' gender differences often become insignificant or less significant (as found by Durodoye Jr. et al., op. cit.). This is considered below (especially when discussing the results in Table S.2).

[18] Gender-bias in self-citation was not found by Mishra et. al. (2018) when biomedicine was examined, although they did find that "… papers by authors with short, disrupted, or diverse careers miss out on the initial boost in visibility gained from self-citations" (p. 1).

[19] Others question whether family commitments truncate career progression, e.g., Coate and Howson (2016), Stack (2004) and Sax et. al. (2002). A more general view is "… for many women, this combination of public and private work creates a stressful situation, which is most probably related to understandings of femininity" (Angervall and Beach, 2020, p. 348; see also Fox, 2005). Maggian et. al. (2020) review some of the wider evidence outside academia as to why there is a gender gap in top positions.

Discussion of Table 1 results in more detail

Noteworthy results shown in Table 1 include: for every increase in age of 5 years men survive, cet. par., an extra 2.2 years while women survive some 2.4 years longer. (The impact of age is considered in more detail below.) Increasing full-time equivalent status by 10% increases the mean survival time of men (women) by 11.2 (6.5) years.[20] A higher salary of £4,000 increases the survival time of men by 1 year, and women by 1.8 years. Those on fixed-term contracts exit earlier (over 4.6 years earlier for women); while being employed in more than 1 HEI is any year prolongs survival by over 4 years for men (1.9 years for women). Having more than one role (e.g., an administrative role such as Head of Department) increases the predicted survival time for men by, cet. par., nearly 7 years but by only 5.4 years for women. Those academics who move institutions were, not surprisingly, much more likely to stay in the HEI sector (by some 17.7 years longer for men and 14.6 years for women). Belonging to a sub-group with a higher research rating in the Research Excellence Framework (REF) prolonged working in Russell Group universities; an increase in the grade point average by a value of 1 increased the survival of both men and women by some 1.2-1.3 years. Working in an academic discipline with 10% more women present increased the mean survival time of men by over 2 years but by only 1.2 years for women.[21] Relative to Full Professors, those who were Associate Professors had lower survival times of some 13 years if male and 9.4 years if female; while those on grades below Associate Professor stayed –8.3 fewer years for men and –5.6 years for women.[22,]

Being of a non-white ethnicity lowered predicted mean survival times for both gender sub-groups, especially those identifying as Black. Compared to the those on teaching only contracts, men only doing research were likely to exit some 13 years earlier while for women this was 9.4 years; those on teaching and research contracts exited 8.3 years earlier for men and 5.6 years for women. All nationality sub-groups survived for shorter periods when compared to those identified as UK nationals; for men this was especially so for those from Japan/South Korea while for women from the Rest of Africa the mean survival time was, cet. par., –5.2 years.

Differences across different academic disciplines are provided in Table S.2,[23] showing substantial differences in mean survival times relative to the benchmark sub-group (Economics and Econometrics); for example, those in clinical dentistry had –14.4 years survival for men and –9.2 years for women (other disciplines with much lower survival times were health & community studies, veterinary science, education, and modern languages).[24]

Discussion of Table 2 results in more detail

These results vary when the marginal effects for males and females are considered separately, given the differing underlying characteristics of males and females; based on the marginal effects from the female equations, women were some 4.5% less likely to be Full Professors, 4.9% less likely to be Associate Professors and some 9.4% more likely to remain in other grades. Table 2 also shows that older age is linked with a higher probability of being a Professor or Associate Professor, but with significantly different effects for men and women: for men, a change in age of 2.72 years increased the likelihood of being a Professor by on average over 45%, but for women the increase was only 15.6%. Thus, for women their age was either related to less investment in productivity-enhancing investment and/or their experience was discounted as not being of the same 'value' as that of men. In contrast,

[20] Figure S.6 below provides more information on the impact of FTE status on mean survival times.
[21] Figure S.7 below provides more information on the impact of this variable on mean survival times.
[22] This shows that, if not promoted, men were much more likely to leave academia.
[23] Figure S.2 below shows there are major differences across disciplines with an average 19.3% of males being Professors (and across disciplines the range is 28.3% between the highest and lowest) and 7.1% of woman Professors (with a range of 14.6% between the highest and lowest).
[24] The inclusion of academic discipline dummies does not 'explain' away gender differences in mean survival times. As reported in Table 1, the overall conditional marginal effect using both male and female observations was –0.500 (significant at the 1% level); when the 44 cost centre dummies are omitted the conditional margin effects is –0.503 (significant at the 1% level).

increasing age by 2.72 years increased the probability of being an Associate Professor by nearly 29% for men (and 34.3% for women).

More detailed information on the relationship between age and the likelihood of observing outcome *k* is provided in Figure S.4. This shows that after reaching an age of 30 years men had an increasing higher probability of being a Full Professor, and by the age of 62 years, men were nearly 20% more likely to be Full Professors relative to women.[25] Men were also more likely to be Associate Professors after reaching 30 years of age, but this gender gap narrows after 48 years of age (as shown by the overlayed graph in Figure S.4b) such that by around 66 years of age women were, cet. par., slightly more likely to be Associate Professors.

An increase in full-time equivalent status of 2.72% increased the likelihood of being a Professor by 0.8% and 1.3%, for women and men respectively (Table 2); the same increase in FTE reduced the probability of being an Associate Professor by 0.1% for men while for women there was an increase of 1.1%. The negative impact of increasing FTE status on the probability of being in the 'other' grade category was larger for women as for men. Overall, increasing FTE status 'pushed' women more towards an Associate Professorship while for men they were more likely to be a Full Professor.

The different gender impact of different levels of FTE status is illustrated in Figure S.5, which shows the marginal impact of both FTE and age on the likelihood of observing outcome *k* for women: as women aged, they were relatively less likely than men to become a Professor, but there was little additional difference connected with FTE status. However, the likelihood of being an Associate Professor declined much faster for women who were on less than 100% FTE contracts between the ages of 32 to 43 years compared to women who worked full-time (cf. Figure S.5b), while the higher probability of women being in 'other' grades is relatively much lower for women who worked longer hours. Thus overall, working fewer hours tended to 'push' woman into the 'other' academic grade. This is consistent with the impact on promotion prospects of women who work fewer hours during particularly child-caring years, and who thus under-invest in research-productivity (cf. the conclusions of Mairese & Pezzoni, 2015, who found promotion of French female physicists were adversely affected by very-low-quality publishing time spells).

Being on a fixed-term contract lowered the probability of being a Professor, especially for men (by 5.9% compared to 2% for women), with men being relatively more likely to belong to 'other' grades if they were fixed-term. Moving across HEI's marginally improved the likelihood of being a Professor (particularly for men, with women who moved relatively more likely to be Associate Professors). Working longer in the sector was also linked with being a Full Professor, especially for men (an increase in tenure of 2.72 years increased the probability of being a Professor by 2.8% for men but only 1% for women); while increased tenure was linked more with an Associate Professorship for women, indicating that longer hours were under-valued for women (these had lower 'quality' enhancing content). Having an administrative role benefited men more than women in terms of being a Professor, as did working in a unit of assessment with a higher REF grade-point-average, but both effects were small in terms of sorting across grades. An increase by 100% in the proportion of academics who were women in the workplace lowered the probability of being a Full Professor by 2.8% for men, but by only 0.7% for women. Conversely, this increase in the proportion of female academics was linked to a 4.2% rise in the likelihood of belonging to the 'others' sub-group for men, but only a 2.2% rise for women, showing that workplaces that were relatively female dominated were more likely, cet. par., to see women promoted to higher grades (suggesting such workplaces operated a fairer, less gender-biased process when it came to promotions).

Table 2 shows that non-white ethnicity was associated with a lower likelihood of being a Professor (and to a lesser extent Associate Professor), especially for men (the major exception being for the 'other' ethnicity sub-group where women were relatively less likely to be Associate Professors). This also was the case for non-UK nationalities, with the exceptions of those from the USA (men were relatively more likely to be Professors and women more likely to be Associate Professors), Canadians (women were

[25] That is, Figure S.4a shows that (cet. par.) the probability of being a Professor at age 62.1 years was 33.3% for men and 13.6% for women. Note this result is based on estimating Equation (14) which controls for academic disciplines.

relatively more likely to be Associate Professors and Professors), and those who came from countries where English was the language used in the country's HEI's (men benefited relatively more for Professorships and women for Associate Professorships). Differences by academic disciplines are provided in Table S.1 (based on the RE ordered probit model). For example, relative to the benchmark sub-group (Economics and Econometrics) nearly all subjects had a lower probability that staff were Full Professors (especially for males) – e.g., nursing & allied health professions (16.8% lower for men and 8.2% lower for women) and with the following all having a 10% or greater probability for men of being a Full Professor: education, art & design, media studies, architecture, and sports science & leisure studies. Those disciplines that did (statistically) better for Professorships were law (especially men), and philosophy (for women).

Discussion of Table 3 in more detail

(a) Promotion to Associate Professor

Considering the results for promotion to Associate Professor (AP), Table 3 shows that for men (women) every increase in age of 5 years reduced the mean time to promotion by 3.9 years (3.2 years). An increase in FTE by 10% reduced the time to promotion by 2.7 for men but 3.2 years for women; men on fixed-term contracts had to wait an average of over 15.5 years to be promoted to AP, while for women the figure was slightly lower at 14.2 years; those who had contracts in more than one university in any year had substantially longer periods to wait for promotion (28-31 years more);[26] while those who also had substantive administration roles were promoted faster (around 19.3-21.2 years shorter periods to promotion, shorter for men); moving across HEI's substantially increased the mean time to promotion to AP (14.1 years for women, and 12.5 years for men);[27] working in a unit of assessment with a higher REF grade-point-average did not substantively reduce time to promotion for males, but an increase in the average GPA by 1 reduced time to promotion for females by 3.1 years;[28] and an increase by 100% in the proportion of academics who were women in the workplace had little impact on time to promotion to AP for males but, cet. par., reduced waiting times for women by just over 0.23 years. Not surprisingly, when compared to those on teaching only contracts, those on research only contracts had a much longer time to wait for promotion (especially women) while those on teaching and research contracts were promoted much faster.

Regarding ethnicity, due to small numbers promoted in various sub-groups there were few statistically significant results; black men, cet. par., took some 22 years longer to reach AP relative to the benchmark group (whites), while being of mixed ethnicity lowered the time to promotion for men by 5.5 years. Men identified as US nationals spent on average nearly 5 fewer years waiting to be promoted to AP (relative to UK nationals), while men from countries were English is the medium for teaching waited 4.2 fewer years (and men from EU pre-2004 member countries waited 1.6 fewer years), while males from China, Russia and the rest of Asia had substantially longer waiting times to promotion. For women, there were much longer waiting times to achieve promotion to AP for those originating from EU accession countries (over 15.5 years longer), Muslim and Arabic countries (over 14 years), China and Japan (28-34 years) and Russia (over 13 years). Table S.1 sets out the differences in average times to promotion by academic disciplines (relative to Economics & Econometrics as the benchmark sub-group); subjects with generally lower relative waiting times were clinical medicine and dentistry, anatomy & physiology, pharmacy & pharmacology, environmental sciences, veterinary science, chemistry, physics, general engineering, mathematics, politics, social work & policy, and theology (and in all instances women in

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[26] As shown in Table A.1, there are few academics in this sub-group (less than 3%), and they were more likely to be engaged in teaching activities in the different HEIs, which may explain the large marginal effect obtained. Note, this variable was omitted when estimating Equation (13) as it resulted in the random effects ordered probit model failing to converge.

[27] This is a different outcome compared to the ordered probit model, where moving HEI increased the probability of being in a higher grade, and the difference is likely because the models do different things (e.g., the ordered probit approach models the probability of an individual being assigned to a particular academic grade) and because the time to promotion model excludes those in the data who were already senior to the 'others' grade when first observed.

[28] Again, this is a different result compared to the ordered probit model.

these subject groups did often much better than men, relative to male and female economists). Waiting times for promotion (relative to the benchmark) were higher in nursing & allied health, minerals & materials engineering, architecture, area studies, education, modern languages, english, art & design, and music & the performing arts.

(b) Promotion to Full Professor

Considering the results for promotion to Full Professor, Table 3 shows that every increase in age of 5 years reduced the mean time to promotion by 1.6 years for women only; for men (women) an increase in FTE status by 10% reduced the time to promotion by around 0.8 (3.6) years; men on fixed-term contracts had to wait an average of nearly 4.3 years to be promoted to Professor, while for women the figure was 6.7 years; those who had contracts in more than one university in any year had substantially longer periods to wait for promotion (at over 23 years more, the figure for women was nearly double that of males); those who also had substantive administration roles were promoted faster (11.7 years shorter period for men and 18.2 years for women); and working in a unit of assessment with a 1 unit higher REF grade-point-average reduced the average time to promotion for males by 1.7 years and for females by 5 years. When compared to those on teaching only contracts, those on research only contracts had a much shorter time to wait for promotion while those on teaching and research contracts were promoted even faster.

Regarding ethnicity, only women classified to the 'other' ethnic sub-group had a significantly longer time to wait for promotion to Professor when compared to white females. There were few statistically significant differences by national grouping, with only EU pre-2004 (rest of Asia) men having a 1.4 (3.8) years lower waiting time. Lastly, Table S.1 sets out the differences in average times to promotion to Professor (conditional on having been promoted to AP) by academic disciplines (relative to Economics & Econometrics as the benchmark sub-group); overall, women waited relatively longer than men across nearly every discipline with statistically significant results (the exception being architecture). Males in environmental sciences, chemistry and physics had shorter waiting times compared to male economists, while those in sports & leisure sciences, architecture, education, modern languages, english, history, music & the performing arts and media studies had longer waits; women in nursing & allied health professions, psychology & behavioural sciences, pharmacy & pharmacology, sports & leisure sciences, social work & policy, business & management studies, education, modern languages, history, art & design, and music & performing arts all had longer waiting times compared to female economists and econometricians.

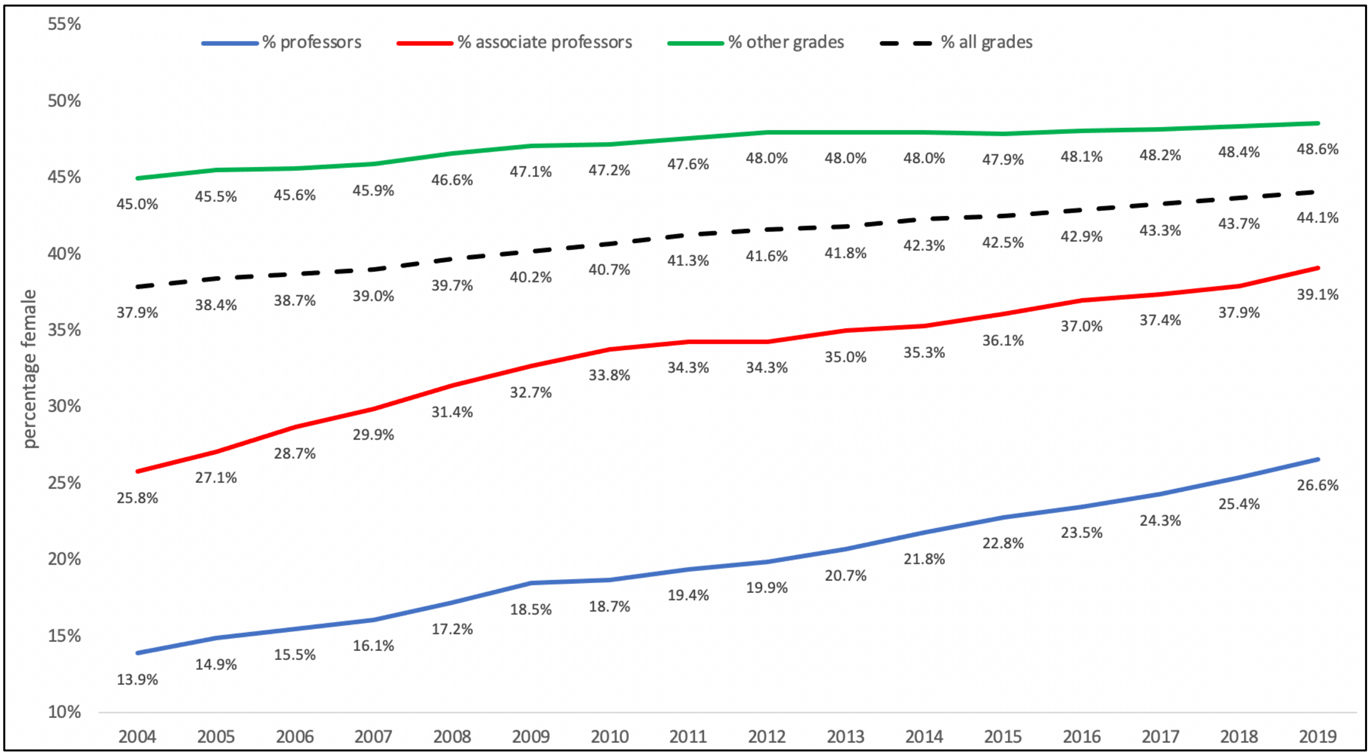
Table S.2: Marginal effects for different academic disciplines from the hazard and ordered probit models, UK Russell Group universities 2004/05 to 2019/20

	Probability of promotion to Professor		Probability of promotion to Associate Professor		Probability of promotion to other grades		Predicted marginal effect of mean survival time		Predicted marginal effect of mean time promotion to Associate Professor		Predicted marginal effect of mean time promotion from AP to Professor	
	males	females	males	females	males	females	males	females	males	females	males	females
Cost centre (benchmark Economics & econometrics)												
Clinical medicine	-0.015***	-0.036***	-0.001***	-0.027***	0.016***	0.063***	-6.997***	-4.527***	-14.660***	-19.007***	-0.528	5.158
Clinical dentistry	-0.094***	-0.037***	-0.017***	-0.028***	0.111***	0.065***	1.608	-1.995**	-11.562***	-17.296***	-0.021	2.157
Nursing & allied health professions	-0.168***	-0.082***	-0.055***	-0.081***	0.222***	0.163***	-14.442***	-9.204***	35.650***	22.907**	6.739	14.008***
Psychology & behavioural sciences	-0.026***	-0.022***	-0.003***	-0.015***	0.029***	0.037***	-7.058***	-4.755***	-3.108	-9.810	3.773	9.712**
Health & community studies	-0.040***	-0.051***	-0.005***	-0.041***	0.044***	0.092***	-11.411***	-7.564***	-1.513	-10.249	2.085	8.449
Anatomy & physiology	-0.064***	-0.035***	-0.009***	-0.026***	0.073***	0.061***	-6.699***	-5.165***	-1.580	-14.528**	2.921	5.934
Pharmacy & pharmacology	-0.053***	-0.032***	-0.007***	-0.024***	0.060***	0.056***	-7.015***	-4.986***	8.950	-17.417**	-0.899	11.088**
Sports science & leisure studies	-0.100***	-0.014**	-0.019***	-0.009**	0.119***	0.023**	-3.887**	-7.433***	10.966	-1.815	25.051*	26.474*
Veterinary science	-0.058***	-0.040***	-0.008***	-0.030***	0.066***	0.070***	-10.727***	-6.893***	-12.372***	-15.203**	-1.126	4.354
Agriculture, forestry & food science	-0.085***	-0.058***	-0.014***	-0.048***	0.099***	0.106***	-6.561***	-3.484**	18.624	12.150	2.277	10.567
Earth, marine & environmental sciences	-0.058***	-0.033***	-0.008***	-0.024***	0.066***	0.058***	-2.567***	-2.554***	-2.671	-14.789**	-3.202*	0.708
Biosciences	-0.072***	-0.055***	-0.011***	-0.045***	0.083***	0.099***	-5.931***	-4.513***	2.309	-1.388	-0.472	3.262
Chemistry	-0.044***	-0.032***	-0.005***	-0.023***	0.049***	0.055***	-4.792***	-4.129***	-1.747	-20.051***	-3.472*	0.114
Physics	-0.066***	-0.012***	-0.009***	-0.008***	0.075***	0.021***	0.016	-0.719	-6.254**	-24.026***	-3.889**	-4.918
General engineering	-0.092***	-0.036***	-0.017***	-0.026***	0.109***	0.062***	-0.890	-1.185	2.144	-19.641***	-0.193	-0.619
Chemical engineering	-0.056***	-0.012***	-0.007***	-0.008***	0.064***	0.019***	-3.988***	-3.777***	-0.612	2.605	-0.821	-4.093
Mineral, metallurgy & materials engineering	-0.075***	-0.021***	-0.012***	-0.015***	0.087***	0.036***	-3.138***	-2.711***	9.596*	-1.559	-2.484	-4.623
Civil engineering	-0.076***	-0.036***	-0.012***	-0.027***	0.088***	0.062***	1.701**	1.134	1.687	-6.893	2.015	-4.255
Electrical, electronic & computer engineering	-0.075***	-0.033***	-0.012***	-0.024***	0.086***	0.056***	1.302**	-0.370	3.129	-0.762	0.707	-2.469
Mechanical, aero & production engineering	-0.077***	-0.024***	-0.012***	-0.017***	0.089***	0.041***	0.736	0.025	3.694	-3.595	1.920	-3.714
IT, systems sciences & computer software engineering	-0.076***	-0.023***	-0.012***	-0.016***	0.088***	0.038***	-1.060*	-0.414	0.838	-10.353	0.093	3.343
Mathematics	-0.015***	0.006	-0.001***	0.003	0.016***	-0.009	-0.593	-0.698	-5.681*	-17.965***	-0.575	-1.486
Architecture, built environment & planning	-0.111***	-0.053***	-0.023***	-0.043***	0.134***	0.096***	0.765	-0.260	12.502***	0.565	5.144*	1.275
Geography & environmental studies	-0.017***	-0.010***	-0.002***	-0.007***	0.018***	0.017***	-4.094***	-3.472***	-0.746	-7.698	1.408	6.245
Area studies	-0.052***	-0.041***	-0.007***	-0.031***	0.059***	0.071***	-3.670**	-1.147	12.548	24.854**	5.025	15.036
Archaeology	-0.084***	-0.036***	-0.014***	-0.027***	0.098***	0.063***	-5.170***	-4.035***	5.217	-3.083	2.708	8.344
Anthropology & development studies	-0.036***	-0.008**	-0.004***	-0.005**	0.040***	0.014**	-3.009**	-3.737***	0.819	-10.142	0.198	8.698
Politics & international studies	-0.011***	-0.000	-0.001***	-0.000	0.012***	0.001	-3.846***	-1.270	-6.860**	-14.465**	3.222	3.032
Law	0.020***	0.008**	0.001***	0.005**	-0.021***	-0.013**	-4.398***	-2.462***	0.369	-11.509*	-0.305	2.520
Social work & social policy	-0.033***	-0.033***	-0.003***	-0.024***	0.036***	0.057***	-5.709***	-3.556***	-5.526	-13.437*	5.109	11.480**
Sociology	-0.036***	-0.013***	-0.004***	-0.009***	0.040***	0.022***	-7.191***	-3.890***	9.211	-9.034	1.071	7.305
Business & management studies	-0.022***	-0.016***	-0.002***	-0.011***	0.024***	0.027***	-4.149***	-3.476***	-2.494	-7.077	-0.940	8.334**
Education	-0.121***	-0.061***	-0.027***	-0.052***	0.148***	0.113***	-11.362***	-6.425***	18.291***	3.793	6.217*	18.667***
Modern languages	-0.097***	-0.064***	-0.018***	-0.055***	0.115***	0.119***	-10.061***	-5.408***	26.180***	33.504***	5.494*	16.675***
English language & literature	-0.065***	-0.017***	-0.009***	-0.012***	0.074***	0.029***	-7.498***	-4.990***	10.188**	3.477	4.753*	5.666
History	-0.050***	-0.010***	-0.006***	-0.006***	0.056***	0.016***	-5.880***	-5.062***	4.525	-7.061	4.752*	8.064**
Classics	-0.034***	-0.014***	-0.004***	-0.010***	0.037***	0.024***	-6.246***	-2.415*	7.996	-1.418	3.859	8.530
Philosophy	-0.022***	0.008*	-0.002***	0.005*	0.024***	-0.013*	1.101	-1.477	1.501	-11.611	-0.695	-4.808

Theology & religious studies	-0.057***	-0.016***	-0.008***	-0.011***	0.064***	0.028***	-7.930***	-5.060***	-2.602	-17.787**	-1.887	5.501
Art & design	-0.121***	-0.058***	-0.027***	-0.049***	0.149***	0.107***	-3.391***	-1.145	17.629**	10.416	1.332	14.610**
Music, dance, drama & performing arts	-0.085***	-0.026***	-0.014***	-0.018***	0.099***	0.045***	2.557*	-0.748	10.722**	-3.050	6.193**	7.221*
Media studies	-0.117***	-0.033***	-0.025***	-0.024***	0.142***	0.056***	-6.455***	-5.084***	-0.245	-1.474	21.122***	6.982

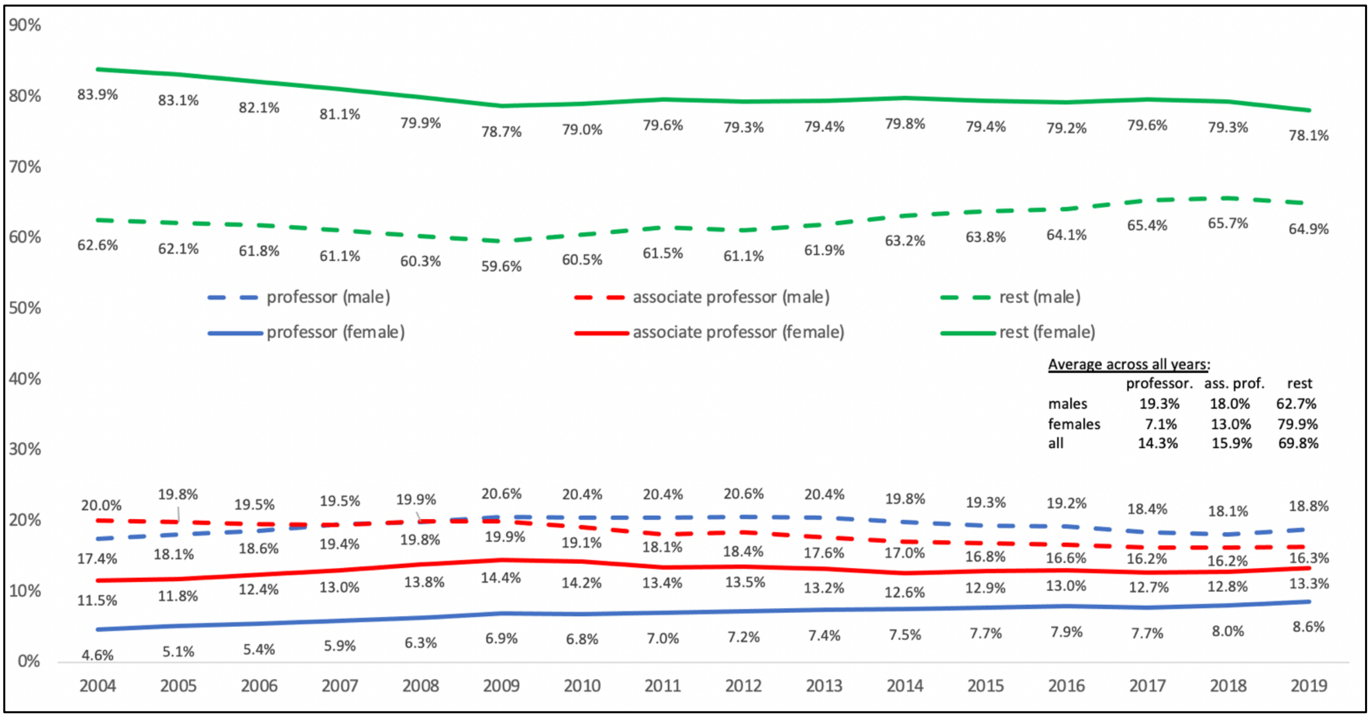
***/**/* indicate statistically significant at 1/5/10% levels (robust standard errors used)

Figure S.1(a): Distribution of female academics in each grade,[a] UK Russell Group universities, 2004/05 to 2019/20



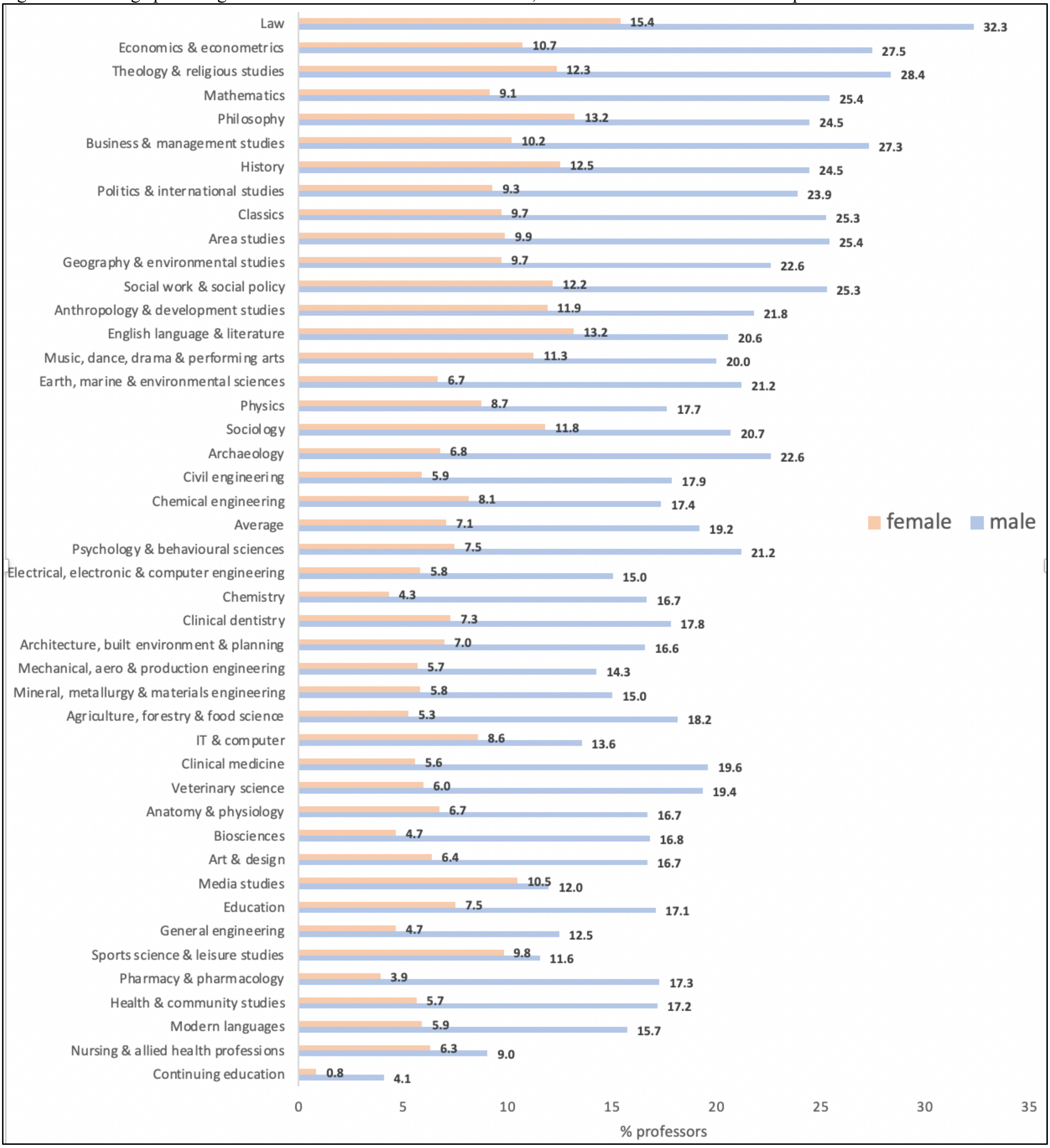
[a] Numbers in each year show the percentage of all academics by grade who were women. Source: HESA (2022)

Figure S1(b): Academic staff by grade and gender,[a] UK Russell Group universities, 2004/05 to 2019/20



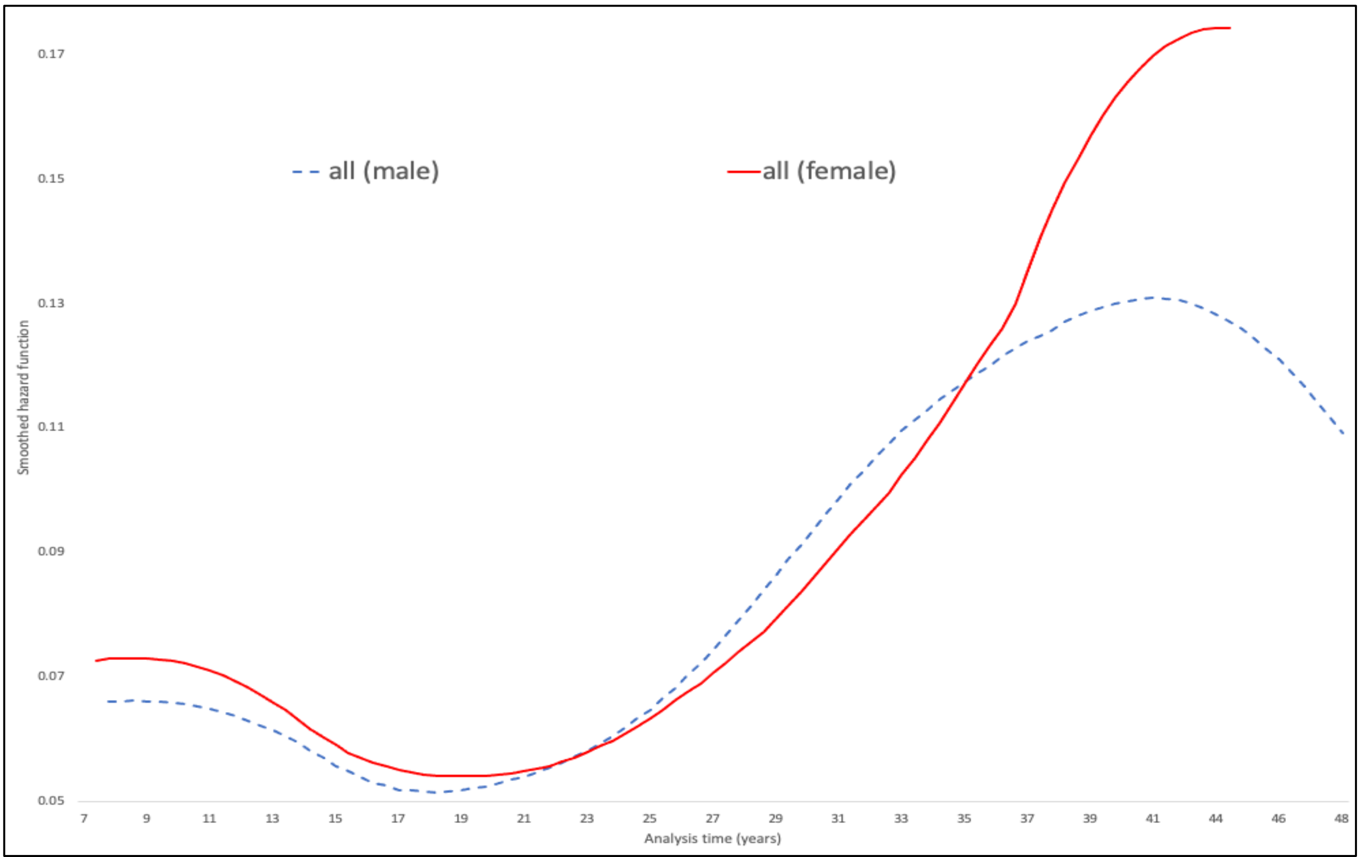
[a] Numbers for each gender sub-group sum to 100% in each year Source: HESA (2022)

Figure S.2 Average percentage of academic staff who were Professors, 2004/05 – 2019/20: Russell Group UK universities[a]



[a] Disciplines are sorted from highest-to-lowest based on *total* percentage of Professors.

Figure S.3. Cox proportional hazards regression[a] of time taken to exit UK Russell Group universities, by gender, 2004/05 to 2018/19

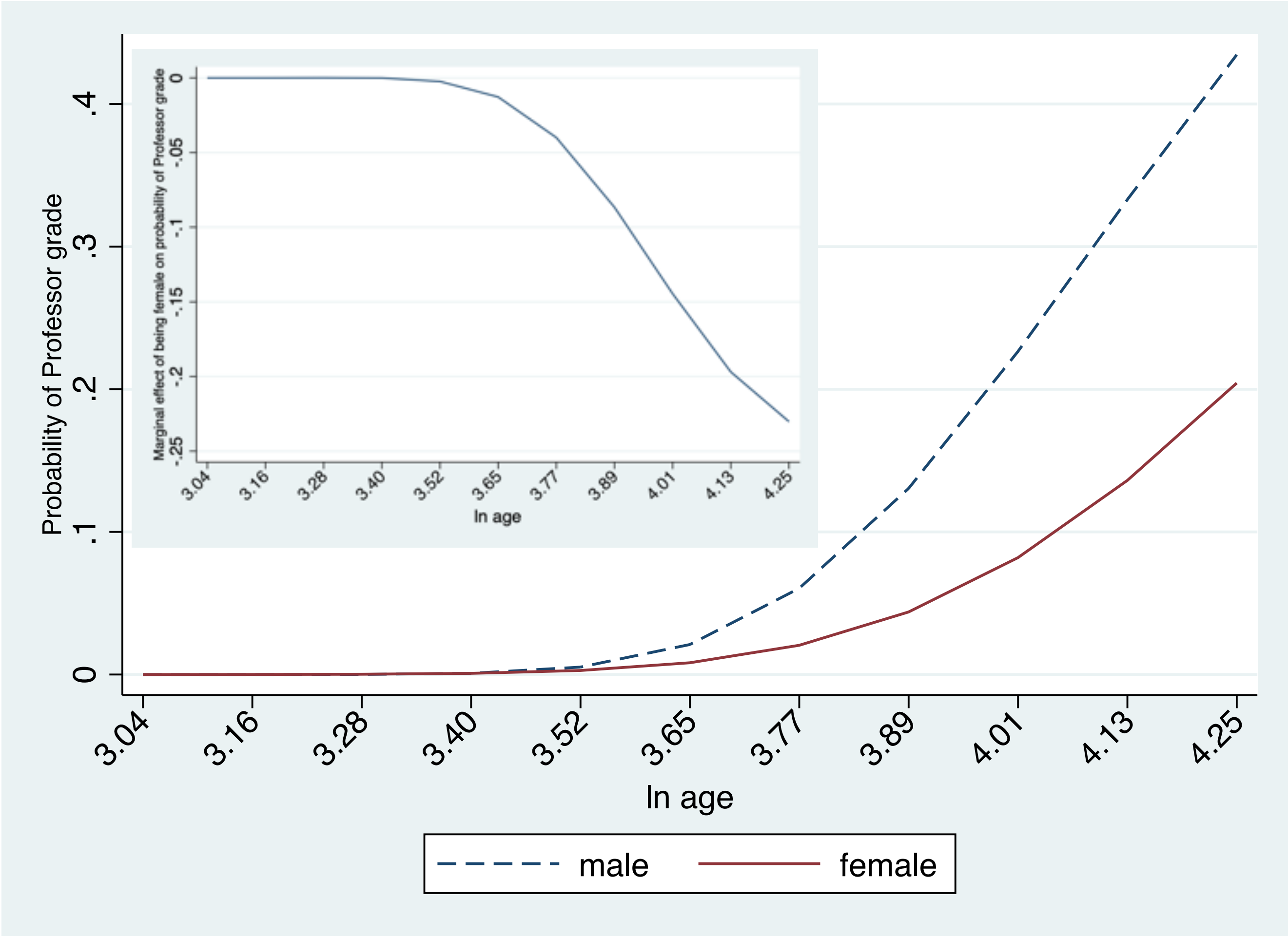


[a] Baseline hazard (no covariates) estimated separately by gender. Source: data provided by HESA(2022)

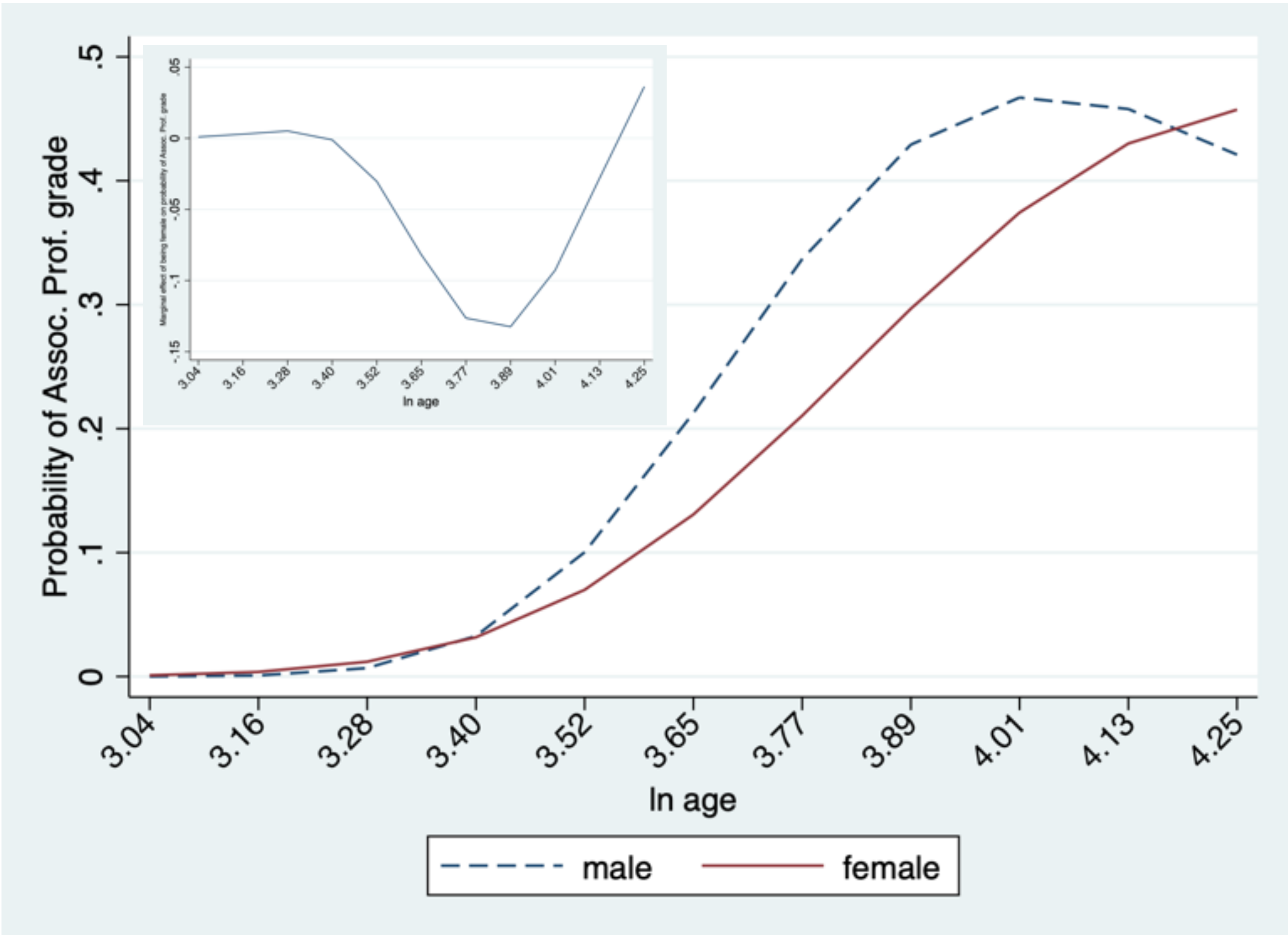
Figure S.3 provides a background to what happened with regard to exiting from academia by showing the baseline hazard function[29] over time by gender. Generally, the risk of exit was higher for women although men with between 22 and 35 years of exposure had a slightly higher risk (Figure 2, in the main text, shows this is confined to academics below Associate Professor grade); after being in the HEI system for around 35 years, the hazard rate for women rises substantially relative to men (suggesting women retire much earlier than men).

[29] That is, the probability or risk of exiting (leaving academia) in each time interval, conditional on having survived to the beginning of that interval divided by the width of the interval.

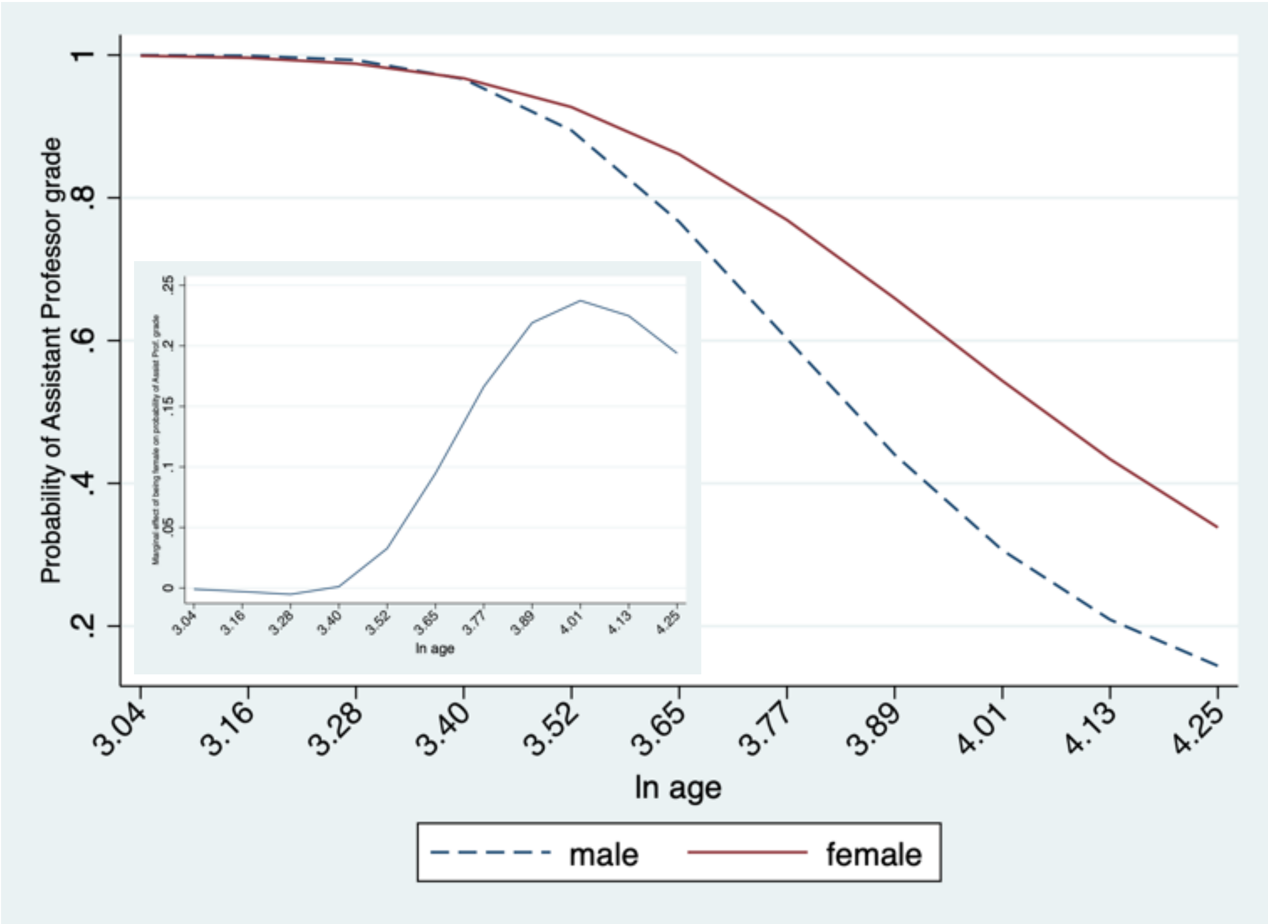
Figure S.4. Predicted academic grade, UK Russell Group universities 2004/05 to 2019/20, by age
(a) Professor



(b) Associate Professor



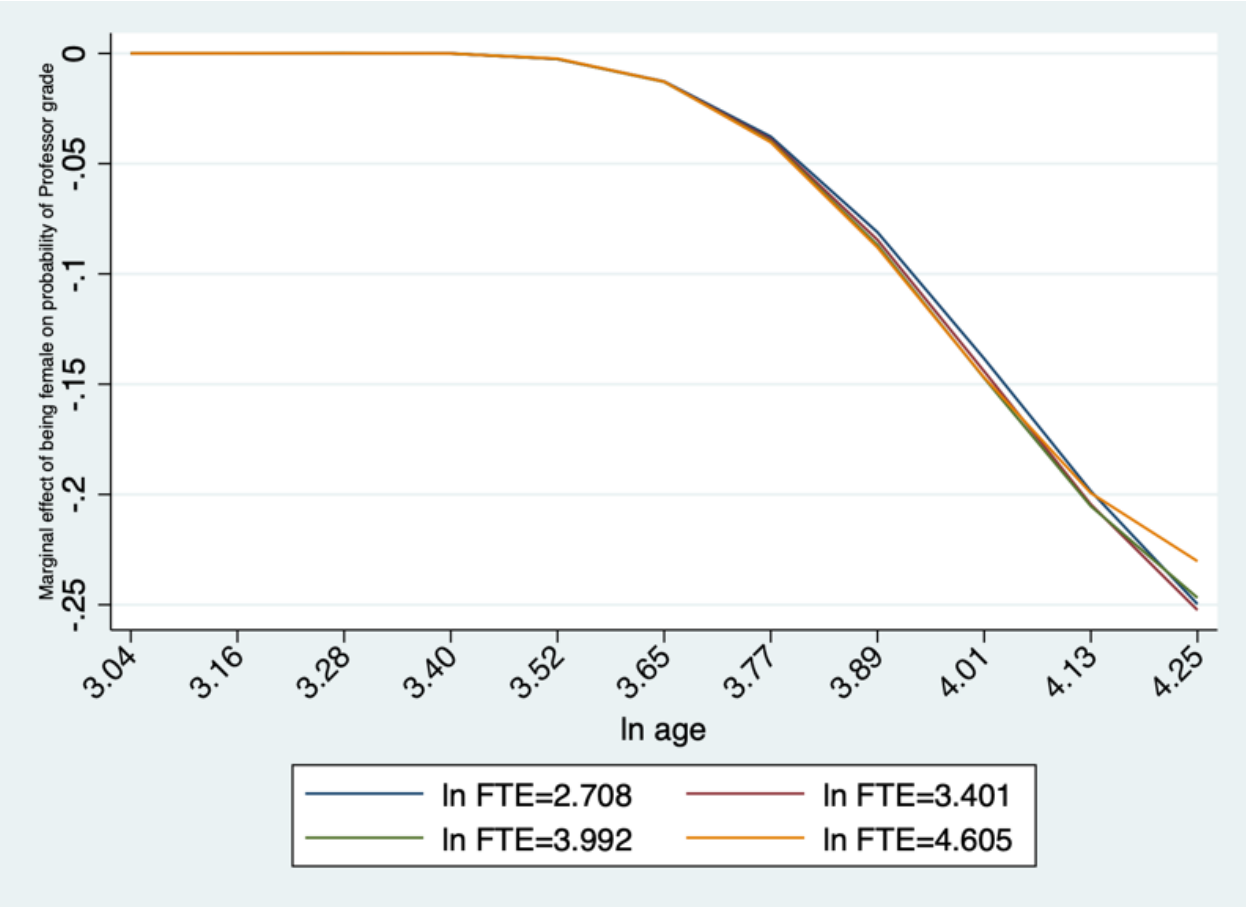
(c) Other grades



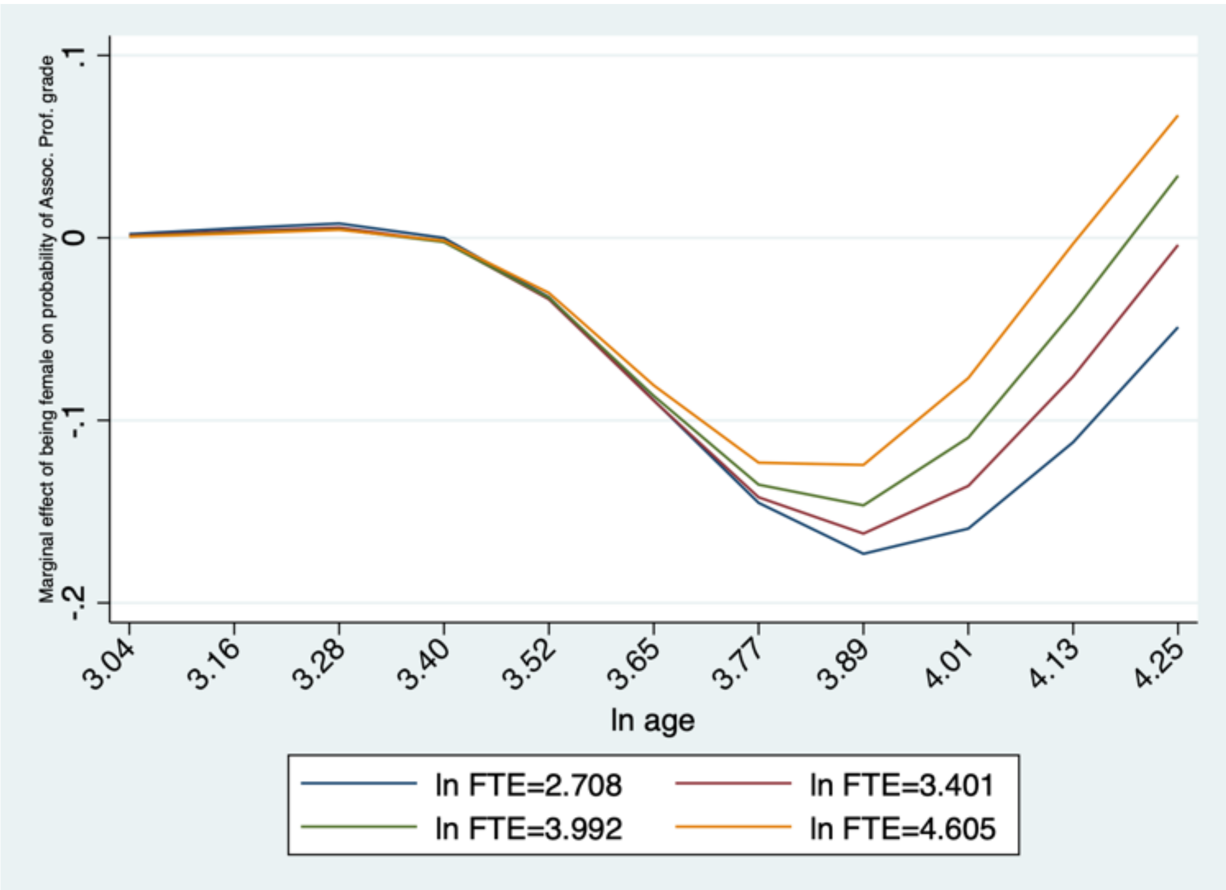
Source: Equation (14)

Figure S.5. Marginal effect ($\partial\hat{t}/\partial x$) due to gender by age and FTE status, UK Russell Group universities 2004/05 to 2019/20

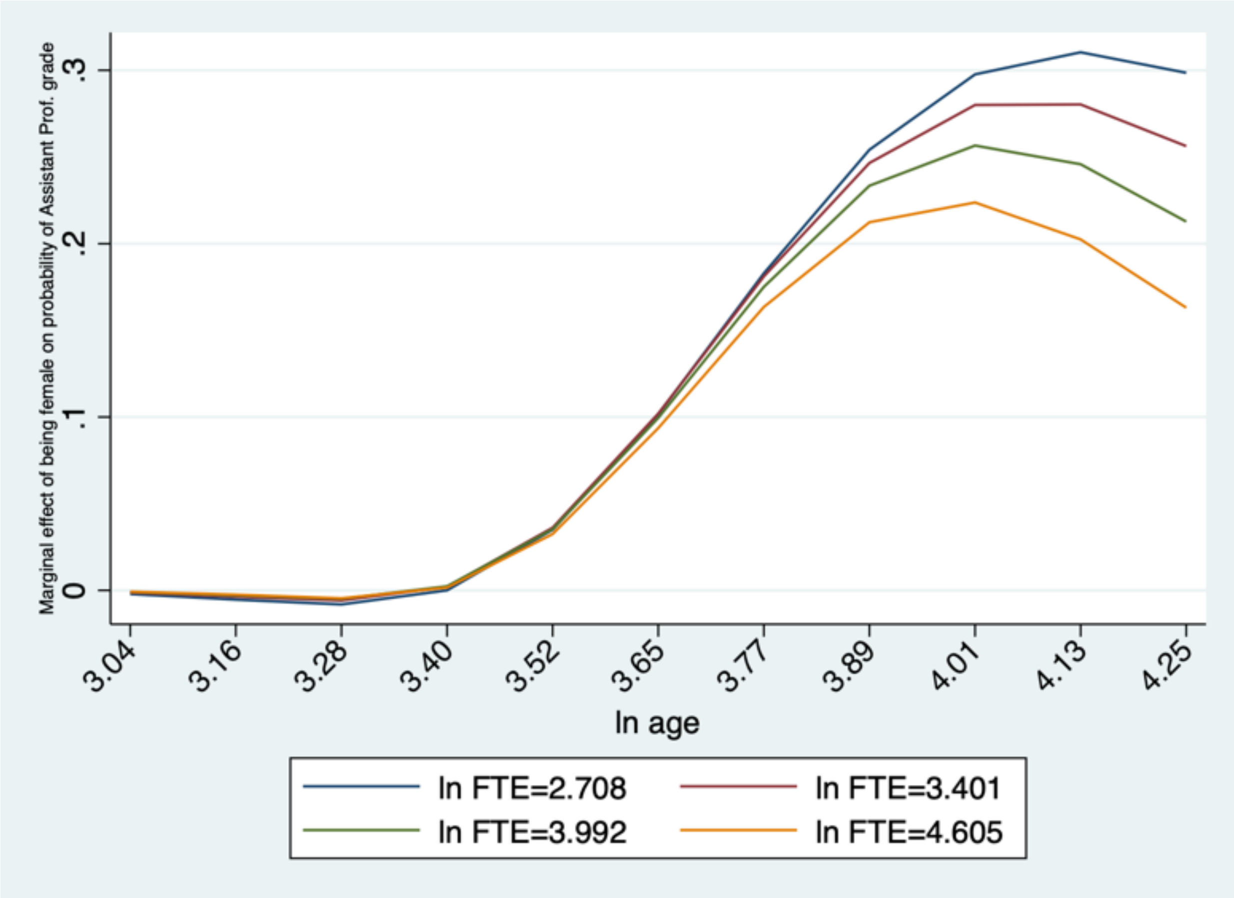
(a) Professor



(b) Associate Professor

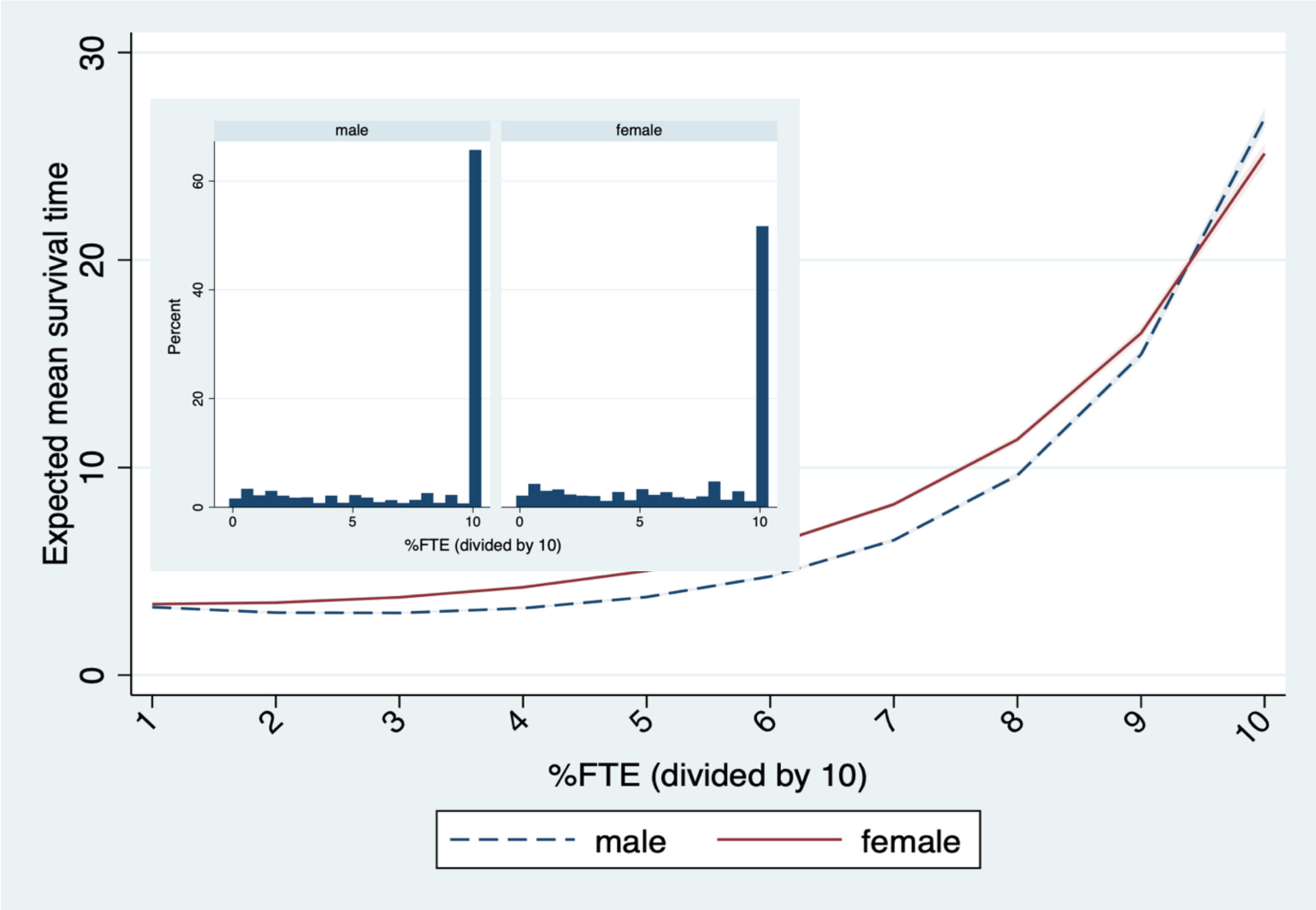


(c) Other grades



Source: Equation (14)

Figure S.6: Predicted survival time: gender by FTE status, UK Russell Group universities 2004/05 to

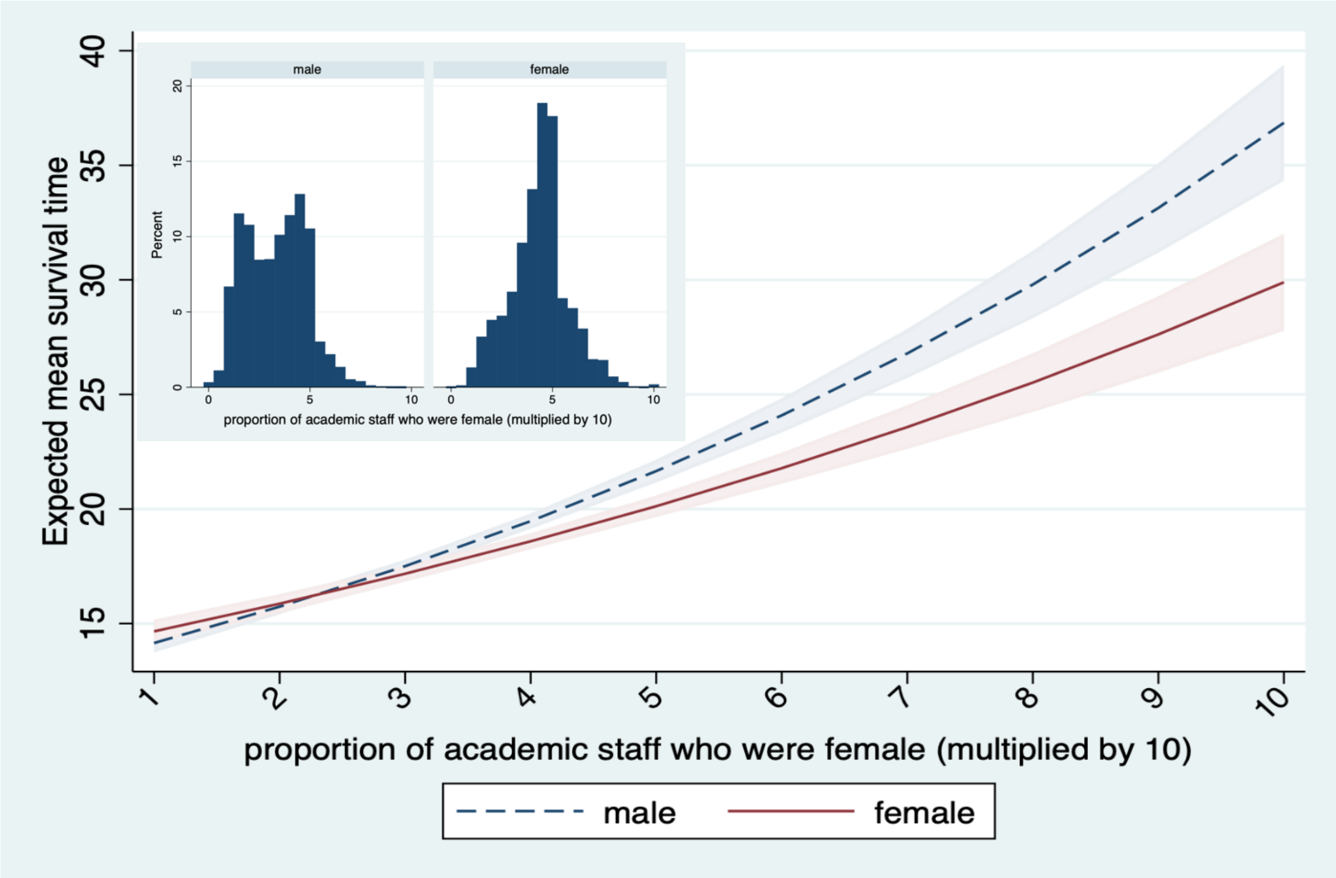


Source: Equation (12)

Figure S.6 helps put into perspective the overall results shown in Table 1 that increasing full-time equivalent status by 10% increased the mean survival time of men (women) by 11.3 (6.6) years, suggesting that men invest more 'quality' hours than women; these results occur because most individuals work full-time, particularly men. For those working less than 100% full-time, the mean survival time also increases with hours worked and is overall higher for women, indicating that as women work longer hours, they 'catch-up' on achieving higher survival rates. Finally, Figure S.7 helps to make clearer the Table 1 results with respect to the impact of more females in the academic workforce on the likelihood of survival.[30] Firstly, Figure S.7 shows that the positive effect, of the greater the proportion of staff who are female in the workplace, on male mean survival time increases significantly relative to the effect on women. It also shows that men are much more likely to work in workplaces where there are significantly fewer women present; for women, workplaces are still mostly male dominated but to a much lesser extent when compared to men, which helps to explain why men have higher, cet. par., survival times as female presence increases. That is, while the presence of relatively more females benefits both men and women (presumably) through a less 'hostile' environment, men working in departments that are increasingly female dominated have (cet. par.) higher survival rates, which suggests women are 'harder' upon themselves.

[30] That is, working in an academic discipline with 10% more women present increased the mean survival time of men by over 2 years but by only 1.3 years for women.

Figure S.7: Predicted survival time: gender by female presence, UK Russell Group universities 2004/05 to 2018/19



Source: Equation (12)

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