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DISCUSSION PAPER SERIES

IZA DP No. 17460

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Steven Bosworth
University of Reading

Marina Della Giusta
University of Turin, Collegio Carlo Alberto and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

When Matthew Met Larry: Explaining the Persistence of Gender Underrepresentation in High Status Organizations*

What explains the persistent under-representation of women at the top organizations within high status occupations? The phenomenon has been documented across countries and neither the closing and reversal of education gaps nor family policies appear effective in closing the gaps. We offer an explanation for the persistence of under-representation based on the mutually reinforcing dynamics resulting from returns to organizational prestige at top organizations (The Matthew Effect) and gender stereotypes in hiring arising from the imperfectly observable ability of workers (The Larry Effect). Our model predicts that when organizational prestige is important and complementary to ability in production, fewer women will be found and hired at higher status organizations, there will be a wage premium for both women and men when they move to them but a greater proportion of men will succeed in doing so, regardless of ability. An aggregate level gender wage gap is thus generated from between-organization wage differences and segregation of women and men to lower- and higher-status organizations respectively. We test the predictions of the model in academia where recognized measures of prestige exist and Matthew effects are well documented. We make use of an employer-employee administrative panel comprising the universe of UK academics and find evidence consistent with the model's predictions: persistence of women's under-representation in higher status organizations and a wage premium for moving of about 3 percent for both women and men.

JEL Classification: C78, J31, J70
Keywords: prestige, stereotypes, discrimination

Corresponding author:
Marina Della Giusta
Via Giuseppe Verdi, 8
10124 Torino TO
Italy
E-mail: marina.dellagiusta@unito.it

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> To what extent is there overt discrimination? Surely there is some. Much more tellingly, to what extent are there pervasive patterns of passive discrimination and stereotyping in which people like to choose people like themselves, and the people in the previous group are disproportionately white male, and so they choose people who are like themselves, who are disproportionately white male. No one who's been in a university department or who has been involved in personnel processes can deny that this kind of taste does go on, and it is something that happens, and it is something that absolutely, vigorously needs to be combated.
>
> Lawrence H. Summers (2005)

Acknowledgements

We are indebted to Erin Hengel and Almudena Sevilla for discussions which developed the findings and ideas of this paper. We would also like to thank seminar participants at the University of Turin, University of Reading, and University of Bergamo, City, University of London; attendees at REBEW 2022, RES 2023, SEHO 2023, ESPE 2023, Annual conference of SIE 2023, and TIBER 2023 for their valuable feedback on earlier versions of this research. We also thank in particular Paula Onuchic and Ignacio Monzón for valuable comments on earlier drafts of the paper. All mistakes remaining are the authors' responsibility.

1 Introduction

Despite sustained progress and the fact that increasingly women graduate at higher rates than men (Goldin et al., 2006, Bertrand, 2011), gender inequality in representation persists within high status occupations, particularly at the top organizations (Petrongolo and Ronchi, 2020; Bertrand, 2018; Blau and Kahn, 2017; Goldin, 2014). Petrongolo and Ronchi (2020) for instance show for both the US and the UK there has been a gender polarization with rises in female employment but this does not apply to the very top tail where men are still predominant and even experienced small gains. Gender underrepresentation at the top of the distribution also contributes to gender inequality at the top of the income distribution (Atkinson, Casarico and Voitchovsky, 2018). Explanations for gender segregation at the top point to the combined effect of increasingly high time investments required by both status-relevant occupations and parenting (Goldin, 2021; Wasserman, 2023; Borra and Sevilla, 2019; Kleven et al., 2019; Cortes and Pan, 2023). However, family policies do not seem to affect gender representation empirically (Corekcioglu, Francesconi, and Kunze, 2020).

High wage firms have been growing more and employ more men thus leading to male overrepresentation in high earning jobs (Stecy-Hildebrandt et al., 2019; Jewell, Razzu and Singleton, 2019). Gender norms and stereotypes and their effect on both the demand and supply of women in high status occupations, have been investigated as a contributing factor (Folke and Rickne, 2022; Petrongolo and Ronchi, 2020; Kunze and Miller, 2017; Babcock, Recalde, Vesterlund and Weingart, 2017; Goldin, 2014; Bertrand, Goldin and Katz, 2010). Highly paid and high status occupations are characterized by strong returns to professional networks, reputation, and firm-specific returns to individual human capital attributes (Burris, 2004; Huber et al., 2022; Baik et al. 2018, Heckman and Moktan, 2020; Morgan et al., 2018; Sine et al., 2003). These features are named "Matthew Effects" in the literature on the sociology of knowledge work (Merton, 1968). The organization in which workers match with colleagues has a strong impact on their productivity and career trajectories (Wapman et al, 2022; Yarrow, 2021; Colussi, 2018).

Our contributions are twofold: We provide a parsimonious model that explains the persistence of gender underrepresentation at top ranked organisations in occupations where status matters and is consistent with current evidence from empirical gender labor economics. We furthermore illustrate the model's occupation-level predictions in an administrative employer-employee panel containing the universe of workers and organizations for UK academia.

Our first contribution is to provide a two sided matching model that explains the persistence of underrepresentation of women in high status organizations with the interaction between individual returns to organizational prestige and the effect they have in amplifying stereotypes in hiring. Existing theories of discrimination are able to account for segregation by prestige (Goldin, 2014) but cannot account for the returns to those women who do enter high status organizations, while theories of stereotyping account for the persistence of biased beliefs but do not explain why they are specific to high status occupations (Bordalo et al, 2016; Oxoby, 2014). Our model provides an endogenous explanation for the persistence of stereotypes in hiring in labor markets where prestige is important.

We posit that organizational prestige is complementary to individual ability in determining individual productivity, and the more the returns to organizational prestige are high, the more the productivity of those employed at high status organizations will be high and the more they will be paid (the Matthew Effect). Gender stereotypes in hiring occur in our model, similarly to Goldin's pollution theory (2014), because inference about a new worker's productivity which is imperfectly observable is made using the heuristic of representativeness on the basis of observable identity characteristics (i.e. gender). As the productive group is historically male an assumption is made that a woman will be less productive than a man, leading to a smaller chance that she is hired by an organization which employs mostly men (the Larry effect).

We use a numerical example to show how the combination of the Matthew and Larry effect will mean that, the higher the returns to prestige in an occupation (Matthew) the higher the returns will be to moving to more prestigious organizations for both women and men, but the less women will be able to do so (Larry). Conversely, in occupations where only individual ability and institutional resources (but not reputation) determine production, the model produces "meritocratic" sortings, where the highest ability workers pair off with the best-resourced organizations with little influence from observable characteristics of workers. Gender stereotypes in hiring are present in many occupations, but they are therefore more persistent in those that provide the highest status returns. Where status concerns are low, our model produces standard results where competition drives out unfounded stereotypes. In addition to predictions about gender representation across occupations, our simulations also generate within-occupation predictions unique to the case of high prestige importance.

Our second contribution is to test the within-occupation predictions of the model in the context of academia, which is characterized by strong returns to organizational prestige (accompanied by actual measures in the form of university rankings), uncertainty about productivity due to long publication lags, and well documented gender gaps. Women are underrepresented in high status organizations in academia in both the US and the UK (Gamage, Sevilla and Smith 2020; Lundberg and Stearns, 2019; Ceci, 2018; Cech and Blair-Loy, 2019) and gender bias in hiring has also been documented (Foschi, Lai and Sigerson, 1994; Steinpreis, Anders and Ritzke, 1999; Moss-Racusin et al., 2012).

We exploit a very rich administrative employer-employee panel describing the universe of academics in an important academic labor market. Our data provided by the Higher Education Statistical Agency (HESA) refers to the universe of academics in the UK over the period 2012-2015. We cannot observe individuals' productivity, but the advantage of using the HESA administrative panel is that we can follow individuals across institutions, therefore controlling for any time invariant individual heterogeneity.

Firstly, we document a strong gender composition - prestige gradient across organizations. The highest QS percentile organizations employ fewer women. There are therefore gender composition pay spillovers, which we estimate. We then concentrate on organization movers, and show that they enjoy premia which are increasing in the share of male colleagues at their new employer and the employer's QS ranking.

Analyzing career trajectories of women and men who move across organizations we find that the same person is paid more the more the institution they move to is higher ranking (and male-dominated). This holds for both men and women, with a similar effect size (premium) of around 3%. As we control for individual worker fixed effects, time-invariant individual attributes like ability cannot explain the male coworker premium.

The rest of the paper is laid out as follows. The next section places our contribution in the context of the literature on the economics of labor market discrimination; then we introduce the model, illustrating its results under differing scenarios regarding the importance of prestige; and generating testable predictions. We then apply the model to the context of academia by providing evidence for its occupation specific predictions. Finally, we discuss implications for other segments of the labor market and other types of stereotypes (based for example on race).

2 Background

Our analysis is driven by three key assumptions. Firstly, high-prestige institutions offer a productivity advantage; secondly, women are less likely to be in these high-prestige institutions; and finally, employers incorrectly attribute the lower average productivity of women to their gender rather than the institutional differences. Each of these assumptions have been well documented in the empirical literature.

There is ample evidence in the managerial and sociological literature for the role of organizational prestige determining outcomes ranging from recruitment and retention all the way to the ability to secure business, influence the outcomes of disputes and output itself (Lange et al., 2011; McDonnell et al., 2018). This is partly through the importance of network effects (Burris, 2004; Yarrow, 2021) and partly through halo or Matthew effects that have been documented in a range of settings including sports (Kim et al., 2014). The Matthew Effect ('For to all those who have, more will be given' Matthew 25:29) was firstly introduced in the sociological literature by Merton and Zuckerman (1968) to explain discrepancies in recognition received by eminent scientists and unknown researchers for similar work. Organizational prestige matters to technology licensing and leads to stratification in the creation and distribution of university-generated knowledge (Sine et al., 2003). It has since been documented in patterns of scientific collaboration, socio-technical and biological networks, the propagation of citations, the emergence of scientific progress and impact, career longevity, the evolution of common English words and phrases, as well as in education and brain development (Yarrow, 2021; McDonnell et al., 2018; Kim et al., 2014; Perc, 2014; Lange, et al., 2011; Burris, 2004). Interestingly the Matthew Effect is regarded as an emergent property of networks and self-organizing systems, but the reasons are considered unknown (Perc, 2014).

Women are particularly underrepresented at those firms with the most institutional prestige within high-status occupations. Gorman and Kmec (2009) find that larger firms with higher billable hour requirements and fewer existing women employees are less likely to hire women. Bertrand and Hallock (2001) show women dramatically underrepresented in corporate leadership roles, and in particular at the largest and most valuable companies. Women lead smaller and less network affiliated hospitals than do men (Song, et al. 2018). This under representation of women at the top organizations within high status occupations applies also to academia, where women are underrepresented in both the US and the UK (Gamage, Sevilla and Smith 2020; Lundberg and Stearns, 2019; Ceci, 2018; Cech and Blair-Loy, 2019) and gender bias in hiring has also been documented (Foschi, Lai and Sigerson, 1994; Steinpreis, Anders and Ritzke, 1999; Moss-Racusin et al., 2012).

Theories of discrimination in economics have long engaged with the use of heuristics of representativeness to explain discrimination (Arrow, 1971; Phelps, 1972): when the productivity of workers is imperfectly observable, it will be assumed to be that of workers with similar observable characteristics and as the historically employed group in high status occupations is male this puts women at a disadvantage. The effect of stereotypes including self stereotypes in biasing beliefs and decisions has been investigated formally in the contexts of political affiliations and beliefs about migrants (Tabellini and Gennaioli, 2023; Bordalo et al, 2016; Coffman, 2014; Fryer, Harms and Jackson, 2019). Self stereotypes are important too: Oxoby (2014) has shown formally how forming beliefs about one's own ability incorporating irrelevant information on observable types can bias downward one's perception of one's own ability (or upward if the type-based biases are positive), and lead to inefficient allocations of agents across more and less skilled sectors in the labor market and a growing segregation over time through the feedback to agents.

The combination of status and stereotypes in hiring is central to Goldin's Pollution theory of discrimination (Goldin, 2014), which poses that female hires may reduce status in a previously all male occupation so that discrimination emerges to protect the club good of professional image, and that as women enter organizational status is thus lowered. The theory is the one closest to our model, in which however we incorporate returns to individual worker productivity from organizational status, which allows us to account for different patterns of women's representation across occupations as well as their persistence in top ranked organizations within high status occupations.

3 Theoretical model

3.1 Agents and endowments

We study a two-sided many-to-one matching market. On one side of the market, *firms* $f_i \in F$, indexed by i, must fill q positions each. Each of these positions may be filled by one *worker* $w_j \in W$, indexed by j. To keep things simple we assume that the number of workers, $|W| = N$, is equal to the number of positions, or $N = n \times q$ where $n = |F|$ is the number of firms. Assume as well that N is even. The strategic agents comprise these n firms and N workers.

Each firm i has a resource endowment $\eta_i \in \mathbb{R}^+$ that is useful in production of output and complementary to the abilities of the workers it matches with. Each worker j is endowed with a type (r_j, g_j) comprising ability $r_j \in \mathbb{R}^+$ as well as gender $g_j \in \{0, 1\}$. Of the N workers, $N/2$ have gender 1 (without loss of generality let this represent men) and $N/2$ have gender 0 (again, without loss of generality, women). The distribution of ability among workers is independent of gender, i.e. $Pr(g_j = 1|r_j) = Pr(g_j = 0|r_j) = 1/2$. Each worker's ability and gender are perfectly observable to every firm. All workers can likewise observe each firm's resource endowment.

3.2 Matching

Let $\mathscr{A} : W \to F \cup \{\varnothing\}$ be a function which maps each worker to at most one firm, or possibly to no firm ($\varnothing$). Since each firm has only q positions available we will define the set of possible *matchings* $\mathscr{A} \in \mathcal{A}$ as

$$\mathcal{A} = \left\{ \mathscr{A} : W \to F \cup \{\varnothing\} \;\middle|\; \left|\mathscr{A}^{-1}\left(\{f_i\}\right)\right| \leq q \,\forall f_i \in F \right\}.$$

I.e. there is no firm whose preimage of any matching has more than q workers in it.

3.3 Production

Output is produced by workers, but their productivity depends on the endowment of their employing firm, as well as that firm's *prestige* $\Pi_i \in \mathbb{R}^+$. Prestige is determined endogenously by matching and production. We must first define production before prestige can be defined in Section 3.4.

The *production* y_{ij} resulting from the match of worker w_j with firm f_i is assumed to take the form

$$y_{ij} = \eta_i \times r_j \times (\phi \Pi_i + 1)$$

The production function has been parametrized such that $\phi = 0$ represents prestige having no importance to output whereas $\phi > 0$ represents prestige having some importance. We will show that $\phi = 0$ results in non-discriminatory stable matches whereas $\phi > 0$ will yield discriminatory matching allocations in equilibrium.

3.3.1 Payoffs

The total amount of production y_i realized by the match of a firm f_i with all its workers under matching $\mathscr{A}$ is simply the sum of the individual production arising from all those matches:

$$y_i = \sum_{j: w_j \in \mathscr{A}^{-1}(\{f_i\})} y_{ij}.$$

Similarly let y^j denote the production realized by worker w_j under $\mathscr{A}$, i.e.

$$y^j = y_{ij} \mid f_i = \mathscr{A}(w_j).$$

We normalize the output of a firm matched to zero workers to 0. Formally, if $\mathscr{A}^{-1}(\{f_i\}) = \varnothing$ then $y_i = 0$. Similarly if $\mathscr{A}(w_j) = \varnothing$ then $y_{ij} = 0$ and $y^j = 0$.

Output is divided between the firm and the worker according to a fixed proportion $\mu \in (0, 1)$ as the worker's share and $1 - \mu$ as the firm's share. Worker w_j's payoff is therefore equal to μy_{ij} and firm f_i's payoff is $(1 - \mu)\, y_i$.

3.4 Prestige

Prestige is related to an firm's overall output, but in an indirect way that depends on *stereotypes*. Importantly, higher prestige is instrumental in the production of output, in a manner which is complementary to firm's endowments and workers' ability. We construct prestige based on how a non-strategic observer with knowledge of the aggregate association between worker gender and firm-level output might infer about that firm, *only using knowledge about the gender composition* *of that firm.* There is therefore the following endogenous relationship between prestige and production: being seen as a firm which employs workers who fit the part of being productive creates the image that the firm is productive, and this image itself improves the firm's (and its workers') productivity.

In the following we build *stereotypes* by considering the distribution of production across firms conditioning on gender. The joint distribution of production depends on the matching allocation $\mathscr{A}$ of workers to firms. Denote the (male) *gender composition* of firm f_i under matching $\mathscr{A}$ by m_i:

$$m_i = \frac{1}{q_i} \sum_{j: w_j \in \mathscr{A}^{-1}(\{f_i\})} g_j.$$

where $q_i = \left|\mathscr{A}^{-1}(\{f_i\})\right|$ is the number of workers matched to firm f_i under the matching $\mathscr{A}$.

3.4.1 Stereotype formation

Suppose that a nonstrategic observer O' can observe each y_i and m_i, but lacks information about the y_{ij}, r_{ij}, or η_i, and is furthermore ignorant of the prior $Pr(g_j = 1|r_j) = Pr(g_j = 0|r_j) = 1/2$. From this observer's perspective, the average expected output $\tilde{y}^1$ for a male worker in this market may be found by

$$\tilde{y}^1 = E_{O'}[y_{ij} \,|\, g_j = 1] = \frac{2}{N} \sum_{i=1}^{n} m_i y_i.$$

Correspondingly for women

$$\tilde{y}^0 = E_{O'}[y_{ij} \,|\, g_j = 0] = \frac{2}{N} \sum_{i=1}^{n} (1 - m_i)\, y_i.$$

Assume without loss of generality that $\tilde{y}^1 \geq \tilde{y}^0$. As the productive group is historically male a hiring manager will assume that a woman will be less productive than a man, leading to a smaller chance that she is hired by a firm which employs mostly men, which thus will continue to be male dominated (the Larry effect). This will in turn make women less productive due to the Matthew Effect, confirming the initial stereotype. Firms that are less concerned about status are the ones that start hiring women first and given there are lower returns from working at these firms this strengthens the perception that women are less productive.

Now, suppose that an even less informed non-strategic observer O'' lacked information about the firm-specific y_i as well, and knew only the m_i, q_i and $\tilde{y}^0$, $\tilde{y}^1$. We are now able to formally define *prestige* Π_i of a firm f_i as its estimated output per worker from the perspective of observer O'':

$$\Pi_i = E_{O''}\left[\frac{y_i}{q_i}\right] = m_i \times \tilde{y}^1 + (1 - m_i) \times \tilde{y}^0. \tag{1}$$

3.5 Stability

Note that the joint production y_{ij} that results from firm i employing worker j is sensitive to who else is matched to whom under $\mathscr{A}$, both at the market level via the stereotypes $\tilde{y}^1$, $\tilde{y}^0$ and at the firm level via coworkers' gender composition m_i. This is therefore a matching market with externalities (Bando et al., 2016). The stability of a matching $\mathscr{A}$ in this market will therefore be defined by comparing *actual* payoffs under $\mathscr{A}$ to *counterfactual* payoffs under prospective matchings e.g. $\mathscr{A}'$ where the counterfactual payoffs under $\mathscr{A}'$ are evaluated with respect to the stereotypes $\tilde{y}^1$, $\tilde{y}^0$ which emerge under $\mathscr{A}$.

Let m_i' represent firm f_i's counterfactual gender composition under matching $\mathscr{A}'$:

$$m_i' = \frac{1}{q_i'} \sum_{j:w_j \in \mathscr{A}'^{-1}(\{f_i\})} g_j$$

with $q_i' = \left|\mathscr{A}'^{-1}(\{f_i\})\right|$ similarly as above. Define as well $\hat{\Pi}_i'$ by

$$\hat{\Pi}_i' = m_i' \times \tilde{y}^1 + (1 - m_i') \times \tilde{y}^0.$$

Note that $\hat{\Pi}'$ contains the terms $\tilde{y}^1$, $\tilde{y}^0$ which are defined with respect to $\mathscr{A}$ and m' which is defined with respect to $\mathscr{A}'$. We can then refer to the counterfactual production arising from a prospective match of a worker w_j with firm f_i by

$$\hat{y}_{ij}' = \eta_i \times r_j \times \left(\phi \hat{\Pi}_i' + 1\right).$$

Recall that at most q workers may be matched to each firm, and that the set of all possible matches which satisfy this restriction is $\mathcal{A}$. Call the subset of all matches which are stable $\mathcal{A}^s \subseteq \mathcal{A}$. The matching allocation $\mathscr{A}$ is *stable* if there is no alternative allocation $\mathscr{A}'$ for which a worker w_k matched to firm f_i under $\mathscr{A}'$ but not under $\mathscr{A}$ is anticipated to produce more than a worker w_j employed by f_i under $\mathscr{A}$ and also more than w_k currently produces in her match under $\mathscr{A}$:

$$\mathcal{A}^s = \left\{\mathscr{A} \in \mathcal{A} : (f_i = \mathscr{A}(w_j) = \mathscr{A}'(w_k) \wedge f_i \neq \mathscr{A}(w_k)) \implies \left(y_{ij} \geq \hat{y}_{ik}' \vee y^k \geq \hat{y}_{ik}'\right)\right\}.$$

Proposition 1 $\mathscr{A} \in \mathcal{A}^s$ *if and only if*

$$\mathscr{A} \in \arg\max_{\mathscr{A}' \in \mathcal{A}} \sum_{i=1}^{n} \sum_{j:w_j \in \mathscr{A}'^{-1}(\{f_i\})} \hat{y}_{ij}'.$$

The proposition follows from the standard matching results (Becker, 1973, pp. 824).[1]

The special case of $\phi = 0$ gives us all of the properties of the standard matching framework – i.e. assortative matching of firms to workers on attributes η and r due to supermodularity of y – since no externality is present. The more general case of $\phi > 0$ maintains some properties of the standard environment: stable matchings cannot result in unmatched workers or firms, and must be assortative on *perceived* attributes. By this we mean no stable match would have a lower ability worker paired with a strictly better endowed firm than a higher ability worker of the same gender. Furthermore no worker with the disfavored-gender would be paired with a strictly better endowed firm than a favored-gender worker of the same ability r. Because the stereotypes $\tilde{y}^1$, $\tilde{y}^0$ depend on the matching $\mathscr{A}$ itself, there can be multiple stable matchings associated with distinct stereotypes and which result in different surpluses.

3.5.1 Welfare

This should not be confused in a normative sense with the surplus maximizing a social planner's problem. In the production function Π enters as a representation of the fact that one worker will get a better consideration for their work if they are matched to a firm where other highly productive workers are expected to be. We suggest instead for normative purposes that matchings should be evaluated according to what would maximize production under a scenario where the information frictions introduced in 3.4 did not apply. I.e. a social planner should rather maximize

$$U = \sum_{i=1}^{n} \sum_{j:w_j \in \mathscr{A}^{-1}(\{f_i\})} \eta_i \times r_j \times \left(\frac{\phi}{q_i} \left(\sum_{k:w_k \in \mathscr{A}^{-1}(\{f_i\})} \eta_i \times r_k \right) + 1 \right).$$

In reality prestige is also congestible. It may not make sense to consider in a welfare calculation whether the total amount of prestige in this market has increased or decreased. This suggests

$$U' = \sum_{i=1}^{n} \sum_{j:w_j \in \mathscr{A}^{-1}(\{f_i\})} \eta_i \times r_j$$

i.e. a more conventional product of firm resources and worker abilities. U and U' can be considered 'meritocratic' welfare criteria in the sense that they only count workers' abilities and not any stereotypes associated with them. Because the production function is supermodular (complementarity of firm endowments and worker abilities), both U and U' are maximized under matching allocations that assign the higher ability workers to the better-endowed firms.

[1]Note that when $\mathscr{A} = \mathscr{A}'$ each $\hat{y}'_{ij} = y_{ij}$. We cannot write the more succinct $\mathcal{A}^s = \arg\max \sum \hat{y}'_{ij}$ since $\hat{y}'_{ij}$ is defined relative to $\mathscr{A}$.

3.6 Illustrative example

Suppose there are two firms: Firm 1 has $\eta_1 = 10$ whereas Firm 2 has $\eta_2 = 5$. There are 8 workers: 4 are women and 4 are men. Of the female workers two have ability $r = 10$ and the other two have $r = 5$. The distribution of ability endowments among men is the same: two men have $r = 10$ while the other two have $r = 5$. Notationally,

$$W = \{(10,0),(10,0),(5,0),(5,0),(10,1),(10,1),(5,1),(5,1)\}$$

where $w_j = (r_j, g_j)$ i.e. worker j's gender is the second element of w_j or $g_j = w_j^{(2)}$ and her ability is the first element $r_j = w_j^{(1)}$.

We will compare three matchings which (excepting isomorphic matchings) are exhaustive of the possible stable allocations per Section 3.5: a non-discriminatory matching $\mathscr{A}_{nd}$, a moderately discriminatory matching $\mathscr{A}_{md}$, and an extremely discriminatory matching $\mathscr{A}_{ed}$.

Notationally, let

$$\mathscr{A}_{nd}^{-1}(F) = \{\{(10,0),(10,0),(10,1),(10,1)\},\{(5,0),(5,0),(5,1),(5,1)\}\},$$

$$\mathscr{A}_{md}^{-1}(F) = \{\{(10,0),(10,1),(10,1),(5,1)\},\{(10,0),(5,0),(5,0),(5,1)\}\},$$

and

$$\mathscr{A}_{ed}^{-1}(F) = \{\{(10,1),(10,1),(5,1),(5,1)\},\{(10,0),(10,0),(5,0),(5,0)\}\}.$$

Or, in words, under matching allocation $\mathscr{A}_{nd}$, firm 1 is matched with all the high-ability workers and firm 2 is matched with all the low-ability workers; under matching allocation $\mathscr{A}_{md}$ the higher-endowment firm 1 is matched to both higher-ability men, one of the higher-ability women, and one of the lower-ability men and firm 2 is matched with the other high-ability woman, both low-ability women, and the remaining low-ability man; and under matching allocation $\mathscr{A}_{ed}$, firm 1 is matched with all the men and firm 2 is matched with all the women.

This gives us a 3x3 matrix of counterfactual matchings and induced stereotypes under which we calculate the counterfactual payoff sums $\sum\sum \hat{y}'$ (see Appendix 1):

3.6.1 When is a discriminatory matching allocation stable?

Firstly note that for any $\phi \geq 0$ the non-discriminatory matching $\mathscr{A}_{nd}$ is stable as it gives the greatest anticipated output under the (absence of) stereotypes it induces. Note also that under the benchmark case of $\phi = 0$, $\mathscr{A}_{nd}$ results in the greatest anticipated surplus of all the matchings even if stereotypes were present. This straightforwardly results from the complementarity of firm

		Induced stereotypes		
		$\tilde{y}^{1,0}_{nd}$	$\tilde{y}^{1,0}_{md}$	$\tilde{y}^{1,0}_{ed}$
Matchings	$\mathscr{A}_{nd}$	$\frac{1000}{2-125\phi}$	$\frac{16000-237500\phi}{32+125\phi(175\phi-19)}$	$\frac{1000-56250\phi}{2-225\phi+5625\phi^2}$
	$\mathscr{A}_{md}$	$\frac{950}{2-125\phi}$	$\frac{15200-175000\phi}{32+125\phi(175\phi-19)}$	$\frac{950-49218.75\phi}{2-225\phi+5625\phi^2}$
	$\mathscr{A}_{ed}$	$\frac{900}{2-125\phi}$	$\frac{14400-146250\phi}{32+125\phi(175\phi-19)}$	$\frac{900-45000\phi}{2-225\phi+5625\phi^2}$

Table 1: Counterfactual payoff sums $\sum\sum\hat{y}'$ under the different possible matchings

resources and worker ability – the most assortative matching produces the most surplus and is therefore stable. Note that since our welfare perspective ignores prestige this is also allocatively the most efficient matching.

Comparing the counterfactual match surpluses from $\mathscr{A}_{md}$ and $\mathscr{A}_{ed}$ to that under $\mathscr{A}_{nd}$ depends on how important prestige is to output. When ϕ is sufficiently large – $\phi > 8/625$ in this particular example – the match surplus under $\mathscr{A}_{md}$ is larger than that of $\mathscr{A}_{nd}$ under its induced stereotypes and is also larger than the anticipated surplus under $\mathscr{A}_{ed}$ so long as $\phi \leq 16/575$ and therefore we would expect the discriminatory allocation to be stable for $\frac{8}{625} < \phi \leq \frac{16}{575}$. $\mathscr{A}_{ed}$ yields the highest anticipated surplus under the extreme stereotypes it induces whenever ϕ exceeds 8/625 in this particular example and therefore we would expect the discriminatory allocation to be stable for $\phi > \frac{8}{625}$. In summary,

$$\mathcal{A}^s = \begin{cases} \{\mathscr{A}_{nd}\} & \phi < \dfrac{8}{625} \\ \{\mathscr{A}_{nd}, \mathscr{A}_{md}, \mathscr{A}_{ed}\} & \dfrac{8}{625} < \phi \leq \dfrac{16}{575}. \\ \{\mathscr{A}_{nd}, \mathscr{A}_{ed}\} & \phi > \dfrac{16}{575} \end{cases}$$

3.6.2 Wages under $\mathscr{A}_{md}$

When prestige is sufficiently important in the production of output and therefore a discriminatory matching allocation must be stable, there will be an aggregate pay gap as well as rents associated with matching to a particular firm conditional on ability.

Keep the above example and set $\phi = 9/625$ such that firm 1 will pass over a high-ability woman in favor of a low-ability man. The wages of the high-ability workers (two men and one woman) at firm 1 are

$$\mu \times 10 \times 10 \times (\phi\Pi_1 + 1) = 1000\mu$$

with the low-ability man being paid

$$\mu \times 10 \times 5 \times (\phi\Pi_1 + 1) = 500\mu.$$

At firm 2 on the other hand the low-ability workers (one man, two women) are paid

$$\mu \times 5 \times 5 \times (\phi\Pi_2 + 1) = 250\mu$$

while the high-ability woman at firm 2 is paid

$$\mu \times 5 \times 10 \times (\phi\Pi_2 + 1) = 500\mu.$$

That the high-ability woman at firm 2 is paid exactly as much as the low-ability man at firm 1 is a fortuitous choice of example figures. But more important is the comparison between the high-ability woman who works for firm 1 and the high-ability woman working at firm 2: a significant premium associated with the male-dominated work environment. Likewise the comparison between the wages of low-ability men at these firms: a similar premium associated with working around other men.

3.7 Summary of theoretical results and model predictions

The key results of the model are as follows.

- In stable equilibria the favored type ($g = 1$) is more desired by higher-ranking firms, who pay them more.
  - I.e. the model generates hiring discrimination – men are preferentially hired by better endowed (higher status) firms, meaning that fewer women will be found and hired at higher status firms,
  - and an aggregate pay gap – since better endowed firms pay more on average.
- There will be a wage premium for both women and men when they move to higher status firms. Either a woman or a man with fixed ability r_j will be paid more if they locate in a firm which is more male dominated (due to higher Π_i).
  - Why? Perceived institutional prestige is actually complementary to worker ability.
  - The wage gap is entirely a between-firm phenomenon (Jewell, Razzu, Singleton, 2020).
  - We currently do not assume that workers are paid for their contribution to firms' prestige. This gives us the result that men and women at the same firm are paid the same conditional on ability.

Let us now consider how our results compare with the extant theories of labor market discrimination. Statistical discrimination theory predicts that as information on the actual productivity of women workers via more exposure to women across firms should lead to increasingly higher representation rather than persistence of underrepresentation, as well as better pay for the discriminated group (Aigner and Cain, 1977). Taste based discrimination (Becker, 1957) would predict men are willing to pay in order to have desired coworker identity, which is not really observed in high status firms. Goldin's pollution theory predicts lowering of the status of firms as they admit more women but this is not observed in practice and women enjoy returns from accessing these positions and firms in the same way as men. Biased representativeness heuristics would be able to explain the persistence of incorrect beliefs (including self beliefs), but this would not predict high wages for women at prestigious firms.

The table below summarizes the predictions of existing models against those of our theory.

THEORY	Markets correct?	Wage gap?	Gender composition effect* on men's wages	Gender composition effect* on women's wages	Hiring bias? (assume markets clear)
Taste based	Yes	0	−	+	Men
Statistical (correct beliefs)	Yes	+	+	−	0
Statistical (incorrect beliefs)	Maybe not	+	+	−	0
Our theory	No	+	+	+	Men

4 Testing the model in academia

4.1 Organizational prestige in academia

A growing body of research on the academic labor market indicates that prestigious institutions confer high career benefits to their faculty, with important network returns that determine positional advantage for faculty working at these institutions (Huber et al., 2022; Popov, 2022; Colussi, 2018). A recent paper by Wapman et al. (2022) analyzes US faculty hiring and retention over the decade 2011-2020 and find evidence of steep hierarchies of prestige based on a small subset of institutions supplying the vast majority of hires across fields, with faculty coming from outside this small group experiencing higher attrition rates. Colussi (2018) has shown the importance of social connections in the publication process in top journals, where 43% of papers are published by scholars connected to the editors. A recent experiment by Huber et al. (2022) has found strong evidence of status bias in peer review through a field experiment in which researchers are invited to review a paper jointly written by a prominent author and by a relatively unknown author, varying whether reviewers see the prominent author's name, an anonymized version of the paper, or the less well-known author's name. Similar advantages to being associated with more prestigious universities have been found in conference paper admissions (Gallegati et al., 2024). Organizational prestige also matters to technology licensing and leads to stratification in the creation and distribution of university-generated knowledge (Sine et al., 2003). The effect of organizational prestige in determining the spread of research and therefore the direction it takes has been documented by Morgan et al. (2018) in computer science in the US and Canada and in economics in the US by Heckman and Moktan (2020), who have documented the so called 'tyranny of the top five', the most important academic journals in the field, which shape the direction of research and individual career opportunities in ways that are not necessarily related with paper quality with the potential exclusion of both female authors and authors not belonging to these networks as well as their ideas and have thus raised both equity and efficiency concerns.

4.2 Persistence of gender underrepresentation in academia

In spite of the progress in women's educational attainment since the 1960s, women are still underrepresented in professorial positions (Ceci, 2018; Cech and Blair-Loy, 2019). The experimental literature on hiring finds a bias in favor of male job applicants (Foschi, Lai and Sigerson, 1994; Steinpreis, Anders and Ritzke, 1999; Moss-Racusin et al., 2012), although this does not appear to be the case for Scandinavian countries (Carlsson et al., 2021), and for professorial positions female applicants are often found to have an advantage over male applicants with similar qualifications (Williams and Ceci, 2015; Ceci, 2018).

In the economics field, women are under-represented in US departments compared to men, particularly at the senior level (Lundberg and Stearns, 2019) and are also paid less than their male counterparts and are less likely to be promoted (Ceci et al., 2014; Ginther and Kahn, 2004, 2009, 2014). Women in economics are under-represented, and are paid less than their male counterparts in the UK, even after accounting for socio-demographic, workplace, and productivity related characteristics (Mumford and Sechel, 2019). Women are less likely than men to have papers accepted at conferences (Hospido and Sanz, 2021). Women's papers improve more through journals' editorial process (Hengel, 2022) and their published papers get more citations (Card et al., 2020). Women get asked more questions in economics seminars than men do – and more questions that are deemed to be unfair (Dupas et al., 2020).

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4.3 Data

The data comprise a panel of academics from the Higher Education Statistical Agency (HESA), a public body which collects administrative personnel data from higher-education institutions in the United Kingdom. These data cover the entire population of academics employed in UK universities. We therefore observe all employee-employer matches and salaries within UK higher ed. and can track individuals across UK academic institutions. Our data cover the years 2012-2015 inclusive and allow us to characterize individuals' demographics and salary as well as the demographic composition and pay distribution of each individual's employing academic department (cost center), as well as those of departments where they were previously employed. The United Kingdom has a national research evaluation which occurs approximately every seven years, and the 2014 Research Evaluation Framework (REF 2014) is included in the sample period we consider. Our data do not include employee names, so we will not explicitly control for research or teaching productivity. Our design instead exploits the data's panel structure to account for any individual-specific unobserved attributes.

The United Kingdom academic job market is relatively competitive, with a high density of institutions within a few commutable geographic areas. Salaries are typically based on a national pay scale with regular yearly increments, but there is substantial scope for negotiation around what spine point of this scale an academic will enter onto at the beginning of each employment relationship. We do not observe the full set of opportunities as offers not taken up do not appear in the dataset; and there is substantial movement between employment in UK higher education, industry or civil service jobs, and other countries' higher education sectors.

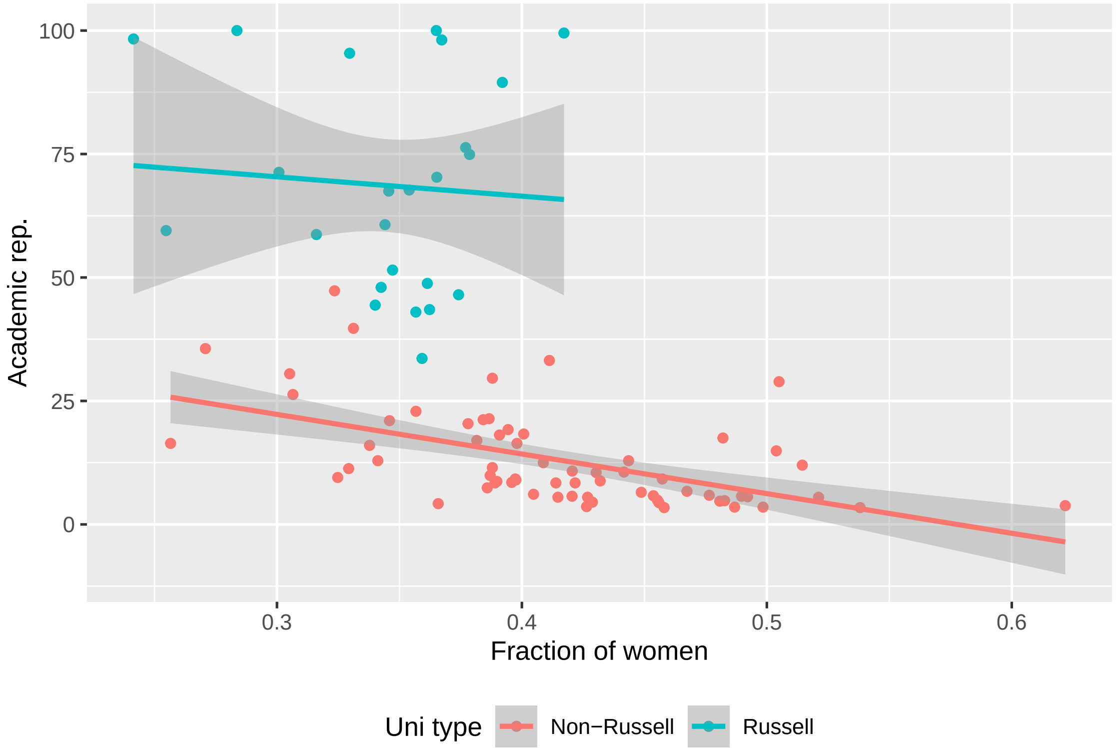
4.4 Descriptive statistics

UK academia is a sector with persistent underrepresentation of women. In Figure 1 we show the correlation between institutions' QS rank (of the university) and proportion of women, for both Russel and non-Russel universities.

Many reasons could underlie the relationship shown that women tend to work at worse (in terms of QS ranking) universities compared with men. We know that since these are department-level figures that it cannot arise from gender segregation across academic fields. There is rather a within-field gradient of gender composition and status. A naive interpretation (the Larry Effect) would be that there are inherent research productivity differences between women and men which lead to men being hired into better institutions. As discussed in Section 4.2 the evidence for such a claim is unfounded and instead there is strong evidence that women's and men's output are evaluated unequally.

We argue that the association shown in Figure 1 informs the perceptions of academics when they use informational shortcuts in evaluating colleagues' work. This association runs both ways. It impacts the perception and therefore evaluation of women because they as a group tend to work at lower-ranked institutions. It also impacts the perception of institutions and therefore the halo effect they confer on their members because institutions which employ more women carry the prejudice which is associated with them.

Figure 1: Correlation between gender composition and rank of university



There is substantial competition for academics in the United Kingdom which is aided by the high geographic density of world-leading universities. On average, 6% of our sample changes employment from one institution in our panel to another within the sample period. These figures are comparable for men and women. Though it has been argued that men have greater mobility across jobs due to norms around couples moving for men's vs. women's careers, and associated bargaining power that comes with mobility, in this particular context that is not in practice the case. This could be because the high geographic density of institutions allows changing jobs without necessitating a move of residence.

5 Empirical specification

5.1 All data

Per the predictions in Section 3 we hypothesize that segregation of academics by gender across academic ranking will lead an academic, regardless of gender and at all individual productivity characteristics, to be paid more when working in institutions which have a greater proportion of male colleagues. We test this prediction with the following reduced form wage equation, Equation 2. We use the notation that i indexes institutions and j indexes worker, consistent with the above.

$$\log(\text{salary}_{ijt}) = \alpha + \beta\, g_{i,-j} + \gamma\, sp_{jt} + \rho\, R_{ij} + \mu_j + \delta_i + \varepsilon_{ijt}, \tag{2}$$

where salary_{ijt} is the time t salary of individual j from department i, $g_{i,-j}$ is the ratio of men (excluding j) in department i who are at j's same academic grade (lecturer, senior lecturer, *etc.*), averaged over all years in which j was employed by that department at that grade,[2] sp_{jt} is a dummy variable equal to 1 if j's spine-point increased in year t, R_{ij} is the QS academic reputation score of department i averaged over all years t where j is employed there, μ_j and δ_t are individual and year fixed effects, respectively, and ε_{ijt} is the error term.

5.1.1 Data notes

Data are restricted to individuals on a full-time, permanent contract. We proxy for department using HESA cost centers. We drop individuals who changed legal sex: these are 1,263 observations from 306 unique individuals. The majority of those individuals changed sex a single time (182 unique individuals), suggesting that these are not administrative errors and instead reflect actual changes to their gender identity. We furthermore drop 3,028 observations where the individual's contract was split over multiple cost centers in the same year. This is because it is more difficult to determine whether an individual changed departments when they were employed by multiple cost centers. When an individual changed contracts mid-year – *e.g.*, because they were promoted or changed institutions – we only keep data on the first contract. Effectively, this just means that mid-year job changes/promotions are "delayed" until the next year. While HESA reports spine points (F_SPOINT), the data are only available for a third of all observations.[3] We therefore assume an individual is given a spine point increase if their salary increased at least 4 percent over the previous year. This figure was based on a (rough) analysis of recent HE single pay spines,[4] which suggests that an individual who receives *both* an inflation *and* spine point increase would always be paid at least 4 percent more than they were paid the previous year. (The salary of an individual who only received an inflation increase would have increased by less than that.)

5.1.2 Results

Table 2 shows results from estimating Equation (2) on the 2012–2015 dataset. The results in Table 2 suggest that both men and women are paid higher wages in institutions with more men. The coefficients are of similar magnitude – in Model 1 it is .038 log points for men and .030 log points for women associated with working in a department with all female colleagues vs. a

[2] Note that $g_{i,-j}$ ranges between 0 and 1.
[3] Interestingly, however, whenever F_SPOINT is missing, F_SALREF is *not* missing.
[4] `https://www.ucu.org.uk/he_singlepayspine`

department with all male colleagues. Model 2 of Table 2 controls in the wage equation whether the worker received an automatic spine point increase to their wage in that year.

Models 3 and 4 keep the spine point controls and adds the QS percentile ranking of the university where the individual is employed, with Model 4 additionally controlling for cost center (discipline) fixed effects. The coefficients on (male) gender composition $g_{i,-j}$ remain qualitatively unchanged in these specifications, but note that the coefficient on QS percentile Academic rep. is negative and significant at the 1% level for men and 10% level for women. Here we need to emphasize that the estimates include individual fixed effects. So the same person might be paid less at a better ranked institution because they are willing to accept a lower salary for greater status. Interestingly, the salary sacrifice that men are willing to take for a better ranked institution is twice as large in magnitude as that for women (.00028 log points per QS percentile for men and .00013 log points per QS percentile for women). This does not mean that higher ranked institutions pay lower salaries. Indeed, regressing academic reputation on log salary controlling for year fixed effects gives a positive coefficient on salary, showing that higher ranked institutions pay more on average. Garro-Marin, Kahn and Lang (2024) find a similar absence of pay premia for academics in US universities *after controlling for individual fixed effects.* If the reputation of an academic institution helps a researcher get published, but these publications have a durable influence on pay at subsequent employers then we cannot give a fully causal interpretation to firm-level pay effects estimated from fixed-effects models.

5.2 New matches: institution movers

Since we predict that academics are paid more in higher-ranked institutions, which tend to hire a greater proportion of men, the influence of academic institution rank and gender composition are confounded (as may be predicted by the stereotype formation mechanism in 1). The way that stereotypes are formed is best seen in marginal cases where a researcher is transplanted from one environment to another. Furthermore, most wage bargaining in academia happens at the start of contracts, following institutional moves. Therefore, restricting our attention to those people in the data set who ever move institutions can inform us about the considerations facing an academic in that situation.

The equation (3) extends the model above with the dummy variable Inst. change, capturing the wage bump a person gets when moving jobs, and also includes the interaction terms Inst. change$\times g_{i,-j}$ as well as Inst. ch.$\times$ac. rep., between the gender composition of the department being moved to and the academic rank of the institution being moved to. This equation is estimated only on those academics who ever move institutions within the sample period 2012-2015.

$$\log(\text{salary}_{ijt}) = \alpha + \beta_1\, g_{i,-j} + \beta_2\, \text{inst. change}_{jt} + \beta_3\, g_{i,-j} \times \text{inst. change}_{jt} \\ + \gamma\, sp_{it} + \rho_1\, R_{ij} + \rho_2 R_{i,j} \times \text{inst. change}_{jt} + \mu_j + \delta_t + \varepsilon_{ijt}, \tag{3}$$

where $g_{i,-j} \times$ inst. change$_{jt}$ is the interaction between $g_{i,-j}$ and inst. change$_{jt}$ and inst. change is measured in two ways:

In order to capture the total effect of moving to a new university with a different departmental gender composition and possibly different rank, it is necessary to add the interaction terms corresponding to the changes being experienced. Let us compare the predicted effect of moving with a general change of gender composition $\Delta g_{i,-j}$ and change of rank ΔAc. rep.

$$\Delta log(salary) = (\beta_1 + \beta_3)\Delta g_{i,-j} + \beta_2 + (\rho_1 + \rho_2)\Delta R_{i,j}.$$

The primary coefficient of interest is β_3, which indicates the relative increase in the wage increment of moving accruing to someone moving to an all-male department as compared with an all-female department. The *total* effect of moving from this hypothetical all-female to all-male department is $\beta_1 + \beta_2 + \beta_3$.

Similarly the wage bump associated with moving from a bottom-ranked to a top-ranked institution, (holding gender composition fixed) would be $\beta_2 + \rho_1 + \rho_2$.

We consider two slightly different definitions of our institutional change variable. In Table 3, inst. change$_{jt}$ is a dummy variable equal to 1 for all $t \geq t'$ and 0 for all $t < t'$. Thus, if individual j changed institutions in year 2013, then inst. change$_{jt}$ is equal to 0 in 2012 and 1 in years 2013–2015. (Individuals who changed institutions multiple times are excluded; see data notes below.) In Table 4, inst. change$_{jt}$ is a dummy variable equal to 1 at time t', 0 at time $t'-1$ and missing for all $t > t'$ or $t < t' - 1$. Thus, if individual j changed institutions in year 2013, then inst. change$_{jt}$ is equal to 0 in year 2012, 1 in year 2013 and is missing in years 2014–2015. (Individuals who changed institutions multiple times are excluded.)

					inst. change$_{it}$	
Year	Staff ID	Contract ID	Inst. ID	Cost centre ID	Table 3	Table 4
2012	********	XX987654321	152	122	0	0
2013	********	00123456789	124	122	1	1
2014	********	00123456789	124	122	1	–
2015	********	00123456789	124	122	1	–

5.2.1 Data notes

Data from individuals who did not change institutions during the sample period are excluded.

124 individuals (corresponding to 481 observations) changed institutions more than once. It seems that a number of these individuals changed institutions and then changed back again – see for example the individual below – so I worry that many of them may not be true institutional (or even departmental) changes, and instead reflect people who made a temporary move or are actually employed by both institutions on some sharing agreement. These individuals are excluded.

Year	Staff ID	Contract ID	Inst. ID	Cost centre ID
2012	********	12345	51	101
2013	********	12345	51	101
2014	********	1111111122	162	101
2015	********	1111111122	162	101

- j is assumed to have changed institutions between time $t-1$ and t if at time $t-1$ he had a contract of employment with one institution and at time t he had a contract of employment with a different institution.

5.2.2 Results

Tables 3 and 4 show results from estimating Equation (3). The results suggest that, conditional on changing institutions, both men's and women's salaries are higher when they move to a department with a higher fraction of men than they are when they move to a department with a higher fraction of women. However, men and women are paid more, relative to their lifetime average salary, in their pre-move department when there are a greater fraction of women. The subsample here is people who ever moved institutions, and for these people spending an earlier phase of their career around a greater proportion of men did not lead to positive wage spillovers, but for those who moved elsewhere they enjoy a greater increase in wage when moving to more male-dominated departments.

This pattern is not straightforward to interpret, but may suggest that male-dominated elite departments extract early-career reputation benefits when individuals are still establishing their research profile. Our model of Section 3 simplifies to fixed bargaining shares of surplus division, however it is likely that institutions have greater bargaining power earlier in researchers' careers than once established. This could lead to negative wage effects as individuals pay for access to the institution's prestige. Once their individual productivity is better known the wage premium becomes apparent as in the overall sample of Table 2.

As in Table 2, the coefficient on QS's academic reputation score in Tables 3 and 4 is negative and significant, although including this control does not appear to have a large impact on the coefficient of interest (namely, the coefficient on inst. change $\times$ $g_{i,-j}$).

The total effect of moving institutions (which is the sum of the coefficient on inst. change and inst. change $\times\, g_{i,-j}$) is positive if $g_{i,-j} = 1$ (i.e. in an all-male department), but it is declining as the fraction of women in the receiving department increases. This is again consistent with the gender-prestige gradient that we observe in Figure 1 and which we predict in our theoretical model (see Section 3), where we predict that stable matches will result in more men, holding ability fixed, ending up at better-endowed institutions which pay more. Real labor markets are of course never in equilibrium, but moves should upset matches which are not stable in preference of those which are. It is therefore in these job switches that we expect our predictions to be most evident.

6 Discussion

We propose an explanation for the persistence of under-representation of women at the top levels of high status occupations, based on the combined effects of the importance of organizational prestige and the implicit association of prestige with an observable component of identity, namely the gender composition of organizations. In our model agents, who are concerned both about prestige and pay, match with organizations with different prestige and resource levels. The productivity of workers at an organization depends on their ability endowment, the endowment of their employing organization, as well as its prestige, which is instrumental to the production of output via a halo effect that allows its workers to be more productive. Gender stereotyping arises from outside observers inferring an organization's status from the gender composition of the existing workforce at organizations and its correlation with productivity. When prestige concerns are low, the model produces meritocratic sortings where the highest ability workers pair off with the best-resourced employers. When prestige concerns are sufficiently high however a low-ability man may be preferred to a high-ability woman when status is associated with maleness – even though the underlying distribution of ability endowments is equal across genders. The combination of prestige concerns and gender stereotyping thus leads to hiring discrimination and higher wages at male-dominated workplaces, which are enjoyed by the majority of men and the minority of women who work there.

We test this theory's predictions in academia, which provides us with publicly available and widely salient measures of organizational prestige (QS rankings). We exploit a panel of matched employers and employees and data from the universe of academics employed at British higher education institutions. We confirm our prediction that institutions with a greater proportion of men will have better QS rankings and pay higher salaries. Furthermore, we confirm our prediction that both men and women who work at these male dominated and better ranked institutions enjoy higher salaries. These results are robust to controlling for unobservable time-invariant individual characteristics via fixed effects. Results from our specifications that focus on the wages of academics who move across institutions (Eq. 3; Tabs. 3-4) confirm our qualitative theoretical prediction that the same woman or same man moving to a more (less) male-dominated department will be paid more (less).

We view our stereotype-prestige theory to be the most parsimonious account of this pattern. Let us consider for due diligence how the above hiring patterns and gender pay externalities might (or might not) arise from extant theories of labor market discrimination. Under Becker's (1957) taste-based model, the identity composition of a workforce constitutes a direct amenity or dis-amenity to the manager or to the employees themselves. If men (or women) preferred to work around other men, we would see men have higher wages compared to women at all departments (regardless of departmental composition), and lower wages associated with working in male-dominated departments (as a compensating differential). We observe however the opposite, for both men and women. If we were to assume instead that men (or women) preferred to work around women, we would see women have higher wages compared to men at all departments (regardless of departmental composition), and higher wages associated with working in male-dominated departments (as a compensating differential). This assumption however does not square with the copious evidence on hiring bias *against* women in academia (e.g. Ceci, 2018; Foschi et al., 1994; Hengel, 2022; Hospido and Sanz, 2021; Moss-Racusin et al., 2012; Sarsons, 2017; Steinpries et al., 1999; Williams and Ceci, 2015). If workers had preferences corresponding to homophily (men preferring to work around other men and women preferring to work around other women) the we would see compensating differentials which go in opposite directions: men would accept lower pay to work around fellow men and women likewise for fellow women. Only one of these however is evident in our wage data for academics.

Two forces combine in our explanation to produce discriminatory outcomes and wage externalities for men and women working in male-dominated institutions:

1. The stereotype that women are less productive forms due to women working at less productive institutions. (The Larry effect)

2. The institutions that more women end up working in *are* less productive because they have worse images owing to (1). (The Matthew effect)

Being in an institution with worse image means that one publishes less as journals use one's affiliation to judge their work. Stereotype-based image is in this way complementary to individual researchers' productivity. Channels (1) and (2) reinforce each other in the matching market equilibrium. Institutions seek out men because they contribute to their image. This (entirely spurious) image benefits their co-workers. Even the women who work with them get paid more.

In summary, our story dovetails with what we know about both stereotypes and the spillovers associated with being in a particular institution. It can explain various axes of disadvantage without recourse to underlying ability differences or ad-hoc assumptions about tastes. We also see our work as advancing Goldin's (2014) pollution theory of discrimination with an underlying mechanism for stereotype formation and more nuanced predictions about how women's and men's wages will be affected by their co-workers' gender.

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Appendix 1 - Model simulation and workings

Illustrative example workings

There are 2 institutions: Firm 1 has $\eta_1 = 10$ whereas Firm 2 has $\eta_2 = 5$. There are 8 workers: 4 are women and 4 are men. Of the female workers two have ability $r = 10$ and the other two have $r = 5$. The distribution of ability endowments among men is the same: two men have $r = 10$ while the other two have $r = 5$.

We compare a non-discriminatory matching $\mathscr{A}_{nd}$ with two discriminatory matchings $\mathscr{A}_{md}$ and $\mathscr{A}_{ed}$. Recall

$$\mathscr{A}_{nd}^{-1}(F) = \{\{(10,0),(10,0),(10,1),(10,1)\},\{(5,0),(5,0),(5,1),(5,1)\}\},$$

$$\mathscr{A}_{md}^{-1}(F) = \{\{(10,0),(10,1),(10,1),(5,1)\},\{(10,0),(5,0),(5,0),(5,1)\}\},$$

and

$$\mathscr{A}_{ed}^{-1}(F) = \{\{(10,1),(10,1),(5,1),(5,1)\},\{(10,0),(10,0),(5,0),(5,0)\}\}.$$

Let us start with $\mathscr{A}_{nd}$. Under $\mathscr{A}_{nd}$, Firm 1's output is

$$y_1 = 10 \times (10+10+10+10) \times (\phi\Pi_1 + 1) = 400\,(\phi\Pi_1 + 1)$$

and that of Firm 2 is

$$y_2 = 5 \times (5+5+5+5) \times (\phi\Pi_2 + 1) = 100\,(\phi\Pi_2 + 1)\,.$$

The stereotypes associated with this matching allocation are

$$\tilde{y}^1 = \frac{1}{2} \times \frac{1}{4} \times 400\,(\phi\Pi_1 + 1) + \frac{1}{2} \times \frac{1}{4} \times 100\,(\phi\Pi_2 + 1)$$

and

$$\tilde{y}_0 = \frac{1}{2} \times \frac{1}{4} \times 100\,(\phi\Pi_2 + 1) + \frac{1}{2} \times \frac{1}{4} \times 400\,(\phi\Pi_1 + 1)\,.$$

The prestiges of Firms 1 and 2 in turn depend on the stereotypes:

$$\Pi_1 = \frac{1}{2}\tilde{y}^1 + \frac{1}{2}\tilde{y}^0$$

and

$$\Pi_2 = \frac{1}{2}\tilde{y}_1 + \frac{1}{2}\tilde{y}_0.$$

Note that since there is no gender segregation there are also no stereotypes and therefore gender-based stereotypes do not feed into institutional prestige, i.e. $\Pi_1 = \Pi_2$. Solving the above system we find

$$\Pi_1 = \Pi_2 = \frac{125}{2 - 125\phi}$$

with equilibrium stereotypes

$$\tilde{y}^1_{nd} = \tilde{y}^0_{nd} = \frac{125}{2 - 125\phi}$$

and

$$y_1 + y_2 = \frac{1000}{2 - 125\phi}.$$

From the perspective of $\mathscr{A}_{nd}$, the counterfactual production associated with $\mathscr{A}_{md}$ and $\mathscr{A}_{ed}$ are

$$\begin{aligned}
\hat{y}^{md}_1 &= 10 \times (10 + 10 + 10 + 5) \times \left(\phi\hat{\Pi}^{nd\to md}_1 + 1\right) \\
\hat{y}^{md}_2 &= 5 \times (10 + 5 + 5 + 5) \times \left(\phi\hat{\Pi}^{nd\to md}_2 + 1\right) \\
\hat{y}^{ed}_1 &= 10 \times (10 + 10 + 5 + 5) \times \left(\phi\hat{\Pi}^{nd\to ed}_1 + 1\right) \\
\hat{y}^{ed}_2 &= 5 \times (10 + 10 + 5 + 5) \times \left(\phi\hat{\Pi}^{nd\to ed}_2 + 1\right)
\end{aligned}$$

where

$$\begin{aligned}
\hat{\Pi}^{nd\to md}_1 &= \frac{3}{4}\tilde{y}^1_{nd} + \frac{1}{4}\tilde{y}^0_{nd} & \hat{\Pi}^{nd\to ed}_1 &= \tilde{y}^1_{nd} \\
\hat{\Pi}^{nd\to md}_2 &= \frac{3}{4}\tilde{y}^1_{nd} + \frac{1}{4}\tilde{y}^0_{nd} & \hat{\Pi}^{nd\to ed}_2 &= \tilde{y}^0_{nd}.
\end{aligned}$$

This gives us

$$\hat{y}^{md}_1 + \hat{y}^{md}_2 = \frac{950}{2 - 125\phi} \text{ and } \hat{y}^{ed}_1 + \hat{y}^{ed}_2 = \frac{900}{2 - 125\phi}.$$

We now move onto $\mathscr{A}_{md}$. Under $\mathscr{A}_{md}$, Firm 1's output is

$$y_1 = 10 \times (10 + 10 + 10 + 5) \times (\phi\Pi_1 + 1) = 350\,(\phi\Pi_1 + 1)$$

and that of Firm 2 is

$$y_2 = 5 \times (10 + 5 + 5 + 5) \times (\phi\Pi_2 + 1) = 125\,(\phi\Pi_2 + 1)\,.$$

The stereotypes associated with this matching allocation are

$$\tilde{y}^1 = \frac{3}{4} \times \frac{1}{4} \times 350\,(\phi\Pi_1 + 1) + \frac{1}{4} \times \frac{1}{4} \times 125\,(\phi\Pi_2 + 1)$$

and

$$\tilde{y}^0 = \frac{3}{4} \times \frac{1}{4} \times 125 \left(\phi \Pi_2 + 1\right) + \frac{1}{4} \times \frac{1}{4} \times 350 \left(\phi \Pi_1 + 1\right).$$

The prestige of firms 1 and 2 in turn depend on the stereotypes:

$$\Pi_1 = \frac{3}{4}\tilde{y}^1 + \frac{1}{4}\tilde{y}^0$$

and

$$\Pi_2 = \frac{1}{4}\tilde{y}^1 + \frac{3}{4}\tilde{y}_0.$$

Solving the above system for Π_1 and Π_2 we find

$$\Pi_1 = \frac{2125 - 21875\phi}{32 + 125\phi\left(175\phi - 19\right)},\ \Pi_2 = \frac{1675 - 21875\phi}{32 + 125\phi\left(175\phi - 19\right)}$$

with equilibrium stereotypes

$$\tilde{y}^1_{md} = \frac{2350 - 21875\phi}{32 + 125\phi\left(175\phi - 19\right)},\ \tilde{y}^0_{md} = \frac{1450 - 21875\phi}{32 + 125\phi\left(175\phi - 19\right)}$$

and

$$y_1 + y_2 = \frac{15200 - 175000\phi}{32 + 125\phi\left(175\phi - 19\right)}.$$

From the perspective of $\mathscr{A}_{md}$, the counterfactual production associated with $\mathscr{A}_{nd}$ and $\mathscr{A}_{ed}$ are

$$\begin{aligned}
\hat{y}_1^{nd} &= 10 \times (10 + 10 + 10 + 10) \times \left(\phi \hat{\Pi}_1^{md \to nd} + 1\right) \\
\hat{y}_2^{nd} &= 5 \times (5 + 5 + 5 + 5) \times \left(\phi \hat{\Pi}_2^{md \to nd} + 1\right) \\
\hat{y}_1^{ed} &= 10 \times (10 + 10 + 5 + 5) \times \left(\phi \hat{\Pi}_1^{md \to ed} + 1\right) \\
\hat{y}_2^{ed} &= 5 \times (10 + 10 + 5 + 5) \times \left(\phi \hat{\Pi}_2^{md \to ed} + 1\right)
\end{aligned}$$

where

$$\begin{aligned}
\hat{\Pi}_1^{md \to nd} &= \frac{1}{2}\tilde{y}^1_{md} + \frac{1}{2}\tilde{y}^0_{md} & \hat{\Pi}_1^{md \to ed} &= \tilde{y}^1_{md} \\
\hat{\Pi}_2^{md \to nd} &= \frac{1}{2}\tilde{y}^1_{md} + \frac{1}{2}\tilde{y}^0_{md} & \hat{\Pi}_2^{md \to ed} &= \tilde{y}^0_{md}.
\end{aligned}$$

This gives us

$$\hat{y}_1^{nd} + \hat{y}_2^{nd} = \frac{16000 - 237500\phi}{32 + 125\phi\left(175\phi - 19\right)} \text{ and } \hat{y}_1^{ed} + \hat{y}_2^{ed} = \frac{14400 - 146250\phi}{32 + 125\phi\left(175\phi - 19\right)}.$$

Let us finally evaluate $\mathscr{A}_{ed}$. Under $\mathscr{A}_{ed}$, Firm 1's output is

$$y_1 = 10 \times (10 + 10 + 5 + 5) \times (\phi\Pi_1 + 1) = 300\,(\phi\Pi_1 + 1)$$

and that of Firm 2 is

$$y_2 = 5 \times (10 + 10 + 5 + 5) \times (\phi\Pi_2 + 1) = 150\,(\phi\Pi_1 + 1)\,.$$

The stereotypes associated with this matching allocation are

$$\tilde{y}^1 = 1 \times \frac{1}{4} \times 300\,(\phi\Pi_1 + 1)$$

and

$$\tilde{y}^0 = 1 \times \frac{1}{4} \times 150\,(\phi\Pi_1 + 1)\,.$$

The prestige of firms 1 and 2 in turn depend on the stereotypes:

$$\Pi_1 = \tilde{y}^1$$

and

$$\Pi_2 = \tilde{y}_0.$$

Solving the above system for Π_1 and Π_2 we find

$$\Pi_1 = \frac{75}{1 - 75\phi},\ \Pi_2 = \frac{75}{2 - 75\phi}$$

with equilibrium stereotypes

$$\tilde{y}^1_{ed} = \frac{75}{1 - 75\phi},\ \tilde{y}^0_{ed} = \frac{75}{2 - 75\phi}$$

and

$$y_1 + y_2 = \frac{900 - 45000\phi}{2 - 225\phi + 5625\phi^2}.$$

From the perspective of $\mathscr{A}_{ed}$, the counterfactual production associated with $\mathscr{A}_{nd}$ and $\mathscr{A}_{md}$ are

$$\hat{y}_1^{nd} = 10 \times (10 + 10 + 10 + 10) \times \left(\phi \hat{\Pi}_1^{ed \to nd} + 1\right)$$
$$\hat{y}_2^{nd} = 5 \times (5 + 5 + 5 + 5) \times \left(\phi \hat{\Pi}_2^{ed \to nd} + 1\right)$$
$$\hat{y}_1^{md} = 10 \times (10 + 10 + 10 + 5) \times \left(\phi \hat{\Pi}_1^{ed \to md} + 1\right)$$
$$\hat{y}_2^{md} = 5 \times (10 + 5 + 5 + 5) \times \left(\phi \hat{\Pi}_2^{ed \to md} + 1\right)$$

where

$$\hat{\Pi}_1^{ed \to nd} = \frac{1}{2}\tilde{y}_{ed}^1 + \frac{1}{2}\tilde{y}_{ed}^0 \qquad \hat{\Pi}_1^{ed \to md} = \frac{3}{4}\tilde{y}_{ed}^1 + \frac{1}{4}\tilde{y}_{ed}^0$$
$$\hat{\Pi}_2^{ed \to nd} = \frac{1}{2}\tilde{y}_{ed}^1 + \frac{1}{2}\tilde{y}_{ed}^0 \qquad \hat{\Pi}_2^{ed \to md} = \frac{1}{4}\tilde{y}_{ed}^1 + \frac{3}{4}\tilde{y}_{ed}^0.$$

This gives us

$$\hat{y}_1^{nd} + \hat{y}_2^{nd} = \frac{1000 - 56250\phi}{2 - 225\phi + 5625\phi^2} \text{ and } \hat{y}_1^{md} + \hat{y}_2^{md} = \frac{950 - 49218.75\phi}{2 - 225\phi + 5625\phi^2}.$$

Appendix 2 - Tables

Table 2: Impact of $g_{i,-j}$ on salary (2012–2015)

	Model 1		Model 2		Model 3		Model 4	
	Men	Women	Men	Women	Men	Women	Men	Women
$g_{i,-j}$	0.03807***	0.02963***	0.03156***	0.02402***	0.03126***	0.02404***	0.03591***	0.02712***
	(0.00338)	(0.00363)	(0.00318)	(0.00342)	(0.00317)	(0.00342)	(0.00326)	(0.00353)
sp_{it}			0.03430***	0.03200***	0.03426***	0.03199***	0.03417***	0.03194***
			(0.00031)	(0.00033)	(0.00031)	(0.00033)	(0.00031)	(0.00033)
Academic rep.					-0.00028***	-0.00013*	-0.00027***	-0.00012*
					(0.00008)	(0.00007)	(0.00007)	(0.00007)
No. obs.	214,789	135,252	214,789	135,252	214,789	135,252	214,789	135,252
R^2	0.437	0.515	0.489	0.568	0.489	0.569	0.491	0.570
Fixed effects								
Year	✓	✓	✓	✓	✓	✓	✓	✓
j	✓	✓	✓	✓	✓	✓	✓	✓
Cost centre							✓	✓

Note: Sample includes only data for the years 2012–2015. Academic rank broken down by lecturer, senior lecturer, reader and professor. Standard errors clustered by individual in parentheses. ***, ** and * statistically significant at 1%, 5% and 10%, respectively.

Table 3: Impact of $g_{i,-j}$ on salary, conditional on institutional change (2012–2015)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
$g_{i,-j}$	-0.03247***	-0.05800***	-0.03439***	-0.05992***	-0.03334***	-0.05780***	-0.01995*	-0.05283***	0.02398***	0.00576
	(0.01183)	(0.01328)	(0.01134)	(0.01275)	(0.01128)	(0.01274)	(0.01120)	(0.01259)	(0.00860)	(0.00992)
Inst. change	0.01173	-0.00724	-0.00441	-0.02027***	-0.00096	-0.01686**	0.00205	-0.01693**	0.02599***	0.01471***
	(0.00869)	(0.00780)	(0.00832)	(0.00745)	(0.00834)	(0.00754)	(0.00831)	(0.00747)	(0.00458)	(0.00467)
Inst. change$\times g_{i,-j}$	0.09063***	0.10628***	0.08880***	0.10383***	0.08483***	0.10040***	0.07847***	0.09984***		
	(0.01364)	(0.01521)	(0.01309)	(0.01468)	(0.01301)	(0.01462)	(0.01283)	(0.01425)		
sp_{it}			0.04046***	0.03749***	0.03989***	0.03698***	0.03955***	0.03676***	0.03921***	0.03662***
			(0.00154)	(0.00174)	(0.00154)	(0.00175)	(0.00151)	(0.00177)	(0.00150)	(0.00178)
Academic rep.					-0.00032***	-0.00025***	-0.00031***	-0.00026***	-0.00072***	-0.00068***
					(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00010)	(0.00011)
Inst. ch.$\times$ac. rep.									0.00076***	0.00071***
									(0.00013)	(0.00014)
No. obs.	13,827	8,869	13,827	8,869	13,827	8,869	13,827	8,869	13,827	8,869
R^2	0.480	0.507	0.518	0.546	0.521	0.549	0.536	0.560	0.539	0.557
Fixed effects										
Year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
j	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost centre							✓	✓	✓	✓

Note: Sample includes only data for the years 2012–2015; academic rank broken down by lecturer, senior lecturer, reader and professor. inst. change$_{jt}$ is a dummy variable equal to 1 in year t' and zero in years $t \neq t'$, where t' is the year when j changed institutions. Standard errors clustered by individual in parentheses. ***, ** and * statistically significant at 1%, 5% and 10%, respectively.

Table 4: Impact of $g_{i,-j}$ on salary, conditional on institutional change (2012–2015)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
$g_{i,-j}$	-0.03680***	-0.06878***	-0.01973*	-0.05790***	-0.01988*	-0.05656***	-0.01098	-0.05067***	0.01993**	-0.00617
	(0.01295)	(0.01398)	(0.01172)	(0.01280)	(0.01168)	(0.01275)	(0.01188)	(0.01279)	(0.00995)	(0.01141)
Inst. change	0.02566	0.00219	0.02179	0.00386	0.02474	0.00733	0.02242	0.00487	0.04433***	0.03408***
	(0.01720)	(0.01440)	(0.01570)	(0.01284)	(0.01567)	(0.01278)	(0.01609)	(0.01272)	(0.01425)	(0.01063)
Inst. change$\times g_{i,-j}$	0.10012***	0.10959***	0.07009***	0.08714***	0.06766***	0.08460***	0.06401***	0.08596***		
	(0.01514)	(0.01669)	(0.01364)	(0.01529)	(0.01359)	(0.01522)	(0.01366)	(0.01450)		
sp_{it}			0.09134***	0.07920***	0.08958***	0.07772***	0.08781***	0.07782***	0.08683***	0.07794***
			(0.00368)	(0.00442)	(0.00371)	(0.00451)	(0.00378)	(0.00470)	(0.00387)	(0.00467)
Academic rep.					-0.00021***	-0.00019***	-0.00022***	-0.00019***	-0.00054***	-0.00052***
					(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00010)	(0.00011)
Inst. ch.$\times$ac. rep.									0.00058***	0.00055***
									(0.00013)	(0.00013)
No. obs.	5,121	3,585	5,121	3,585	5,121	3,585	5,121	3,585	5,121	3,585
R^2	0.375	0.369	0.488	0.484	0.490	0.487	0.511	0.511	0.514	0.506
Fixed effects										
Year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
i	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost centre							✓	✓	✓	✓

Note: Sample includes only data for the years 2012–2015; academic rank broken down by lecturer, senior lecturer, reader and professor. inst. change$_{jt}$ is a dummy variable equal to 1 at time t', 0 at time $t'-1$ and missing for all $t > t'$ or $t < t'-1$, where t' is the year when j changed institutions. Standard errors clustered by individual in parentheses. ***, ** and * statistically significant at 1%, 5% and 10%, respectively.