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# The glass ceiling revisited: empirical evidence from the German academic career ladder

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Women are underrepresented in leadership positions – academia is no exception. Using data on careers of doctoral graduates in Germany, we study gender differences in the decision to stay at university as a postdoctoral researcher and in the intention to become a professor. We find that gender gaps related to aiming for a professorship can be fully explained by observable characteristics other than gender. On the contrary, even after adding controls for an array of characteristics relevant to academic careers, we find female graduates to be 5.9 percentage points less likely to hold a postdoctoral position which allows them to qualify for professorship.

**JEL-Code:** I26; J16; J24

**Keywords:** female labour supply; gender gap; higher education; glass ceiling

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# 1. Introduction

Despite equal educational opportunities and equality acts, women are still underrepresented in leadership positions (e.g., Petrongolo, 2019). Academia is no exception.<sup>1</sup> For instance, in Germany, where slightly more women than men have graduated from universities in recent years, the share of women nevertheless declines with every step of the academic career ladder (doctorate: 45%, habilitation: around 30%, professorship: around 24%).<sup>2</sup> Prior research has identified psychological attributes, preferences/social norms, and a greater demand for flexibility in the workplace (mainly caused by motherhood) as the most important reasons for the ‘glass ceiling’ that prevents women from obtaining high-status, high-income jobs (e.g., Bertrand, 2018).

In this study we use data on the careers of doctoral graduates in Germany to examine gender differences in the decision to stay at the university as a postdoctoral researcher and to aspire to a professorship. We are particularly interested in whether the lower share of women in academic top positions can be fully explained by the characteristics mentioned. Furthermore, we account for variables previously identified as being relevant to academic careers, such as mentoring (Hilmer and Hilmer, 2007; Blau et al., 2010) and publishing (McDowell et al., 2006; Sarsons, 2017). Decomposition techniques are used to examine how much different sets of covariates contribute to the glass ceiling phenomenon in academia. We find that differences in doctorate-related variables like the final grade can explain about 65% of the gaps, whereas the discipline plays a major role for staying at the university but not for aspirations. Finally, while gender gaps related to aiming for a professorship can be fully explained by observable characteristics, female graduates are 5.9 percentage points less likely to hold a postdoctoral position which allows them to qualify for professorship. This finding is important as we cannot rule out that unobserved

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<sup>1</sup>In fact, measures intended to create equal opportunities may also have unintended consequences. For instance, Antecol et al. (2018) find that ‘clock-stopping policies’ extending fixed-term contracts for new parents cause an increase in tenure of men relative to women. For Germany, Funken et al. (2013) conclude that female scientists are disadvantaged by the increased competition for a tenure caused by a considerable increase in fixed term post-doc positions but no significant increase in professorships or other (very rare) permanent positions in academia. This finding is supported by Beaufaÿs and L other (2017).

<sup>2</sup>C.f. Federal Statistical Office of Germany (2019). For other countries, see Catalyst (2020) and references therein.

factors (e.g., factors related to the hiring decision) may include forms of discrimination.

## 2. Data

The data set is based on the *Promoviertenpanel 2014* (“Careers of PhD Holders 2014”) provided by the German Centre for Higher Education Research and Science Studies (DZHW). The *Promoviertenpanel 2014* was funded by the Federal Ministry of Education and Research and designed as a full census of researchers who obtained doctorates during the academic year 2013/14, 28,147 individuals altogether. The data was collected via questionnaires in two waves in 2015 (first wave: standardised self-administered survey, 5,412 responses, net response rate of 27.2%) and 2016 (second wave: standardised online survey, 3,188 responses, net response rate of 66.1%).<sup>3</sup>

Top academic career ambitions are surveyed by two questions in the second wave: “Are you aiming at a professorship?” and “Are you planning or have you started any of the following scientific qualifications: habilitation, junior professorship, research group leader, scholarship/funding program”.<sup>4</sup>

From the first question we created a binary variable *professorship* derived from whether the answer for the first question was “Yes, I am aiming at a professorship” (*professorship* = 1, zero otherwise) and from the second question we constructed a binary variable *stay* for choosing a career path that qualifies for a professorship (*stay* = 1, zero otherwise).<sup>5</sup> After discarding non-responses, we were left with 3,036 observations.<sup>6</sup>

Table 1 presents summary statistics for our key variables by gender. For both *profes-*

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<sup>3</sup>See the official documentation (accessible via [doi.org/10.21249/DZHW:phd2014:2.0.0](https://doi.org/10.21249/DZHW:phd2014:2.0.0)) and Jaksztat et al. (2017) for further information on the data set.

<sup>4</sup>Information on these academic positions can be found on this website maintained by the German Federal Ministry of Education and Research (BMBF): <https://tinyurl.com/y7dxflqe>.

<sup>5</sup>Note that we also categorized individuals who stated “I already hold a chair” as *professorship* = 1 when this did not include ‘Fachhochschulen’ (universities of applied sciences). The reason is that ‘Fachhochschulen’ aim to qualify their students for a more practical career. Being a professor there requires work experience outside academia and typically does not qualify postdocs for a professorship at a traditional ‘academic’ university.

<sup>6</sup>Since questions about *professorship* and *stay* were both posed in the second wave, a potential concern is that dropouts might bias our results. This would be the case if, for instance, male subjects who are more attached to science were more inclined to respond to the second survey. Yet, neither our gender variable nor a variable which measures attachment to science (first wave question: “Aim of life: career in science”) differ significantly across the waves (two sample *t*-tests, *p*-values 0.391 and 0.330, respectively).

*sorship* and *stay*, the percentage of women is lower than that of men. The table shows further gender differences, notably in publications, supervisors of the same gender, and family status.

The data set also includes variables related to personality traits: ‘The Big Five’, self-efficacy, and locus of control. Individuals were asked to rate the extent to which they agree with trait-related statements on a five-point scale (1 = strongly disagree, 5 = strongly agree). Since several statements correspond to each personality trait, we calculate the arithmetic mean across the relevant statements so that our personality trait variable still displays values between one and five. Significant gender differences (at the 5% level) can be observed for all of these variables except for the locus of control, see Table A.1 in the Appendix.<sup>7</sup>

### 3. Empirical approach and results

We estimate the linear probability model

$$Y_i = \beta_0 + \beta_1 FEMALE_i + \gamma' X_1 + \delta' X_2 + \sigma' X_3 + \varepsilon_i \quad , \quad (1)$$

where  $Y_i$  is the endogenous outcome of interest ( $Y_i = stay_i$ : individual  $i$  holds (or would hold) an academic position which would allow them to qualify for a professorship,  $Y_i = professorship_i$ : individual  $i$  aims for a professorship).  $X_1$ ,  $X_2$ , and  $X_3$  are vectors including, respectively, covariates related to demographics (age, native country, parental background, family status), academic characteristics usually associated with the chance of obtaining a chair at a university (grade, duration, form, publications (with and without peer reviews, in collections, books), funding, teaching experience, mentoring (reputation, gender, emotional support), networks, geographical location of the univer-

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<sup>7</sup>It should be noted that Cronbach’s alpha reliabilities (Cronbach, 1951) are high for our measures of self-efficacy and locus of control (0.807 and 0.700). The values are considerably lower for the ‘The Big Five’, which can be explained by a smaller number of items and an equivocal question related to agreeableness (“I tend to criticise other people”).

Table 1: Summary statistics

		N	Mean	Std. Dev.	Definition
professorship	♂	1,461	<b>0.160</b>	-	I already have a professorship or
	♀	1,575	<b>0.097</b>	-	Yes, I am aiming at a professorship.
stay	♂	1,461	<b>0.238</b>	-	Habilitation, junior professorship,
	♀	1,575	<b>0.173</b>	-	scholarship/funding program.
<hr/>					
<i>doctorate</i>					
time	♂	1,452	<b>4.946</b>	2.061	Time taken to obtain doctorate.
	♀	1,566	<b>4.771</b>	1.991	
grade	♂	1,459	<b>1.950</b>	0.672	Final grade (1 (summa cum laude), 2 (magna cum laude), 3 (other)).
	♀	1,572	<b>2.110</b>	0.749	
teaching	♂	1,411	<b>2.242</b>	3.674	Time spent on teaching (hours per week).
	♀	1,503	<b>1.639</b>	3.286	
network	♂	1,447	<b>2.915</b>	1.182	Managed to build a large, supportive network (1 (disagree) to 5 (fully agree)).
	♀	1,560	<b>2.727</b>	1.215	
networkInt	♂	1,435	<b>2.897</b>	1.423	How much importance was assigned to internat. contacts during PhD? (1 (not at all) to 5 (highly))
	♀	1,575	<b>2.647</b>	1.487	
publications	♂	1,444	<b>2.789</b>	4.651	Number of peer-reviewed publications.
	♀	1,554	<b>1.707</b>	2.460	
reputation	♂	1,450	<b>4.051</b>	0.938	Reputation of the main supervisor (1 (low) to 5 (high)).
	♀	1,545	<b>3.945</b>	0.971	
samegender	♂	1,456	<b>1.990</b>	1.264	Number of supervisors of the same gender.
	♀	1,564	<b>0.709</b>	0.889	
supemo	♂	1,434	3.297	1.306	I always received emotional support from my sci. environment (1 (disagree) to 5 (fully agree)).
	♀	1,561	3.434	1.373	
recommendation	♂	1,446	<b>0.889</b>	-	Recommendation to pursue academic career (yes/no).
	♀	1,557	<b>0.230</b>	-	
docreason	♂	1,455	<b>3.085</b>	1.191	Academic career was the reason to start the PhD project (1 (disagree) to 5 (fully agree)).
	♀	1,568	<b>2.998</b>	1.200	
<hr/>					
<i>demographics</i>					
female	-	3,036	51.88	-	
age	♂	1,461	<b>35,536</b>	5.628	
	♀	1,573	<b>34.426</b>	5.360	
east	♂	1,453	<b>0.203</b>	-	Living in eastern Germany (yes/no).
	♀	1,564	<b>0.247</b>	-	
birthGer	♂	1,461	0.908	-	Born in Germany (yes/no).
	♀	1,575	0.901	-	
parentsGer	♂	1,440	0.907	-	Parents born in Germany (yes/no).
	♀	1,547	0.920	-	
acadback	♂	1,461	<b>0.645</b>	-	Father or mother has academic degree (yes/no).
	♀	1,575	<b>0.693</b>	-	
pHHinc	♂	1,461	<b>0.345</b>	-	Household shared with full-time working partner (yes/no).
	♀	1,575	<b>0.541</b>	-	
children	♂	1,434	<b>0.411</b>	-	Children (own, adopted or partner's children) living in the household (yes/no).
	♀	1,542	<b>0.342</b>	-	
childimp	♂	1,452	4.168	1.185	Aim of life: own children (1 (disagree) to 5 (fully agree)).
	♀	1,566	4.192	1.224	

Mean pairs difference: bold  $p < 0.05$

sity (federal state)), and personality traits ('The Big Five', self-efficacy, locus of control). Discipline fixed effects and a binary variable related to the geographical location of the university (eastern Germany, for instance, has a higher average childcare coverage) are always included. Additionally, we use discipline dummies and an interaction term  $children \times pHHinc$  since a second source of income may have an impact on the relationship between children and career decisions.

$\beta_1$  then captures the gender effects that cannot be explained by those observable characteristics which have been identified as being important for gender gaps in labour markets in general, and in the academic world in particular. Coefficients are estimated using OLS regressions. As a robustness check, we replicate the analysis using a Logit estimator (see Table A.2 in the Appendix). The main results are unchanged.

Table 2: The gender gap in academic careers

	<i>professorship</i>				<i>stay</i>			
	Base (1)	Full (2)	Diff. (3)	% Expl. (4)	Base (5)	Full (6)	Diff. (7)	% Expl. (8)
<b>female</b>	-0.064** (0.014)	-0.023 (0.018)	-0.041	-64.06%	-0.065** (0.015)	-0.059** (0.020)	-0.006	-9.89%
<i>additional controls</i>								
discipline	<i>no</i>	<i>yes</i>	0.004 (0.008)	+6.25%	<i>no</i>	<i>yes</i>	0.037** (0.008)	+56.92%
doctorate	<i>no</i>	<i>yes</i>	-0.042** (0.011)	-65.63%	<i>no</i>	<i>yes</i>	-0.042** (0.013)	-64.62%
demographics	<i>no</i>	<i>yes</i>	-0.003 (0.004)	-17.19%	<i>no</i>	<i>yes</i>	-0.010* (0.005)	-15.39%
personality traits	<i>no</i>	<i>yes</i>	-0.010 (0.006)	-15.63%	<i>no</i>	<i>yes</i>	-0.003 (0.005)	-4.62%
<i>N</i>	3,036	2,497			3,036	2,497		
<i>R</i> <sup>2</sup>	0.009	0.225			0.007	0.283		

- Data: DZHZ *Promoviertenspanel 2014*

- Coefficients are estimated in a OLS regression framework.

- Robust standard errors in parentheses, \*  $p < 0.05$ , \*\*  $p < 0.01$

- The number of observations varies according to differences in non-responses across variables.



Table 3: The gender gap in academic careers – sample splits

	<i>professorship</i>			<i>stay</i>		
	<b>female</b>	<b>male</b>	<i>Difference</i>	<b>female</b>	<b>male</b>	<i>Difference</i>
parentsGer	-0.020 (0.035)	-0.003 (0.034)	-0.017	-0.021 (0.040)	-0.100* (0.045)	0.079
grade	-0.016 (0.016)	-0.061** (0.017)	0.045*	-0.024 (0.018)	-0.077** (0.019)	0.053*
time	-0.005 (0.004)	-0.014** (0.005)	0.009	-0.005 (0.005)	-0.006 (0.006)	-0.001
network	0.011 (0.008)	0.025* (0.010)	-0.014	0.031** (0.010)	0.023* (0.011)	0.008
recommendation	0.100** (0.024)	0.100** (0.029)	0.000	0.122** (0.031)	0.174** (0.033)	-0.52
docreaseon	0.059** (0.008)	0.079** (0.010)	-0.020	0.090** (0.009)	0.100** (0.011)	-0.010
<i>additional controls</i>						
discipline & east	<i>Yes</i>	<i>Yes</i>		<i>Yes</i>	<i>Yes</i>	
doctorate <sup>a</sup>	<i>Yes</i>	<i>Yes</i>		<i>Yes</i>	<i>Yes</i>	
demographics <sup>b</sup>	<i>Yes</i>	<i>Yes</i>		<i>Yes</i>	<i>Yes</i>	
personality traits <sup>c</sup>	<i>Yes</i>	<i>Yes</i>		<i>Yes</i>	<i>Yes</i>	
N	1,274	1,223		1,274	1,223	
R <sup>2</sup>	0.260	0.267		0.289	0.320	

- Data: DZHZ *Promoviertenpanel 2014*

- Table shows a selection of all variables whose estimated coefficients are found to be statistically greater than zero (at or below the 5% significance level).

- Coefficients are estimated in a OLS regression framework.

- Robust standard errors in parentheses, \* p<0.05, \*\* p<0.01

- Chow (1960) tests are used to test the equality of coefficients.

- <sup>a</sup> networkInt, reputation, samegender, supemo, teaching, publications (various types)

- <sup>b</sup> age, birthGer, acadback, children, pHHinc, children\*pHHinc

- <sup>c</sup> openness, extraversion, conscientiousness, agreeableness, neuroticism, self-efficacy, locus of control

## Results

Table 2 presents unconditional and conditional estimates of  $\beta_1$ . In addition, the importance of any given factor in explaining the outcome variable is quantified using the order-invariant decomposition method proposed by Gelbach (2016).

First, female scientists are 6.4 percentage points (50.39% of the *professorship* mean) less likely to aim for a professorship (column (1)). Adding our sets of controls reduces the gender gap by 4.1 percentage points, leaving a non-significant 2.3 percentage points gap (column (2)). Most notably, differences in doctorate-related variables, such as the number of publications and the final grade, account for 65.63% of the unconditional disparity. We conclude from the fact that the estimated coefficient of the gender dummy in the full model is not different from zero that there are no inexplicable gender differences in the ambition to obtain a chair.

Second, we find that women in our sample are 6.5 percentage points less likely to *stay* at the university on average (column (1)). Evaluated at the sample mean of 0.205, this translates into a 32% lower probability for women to follow a career path to professorship. Unlike *professorship*, adding controls reduces the gap by only 0.6 percentage points gap (columns (6) and (7)). A gender gap of 5.9 percentage points remains unexplained by observed characteristics. A detailed decomposition of the part of the gap that can be explained by each of the four covariate sets shows that accounting for potential differences in disciplines even widens the gap by 3.7 percentage points (e.g., because the ‘bottleneck’ for females differ in size), whereas doctorate-related variables and, to a lesser extent, covariates related to demographics reduce it.

Additionally, sample splits highlight gender-specific effects for our set of controls. A selection of all variables whose estimated coefficients are found to be statistically greater than zero (at or below the 5% significance level) are presented in Table 3. It shows that the most striking difference relates to the final grade of the doctorate. In particular, male graduates with better grades are more likely to aim at a professorship and also more likely to choose an academic position qualifying for a professorship.<sup>8</sup> This could be interpreted

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<sup>8</sup>This effect is completely driven by the difference between *summa cum laude* (with distinction) and *magna cum laude* (very good). These higher grades are usually considered to be needed for careers

in the way that the men in our sample react more strongly to formal feedback.

## 4. Conclusion

Female under-representation in top positions is a long-standing phenomenon in academia. Our results from data on the careers of doctoral graduates in Germany suggest that there are barriers for female junior researchers who aim for these positions: they are 6.4 and 6.5 percentage points less likely to aim for a professorship and to hold an academic position which would allow them to qualify for a professorship, respectively.

In the case of ambitions, these barriers can be identified. That is, the gap can be fully explained by observable characteristics, notably by doctorate-related variables like publications and the final grade. On the contrary, despite using a large set of controls including characteristics which have been found important for (academic) careers, a gap of 5.9 percentage points with regard to postdoc positions cannot be explained by our model.

Our results hence suggest that there are barriers for female scientists who aim for top positions in academia. As a consequence of the gender bias in ‘stay decisions’, the supply of female talents decreases. In line with Bertrand (2018), we therefore expect better economic outcomes when gender itself is not a predictor for staying at the university and having the opportunity to reach for academic top positions. Since we are unable to observe the hiring process, we cannot rule out that indirect or anticipated discrimination might play a role.

In this light, our results could be interpreted such that policies aiming at a higher share of females in academic top positions should include measures to prevent hiring discrimination, like anonymous job applications (e.g., Åslund and Skans, 2012; Bertrand and Duflo, 2017), gender quotas, and more female experts being involved in the recruitment process (acknowledging that there is mixed evidence from existing work, such as De Paola and Scoppa (2015) and Bagues et al. (2017)).

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in the German academic system. In our sample, only around three or four percent of the subjects without these grades aim for a professorship and hold a postdoc position.

A limitation of our study is that our data does not allow to uncover the underlying mechanisms of gender differences in our explanatory variables. Why do male graduates receive better grades and are more engaged in networks? For instance, we do not have information on the time spent on domestic responsibilities, particularly with respect to childcare. This is important, because differences in the time allocated to childcare can, for instance, explain gender gaps in publications (Lundberg and Stearns, 2019).

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## A. Additional Tables

Table A.1: Summary statistics for personality traits

		N	Mean	Std. dev.
<i>The Big Five personality traits</i>				
Extraversion	♂	1,455	<b>3.120</b>	0.963
	♀	1,568	<b>3.392</b>	0.927
Agreeableness	♂	1,455	<b>3.218</b>	0.732
	♀	1,571	<b>3.310</b>	0.751
Conscientiousness	♂	1,455	<b>3.948</b>	0.733
	♀	1,572	<b>4.231</b>	0.679
Neuroticism	♂	1,454	<b>2.485</b>	0.826
	♀	1,572	<b>2.869</b>	0.858
Openness to experience	♂	1,456	<b>3.374</b>	0.939
	♀	1,573	<b>3.527</b>	0.989
Self-efficacy	♂	1,450	<b>4.267</b>	0.554
	♀	1,554	<b>4.174</b>	0.572
Locus of control	♂	1,446	3.065	0.391
	♀	1,555	3.069	0.415

Mean pairs difference: bold  $p < 0.05$

Table A.2: The gender gap in academic careers – Logit regressions.

	<i>professorship</i>		<i>stay</i>	
	(1)	(2)	(3)	(4)
<b>female</b>	-0.064** (0.012)	-0.025 (0.016)	-0.065** (0.016)	-0.048** (0.018)
<i>additional controls</i>				
discipline	<i>no</i>	<i>yes</i>	<i>no</i>	<i>yes</i>
doctorate	<i>no</i>	<i>yes</i>	<i>no</i>	<i>yes</i>
demographics	<i>no</i>	<i>yes</i>	<i>no</i>	<i>yes</i>
personality traits	<i>no</i>	<i>yes</i>	<i>no</i>	<i>yes</i>
<i>N</i>	3,036	2,463	3,036	2,474
<i>Pseudo-R</i> <sup>2</sup>	0.012	0.298	0.064	0.300

- Data: DZHZ *Promoviertentpanel 2014*

- Coefficients are estimated in a Logit regression framework. The table presents marginal effects.

- Some observations were dropped by Stata because of perfect predictions.

- Robust standard errors in parentheses, \* p<0.05, \*\* p<0.01