ERASMUS UNIVERSITY ROTTERDAM

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Bachelor Thesis Economics and Business Economics, Policy Economics

Examining the relationship between female representation in professor roles and female students' accomplishments.

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I. Introduction

Gender equality is the 5th out of the 17 current Sustainable Development Goals (SDGs) with one of the sub-targets calling for “full participation in leadership and decision-making” (The Global Goals, 2015). Currently, women worldwide are underrepresented in positions of power, even though they constitute a large part of the workforce. Only 28% of managerial positions worldwide are held by women, according to data from the World Economic Forum's Global Gender Gap Report 2021 (World Economic Forum, 2021).

Research identifies different reasons for this at multiple steps of the hiring process. Starting with the application there are significant differences in the jobs men and women apply for, with women self-selecting into lower-paying jobs (Fluchtmann et al., 2022). This holds even for workers with otherwise similar labor market characteristics.
Women who do go through with the application process face another issue when coming in contact with hiring managers. The results of the study by Castilla and Benard (2010) show that hiring managers are more likely to hire candidates that share the same gender and ethnicity, even when the qualifications of the candidates were identical. This could lead to a disadvantage in environments where most decisions are made by white male managers.

Academia is another area in which men disproportionally occupy more positions than women. With the rising number of female Ph.D. holders, one would also expect the number of females at upper levels of the academic career ladder to rise at a similar rate, which is not observed in reality, especially for full-time professors (Zinovyeva & Bagues, 2010). To give an example relevant to this research, in the U.S. the majority of nontenure-track academics are women, but for tenure-track and full professors it is 44% and 36% respectively (American Association of University Professors, 2018).

These low numbers are disappointing considering the effect of the professor’s gender on students. Carrell et al. (2010) find on average a large gap in introductory math and science courses between men and women of the same initial ability, with women scoring much lower.

Then using a randomized setting they conclude that being assigned to a female professor helps mitigate such gap and leads to better outcomes for female students.

Stout et al. (2011) study the effects instructor's gender has on female science, technology, engineering, and mathematics (STEM) students and concluded that they benefited from having contact with female experts. Same-sex professors had psychological effects on the students by increasing their self-efficacy, identification with the field, and commitment to further pursue STEM. The authors draw a logical conclusion that it is desired to increase the visibility of female experts in the field to increase female students' sense of belonging (Stout et al., 2011).

It is not only women one comes in contact with that affect behavior and self-esteem: representation is an important factor too. Lawson et al. (2022) show that women in leadership positions in organizations help mitigate gender stereotypes, which are agreed to be the source of maintaining inequality. Representation changes women's beliefs of what being a woman is and helps them progress within organizations as well as in society.

Representation in academia could potentially have a similar effect on other women from the same environment by empowering them and reducing stereotyping. However, most previous research focuses on the effect coming from one-to-one contact with a female instructor, with only a handful of papers studying higher education institutions. In addition to the role model effects rising from the direct contact between students and their professors, I look into the potential effect representation of women in high positions at university could have on students enrolled there through visibility. Another important contribution my research adds to the existing literature is the fact that I include longer-term outcomes, i.e. mean earnings after graduation, as well as academic outcomes throughout study. Overall, this research aims to close the research gap about women representation effects in the area of higher education and to assess whether the female presence in high positions at universities is related to more desirable female students' future outcomes.

Hence the research question is: “Does a larger share of female full professors in university positively affect the future outcomes of female students?"

I study this relationship by examining data from the United States Department of Education using the Ordinary Least Squares method. The available datasets provide information on 5,547 educational institutions around the US and include a set of institutional, student body, and faculty characteristics, which allows me to have a large sample size and include a varied set of controls to decrease the bias of my results. A representative dataset provides a high external validity allowing for interpreting results generally.

As one can define future outcomes differently the question will be studied using different specifications. 6-year outcomes such as mean earnings and completion rate will be used as future outcomes. I will have retention and withdrawal rates within 2 years that can show the influence of females on students' perseverance in their chosen field.

The potential significance of this study lies in understanding how crucial representation is in education. With the number of female instructors having a large and positive effect on female students' outcomes and the desirability of increasing these outcomes, it could show how urgent it is for more female professors hiring and empowerment. The study could act as a call for the implementation of hiring policies in academia focused on promoting diversity, inclusion, and gender equality. With current discussions of the Eindhoven Technical University policy which only allows female applicants for positions where women are underrepresented to achieve a 30/70 gender ratio, the study could give an insight into the potential outcomes of the policy for students (Shufei, 2021).

The results of the main analysis show that share of women has a positive and significant relationship with female mean earnings 6 years after enrollment, and a 10% increase in the share is associated with a 712.70 US dollars increase in the mean earnings, which corresponds to around 2% of the average mean earnings. Acknowledging the fact that earnings inequality comes from multiple sources, I conclude that this finding is economically significant and contributes to the gender earnings gap. As for academic outcomes, the relationship with retention rate is statistically significant and negative and can be interpreted as a 1% decrease in retention rates for female students associated with a 10% increase in the proportion of female professors in the full-time faculty. The analyses for withdrawal and completion rates produce insignificant results. I use similar indicators for male students and find that those are correlated with the share of women in the faculty but to a smaller extent. A 10% increase in the share of women is associated with a 290.71 US dollar increase in future male earnings compared to a 712.70 US dollar increase for females. The retention rate for males is associated with the representation of women in faculty to the same degree. Although a 10 percentage points increase in the share of women is correlated with a 0.01-point decrease in the completion rate for male students I find this result economically insignificant considering the average completion rate of 0.42. I discuss the results more thoroughly in succeeding sections.

The research paper is structured as follows: I start by reviewing the relevant literature for the topic (Section II) and subsequently discussing the data and methods I am using to answer the research question (Section III). I formulate the hypotheses and report the results of my main analysis in Section IV. Next, in Section V, I conduct analyses of male students' outcomes. In Section VI I reflect on results using clustered standard errors as a robustness check. Section VI concludes with a reflection on the validity of the results, their policy implementation, and suggestions for future research.

II. Literature Review

Carrell et al. (2010) argue that the small gap between female and male test scores in math is unable to explain the large gap in representation in STEM careers and something must be happening to students during university that makes them make such different choices. They exploit the randomization of students to introductory classes at the United States Air Force Academy (USAFA) and focus on the effect of the instructor's gender on students' outcomes which indicates their persistence in STEM. Their data set consists of 9,015 students who graduated from USAFA in the years 2001 to 2009 provided by the school itself. The setting at the Academy is such that students are allocated to small classrooms allowing for a close connection between students and instructors, and outside-the-classroom interaction is also encouraged. Using a linear regression which includes dummy variables for the gender of the student, the gender of the instructor, and an interaction variable between the two, the researchers can conclude that the science and math professor's gender makes a difference: for females from the full sample, the grade increases when they are assigned to a female teacher, for males the effect is the opposite. When the sample is restricted to high-performing students, the positive effect on females increases and no effect on males is observed anymore which fully closes the gender performance gap. The same holds for longer-term outcomes such as the likelihood of following a follow-up STEM course, the likelihood to withdraw from the university, and the likelihood to graduate with a STEM degree, where again the largest effect is observed for high-performing individuals. There is no evidence of the gender effect in humanitarian courses. They conclude that the largest mechanism through which female professors affect female students is by changing their attitudes toward STEM subjects and careers. Many male professors also have positive effects on female students, so gender is correlated with better outcomes but not exclusively. This indicates that there must be other characteristics non-related to gender that act as mechanisms driving the effects, however, these are not observed in the data. As the study is based on the USAFA which is inherently different from an average American university due to higher admission requirements and the military character of the institution (17% of students are females, 5% are black) these could lead to a low external validity. However, the author notes that this fact helps to interpret the results as the effect on high-ability individuals which are the people whom we would prefer to nudge towards STEM careers (Carrell et al, 2010).

Bettinger and Long (2005) conduct a state-wide study using data from Ohio universities. Their sample size consists of students entering the schools at the age of 18-20 years old in the years 1998 and 1999. The main model is a linear regression model with the proportion of courses in a certain subject a student took from a female instructor in their first year of study as the main explanatory variable. To deal with selection issues they use the instrumental variable method with the *Deviation from Steady-State Female Composition* variable as the instrument. This variable shows the deviation of the female staff composition of a faculty from the 30 percent being the “steady-state”. They include course fixed effects and find mixed results for the impact of female professors: female students are more likely to take follow-up courses in mathematics and statistics and geology when the introductory course was taught by a female compared to by a male, but the opposite holds for biology and physics. They observe similar mixed effects for humanitarian courses (negative effect for political science, positive for education and psychology) (Bettinger and Long, 2005). Contrary to Carrell et al. (2010) they do not find any significant effect of instructor's gender on major choice of the female students. As the paper uses data from multiple universities rather than focusing on one, like Carell et al. (2010), it has arguably larger external validity and is used to make claims on the national level.

Hoffmann and Oreopoulos (2009) study the effects of professor gender on student academic outcomes using data from the University of Toronto’s Arts and Science Faculty from Canada. Their sample includes detailed information on students and staff from the years between 1996 and 2005. 34,352 students are entering a full-time undergraduate program from Ontario high schools that are between 17 and 20 years old. They restrict their focus to courses with at least 50 students in a section. The researchers use a linear regression method including fixed effects for student, course, and course by gender, with the interaction between dummy variables of student's and instructor's genders as the key explanatory variable. Contrary to the previously discussed large effects of female instructors, Hoffmann and Oreopoulos (2009) find small magnitudes in their results. Students' grade performance and the likelihood of dropping class are affected, however, these seem to be driven by male students performing worse when assigned a female teacher, with female students performing the same compared to having a male teacher. As seen in Carrell et al. (2010) effects of female teachers could be heterogeneous in terms of student's ability, with high-performing individuals being more affected. It would be important to check the effect variability in Hoffmann and Oreopoulos (2009) as well before concluding the minor role of the instructor's gender on students' outcomes.

A paper by Canes and Rosen (1995) uses the data from Princeton, Michigan, and Whittier universities from the period 1974-1988 period to study the effects of the proportion of female faculty on female students’ graduation rates. The research question focuses on the effects that a larger share of women in a department have on the decision of women to enroll in a certain program other than examining the effects on their outcomes during the study or after. In their linear regression model specification, the authors include time trends and departmental fixed effects and estimate the results separately for each university. A detailed panel dataset allows them to differentiate between majors and include departmental fixed effects in the regression, instead of including a large vector of controls, like I do. Fixed effects tool has a larger internal validity than a simple linear regression model as it allows to control for all the stable differences that might be absent in the control set. At the same time, limiting the sample size to three schools decreases the external validity of their results as the sample is not representative to draw conclusions even on a national level and could be specific to the universities from the sample. The estimated coefficients for the proportion of female faculty are insignificant and robust to several specifications. The study concludes that increasing the representation of female faculty does not support the notion of increasing female enrollment (Canes and Rosen, 1995).

Dee (2005) studies the effect of instructor similarity in terms of race, ethnicity, and gender on teacher evaluations in post-secondary education using the sample of 24,599 8th-grade students from 1,052 public and private schools from the National Education Longitudinal Study of 1988. They find that students are perceived as inattentive when they do not share race or gender with the teacher with the use of fixed-effects logit models. This study shows the effects of subjective opinion of teachers rather than real student performance, however, this is important in the school setting where the teacher-student interaction is very high.

Building on Dee (2005), Dee (2007) examines not only teachers' evaluations of student performance but also actual student performance and students' attitudes using the same dataset. Here he estimates the effects using different specifications: ordinary least squares (OLS) model including school fixed effects and first difference (FD). The OLS estimates the effects of teacher gender on student performance in math and science, and English and history. FD shows the difference for the same student's outcomes in these two categories of subjects which allows them to account for student fixed effects. However, the researchers acknowledge that this method assumes that the subject should not matter for the gender effect, which is not true if the stereotype threat which is more present for math and science was driving the results. With test scores as the dependable variable, both OLS and FD show an insignificant positive effect of female teachers on female students. FD also shows a negative significant effect of female teachers on boys. When separated by subject we see that girls' math test scores decrease with a female teacher, the same for boys; at the same time, girls benefit from a female teacher in history. The author notes that a big pitfall of the study is the fact that the nonrandom assignment is present, meaning that some groups may be selected to be specially assigned to a female teacher. If there is ability grouping happening with low-ability classes being assigned to female teachers it could sabotage the results found on the performance effects. The auxiliary regressions prove that the ability grouping exists for math classes, with female teachers being assigned lower-performance students explaining the previously negative results on math performance for both boys and girls. Taking this into account, the researcher limits the sample size to those schools that were not sent a math performance survey and only focus on science, history, and English classes. Now, he finds sizable effects of instructor's gender on student performance, which help close the performance gender gap by more than half in science by increasing girls' performance and harming the performance of boys. The performance gap would decrease by a third if a female English teacher was replaced by a male, this time by improving the boys' performance and harming the performance of girls. These results are not seen as desirable as at least one group of students is at a disadvantage. Regarding the attitudes of students, girls start perceiving science as more useful for their future when assigned to a female science teacher which is a positive outcome. The researcher does not advise for policy implications such as single-gender schooling or segregation of students and teachers based on gender but provides a suggestion for further examining the relative importance of mechanisms such as role model effects, stereotype threat, and teacher biases (Dee, 2007).

A study by Lim and Meer (2020) exploits the random assignment of students to classrooms in South Korean middle schools where ability grouping is not very common. Their dataset consists of 7th-grade students and their teachers in 2010 with the data being available through 12th grade, including a follow-up survey shortly after high school graduation on postsecondary outcomes, and derived from the Seoul Education Longitudinal Study of 2010. The general form of the estimation strategy is an OLS which includes a rich set of controls of student and teacher characteristics, as well as school-by-subject by ability group-level fixed effects to ensure unbiased estimation of the coefficients. They find that having a female math teacher in 7th grade significantly increases girls' performance in standardized tests that year compared to having a male teacher, with boys being affected insignificantly. They highlight notable persistent effects of instructor's gender as they are large throughout high school: female students are more likely to take an advanced math course, plan to major in STEM, attend a STEM-focused school, and reduce the likelihood of saying they are not planning on attending a university. The researchers argue that these teachers' gender impacts students by changing their attitudes, aspirations, and choices in course-taking and high-school quality (Lim and Meer, 2020).

As can be seen, so far, the studies which research the importance of female representation in instructional staff focused on the mentoring and role model effects. Lawson et al. (2022) find that companies that have women in leadership positions reduce the use of stereotypical organizational language. Language is one of the indicators of deep-rooted stereotypes, hence this change signals a change in people's attitudes toward women. This also changes other women's beliefs of what it means to be a woman and empowers them to take on leadership positions (Lawson et al., 2022). A similar effect is seen in politics when women represented by women in Congress express a greater interest and participation in politics (High-Pippert & Comer, 1998).

There are reasons to believe that the positive effects of female representation, other than role model effects, could be observed in academia too. Compared to the previous research on the female effect in academia, my study focuses on the potential effects greater female representation can have on other women around, specifically students, whose changed beliefs can lead to positive attitudes towards their study and better job-market outcomes in the future.

III. Data and Methodology

To analyze the effect of female representations in the university faculty on female students' outcomes I will combine two datasets openly provided by the United States Department of Education. Both have information on colleges on the federal level providing a large sample size. The first, College Scorecard, is intended for public use and provides information about educational institutions to prospective students. This dataset contains a variety of variables that describe each university in terms of fields of study, costs, admissions, outcomes, etc. The Integrated Postsecondary Education Data System (IPEDS) program collects basic data on all higher education institutions in the US. The program's data will be used to acquire information on the faculty composition by gender.

The outcomes of female students from the College Scoreboard that I will be using are recorded in terms of either 2 or 6 years after entry. To make the analysis consistent I will focus on the cohort of students starting their study in 2015 and the faculty that they had in the first year of study. Hence, the outcomes within 2 years are recorded in the year 2017, and 6 years after entry – in 2021.

The descriptive statistics of the main variables I will be using for the research are reported in Table 1. Less than 2% of the institutions are single-sex; there is almost an equal representation for public, private nonprofit, and private for-profit institutions; on average in the sample, there are 2878 degree-seeking students enrolled, but this largely varies with a standard deviation of 5971.37. The cost variable is calculated as average costs incurred minus the average scholarship received, hence can take negative values if the scholarship exceeds the costs, with the minimum value being -4,247 US dollars in the sample. Around 60% of the faculty are working full-time on average. With regards to the student body characteristics, the average share of females in the sample is 63%, meaning that most institutions have more women students enrolled than men, and the average share of financial aid-dependent students within the institutions from my sample is 58%, for first-generation students the mean share is 44%, for white – 47%, for black – 18%, for Hispanic – 20%, for Asian – 0.04%. In the sampled institutions on average, most students received federal loans or Pell Grant while in school. The distribution of the share of women in the full-time faculty is shown in Figure 1 showing that most institutions are concentrated around the 50/50 share. Comparing the outcome measures for male and female students shows that even though the completion rates 6 years after enrollment are higher for females, their mean earnings are always lower.

To separate the institutions into different categories depending on the kind of education they provide, the databases use Carnegie Basic Classification. This classification framework divides the institutions into 34 specific groups (the detailed flowchart of the classification scheme can be found in Appendix A); however, I unite them on a larger level of classification and create nine groups: Associate's Colleges, Special Focus, 2 years, Special Focus, 4 years, Baccalaureate/Associate's Colleges, Tribal Colleges and Universities, Doctoral Universities, Baccalaureate Colleges, Master's Colleges and Universities, Not applicable/Not classified. The table of frequencies for each kind of institution is shown in Table 2. In the dataset, the classification is not available for most institutions, and the largest groups of those, which are classified, are Associate's Colleges with 17% of the sample, Master's Colleges and Universities, and Special Focus, 4 years, with 12% each.

Table 1

Descriptive statistics of the main variables

Variable	**Full sample**				
	N	Mean	Std. Dev.	Min	Max
Institutional Characteristics:					
Women-only	5,547	0.01	0.08	0	1
Men-only	5,547	0.01	0.10	0	1
Control					
Public	5,547	0.34	0.47	0	1
Private nonprofit	5,547	0.31	0.46	0	1
Private for-profit	5,547	0.35	0.48	0	1
Enrollment of degree-seeking students	5,291	2878.14	5971.37	0	129615
Cost	4,989	15316.09	8099.43	-4247	107980
Faculty:					

% Fulltime	3,516	0.60	0.28	0	1
% Female fulltime	3,478	0.50	0.18	0	1
Student body characteristics:					
Share of Female	4,674	0.63	0.19	0.02	0.98
Share of Dependent	5,087	0.52	0.24	0.03	0.99
Share of First-generation	4,818	0.44	0.13	0.09	0.96
Share of White	5,291	0.47	0.28	0	1
Share of Black	5,291	0.18	0.22	0	1
Share of Hispanic	5,291	0.20	0.23	0	1
Share of Asian	5,291	0.04	0.08	0	0.99
Percentage Received a Federal Loan	4,320	0.76	0.23	0.01	0.99
Percentage Received a Pell Grant	4,510	0.72	0.17	0.11	1
Median Family Income	5,268	29621.52	20021.31	0	179864
Outcome variables:					
Female Students:					
Mean Earnings	3,284	31124.60	10732.52	10700	141600
Completion Rate	3,452	0.48	0.21	0.01	0.97
Withdrawal Rate	2,969	0.28	0.15	0.02	0.81
Retention Rate	2,573	0.31	0.19	0.01	0.88
Male Students:					
Mean Earnings	3,284	37327.01	12513.24	14800	166900
Completion Rate	3,452	0.42	0.21	0.00	0.94
Withdrawal Rate	2,969	0.35	0.17	0.02	0.82
Retention Rate	2,573	0.30	0.19	0.01	0.86

Notes: The descriptive statistics are based on institutional data from 2015 when the researched cohort entered the institutions. For the outcome variables, the Mean Earnings shows the mean earnings of students if working and not enrolled 6 years after entry at the original institution by gender, the Completion Rate shows the percent of students who completed within 6 years at the original institution by gender, the Withdrawal, and the Retention Rates show the percent of students withdrawn and who were still enrolled at the original institution within 2 years by gender respectively.

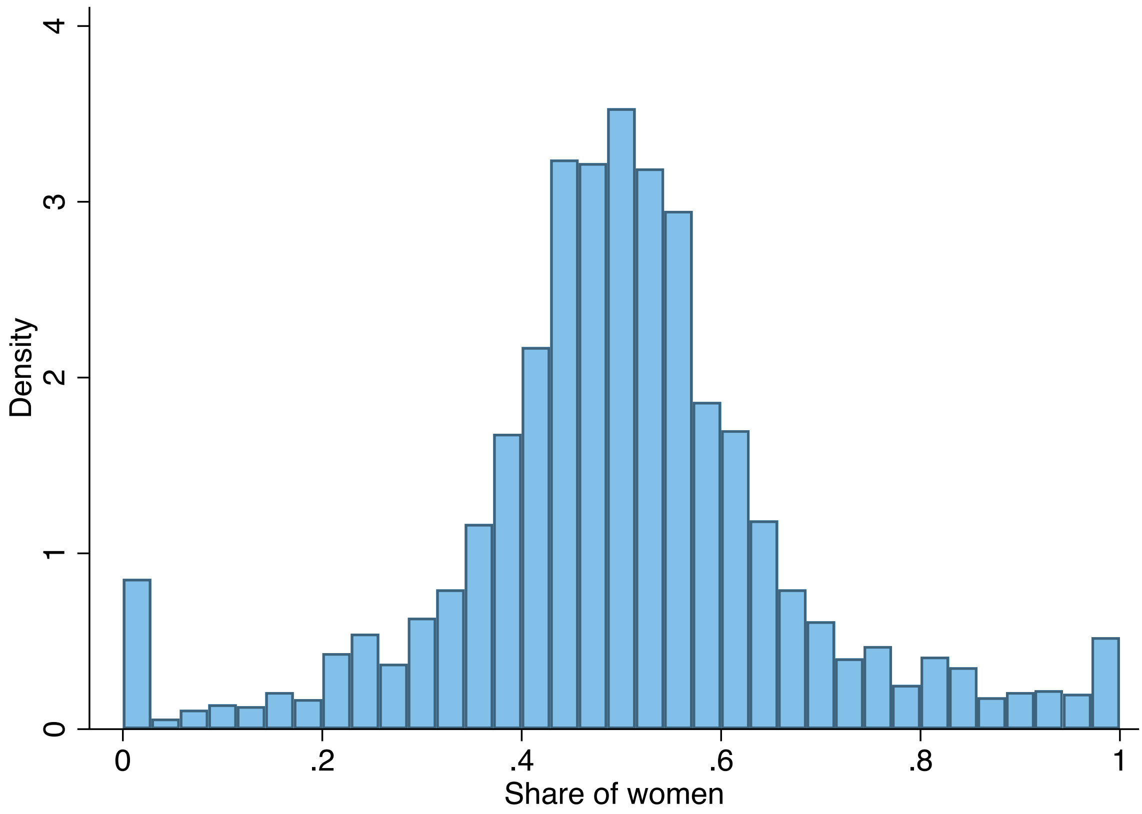
Table 2

Institution’s classification, table of frequencies

Group	N	Percentage	Do not report (percentage)
Total	5445	100	38.05
1. Associate’s Colleges	930	17.08	2.04
2. Special Focus, 2 years	296	5.44	35.81
3. Special Focus, 4 years	658	12.08	24.62
4. Baccalaureate/Associate's Colleges	95	1.74	1.05
5. Tribal Colleges and Universities	34	0.62	0
6. Doctoral Universities	463	8.50	0.43
7. Baccalaureate Colleges	519	9.53	3.47
8. Master’s Colleges and Universities	663	12.18	1.66
9. Not applicable/Not classified	1,787	32.82	98.10

Figure 1

Distribution of the share of women in the full-time faculty.



There are a few limitations to using these databases. As the collection methods and data encoding are not identical, when merging the datasets using a unique university identifier 724 observations are dropped due to no match, leaving us with a sample size of 6,046. The reliability of data also depends on the data collection and reporting methods that could vary by university.

IPEDS dataset only contains the information on universities that decided to provide the data, meaning that some will be excluded from the study due to missing data, leading to the potential problem of selection bias. A total of 2,568 institutions did not report the data on their full-time instructors. It is mostly institutions unclassified in the Carnegie Classification and Special Focus, 2 years institutes that do not report their faculty composition, which diminishes the comparison between different groups.

To study the relationship between faculty gender composition and student outcomes I use the Ordinary Least Squared (OLS) method. It estimates the unknown coefficients of a linear regression model by minimizing the sum of the squared differences between the actual and fitted values of the dependent variable. Additionally, standard errors provide information about the precision of the estimated coefficients, where smaller values indicate better accuracy. This procedure uses the residuals in calculating the standard deviation of the sample mean.

As the treatment (fraction of female professors at a given university) is not randomized for this study the estimated coefficient of a simple linear regression cannot be causally interpreted due to endogeneity. One of the sources of this is omitted variables so to decrease the omitted variable bias (OVB) I will include a vector of control variables in the model. Variables that are held constant throughout the time of the study and variables that could potentially influence both the dependent and the independent variables are defined as control variables. To control for university characteristics I will use variables indicating the state a university is located in, the control of institutions (public, private nonprofit, or private for-profit), single-sex institutions, and the proportion of faculty that is full-time, as these are likely to affect both the ratio of female full-professors and future outcomes of female students. Controls for student body characteristics will be the share of female students, the percentage of female students who were still enrolled within 2 years, the share of financially dependent students, the share of first-generation students, the share of students per race/ethnicity, and others.

The full model is:

$$Female\ Students'Outcome_i = \beta_1 Fraction\ of\ Female\ Professors_i + \beta_2 X_i + v_i$$

where *Female Students' Outcome* is the dependent variable, *the Fraction of Female Professors* is the main variable of interest, *X* is the vector of control variables for the university characteristics, and *v* is the error term for a university *I;* I use robust standard errors to establish the significance of the main coefficient estimate β_1.

Even though the data sources I am using contain many variables, there are potentially other non-recorded variables that could influence both the treatment and the dependent variable causing endogeneity. One of the variables that could be an important control is a variable indicating the initial abilities of students enrolled at a given university which can be proxied by the average SAT score of the enrolled students. As I want to estimate the effect of the female faculty on student outcomes it is important to be able to interpret the results ceteris paribus.

Even though the used dataset contains average SAT scores of the admitted students only a limited number of institutions disclose this information (1,036 out of 6,046), which significantly decreases the sample size for a linear regression estimation harming the precision of the estimation. Still, a separate regression including average SAT scores in the control vector will be conducted to compare the results in Table 2.

A variable completely missing from the data that should be included in the controls' vector is the institution's ranking. U.S. News college ranking could be used for these purposes as it is known as the most influential college ranking in the country. The algorithm assigns a score to each institution using a seven-dimension weighted scale, namely graduation and retention rates, social mobility (performance of grant recipients), graduation rate performance, undergraduate academic reputation, faculty resources for the academic year, student selectivity for the entering class, financial resources per student, average alumni giving rate, and graduate indebtedness. The top performing school in each ranking gets assigned an overall score of 100, others are scored relatively to the top school on a scale of 0-99 reflecting the distance from the top performer. As the current trend is to promote women to higher positions and increase women's representation, institutions with a higher ranking that receive more media coverage might hire more females for full-time faculty as they are more concerned with their public image. At the same time, female graduates from these high-ranked universities are more likely to succeed in the job market and have better future outcomes. With the ranking variable influencing both the outcome variable and the main independent variable not including it in the model as a control leads to an OVB. I do acknowledge the limitations behind ranking a large variety of institutions using the same scale, however as the university ranks in the U.S. are largely used and trusted ("In the month that the 2011 rankings came out, the U.S. News Web site recorded more than ten million visitors", Gladwell, 2011) their influence on student outcomes and media coverage is undeniable.

There are more variables I am not able to include in the estimation due to data unavailability, which is the main disadvantage of the OLS method. This means I will not be able to interpret the results as causal, but for the given research question an association is a good indicator of the relationship. I conduct a robustness check increasing my confidence in the interpretation of the results.

As a study by Bettinger and Long (2005) shows that it is the full-time instructors who have a greater effect on students, I will restrict the specification of the fraction of female professors to those with a full-time position as the main independent variable. I define the long-term outcomes of students as the mean earnings of female students who are not enrolled 6 years after entry as this best indicates the earnings right after graduation. As earnings are not always the best indicator of success and may largely depend on the field of work rather than the result of the female professors' influence definitions of student outcomes will be investigated in section IV: share of female students that complete the study in their original institution within 6 years, withdrawal, and retention rates within 2 years to check whether the presence of women also influences students' ambitions and perseverance.

IV. Main Analysis

Following from the related literature I expect to see a positive relationship between representation of females in the faculty and favorable female students' outcomes. Hence the main hypothesis of my analysis is formulated as follows:

H1: A larger share of women in the full-time faculty is positively associated with favorable female student outcomes.

I begin by defining the outcomes as mean earnings of female graduates 6 years after enrollment using model (1).

Hence the first sub-hypothesis I will study is:

H1.1: A larger share of women in the full-time faculty is positively associated with larger mean female graduates' earnings.

Table 2

Female students' outcomes 6 years after enrollment as dependent variables

	Mean Earnings			**Completion**
	(1)	(2)	(3)	(4)
Share of women	-7,902.64***	7,126.96***	14,211.68***	0.06*
	(1,791.35)	(1,164.34)	(2,232.72)	(0.02)
Constant	3,6203.14***	-1,712,667.11	-3,092,729.15*	-48.15*
Controls		Yes	Yes + average SAT score	Yes
Number of observations	2858	2393	1067	2437
R^2	0.01	0.75	0.77	0.76

Notes: Standard errors in parentheses are robust. ∗ p<.10, ∗∗ p<.05, ∗∗∗ p<.01

Figure 2

Scatter plot of mean earnings of female students on the share of female professors by university classification.

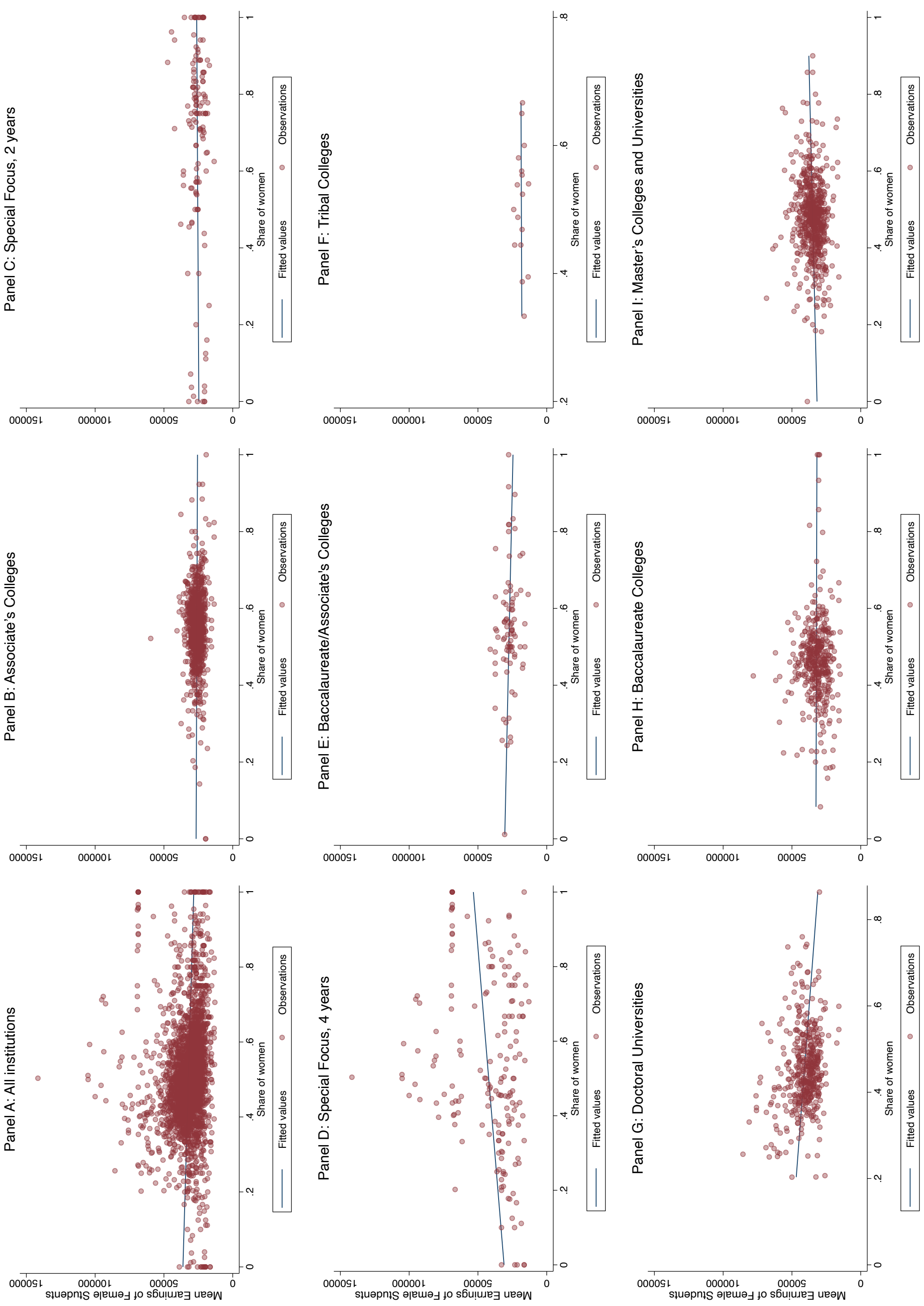


Table 2 presents the results of the different specifications of the model. The first specification shows the estimated coefficient of the share of women in full-time positions at that given university in the first year the female students were enrolled without including any controls. The results of the visual analysis of this relationship are shown in Figure 2. At first glance, a simple linear regression of mean earnings on the share of female professors produces a negative trend line when considering all classes of institutions (Panel A, Figure 2). When I conduct this analysis separating institutions by their classification, the produced results differ by class. For example, the trend line for Special Focus 4-year institutions is positive (Panel D, Figure 2), and the trend line for Doctoral Universities (Panel G, Figure 2) is even more negative than the cumulative one. Since this relationship is different for different kinds of institutions it is inappropriate to conduct a linear regression without controlling for different institutional characteristics.

As I include more explanatory variables, controlling for the institutional characteristics as well as student body and faculty characteristics, the estimated coefficient changes substantially (column 2, Table 2). The earlier coefficient of -7,902.64 (column 1, Table 2) was indicating that a 10% increase in the share of women in the faculty is associated with 790.26 US dollars *decrease* in mean female earnings 6 years after enrollment. The enhanced specification produces a coefficient (column 2, Table 2) that can be interpreted as an association between a 10% increase in the share of female faculty and a 712.70 US dollar *increase* in mean future female students' earnings. This proves that a simple regression that does not include any controls produces a coefficient confounded by omitted variables. As the independent variable is not randomized in the sample, I anticipated such a drastic change.

A large difference in the estimated coefficient is observed as I add the average SAT score of the enrolled students to the vector of control variables: the main coefficient nearly doubles, keeping significance at the 1% level. Now a rise of 10 percentage points in the proportion of women is positively associated with a 1421.19 US dollars increase in female students' mean earnings. However, the sample size decreases from 2,393 to 1,067 which means that there might be selection bias based on the reporting of the average SAT score. To test this, I analyze column 2 (without the control for SAT scores) limiting the sample to the sample from column 3. For this sub-sample, the coefficient from specification 2 would have been 12,797.75

compared to 7,126.96 from the full sample, which would not lead to as shocking of an increase when including the SAT scores considering the economic significance of the results. For the sake of avoiding such selection bias and keeping a balanced sample, I conclude that model 2 is the most appropriate for providing an answer to the first hypothesis. A positive association between the female faculty ratio and mean earnings of female graduates is found to support sub-hypothesis 1.

Considering the average mean earnings being 31074.25 US dollars, the results from column 2 indicate that an increase in the share of women in the full-time faculty is associated with an increase in mean earnings equal to 2% of the average. This finding should be seen as economically significant since the overall gender pay inequality comes from multiple sources and accumulates from these seemingly small numbers into a large gap.

Inspired by the effects on graduation rates found by Carrell et al. (2010) I change the definition of outcomes to the completion rates of female students within 6 years from the start of their study and research the second sub-hypothesis:

H1.2: A larger share of women in the full-time faculty is positively associated with larger female students' completion rates.

I use the same model specification as in column 2 for this analysis. The results are reported in column 4, Table 2. Again, the coefficient cannot be interpreted causally and should be seen as an association due to OVB. Even though the coefficient of the share of female faculty appears to be positive at 0.06 and significant at the 10% level, its economic significance is subject to criticism. It can be interpreted as when the increase in the share of women in the full-time faculty of 10% is associated with a 0.6% increase in completion rates of female students within 6 years increase by 0.6% which is a small marginal increase. Anyway, seeing the positive significant association I reject the null hypothesis to the sub-hypothesis 2 of no association between the female faculty ratio and completion rates of female students.

Following the reviewed literature, I use my model to estimate the effect of the share of female professors on shorter-term academic outcomes. Whereas Hoffman et al. (2009) find an insignificant effect of female professors on female students' withdrawal rates, I investigate this using a different methodology. I define the outcomes as retention and withdrawal rates of female students within 2 years of the start of their study. The idea behind these is that women professors positively affect female students' attitudes towards their chosen degrees and careers inspiring them to keep to their studies.

The relevant hypotheses are:

H1.3: A larger share of women in the full-time faculty is negatively associated with female students' withdrawal rates in the first two years of the study.

H1.4: A larger share of women in the full-time faculty is positively associated with female students' retention rates in the first two years of the study.

Using the same model specification as before I estimate the effect of the share of women in the first year of study on the retention and withdrawal rates of female students within the first 2 years and show the results of the estimation in Table 3. The estimation of the withdrawal rates yields a statistically insignificant negative coefficient for the share of women of -0.03. This result speaks against the sub-hypothesis 3 hence I reject the sub-hypothesis. The coefficient of representation of women in the faculty turns out to be negative and statistically significant at the 5% level for the estimation of the retention rates. This is the opposite of what I expected to find hence I do not have enough evidence to support sub-hypothesis 4. However, within 2 years female students might have transferred to another institution, died, or have an unknown status. Due to the retention and withdrawal variables being only related to the student's status at the original institution, it is not possible to conclude about the overall withdrawal and retention rates.

Table 3

Female students' outcomes 2 years after enrollment as dependent variables

Rates	(1) Withdrawal	(2) Retention
Share of women	-0.03	-0.05**
	(0.02)	(0.02)
Constant	24.79	-13.19
Controls	Yes	Yes
Number of observations	2291	2166
R^2	0.82	0.88

Notes: Standard errors in parentheses are robust. ∗ p<.10, ∗∗ p<.05, ∗∗∗ p<.01

V. Male outcomes

In this section, I investigate whether male student outcomes are correlated with the share of women in the full-time faculty. The relationship between these variables is hard to predict.

On one hand, an increasing share of women professors means the share of male professors decreases. As most of the studies which find a positive effect on female students' outcomes when increasing female representation refer to the role model effect, the same could be expected from male professors to male students. The study by Carrell et al. (2010) mostly focuses on female student outcomes but does so by comparing the impact a larger share of female instructors has on both males and females. This makes it possible to conclude the effects for both genders. Their findings indicate that an increasing number of female professors has a slightly negative effect on male initial performance in the course and follow-up STEM courses driven by the effects on students with a lower initial ability proxied by SAT scores in math. This shows that role model effects are not as significant for males, at least in male-dominated fields like STEM.

On the other hand, if the students are mostly impacted through stereotype threat this could lead to different outcomes for male students. In case when the course which corresponds to a male-dominated profession is taught by a female, the males in the course do not suffer from it, as shown in Carrell et al. (2010) using the results of STEM-related classes. However, there is a reason to believe that just like females being victims of stereotyping in male-dominated fields, males face the same issues in female-dominated fields. In this case, having a female instructor would increase the stereotype threat and could lead to a decrease in male performance and outcomes.

In my data sample, I am unable to differentiate between studies that correspond to traditionally male- or female-dominated fields of work which means it is not possible to analyze the effect variability. However, as males are more likely to be students in male-dominated fields, the found relationship will mostly show the correlation between larger female representation in professor roles and male outcomes through hypothetically diminishing the role model effects male-to-male. Using the same model as in column 2, Table

2, I estimate the association between the share of women in the full-time faculty and male outcomes, showing the results in Table 4.

Table 4

Estimation of the association between female representation and male outcomes

	Mean earnings	Completion rate	Withdrawal rate	Retention rate
Share of women	2907.13*	-0.05*	-0.01	-0.07***
Standard error	1444.23	0.02	0.02	0.02
Constant	-2,690,792.34	-12.59	14.73	-14.47
Number of observations	2393	2437	2291	2166
R^2	0.68	0.74	0.81	0.89

Notes: ∗ p<.10, ∗∗ p<.05, ∗∗∗ p<.01

Contrary to the concern of a negative relationship between a larger share of women professors (lower share of male professors) and male students' outcomes due to a decrease in the share of male role models, the results seem to disprove that. The positive and significant coefficient in Column 1 shows that a 10% increase in the share of women at a university is associated with an increase in male earnings by 290.71 US dollars. It is important to note, that this coefficient cannot be interpreted causally due to the limitations of the chosen methodology. Still, the positive sign of the coefficient and the significance level of 10% helps me reject the null hypothesis of no relationship between male students' future earnings and the share of women professors during their first year of study. Comparing this with the result from the regression of female earnings on the share of women (Column 2, Table 2), shows that the association is larger in magnitude and more statistically significant for women.

At the same time, the data reveals a negative connection between female representation in professor positions and completion and retention rates of male students: a 10-percentage point increase in the female participation rate is associated with a 0.01-point decrease for both rates (Columns 2 and 4, Table 4). Even though statistically significant, these results seem to not be significant economically considering the average completion and retention rates of

0.42 and 0.30 respectively for males. The regression of male students' withdrawal rates on the share of women professors yields a statistically insignificant result (Column 3, Table 4).

VI. Clustered standard errors

So far, I have been using robust standard errors when interpreting the significance of the coefficients estimates. However, Cameron and Miller (2015) suggest that if the regression model errors are correlated within the groups, incorrect conclusions on significance could be made. Carnegie groups universities into classes based on observable characteristics, the exact flowchart can be found in Appendix, Figure A. There is a reason to believe that universities put in the same group based on observable characteristics, would be similar in terms of unobservable characteristics too. The way to incorporate this in the model is to cluster the standard errors. Following Cameron and Miller (2015), I change the model used to estimate female mean earnings, completion, retention, and withdrawal rates' coefficients by additionally clustering the standard errors by the university. The results can be seen in Table 5.

Table 5

Investigation of the mean earnings and completion results sensitivity

		Mean earnings	**Completion rate**	**Retention rate**	**Withdrawal rate**
Share of women		7,126.96 **	0.06	-0.05	-0.03
Standard error	**Robust**	1,164.34	0.02	0.02	0.02
	Clustered	2,601.98	0.04	0.01	0.03
Constant		-1,615,623.70	-41.79	-13.19	24.79
Number of observations		2393	2437	2166	2291
R^2		0.75	0.76	0.88	0.82

Notes: ∗ p<.10, ∗∗ p<.05, ∗∗∗ p<.01

Looking at the results for Mean Earnings in column 1, Table 5, the standard error of the coefficient increases when I cluster by class, decreasing the coefficient's significance from 1% level to 5% level. For previously significant coefficients of share of women in the estimation of completion rate, the standard error increases (the minor change cannot be seen in column 4, Table 4, due to rounding up to 2 decimals) making it insignificant. The standard error of the retention rate surprisingly decreases, but the coefficient still does not have a significant interpretation. This, in addition to the previous checks, shows that the coefficient of the mean earnings estimation proved to be the most robust to different specifications.

VII. Conclusions and Discussions

Previous literature has found positive effects of women on students' outcomes, especially female students. Most of the study researched the impact of close interactions between female professors and their students, identifying role model effects as one of the most important mechanisms. Other research found that the visibility of women in positions of power has a positive effect on other women in the circle by reducing stereotyping and, hence empowering them. This paper aimed to establish whether the same positive association can be seen at universities, by researching the relationship between the higher representation of women in positions of power at a university (i.e., full-time faculty) and its female students' outcomes during and after study.

As previously discussed, assumptions needed to causally interpret the findings of the method chosen for this research (OLS) are violated due to possible omitted variable bias. Nevertheless, I argue that the set of controls used in my analysis is rather extensive, and the additional robustness check with the use of clustered standard errors instead of robust increases my confidence. I conclude that the higher ratio of females in the full-time faculty seems to be positively associated with higher mean earnings of female students at a given university 6 years after entry. Using different definitions of outcomes, such as completion rate within 6 years after entry, withdrawal, and retention rates within 2 years after entry, I find no significant association between these and the representation of women.

A possible explanation for why the mean earnings increase when at the same time the completion rates do not change, is increased quality of education and hence better job outcomes. As in the data set, I do not have variables indicating the quality of education I fail to research this mechanism. I believe that future research should also investigate the association between the representation of females in the faculty and other job market outcomes such as employment rate, as earnings largely depend on the industry and are not always able to capture career success.

To improve on the methods used in this research paper and decrease the bias in the results, an improvement could be the use of panel data. The main limitation of the linear regression method used is the inability to include all the control variables in the model due to some being unobserved, like 'Ranking' mentioned as one of the variables which need to be included but are not present in the data. Using panel data allows for the inclusion of fixed effects in the regression model which would automatically control for the characteristics which do not vary throughout the years, even if unobserved. This would improve the confidence of the estimation results and is advised for future research.

References

American Association of University Professors. (2018). The Annual Report on the Economic Status of the Profession. In *American Association of University Professors*. Retrieved April 15, 2023, from https://www.aaup.org/sites/default/files/ARES_2017-18.pdf

Bettinger, E., & Long, B. T. (2005). Do Faculty Serve as Role Models? The Impact of Instructor Gender on Female Students. *The American Economic Review*, *95*(2), 152–157. https://doi.org/10.1257/000282805774670149

Bichsel, J., & McChesney, J. (2017). The Gender Pay Gap and the Representation of Women in Higher Education Administrative Positions: The Century So Far. In *Research Report. CUPA-HR.* Retrieved April 15, 2023, from http://www.cupahr.org/surveys/briefs.aspx

Boring, A. (2017). Gender biases in student evaluations of teaching. *Journal of Public Economics*, *145*, 27–41. https://doi.org/10.1016/j.jpubeco.2016.11.006

Canes, B. J., & Rosen, H. S. (1995). Following in Her Footsteps? Faculty Gender Composition and Women's Choices of College Majors. *Industrial and Labor Relations Review*, *48*(3), 486–504. https://doi.org/10.1177/001979399504800308

Carrell, S. E., Page, M., & West, J. (2010). Sex and Science: How Professor Gender Perpetuates the Gender Gap*. *Quarterly Journal of Economics*, *125*(3), 1101–1144. https://doi.org/10.1162/qjec.2010.125.3.1101

Castilla, E. J., & Benard, S. (2010). The Paradox of Meritocracy in Organizations. *Administrative Science Quarterly*, *55*(4), 543–676. https://doi.org/10.2189/asqu.2010.55.4.543

Dee, T. S. (2005). A Teacher Like Me: Does Race, Ethnicity, or Gender Matter? *The American Economic Review*, *95*(2), 158–165. https://doi.org/10.1257/000282805774670446

Dee, T. S. (2007). Teachers and the Gender Gaps in Student Achievement. *Journal of Human Resources*, *XLII*(3), 528–554. https://doi.org/10.3368/jhr.xlii.3.528

Figlio, D. N., Schapiro, M. O., & Soter, K. B. (2015). Are Tenure Track Professors Better Teachers? *The Review of Economics and Statistics*, *97*(4), 715–724. https://doi.org/10.1162/rest_a_00529

Fluchtmann, J., Glenny, A., Harmon, N. A., & Maibom, J. (2022). The Gender Application Gap: Do Men and Women Apply for the Same Jobs? *Social Science Research Network*. https://doi.org/10.2139/ssrn.4114410

Gladwell, M. (2011, February 7). The Trouble with College Rankings. *The New Yorker*. https://www.newyorker.com/magazine/2011/02/14/the-order-of-things

Global Goals. (2015.). Goal 5: Gender equality. Retrieved from https://www.globalgoals.org/goals/5-gender-equality/

High-Pippert, A., & Comer, J. (1998). Female empowerment: The influence of women representing women. *Journal of Women, Politics & Policy*, *19*(4), 53–66. https://doi.org/10.1080/1554477x.1998.9970860

Hoffman, F., & Oreopoulos, P. (2009). A Professor Like Me: The Influence of Instructor Gender on College Achievement. *Journal of Human Resources*, *44*(2), 479–494. https://doi.org/10.1353/jhr.2009.0024

Lawson, M. L., Martin, A., Huda, I., & Matz, S. (2022). Hiring women into senior leadership positions is associated with a reduction in gender stereotypes in organizational language. *Proceedings of the National Academy of Sciences of the United States of America*, *119*(9). https://doi.org/10.1073/pnas.2026443119

Lim, J., & Meer, J. (2020). Persistent Effects of Teacher–Student Gender Matches. *Journal of Human Resources*, *55*(3), 809–835. https://doi.org/10.3368/jhr.55.3.0218-9314r4

Mengel, F., Sauermann, J., & Zölitz, U. (2017). Gender Bias in Teaching Evaluations. *Journal of the European Economic Association*, *17*(2), 535–566. https://doi.org/10.1093/jeea/jvx057

Mohr, T. S. (2021, November 2). *Why Women Don't Apply for Jobs Unless They're 100% Qualified*. Harvard Business Review. https://hbr.org/2014/08/why-women-dont-apply-for-jobs-unless-theyre-100-qualified

Shufei. (2021). TU/e will continue with the quota: at least 30% female. *Eindhoven News*. https://eindhovennews.com/news/2021/03/tu-e-will-continue-with-the-quota-at-least-30-female/

Stout, J. C., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, *100*(2), 255–270. https://doi.org/10.1037/a0021385

World Economic Forum. (2021). Global gender gap report 2021. http://www3.weforum.org/docs/WEF_GGGR_2021.pdf

Zinovyeva, N., & Bagues, M. (2010). Does Gender Matter for Academic Promotion? Evidence from a Randomized Natural Experiment. *Documentos De Trabajo (FEDEA)*, *15*, 1–34. http://ftp.iza.org/dp5537.pdf

Appendix

A: Carnegie Basic Classification flowchart, Carnegie Foundation (2021)

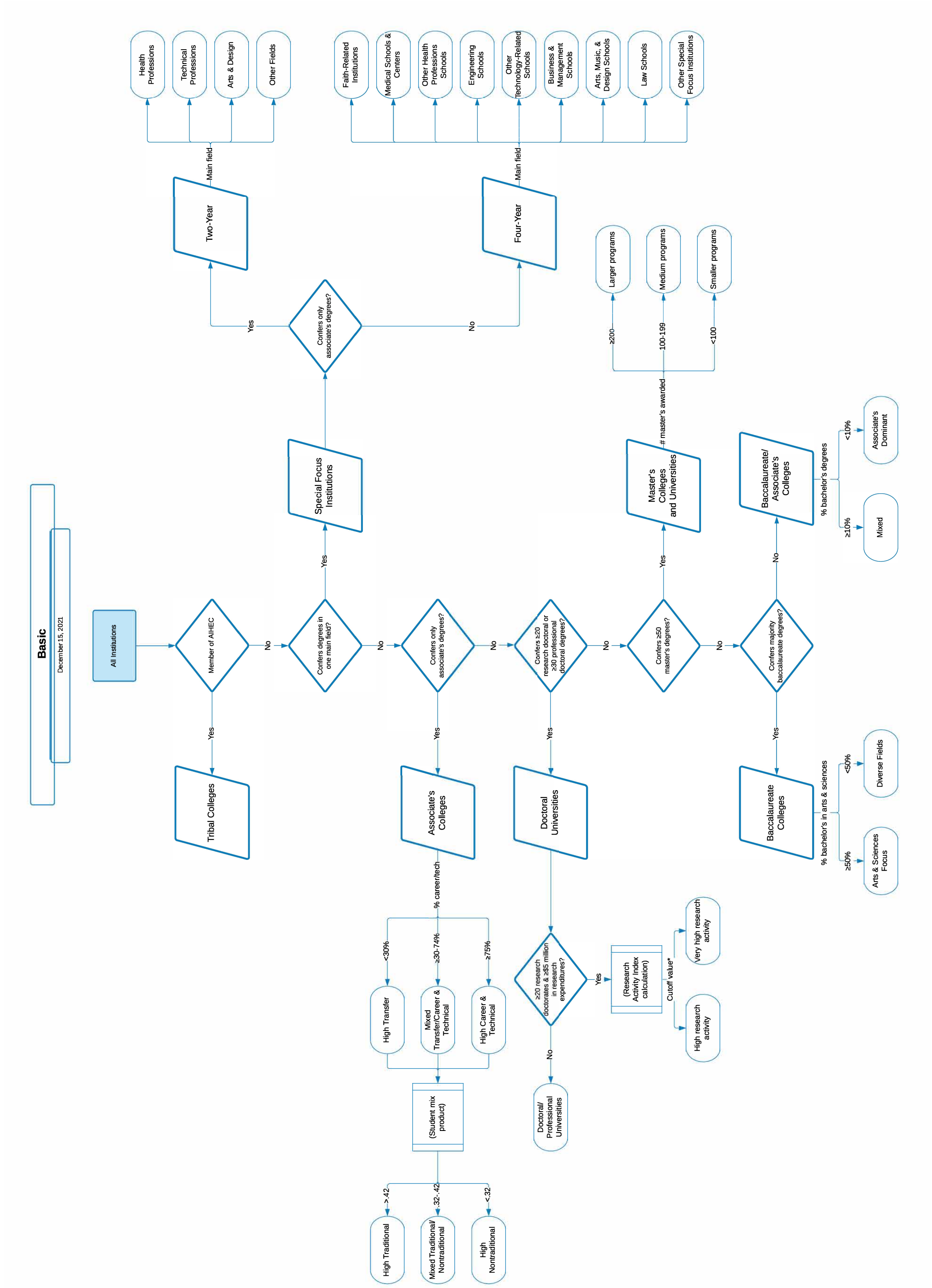


Table A1

Regression of mean earnings of female students on the share of women using the sub-sample from column 3, Table 2

	Mean Earnings
Share of women	12,797.75***
	(2,310.66)
Constant	-2,800,686.00
Controls	
Number of observations	1067
R^2	0.76

Notes: Standard errors in parentheses are robust. * p<.10, ** p<.05, *** p<.01