

Gender Differences in the Choice of Major: The Importance of Female Role Models*

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Abstract

We report results from a novel field experiment aimed at increasing the percentage of women majoring in economics by exposing students enrolled in principles of economics classes to charismatic career women who majored in economics at the same university. We find that the role model intervention significantly increased female students' likelihood of planning to major in economics (self-reported) and enrolling in further economics classes (administrative data), while having no impact on male students. The women that were impacted by the intervention were previously planning to major in lower-earning fields, suggesting that our low-cost intervention could have a significant impact on the treated women's future income streams.

Keywords: Education gender gap, role models, field experiment, economics.

JEL classification codes: A22, C93, I23, I24, J16.

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1 Introduction

Women’s participation in higher education has increased dramatically in the last 60 years.¹ In the US, the percentage of bachelor degrees awarded to women has risen from about 25% in the 1950s to over 50% in the 2000s (National Center for Education Statistics and NSF, Science & Engineering Indicators, 2016). The gender distribution across undergraduate fields of studies has also changed over time. According to the latest data provided by the National Center for Education Statistics, many traditionally male-dominated fields of study – including physical sciences, mathematics, natural sciences and business studies – have seen a steady increase in the enrollment and graduation of women.² In contrast, other fields have made little progress over the years and remain heavily male-dominated. Economics is one of these, with only 30% of bachelor degrees awarded to women – the same percentage as in the mid 1990s. Engineering and computer science are also lagging noticeably behind, with only 19% and 18% of degrees respectively conferred to women in 2013 (NSF, Science & Engineering Indicators, 2016).

As recently discussed in Bayer and Rouse (2016), one reason why achieving higher gender diversity within majors is important and desirable is that it may enhance productivity and overall performance in team work, and it may contribute to the production of novel ideas (Ellison and Mullin, 2014; Hoogendoorn et al., 2013; Bear and Woolley, 2011). Moreover, recent studies (Arcidiacono, 2004; Kirkeboen et al., 2016) show that the choice of major significantly affects one’s earnings potential, and male-dominated fields tend to lead to higher paying jobs. Economics, for instance, is the highest earning major in the social sciences (Black et al., 2003; Carnevale and Cheah, 2015) and has been shown to generate higher earnings than a business degree (Black et al., 2003).³ This suggests that closing the gender gap in male-dominated majors may significantly contribute to the reduction of gender differences in access to high paying jobs and/or leadership positions.⁴ Greater gender diversity may also have important consequences on aggregate outcomes. Indeed, under the assumption of no gender differences in innate abilities, gender imbalances in self-selection into fields of study (and subsequent careers) may result in misallocation of talents – where individuals

¹For a review of the evolution of female participation in tertiary education in the US, see Goldin et al. (2006).

²About 47% of business degrees, 46% of natural sciences degrees and 43% of math degrees and 39% of physical science degrees are currently awarded by women. See: https://nces.ed.gov/programs/digest/current_tables.asp

³Using recent census data, Carnevale and Cheah (2015) also report that the median salary of an experienced worker, aged 30 to 54 years of age, who majored in economics is the highest in the social sciences and the thirteen highest among all majors.

⁴Carroll et al. (2014), for instance, estimate that women with an economics major bachelor degree earn 20.1 percent more than women with other majors.

are not pursuing their comparative advantages – that could significantly affect aggregate outputs, as recently shown in Hsieh et al. (2013). Increasing the number of women studying economics may be especially relevant for real-world aggregate outcomes, as there is evidence (May et al., 2014, 2018) that female and male economists both in the US and in Europe have significantly different views on a variety of policy issues, including government intervention, market solutions, environmental protection and gender equality.

The existing literature has looked at a number of factors that may affect the underrepresentation of women in certain fields, including economics, e.g., gender differences in math aptitude (Emerson et al., 2012), sensitivity to grades (Rask and Tiefenthaler, 2008; Goldin, 2013; Kugler et al., 2017), taste for the subject matter (Dynan and Rouse, 1997; Wiswall and Zafar, 2014)⁵ and preferences over different job attributes, which are linked to different majors (Wiswall and Zafar, 2017).⁶ Moreover, in a recent study, Reuben et al. (2017) identify a robust link between gender differences in students’ overconfidence and competitiveness and their expectations of future earnings, which in turn are likely to affect the choice of major. In a similar vein, Buser et al. (2014) show that gender differences in competitiveness among high schoolers correlates with their choice of major. Finally, Flory et al. (2014) employ a field experiment to show that competitive on-the-job settings can deter women from applying to jobs.⁷

In this paper, we depart from the above studies and ask whether the gender imbalance observed in certain fields of study may be partly due to a lack of female role models. Specifically, we employ a field experiment to test whether exposure to carefully selected female role models may be an effective way to induce more women to major in a male-dominated field. We focus on economics, although our methodology could be easily applied to other fields of study.

The empirical evidence of the effects of role models and/or mentorship programs on individual behaviors and outcomes is scarce.⁸ A recent study by Lyle and Smith (2014) exploits the random nature of junior officers’ assignments to senior officer mentors within the US Army to provide evidence of the causal impact of high quality mentorship on career advancements. Using a similar identification strategy, Kofoed et al. (2017) find evidence of a

⁵For a review of the literature, see Allgood et al. (2015) and Bayer and Rouse (2016).

⁶The authors found that men prioritize earnings prospects while women tend to favor jobs that provide flexibility and job stability.

⁷For seminal evidence on gender differences in competitiveness, see Niederle and Vesterlund (2007).

⁸Theoretically, the importance of mentoring has been studied by Athey et al. (2000), which employs a model with different types of employees (e.g., male and female) within an organization under the assumption of type-based mentoring, whereby upper-level employees of one type – say women – would mentor lower-level employees of the same type. The model shows that increasing the number of upper-level employees of the minority type – e.g., women – may have long-run benefits due to advantageous mentoring of low-level employees of the same type.

significant impact of mentorship by a female rather than a male officer on the occupational preferences of female cadets at the United States Military Academy at West Point. In academia, Blau et al. (2010) assess the impact of a mentoring program in economics that randomly assigned applicants – all junior female faculty – to either a control group or a treatment group that received mentorship from a senior female faculty; the program was successful in increasing the number of publications of junior female faculty and the number of grants awarded to them.^{9,10}

Could female role models induce more women to major in a male-dominated field? A number of studies have attempted to address this question by examining the effect of female professors on female students' decision to major in a given field, showing mixed results (see for example Bettinger and Long, 2005; Canes and Rosen, 1995; Dynan and Rouse, 1997; Hoffmann and Oreopoulos, 2009; Rask and Bailey, 2002).¹¹ A limitation of these studies lies in the students' ability to self-select into classes and therefore choose their professors; this creates important challenges for the identification of the causal impact of the gender (or other characteristics) of the instructor on students' choice of major. Three recent studies overcome these challenges by examining contexts where students are randomly assigned to instructors. Lim and Meer (2017a) exploit the random assignment of students to classrooms in Korean middle schools and show that female students perform better in standardized test scores when they are matched with female instructors. In a follow-up paper, Lim and Meer (2017b) find that female students that are matched with female math teachers in 7th grade are more likely to take advanced math courses in high school, to attend a STEM-focused high school and to plan to major in STEM. Carrell et al. (2010) exploit the randomized assignment of instructors of mandatory standardized courses to students at the US Air Force Academy. They find that the proportion of introductory courses taught by female professors significantly increased the likelihood that top female students, as measured by their SAT math score, would complete a STEM major.¹²

While the relationship between the gender of an introductory class professor and the

⁹On the other hand, Gardecki and Neumark (1998) find no evidence of the gender of the Chair of the department and the number of female faculty on job outcomes of female PhD students in economics.

¹⁰Another important study providing evidence of the importance of female role models in a different setting, is Beaman et al. (2012), who examine the impact that an increase in the presence of women in government councils had on the educational attainment of girls in India. The results show that continuous exposure to female leaders significantly affected the aspirations of young women and eliminated the gender gap in educational attainment among adolescents.

¹¹For a review, see Allgood et al. (2015) and Bayer and Rouse (2016).

¹²The authors then examine unobservable differences between male and female professors by estimating a professor-specific “value-added” for male and female students. While the value-added is correlated with professor gender, it does not predict long term outcomes, leaving open questions on what exactly is the main driver of the estimated impact of female professors on top female students' choices and behavior.

likelihood of majoring in STEM is quite strong, there is no evidence of such relationship in the field of economics (see, e.g., Ashworth and Evans (2001); Bettinger and Long (2005); Dynan and Rouse (1997)).¹³

All existing studies, including Lim and Meer (2017a,b) and Carrell et al. (2010), implicitly assume that a professor could act and be perceived by a student as a role model based purely on gender matching. We do not focus on female economics instructors as, based on the existing economics literature, we suspect that, while gender matching is likely to be important, and possibly necessary, it may not be sufficient to successfully induce women to choose the economics major. We examine the impact of female role models on female students' decisions to study economics by adopting a different approach. We define *role models* as individuals who inspire female students to make similar education choices in order to have a comparable career path.¹⁴ In principle, both men and women could act as role models.

Our methodology relies on the identification of role models with the help of two female students currently majoring in economics. The students shortlisted economics alumni on the basis of their interests in their current sectors of work. We then contacted the shortlisted alumni and invited them to be interviewed via Skype. The students conducted scripted interviews with the finalists who agreed to be interviewed, and chose the best two on the basis of their assessment of the alumni's jobs, communication skills and overall charisma. Both finally chosen role models were women.¹⁵

We employed a field experiment to examine the impact that these carefully selected female role models might have on young women's decisions to major in economics. In particular, we randomly selected Principles of Economics classes – which are typically large and gender balanced – to receive visits by each of the two role models in the 2016 Spring semester. Each visit consisted of a discussion about the role model's experience as an economics major, a description of their career paths and achievements, and an explanation of how their specific major (economics) contributed to their success on the job.

Since treatment and control classes existed and were taught by the same instructors also

¹³Note that the studies that have been conducted in the field of economics use observational data only. There is no study, to the best of our knowledge, exploiting the random allocation of students to economics instructors.

¹⁴A few studies in social psychology have also investigated the impact that role models may have on female students' attitudes toward male-dominated fields. For instance, Stout et al. (2011) conducted experiments where math or STEM majors are either exposed to confederates posing as math majors (study 1) or are asked to read biographies of female versus male engineers (study 2). The outcome variables are students' subsequent answers to Implicit Association Tests aimed at measuring implicit attitudes toward math or STEM, as well as direct elicitation of such attitudes.

¹⁵While there were men in our set of interviewed finalists, they were not deemed as the most inspiring by our two female students. For further discussion, see Section 2.2.

the year preceding the intervention (Spring 2015), we are able to employ a difference-in-differences estimation strategy to assess the impact of the role model visits on male and female students' interest in the economics major. We have two outcome variables: actual enrollment in an Intermediate Economics class in the year following the intervention, and self-stated intention to major in economics, as registered through a survey conducted at the end of the semester in both Spring 2016 and Spring 2015.

Our results show that the role model intervention had a significant and large impact on both outcomes for female students, while having no impact on male students. Being in a class that received the role model visits increased the likelihood that a female student would take an intermediate microeconomics class the following academic year by 13 percentage points, and the likelihood that she would express the intention to major in economics by 7.9 points. This corresponds to a 100 percent increase in both variables. Similarly to Carrell et al. (2010), the effect of the intervention is especially large for top female students, defined as those who have a cumulative GPA of 3.7 or higher; they see a 27 percentage point increase in the likelihood of enrolling in intermediate micro the following year.

Our survey data also allows us to examine which fields of study the intervention is more likely to have attracted female students from. This is important, since, if we were pulling women away from other male-dominated fields also leading to high-paying jobs – e.g., STEM – our intervention would possibly be counter-productive, as it would diminish gender diversity in other male-dominated fields and possibly also lower the earnings potential of our target population. Our data suggests that the role model intervention did not affect the intentions of women planning to major in male-dominated fields leading to high wages, including STEM, business and finance. Instead, the intervention significantly lowered the percentage of women planning to major in humanities or languages. This suggests that the economic impact of our role model intervention may be significant, as the future wages of our target population could be substantially larger as a result.

Overall, our study provides strong evidence of the impact of female role models on women's self-selection into fields of study in which men are traditionally overrepresented. What makes the study unique is the use of a controlled field experiment, which allows clear identification of the impact of the role models, and the novel methodology employed to identify such role models, which crucially relied on the opinions of current female students. Lastly, the simplicity of the design makes our intervention easily replicable (in economics as well as in other male-dominated fields) and suggests that the long-term goal of moving towards gender parity in the economics profession at all levels could be achieved at a relatively low cost by exposing students enrolled in principles classes to successful and inspiring alumnae.

The paper is organized as follows. In Section 2 we describe the field experiment and

the university setting in which it was implemented. In Section 3, we describe our data and present our empirical strategy. Section 4 describes our results and Section 5 conducts robustness checks. Finally, Section 6 concludes.

2 Experimental Design

As part of the study, we conducted: 1) a survey of students enrolled in Principles of Economics classes in Spring 2015 and Spring 2016; 2) a field experiment consisting in randomly selecting 4 of the 10 Principles of Economics classes offered in Spring 2016 to receive visits by two carefully chosen role models. As a result of the randomization, about 350 students were in either a control or a treatment principles class in Spring 2016. In order to estimate the impact of the role model visits on female students' interest in economics, we also collected administrative data on students' enrollment in Intermediate Economics classes the year following the intervention (or following the survey). In this section, we start by describing the university setting where the experiment took place (Section 2.1). We then provide details about our field experiment and study procedures (Section 2.2). We conclude by describing our estimation strategy (Section 2.3).

2.1 The University Setting

We conducted our study at Southern Methodist University (SMU). Although SMU is a small private university,¹⁶ the number of students majoring in economics every year, averaging 166 between 2009 and 2015, is comparable to that of larger universities and is in line with the average number of economics majors across the top 100 US universities (Goldin, 2015).¹⁷

SMU operates over two semesters: a Fall semester, starting in August and ending in December, and a Spring semester, starting in January and ending in May. Our study involves students enrolled in Principles of Economics classes in either Spring 2015 or Spring 2016.¹⁸ Principles of Economics classes are especially popular at SMU, with over 600 students enrolled

¹⁶SMU is located in Dallas, Texas. In the latest (2017) university ranking provided by the US News and World Report, SMU appears ranked 56th in the nation, same as the University of Texas-Austin and George Washington University. In 2015, SMU had a total of 11,739 students. For additional information about SMU, see: <http://www.smu.edu/AboutSMU/Facts>

¹⁷See: https://scholar.harvard.edu/files/goldin/files/planninggroup_data_notes_0.pdf

¹⁸SMU also has two 4-week long Summer terms, in June and July. Classes held during the summer are very different than standard classes, as they take place daily and they are typically very small (i.e., less than 20 students). The student population taking summer classes is also quite different, i.e., typically older and in need of credit hours, e.g., in order to graduate by an imminent date. Given these differences between summer classes and regular classes, we exclude summer classes from our analysis.

and multiple classes – or sections – being offered every semester. Crucially, these classes are typically gender balanced, with women making up between 44 and 47 percent of the enrolled students in the past 6 academic years.¹⁹ In contrast, Intermediate Microeconomics classes – for which Principles classes are a prerequisite – are gender imbalanced, with only about 26% of the enrolled students being women (2009-2015 average). The gender imbalance remains and even worsens by the time of graduation, with less than one fourth of economics degrees being awarded to women, the average being 21% in the last 6 years. This is below the national average of 30% (Bayer and Rouse, 2016). Using Goldin (2015)’s conversion ratio, which is the ratio of the percentage of men majoring in economics to the percentage of women majoring in economics in a given university, SMU has a score of 4.493 (2011-2013 average), meaning that there are more than 4 men for every woman majoring in economics. This is substantially higher than the average for the top 100 US universities computed for the same time period, which is equal to 3.

The above statistics make SMU the ideal setting for a study aimed at increasing the percentage of women majoring in economics. Below, we provide details on our experimental design and empirical strategy.

2.2 The Field Experiment

The study started in Spring 2015, when we surveyed all students taking Principles of Economics classes. There were 11 classes being offered and taught by seven instructors, four women and three men, at different days and times of the week.²⁰ Students could enroll in any of the available classes following a first come first serve rule. A total of 722 students took a Principles class in Spring 2015. We conducted our survey in the last week of classes at the end of April 2015, involving a total of 549 students.²¹ We collected demographic characteristics and, most importantly, we asked students to state their intended major. We conducted an identical survey the following year, at the end of April, with the 2016 Spring cohort.

The same classes, meaning classes taught on exactly a given day and time of the week, by a given instructor, were offered in Spring 2016, with two exceptions.²² A total of 688 students were enrolled in a Principles class that semester; we have survey data for 503 of

¹⁹One reason for the high number of students taking the Principles classes is the presence of a Business School, which requires prospective students to take such classes.

²⁰Three instructors taught two classes each.

²¹The survey was conducted during class time. Therefore, we have data only on the students that were present the day of the survey (76%).

²²Two instructors taught two classes each. One instructor who taught two classes in 2015 only taught one class in 2016, hence the number of classes being 10 rather than 11 in Spring 2016. One control class changed instructor and weekly schedule in 2016. In Section 5, we conduct robustness checks of our main findings by dropping the classes that changed between the two years.

them.²³ In Spring 2016, there were 4 small classes (i.e., capped at 40 students) and 6 large classes (i.e., of 100 or more students) being offered. The enrollment class caps are decided by the department of economics on the basis of classroom and instructor availability. They are not dictated in any way by student demand. At any time during the class enrollment period, students can only enroll in classes whose cap size has not been met yet.

Since we aimed to have a balanced number of students in the 2016 treatment and control classes, we stratified our class-level randomization by class size. We randomly selected one small class and three large classes to receive the role model intervention. Note that our randomization also defined treatment and control classes in Spring 2015, even though the treatment classes were treated only in 2016. The fact that treatment and control classes existed the year prior the intervention allows us to employ a difference-in-differences estimation strategy, as discussed in Section 2.3.

The most crucial feature of our design is the identification of role models that could inspire female students enrolled in principle classes to keep studying economics and eventually graduate with an economics degree. We identified such role models during the Fall 2015 semester with the help of two undergraduate female students who were majoring in economics at the time. We first obtained the list of economics alumni who graduated between 1985 and 2010 and then proceeded to shortlist 18 role model candidates based purely on the students' interest in the alumni's sector of work and current job. We contacted the shortlisted candidates via email asking for their availability and willingness to be interviewed via Skype by our female students. The email did not mention the specific aim of the study; it only stated that the economics department had shortlisted 18 especially inspiring alumni²⁴ and we aimed to gather some additional information about their current position, as well as their previous jobs and their experience as an economics student at SMU.²⁵

Seven alumni replied expressing their availability for and interest in the Skype interview. The Skype (scripted) interviews were conducted by our two female students, which then proceeded to select our final two role models based on their impressions on the candidates' jobs, their appreciation for the field of economics, and, crucially, their communication skills and overall charisma. Both finally selected role models are women. One role model graduated in 2008 and started her career by working in management consulting for two years. She had then decided to completely change her career path by going to work for an international NGO in Nicaragua, and then as a director of operations at a toy company based in Honduras. She now works in Operations at a fast-growing candy retail company. The second role

²³Again, participation in the survey was conditional on class attendance.

²⁴We did not restrict the selection to females. Therefore, we initially shortlisted 8 women and 10 men.

²⁵The specific content of the email is available upon request.

model graduated in 1991 and has had a stellar career in marketing, becoming the senior director of North American Marketing & Information Technology at a large international communications company. While the two role models work in very different sectors, what they have in common is that their jobs are not stereotypically associated with the economics major.

We formally invited each role model to visit SMU in Spring 2016. Both role models accepted our invitation and independently visited four Principles of Economics classes – our treatment classes – between March and April 2016.²⁶ All treatment classes received a visit from both role models, therefore we cannot differentiate the impact that each role model, i.e. their specific individual characteristics, may have had on the treated students. We can only identify the joint impact of the two alumnae on the students’ interest in the economics major.

The purpose of the role model visits was for the two alumnae to talk about their experiences as economics majors, their career choices and their current jobs. More importantly, we asked them to discuss how majoring in economics helped them succeed in their careers. We also emphasized that it was important to try and involve students in the discussion (e.g. welcoming their questions) as much as possible.

We did not inform the class instructors about the purpose of study, to avoid possible changes in instructors’ behavior as a result of the intervention. We also did not inform the role models about the objective of the research study and therefore they did not know that we intended to examine the impact that their visit would have on female students’ decision to continue studying economics. As a result, the speeches to the classes were gender-neutral, i.e., no gender-specific issues were discussed. This allows us to examine whether the women were perceived as role models by female students more than by male students not due to the content of the discussion being “female-oriented” but rather the fact that their gender, their jobs and their personal experiences might have been, by design, more inspiring to females than males.

It is important to note that the two role models chosen happened to both be female, as these two were the most inspiring to the undergraduate female students that assisted us in the role model selection process.²⁷ Ideally, we would have liked to also include a treatment that exposed students to two “identical” male role models in order to disentangle the role of gender matching from the role of information about the two specific career paths chosen by our female role models. However, even if we had a sample size large enough to include

²⁶The first role model visited each class on March 21st or 22nd, depending on the class schedule. The second role model visited each class on April 6th or April 7th.

²⁷The initial shortlist did include males, and three men made it to the Skype interviews but were ultimately not chosen by the two female students that conducted the scripted interviews.

an additional set of treatment classes in our study (which we did not), it would have been impossible to find male “clones” of our female role models, i.e., two men with same career profiles, comparable levels of charisma and other individual characteristics to create the perfect male counterfactual treatment.²⁸

2.3 Empirical Strategy

As outlined above, the treatment took place at the class level in 2016, yet the treatment and control classes also existed in 2015. Since we had a small number of classes over which we randomized, it was unlikely that we would achieve a balance between treatment and control groups (as noted in Table I below).²⁹ We acknowledge that each class may have different types of students since we have self-selection into classes, and that students in different classes are likely to be subject to different stimuli, as they are exposed to different instructors, curricula and teaching styles. Therefore, we take advantage of the fact that the same classes (i.e., same instructors and time schedules) were offered both in 2015 and 2016 to estimate our treatment effects using a difference-in-differences model as the optimum strategy (Angrist and Pischke, 2008). Since class attendance was not mandatory the days of the role model visits, the estimate can be seen as the intent-to-treat effect of the intervention using equation 1 below,

$$Y_i = \beta_0 + \beta_1 dt_i + \beta_2 dT_i + \beta_3 dt_i * dT_i + \delta \mathbf{X}_i + u_i \quad (1)$$

where Y_i is our proxy for student i 's interest in the economics major; dt is a dummy equal to 1 if the student took the class in 2016 and 0 if he or she took a class in 2015; dT is a dummy equal to 1 if the student is in a treatment class and 0 if he or she is in a control class. The interaction between these two dummies is our coefficient of interest (i.e. $post*treat$).³⁰

As noted above we allow for imbalance in pre-treatment characteristics across classes by including X , a vector of demographic controls and class characteristics, to account for slight differences seen in our balance tests (see below for further discussion).

²⁸While videotaping the role models and using male actors to reproduce their speeches would theoretically be possible, in practice, the use of actors presenting themselves as working in given fields and having very specific study and work experiences would imply deceiving the students in the audience. Even if deception were not a problem, the Q&A section of the classroom visits would be difficult to predict and handle by actors, as it may involve job specific questions and students' requests of business cards and contact details.

²⁹However, simple pair-wise chi-square tests of the difference between treatment and control outcomes do show significant difference in our outcome variables, as shown in Tables 2 and 5.

³⁰We could also have estimated only the difference post-treatment for only those in treated classes. However, if we found a significance difference in the outcomes of students enrolled in post- and pre-treatment treatment classes we could not confidently attribute that difference to the intervention, as both students' characteristics and teaching methods may have changed between the two years.

Our ideal outcome variable is a student’s decision to major in economics. However, at SMU, students can declare their major at any time after having completed 30 credit hours (in any field). There is no deadline for declaring a major; thus, students can choose their major at any time, up to their final semester at SMU. This implies that having the decision to major in economics as our outcome variable would require waiting two more years to be able to estimate the impact of the intervention. Instead, we examine the effect of our treatment on two outcome variables that are meaningful proxies for a student’s interest in the economics major. We first look at whether the student enrolled in Intermediate Microeconomics (ECO 3301) the following academic year, either in Fall or Spring. We then employ a dummy equal to 1 if the student self-reported (in our survey) his or her intention to major in economics. In Section 3, we provide evidence that these variables are a good indication of a student’s majoring decision. Given the dichotomous nature of our dependent variables, we estimate equation 1 using probit regressions.

As our treatment is at the class level, we cluster the standard errors at the class level (Abadie et al., 2017).³¹ Since there are fewer than 30 clusters (12 clusters), we follow Angrist and Pischke (2008) and Cameron and Miller (2015) and apply the correction for the small number of clusters by using wild score bootstrapping (Kline et al., 2012), which is appropriate for nonlinear models.³²

3 Results

3.1 A first look at the data

A total of 1410 students took a Principles of Economics class in either Spring 2015 (722) or Spring 2016 (688). Of them, 45% (632) were women. Of the Spring 2016 cohort, 49% (340) of the students were in a class which was treated, i.e. visited by the role models. While the gender compositions of the treatment and control classes in 2015 are not significantly different from each other, with 46% and 44% of students being women, respectively, in 2016 the treatment classes had significantly fewer women enrolled than the control classes (38% versus 51%, p-value of 0.001).

In Table I, we report descriptive statistics and conduct balance tests using both the administrative data and the survey data. In particular, from the administrative data we have

³¹In our robustness section, we also employ class-level fixed effects, while restricting the analysis to the 9 classes that did not change between 2015 and 2016.

³²In a previous draft of the paper we clustered at the class-year level (21 clusters) and obtained similar results. In the current draft, we follow Abadie et al. (2017) to cluster at the class level only. Note also that linear probability model with Wild Bootstrapped standard errors (Cameron and Miller, 2015) gives extremely similar results and these are presented in the annex for convenience.

information on the students' in-state or out-of-state status, their year of study, e.g. whether they are freshmen, their cumulative GPA, whether they are American or international students. From the survey data we have information about whether they belong to a fraternity or a sorority, whether they are athletes and whether they took an economics class in high school.

Testing for significant differences in student characteristics between control and treatment classes in 2016, on both the male and female student samples, shows some significant differences, as might be expected given the small number of classes from which we were able to randomize our treatment and control sets of students. In particular, we see that there are significantly fewer American students in the female treatment group, as well as more freshmen. Moreover, in both the male and female samples the cumulative GPA of students enrolled in treatment classes is slightly lower. We do not see any significant differences in the survey-based individual characteristics between treatment and control classes for the female sample. The same is true for the male sample with the exception of the percentage of students that took economics in high school, which is lower for the treatment group in 2015.

We take the imbalances observed in the data into account in our empirical analysis in Section 3, where we include student characteristics in our set of controls; we also conduct robustness checks by restricting the analysis to American students only. Finally, following Carrell et al. (2010), we also estimate treatment effects separately for the top performing female students.

3.2 Impact on Enrollment in Intermediate Microeconomics

Intermediate Microeconomics is a prerequisite for upper level economics classes. Therefore, if a student wants to major in economics, he or she needs to take this class, the sooner the better. In order to assess the validity of using enrollment in Intermediate Microeconomics as a proxy for interest in the economics major, we examined administrative data on students who took Principles of Economics in the Spring semesters of 2008 or 2009 and completed their degree by Fall 2014. About 80% of the 2008 and 2009 cohorts who majored in Economics took the Intermediate class the year following their Principles class. This compares to 21% of students who were in the same Principles classes and did not major in Economics (differences significant at the 1 percent level).³³ This confirms that enrollment in Intermediate Microeconomics is indicative of a student's intention to major in economics.

³³We also looked at the percentage of students who took Intermediate Micro the year following their Principles class and decided to major in economics. The 2008 and 2009 cohort data show that 53% of the students that took Intermediate Microeconomics the year following their Spring Principles class ended up majoring in economics, as compared to 7% of those who did not (the difference is significant at the 1 percent level).

Figure I and Table II show the percentages of male and female students who took an Intermediate Microeconomics class the year immediately following their Principles class, i.e. either Fall 2015 or Spring 2016 for the 2015 cohort, and either Fall 2016 or Spring 2017 for the 2016 cohort. Since about 7% of students failed the Principles class, we exclude them from our sample, as they would not be eligible to take an Intermediate Microeconomics class the following semester.³⁴ This leaves us with 1310 students, of which 46% (601) are women. Table II also reports the p-values generated by Chi square tests aimed at identifying either differences between treatment and control in a given year, or gender differences within treatment and control classes in 2015 or 2016.

Around 25% of men enrolled in an Intermediate Microeconomics class in the year following the spring semester in which they took a Principles class. This proportion is the same across the treatment and control classes and the two years. In 2015, the proportion of women who enrolled in Intermediate Microeconomics in the Fall is around 13%, and is the same across treatment and control groups. In 2016, the proportion in the untreated classes is 11.18%, whereas over 18% of women in the treated classes had enrolled; this difference is statistically significant ($p = 0.065$).

Next, we present results from the regression analysis, which allows us to examine the effects of the role model intervention on male and female students by conducting difference-in-differences estimation, as explained in Section 2.3. Table III shows the probit results when the dependent variable is a dummy equal to 1 if the student took the Intermediate class in the year directly following their Principles class, and 0 otherwise. We analyze men and women separately. In the first and third columns, we employ our most parsimonious specification, which only includes the 2016 year dummy, the treatment class dummy and the interaction between the two. In the second and fourth columns, we include all the controls obtained from administrative data, for which we provide summary statistics in Table 1. We also control for a dummy equal to 1 if the student was in a small class, and a dummy equal to 1 if the class was taught by a female professor. Finally, we include the grade that the student got in the principles class.³⁵ For all specifications we report p-values obtained when implementing

³⁴While keeping the students who failed their principles class in the sample does not alter our results substantively, we believe that dropping them is more appropriate given the requirements of the upper level economics courses.

³⁵We observe significantly lower grades in treatment than control classes in 2016 for both men (3.19 versus 3.30, significant at the 5 percent level) and women (3.39 versus 3.48, significant at the 10 percent level). Results from regression analysis - available upon request - shows that the grades observed in the treated classes are not lower because of the intervention; they are lower as a result of pre-intervention student characteristics, with students' cumulative GPA being the stronger predictor. Previous research (Goldin, 2013; Rask and Tiefenthaler, 2008) suggests that women may be especially sensitive to their grades, i.e., their decision to pursue a given major may be conditional on obtaining a high grade in introductory courses. If this is true, the lower average grades in the treatment classes would work against us finding a positive

the wild score bootstrapping correction (Kline et al., 2012) for the small number of clusters. Estimates generated by linear probability models with Wild Bootstrapped standard errors are reported in Table A4 in Appendix.

The estimates displayed in the first two columns of Table III show that the role model intervention had no effect on men’s decisions to enroll in Intermediate Micro the following semester. In contrast, we find strong evidence that the intervention had a positive and significant effect on women’s enrollment rates. Interpreting the interaction term in a probit model is not straightforward. Norton et al. (2004) show this is the case for all non-linear models. Importantly, they show that the marginal effect of the interaction term may not be the same as the coefficient (β_3 in our case), and further that the standard t-test is inaccurate. We therefore use the methodology introduced by Norton et al. (2004) to calculate the marginal effect of the interaction term.³⁶

For the male students, we can confirm that there is no significant effect. For female students the interaction is significant ($z = 2.623$), and the mean is 0.13, which we interpret as a 13 percentage point increase in enrollment rate caused by the role model intervention.³⁷ This is quite a considerable effect, considering that the average baseline enrollment rate is about 13%.³⁸ In fact, our estimates suggest that the role model intervention doubled the percentage of female students taking Intermediate Micro the academic year following their enrollment in a Principles class. In line with previous findings concerning the economics field, having a female professor does not seem to have a significant impact on women’s enrollment decisions.³⁹

We conducted the same analysis for enrollment in Intermediate Micro the semester following the principles class. The results, which are shown in Table A1 in the Annex, are qualitatively similar.

impact of the role model intervention on female students’ decision to pursue further studies in economics. In other words, if we do find a positive impact of the intervention, it would be despite the fact that the treated female students were less likely to earn a high grade in the class.

³⁶See also Puhani (2012) and Karaca-Mandic et al. (2012) for a discussion on the application to nonlinear difference-in-differences interactions.

³⁷Note that when we compute marginal effects of interaction terms, we cannot apply the wild score bootstrapping. However, since wild score bootstrapping does not affect the point estimates and we have found little difference between the corrected and uncorrected p-values, we do not see this as a problem.

³⁸See A4 in Appendix for the corresponding linear probability estimates.

³⁹The negative impact of cumulative GPA on both male and female students’ likelihood to enroll in intermediate microeconomics may reflect the decision of top students to enroll in the SMU Business School after taking the Principles classes. In fact, both taking the principles classes and obtaining a GPA of 3.3 or higher are a requirement for acceptance into the SMU Business School.

3.3 Impact on Intention to Major in Economics

The analysis of self stated intention to major in economics is restricted to the students that were present the day we conducted the in-class survey, i.e. 549 students (77%) in 2015 and 503 (73%) in 2016.⁴⁰ As part of our survey, we asked students enrolled in Principles classes to state their intended major. In the self-administered questionnaire, they could write down up to two desired majors. Here, our outcome variable is a dummy equal to 1 if the student listed economics as one of their intended majors, and 0 otherwise.

One concern may be that students may have over-reported their intention to major in economics, given that the survey was not anonymous and it was conducted during an economics class, under the supervision of their economics instructor. The bias may be even larger for the treatment classes, since, during their visits, the role models emphasized the importance of the economics major.⁴¹

One way to address these concerns is to examine the correlation between self-reported intention to major in economics and subsequent enrollment in further economics classes – a more objective measure of actual interest in the economics field. We find that intention to major in economics is a strong and significant predictor of male and female students’ decision to enroll in Intermediate Microeconomics the following academic year. In particular, probit regressions show that men and women that stated their intention to major in economics in the survey are, respectively, about 51 and 55 percentage points more likely to enroll in Intermediate Microeconomics the following year.⁴²

Table IV and Figure II show the percentages of male and female students enrolled in treatment and control classes in 2015 and 2016 who stated their intention to major in economics. For the three untreated class groups the proportion of men planning to major in economics is significantly higher (about 17% on average) than that of women (around 7%). Moreover, there are no differences between treatment and control classes, both in 2015 and 2016, with respect to men students’ plans to major in economics. The same applies to female

⁴⁰When testing for selection into the survey, we see no significant difference between the proportion of treated and untreated students entering the surveyed sub-sample. Females were however more likely to be present the day of the survey, and those surveyed were more likely to have a female instructor. Students who were present in class were (reassuringly for the instructors) more likely to get a high grade - defined as greater than a B – in the class. Since the survey was unannounced by the class instructor, we can assume that attendance the day of the survey is a good indication of average attendance during the semester. When restricting the sample to the surveyed subjects, we see no significant difference between treatment and control classes in their gender composition.

⁴¹We limited this possibility by making sure that the role model visits took place 3 to 5 weeks before the administration of the survey.

⁴²These percentage points are computed over the 2 years, 2015 and 2016. In 2015, male and female students who stated an interest in the economics major were both 57 percentage point more likely to enroll in Intermediate Micro the following year. In 2016 men and women who stated an interest in the major were 44 and 52 percentage points more likely to enroll in Intermediate Micro.

students enrolled in the 2015 control and treatment classes. In contrast, the classes that received the role model intervention saw a higher proportion of women planning to major in economics (11.93%) as compared to the women in the control classes (6.98%). Although the difference is not statistically significant, the increase in the percentage of women interested in the economics major – caused by the role model intervention – seems to have annulled the gender gap observed in all the other class groups.

In Table V we employ the same specifications as in Table III. The dependent variable is now a dummy equal to 1 if the student listed economics as his or her intended major, and 0 otherwise. Mirroring the enrollment results, we find no significant effect of the role model intervention on male students. However, we do find a significant impact on female students, when controlling for student characteristics (column 4). When we compute the marginal effect of the treatment on women we find that the role model visits increased the percentage of female students wishing to major in economics by 7.9 percentage points.⁴³ This suggests that the impact of the intervention was, once again, large, given that the baseline percentage of women interested in economics is about 7%.

3.4 Impact on top students

An important finding of Carrell et al. (2010) is that female instructors had a significant impact on the majoring decision only of top female students. In fact, Carrell et al. (2010) find that, for the highest ability women, having exclusively female introductory math and science professors increased the likelihood of majoring in STEM by 26 percentage points as compared to being assigned exclusively to male faculty. Following Carrell et al. (2010), in this section we investigate whether the role model intervention was especially impactful on female students that have a cumulative GPA ≥ 3.7 . About 30% of all female students belong to the top student category with no significant differences across years and treatment and control classes.

In Table VI, we replicate the analyses conducted in Tables III and V while restricting the sample to the top female students. The results are striking: the marginal effect of the role model intervention is 27 percentage points on enrollment in Intermediate Microeconomics the following academic year ($z = 2.44$). This percentage point increase resembles very closely that found by Carrell et al. (2010).

Figure A1 in the Appendix also shows the enrollment rates of top male students in control and treatment classes in both 2015 and 2016.⁴⁴ It appears that 2016 saw a significant decline

⁴³As before, we use the methodology introduced by Norton et al. (2004) to calculate the marginal effect of the interaction term, as above.

⁴⁴In both years and no matter the type of class (treatment or control), male students have a significantly

in top male students enrolling in Intermediate Micro, in both treatment and control classes. We conclude that our intervention was not the cause, as the decline is not significantly different between control and treatment classes.

3.5 Where are we attracting female students from?

Overall, our empirical estimates show that the role model intervention had a positive, significant and sizeable impact on female students' interest in the field of economics. The impact was especially large for top female students. While we believe that achieving gender balance in a male dominated field like economics should be seen as a goal in itself, role model interventions like ours would be especially desirable if they could positively affect the earnings potential of female students that would otherwise major in a field conducive to lower incomes than their male counterpart. Conversely, having an intervention that attracted toward economics female students that would have otherwise majored in another male-dominated high-earnings field (e.g. finance or STEM), may be counter-productive in terms of its overall economic impact.

Here we use data from our survey to identify the fields of study that saw a reduction in female students' interest as a result of our intervention. Based on students' open-ended answers to our question on their desired majors – note that they could enter up to two – we generate a series of 0-1 dummies associated with their interest in majoring in different fields of study. We distinguish between high-earning majors, defined as STEM, finance, business and marketing, and low-earning majors, defined as other social sciences (e.g., psychology, anthropology and political science), arts, communication studies, and humanities and languages.

Figures III and IV display the percentage of male and female students, in control and treatment classes in 2015 and 2016, stating each field of study, grouped in either the high-earning or the low-earning category, as one of their desired majors (or the only desired one). Figure III shows that the role model intervention did not cause a decline in women's (or men's) interest in any of the high-earning majors. Figure IV suggests that the role model intervention reduced the percentage of women interested in humanities and languages majors.

This is confirmed by probit regressions, displayed in Table VII, where the dependent variable is a dummy equal to 1 if the student expressed the desire to major in humanities or languages and 0 otherwise. The estimates in columns 3 and 4 suggest that the role model visits significantly reduced the likelihood that female students expressed an interest in

lower cumulative GPA than female students. In order to make the sample of top male students comparable in size to that of top female students, we define top male students as those with a cumulative GPA of 3.52 or higher. This corresponds to 30 percent of the male student sample.

humanities or languages majors, while having no significant impact on men. The marginal effects are 11 and 12 percentage points respectively for the interaction terms in columns (3) and (4).

3.6 Female student performance in Intermediate Microeconomics

An important follow up question is whether the performance of the treated female students in the Intermediate Economics classes is in any way different than that of the untreated students. If we had attracted female economics students that are unlikely to do well in this field, we would see a decline in the average performance of female students that were in the treated Principles classes as compared to those in the control classes. This would be less than optimal for two reasons. First, the intervention would have possibly contributed to a misallocation of talents, where individuals pursuing a given major are not those that have a comparative advantage in it, as discussed in Hsieh et al. (2013). Second, if the female students that enrolled in Intermediate Economics classes as a result of the intervention were to perform less well as others, they would be less likely to enroll in upper level economics classes and ultimately major in economics.⁴⁵ This implies that the role model intervention would have only a short term impact on female students' choices and behaviors.

The analysis of the average grades obtained in treatment versus control classes in both 2015 and 2016, displayed in Table VIII, shows that treated women achieved higher grades on average than those that were enrolled in control Principles classes, although the difference is not statistically significant. Besides reporting average grades obtained in Intermediate Micro, Table VIII also displays the average scores obtained in a Core Exam, which all the students enrolled in Intermediate Microeconomics need to take toward the end of the semester. This exam provides a more objective measure of student performance, as it is prepared and administered by the economics department rather than the students' instructors, and it is the same for all the students enrolled in an Intermediate Microeconomics class in a given semester.⁴⁶ Descriptives on students' performance in the Core Exam confirm that the treated female students performed equally, if not better, than the control female students.

⁴⁵This is especially true given the empirical evidence on women's sensitivity to course grades (Goldin, 2013; Rask and Tiefenthaler, 2008).

⁴⁶In Fall 2015, there were 5 classes of ECO 3301 being offered, taught by 4 instructors. In Fall 2016, there were 4 classes being offered, taught by 3 professors. Of these 4 classes, 3 were the same as in Fall 2015. In Spring 2016 and Spring 2017, there were 4 classes offered, each taught by a different professor. Two classes were identical between the 2 years. Comparing the two academic years, in 2015-2016, 328 students were able to take Intermediate Micro, versus 304 in 2016-2017. Note that it is the department of Economics, not student demand, that decides the number of classes being offered every semester. The decision is made based on funding, instructor availability and classroom constraints.

4 Robustness Checks

4.1 Treatment Effects on the American students

As discussed in Section 3.1, there were some imbalances in the percentage of American versus foreign female students enrolled in control versus treatment classes in 2016. In particular, the treatment classes have a significantly lower percentage of American students. If foreign female students are more likely to pursue economics studies than domestic students, which is the case in our sample,⁴⁷ our treatment effects could simply be a reflection of the different compositions of the female student body in control versus treatment classes. In this section, we check whether this is the case by first including an American dummy in our empirical specification, and then by estimating the treatment effects on American female students only (Table IX).

The estimates in the first column of Table IX show that controlling for the American dummy does lower the statistical significance of our treatment effect on the self-stated intention to major in economics. The estimated impacts of the treatment on enrollment in Intermediate Micro the following year, however, remain statistically significant, and are very similar in magnitude to those observed in Table III. As an additional robustness check, in columns 3 and 4, we test whether the American female students, in particular, were affected by our role model interventions. We found that they were. Our estimates suggest that the American female students that were in a treated Principles class in 2016 are about 7 percentage points more likely to express an interest for the economics major, and 11 percentage points more likely to enroll in Intermediate Micro within a year.

4.2 Excluding the two control classes that changed in 2016

As mentioned in Section 2.2, 11 Principles classes were offered in Spring 2015 versus 10 in Spring 2016. Between the two years, two control classes changed. One class that was offered in 2015 was not offered in 2016, whereas another class changed instructor and time schedule. In this section, we check whether our main findings are robust to dropping these classes from the empirical analysis.

⁴⁷In our overall sample, across the two years, 18% of foreign female students versus 7% of American female students stated the desire to major in economics in our survey ($p = 0.018$). The difference in the preferences of foreign and domestic students holds also for men, with 31% of foreign male students interested in the economics major versus 15% of American students ($p = 0.007$).

4.2.1 Replication

In Table X, we replicate the analysis reported in Tables III and V. The estimates show that our results are robust to restricting the sample to the 9 Principles classes that did not change instructor or teaching schedule between 2015 and 2016. Our coefficient of interest remains statistically significant for the enrollment variable. The results on majoring in economics become just insignificant ($p=0.12$). We repeat this check for the top female students in Table A2 in the Annex, again the main results for enrollment the following year are robust to dropping the control classes that changed between the two years.

4.2.2 Including class fixed-effects

In Table XI, we include class fixed effects in a robustness check for the classes that did not change. Even though the sample size is naturally smaller, the main results concerning student enrollment in intermediate micro the year following the intervention are robust to the inclusion of class fixed effects. The results concerning self-reported plans to major in economics are again weaker, possibly due to the smaller sample size. The same robustness check for male students is shown in Annex Table A3.

4.3 Pre-Intervention Trends

An important assumption of the difference in differences estimation model is that, in the absence of the intervention under study, the difference between the treatment and control group would be constant over time. In order to check whether the assumption of parallel trends holds in our setting, we obtained data on enrollment in Intermediate Micro for the Spring 2014 cohort, i.e., the students that took Principles classes in Spring 2014. Naturally for these students we only have administrative data, since their enrollment in Principles classes preceded the start of our study. One complication is that a total of 4 classes changed between Spring 2014 and Spring 2016. Therefore, our analysis is restricted to 7 classes – 3 treatment classes and 4 control classes – that remained unchanged between the three years.

Figure V displays the percentages of male and female students that took Principles classes in Spring 2014, Spring 2015 or Spring 2016 and enrolled in Intermediate Micro the following academic year. The figure shows that the pre-intervention enrollment trends are almost identical for the female students in the 2014 and 2015 cohorts, whereas the post-treatment trends diverge sharply, with the women in the treatment classes showing a significant increase in their enrollment rates and the women in the control classes following the downward trend observed in previous years. This confirms the validity of our estimated treatment effects.

5 Conclusions

Closing the gender gap in quantitative, high-paying subjects such as economics is an important goal, that has proven remarkably stubborn to achieve. Existing research has generated mixed evidence on what may lead women to stay away from certain majors and, consequently, certain career paths. In the field of economics, a number of studies have disproved the existence of a link between math aptitude and the existing gender gap in majoring choices, and have provided contradictory results with respect to the role that instructor gender may have on students' study decisions. Crucially, the existing empirical investigations raise questions about identification and causality, since shared information about instructor characteristics and teaching methods play a significant role in both students' self-selection into a given class and their decisions regarding future studies in a given field.

In this paper, we employed a field experiment to investigate the impact that female role models may play in young women's decisions to major in economics. Our underlying assumption is that the scarcity of female economics majors, which has remained quite constant for the last 60 years, has led to a very low likelihood that young women can come into direct contact with successful and accomplished women, working in interesting fields, having majored in economics. This, in turn, may be one of the leading factors contributing to the scarcity of young women thinking of economics as their potential field of study and subsequent work. We tested whether and to what extent female role models are important by conducting a randomized intervention that put female students enrolled in Principles of Economics classes in direct contact with two successful economics alumnae. A crucial feature of our study is that we chose the role models with the help of two current female economics majors on the basis of their interest in the role models' careers and their assessment of the role models' communication skills and charisma. As a result, the fields of work of the chosen role models – non-profit, sales management and marketing – are not stereotypically associated with the economics major.

We randomly selected Principles of Economics classes – which are typically large and gender balanced – being offered in Spring 2016 to receive a 15 minute visit by each role model. Since the same classes, taught by the same instructors and at the same day and time of the week, were offered the previous year, we employed difference-in-differences regressions to estimate the impact of the intervention on both enrollment in Intermediate Economics classes and self-stated (survey-based) intention to major in economics.

We found evidence of a strong and large effect of the role model visits on both outcomes for female students and on neither outcome for male students. The treatment effect is especially large for top female students, i.e., those with a GPA higher than 3.7. Survey data also

allowed us to investigate which fields of study female students would have likely majored in, absent the intervention. We found that the treatment did not take women from other high-earning subjects, such as STEM or finance. Rather, the role model visits caused a decline in the percentage of women interested in humanities and languages majors, providing suggestive evidence that the intervention attracted towards economics women that would have otherwise majored in fields leading to lower-earning jobs. One concern may be that the intervention may have led to a misallocation of talents by attracting women that are unlikely to succeed in the field of economics. Our analysis of students' performance in the Intermediate Economics classes show that this is not the case, as the treated female students performed equally, if not better, than the female students coming from the control Principles classes.

Overall, the evidence presented shows that a simple, and low cost intervention can significantly increase the percentage of women majoring in Economics. This is an important finding for a number of reasons. First, achieving gender diversity in economics, as in any other field of study, is desirable per se, due to the potential effects of diversity on the contribution of ideas, as well as on team productivity and performance. Second, since the economics major leads to high-paying jobs, increasing the percentage of women in this field may contribute to the reduction of the gender gap in top-earning careers and leadership positions. Moreover, attracting more women toward economics may also have important aggregate consequences in terms of sorting and efficiency – if women who are likely to be successful in economics (or any other subject) are not choosing it, then nudging them into the field will improve the overall allocation of talents within the economy. Finally, as recent research shows that male and female economists have significantly different views on numerous economic policy issues, increasing the number of female economists may have a significant impact on the economic policies being implemented within a society.

One possible caveat of our study is that, by design, we are unable to identify precisely which characteristics of the role models were the most important in influencing young women to pursue economics: whether it was that the careers they both had pursued were more attractive to women, yet not usually perceived as linked to the economics major, or the information they provided on how their economics studies helped them on the job, or simply their charisma and personal experiences which were influential. Nevertheless, the crucial factor in our design was that the role models were chosen by female undergraduates – who perhaps implicitly knew best what would inspire their peers. An interesting extension to our study would be to compare the impact of role models' visits with those obtained when providing students with handouts (or instructors' presentations) reporting the same information presented by the role models, i.e., information about the specific career paths of the two

alumnae. This would allow disentangling the effects of *information* from those of *inspiration by role models*.⁴⁸

Since we only had female role models, we are also unable to assess the role that the gender of the role models played in influencing our female students, although the fact that we found no effect on male students is indicative that gender matching is important. Further work could compare male and female role models and their differential effects on male and female students, as well as experiment with the careers of the role models. The analysis could also be easily extended to other male-dominated or female-dominated fields of study. Overall, we consider this paper a first step in a rich potential area of research on role model effects, not only in undergraduate economics.

⁴⁸See Nguyen (2008) for an example of an intervention comparing the effectiveness of a role model intervention and an intervention providing information about statistics concerning returns to education in Madagascar.

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Tables and Figures

Table I: Balance Tests

	Control classes 2015 (untreated)	Treatment classes 2015 (untreated)	Control classes 2016 (untreated)	Treatment classes 2016 (treated)
<i>Men</i>				
American student	89.27%	88.14%	93.49%	88.57%
In-state student	25.37%	16.49%**	20.71%	20.00%
Freshman	82.93%	89.69%**	86.39%	90.48%
Cumulative GPA	3.13	3.19	3.30	3.19**
Belongs to fraternity or sorority ⁺	52.59%	51.45%	44.83%	44.29%
Took econ in high school ⁺	70.90%	56.93%**	63.38%	62.59%
Athlete ⁺	5.30%	4.38%	5.36%	6.77%
<i>Women</i>				
American student	92.95%	94.61%	92.18%	79.23%***
In-state student	22.44%	24.55%	21.23%	21.54%
Freshman	83.97%	84.43	82.68%	95.38%***
Cumulative GPA	3.44	3.40	3.48	3.39*
Belongs to fraternity or sorority ⁺	28.13%	29.73%	29.85%	25.00%
Took econ in high school ⁺	64.06%	63.51%	66.92%	58.04%
Athlete ⁺	7.14%	5.59%	7.09%	10.09%

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Test is of equality between treatment and control groups in the corresponding year, separately by gender. Sample size 699 men, 601 women. ⁺ indicates survey variable (survey responses sample size 516 men, 507 women).

Table II: Enrollment in Intermediate Micro by treatment class, year and gender

	Control classes 2015 (untreated)	Treatment classes 2015 (untreated)	Control classes 2016 (untreated)	Treatment classes 2016 (treated)
<i>Enrolled in ECO3301 within a year</i>				
<i>Male</i>	22.78%	30.34%	22.01%	25.27%
<i>Female</i>	15.13%	11.46 %	11.18%	18.85%
H0: Male=Female (p-value)	0.078*	0.000***	0.008***	0.190
H0: Control=Treatment; male, 2015 (p-value)	0.105			
H0: Control=Treatment; female, 2015 (p-value)	0.342			
H0: Control=Treatment; male 2016 (p-value)	0.480			
H0: Control=Treatment; female, 2016 (p-value)	0.065*			

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. P-values generated by Chi-Square tests. The analysis is restricted to students that passed the Principles class in Spring 2015 or Spring 2016.

Table III: Treatment Effects on Enrollment in Intermediate Micro (Year Following Treatment)

Dep. Variable: Dummy equal 1 if s/he took Microeconomics within year				
	Men	Men	Women	Women
Year 2016	-0.026 (0.810)	-0.014 (0.914)	-0.186 (0.197)	-0.225 (0.176)
Treatment class (in 2015)	0.231 (0.112)	0.232 (0.126)	-0.171 (0.181)	-0.251** (0.020)
Treatment class x 2016	-0.126 (0.376)	-0.128 (0.464)	0.505** (0.013)	0.593** (0.013)
Female Professor		0.145 (0.245)		0.129 (0.395)
In-state student		-0.024 (0.902)		-0.061 (0.656)
Freshman		-0.153 (0.519)		0.046 (0.818)
Cumulative GPA		-0.306* (0.080)		-0.561* (0.083)
Grade in Principles		0.006 (0.956)		0.299 (0.110)
Small class		-0.058 (0.776)		-0.245 (0.107)
Constant	-0.746*** (0.006)	0.304 (0.574)	-1.031*** (0.005)	-0.039 (0.950)
Observations	699	699	601	601

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dependent variable is a dummy equal 1 if s/he took ECO3301 the year following the Principles class. Score wild cluster bootstrap p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table IV: Interest in the field of Economics by treatment class, year and gender

	Control classes 2015 (untreated)	Treatment classes 2015 (untreated)	Control classes 2016 (untreated)	Treatment classes 2016 (treated)
<i>Plans to major in Economics</i>				
<i>Male</i>	19.55%	16.79%	15.04%	15.79%
<i>Female</i>	7.14%	6.99%	6.98%	11.93%
H0: Male=Female (p-value)	0.004***	0.011**	0.043**	0.390
H0: Control=Treatment; male, 2015 (p-value)	0.556			
H0: Control=Treatment; female, 2015 (p-value)	0.962			
H0: Control=Treatment; male, 2016 (p-value)	0.872			
H0: Control=Treatment; female, 2016 (p-value)	0.189			

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The p-values are generated by Chi-Square tests. Surveyed students only (N=1052).

Table V: Treatment effects on the intention to major in economics

Dep variable: Dummy equal 1 if s/he plans to major in economics				
	Men	Men	Women	Women
Year 2016	-0.177 (0.172)	-0.144 (0.263)	-0.012 (0.951)	-0.002 (0.993)
Treatment class (in 2015)	-0.105 (0.566)	-0.067 (0.618)	-0.011 (0.953)	0.009 (0.960)
Treatment class x 2016	0.136 (0.556)	0.104 (0.662)	0.310 (0.172)	0.473* (0.069)
Female Professor		0.252** (0.036)		0.268 (0.137)
In-state student		0.215* (0.079)		-0.103 (0.575)
Freshman		-0.360 (0.246)		-0.567 (0.108)
Cumulative GPA		-0.324** (0.074)		-0.278 (0.550)
Grade in Principles		0.105 (0.283)		0.351 (0.123)
Small class		-0.092 (0.309)		-0.126 (0.371)
Constant	-0.858*** (0.003)	-0.025 (0.943)	-1.465*** (0.006)	-1.301 (0.162)
Observations	516	516	507	507

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal to 1 if student plans to major in economics, 0 otherwise. Score wild cluster bootstrap p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table VI: Treatment Effects on Top Female Students

	Took Micro (Year)		Econ Major	
Year 2016	-0.580**	-0.564**	0.052	-0.050
	(0.020)	(0.048)	(0.856)	(0.866)
Treatment class (in 2015)	-0.442*	-0.493**	-0.217	-0.216
	(0.087)	(0.064)	(0.365)	(0.353)
Treatment class x 2016	1.393**	1.348**	0.592	0.658
	(0.026)	(0.029)	(0.134)	(0.142)
Female Professor		-0.044		0.130
		(0.699)		(0.484)
In-state student		0.216		-0.165
		(0.363)		(0.629)
Freshman		0.399		-1.014
		(0.377)		(0.218)
Cumulative GPA		2.006		2.931*
		(0.164)		(0.089)
Grade in Principles		-0.205		-0.357
		(0.616)		(0.256)
Small class		-0.418x		-0.546**
		(0.114)		(0.033)
Constant	-0.994***	-8.258	-1.348***	10.374
	(0.015)	(0.085)	(0.012)	(0.105)
Observations	185	185	165	165

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal 1 if the student plans to major in economics and/or took ECO3301 the year following the Principles class. Score wild cluster bootstrap p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table VII: Intention to major in Humanities or Languages

Dep var: Dummy=1 if s/he intends major in Humanities or Languages				
	Men	Men	Women	Women
Year 2016	0.076 (0.928)	0.037 (0.970)	0.249 (0.299)	0.187 (0.429)
Treatment class (in 2015)	0.271* (0.086)	0.215 (0.322)	0.346 (0.396)	0.376 (0.298)
Treatment class x 2016	-0.347 (0.573)	-0.338 (0.594)	-0.859** (0.048)	-0.907** (0.022)
Female Professor		-0.029 (0.816)		0.263 (0.196)
In-state student		0.007 (0.977)		-0.166 (0.383)
Freshman		-0.057 (0.876)		0.699*** (0.004)
Cumulative GPA		0.505** (0.048)		0.061 (0.873)
Grade in Principles		-0.157 (0.448)		-0.125 (0.412)
Small class		-0.356 (0.225)		0.295 (0.109)
Constant	-1.779*** (0.005)	-2.834** (0.011)	-1.526*** (0.004)	-2.173*** (0.004)
Observations	516	516	507	507

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal 1 if s/he plans to major in humanities or languages. Score wild cluster bootstrap p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table VIII: Female Students' performance in Intermediate Microeconomics by treatment class and year and gender

	Control classes 2015 (untreated)	Treatment classes 2015 (untreated)	Control classes 2016 (untreated)	Treatment classes 2016 (treated)
Average grade	3.33	3.39	3.02	3.26
H0: Control=Treatment; 2015 (p-value)	0.813			
H0: Control=Treatment; 2016 (p-value)	0.452			
Core Exam score	0.63	0.60	0.59	0.69
H0: Control=Treatment; 2015 (p-value)	0.499			
H0: Control=Treatment; 2016 (p-value)	0.212			

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The p-values are generated by two-sided tests of equality of means (ttests).

Table IX: Controlling for American students

Dummy equal 1 if she plans to major in economics and/or took Micro				
	Full Female Sample		Only American Female students	
	Took Micro (Year)	Econ Major	Took Micro (Year)	Econ Major
Year 2016	-0.231*	-0.030	-0.243	-0.202
	(0.146)	(0.912)	(0.126)	(0.449)
Treatment class (in 2015)	-0.251**	0.021	-0.307**	-0.015
	(0.019)	(0.908)	(0.016)	(0.937)
Treatment class x 2016	0.527**	0.408	0.541**	0.537*
	(0.020)	(0.140)	(0.021)	(0.093)
Female Professor	0.148	0.316	0.086	0.209
	(0.398)	(0.107)	(0.602)	(0.237)
In-state student	-0.009	-0.051	-0.017	-0.061
	(0.950)	(0.792)	(0.909)	(0.690)
Freshman	0.043	-0.573	0.056	-0.542
	(0.829)	(0.106)	(0.794)	(0.170)
Cumulative GPA	-0.570*	-0.299	-0.517	-0.372
	(0.083)	(0.549)	(0.109)	(0.492)
Grade in Principles	0.318*	0.363	0.340	0.358*
	(0.098)	(0.104)	(0.122)	(0.076)
Small class	-0.223	-0.111	-0.207*	-0.170
	(0.143)	(0.404)	(0.113)	(0.297)
American	-0.520*	-0.576		
	(0.086)	(0.139)		
Constant	0.389	-0.772	-0.335	-0.944
	(0.659)	(0.422)	(0.532)	(0.412)
Observations	601	507	547	468

Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dep. Variable: Dummy equal 1 if the student plans to major in economics and/or took ECO3301 the year following the Principles class. Score wild cluster bootstrap p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table X: Females excluding classes that changed between 2015 and 2016

	Micro (Year)		Econ Major	
Year 2016	-0.123 (0.411)	-0.209 (0.250)	-0.015 (0.960)	-0.029 (0.937)
Treatment class (in 2015)	-0.109 (0.383)	-0.212* (0.051)	0.030 (0.893)	0.009 (0.961)
Treatment class x 2016	0.442** (0.033)	0.571** (0.018)	0.326 (0.251)	0.492 (0.121)
Female Professor		0.090 (0.576)		0.261 (0.148)
In-state student		-0.070 (0.619)		0.013 (0.937)
Freshman		0.077 (0.739)		-0.529 (0.177)
Cumulative GPA		-0.556 (0.111)		-0.260 (0.632)
Grade in Principles		0.307* (0.121)		0.312 (0.184)
Small class		-0.275 (0.148)		-0.154 (0.309)
Constant	-1.093*** (0.017)	-0.115 (0.868)	-1.491*** (0.020)	-1.284 (0.314)
Observations	546	546	452	452

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal 1 if the student plans to major in economics and/or took ECO3301 the year following the Principles class. P-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (9 clusters) .

Table XI: Robustness: Including Class Fixed Effects

	Micro (Year)		Econ Major	
Year 2016	-0.0396 (0.750)	-0.0468 (0.714)	0.0236 (0.910)	0.198 (0.571)
Treatment class x 2016	0.416*** (0.038)	0.489*** (0.007)	0.319 (0.315)	0.319 (0.306)
In-state student		-0.116 (0.452)		-0.0116 (0.935)
Freshman		-0.0931 (0.690)		-0.658 (0.164)
Cumulative GPA		-0.651* (0 .098)		-0.354 (0.525)
Grade Principles		0.367* (0.085)		0.429 (0.133)
Constant	-1.358* (0.091)	-0.209 (0.773)	-1.696*** (0.086)	-1.245 (0 .375)
Observations	546	546	463	463

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal 1 if the student plans to major in economics and/or took ECO3301 the year following the Principles class. P-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (9 clusters).

Figure I: Enrollment in Intermediate Micro, following year

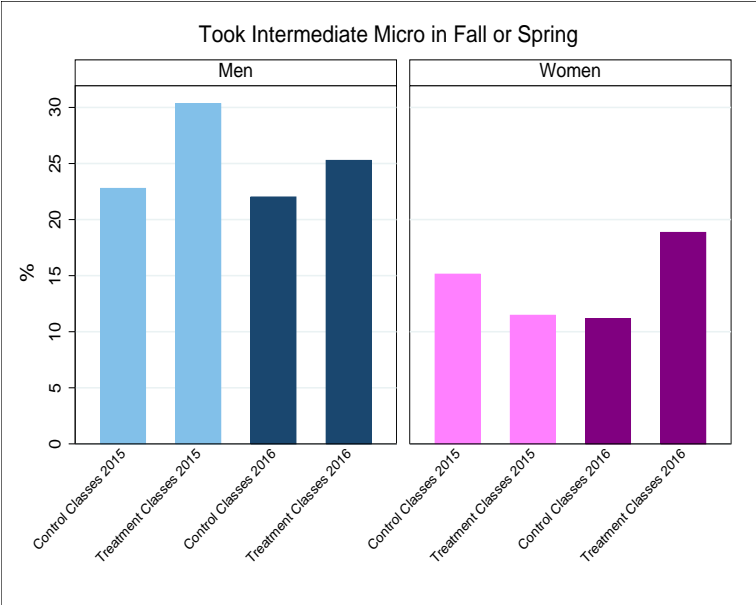


Figure II: Intention to Major in Economics

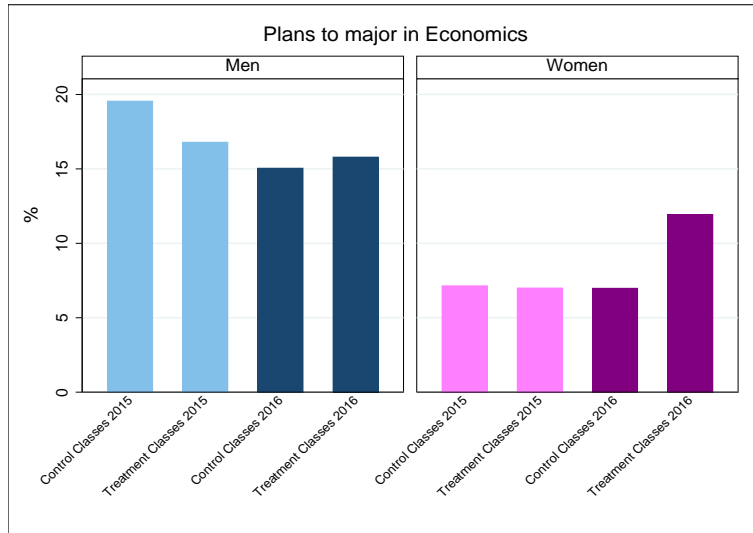


Figure III: Intention to major in other high-earning fields

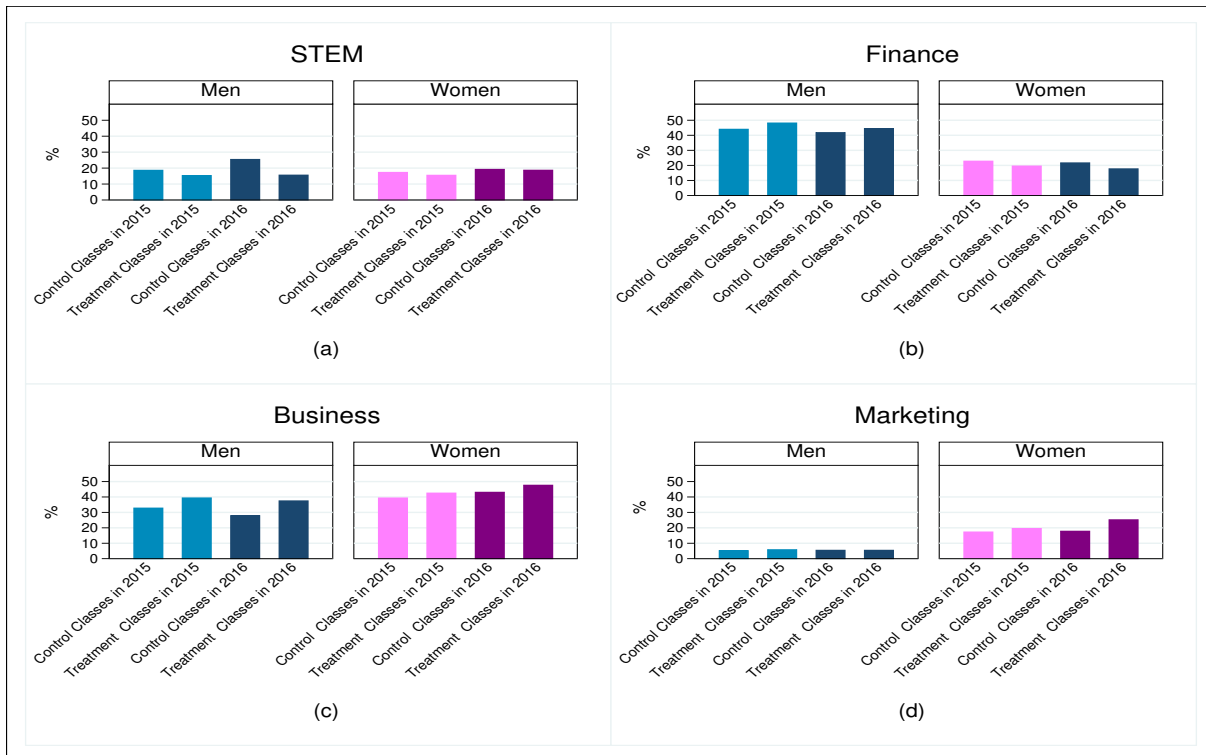


Figure IV: Intention to Major in lower-earning fields

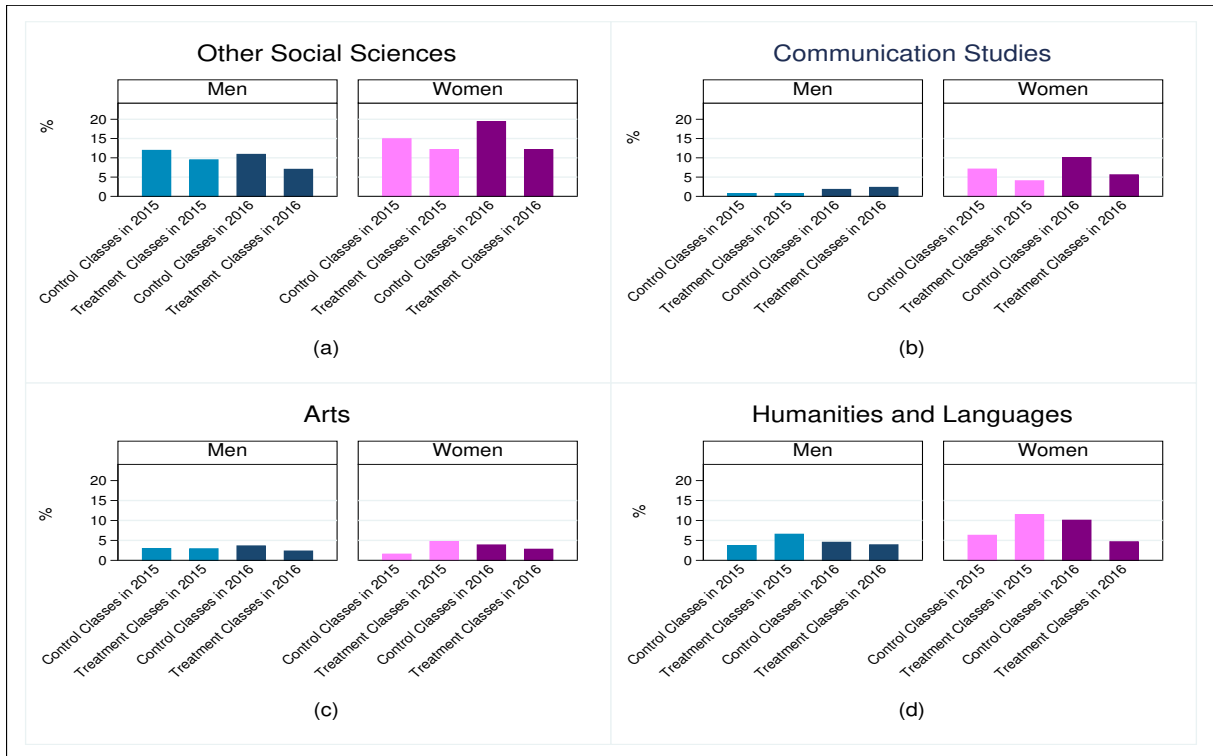
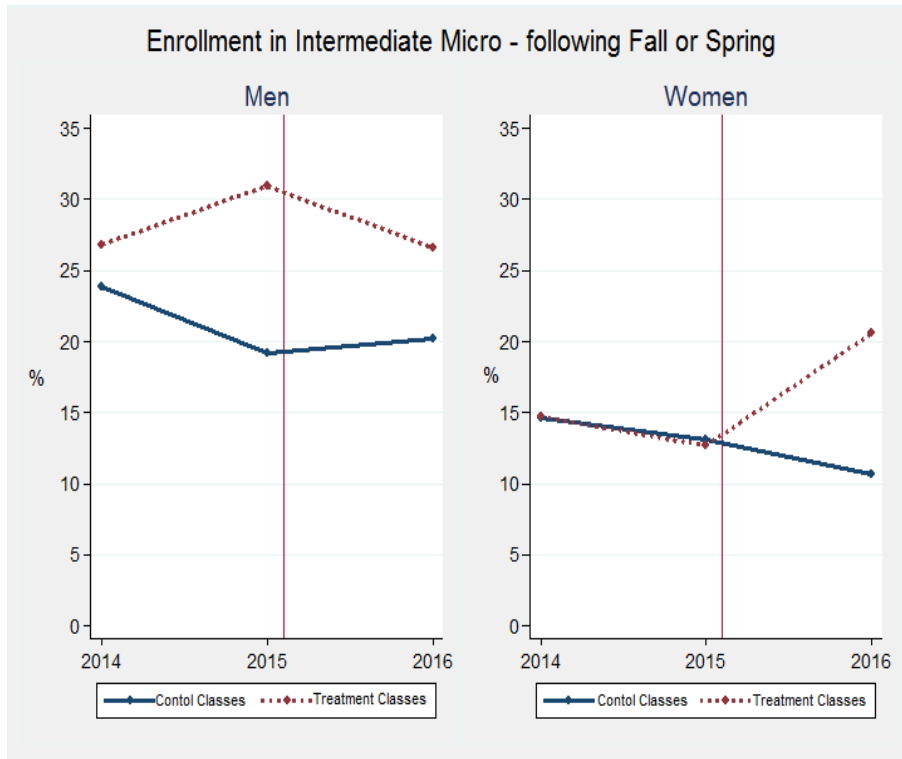


Figure V: Common trend



Annex: FOR ONLINE PUBLICATION

Table A1: Treatment Effects on Enrollment in Intermediate Micro (following semester)

Dep. Variable: Dummy equal 1 if s/he took Microeconomics in Fall	Men		Women	
	Men	Men	Women	Women
Year 2016	-0.099 (0.458)	-0.136 (0.347)	-0.216 (0.179)	-0.287* (0.098)
Treatment class (in 2015)	0.007 (0.981)	-0.004 (0.989)	-0.066 (0.815)	-0.105 (0.593)
Treatment class x 2016	-0.054 (0.850)	0.030 (0.910)	0.539** (0.012)	0.720*** (0.008)
Female Professor		0.293 (0.220)		0.333 (0.243)
In-state student		-0.219 (0.215)		0.058 (0.707)
Freshman		-0.342 (0.178)		-0.392 (0.142)
Cumulative GPA		-0.296* (0.065)		-0.145 (0.691)
Grade in Principles		0.121 (0.311)		0.265 (0.113)
Small class		-0.051 (0.871)		-0.214 (0.405)
Constant	-1.111*** (0.006)	-0.317 (0.171)	-1.458*** (0.003)	-1.628* (0.080)
Observations	699	699	601	601

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dependent variable is a dummy equal 1 if s/he took ECO3301 the following semester. P-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (12 clusters).

Table A2: Treatment Effects on Top Female Students (Excluding classes that changed)

	Took Micro (Year)		Econ Major	
Year 2016	-0.712**	-0.774**	0.211	0.142
	(0.026)	(0.012)	(0.501)	(0.698)
Treatment class (in 2015)	-0.469*	-0.559**	-0.167	-0.151
	(0.088)	(0.034)	(0.543)	(0.589)
Treatment class x 2016	1.526**	1.591**	0.433	0.440
	(0.023)	(0.020)	(0.317)	(0.420)
Female Professor		-0.089		0.095
		(0.459)		(0.546)
In-state student		0.140		-0.100
		(0.536)		(0.768)
Freshman		0.313		-1.094
		(0.526)		(0.216)
Cumulative GPA		2.160		3.793*
		(0.212)		(0.052)
Grade in Principles		-0.202		-0.317
		(0.664)		(0.433)
Small class		-0.599**		-0.438*
		(0.047)		(0.051)
Constant	-0.967* **	-8.653	-1.398**	-13.872*
	(0.025)	(0.122)	(0.028)	(0.060)
Observations	168	168	150	150

Notes: Score wild cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions. Dep. Variable: Dummy equal 1 if the student plans to major in economic and/or took ECO3301 the year following the Principles class. Classes that changed between years are removed from the analysis. Cluster robust p-values generated using boottest command in Stata 14 (Roodman et al., 2016) for standard errors clustered at the class level (9 clusters).

Table A3: Robustness: Including Class Fixed Effects (Males)

	Micro (Year)		Econ Major	
Year 2016	-0.012 (0.904)	0.016 (0.907)	-0.024 (0.900)	0.029 (0.857)
Treatment class x 2016	-0.132 (0.397)	-0.152 (0.414)	-0.103 (0.748)	-0.126 (0.660)
In-state student		0.061 (0.759)		0.193 (0.133)
Freshman		-0.325 (0.283)		-0.552 (0.149)
Cumulative GPA		-0.309 (0.115)		-0.386** (0.029)
Grade in Principles		-0.022 (0.877)		0.143 (0.503)
Constant	-0.745 (0.135)	0.503 (0.310)	-0.909 (0.167)	0.177 (0.803)
Observations	651	651	441	441

Notes: Cluster bootstrap p-values (Kline et al., 2012) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Probit regressions with Class Fixed effects. Dependent variable is a dummy equal 1 if he took ECO3301 the following year, or plans to major in economics respectively. P-values generated using boottest command in Stata 14 (Roodman et al., 2016), clustered at the class level (9 clusters). Note that sample size is smaller for Micro(fall) since one class drops from the estimation due to lack of variation in the outcome variable.

Table A4: Treatment Effects on Enrollment in Intermediate Micro (following year): Linear Probability Model

	Men	Men	Women	Women
Year 2016	-0.008 (0.940)	-0.001 (1.000)	-0.040 (0.240)	-0.046 (0.280)
Treatment class (in 2015)	0.076* (0.080)	0.077 (0.200)	-0.037 (0.160)	-0.049** (0.040)
Treatment class x 2016	-0.043 (0.260)	-0.046 (0.320)	0.113*** (0.000)	0.127* (0.060)
Female Professor		0.044 (0.320)		0.028 (0.460)
In-state student		-0.011 (0.720)		-0.014 (0.640)
Freshman		-0.052 (0.580)		0.008 (0.660)
Cumulative GPA		-0.099 (0.140)		-0.120 (0.140)
Grade in Principles		0.002 (1.000)		0.063 (0.160)
Small class		-0.018 (0.840)		-0.052 (0.240)
Constant	0.228*** (0.000)	0.573*** (0.000)	0.151*** (0.000)	0.372** (0.040)
Observations	699	699	601	601
R-squared	0.006	0.018	0.008	0.021

Notes: Cluster robust bootstrapped p-values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. LPM regression. Dependent variable is a dummy equal 1 if s/he took ECO3301 the following year. Cluster robust p-values generated using `clustse` command in Stata 14 (Menger, 2015) for standard errors clustered at the class level (12 clusters).

Table A5: Treatment Effects on Intent to Major in Economics: Linear Probability Model

	Men	Men	Women	Women
Year 2016	-0.045*	-0.036	-0.002	-0.000
	(0.080)	(0.200)	(1.000)	(0.960)
Treatment class (in 2015)	-0.028	-0.019	-0.001	-0.003
	(0.640)	(0.580)	(1.000)	(1.000)
Treatment class x 2016	0.035	0.025	0.051	0.071*
	(0.600)	(0.640)	(0.180)	(0.100)
Female Professor		0.059***		0.036
		(0.000)		(0.140)
In-state student		0.051		-0.011
		(0.160)		(0.720)
Freshman		-0.105		-0.098
		(0.240)		(0.420)
Cumulative GPA		-0.079*		-0.031
		(0.100)		(0.560)
Grade in Principles		0.024		0.043*
		(0.320)		(0.100)
Small class		-0.024		-0.020
		(0.520)		(0.480)
Constant	0.195***	0.426***	0.071*	0.114
	(0.000)	(0.000)	(0.060)	(0.460)
Observations	516	516	507	507
R-squared	0.002	0.026	0.005	0.033

Notes: Cluster robust bootstrapped p-values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. LPM regression. Dependent variable is a dummy equal 1 if s/he took ECO3301 the following year. Cluster robust p-values generated using clustse command in Stata 14 (Menger, 2015) for standard errors clustered at the class level (12 clusters).

Table A6: Treatment Effects on Top Female Students (Linear Probability Model)

	Took Micro (Year)		Econ Major	
Year 2016	-0.102** (0.020)	-0.097* (0.080)	0.009 (0.760)	-0.010 (0.920)
Treatment class (in 2015)	-0.085** (0.040)	-0.088** (0.040)	-0.030 (0.520)	-0.047 (0.220)
Treatment class x 2016	0.294 (0.120)	0.279* (0.080)	0.111 (0.160)	0.123* (0.100)
Female Professor		-0.005 (.960)		0.008 (0.900)
In-state student		0.042 (0.400)		-0.013 (0.820)
Freshman		0.049 (0.440)		-0.200 (0.380)
Cumulative GPA		0.400 (0.260)		0.434 (0.100)
Grade in Principles		-0.036 (0.620)		-0.057 (0.140)
Small class		-0.072 (0.120)		-0.079 (0.100)
Constant	0.160*** (0.000)	-1.278 (0.280)	0.089*** (0.000)	-1.160 (0.220)
Observations	185	185	165	165
R-squared	0.051	0.074	0.018	0.070

Notes: Cluster robust bootstrapped p-values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. LPM regression. Dependent variable is a dummy equal 1 if she took ECO3301 the following year or plans to major in economics. Cluster robust p-values generated using `clustse` command in Stata 14 (Menger, 2015) for standard errors clustered at the class level (12 clusters).

Figure A1: Top students Enrollment in Intermediate Micro

