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Economic Inquiry

A simple nudge increases socioeconomic diversity in undergraduate Economics

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Abstract

We assess whether a light-touch intervention can increase socioeconomic and racial diversity in undergraduate Economics. We randomly assigned over 2200 students a message with basic information about the Economics major; the basic message combined with an emphasis on the rewarding careers or financial returns associated with the major; or no message. Messages increased the proportion of first generation students majoring in Economics by five percentage points. This effect size was sufficient to reverse the gap in Economics majors for first generation students. Suggestive evidence indicates the effects may be driven by first generation students who were not also underrepresented minorities.

KEYWORDS
college major choice, diversity in Economics, higher education, nudges, randomized control trial

JEL CLASSIFICATION
A22, I21, I23

1 | INTRODUCTION

Differences in earnings across graduates of different disciplines rival, and in some cases exceed, the difference in earnings between college and high school graduates (Arcidiacono, 2004; Altonji et al., 2012; Altonji, Kahn, & Speer, 2016; Altonji, Arcidiacono, and Maurel, 2016). As in many STEM (Science, Technology, Engineering, Mathematics) fields, an Economics degree offers high future salaries, but the share of graduates who are underrepresented minorities (URM) or first generation students is low.[1] URM students earn 20% of all bachelor's degrees, but only 12% of Economics degrees (Bayer & Wilcox, 2019). First generation students earn 42% of all bachelor's degrees, but only 22% of Economics degrees (Schultz & Stansbury, 2022). Given the high potential returns to an Economics degree found in both observational and quasi-experimental studies (Bleemer & Mehta, 2022), the underrepresentation of these groups contributes to income inequality.[2] Underrepresentation of URM and first generation individuals in the Economics profession (Bayer, Hoover, & Washington, 2020; Bayer & Rouse, 2016; Schultz & Stansbury, 2022) may also have consequences for the questions studied by economists and corresponding policy recommendations (May et al., 2014). The lack of diversity in the field begins with undergraduate Economics majors.

Abbreviations: AEA, American Economic Association; OLS, ordinary least squares; OSU, Oregon State University; STEM, Science, Technology, Engineering, Mathematics; URM, underrepresented minorities.

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One channel that impacts major choice is information. In choosing a college major, students form beliefs about the earnings and utility they expect to receive from potential majors (Stinebrickner & Stinebrickner, 2013; Zafar, 2013), and revise these beliefs in response to new information (Wiswall & Zafar, 2014, 2015). If all prospective Economics students chose their major with similar information and constraints, disparities by demographic group would only reflect differences in preferences and be of little concern. Evidence of information gaps among women, URMs, and first generation students in Economics (Bayer, Bhanot, & Lozano, 2019; Bayer, Hoover, & Washington, 2020; Jeitschko, 2019), however, suggests these factors also matter. There is also evidence that these underrepresented groups face disparate treatment within the profession (Allgood et al., 2019; Bayer, Hoover, & Washington, 2020; Wu, 2018, 2020). Sharing information that may improve perceptions of economics is therefore a "Best Practice" recommended by the American Economic Association (AEA) to "correct gender and racial/ethnic disparities in knowledge about economics" (Bayer, Kalemli-Özcan et al., 2019). If students enter college with limited information about what economists study, and if either knowledge or preferences for career paths vary across student groups, then informing students about the true variety of topics in Economics could increase diversity. In addition, students may differ in their negative perceptions about Economics, their feeling of exclusion from the profession, or the extent to which they have considered Economics as a possible career path. Outreach could therefore increase diversity by promoting a greater sense of inclusion among students from groups that are underrepresented in Economics, or simply by increasing the salience of an Economics major among those who had previously not considered it. The AEA suggests using email as a method to address knowledge deficits and misconceptions held by students, noting the effectiveness of such interventions: "When faculty proactively offer information about the breadth of the field of economics, more students from underrepresented groups study economics" (Bayer, Kalemli-Özcan et al., 2019). This paper tests that claim, focusing on URM and first generation students as the underrepresented groups. We provide evidence in a different context from previous work and vary the type of information provided.

We designed a randomized control trial to test whether students respond to messages about majoring in Economics. The experiment included more than 2200 students enrolled in Economics Principles courses at Oregon State University. We randomly assigned students to receive messages emphasizing the rewarding careers or financial returns associated with the Economics major. The rewarding careers message took two forms, a video produced for wide distribution by the AEA (henceforth, the "AEA video") or a local version featuring current and recent Economics students at the university ("OSU video"). The AEA video is used by many departments attempting to attract underrepresented students by correcting information gaps and promoting inclusion, and the OSU video allows us to test for role model effects of receiving similar information from peers, in the spirit of Porter and Serra (2019) and Patnaik et al. (2023). The financial returns message ("earnings information") contrasted salaries for Economics graduates with those from other majors. We compare these groups to students receiving no email ("control") and to a group receiving a message with basic information about the major. All message content aligns with recommendations to promote diversity in Economics (e.g., Bayer, Hoover, & Washington, 2020). This paper is a companion to Pugatch and Schroeder (2021), which analyzed the effects of the same experiment on the gender composition of Economics majors.

These email messages increased the probability that first generation students went on to major in Economics by five percentage points. This effect size was sufficient to reverse the gap in Economics majors between first generation and non-first generation students. Effect sizes were larger and more precise for better-performing students. Results when combining first generation and URM students into a single group were similar. However, results when specifying URM students as a separate group were insignificant, suggesting that the gains among first generation students were concentrated among those who were not also underrepresented minorities. The outcome is drawn from administrative data collected in the academic year following treatment, meaning the effects represent a durable change in revealed preference. We use our results to conduct a thought experiment. How would the proportion of first generation Economics majors change if the intervention became departmental policy? In this scenario, the first generation proportion would more than double from 0.08 to 0.22. For students earning a B- or better, the implied increase is from 0.11 to 0.25, or 127%.

Using survey data on perceptions of Economics at the end of the course, we find that the intervention increased the appeal of expected future income and decreased concerns about diversity and lack of relevance of Economics among URM students, consistent with lack of inclusion in Economics among this group (Bayer, Bhanot, et al., 2020). We fail to find heterogeneous treatment effects by message content, suggesting the common elements of information provision and encouragement led to the effectiveness of the messages. Despite the improved attitudes toward economics, however, we do not find a statistically significant increase in Economics majors among URM students, suggesting that more substantial interventions may be required for this group.

We contribute to the burgeoning literature on promoting interest in undergraduate Economics among groups underrepresented in the field. The large scale and negligible marginal cost of our experiment—the intervention consisted of a single email—help to understand the frontier of informational nudges to promote undergraduate Economics. We complement Bayer, Bhanot, and Lozano (2019), who test similar messages among incoming students, by extending their work in three main ways. First, their study occurred at elite liberal arts colleges, whereas our setting is a public university with an acceptance rate exceeding 80%. We therefore extend their work to a new setting which is more representative of the typical college student. Second, we test several versions of our message, each consistent with guidelines for promoting diversity in Economics, to learn about their relative effectiveness. Finally, whereas Bayer, Bhanot, and Lozano (2019) included only underrepresented (female, URM, and first generation) students, our study includes students from all backgrounds, allowing comparisons in responses between groups with differential representation in Economics.

Both studies find positive effects of an information intervention on interest in Economics among first generation and URM students. Whereas in Bayer, Bhanot, and Lozano (2019) these effects faded after an academic year, in our case the outcomes were measured in the academic year following the experiment, suggesting durable behavior change. Our results also contribute to the literature on the influence of perceptions of a college major on student choices (Haggag et al., 2021).

Related work looks at female participation in Economics. In our experiment, only male students (unconditional on first generation/URM status) majored in Economics at higher rates in response to the messages. As a result, the same counterfactual thought experiment we conduct in this paper would dramatically decrease the proportion of female Economics majors in our sample (Pugatch & Schroeder, 2021). Experimental evidence from the Undergraduate Women in Economics (UWE) challenge suggests that deeper engagement may be required to increase female interest in Economics (Avilova & Goldin, 2018; Li (2018); Porter & Serra, 2019). More recent work is also consistent with this interpretation, for both women and underrepresented minorities (Gentry et al., 2023). Similarly, other RCTs intended to increase interest in Economics using nudges without personal interaction had only modest to null results among female students (Antman et al., 2020; Halim et al., 2021).

Our work therefore helps to draw a more nuanced picture of the AEA's recommendation to reach out to students and share information. Gaps in information, perceptions or salience of Economics may be unevenly distributed among different underrepresented groups, leading to different responses to interventions. Arms-length interventions to increase interest in Economics could therefore have a stronger effect among first generation students.

2 | RESEARCH DESIGN

2.1 | Context

The study occurred at Oregon State University (OSU), the largest university in the state, with 35,000 students. In the academic year of the study, 2018–2019, first generation students made up 23% of the student body. Underrepresented minority (URM) students were 12% of students.

The academic year at OSU consists of three 10-week terms. The Economics Principles sequence at OSU includes two courses, Introduction to Microeconomics and Introduction to Macroeconomics. The Principles classes are popular, fulfilling course requirements for 40 other majors and 15 minors. Accordingly, 98% of students in our sample are not Economics majors when entering the course, offering an excellent opportunity to introduce students to the discipline and ask them to consider the major. Within our sample, the most popular majors at baseline are business (49%) and engineering (26%). The sample includes eight sections of Introduction to Microeconomics and five sections of Introduction to Macroeconomics. These course sections were taught by one white female instructor (four sections of Introduction to Microeconomics) and three white male instructors (the remaining nine sections). Most Principles students take one course or the other. Students who take both courses may take them in either order, and occasionally take them simultaneously.

Admitted students to Oregon State are assigned the major listed as their preference when applying. In our sample, 8% of students were in exploratory programs for undecided students at baseline. Students who want to switch to Economics from another major must meet with an academic advisor. These institutional features may lead to persistence in major choice compared to institutions where “undecided” is the default major for entering students.

2.2 | Experiment

We invited all students registered in Economics Principles courses on OSU's main Corvallis campus to participate in the study. Participants were randomly assigned to the following groups.

1. *Control*: no encouragement message.
2. *Basic information*: encouragement message based on description of Economics major on departmental website, including information about potential careers.
3. *Earnings information*: basic information, plus information on earnings of Economics graduates one and 15 years after graduation.
4. *AEA video*: basic information, plus link to American Economic Association video "A career in Economics...it's much more than you think."
5. *OSU video*: basic information, plus link to video testimonials by current Economics students and alumni of Oregon State University.

All treatments align with recommendations to promote diversity in Economics by sharing information about the major. Moreover, the additional content of the earnings information, AEA video, and OSU video treatments emphasizes perceived information gaps among groups underrepresented in Economics. Respondents to a survey of underrepresented minorities in Economics wished they had more information on "(w)hat you can do with an economics degree.... Respondents also wished they had known more about economic research and what academic economists do outside of the classroom. They wanted salary information too" (Bayer, Hoover, & Washington, 2020, pp. 201–202).

Treated students were sent one message, in Week 8 of the 10-week course, from the email account of the student's instructor.[3] All emails had an identical subject line, "ECON (201/202): Consider majoring in Economics!" Messages appear in Appendix A, Figures A1–A4. We repeated the experiment in each of the three terms (fall, winter, and spring) of the 2018–2019 academic year.[4]

We randomly assigned treatments at the level of individual students, stratifying by course section and class year (freshman/sophomore/other). We assigned each treatment with equal probability within strata, though the total number of students in each group differed due to uneven strata sizes. Because students may take both introductory courses in the same term, or repeat the same course in multiple terms, it is possible to be assigned to a treatment group more than once. Main results use student course enrollment as the unit of analysis, which we refer to as the student for brevity. We also check robustness to repeated observations from the same student.

2.3 | Data

We have administrative data and baseline and endline surveys from study participants. The baseline and endline surveys were conducted during the first and last 2 weeks, respectively, of each 10-week term. The endline survey therefore occurred in Weeks 9–10, after treatment was sent in Week 8. Students earned course credit for completing the surveys. Surveys included questions about the likelihood of majoring or minoring in Economics and perceptions of the Economics major. Administrative data include measures of experimental take-up, such as whether students opened treatment emails, clicked on links within those emails, or scheduled appointments with the Economics Academic Advisor. Administrative data also include student demographics, grades, and major. Our primary outcome of interest is an indicator for majoring in Economics as of Winter 2020.[5] Our main results therefore represent the effects of the treatments two to four terms after the experiment, ensuring that students had sufficient time to reflect on the information and take the necessary administrative steps. Other outcomes come from the endline survey.

3 | METHODOLOGY

Our primary specification is the ordinary least squares (OLS) regression:

$$\text{EconMajor}_{is} = \alpha_0 + \sum_{j=1}^{4} \alpha_j T_{j,is} + \sum_{j=1}^{4} \beta_j \left(T_{j,is} \times G_{is}\right) + X_{is}\theta + \varepsilon_{is} \quad (1)$$

In Equation (1), j indexes treatment arms; i indexes students; s indexes strata; EconMajor is an indicator for majoring in Economics, the outcome of interest; T_1 through T_4 are indicators for belonging to each of the four treatment arms (basic information, earnings information, AEA video, or OSU video; the control group is the omitted category); G is an indicator for belonging to a demographic group of interest, such as first generation or underrepresented minority; X is a vector of controls, including the main effect of the demographic group G, the baseline outcome, and strata dummies; and ε is an error term. The inclusion of strata dummies isolates the random variation in treatment status within strata. The baseline outcome adjusts for any prior outcome differences between treatment groups and increases precision. We estimate heteroscedasticity-robust standard errors, consistent with random assignment at the student level (Abadie et al., 2017).[6]

Our coefficients of interest are β_1 through β_4, which measure differential effects of each treatment among students in demographic group G. For instance, β_1 measures whether basic information changed the proportion of Economics majors from group G differently from the effect of this treatment in the rest of the sample.

We also estimate a simplified version of Equation (1) which bundles all treatments into a single indicator. We analyze outcomes using the full sample and for the subsample of students who earned a B- or above, given past evidence of a greater response to informational nudges among better-performing students (Li, 2018; Pugatch & Schroeder, 2021).

4 | RESULTS

4.1 | Descriptive statistics

The experiment included 2277 participants, or 85% of Economics Principles course enrollment.[7] First generation and underrepresented minority students each comprise 10% of the sample, lower than their proportions in the university (23% and 12%, respectively). Table 1 shows summary statistics for the sample, by first generation and underrepresented minority status. Compared to other students, first generation or underrepresented minority students are approximately equally likely to be female, but are less likely to be white, have lower GPAs, and are less likely to expect an A in the course (Panel A, columns 1–2). Overlap among first generation and underrepresented minority students is high, with 38% of first generation students also URM, and 40% of URM students also first generation (Table 2). For this reason, we group them together in some analyses. Nonetheless, the imperfect overlap highlights the fact that they are distinct groups with potentially different reasons for being underrepresented in Economics. Accordingly, we also look for heterogeneous effects of treatment within and between these groups.

At baseline, the proportion of first generation or URM students majoring in Economics was higher than students not from these groups (3% vs. 2%), but not statistically distinguishable. Because our sample consists of introductory Economics students, these similarities may reflect selection on prior interest in the subject. However, first generation/URM students were significantly less likely to report an intention to minor in Economics, and had lower intentions to major and minor in Economics on a 0–100 scale. Perceptions of Economics also differed at baseline, with first generation/URM students less likely to cite future income or rewarding careers as the biggest appeal of Economics. URM students were more likely to cite lack of diversity as the biggest drawback to Economics than non-URM students.

Table 1, Panel B shows endline outcomes. Endline survey attrition did not differ by first generation/URM status. By definition, there is no attrition in the administrative data.[8] Differences in majoring and minoring in Economics persisted at endline, though these differences leave open the possibility that first generation/URM students responded differently to treatment. We assess this question in the next subsection.

Table 3 presents baseline characteristics conditional on treatment status to test for balance. Baseline values were imbalanced by treatment status for two characteristics: female and first generation. We will present robustness checks which include indicators for these characteristics in the controls.

4.2 | Treatment effects estimates

About two-thirds of treated students opened the intervention emails, with similar rates on this and other take-up measures between first generation/URM students and students not in these groups (Appendix Table A1). In the sample, 71 students majored in Economics by Winter 2020, or 3.2%. Of these, 33 students—46% of Economics majors—were not Economics majors at baseline. By contrast, only six students switched out of Economics.[9] Of the 33 students

TABLE 1 Summary statistics.

	First gen. or URM		First generation		URM	
	No (1)	Yes (2)	No (3)	Yes (4)	No (5)	Yes (6)
Panel A: Baseline characteristics						
Female	0.36	0.33	0.35	0.35	0.36	0.31
White	0.65	0.24***	0.61	0.37***	0.65	0.00***
First generation	0.00	0.64***	0.00	1.00	0.07	0.40***
Underrepresented minority	0.00	0.6***	0.07	0.38***	0.00	1.00
Underrepresented minority (inc. multiple race)	0.07	0.64***	0.13	0.44***	0.07	1.00***
High school GPA	3.49	3.40***	3.48	3.41**	3.48	3.37***
GPA at Oregon State, previous terms	3.09	2.94***	3.08	2.95***	3.08	2.92***
Expected grade: A	0.51	0.46*	0.51	0.44*	0.51	0.45*
Expected grade: B	0.44	0.46	0.44	0.48	0.44	0.48
Economics major	0.02	0.03	0.02	0.03	0.02	0.02
Intends to minor in Economics (0/1)	0.05	0.02***	0.05	0.02**	0.05	0.00***
Intends to major in Economics (0–100)	19.1	15.0***	18.9	14.5**	18.9	14.2***
Intends to minor in Economics (0–100)	27.5	21.6***	27.2	20.7***	27.0	22.4**
Biggest appeal of Economics major:						
Fun to study	0.18	0.20	0.18	0.19	0.18	0.20
Income	0.37	0.32*	0.37	0.31*	0.37	0.31*
Rewarding career	0.21	0.17**	0.21	0.17	0.21	0.18
Biggest drawback of Economics major:						
Boring	0.23	0.21	0.23	0.18**	0.23	0.20
Too difficult	0.38	0.34	0.38	0.37	0.38	0.34
Too focused on making money	0.07	0.06	0.07	0.06	0.07	0.06
Lack of diversity	0.03	0.05	0.04	0.03	0.03	0.08**
Panel B: Outcomes						
Completed endline survey	0.87	0.85	0.87	0.86	0.87	0.85
Course grade (0–4)	2.40	2.17***	2.39	2.17***	2.40	2.08***
Economics major	0.03	0.04	0.03	0.04	0.03	0.03
Intends to minor in Economics (0/1)	0.04	0.02**	0.04	0.02	0.04	0.02**
Intends to major in Economics (0–100)	18.5	15.2**	18.2	15.7	18.4	14.3**
Intends to minor in Economics (0–100)	26.2	21.9**	25.8	22.8	25.9	21.6**
Biggest appeal of Economics major:						
Fun to study	0.15	0.14	0.15	0.14	0.15	0.13
Income	0.40	0.33**	0.40	0.31**	0.39	0.34
Rewarding career	0.18	0.19	0.18	0.19	0.18	0.20
Biggest drawback of Economics major:						
Boring	0.26	0.26	0.26	0.25	0.26	0.25
Too difficult	0.40	0.38	0.40	0.40	0.40	0.38

TABLE 1 (Continued)

	First gen. or URM		First generation		URM	
	No (1)	Yes (2)	No (3)	Yes (4)	No (5)	Yes (6)
Too focused on making money	0.06	0.06	0.06	0.06	0.06	0.06
Lack of diversity	0.04	0.06	0.04	0.06	0.04	0.09**
Took Economics course (after principles)	0.03	0.06*	0.03	0.05	0.03	0.06
N	1908	369	2041	236	2054	223
Proportion	0.84	0.16	0.90	0.10	0.90	0.10

Note: Table shows baseline characteristics and outcomes by first generation and underrepresented minority (URM) status. Sample is all students who participated in study. Underrepresented minority is defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Pacific Islander. URM status does not include multiracial or international students. Stars indicate significant differences with column to left.

*Significant at 10%, **significant at 5%, ***significant at 1%.

Source: Administrative data and baseline and endline surveys.

TABLE 2 Distribution of first generation and underrepresented minorities (URM) students.

	Non-first generation	First generation	Total
Non-URM	1908	146	2054
URM	133	90	223
Total	2041	236	2277

Note: Table shows distribution of first generation and underrepresented minority (URM) status. Sample is all students who participated in study. Underrepresented minority is defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Pacific Islander. URM status does not include multiracial or international students.

Source: Administrative data.

who switched into Economics, six were first generation or underrepresented minority students, all of them treated. Of the six students who switched out of Economics, four were first generation or URM, with three from the control group (Appendix Table A2).

The results of estimating Equation (1) appear in Table 4. We interact treatment with one of three group indicators: (1) first generation or URM, (2) first generation, and (3) URM. Being in the combined first generation or URM group is associated with a lower probability of majoring in Economics by four percentage points, significant at 5% (columns 1–2). The point estimates of this coefficient were larger in magnitude, at 10% points, for the subsample of students who earned a B- or above in the course, although only weakly statistically significant (columns 3–4).

In these regressions, none of the individual treatments had a statistically significant effect on students who were neither first generation nor URM (columns 1 and 3). The interaction terms, however, indicate that there were positive and significant impacts of the treatments for students in the first generation or URM group. The basic information email increased the probability that a student in this group majored in Economics by eight percentage points, significant at 5% (column 1). This effect was even stronger for the B- and above subsample, where the coefficient was 19% points, likewise significant at 5%. In both cases, assignment to the basic information treatment more than reversed the gap in majoring in Economics for students of this demographic group. The interaction between the AEA video treatment and first generation or URM status produced somewhat smaller and less precise coefficients, but still sufficient to overcome the gap, at 5% points in the full sample and 13% points in the B- and above sample (columns 1 and 3). Regressions using an indicator for assignment to any treatment email show similar results. The indicator for any treatment was insignificant, but the interaction between this indicator and the first generation or URM group was statistically significant at 5%, increasing the probability of majoring in Economics by 5% points in the full sample and by 12% points in the B- and above group (columns 2 and 4).

Looking at first generation and URM students separately reveals differential effects of treatment. Being a first generation student was associated with a four percentage point lower probability of majoring Economics, significant at 10% (columns 5–6); the coefficients were larger in magnitude but insignificant for the B- or above group (columns 7–8). The interaction between any treatment and first generation was significant at 5%, increasing the probability of majoring in Economics by five percentage points (column 6). For the B- or above group, this coefficient was 13% points,

TABLE 3 Baseline balance.

	Treatment arm					
	Control (1)	Basic information (2)	AEA video (3)	Earnings information (4)	OSU video (5)	*F*-test (*p*-value) (6)
Female	0.32	0.41	0.36	0.35	0.33	0.05
	(0.47)	(0.49)	(0.48)	(0.48)	(0.47)	
White	0.57	0.58	0.59	0.58	0.61	0.84
	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	
Asian	0.08	0.08	0.06	0.06	0.07	0.67
	(0.27)	(0.27)	(0.24)	(0.24)	(0.26)	
Underrepresented minority	0.10	0.09	0.10	0.11	0.08	0.51
	(0.30)	(0.29)	(0.30)	(0.32)	(0.27)	
First generation	0.14	0.08	0.09	0.09	0.12	0.03
	(0.35)	(0.27)	(0.29)	(0.29)	(0.32)	
High school GPA	3.46	3.50	3.45	3.49	3.46	0.20
	(0.40)	(0.37)	(0.42)	(0.37)	(0.42)	
Oregon State GPA	3.05	3.05	3.07	3.10	3.05	0.52
	(0.56)	(0.56)	(0.56)	(0.52)	(0.58)	
Expected grade: A	0.48	0.49	0.48	0.54	0.52	0.22
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	
Expected grade: B	0.46	0.45	0.47	0.41	0.42	0.22
	(0.50)	(0.50)	(0.50)	(0.49)	(0.49)	
Intends to major in Economics	0.03	0.02	0.03	0.04	0.05	0.18
	(0.17)	(0.14)	(0.18)	(0.19)	(0.21)	
Intends to minor in Economics	0.05	0.03	0.04	0.06	0.03	0.28
	(0.22)	(0.18)	(0.20)	(0.24)	(0.18)	
Likelihood of majoring in Economics (0–100)	17.45	17.25	19.16	20.12	18.07	0.38
	(24.40)	(24.34)	(26.13)	(26.09)	(25.27)	
Likelihood of minoring in Economics (0–100)	26.23	25.68	27.18	27.37	26.22	0.87
	(26.91)	(27.18)	(27.11)	(28.03)	(25.85)	
Completed endline survey	0.87	0.85	0.86	0.89	0.87	0.51
	(0.34)	(0.36)	(0.35)	(0.31)	(0.34)	
N	456	455	455	460	451	2277

Note: Table shows mean of baseline characteristics, by study arm. Standard deviations in parentheses. Column (6) report *p*-values of joint test of treatment dummies on baseline characteristic, controlling for strata dummies. Underrepresented minority is defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Pacific Islander. URM status does not include multiracial or international students.

significant at 10% (column 8). Looking at the treatments individually, the coefficients on the interaction with the basic information treatment are similar in magnitude to the above estimates, but weakly significant (columns 5 and 7). Additionally, interactions between first generation status and the AEA video and OSU video are positive and weakly significant, and the basic information email is weakly significant on its own for the B- or above group (columns 5 and 7).

The coefficients on the URM indicator have negative signs with slightly smaller magnitudes than first generation, but none are statistically significant (columns 9–12). While most of the interactions between treatments and URM status are positive, with larger magnitudes in the B- or above sample, none are statistically different from zero. The

TABLE 4 Results.

	Major in Economics											
	First generation or URM				First generation				URM			
	All		B- or above		All		B- or above		All		B- or above	
Outcome group sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Basic information	0.006		0.019		0.011		0.029*		0.015		0.038**	
	(0.009)		(0.016)		(0.009)		(0.017)		(0.009)		(0.018)	
Earnings information	0.011		0.025		0.012		0.027		0.015		0.033*	
	(0.010)		(0.020)		(0.010)		(0.019)		(0.010)		(0.019)	
AEA video	0.003		0.010		0.004		0.012		0.008		0.020	
	(0.008)		(0.016)		(0.008)		(0.017)		(0.008)		(0.016)	
OSU video	−0.003		−0.004		−0.002		−0.003		0.005		0.010	
	(0.008)		(0.014)		(0.008)		(0.015)		(0.008)		(0.015)	
Basic info*group	0.081**		0.188**		0.080*		0.188*		0.045		0.100	
	(0.033)		(0.083)		(0.046)		(0.114)		(0.037)		(0.104)	
Earnings*group	0.023		0.064		0.021		0.052		0.005		0.030	
	(0.020)		(0.058)		(0.021)		(0.059)		(0.023)		(0.082)	
AEA video*group	0.048*		0.128*		0.059*		0.155		0.033		0.110	
	(0.025)		(0.075)		(0.034)		(0.097)		(0.031)		(0.115)	
OSU video*group	0.041		0.108		0.056*		0.134*		−0.006		−0.022	
	(0.027)		(0.073)		(0.029)		(0.077)		(0.032)		(0.117)	
Group	−0.043**	−0.043**	−0.104*	−0.102*	−0.038*	−0.038*	−0.081	−0.080	−0.024	−0.024	−0.072	−0.069
	(0.019)	(0.019)	(0.054)	(0.054)	(0.021)	(0.021)	(0.058)	(0.058)	(0.020)	(0.020)	(0.078)	(0.078)
Treatment		0.004		0.013		0.006		0.017		0.011		0.025**
		(0.007)		(0.012)		(0.007)		(0.012)		(0.007)		(0.012)
Treatment*group		0.048**		0.120**		0.052**		0.126*		0.020		0.061
		(0.021)		(0.059)		(0.024)		(0.065)		(0.024)		(0.085)
N	2238	2238	1003	1003	2238	2238	1003	1003	2238	2238	1003	1003
Control mean	0.023	0.023	0.037	0.037	0.023	0.023	0.037	0.037	0.023	0.023	0.037	0.037
All interactions = 0	0.09	0.02	0.15	0.04	0.11	0.03	0.16	0.05	0.52	0.40	0.64	0.47

Note: Sample is all students who consented to participate in study. Outcome is dummy for majoring in Economics, from administrative data in Winter 2020 or most recent available. Underrepresented minority (URM) is defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Pacific Islander. URM status does not include multiracial or international students. All regressions include strata dummies and control for baseline outcome. Heteroskedasticity-robust standard errors in parenthesis.

*Significant at 10%, **significant at 5%, ***significant at 1%.

main effect of treatment for students earning a B- or better is positive and significant, but the interaction with URM is not statistically significant (Table 4, column 12). Together, these results suggest that the positive effects for the combined group may be driven by first generation students.

To investigate this potential heterogeneity further, we re-estimate Equation (1), interacting treatment with the indicator for URM, the indicator for first generation, and an indicator for being both first generation and URM. Results for the bundled treatment indicator are presented in Table 5. The coefficients on treatment and its interactions with the URM indicator are all statistically insignificant. The coefficients on the interactions between the bundled treatment and first generation are both positive and significant at 5%, indicating an increase in the probability of majoring in Economics of 8% points for the full sample and 17% points for the B- and above subsample. The coefficient on the three-way interaction is negative and weakly significant for the full sample, and negative and insignificant for the B- and above

TABLE 5 Results: Full set of interactions, bundled treatment indicator.

	Major in Economics	
Outcome sample	**All (1)**	**B- or above (2)**
URM	−0.049	−0.168
	(0.042)	(0.149)
First generation	−0.061*	−0.120
	(0.034)	(0.076)
URM*first generation	0.095*	0.295*
	(0.052)	(0.162)
Treatment	0.004	0.013
	(0.007)	(0.012)
Treatment*URM	0.042	0.147
	(0.045)	(0.155)
Treatment*first generation	0.080**	0.169**
	(0.038)	(0.084)
Treatment*URM*first generation	−0.105*	−0.288
	(0.060)	(0.181)
N	2238	1003
Control mean	0.023	0.037
All treatment interactions = 0	0.398	0.158

Note: Sample is all students who consented to participate in study. Outcome is dummy for majoring in Economics, from administrative data in Winter 2020 or most recent available. Underrepresented minority (URM) is defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Pacific Islander. URM status does not include multiracial or international students. All regressions include strata dummies and control for baseline outcome. Heteroskedasticity-robust standard errors in parenthesis.

*Significant at 10%, **significant at 5%, ***significant at 1%.

sample. These results suggest that, not only were gains concentrated among first generation students, it may have been non-URM first generation students driving the increase in majors.

Taken together, these results provide evidence that an email message from a course instructor can successfully encourage underrepresented students to major in Economics. The positive effects represent a lasting change in revealed preference, since the outcome is measured by administrative data collected in the academic year following treatment. Overall, we find that a simple nudge—a single email during a 10-week course—can reverse the lower likelihood of majoring in Economics found for first generation students.

4.3 | Robustness checks and mechanisms

Treatment effects reported in Table 4 represent intent to treat (ITT) estimates of treatment assignment. Effect magnitudes may therefore be attenuated by students who were inattentive to treatment messages. Data on which students opened the treatment emails allows us to estimate an additional set of treatment effects. Table A3 reports two stage least squares (2SLS) estimates for the effect of opening a treatment email, using treatment assignment and its interaction with the group indicator as instruments. Because our experiment has one-sided noncompliance (by definition, no student in the control group opens a treatment email), there are no always takers. The treated students who opened the email are therefore all compliers. Accordingly, the 2SLS estimates represent both the local average treatment effect (LATE) for compliers and the average treatment effect on the treated (ATT). Results are consistent with ITT estimates, but with slightly larger magnitudes. Opening the email leads to a 6.8% point larger increase in majoring in Economics among first generation students, rising to 15.2% points among students earning a B- or better. Point estimates are positive but not precisely estimated for the URM interaction terms.[10] In most of the remaining analysis, we continue to

group first generation or URM students into a single category to increase statistical power, while acknowledging that our main results are driven by first generation students.[11]

In Appendix Table A5, we check the robustness of our results to several alternative specifications. Column (1) adds controls for variables imbalanced at baseline (female and first generation). Column (2) controls for Phase Two of the experiment, in which two versions of a second encouragement message were sent after the course ended to students earning a B- or better (see footnote [4]). We include dummies for Phase Two control and Phase Two treatment, with students not in Phase Two as the omitted category. We do not include Phase Two controls in the main specification because eligibility may be affected by the Phase One treatment, and Phase Two did not influence the decision to major in Economics (Appendix Table A12). We nonetheless check robustness here. Finally, column (3) limits the sample to one observation per student, removing duplicate entries of students who took both Principles courses or repeated a course, redefining treatment as number of times exposed to each message, and adding an additional control for taking a previous Principles course.[12] Each specification builds on the previous, that is, column (2) includes the baseline controls from column (1), and column (3) includes the baseline and Phase Two controls from columns (1)–(2).

Results from the first two columns are very similar to the main results from Table 4. In column (3), the magnitude and precision of the interaction between treatment and first generation or URM status fall. However, the pattern of point estimates remains consistent with the main results. A similar pattern repeats for first generation and URM students separately in columns (4)–(9), with the first two robustness checks similar to the main results and consistent point estimates in the third. Panel B shows similar findings for students earning B- or better. The robustness checks demonstrate consistency with the main results.[13] These results do, however, suggest that students who were treated more than once may have responded more strongly. The Phase Two emails to students who earned a B- or above may have had a similar effect to a second treatment, contributing to the stronger treatment effects for this group. It is also possible, however, that students who received two treatments because they chose to take both Principles classes had a stronger initial interest in Economics. Combined with the evidence that the treatments were most effective for students who earned a B- or higher, this possibility indicates that the positive effects of the intervention might depend on, or be enhanced by, initial interest or belief of success in majoring in Economics.[14]

To investigate mechanisms underlying treatment effects, we analyze whether the experiment changed student perceptions of Economics, using baseline and endline survey data.[15] We find evidence that the treatments shifted perceptions about the Economics major, most often and in different ways for first generation and URM students. We define an indicator variable that is equal to one if a student changed their response to a question about the "biggest appeal" of Economics to each of the following options: fun to study; leads to more future income; and leads to a fulfilling career. The first panel of Table 6 presents the results of regressing this indicator on the individual treatments or the bundled treatment indicator, along with interactions between treatments and the first generation or URM indicator. There were no effects on any of the biggest appeal outcomes for students not in the first generation or URM group. There is some evidence, significant at 10%, that students in the first generation or URM group were differentially more likely to change their answer to "future income" as the biggest appeal of Economics after receiving the treatment (Column 6), particularly the basic information and the earnings treatments (Column 5). This effect is stronger and more precise for the subsample of students who earned a B- or above. For this group, the coefficient on the treatment indicator is 0.01 and not statistically significant, but the interaction term indicates that treatment increases the probability that a first generation or URM student answered "future income" by an additional 14% points, significant at 5% (Table A7).[16]

We next define an indicator variable equal to one if a student changed their response to a question about the "biggest drawback" of Economics *away* from each possible option, including: too boring or not relevant to my life; too focused on making money; and lack of diversity among faculty and/or students. No longer giving one of these answers is an indication that the intervention may have ameliorated the given concern. Here, there were some effects for students who were not first generation or URM. All students who received a treatment were more likely to change their answer away from "too focused on money" as the biggest drawback of Economics, compared to control group students (Table 4, Column 10). The treatments had differential effects for first generation or URM students on the other two outcomes shown in the second panel of Table 6. Receiving the basic information treatment increased the probability that first generation or URM students no longer cited "boring or not relevant to my life" as the biggest drawback of Economics by 15% points, significant at 5% (Column 7). Receiving any treatment increased the probability that a first generation or URM student no longer saw "lack of diversity" as the biggest drawback to Economics by 4.3% points more than non-first generation or URM students, significant at 5% (Column 12). This interaction term is opposite in sign and more than double the main effect of first generation or URM, suggesting the treatment eliminated lack of diversity as first generation and URM students' biggest concern about Economics. Students who were induced by the treatments to change

TABLE 6 Improved Perceptions of Economics, first generation or underrepresented minorities (URM) students.

	Biggest appeal of Economics major, changed answer to:						Biggest drawback of Economics major, changed answer away from:					
	Fun to study		Rewarding career		Future income		Boring or not relevant		Too focused on money		Lack of diversity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Basic information	0.003		−0.032		−0.011		−0.020		0.023		0.001	
	(0.020)		(0.024)		(0.028)		(0.024)		(0.015)		(0.011)	
Earnings information	0.003		−0.022		0.008		0.038		0.036**		−0.004	
	(0.020)		(0.024)		(0.029)		(0.027)		(0.015)		(0.011)	
AEA video	0.001		−0.030		0.025		−0.022		0.019		0.011	
	(0.020)		(0.024)		(0.030)		(0.024)		(0.014)		(0.013)	
OSU video	−0.009		−0.019		0.029		−0.064***		0.025*		0.013	
	(0.019)		(0.025)		(0.030)		(0.022)		(0.015)		(0.013)	
Basic info*first generation or URM	0.013		0.021		0.126*		0.146**		−0.030		0.066*	
	(0.041)		(0.059)		(0.066)		(0.065)		(0.021)		(0.035)	
Earnings*first generation or URM	0.056		0.010		0.111*		0.029		0.016		0.055*	
	(0.047)		(0.059)		(0.067)		(0.061)		(0.038)		(0.030)	
AEA video*first generation or URM	0.036		0.017		0.058		0.012		−0.006		0.055	
	(0.043)		(0.059)		(0.066)		(0.050)		(0.031)		(0.034)	
OSU video*first generation or URM	0.041		−0.005		0.039		0.038		−0.002		−0.005	
	(0.043)		(0.058)		(0.063)		(0.047)		(0.031)		(0.022)	
First generation or URM	−0.039	−0.039	−0.004	−0.004	−0.095**	−0.095**	−0.050	−0.049	−0.009	−0.009	−0.021**	−0.021**
	(0.026)	(0.026)	(0.041)	(0.041)	(0.038)	(0.038)	(0.035)	(0.035)	(0.017)	(0.017)	(0.009)	(0.009)
Treatment		−0.000		−0.026		0.012		−0.016		0.026**		0.005
		(0.016)		(0.020)		(0.023)		(0.020)		(0.011)		(0.009)
Treatment*first generation or URM		0.037		0.011		0.084*		0.054		−0.006		0.043**
		(0.032)		(0.046)		(0.047)		(0.041)		(0.021)		(0.017)
N	1972	1972	1972	1972	1972	1972	1974	1974	1974	1974	1974	1974
Control mean	0.063	0.063	0.119	0.119	0.149	0.149	0.109	0.109	0.023	0.023	0.018	0.018
All interactions = 0	0.730	0.246	0.991	0.818	0.288	0.077	0.244	0.192	0.489	0.781	0.061	0.013

Note: Table reports coefficients of regressions of indicated outcome on treatment status. Outcomes are responses to endline survey questions on biggest appeal/drawback of Economics major. Sample is all study participants who completed endline survey. All regressions include strata dummies. Heteroskedasticity-robust standard errors in parentheses.

*Significant at 10%, **significant at 5%, ***significant at 1%.

their answers appear to have instead chosen one of the two remaining options for the "biggest drawback" question. Redefining the dependent variable as a switch *to* a given answer reveals that all students who received treatments were more likely to choose "too difficult" as the biggest drawback, and students in the first generation or URM group were additionally more likely to choose "other" (Table A8).

These results suggest potential mechanisms for the increase in first generation and URM students majoring in Economics. While the different treatment emails varied in their emphasis, all treatments provided information on the career paths of OSU Economics graduates. This information was in the body of each email and did not require students to click a link or watch a video. While the text that was common to all email treatments did not include specific salary information, it did highlight careers in banking, consulting, and the corporate sector, which students could assume to be high-paying. The common language also mentioned careers in public policy, law, and government, which could have

influenced students with limited information or misconceptions about the topics studied by economists and the careers available to Economics majors. If first generation or URM students enter the Principles classes with less or different information about Economics, then the treatments could have a greater impact on their perceptions. Similarly, if students have different preferences about what they value as relevant to their lives, the information in the treatments could change their perceptions by a greater magnitude or in different directions.

Table 7 presents the results of repeating this exercise including the full set of interactions with the bundled treatment indicators first generation; URM; and first generation and URM. The interaction between the treatment indicator and URM is positive and significant for changing the biggest appeal of Economics to "fun to study" and "future income," as well as no longer reporting "lack of diversity" as the biggest drawback. None of the coefficients on the interaction between treatment and first generation are significant, and the triple interaction is negative and significant for "future income".

While the treatment did shift perceptions among URM students, it did not cause a statistically significant increase in majoring in Economics for this group, as discussed above. Providing information or correcting misperceptions about the field may not be enough to have a substantial effect on improving racial diversity in Economics. In contrast, perceptions did not significantly shift among first generation students, but this group did increase its proportion of Economics majors, suggesting the emails had an effect through channels other than information. Other potential mechanisms include a reduction in feelings of exclusion stemming from lack of representation in Economics. All treatments originated from the student's instructor and took an encouraging tone. A personal invitation to major in Economics may have a stronger effect for students who had not previously seen themselves fitting in or welcomed to the discipline. It is also possible that simply increasing the salience of majoring in Economics had a stronger effect on first generation students, particularly if these students were less likely to have been exposed to Economics in the past or considered an

TABLE 7 Improved Perceptions of Economics major, full set of interactions, bundled treatment indicator.

	Biggest appeal of Economics major, changed answer to:			**Biggest drawback of Economics major, changed answer away from:**		
	Fun to study (1)	**Rewarding career (2)**	**Future income (3)**	**Boring (4)**	**Focused on money (5)**	**Lack of diversity (6)**
URM	−0.055***	−0.066	−0.186***	−0.050	0.038	−0.017
	(0.018)	(0.054)	(0.028)	(0.067)	(0.057)	(0.011)
First generation	−0.039	0.047	−0.096*	−0.069*	−0.022*	−0.024**
	(0.038)	(0.068)	(0.051)	(0.039)	(0.013)	(0.011)
URM*first generation	0.067	−0.009	0.254***	0.097	−0.042	0.022
	(0.059)	(0.104)	(0.092)	(0.095)	(0.059)	(0.015)
Treatment	−0.000	−0.026	0.012	−0.016	0.026**	0.005
	(0.016)	(0.020)	(0.023)	(0.020)	(0.011)	(0.009)
Treatment*URM	0.076**	0.060	0.172***	0.096	−0.054	0.076**
	(0.035)	(0.063)	(0.049)	(0.076)	(0.060)	(0.030)
Treatment*first generation	0.019	−0.038	0.085	0.061	0.007	0.017
	(0.045)	(0.076)	(0.065)	(0.052)	(0.024)	(0.019)
Treatment*URM*first generation	−0.081	0.030	−0.235**	−0.182	0.059	−0.067
	(0.078)	(0.121)	(0.118)	(0.113)	(0.069)	(0.042)
N	1972	1972	1972	1974	1974	1974
Control mean	0.063	0.119	0.149	0.109	0.023	0.018
All treatment interactions = 0	0.187	0.647	0.00480	0.388	0.775	0.0678

Note: Table reports coefficients of regressions of indicated outcome on treatment status. Outcomes are responses to endline survey questions on biggest appeal/drawback of Economics major. Sample is all study participants who completed endline survey. All regressions include strata dummies. Heteroskedasticity-robust standard errors in parentheses.

*Significant at 10%, **significant at 5%, ***significant at 1%.

Economics major before. These channels suggest the possibility that targeted outreach alone may nudge some underrepresented students, but that understanding the diverse reasons for lack of representation among different groups is critical to increasing representation from all underrepresented groups.

4.4 | Policy simulation

Our main results in Table 4 demonstrate a positive effect of informational nudges on majoring in Economics among first generation students. Suppose Oregon State University adopted this intervention as Economics Department policy. How would the policy change the prevalence of first generation students among Economics majors?

Table 8 presents results from this counterfactual exercise. The "control" scenario presents the status quo, by extrapolating the control group proportion majoring in Economics within each student group (columns 2 and 5) to the entire study population. In this scenario for the full sample, 4 first generation/URM students and 47 non-first generation/URM students would be Economics majors, for a first generation/URM proportion of 0.08 (column 7). The "treatment" scenario adjusts the proportions according to the group-specific point estimates of the treatment effect (Table 3, column 6). In this scenario, the implied first generation proportion more than doubles to 0.22.

Panel B of Table 7 repeats the exercise for the subsample of students earning a B- or better. The increase in the first generation proportion under the treatment scenario is now even more dramatic, given the greater response to treatment among better-performing first generation students (Table 3, column 8). The first generation proportion rises from 0.11 to 0.25, an increase of 127% over the control scenario.

A potential objection to this counterfactual exercise is that the absolute numbers of students are relatively small. Admittedly, the small base of first generation students majoring in Economics render the proportional changes particularly dramatic. Yet the numbers of affected students increase, with similar results, when including URM students in the policy simulation (Table A11). Moreover, the exercise is based on relatively precise point estimates—particularly for first generation students—generated from an experiment involving more than 2200 students at a large public university. Additionally, this exercise suffers from the well-known limitations of policy simulations in partial equilibrium. We also do not account for further changes to the demographic mix of Economics students which might occur between the Principles courses and graduation, particularly in the absence of other efforts to retain underrepresented students. Our results nevertheless suggest that a simple informational nudge can increase socioeconomic diversity in the Economics major.

5 | CONCLUSION

Our simple intervention increased Economics majors among first generation students. The contrast between this result and our findings for URM students, as well as findings from the literature on women in Economics, highlights the

TABLE 8 Economics majors, counterfactual exercises.

	Not first generation			First generation			Projected first generation proportion
Scenario	Base population (1)	Major proportion (2)	Major projected (3)	Base population (4)	Major proportion (5)	Major projected (6)	(7)
Panel A: All students							
Control	2011	0.023	47	227	0.017	4	0.08
Treatment	2011	0.029	59	227	0.075	17	0.22
Panel B: B- or better							
Control	922	0.035	32	81	0.053	4	0.11
Treatment	922	0.052	48	81	0.196	16	0.25

Note: Table shows projected proportions and numbers of Economics majors under scenarios listed in first column. "Control" scenario based on proportions majoring in Economics among control group. "Treatment" scenario based on change in proportion majoring in Economics in response to treatment. Base population refers to sample size within the study population. Column (7) shows projected first generation student proportion among Economics majors, that is, column (6)/(column [6] + column [3]).

importance of understanding the experiences of different underrepresented groups and the factors that may limit interest in Economics. For example, women have earned the majority of bachelor's degrees in the US for the past 40 years. First generation college students, on the other hand, enter college with less exposure to higher education than their peers. A short, informational message encouraging a student to major in Economics would be expected to have the strongest impact where gaps in knowledge about or salience of Economics are largest. After the gains from an initial amount of information or encouragement are achieved, more intensive work may be required to further increase participation in Economics among underrepresented students.

In this study and Bayer, Bhanot, and Lozano (2019), a one-time message was sufficient to change behavior among first generation students. By contrast, successful approaches to increase female interest in Economics (Gentry et al., 2023; Li, 2018; Porter & Serra, 2019) included personal engagement with students, whereas less successful approaches used only light-touch interventions (Antman et al., 2020; Bayer, Bhanot, & Lozano, 2019; Pugatch & Schroeder, 2021). Together, these results suggest the promise and limitations of nudges to increase diversity in Economics. The approaches more likely to succeed address the distinct barriers faced by different groups.

Given the bias and hostile environment faced by URM students in Economics (Bayer, Hoover, & Washington, 2020), substantially increasing majors among this group is likely to require more than light-touch interventions. Within our sample, underrepresented minorities cite lack of diversity as the biggest drawback of Economics at more than twice the rate of non-URM students. These findings echo the exclusion felt by underrepresented students in Economics documented elsewhere (Bayer, Bhanot, et al., 2020; Bayer, Hoover, & Washington, 2020). Support programs targeted to students underrepresented in the discipline offer promise but remain relatively rare, with the most effective program elements still unknown. Shifting the content of Principles courses (Bayer, Bruich, et al., 2020; Benjamin et al., 2020; Bowles & Carlin, 2020; Owen & Hagstrom, 2021) may also complement targeted messaging and engagement to increase diversity in Economics. Future work may determine whether these changes complement or substitute for marketing efforts to diversify the student population. Pursuing these questions will help to better understand how to promote diversity in Economics and other disciplines.

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CONFLICT OF INTEREST STATEMENT

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DATA AVAILABILITY STATEMENT

Computer code and other replication materials for this paper are available at Pugatch and Schroeder (2023). The data that support the findings of this study are available from Oregon State University. Restrictions apply to the availability of these data, which were used under license for this study. Data are available with the permission of the Oregon State University Office of the Registrar at https://registrar.oregonstate.edu/data-requests.

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ENDNOTES

[1] Following standard definitions, we use the term URM to refer those who identify as American Indian/Alaska Native, Black, Hispanic, and Native Hawaiian/Pacific Islander, and first generation if neither parent has a bachelor's degree.

[2] These patterns extend beyond Economics. URM and first generation students account for 13% and 38% of graduates in STEM (Science, Technology, Engineering, and Math) fields, respectively, compared to 19% and 45% in non-STEM fields. Median mid-career earnings of STEM graduates are $90,000, compared to $60,320 among non-STEM graduates (authors' calculations using data from U.S. Department of Education, National Center for Education Statistics, Baccalaureate and Beyond: 2008/2018 [B&B]).

[3] We (the researchers) sent the messages from instructor accounts. Instructors and the Economics Academic Advisor were blinded to the treatment status of individual students.

[4] The experiment also included a second phase, which tested a "resilience" message among a subset of better-performing students after the course ended. This paper focuses on Phase One, both for brevity and because we failed to find statistically significant effects of the Phase Two intervention. For Phase Two description and results, see the appendix and working paper version (Pugatch & Schroeder, 2020).

[5] The data were recorded in January 2020, before COVID-19 cases were widespread in the U.S. We did not observe an administrative major in Winter 2020 for 48 students. For these students, the outcome is an indicator for being an Economics major in the last term observed, provided this was at least one term later than when the student was in the experiment.

[6] Our companion paper followed an analysis plan focused on gender differences in the response to treatment. We build on that analysis plan in this paper, but our focus on different demographic groups and differences in specification make the analysis exploratory.

[7] To participate, students had to be at least 18 years old, complete the baseline survey, and consent.

[8] The administrative data fails to report post-study major for 39 students, however, because the term in which they took Principles is the last term we observe them enrolled at the university.

[9] The most popular fields from which students switched into Economics were Business (11 of 33 students) and undecided (10 students). Of the six students who switched out of Economics, two each chose Political Science, Public Policy, and Psychology.

[10] We also characterize compliers using baseline data, using a method based on Kowalski (2016). We define compliers as students assigned to treatment who opened the email. We compare them to never takers, who we define as students assigned to treatment who do not open the email. Table A4 presents results, separately for first generation/URM students and those in neither category. Compared to never takers, compliers with opening the email are more likely to be female, have higher GPA, are more likely to expect an A in the class, less likely to be freshmen or sophomores, and slightly more interested in majoring in Economics. The direction and magnitudes of these differences are similar for first generation/URM students as others, though less precise due to smaller samples. These characteristics are consistent with the stronger response to treatment among better-performing students.

[11] Our results mirror Bayer, Bhanot, and Lozano (2019), whose online appendix also reports significant treatment effects for first generation students and positive but noisy treatment effects for URM students.

[12] Removing duplicates drops 332 instances of a student appearing a second time; 22 instances of a student appearing a third time; and one instance of a student appearing a fourth time. Together, these dropped observations represent 16% of the original sample size of 2238. Of the 332 students who appear more than once, 236 took both macro and micro without repeating either; 78 took one course and repeated it one or more times; and 18 took both courses and repeated one. For students who participated in a pilot version of this study in Spring 2018, the number of times they received a treatment includes the pilot emails.

[13] We also analyze minoring in Economics as an outcome, using self-reported data from the endline survey, but fail to find significant treatment effects (Appendix Table A6).

[14] To explore whether composition of the comparison group affects results, we repeat the main regressions, interacting the treatment indicators with both the URM and the first generation indicators. Estimates are similar to the main results in Table 3, but less precise.

[15] We find no evidence that treatment affected students' grades in the Principles courses (Appendix Table A10), suggesting that an increase in effort was not a relevant mechanism.

[16] Using each response at endline as a dependent variable and controlling for its baseline value produces results that are consistent with Table 6 where coefficients are significant, but overall gives a less clear picture of the mechanisms underlying our estimated treatment effects. Results appear in Table A9.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

Intervention messages

ECON 201: Consider majoring in Economics!

Jon Chesbro <jon.chesbro@oregonstate.edu>
Mon 5/20/2019 12:00 PM
To: Schroeder, Elizabeth <Liz.Schroeder@oregonstate.edu>

Having trouble reading this? To view this email as a web page, click here.

Hi Liz,

I hope you have enjoyed learning about Economics this term. As you plan your future studies, **I encourage you to consider majoring or minoring in Economics.** In addition to a traditional Economics degree, Oregon State University's Economics Program offers options in Managerial Economics; Law, Economics and Policy; and Mathematical Economics. Economics training provides excellent preparation for graduate work in Economics, Public Policy, Law, and Business. OSU Economics graduates also use their degrees to work professionally in the public (federal, state and local government) and private (banking, consulting, retail, and corporate) sectors.

If you are interested in majoring or minoring in Economics or would like to learn more, please make an **appointment** with Laura Relyea, the Economics Academic Advisor.

Sincerely,
Jon Chesbro
Instructor, Economics

You may update your profile here.
This email was sent by: Oregon State University, Printing & Mailing Services,4700 SW Research Way, Corvallis, OR 97333

FIGURE A1 Phase one: Basic information.

ECON 201: Consider majoring in Economics!

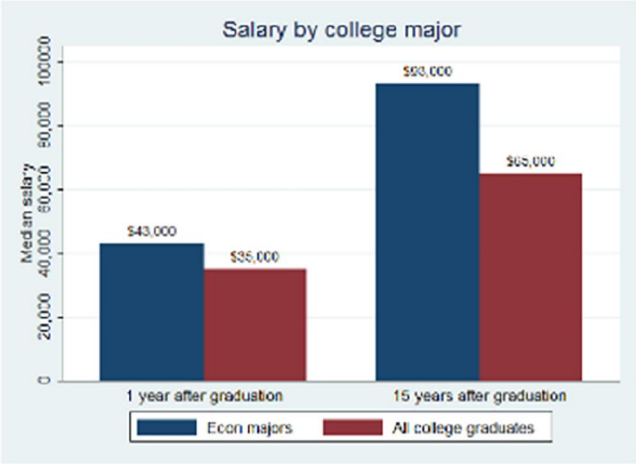
Camille Nelson <camille.nelson@oregonstate.edu>
Mon 5/20/2019 12:00 PM
To: Schroeder, Elizabeth <Liz.Schroeder@oregonstate.edu>

Having trouble reading this? To view this email as a web page, click here.

Hi Liz,

I hope you have enjoyed learning about Economics this term. As you plan your future studies, **I encourage you to consider majoring or minoring in Economics.** In addition to a traditional Economics degree, Oregon State University's Economics Program offers options in Managerial Economics; Law, Economics and Policy; and Mathematical Economics. Economics training provides excellent preparation for graduate work in Economics, Public Policy, Law, and Business. OSU Economics graduates also use their degrees to work professionally in the public (federal, state and local government) and private (banking, consulting, retail, and corporate) sectors.

Majoring in Economics can be a smart career decision. Average earnings for economics majors are higher than the overall average for college graduates, both at the start of their careers and throughout their lives.



Source: hamiltonproject.org/charts/career_earnings_by_college_major/

If you are interested in majoring or minoring in Economics or would like to learn more, please **make an appointment with Laura Relyea, the Economics Academic Advisor.**

Sincerely,
Camille Nelson
Senior Instructor, Economics

You may update your profile here.
This email was sent by: Oregon State University, Printing & Mailing Services,4700 SW Research Way, Corvallis, OR 97333

FIGURE A2 Phase one: Earnings information.

ECON 202: Consider majoring in Economics!

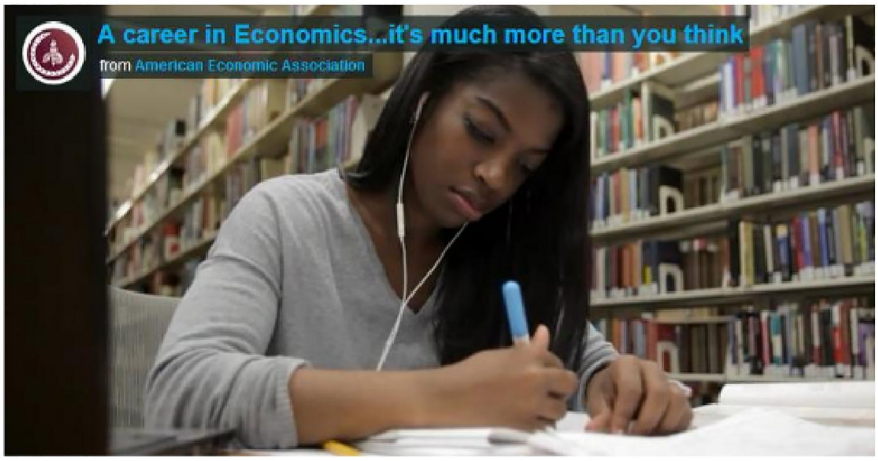
Mike Nelson <mike.nelson@oregonstate.edu>
Mon 5/20/2019 12:00 PM
To: Schroeder, Elizabeth <Liz.Schroeder@oregonstate.edu>

Having trouble reading this? To view this email as a web page, click here.

Hi Liz,

I hope you have enjoyed learning about Economics this term. As you plan your future studies, **I encourage you to consider majoring or minoring in Economics**. In addition to a traditional Economics degree, Oregon State University's Economics Program offers options in Managerial Economics; Law, Economics and Policy; and Mathematical Economics. Economics training provides excellent preparation for graduate work in Economics, Public Policy, Law, and Business. OSU Economics graduates also use their degrees to work professionally in the public (federal, state and local government) and private (banking, consulting, retail, and corporate) sectors.

Learn more in this video about careers in Economics...it's much more than you think!



If you are interested in majoring or minoring in Economics or would like to learn more, **please make an appointment with Laura Relyea, the Economics Academic Advisor.**

Sincerely,
Mike Nelson
Senior Instructor, Economics

You may update your profile here.
This email was sent by: Oregon State University, Printing & Mailing Services,4700 SW Research Way, Corvallis, OR 97333

FIGURE A3 Phase one: American Economic Association (AEA) video.

ECON 201: Consider majoring in Economics!

Camille Nelson <camille.nelson@oregonstate.edu>
Mon 5/20/2019 12:00 PM
To: Schroeder, Elizabeth <Liz.Schroeder@oregonstate.edu>

Having trouble reading this? To view this email as a web page, click here.

Hi Liz,

I hope you have enjoyed learning about Economics this term. As you plan your future studies, **I encourage you to consider majoring or minoring in Economics**. In addition to a traditional Economics degree, Oregon State University's Economics Program offers options in Managerial Economics; Law, Economics and Policy; and Mathematical Economics. Economics training provides excellent preparation for graduate work in Economics, Public Policy, Law, and Business. OSU Economics graduates also use their degrees to work professionally in the public (federal, state and local government) and private (banking, consulting, retail, and corporate) sectors.

Learn more in this video about what it's like to major in Economics at Oregon State!

If you are interested in majoring or minoring in Economics or would like to learn more, **please make an appointment with Laura Relyea, the Economics Academic Advisor.**

Sincerely,
Camille Nelson
Senior Instructor, Economics

You may update your profile here.
This email was sent by: Oregon State University, Printing & Mailing Services,4700 SW Research Way, Corvallis, OR 97333

FIGURE A4 Phase one: Oregon State University (OSU) video.