Can Better Information Reduce College Gender Gaps? The Impact of Relative Grade Signals on Academic Outcomes for Students in Introductory Economics

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Abstract

This paper considers the impacts of grades and information on gender gaps in college major and college dropout rates at a large public flagship university. Observational and experimental results suggest women are more responsive to introductory economics grades when deciding whether to major in economics while men are more responsive to introductory economics grades when deciding whether to drop out of college. Providing better information about grade distributions appears to only somewhat mitigate these impacts. These results suggest better information may blunt the impact of relative grade sensitivities on college gender gaps but may not fully outweigh the saliency of grades. Finally, we consider the extent to which aligning economics grading standards with those of competing disciplines would reduce the gender gap in economics graduates but find relatively limited impacts.

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I. INTRODUCTION

Despite the fact that women constitute a majority of college students across the United States, they remain significantly underrepresented in several fields, such as economics, which plays a critical role in informing public policy and shares similarities with STEM fields.[1] Aside from the losses to society due to women's underrepresentation in economics, these facts also suggest important losses for women themselves, since college major has been tied to long-term job security and income over the life-cycle (Allgood, et al. 2011; Webber 2014). While all of the underlying reasons for the gender disparity in economics are not well-understood, one strand of research identifies the importance of information signals, such as those conveyed by grades which may provide information about a student's likelihood of success in a given academic major and ultimately, career (Zafar 2013). However, as we explore here, gender disparities among college graduates could be the result of both college major choice and college dropout decisions, and both may be impacted by relative grade signals, with responsiveness varying across gender. This raises the possibility that changes in grading policies aimed at alleviating gender disparities may have unintended consequences if, for instance, men are less likely to drop out as grades rise, just as women may be more likely to major in a given discipline. Astorne-Figari and Speer 2018) find evidence for these cross-gender differences and show that there is no gender gap in persistence in STEM majors after accounting for these offsetting tendencies. Nevertheless, the existing literature on gender and college major choice in economics has much more limited explorations into the links between gender, grades, and dropout decisions, perhaps due to the fact that studies have largely originated from elite institutions, where dropping out of college is rare (Zafar 2011)[2] In contrast, this study uses both observational and experimental approaches at a large public institution to explore the impacts of relative

[1] Although women represent about 35% of all economics majors nationwide (Chevalier 2019), after scaling by the relative numbers of male and female college graduates, there are roughly 2.9 male economics majors for every female economics major (Avilova and Goldin 2018, Goldin 2013).

[2] While Stinebrickner and Stinebrickner (2012; 2014) make valuable contributions to the literature on academic preparation, learning in introductory coursework, and the college dropout decision, these studies take place in a very unique setting - a small liberal arts college where all students receive a full tuition subsidy (Stinebrickner and Stinebrickner 2012).

grades on both college major and college dropout decisions that can result in gender disparities in fields such as economics.[3]

We consider the impacts of introductory course grades, as the costs of switching major and college persistence increase into later periods, thus justifying the focus on introductory courses in early college years across the majority of the literature connecting academic performance with college major choice and dropout decisions.[4] Moreover, college dropout is most commonly observed within the first academic year (Hanson 2024), and is closely related with academic performance (Stinebrickner 2012), thus it is natural to investigate the impact of grades in introductory courses which are taken early in college on college dropout decisions. Using institutional records on students who took introductory economics courses, we begin by establishing that women are less likely to major in economics compared with men and also less likely to drop out, and show that students in our sample receive lower grades in introductory economics courses compared with courses in other departments taken contemporaneously. In this context, we conduct an observational study of the relationship between grades within and outside of economics on college major and dropout outcomes and how these impacts vary for men and women. The rich information provided by our institutional records allows us to control for a broad and detailed set of background characteristics, and hold constant characteristics of the class environment to isolate the relationship between individual grades within and outside of introductory economics. We find that women are more responsive to grades in introductory economics, controlling for grades in other courses, when deciding whether to major in economics. While some studies have found women to be more responsive to grades in selecting college major (Owen 2010), others have not (Main and Ost 2014; Astorne-Figari and Speer 2018). Our contribution in this area is to show that this result persists after holding class attributes fixed and conditional on student performance in courses outside of

[3] The 6-year graduation rate at the institution in this study was 69% for freshmen entering in 2013. This is slightly higher than the overall average 6-year graduation rate for all freshmen entering a 4-year institution in 2012 (62%), but well below the average for the most selective institutions (90%) (NCES 2020).

[4] Using longitudinal data on learning and beliefs, Stinebrickner and Stinebrickner (2014) show that learning about academic ability can explain a substantial component of the dropout decision in the early years of college, when dropping out is most likely to occur. Moreover, experimental papers aimed at addressing the gender gap in economics primarily focus on students in the introductory courses (see for example Owen 2023, Porter and Serra 2020, Li 2018, Pugatch and Schroeder 2020; Bedard, Dodd, and Lundberg 2021).

introductory economics. We also contribute by showing that these results are robust to considering a comparable set of students who are choosing between closely connected majors, and thus taking a similar set of courses which all require introductory economics. Moreover, we add to this literature by showing that the opposite result holds for the college dropout decision, where it is men who are more responsive to introductory economics grades, controlling for grades in other courses. While the much more limited research on the relationship between college dropout decisions and grades has shown that men are more likely to drop out than women (Astorne-Figari and Speer 2018) and links dropout behavior with academic performance and beliefs for both men and women (Stinebrickner and Stinebrickner 2012), to our knowledge, ours is the first paper to find that men are more responsive to introductory course grades in the decision to drop out of college.

To further explore gender differences in beliefs about the information conveyed by grades and test whether those beliefs can be altered, we conducted a randomized experimental intervention in which we asked a group of students for their grades and elicited students' beliefs about their relative performance in introductory economics courses. For a subset of that group, we also provided students with individualized information about their relative performance in introductory economics compared with past economics graduates, our benchmark for a successful outcome. The main results indicate that women asked to provide information about their relative performance in introductory economics are less likely to major in economics compared with the control group, whereas men in the same treatment group are more likely to drop out of college. Thus, our experimental study finds gendered patterns consistent with those from our observational study. Furthermore, it addresses whether providing better information on how to interpret grades can blunt the impacts of relative grade sensitivities on college gender gaps. Our experimental design is most closely related to Owen's (2023) study which also solicited and provided information about relative performance, but did not see a significant impact on majoring in STEM over five semesters following the experiment. In contrast, we observe students five years after the completion of our experiment and are thus able to observe whether students graduate or drop out – a decision which we consider in the context of college major choice and introductory grade signals.

In our experimental study, providing better information about the link between grades and the likelihood of success in the major appears to somewhat mitigate the adverse impacts of asking students about their grades and perceived performance but is not sufficient to overcome the latter. While this suggests the possibility that improving informational content of grades may help shrink college gender gaps, our inability to fully offset the effects of asking about relative performance may also point to a larger difficulty in overcoming the heightened impact of the grade signal with a neutral informational intervention, in contrast to other interventions which explicitly encourage students (e.g., Bedard et al. 2020; Li 2018; Porter and Serra 2020). Another possibility is that providing better information on how to interpret grades may not be as successful at addressing college gender gaps compared with policy changes that harmonize grading standards across departments (e.g., Butcher et al. 2014; Ahn et al. 2024) or which reduce the saliency of letter grades more generally.

In light of these results, we conduct a back-of-the-envelope style exercise to explore whether altering grading standards would be an effective strategy to close the gender gap in economics. More specifically, we examine the extent to which aligning grading standards in introductory economics more closely with competing disciplines, the equivalent of raising introductory economics grades by .3 points, all else equal, would affect the share of women graduating with an economics degree. Using a sample from our observational study, we find that altering the grade distribution in such a way would result in a slightly higher share of women graduating with an economics degree, despite the relatively lower dropout rates among men, and thus, an increased number of male economics degree holders. However, our estimates suggest that the total impacts of altering grading standards themselves are modest and would only increase the share of female economics graduates by about 2.5%, suggesting that changing grade distributions is no panacea in terms of reducing the gender gap in economics.[5]

[5] Similarly, Owen (2021) finds that raising the average grade in introductory economics courses would not close the gender gap in economics since more men would major in economics as well. In contrast, Ahn et al. (2024) estimate a structural model and find that equalizing grades across majors would substantially increase women's enrollment in STEM courses (including economics) and reduce the gender gap in STEM majors because STEM classes have lower grading practices and women value grades more than men.

The remainder of the paper proceeds as follows. Section II discusses the background of this study, including literature on the determinants of college major choice, the role of academic performance as an information signal, and related gender disparities, as well as the context in which the experimental study was initiated. Section III discusses the empirical strategy for both the observational study and the experiment. Section IV reviews the data and summary statistics. Section V presents results and robustness checks for both studies. Section VI considers the hypothetical impacts of changing the grading distribution in introductory economics to be in closer alignment with other disciplines. Section VII concludes.

II. BACKGROUND

A. Determinants of Gender Gaps in College Major and College Dropout

A long literature examines the determinants of college major choice, and how they differ by gender.[6] In a model where students maximize their utility by weighing the expected returns of graduating with a particular major against the costs of degree completion (Arcidiacono, et al. 2012; Arcidiacono, et al. 2016), gender gaps may result from demographic differences in preferences (Wiswall and Zafar 2015; Zafar 2011)[7], or differences in unobserved culture of the major, which may explain why college major switchers are more likely to switch to demographically similar majors (Astorne-Figari and Speer 2019). While inherent ability and prior preparation could affect both the major-specific costs and returns to college, studies have found that measures of aptitude cannot fully explain existing gender gaps (Zafar 2013; Dynan and Rouse 1997, Emerson, et al. 2010), and limited evidence for the role of quantitative requirements or the share of female faculty members (Emerson, et al. 2018).

[6] Many studies in this literature relate to the link between academic performance and selection of a college major more broadly (e.g., Stinebrickner and Stinebrickner 2012, Zafar 2011), some study STEM disciplines specifically (e.g., Speer 2019), which sometimes includes economics (e.g., Owen 2023), and others relate only to economics (e.g., Owen 2010; Main and Ost 2014), including UWE interventions specifically (e.g., Li 2018; Porter and Serra 2020).

[7] Speer (2019) finds a large gender gap in initial STEM major for the most STEM-ready students, suggesting large differences between men and women at the outset of college in interest in STEM majors.

One strand of research identifies the importance of grades and relative sensitivity to grades across genders as an important factor contributing to this phenomenon. To the extent that grades convey information about student abilities, it stands to reason that grades in introductory courses would be a factor determining college major choice. This may be because grades signal the level of effort required to complete a degree in a given field and also because they may signal an individual's comparative advantage in the job market and beyond (Allgood, et al. 2015). While some studies have found women to be more responsive to letter grades as a form of encouragement to major in economics (Owen 2010), others have not (Main and Ost 2014; Astorne-Figari and Speer 2018).[8]

In a model of learning how well-matched students are to college major during the first years of college coursework, survey evidence suggests students update their beliefs in response to academic performance at elite private universities (Zafar 2011) and small liberal arts colleges (Stinebrickner and Stinebrickner 2012, 2014).[9] While dropout rates are too small for analysis in the institutional context of Zafar (2011), Stinebrickner and Stinebrickner (2012) suggest that men's higher dropout rates relative to women are linked with men's lower effort levels and lower academic performance, as well as their relatively overoptimistic views of their abilities at college entrance compared with women.[10] Given the importance of contextual differences across college environments, however, it is important to question whether these results would generalize to large public universities such as in the current study, where dropout rates are significantly higher than at liberal arts colleges and elite private universities. Experimental interventions in this area also suggest that college major choice may respond to informational interventions, though the focus has been on providing salary-related information (Wiswall and Zafar 2015; Conlon 2021), as opposed to altering the informational content of grades which we attempt to do here.[11] Owen's (2023)

[8] McEwan et al. (2021) find that women just above letter-grade cutoffs are much more likely to major in economics compared with women just below, however, the setting is an all-women's college, so they cannot be compared with similar men.
[9] Test scores may also provide information signals in preparation for major-specific coursework (Avery 2018).
[10] Disparities in dropout rates across demographic groups may also be tied to strategic course-taking behavior in response to academic probation policies, though Casey et al. (2018) find little evidence for heterogeneity across genders.
[11] The broader education literature suggests the target of the information (e.g. student or guardian) may be another important factor in the intervention (Ajayi et al. 2017), but, as with most studies on college-age individuals, we do not pursue variation in the target of the treatment here.

study is most closely related to ours in that it solicited and provided information about relative performance in introductory STEM courses (including economics), but importantly, the informational component was framed as a form of encouragement, as opposed to the neutral informational intervention we propose here. Moreover, the follow-up period in Owen (2023) was relatively short compared with the long-term study we conduct here, where we observe students four years after the completion of our experiment and are thus able to observe whether students graduate or drop out.

B. Relative Sensitivities in Response to Grade Information Across Genders

Within the literature on the link between grades and college major choice, an important strand identifies the role of relative grades within the major to those outside of it. If certain groups are more sensitive to grades, these comparisons will lead to under-representation of these groups in disciplines with higher grading standards and lower GPAs overall (Butcher et al. 2014). The fact that women tend to receive higher grades than men overall, particularly in most subjects outside of economics (Walstad and Boshardt 2019), suggests that relative sensitivities to grades, and the signal they provide, may be an important contributor to the gender gap in economics. However, the evidence is mixed on whether women are more responsive to relative grades within versus outside of economics in determining college major choice, with some studies supporting this conclusion (Rask and Tiefenthaler 2008), others finding mixed evidence (Ahlstrom and Asarta 2019), and still others finding that men are more responsive to grades (Rask 2010). Our observational study contributes to this literature by evaluating the influence of relative grades after holding all other class characteristics and a host of individual characteristics fixed, as well as considering relative impacts in the setting of a public flagship university. As robustness, we include specifications similar to ones adopted in prior studies, to ensure that our results are not driven by assumptions about functional form.

Moreover, if the sorting process within which individuals match to college majors relies heavily on the extent to which grades are good indicators of relative performance and ultimate success in college and beyond, the fact that grading standards are not uniform across fields is an important consideration. For instance, a lower grade in economics may be

compared with a higher grade in a different department, despite the fact that the student's performance in each class was similar relative to her peers.[12] Thus, improving the informational content of grades, as a measure of relative success in the major and beyond, as we attempt to do here, could improve academic and career outcomes and, if women are more responsive to relative grades, reduce gender gaps in college major and beyond.

C. Interventions Aimed at Addressing the Gender Gap in Economics

Research on the determinants of college major choice have intersected with work on gender disparities in field of study to suggest a number of factors that could reduce the gender gap in economics.[13] These include improving informational awareness about research topics in economics and the professional outcomes of economists (Bayer, Bhanot, and Lozano 2019),[14] leveraging mentoring relationships and associated role model effects (Porter and Serra 2020), and altering course content in introductory courses to be more representative of the economics discipline and of broader interest to undergraduates (Bayer et al. 2020; Bansak and Starr 2010).

The experimental study in this paper was inspired and supported by the 2015 Undergraduate Women in Economics (UWE) Challenge which randomized colleges and universities at the national level into treatment and control schools and awarded treatment schools a small financial incentive to conduct some treatment to increase the proportion of women in the undergraduate major (Avilova and Goldin 2018). While no specific treatment was assigned by the UWE organizers, schools were encouraged to adopt an intervention in one or more of the following areas thought to be successful at increasing women's participation in economics: (1) better information, (2) mentoring and role models, and (3) instructional content. Although randomization within the institution was not required, some treatment schools did conduct randomized controlled trials including Porter and Serra

[12] This would be consistent with the mechanism in Butcher et al. (2014), which finds that an anti-grade inflation policy that effectively lowered grades in disciplines with relatively lenient grading standards worked to increase majors in economics. Since the setting was an all-women's college, however, it is not possible to compare gendered responses to the policy.

[13] See Bayer and Rouse (2017) for a review of factors affecting diversity in economics more broadly.

[14] This research connects with broader experimental studies which find that providing salary information by major to college students has a significant impact on college major choice (Wiswall and Zafar 2013; Conlon 2021).

(2020) which targeted area (2) and Li (2018) which targeted all three areas collectively. While the goal of the national UWE initiative was aimed at increasing the representation of women in economics, the experiment evaluated in this paper was explicitly designed as a neutral informational intervention, as opposed to one that overtly encouraged students to major in economics (Pugatch and Schroeder 2020; Bedard et al. 2021; Owen 2023). Ideally, this will enable us to learn more broadly about gender differences in the response to information signals associated with grades and contribute to the literature on college major choice more broadly.

III. DATA

A. Observational Study

As we are focused on the role that the informational content of grades plays in academic outcomes, our observational study sample is comprised of all students who took a first course in economics between summer 2000 and spring 2015 at a large public flagship university.[15] We observe students through Spring 2020, thus allowing the final cohort in the sample to be observed five years following their first introductory economics course.[16] While students may in principle change majors at any time, they are encouraged to do so as early as possible and are very unlikely to switch majors later in their academic careers. Thus, we follow the practice of limiting attention to students who took introductory economics in their first two years of college. For purposes of constructing our economics major outcome,

[15] Overall undergraduate enrollment at the institution in 2015 was approximately 25,000 full-time students and about 2,000 part-time students. The only type of undergraduate economics degree offered is a Bachelor of Arts in Economics (offered in the College of Arts and Sciences), however, students can earn an economics minor as well. Economics is required for the economics major and minor, international affairs major, environmental studies major, political science major, and business major (B.S. in Business Administration offered in the School of Business). The minimum passing grade in the introductory economics course (Principles of Microeconomics) is C-.

[16] From 2000-2011, the first introductory course in economics could have been either Principles of Microeconomics or Introduction to Economics, a one-semester course covering both introductory micro and macro topics. The latter course was discontinued after 2011, however, our use of class fixed effects in the preferred specification should net out any differences across these two courses. Our main results are robust to including only students in Principles of Microeconomics. Throughout, we use the terms principles of micro and introductory economics interchangeably to refer to the first course in the economics sequence.

students may have declared economics as their major at any point in time, so long as their final major was economics.[17]

Table 1 presents summary statistics of the observational study sample of 34,513 students.[18] Differences between men and women are also reported, and we note that, with the exception of introductory economics grade and proportion black, all differences between men and women are statistically significant at the 1% level.[19] Relative sample sizes already suggest men will be more likely to major in economics, as they constitute approximately 60% of the sample. This gender gap is even more pronounced when we look at college major: the fraction of men in the sample who ultimately major in economics is more than twice that of women (9.6% versus 4.4%). There is also a substantial gender gap in college dropout rates, with men being much more likely to drop out than women (24.1% versus 17.8%). Men are also more likely to have entered college having declared economics as a major (3.5% versus 1.1%), somewhat more likely to have entered college as undecided majors (35.4% versus 32.6%), and less likely to be in the College of Arts & Science at entry where economics is housed (58.6% versus 66.0%).

On average, men and women take introductory economics in the second term, with men taking it slightly earlier than women (2.08 versus 2.35). Men also have slightly higher ACT Math scores (26.24 versus 24.91) but lower ACT English/Reading scores (49.82 versus 50.68) and lower high school GPAs (3.44 versus 3.61). Importantly, men and women also have very similar grades in the introductory economics course (2.620 for men versus 2.625 for women), just below a B- on average.[20] These patterns are similar when conditioning on graduation, however, the average grades and test scores are all somewhat higher for college graduates, as expected (Appendix Table A1). The one notable exception is that men earn slightly higher grades in introductory economics courses that are statistically significant when we condition on graduating (2.795 for men versus 2.748 for women). These statistics

[17] This includes students with multiple majors so long as economics was one of the majors.
[18] For students who retake introductory economics, we use only their first attempt.
[19] P-values for the differences are provided in tables throughout the main results. P-values for appendix tables are available upon request.
[20] Any non-standard grades (e.g. Withdrawn, Incomplete, etc.) are treated as missing values.

mirror broader patterns found in the literature suggesting women generally earn higher grades on average, but not in economics (Walstad and Boshardt 2019).[21]

Figure 1 shows the distribution of introductory economics grades for men and women (Panel A) as well as the introductory economics grades conditional on majoring in economics for the students in the observational study (Panel B). Consistent with the patterns observed in Table 1, men and women who take introductory economics have very similar grades (Panel A), but after conditioning on majoring in economics, it appears that women are more likely to earn grades at the very top of the distribution, while men are more likely be represented in the middle range (Panel B). This is consistent with women taking a worse informational signal from their grades in introductory economics and thus choosing not to major in it, despite earning similar grades to men.

Figure 2 examines the term-level GPA of students in the observational study, excluding the introductory economics course. Panel A shows that GPAs for all women in the sample are higher outside of economics relative to men in the sample. If anything, this pattern is even more dramatic when we condition on students majoring in economics (Panel B), suggesting that women who major in economics would likely dominate the upper tails of other fields as well.[22] These patterns are consistent with strong grade signals for women outside of economics relative to within the introductory economics course. However, this does not control for the fact that men and women may take different courses outside of economics. We will address that issue in the robustness section where we look at men and women taking similar courses in related fields. Nevertheless, the stylized facts summarized here motivate our investigation of the possibility that relative grade sensitivities across genders may play a role in the gender gap in undergraduate economics majors.

[21] As we will be evaluating the impacts on college dropout as well as on college major choice, in general, we do not condition the sample on graduating, however, analogous results tables in Appendix Tables A2-A5 and Figures B1-B2, suggest that results on relative grade impacts for the college major choice outcome are qualitatively similar if we restrict attention to the sample of graduates.

[22] These distributional graphs are qualitatively similar if we limit the sample to graduates (Appendix Figure B1 and B2), though men who graduate are slightly overrepresented at the very top of the distribution of introductory economics grades relative to graduate women.

B. Experimental Study

The experimental study sampling frame was made up of all students who took principles of microeconomics at a large public flagship university in Fall 2015. This was the first course in the economics sequence at the time and was offered every term by numerous instructors simultaneously. Students may have taken it as a required course for economics or other majors (e.g., business, environmental studies, political science, international affairs), or as a distributional requirement to satisfy the core curriculum. Thus, a large number of students were enrolled in the course in Fall 2015 (1880 students). Students were invited to participate in the study via email and 245 students gave informed consent to participate.[23] Study participants were randomized into three groups, stratified on gender.

The control group (57 students) received no further contact but agreed to have their institutional records examined as part of the study. In the spring semester following the term in which study participants took the introductory course, students in treatment group 1 (60 students) were emailed a link to a Qualtrics survey which asked two questions. First, they were asked to recall their letter grade in principles of microeconomics. Second, they were asked to compare their performance in principles of microeconomics with the performance in principles of microeconomics of students who went on to graduate with a degree in economics from the same university.[24] Specifically, they were asked to report their percentile rank in that distribution and provided with an example to illustrate the comparison: "For example, if you think you are in the 70th percentile, that means you think your grade in ECON XXXX is greater than or equal to 70% of **ECON XXXX grades earned by recent Economics graduates from University Name** [emphasis in original]."[25] Students in treatment group 2 (128 students)[26] were contacted in the same manner and asked the

[23] As an incentive to participate in the study, students who participated were entered into a lottery which awarded twenty students with a $100 prize. Checks were mailed to winners of the lottery by the end of the spring semester. One student who elected to participate could not reliably be matched with student records and was not included in the analysis sample.

[24] This marks another important distinction with Owen's (2023) experimental study which asked students to compare their grades with other students in the same introductory STEM course, as opposed to students who had successfully graduated in the major.

[25] See Appendix C for texts of the treatment interventions.

[26] Treatment group 2 was designed to be about twice as large as treatment group 1 to allow for subsequent study of heterogeneous effects in treatment group 2. Unfortunately, the small sample size effectively negated this line of inquiry.

same set of questions as treatment group 1 but were subsequently given the information regarding percentile rank that had been elicited from treatment group 1. Percentile ranks were determined by comparing the principles of micro grades of study participants with the principles of micro grades of the 2013-2015 graduating cohorts in economics (Appendix Figure B3).[27] Finally, students in treatment group 2 were told that "This means that your Principles of Micro grade was greater than or equal to approximately X percent of the Principles of Micro grades **earned by Economics degree-holders**," where X was replaced with the relevant percentile [emphasis in original]. Unfortunately, only a portion of treatment students responded to the survey (N=30 in treatment group 1 and N=76 in treatment group 2), and we cannot be certain how many students in either treatment group viewed the survey and elected not to respond. Thus, our analysis will use the sample who gave consent to participate to estimate intent-to-treat (ITT) effects and we will separately provide results on the sample who responded to the survey in the appendix.[28]

In sum, students in the second treatment group who responded to the survey were both asked to report their grades and their perceptions on their relative performance (same as treatment group 1) and were also able to learn where the grade they earned in principles of micro lied in the distribution of economics graduates, a measure of how likely it was for them to successfully graduate as an economics major. In comparison, students in the first treatment group were only asked for their grades and their beliefs about their relative performance. Since asking for beliefs and providing information that might update those beliefs may have separate impacts, it was important to have two treatment groups in order to differentiate those effects. The difference between the two estimates can give an estimate of the impact of providing better information on grade signals.

By stratifying the randomization scheme on gender, the research design also aimed to ensure that sufficient male and female students were randomized into treatment and

[27] To avoid confusing student participants, these percentile ranks did not include grades which fell below the minimum required to earn credit for the course, and thus reflected the higher grade earned by past students who had to retake the course.

[28] While there was a relatively low response rate in the experimental study, note that there is no attrition from the experimental sample in the strict sense since the treatment occurred at one point in time, and we are able to track individuals through administrative records. Nevertheless, the lower rate of response to the survey raises the possibility of selection bias in response to the survey, which is why we focus on the intent-to-treat results in the main paper and present the results conditional on responding the survey in the appendix.

comparison groups. This enables us to explore whether men and women respond differently to being asked information about grades as well as being given information about relative performance.[29] It is worth noting that the answer may vary depending on the outcome, for instance if men are less affected by the treatments when deciding on their college major compared with women but more affected with regard to college dropout decisions. The latter may be particularly salient in the current context, because unlike studies at liberal arts colleges and private elite universities, the six-year graduation rate at the large public flagship university hovers close to 70 percent.

Table 2 presents summary statistics for the entire sample of treatment and control groups who gave consent to participate in the experiment, and whose outcomes are observed through the spring semester of 2019.[30] Students in the experimental study look roughly similar demographically, as well as on the basis of pre-college test scores and high school GPA, despite the small sample sizes. Performance in the introductory course is roughly similar across treatment and comparison groups (2.9 to 3.0 GPA) as well as for term GPA outside of economics (3.1 to 3.3).

Focusing on the subsample of students who responded to the survey after the completion of the introductory economics class, we see some suggestive evidence that women are less confident about their performance in economics. Women are somewhat more likely to report a grade in introductory economics less than or equal to the one they actually received while men are more likely to report a grade somewhat higher than the one they received (Figure 3). Comparing student reports of their perceptions on their performance in introductory economics, as given by the difference between their reported percentile ranks in the distribution of successful graduates and their actual performance, we see that women are broadly spread out between -50 and 50 (Figure 4), suggesting that they are also less certain about their relative performance. While the distribution of men's

[29] Indeed, Bobba and Frisancho (2022) find evidence that male and female high school students differ in the extent to which they process new information about their relative abilities.

[30] Note that this follow-up duration allows student participants at least four years to graduate, if they took principles of microeconomics in their first semester at the university, and five years if they took the course in their sophomore year. As of spring 2019, there were only 18 students from the sample who had not graduated but were still enrolled at the university.

reported-actual percentiles is centered to the left of zero, the distribution is narrower, suggesting they are more certain than women.

IV. EMPIRICAL STRATEGY

A. Observational Study

To determine the relative impact of grades within and outside of introductory economics on academic outcomes, we estimate the following regression equation for both men and women:

$$(1)\quad Y_{ij} = \alpha + \theta_1\left(EconA_{ij}\right) + \theta_2\left(EconB_{ij}\right) + \delta_1\left(TermGPA\_A_{i-j}\right) + \\ + \delta_2\left(TermGPA\_B_{i-j}\right) + \boldsymbol{X_{ij}\beta} + \varphi_j + \varepsilon_{ij}\,.$$

where Y_{ij} is an academic outcome (e.g., college major, dropout) for individual *i* who took introductory economics class *j*. While enrollment in class *j* varies over both instructor and time period, both elements are subsumed in this class fixed effects model which looks at variation in grades across students enrolled in the same class, in the same time period, with the same instructor, and thus holds constant those aspects of the course which might separately impact both course grades and other academic outcomes. $EconA_{ij}$ is an indicator for whether individual *i* received a grade of A- or A in the introductory economics class *j* and $EconB_{ij}$ is an indicator for whether individual *i* received a grade of B-, B, or B+ in class *j*. The comparison group is made up of students who received introductory economics grades below a B-, which is the mean grade guideline set for the course.[31] Similarly, $TermGPA\_A_{i\text{-}j}$ is an indicator for whether individual *i*'s average GPA outside of introductory economics in the term in which s/he took the introductory economics course was 3.7 or above, and $TermGPA\_B_{i\text{-}j}$ is an indicator for whether individual *i*'s average GPA outside of introductory economics in the term in which s/he took the introductory economics course was greater than or equal to 2.7 and less than 3.7, and the comparison group includes the set of students

[31] The departmental administration instructs teaching faculty to set the average course grade around this benchmark.

with GPAs outside of economics below 2.7. $\boldsymbol{X_{ij}}$ is a vector of individual characteristics including baseline ability measures such as college test scores and high school GPA as well as demographic indicators and other academic characteristics.[32] Finally, φ_j is the class-fixed effect, which subsumes instructor and semester-year fixed effects, as it effectively varies at the instructor-semester-year level, and ε_{ij} is an i.i.d. error term that we cluster at the class level throughout the estimation. This allows us to control for all aspects of the class (e.g., gender/race/ethnicity of the instructor, time of day of the class, quality of instruction, etc.) and thus purge our estimates of any correlations between those factors, academic performance, and our outcomes of interest. While this is our preferred specification, we also present results separately with instructor and semester-year fixed effects in lieu of class fixed effects as well as results with individual and course-specific controls instead of the fixed effects.[33] The main specification is estimated using OLS and thus should be interpreted within the context of the linear probability model.[34]

While the rich set of individual-level controls and class-level fixed effects in the OLS model allow us to isolate how introductory course grades are related to college major and dropout decisions for men and women, they are still vulnerable to omitted variable biases like unobserved differences in childhood background that might be correlated with college major choice and introductory course grades and thus may cloud a causal interpretation of these estimates. Although it is not clear why any omitted variable biases would operate in such a way as to produce a gendered pattern of results, we recognize that the observational results would also not indicate why grades might affect women more than men. Thus, to bolster the causal interpretation and determine whether the mechanism behind the observational results is the informational content of grades, we turn to an experimental design which alters information about relative performance in introductory classes. To the extent that the experimental results show that women display greater responsiveness to

[32] Individual ability controls include ACT Math score, ACT English/Reading score, and high school GPA. Other individual-level controls include the term in the academic career in which the student took economics (ranges from 1 to 7), race/ethnicity indicators (including non-resident alien), first generation indicator, indicators for entry college, and indicators for entry major.

[33] In models without fixed effects, we include class and instructor characteristics. Class-level characteristics include class size, and proportion of the lecture that is female. Instructor characteristics include demographic indicators for instructor (female, foreign, and white).

[34] Estimation using probit or logit yielded qualitatively similar results. These results are available upon request.

information in the college major decision and men display greater responsiveness in the dropout decision, the experimental results can also provide support for the findings from the observational study.

B. Experimental Study

For the experimental study, we estimate the impact of asking for grades and beliefs about relative grades in introductory economics (assigned to treatment groups 1 and 2) as well as providing information about those grades (assigned only to treatment group 2), on academic outcomes such as college major choice and college dropout relative to the comparison group who consented to treatment but received no further contact. Since we have randomized the experimental study participants into treatment and control groups, estimation is straightforward:

$$(2) \qquad Y_i = \varphi + \pi_1(Treat1_i) + \pi_2(Treat2_i) + \nu_i$$

where Y_i is an academic outcome: indicator for whether individual i majors in economics and, separately, whether the individual is observed to drop out of college within 4 years of the study.[35] $Treat1_i$ is a dummy variable indicating assignment to treatment group 1 and $Treat2_i$ is a dummy variable indicating assignment to treatment group 2. Since both treatment groups were asked for the same information about grades and beliefs about relative performance, $\pi_2 - \pi_1$ measures the impact of providing information on the outcome of interest whereas π_1 measures the impact of only asking for that information. For precision, we also present results controlling for introductory economics numeric course grade, however, the small sample size of the experimental study limits our capacity to include further interaction terms and controls. Equation (2) is estimated separately for men and women and, given the randomization inherent in the experimental study, standard errors are clustered at the individual level.[36] As noted above, not all students in the

[35] Note that this would allow for graduation within four or five years of enrollment at the university if the student enrolled in introductory economics in the fall or spring of the freshman or sophomore year, respectively.

[36] These results are robust to clustering at the class level.

treatment group followed up with the treatment, so we will focus on intent-to-treat estimates, but also present estimates on the sample who responded to the survey in the appendix.

V. RESULTS

A. Observational Study

1. College Major Choice

a. Main Results—College Major

Table 3 reports the main results from estimating the impact of grades within and outside of introductory economics on the likelihood of majoring in economics, culminating in estimates of the coefficients from the class fixed effects model in equation (1)[37]. We build toward that specification by first showing the results for men and women which only include the variables indicating grades in introductory economics as well as grades in other courses taken in the same term with no other controls in the model (columns 1 and 2, respectively). The p-value of the difference between the coefficients in columns 1 and 2 is shown in column 3. It is important to note that we cannot conclude that men respond differently to A or B grades in introductory economics than women, but the coefficients on grades outside of introductory economics indicate men and women may respond differently to other grades. While the magnitude of all coefficients appear larger for men than women, men also major in economics at substantially higher rates than women (9.6% versus 4.4%, respectively), and thus we evaluate coefficients relative to those average levels.

We begin by noting that, even without any controls, grades within and outside of economics are an important predictor of majoring in economics and our variables of interest maintain statistical significance at the 1% level throughout. Even in the most parsimonious specification, the conditional correlations clearly demonstrate that grades above a B- have a positive impact on majoring in economics, while grades above a B- outside of economics, as given by the term GPA coefficients, have a negative impact on majoring in the field. This is true for both men and women, however the magnitudes of the effects relative to the average major rates

[37] In appendix table D1, we build toward that specification by progressively adding controls. General patterns of results are maintained as controls are added across columns.

by gender already suggest that women are more responsive to grades in economics. For example, the impact of earning an A- or above in introductory economics relative to earning a grade below B-, controlling for performance outside of economics, suggests a 113% (.0496/.0439) increase in majoring in economics for women, while only a 60% (.0577/.0959) increase for men. These patterns are generally maintained as we move across columns, adding an extensive set of individual characteristics and ability controls, as well as instructor and semester fixed effects. Interestingly, the results from these intermediate specifications suggest that responsiveness to introductory economics grades generally rises with the addition of individual and class-level controls while the responsiveness to grades outside of economics falls.

Columns 4 and 5 show the results with all controls and class fixed effects, which are essentially the equivalent of instructor-semester-year fixed effects, and we rely on variation across students within the same class, taught by the same instructor in the same term, and control for a host of individual covariates. The magnitudes of the coefficient estimates, relative to the average of the dependent variable, indicate that men would be about 73% more likely to major in economics as a result of earning an A- or above in introductory economics relative to earning a grade below B-. In comparison, the likelihood of a woman majoring in economics more than doubles (119% increase) as a result of earning an A- or above relative to earning a grade of B- or below in introductory economics. Similarly, the likelihood of a woman majoring in economics is about 63% higher if she earns between a B- and a B+, relative to a grade below a B- while the analogous statistic for a man is only 40%. Column 6 shows the p-value for the difference between coefficients in columns 4 and 5, which offers weak support that the coefficients of men and women are statistically different from one another.

In contrast, women are only slightly more responsive than men to grades outside of introductory economics when determining whether to major in economics. In the class fixed effects model, a woman (man) is about 38% (34%) less likely to major in economics if her (his) term GPA outside of economics is A- or above, relative to having a GPA below B-, conditional on her (his) performance in introductory economics. The analogous magnitude is only 20% (17%) for a woman (man) if her (his) grade is in the B- to B+ range outside of economics, and the estimate is only moderately statistically significant in the case of

women.[38] We also note that the differences between men's and women's responsiveness to grades within economics are statistically significant at the 10% level, but these differences across gender are not statistically significant for grades outside of economics.[39]

Taking the ratios of the rates of responsiveness to grades within introductory economics relative to grades outside of it allows us to compare responsiveness of men and women to relative grades. Given that women's responsiveness to grades within introductory economics is so much larger than that of men, but similarly responsive to grades outside of introductory economics, it makes sense that women are found to be much more responsive to relative grades. Specifically, women are over 3.1times (119/38) as responsive to A grades in introductory economics relative to A grades outside of it, while men are about 2.1 times (73/34) as responsive to A grades in introductory economics relative to A grades outside of it. Analogous comparisons of rates of responsiveness to B grades within versus outside of introductory economics for men and women are very similar. Thus, the impact of grades within economics relative to outside of economics on college major choice appears to be much higher for women than for men, suggesting that grades in introductory economics are playing a relatively larger role in determining women's decision to major in economics.[40]

b. Robustness and Extensions—College Major

One concern with the main sample of the observational study is that some students enter college already having decided their majors, and once tied to a major, students may be less responsive to grade signals. Although we control for college of entry in our main results, if those patterns are systematically correlated with gender, the concern is that they may be driving the results from Table 3. To address this, Table 4 columns 1 and 2 consider the population of students that enter college as undecided majors in the College of Arts and Sciences, the college within which economics is housed[41]. Absolute magnitudes appear

[38] An alternate specification was run to investigate how the interactions of economics and term grades impact major choice. As one would expect, the largest responsiveness changes for both genders occurs when the student receives a high mark in economics and an average of a C+ or lower outside of economics. Results are available upon request.
[39] See results tables for p-values on gender differences throughout.
[40] These results are qualitatively similar if we restrict attention to graduates only (Appendix Table A2).
[41] Appendix Table D2 shows the results from Table 4 and also includes results for running the specifications with no controls.

somewhat higher for this group, but so are rates of majoring in economics (14.5% for men and 6.4% for women). Specifically, women in this category are 128% (.0818/.0639) more likely to major in economics if they receive an introductory economics grade in the A range while men are about 63% (.0916/.145) more likely to major in economics given the same grade. The fact that these rates are somewhat higher than for the broader sample in Table 3 make sense since these students are beginning their studies as truly undecided majors, and thus more susceptible to new information. More qualitatively, we can say that the same gendered pattern emerges in Tables 3 and 4: women's decision to major in economics is much more responsive to above average grades in introductory economics in comparison with men, even after controlling for other grades.

Women are also much more responsive to grades in introductory economics relative to grades in other courses when it comes to college major choice. For instance, for men, the magnitudes of the coefficient estimate associated with earning an A- or above in introductory economics is almost the same as the magnitude of the coefficient estimate associated with earning an A- or above outside of economics (.0916 versus -.0903 in column 3), whereas the analogous comparison for women yields a ratio that is more than twice as large (.0818 versus -.0362 in column 4).[42] This reinforces the interpretation that women are more responsive to grades within economics than men and much more responsive to grades in introductory economics relative to other grades when determining whether to major in the field. Column 3 shows the p-values for the difference between coefficient values in columns 1 and 2, indicating that there is a statistically different response of women and men to getting an A- or better grade outside of economics, but we cannot reject the null that men and women have the same percentage point response to their economics grades or grades in the B- range outside of economics.

Another concern may be that men and women take different courses outside of economics, and they may choose to do so in a way that fits the pattern of the results. To address this, Table 4, columns 4 and 5 , considers the subsample of students who took at least one introductory course in a major that "competes" with economics within the same

[42] Note that this is equivalent to comparing rates of responsiveness to grades within versus outside of introductory economics since the coefficients in the numerator and denominator would each be divided through by the same average major rate for men and women, respectively.

college at the university, that is, a major that includes introductory economics as a requirement. These majors include political science, environmental studies, and international affairs, and thus, students who took introductory economics and at least one other introductory course in this group are likely to have similar interests and be choosing between economics and a "competing major" at the time when they are enrolled in introductory economics.[43] In place of our term A and term B controls, we construct analogous indicators reflecting the maximum grade taken in the introductory "competing" course (*Comp_A*$_{i\text{-}j}$.and *Comp_B*$_{i\text{-}j}$). While estimates of the impact of competing course grades on majoring in economics are imprecise in this sample, we continue to see that the impact of earning above average grades in introductory economics on majoring in economics is higher for women than men.[44] Specifically, earning an A- grade or above in introductory economics increases the likelihood of a woman majoring in economics by about 100% relative to the average major rate for women in this group (.0624/.0612) while for a man the analogous increase is about 63% (.08/.126).

As discussed in the Background section, other studies have considered the relative impacts of grades on college major choice with different specifications and do not adopt the class fixed effects model used here. However, one may question whether the gendered patterns we observe might be different if we controlled for grades using an alternative measure. Table 5 considers this possibility by using two alternative measures from a few prominent studies in this area. More specifically, Panel A uses the ratio of introductory economics grade to term GPA (relative ratio TGPA) in the spirit of Ahlstrom and Asarta (2019) and Rask and Tiefenthaler (2008) while Panel B considers the numeric introductory economics grade and term GPA separately, in the style of Rask (2010). Comparing the results with the averages of men and women majoring in economics in these samples yields qualitative results much like those from our main results.

Based on the absolute or relative magnitudes of the coefficients, the evidence suggests that women are more responsive to grades within introductory economics relative

[43] Business is not considered a competing major in this section as it is outside of the College of Arts and Sciences and requires a separate admissions process.

[44] Estimates of the competing courses grades are statistically significant and negative if we restrict attention to the sample of graduates (Table A3), but we include non-graduates in this exercise as well since college dropout is an outcome to be considered below.

to outside of it when it comes to college major choice. Relative to their respective rates of majoring in economics, in Panel A, we see that given a 100% increase in the ratio of the introductory economics grade to the term GPA, women would be about 100% more likely to major in economics relative to their average major rate (.0441/.0440). In comparison, an analogous change would only lead to an increase in the likelihood of majoring in economics of about 34% for men, relative to their average rate of majoring in economics (.0327/.0966). These results are qualitatively similar even when adding interaction terms for different points in the distribution of the relative ratio (columns 4 and 5), although coefficient estimates on the interaction terms are only statistically significant at the lower end of the distribution. Nevertheless, the qualitative comparison across men and women remains the same, and is consistent with women being more responsive to economics grades relative to grades outside of economics when deciding whether to major in economics.

As with our preferred specification, the empirical approach in Panel B allows us to separate out the impact of changes in introductory economics grades from the impact of other grades on college major choice. Again, we find that women are more responsive to grades in introductory economics compared with men, even after controlling for other grades. Specifically, an increase in one grade point in the introductory economics grade, holding grades outside of economics fixed, leads to a 56% increase in majoring in economics for women (.0247/.0439), but only 39% for men (.0376/.0959). The fact that response rates are more muted compared with our results from above may be due to the linearity imposed in this model, which estimates the same marginal effect for those moving from low grades to middling grades as for those moving from middle to high grades. Thus, we prefer the specification presented in equation (1), which allows for the saliency of letter grades in particular to impact academic outcomes, and a more flexible functional form that allows for nonlinearities in responsiveness to grades. Nevertheless, the results from these alternative specifications using the class fixed effects model yield similar results suggesting that women are more responsive to grades in introductory economics compared with men.

2. College Dropout Decision

a. Main Results—College Dropout

Table 6 considers the impact of grades within and outside of introductory economics on the likelihood of dropping out of college.[45] While the latter is clearly a more extreme outcome than college major choice, it is also quite salient in this institutional context, where the 6-year graduation rate hovers close to 70 percent. Interestingly, the gap between men and women's responsiveness narrows substantially when we move to the college dropout outcome, despite the fact that men in the sample are much more likely to drop out than women (24.1% versus 17.8%). In fact, men are now somewhat more responsive to above average grades in introductory economics compared with women, relative to their average dropout rates. Specifically, men (women) reduce their likelihood of dropping out by 51% (45%) in response to an A- or above, and 42% (38%) in response to earning between a B- and B+ in introductory economics, relative to earning an introductory economics grade below B-. At the same time, the impacts of A range and B range term GPAs outside of introductory economics are somewhat higher for women than for men, reducing dropout rates between 75% and 78% for women, and between 67% and 70% for men, respectively.[46]

Furthermore, comparing the rates of responsiveness to grades in introductory economics to grades in other courses, we see that the impact of relative grades in introductory economics on college dropout is higher for men than for women, just as the opposite was true for the college major decision. For instance, the ratio of the magnitude of the impact of A grades in introductory economics relative to other grades on college dropout decisions is about 0.76 for men while it is only 0.60 for women. Comparisons across genders on the impact of B grades in introductory economics relative to other grades yields similar results (ratios of 0.60 for men and 0.49 for women). These results are consistent with men being tied more firmly to the economics major and thus more impacted

[45] Appendix Table D3 shows the results from Table 6 and also includes results for progressively adding controls.

[46] Note also that the differences between men's and women's responsiveness to grades within economics are statistically significant at the 1% level, but these differences across gender are only statistically significant for B range grades outside of introductory economics. It should also be noted that the magnitude of the impact of the term GPA excluding introductory economics on college dropout is likely higher than the magnitude of the impact of the introductory economics grade because it is harder to overcome a lower aggregate GPA than a single low grade.

by grades within the major relative to outside of the major when it comes to deciding whether to drop out of college.

b. Robustness and Extensions—College Dropout

As before, we can show that these results are robust to alternative specifications. Specifically, Table 7 presents results from a model using a linear grade point measure for introductory economics grade and a linear term GPA measure on the full observational sample. Results are qualitatively similar, providing further evidence that men are more responsive to introductory economics grades when it comes to the college dropout decision. As before, the estimates are also more muted using the linear specification versus the nonlinear regression model in equation (1). In particular, a one point increase in the introductory economics grade, holding all other grades fixed, reduces the dropout rate by 20.7% for men and by 18.4% for women. At the same time, the impact of introductory economics grades relative to the impact of other grades, as given by the ratios of the coefficients on introductory economics grade to term GPA is substantially higher for men than women (.370 for men versus .269 for women). Thus, we continue to see evidence that men are more responsive to introductory economics grades when determining whether to drop out of college.

Table 8 extends the exploration of the college dropout results to examine how they might differ for the population who enter college as undecided majors (columns 1 and 2) as well as the sample of students who take similar coursework, where term GPA is replaced with grades in competing courses (columns 4 and 5).[47] Thus, this set of results is analogous to the results presented in Table 4 for the college major decision. As with prior results, we note that the average of the dependent variable differs for these two samples in important ways: dropout rates for students that begin as undecided majors are somewhat higher (0.283 for men and 0.204 for women), while average dropout rates for students that take competing courses are somewhat lower (0.195 for men and 0.143 for women). However, men continue to be more likely than women to drop out in both samples. Beyond that we

[47] Appendix Table D4 shows the results from Table 8 and also includes results for running the specifications with no controls.

see that responsiveness to grades in introductory economics, relative to other grades, are again somewhat higher for men than women in the sample who enter as undecided majors. Specifically, the ratio of the magnitude of the coefficient on A grades in introductory economics to the magnitude of the impact of A grades outside of economics on college dropout decisions in that sample is about 0.83 for men while it is only 0.71 for women. Comparisons across genders on the impact of B grades in introductory economics relative to other grades suggest similar, though more muted, results for relative rates of responsiveness to grades within versus outside of economics (ratios of 0.60 for men and 0.59 for women).

The results for students who take competing introductory courses also show that men are relatively more responsive to introductory economics grades when deciding whether to drop out of college. The ratio of the impact of an A grade in introductory economics relative to an A in a competing course is about 0.39 for men and 0.30 for women, while the analogous ratio of B coefficients is about 0.43 for men and 0.33 for women. At the same time, we see that relative to the average dropout rates for each group, higher introductory economics grades have a greater impact on reducing the dropout rate for men than for women, holding competing course grades fixed. In particular, earning an A grade in introductory economics, relative to earning a grade below B-, while holding the competing course grade fixed, reduces the likelihood of dropping out for men (women) in this sample by 42% (32%), relative to the average dropout rate for each group. The analogous impacts for B grades in introductory economics reduce the dropout rate for men (women) by 39% (33%). Thus, even in this subsample, we see that men are relatively more responsive to grades in introductory economics controlling for grades outside of economics, when determining whether to drop out of college, just as results from above suggested women were more responsive to grades in introductory economics when determining whether to major in economics. We turn now to the experimental study to see whether altering student's information about their relative performance in introductory economics courses affects the decision to major in economics and drop out of college, and whether differential response rates of women and men in the experimental treatment groups support the patterns observed in our observational study.

B. Experimental Study

1. Suggestive Evidence

We focus on the intent-to-treat measures of participation and preface this discussion by noting the small sample sizes of treatment and comparison groups, particularly conditional on responding to the survey. Thus, this discussion is only meant to be suggestive of mechanisms underlying the experimental results that link with our observational study. In this vein, Figure 5 shows the distribution of relative performance, as measured by the difference between economics and non-economics grades, by treatment status, for economics majors and non-majors. As we move from the control group to treatment group 1, we note that relative performance for economics majors is shifted to the right. This is consistent with the interpretation that simply asking students to recall their grades can increase the saliency of grades and thus induce students with weaker grades in introductory economics, relative to outside of economics, to choose a non-economics major. This rightward shift in relative performance for majors also appears for treatment group 2, but less so, which would be consistent with a mitigating influence of providing information on the link between grades and academic success as an economics major.

Figure 6 examines the analogous distributions of relative grades by treatment status, but this time distinguishing between dropouts and non-dropouts. Similar to the analogous graphs in Figure 5, the distribution of relative grades for dropouts and non-dropouts in the control group is more evenly spread. For treatment group 1, the distribution of relative grades for non-dropouts is relatively more tightly centered on 0 which would again be consistent with increased grade saliency and responsiveness to grades for treatment group 1. A similar, though not as dramatic pattern, is observed for treatment group 2, which again is consistent with some mitigating effect of providing better information on how to interpret grade signals on dropout rates for treatment group 2.[48]

2. Experimental Results

a. College Major Choice

[48] Appendix Figures B4 and B5 present the analogous results conditional on responding to the survey.

Table 9 presents the experimental results for the economics major outcome of the sample of students from the Fall 2015 introductory economics course who agreed to participate in the study. All coefficients on treatment indicators are negative suggesting that the experimental treatment deterred men and women from majoring in economics, however the magnitudes for women are somewhat larger than for men, whereas the impacts for men hover much closer to 0. While most of the estimates are noisy, in part due to the small sample size, we note that they are statistically significant at the 5% level for treatment group (1) in the sample of women (coefficient estimate of -0.16). This suggests that women in treatment group 1 were about 16 percentage points less likely to major in economics than women in the control group and is consistent with the notion that women are more responsive to grades as treatment group (1) students were asked to recall and interpret their grades in introductory economics but not given any information. Recalling that students in treatment group 2 were asked for similar information but were also given information on the link between introductory grades and the likelihood of successful graduation as an economics major, we note that the coefficient on the treatment group 2 indicator is also negative, but smaller in magnitude and not statistically significant relative to the control group. This suggests that the new information may have mitigated the negative impact of grade recall on majoring in economics.

Column (5) of Table 9 shows that the experimental results are robust to adding a control for numeric introductory economics grade. Although an increase of one point in the introductory economics grade increases the likelihood of majoring in economics by about 4.5 percentage points, the magnitude of the coefficient on treatment 1, that is, being asked to recall the introductory economics grade and link it with beliefs about likelihood of success in the major, is associated with a decline in the likelihood of majoring in economics similar in magnitude to results from above (-0.155).[49] For both specifications (those including course grades as a control and those without course grade as a control), we cannot reject the null hypothesis that the impact of the treatments on men and women are the same.

[49] Treatment estimates are very similar if term GPA is added to the model instead. These results are available upon request.

As discussed in the Data section, a large portion of the sample did not respond to the survey, and thus some may question whether the results are actually driven by treatment participation. To address this issue, Appendix Table A5 includes results for students who responded to the survey. While the sample size drops considerably, the coefficient estimate associated with treatment group 1 is similar in magnitude and maintains statistical significance for women.[50] The magnitude of the coefficient on treatment 1 is also very similar (-.161) and statistically significant at the 10% level, if we limit the sample to women who graduate (Appendix Table A6).

b. College Dropout Decision

As the observational study suggests that men may be more responsive to grades when deciding to drop out of school, Table 9 Panel B presents the results from estimating the impact of the experimental treatments, relative to the control group, on dropping out of college. Consistent with the results from the observational study, it is now men that appear more responsive to grade signals. In particular, treatment 1 increases the likelihood of dropping out for men by about 27.1 percentage points and treatment 2 increases dropout by 16.3 percentage points (column 1). Both estimates are statistically significant at the 1% level and both are substantial relative to the mean dropout rate for this group (21.3%). Since both treatments asked students to recall and interpret their grades, these results indicate that the saliency of introductory course grades is significantly linked with men's dropout rates. [51]

As discussed in the empirical strategy section, the difference between the two treatment group coefficient estimates gives the impact of providing information on relative performance since both treatment groups were asked for information and beliefs but only students in treatment group 2 were given information.[52] Using the estimates from Panel A, this calculation suggests that giving better information on the link between introductory

[50] We also explored interacting treatment with difference between reported and actual percentile rank, but sample sizes were too small for meaningful interpretation.

[51] Table A5 of the appendix shows the magnitudes of the impacts on men fall when conditioning on response to the survey (Panel B), but this may simply reflect the fact that men who drop out may not participate in the survey. We also explored interacting treatment with difference between reported and actual percentile rank, but sample sizes were too small for meaningful interpretation.

[52] Of course, this treatment estimate should be interpreted within the context of our experimental study in which individuals in both treatment arms were encouraged to reflect on their introductory course grades. A different research design in which only information on percentile rank was given might find different results.

economics performance and success in the major reduces men's likelihood of dropping out by 10.8 percentage points (.163 - .271), or about 51% relative to the mean dropout rate for men in this sample (21.3%). But it is important to note that treatment group 2 is still more likely to drop out relative to the control group who was not asked to think about their grades at all. These results are roughly similar even after controlling for numeric course grade in the introductory economics course (column 4).[53] In contrast, the point estimates on the treatment dummies are much smaller for women than men and not statistically significant for women, suggesting that the interventions did not have a significant impact on women's dropout rates. More formally, we can reject the hypothesis that the intervention had the same impact on male and female dropout rates at the 10% significance level (p-value of 0.0637 when we do not control for course grade and a p-value of 0.0556 when we do control for class grade). This is consistent with women's dropout rates being less responsive to relative grade signals, as was seen in the observational study.

VI. Impacts of Changing Grading Standards on the Gender Gap in Economics

Having demonstrated that women are relatively more responsive to introductory economics grades in terms of college major and men are more responsive in terms of college dropout, all else equal, we consider the policy question of whether an alignment of grading standards of economics with other social sciences would result in an increase in the share of women graduating with an economics degree. Specifically, we consider the impact of raising introductory economics grades by 0.3 points (i.e., converting B+ to A- grades and C+ to B- grades), which is close to the average difference between introductory economics grades and those in closely related disciplines. While this policy prescription may work in raising the share of underrepresented groups majoring in economics at institutions where dropping out is relatively uncommon, this strategy ignores the inverse relationship between academic performance and college dropout decisions, which is particularly salient for men at less-selective institutions. On the one hand, assigning a greater share of As and Bs to students in introductory courses would result in a greater share of women majoring in economics, but

[53] Treatment estimates are very similar if term GPA is added to the model instead. These results are available upon request.

at the same time, it would result in a lower share of men dropping out of college, and thus ultimately graduating with a degree in economics, all else equal. In sum, the total impact of changing grading standards, considering both effects, depends on the relative magnitudes of those effects.

To weigh the impact of this policy change, we start by considering the sample of students who took introductory economics and began their coursework in Fall 2014 or earlier, thus allowing them the opportunity to graduate within six years and be observed within our data window. Women make up about 39.9% of this sample. We then estimate our main regression model (equation 1) on men and women in the sample, focusing first on the results with a binary dependent variable equal to one if an individual graduates within 6 years and zero otherwise (Appendix Table A7, columns 1-2). Using these estimates, we then calculate the marginal effects of moving men's and women's introductory economics grades from a B+ to an A- (equivalent to the difference in the coefficient on A and B Range) and moving from a C+ to a B- (equivalent to the difference between the coefficient on B range, since the comparison group is below B-). We multiply each of these marginal effects by the respective shares of men and women in each of the *ex-ante* B+ and C+ categories. Finally, we add the resulting increases in male and female graduates to the initial male and female graduates under the current grading policy to determine the *ex-post* share of graduates among men and women in the sample. For example, approximately 79.8% of women in the sample graduate within 6 years under the current grading standard and after lowering the grading standards, the share rises by approximately 1 percent to an 80.6% 6-year graduation rate for women in the sample. In comparison, approximately 72% of men in the sample graduate within 6 years under the current grading standard. All else equal, we would predict this share to rise by 1.7% to a 73.2% 6-year graduation rate for men in the sample under the hypothetical grading standard.

Using the same strategy, we can evaluate the impact of the hypothetical grading policy on shares of men and women graduating with an economics degree. Restricting the above sample to those who graduated within 6 years of beginning their studies, we can estimate equation (1) on the resulting sample of graduates where the outcome is a binary variable equal to one if the individual earns an economics degree (Appendix Table A7, columns 3-4). Under current grading standards, economics majors make up about 5.3% of the sample of

female graduates and 12.6% of the sample of male graduates. Calculating the marginal impact of changing the grading standard as laid out above, suggests moving to the hypothetical grading standard would result in an increase of 9.4% in the share of economics majors among women and 5.1% in the sample of men. This would shift female economics graduates as a share of all economics graduates from 23.8% of all economics graduates under the current grading system to 24.5% of all economics graduates under the new grading standards. However, weighting these shares by the change in the likelihood of graduating within six years using the calculations above would result in a reduction in the share of women economic graduates to 24.4% under the new grading standards, or about a 2.5% increase relative to the current share of women economics graduates. This corrected share is smaller than the one calculated using only the economics major outcome due to the relatively larger reduction in dropout rates among men highlighted above.[54]

VII. CONCLUSION

This paper contributes significantly to the rather limited literature on gender disparities in college dropout decisions and the larger literature on college major choice by examining the impacts of introductory course grades on academic outcomes, using both observational and experimental methodologies in the same institutional context. Our observational study of students who took introductory economics finds important gender differences in the decision to major in economics and the decision to drop out of college. While both decisions are heavily influenced by grades within and outside of introductory economics, women are relatively more responsive to grades in introductory economics when it comes to majoring in economics just as men are relatively more responsive to introductory economics grades when it comes to the college dropout decision. Although other researchers have found women to be more responsive to grades in selecting college major (Owen 2010), still others have not (Main and Ost 2014; Astorne-Figari and Speer 2018). Moreover, while others have investigated the academic determinants of dropping out of college (Astorne-Figari and Speer

[54] These shifts are relatively small in part because there are relatively few students affected by the change in grading policy given our regression model (only those earning B+ and C+ introductory economics grades *ex-ante*). It may also reflect the fact that we have held all else fixed, and in particular, the share of women who take introductory economics classes. Altering the grading standards in the course might ultimately affect that share as well, though that is out of the scope of the analysis here.

2018; Stinebrickner and Stinebrickner 2012, 2014), to our knowledge ours is the first to find that men are more responsive to introductory course grades in deciding to drop out of college. This is a significant contribution, as many public institutions struggle with gender gaps in college major, but also with retention, and are often underrepresented in the literature which focuses on liberal arts colleges and elite private universities where dropping out of college is relatively rare.

Our experimental study finds gendered patterns consistent with those from the observational study and addresses whether providing better information on how to interpret grades can blunt the impacts of relative grade sensitivities on college gender gaps. We find that women who were randomly asked to recall their introductory economics grades and connect those grades with the likelihood of success in the major are less likely to major in economics. Similarly, men in the treatment group assigned only to provide their grades and their beliefs about those grades are more likely to drop out. While providing students with better information on the link between grades and academic success appears to somewhat mitigate the impact of eliciting grades and beliefs about those grades, the former intervention does not appear to have been strong enough to overcome the impact of grade saliency on college major for women and dropout for men. The difficulty in promoting female interest in the economics major despite additional information is consistent with Owen (2023) and may be at least partially explained by results from the experimental literature on gender stereotypes which shows that gender stereotypes shape beliefs and behavior (Bordalo et al. 2019; Coffman 2014; Coffman et al. 2024). While other institutions which participated in UWE reported greater success rates with encouragement and role model interventions (e.g., Li 2018; Porter and Serra 2020), our results call into question whether better information alone can overcome the primacy of letter grades.

In light of the results on relative grade responsiveness across genders and differences in grading distributions across disciplines, administrators seeking to close gender gaps might be motivated to standardize grades across units, as has been attempted at other institutions (Butcher et al. 2014; Owen 2021). Our back-of-the-envelope calculations considering the impact of aligning grading standards with other disciplines suggests this would result in a modest increase in the share of women graduating with an economics degree. In particular, we find that the grading policy shift considered here would raise the

share of women with an economics degree by about 2.5%. Our results contrast with those from Ahn et al. (2024) who find that equalizing grades across majors would substantially increase women's enrollment in STEM courses, a difference that may be due to the broader systemic change in grading policies considered in that context. Instead, our findings are more in line with the relatively small changes observed in a natural experiment by Owen (2021).[55] In our case, we cannot ignore the fact that women would continue to be severely underrepresented in the field despite a grade alignment policy change across competing majors, and women would still represent less than a quarter of all economics graduates at this institution. Consequently, educators seeking to meaningfully reduce gender gaps in college majors would be wise to consider broader changes to attract and retain more women in the fields in which they are underrepresented and further research should explore their relative impacts.

[55] Another important distinction is that in our institutional setting, raising grades in economics courses may lead to more women majoring in business, a result found in Owen (2021).

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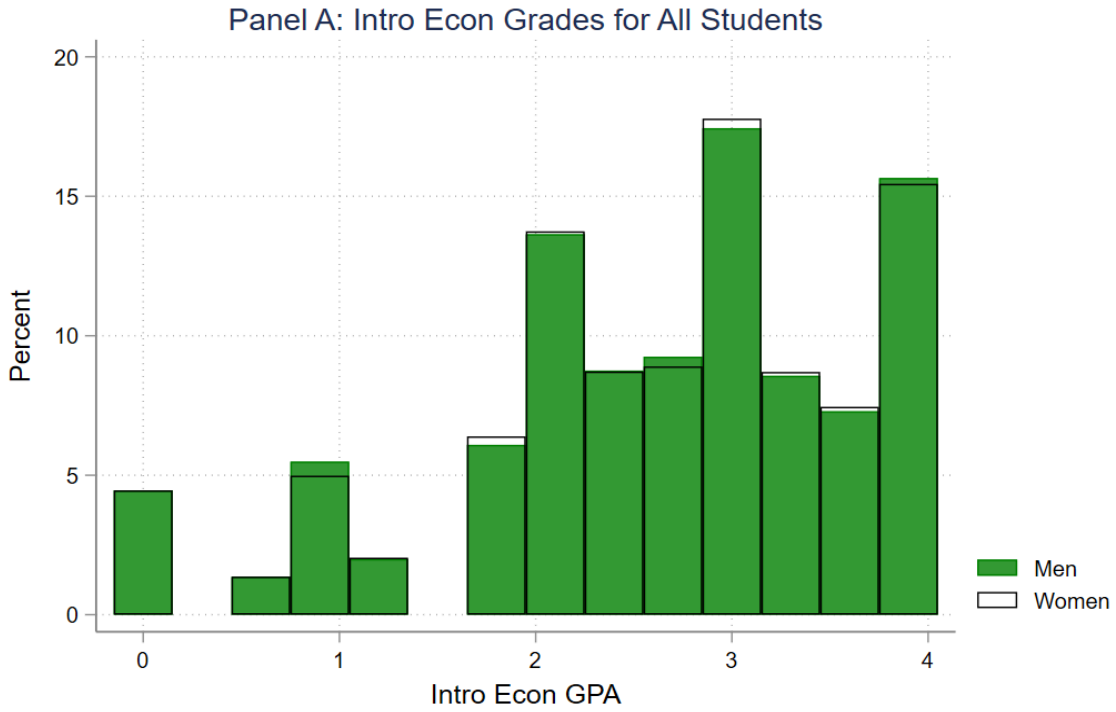
Figures

Figure 1: Introductory Economics Grades



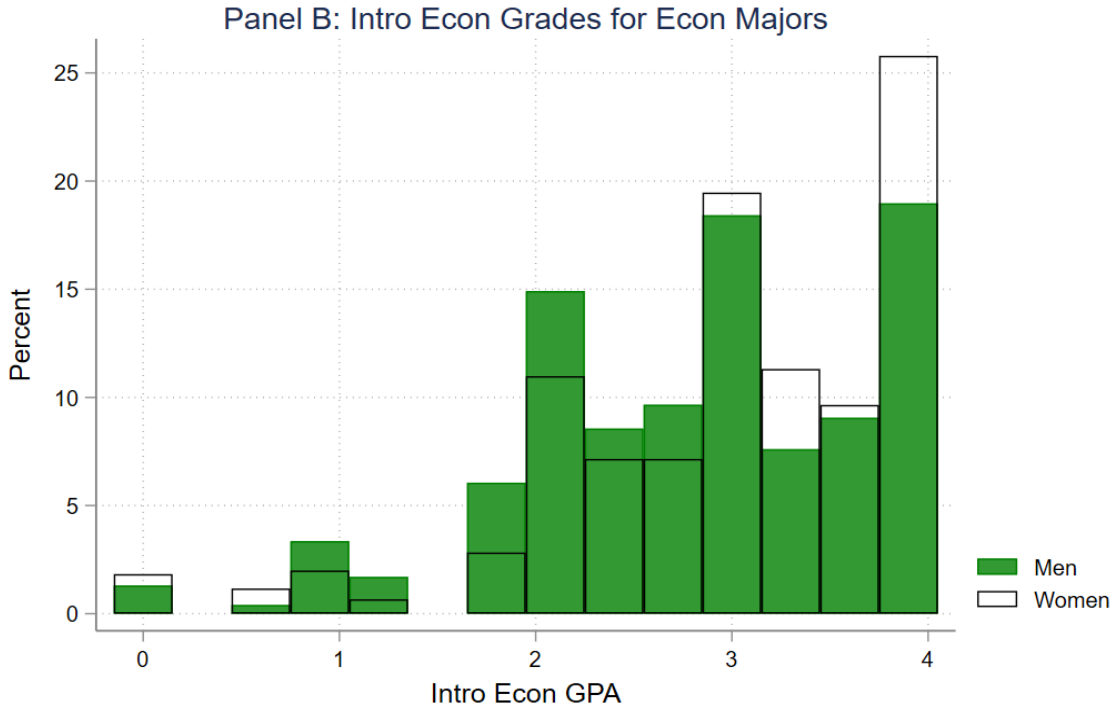


Figure 2: Term GPA in semester of Introductory Economics (Economics Grade Excluded)

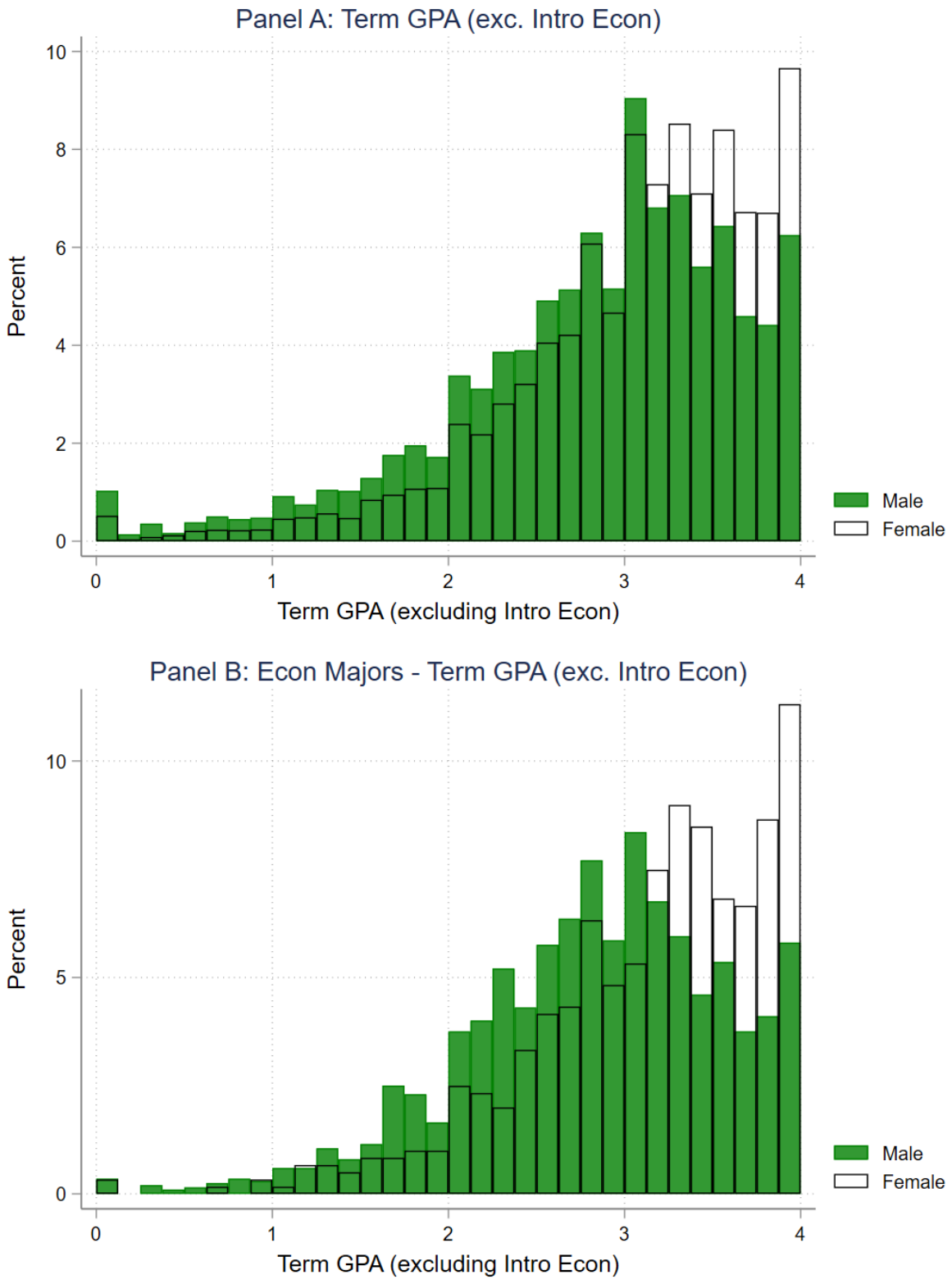


Figure 3: Experimental Study, Differences between Introductory ECON Grade and Actual Grade, Treatment Arms 1 and 2

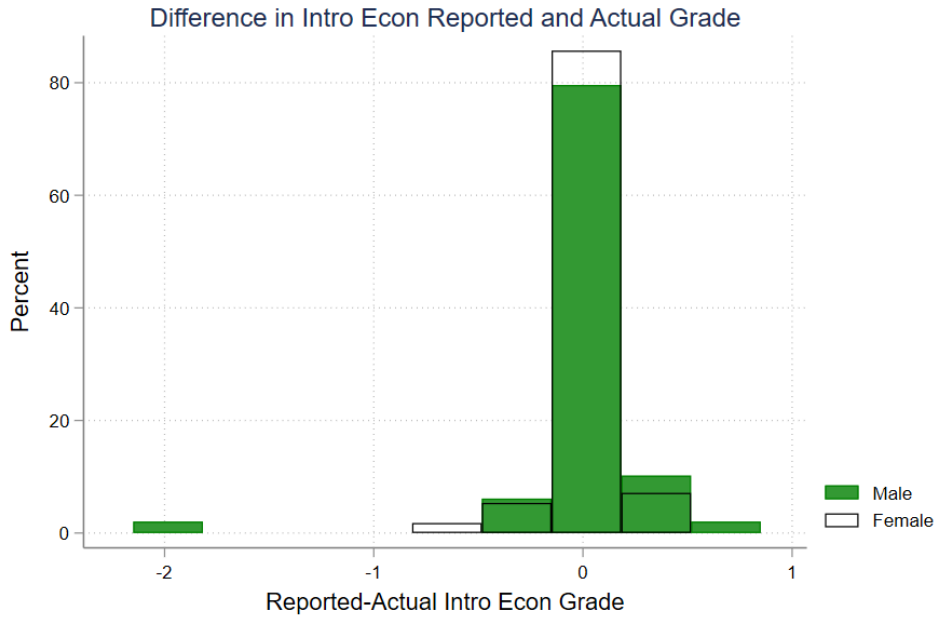


Figure 4: Experimental Study, Difference Between Intro ECON Reported Percentile and Actual Percentile, Treatment Arms 1 and 2

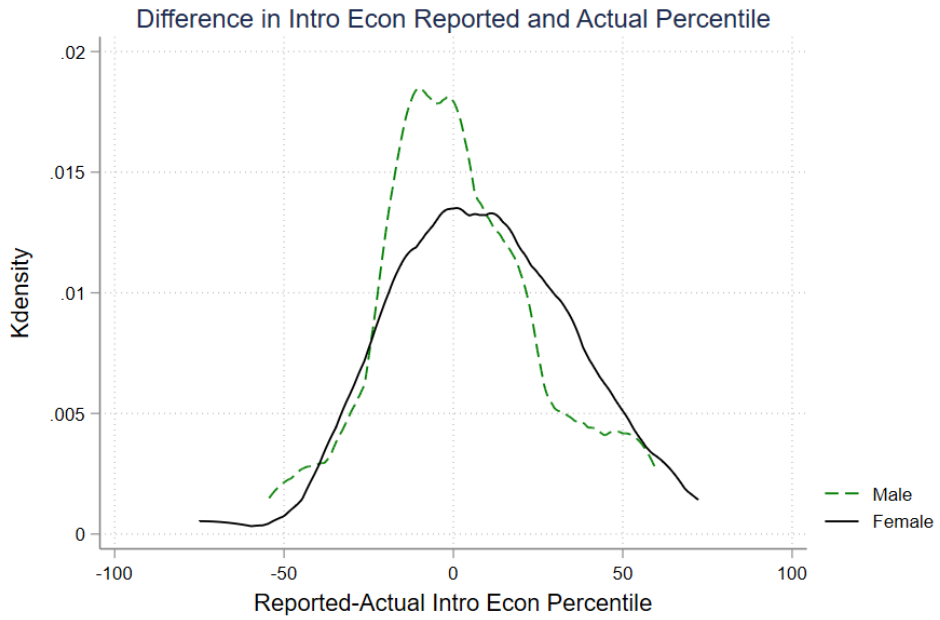


Figure 5: Difference in Econ Grade and Term GPA for ECON Majors and Non-Majors by Treatment Status in Experimental Study, Intent-to-Treat

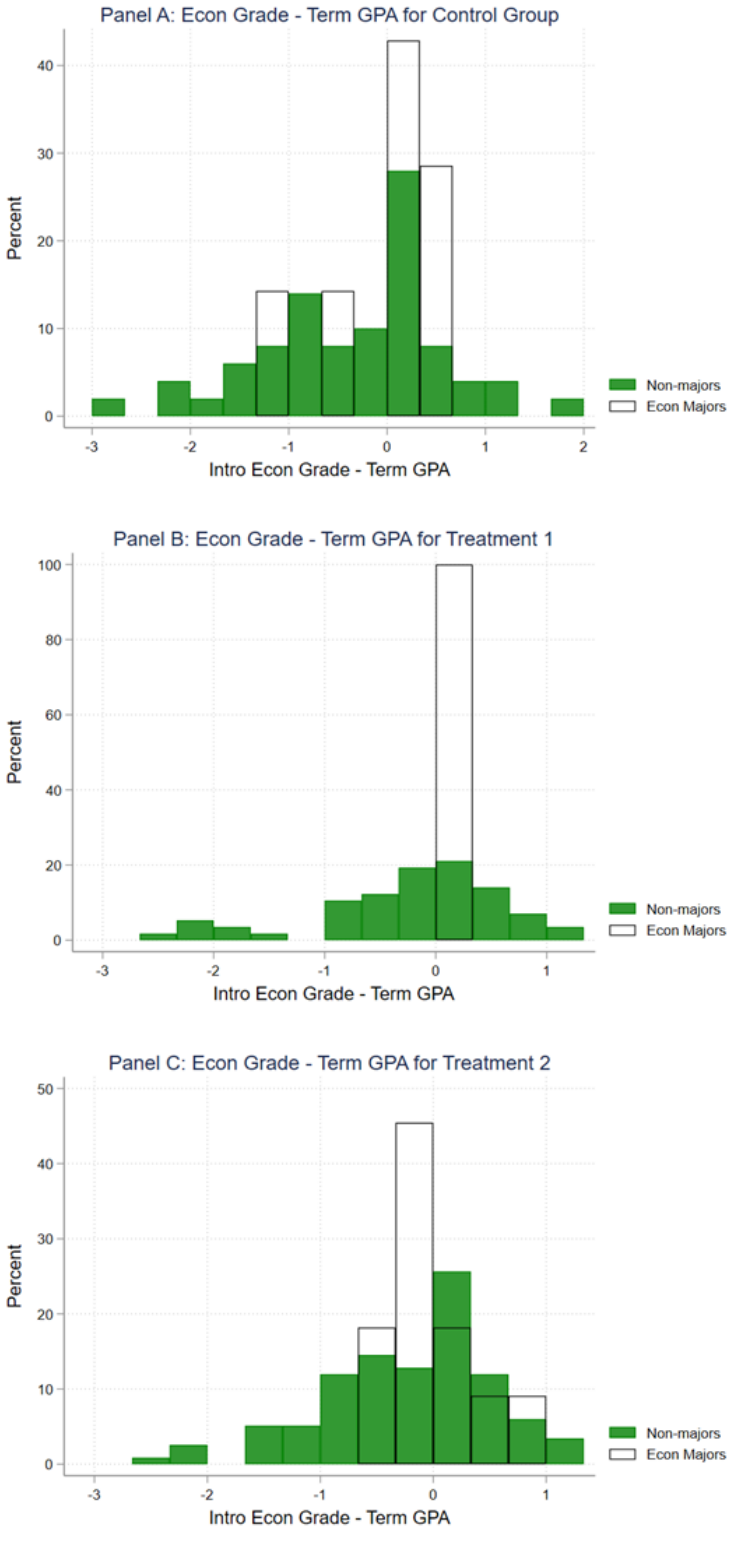
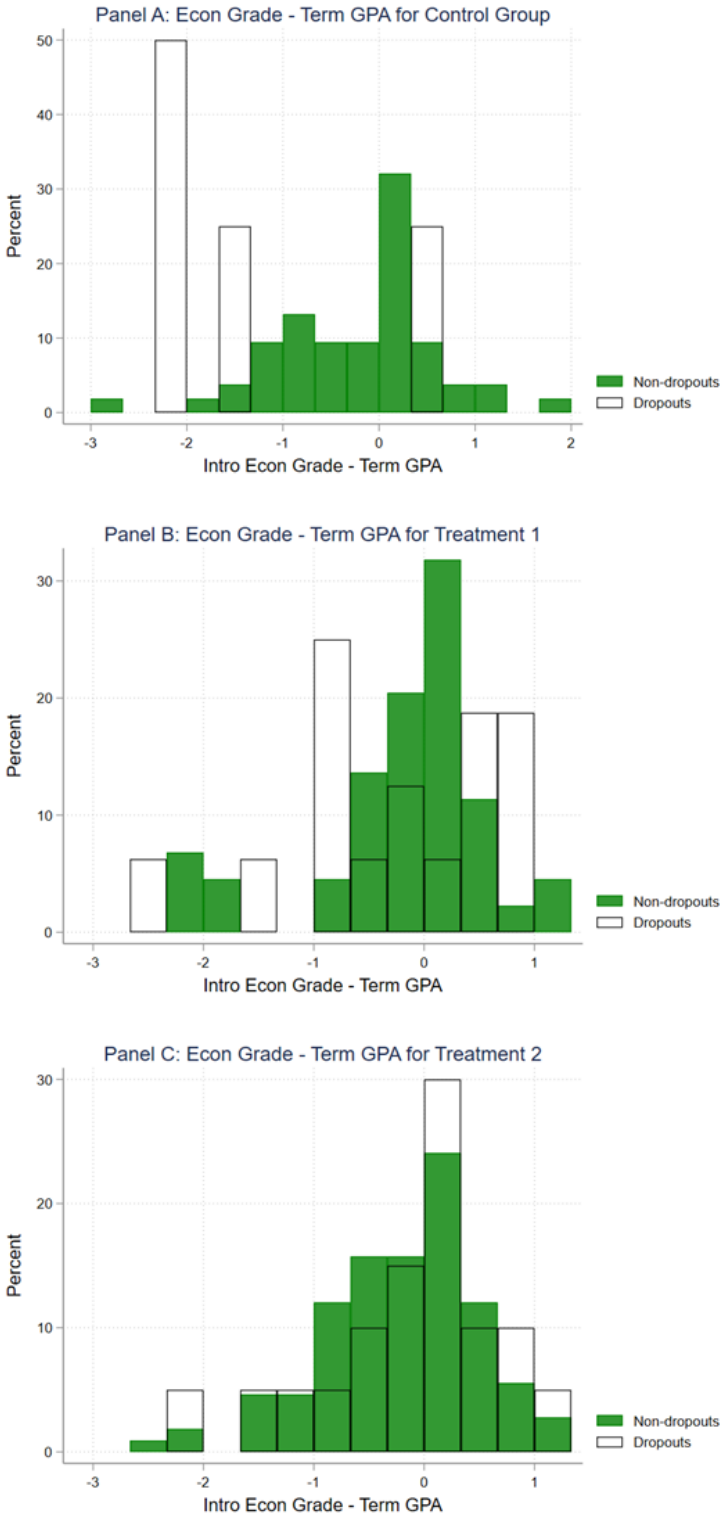


Figure 6: Difference in Econ Grade and Term GPA for Dropouts and Non-dropouts by Treatment Status in Experimental Study, Intent-to-Treat



Tables

Table 1: Summary Statistics from Observational Study Sample,

	Men	Women	P-value of Difference
White	0.812	0.792	0.000
	(0.391)	(0.406)	
Black	0.0152	0.0140	0.370
	(0.122)	(0.118)	
Asian	0.0617	0.0753	0.000
	(0.241)	(0.264)	
Term Intro Econ is taken	2.079	2.354	0.000
	(1.670)	(1.800)	
Introductory ECON Grade	2.620	2.625	0.664
	(1.047)	(1.042)	
Term GPA (Excl. Intro Econ)	2.827	3.062	0.000
	(0.818)	(0.720)	
Final Major in Econ	0.0959	0.0439	0.000
	(0.295)	(0.205)	
Entry Major: Econ	0.0350	0.0109	0.000
	(0.184)	(0.104)	
Entry Major: Undecided A&S	0.354	0.326	0.000
	(0.478)	(0.469)	
Entry College: Arts and Sciences	0.586	0.660	0.000
	(0.493)	(0.474)	
ACT Math	26.24	24.91	0.000
	(3.688)	(3.643)	
ACT English/Reading	49.82	50.68	0.000
	(8.734)	(8.720)	
High School GPA	3.439	3.608	0.000
	(0.367)	(0.331)	
Dropout	0.241	0.178	0.000
	(0.428)	(0.383)	
N	20,828	13,685	34513

***denotes difference is statistically significant at the 1% level

Table 2: Summary Statistics of Experimental Sample

	Control		Treatment Group 1		Treatment Group 2		Control-TG1	Control-TG2
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	P-value of difference	P-value of difference
Panel A: Characteristics[a]								
Female	0.439	57	0.450	60	0.445	128	.902	.933
	(0.501)		(0.502)		(0.499)			
White	0.737	57	0.750	60	0.703	128	.872	.642
	(0.444)		(0.437)		(0.459)			
Black	0.0351	57	0.0167	60	0.0313	128	.533	.893
	(0.186)		(0.129)		(0.175)			
Asian	0.0526	57	0.0333	60	0.0703	128	.610	.654
	(0.225)		(0.181)		(0.257)			
ACT Math	26.28	43	26.98	46	26.52	106	.350	.727
	(4.256)		(2.620)		(3.584)			
ACT English	27.91	43	27.02	46	26.75	106	.354	.167
	(4.942)		(4.003)		(4.433)			
HS GPA	3.590	52	3.562	55	3.607	116	.696	.804
	(0.381)		(0.360)		(0.403)			
Intro Econ Grade	2.965	57	2.892	60	3.026	128	.709	.674
	(0.986)		(1.121)		(0.872)			
Term GPA (excl. Intro Econ)	3.288	57	3.120	60	3.248	128	.190	.681
	(0.653)		(0.722)		(0.593)			
Panel B: Outcomes								
Dropout	0.0702	57	0.267	60	0.156	128	.00445	.109
	(0.258)		(0.446)		(0.365)			
Graduate	0.614	57	0.533	60	0.656	128	.382	.582
	(0.491)		(0.503)		(0.477)			
Econ Major	0.123	57	0.0500	60	0.0859	128	.162	.437
	(0.331)		(0.220)		(0.281)			
Percentile Reported	.	0	71.18	30	68.97	76	.	.
	(.)		(20.03)		(20.92)			
Higher Reported Percentile	.	0	0.533	30	0.526	76	.	.
	(.)		(0.507)		(0.503)			
Difference in Percentile	.	0	5.521	30	5.618	76	.	.
	(.)		(23.24)		(27.50)			

**denotes difference is statistically significant at the 5% level

[a] Regressing each treatment group on observable characteristics results in an F-test with a p-value of 0.3744 for treatment group 1 and 0.5018 for treatment group 2, indicating that we cannot reject the null hypothesis that the coefficients on all observable characteristics are zero for both regressions.

Table 3: Main Results on Impacts of Grades Within and Outside of Econ on Majoring in Econ. Full Sample including non-graduates.

	(1)	(2)	(3)	(4)	(5)	(6)
			P - value of			P - value of
VARIABLES	Men	Women	diff	Men	Women	diff
econA	0.0577***	0.0496***	0.383	0.0699***	0.0521***	0.0800
	(0.00650)	(0.00622)		(0.00702)	(0.00655)	
econB	0.0258***	0.0248***	0.878	0.0387***	0.0275***	0.0918
	(0.00506)	(0.00411)		(0.00518)	(0.00419)	
termA	-0.0520***	-0.0217***	0.00607	-0.0326***	-0.0166**	0.160
	(0.00789)	(0.00758)		(0.00806)	(0.00798)	
termB	-0.0291***	-0.0144***	0.0347	-0.0167***	-0.00859*	0.260
	(0.00503)	(0.00470)		(0.00499)	(0.00510)	
Observations	20,828	13,685	34,513	20,828	13,685	34,513
R-squared	0.005	0.007	0.014	0.097	0.099	0.106
Ability Controls	NO	NO	NO	YES	YES	YES
All Controls	NO	NO	NO	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO	NO	NO
Instr FE	NO	NO	NO	NO	NO	NO
Class FE	NO	NO	NO	YES	YES	YES
econ major average	0.0959	0.0439	0.0753	0.0959	0.0439	0.0753

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Independent variables include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Table 4: Subsample Results on Impacts of Grades Within and Outside of Econ on Majoring in Econ, including non-graduates.

	(1)	(2)	(3)	(4)	(5)	(6)
	Undecided A&S	Undecided A&S		Competing Courses	Competing Courses	
VARIABLES	Men	Women	P - value of diff	Men	Women	P - value of diff
econA	0.0916***	0.0818***	0.652	0.0800***	0.0624***	0.269
	(0.0148)	(0.0146)		(0.0160)	(0.0126)	
econB	0.0475***	0.0316***	0.248	0.0217**	0.0402***	0.331
	(0.0105)	(0.00946)		(0.0106)	(0.00898)	
termA	-0.0903***	-0.0362**	0.0313			
	(0.0177)	(0.0175)				
termB	-0.0328***	-0.0196**	0.331			
	(0.00932)	(0.00987)				
compA				0.0147	-0.0124	0.439
				(0.0129)	(0.0128)	
compB				0.0193*	-0.00740	0.570
				(0.0100)	(0.00969)	
Observations	7,378	4,461	11,839	6,595	4,329	10,924
R-squared	0.076	0.115	0.099	0.128	0.157	0.145
Ability Controls	YES	YES	YES	YES	YES	YES
All Controls	YES	YES	YES	YES	YES	YES
Class FE	YES	YES	YES	YES	YES	YES
Mean Y	0.145	0.0639	0.114	0.126	0.0612	0.100

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Independent variables in columns 1-3 include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). In columns 4-6, term GPA indicators are replaced by the maximum grade in a competing introductory course within the same college (compA – max grade of A- or above, and compB – max grade between B- and B+). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Table 5: Observational Study: Impacts of Relative Grades on Majoring in Economics, Robustness to Functional Form Used in Prior Studies.

	(1) Men	(2) Women	(3) P - value of diff	(4) Men	(5) Women	(6) P - value of diff
	Panel A: AA/RT Robustness (econ major), full sample					
RelativeRatio_TGPA	0.0327***	0.0441***	0.146	0.0319***	0.0369***	0.639
	(0.00517)	(0.00662)		(0.00770)	(0.00755)	
RR_top25				-0.00248	0.00189	0.533
				(0.00530)	(0.00498)	
RR_bottom25				-0.0276***	-0.0208***	0.558
				(0.00960)	(0.00599)	
Observations	20,614	13,615	34,229	20,614	13,615	34,229
R-squared	0.095	0.097	0.104	0.096	0.098	0.105
All Controls	YES	YES	YES	YES	YES	YES
Class FE	YES	YES	YES	YES	YES	YES
Mean Y	0.0966	0.0440	0.0757	0.0966	0.0440	0.0757
	Panel B: Rask 2010 (econ major), full sample					
grade_pt	0.0300***	0.0225***	0.0197	0.0376***	0.0247***	0.000427
	(0.00244)	(0.00218)		(0.00273)	(0.00245)	
T_GPA	-0.0261***	-0.0158***	0.0148	-0.0166***	-0.0117***	0.257
	(0.00301)	(0.00325)		(0.00302)	(0.00344)	
Observations	20,828	13,685	34,513	20,828	13,685	34,513
R-squared	0.007	0.008	0.016	0.101	0.101	0.109
All Controls	NO	NO	NO	YES	YES	YES
Class FE	NO	NO	NO	YES	YES	YES
Mean Y	0.0959	0.0439	0.0753	0.0959	0.0439	0.0753

Robust standard errors, clustered at the class level, in parentheses *** p<0.01, ** p<0.05, * p<0.1

In panel A, RelativeRatio_TGPA which is the ratio of the introductory economics grade with the term GPA (econ grade excluded). RR_top25 and RR_bottom25 interact the ratio of grades with an indicator for the top 25% and bottom 25%. In Panel B, grade_pt is the numeric introductory economics grade and T_GPA is the term GPA with the economics grade

excluded. Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major).

Table 6: Impact of Grades on Dropout outcome: Full Sample of Observational Study

VARIABLES	(1) Men	(2) Women	(3) P - value of diff	(4) Men	(5) Women	(6) P - value of diff
econA	-0.138***	-0.101***	0.00329	-0.123***	-0.0798***	0.00170
	(0.00863)	(0.00934)		(0.00936)	(0.0107)	
econB	-0.112***	-0.0850***	0.00453	-0.102***	-0.0677***	0.000639
	(0.00657)	(0.00731)		(0.00648)	(0.00780)	
termA	-0.176***	-0.162***	0.374	-0.162***	-0.134***	0.0930
	(0.0110)	(0.0115)		(0.0115)	(0.0119)	
termB	-0.181***	-0.154***	0.0194	-0.169***	-0.138***	0.00933
	(0.00717)	(0.0107)		(0.00710)	(0.0106)	
Observations	20,828	13,685	34,513	20,828	13,685	34,513
R-squared	0.088	0.064	0.085	0.126	0.114	0.127
Ability Controls	NO	NO	NO	YES	YES	YES
All Controls	NO	NO	NO	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO	NO	NO
Instr FE	NO	NO	NO	NO	NO	NO
Class FE	NO	NO	NO	YES	YES	YES
dropout average	0.241	0.178	0.216	0.241	0.178	0.216

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Independent variables include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Table 7: Impacts of Introductory Course Grades on College Dropout Decision: Robustness to Functional Form

	(1)	(2)	(3)	(4)	(5)	(6)
			P-value of			P-value of
VARIABLES	Men	Women	Diff	Men	Women	Diff
	-	-		-	-	
grade_pt	0.0512***	0.0350***	0.00486	0.0499***	0.0328***	0.00605
	(0.00409)	(0.00448)		(0.00451)	(0.00474)	
T_GPA	-0.139***	-0.129***	0.229	-0.135***	-0.122***	0.125
	(0.00519)	(0.00683)		(0.00547)	(0.00722)	
Observations	20,828	13,685	34,513	20,828	13,685	34,513
R-squared	0.129	0.098	0.123	0.163	0.142	0.160
Ability Controls	NO	NO	NO	YES	YES	YES
All Controls	NO	NO	NO	YES	YES	YES
Class FE	NO	NO	NO	YES	YES	YES
Mean Y	0.241	0.178	0.216	0.241	0.178	0.216

Robust standard errors, clustered at the class-level, in parentheses *** p<0.01, ** p<0.05, * p<0.1
Grade_pt is the numeric introductory economics grade and T_GPA is the term GPA with the economics grade excluded. Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Table 8: Subsample Results on Impacts of Grades Within and Outside of Introductory Economics on Dropping Out of College

	(1) Undecided A&S	(2) Undecided A&S	(3)	(4) Competing Courses	(5) Competing Courses	(6)
VARIABLES	Men	Women	P - value of diff	Men	Women	P - value of diff
econA	-0.109***	-0.0879***	0.440	-0.0816***	-0.0453***	0.00192
	(0.0173)	(0.0197)		(0.0146)	(0.0166)	
econB	-0.0815***	-0.0600***	0.278	-0.0757***	-0.0465***	0.00347
	(0.0111)	(0.0159)		(0.0109)	(0.0138)	
termA	-0.132***	-0.123***	0.726			
	(0.0210)	(0.0214)				
termB	-0.136***	-0.101***	0.0443			
	(0.0126)	(0.0168)				
compA				-0.207***	-0.150***	1.04e-07
				(0.0157)	(0.0203)	
compB				-0.176***	-0.143***	1.58e-08
				(0.0137)	(0.0185)	
Observations	7,378	4,461	11,839	6,595	4,329	10,924
R-squared	0.154	0.165	0.164	0.144	0.145	0.146
Ability Controls	YES	YES	YES	YES	YES	YES
All Controls	YES	YES	YES	YES	YES	YES
Class FE	YES	YES	YES	YES	YES	YES
Mean Y	0.283	0.204	0.254	0.195	0.143	0.175

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Independent variables in columns 1-4 include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). In columns 5-8, term GPA indicators are replaced by the maximum grade in a competing introductory course within the same college (compA – max grade of A- or above, and compB – max grade between B- and B+). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major)

Table 9: Experiment Main Results. Intent-to-treat Estimates.

	(1)	(2)	(3)	(4)	(5)	(6)
	Men	Women	P - value of diff	Men	Women	P - value of diff
Panel A: Outcome –Major in Economics						
Treatment Group 1	-0.0028	-0.160**	0.132	-0.0014	-0.155**	0.133
	(0.0726)	(0.0744)		(0.0729)	(0.0718)	
Treatment Group 2	-0.0092	-0.0723	0.544	-0.0112	-0.0747	0.537
	(0.0619)	(0.0835)		(0.062)	(0.082)	
Course Grade				0.0295	0.0448**	0.634
				(0.0261)	(0.0191)	
Observations	136	109	245	136	109	245
R-squared	0	0.041	0.018	0.009	0.067	0.034
Mean Y	0.0882	0.0826	0.0857	0.0882	0.0826	0.0857
Panel B: Outcome – Drop Out of College						
Treatment Group 1	0.271***	0.105	0.212	0.266***	0.094	0.159
	(0.0936)	(0.0937)		(0.0893)	(0.0827)	
Treatment Group 2	0.163**	-0.0098	0.0637	0.170**	-0.0038	0.0556
	(0.0662)	(0.0648)		(0.0672)	(0.0603)	
Course Grade				-0.105***	-0.111***	0.909
				(0.0383)	(0.0361)	
Observations	136	109	245	136	109	245
R-squared	0.053	0.026	0.067	0.109	0.162	0.145
Mean Y	0.213	0.101	0.163	0.213	0.101	0.163

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Treatment Group 1 consists of students that were asked for grades and their beliefs about their grades. Treatment Group 2 were asked for grades and beliefs and were provided information about their grades. Course Grade is a linear control for the numeric grade the student received in introductory economics.

APPENDICES

Appendix A: Supplementary Tables

Appendix Table A1: Summary Statistics of Observational Study Sample, Conditional on Graduating

	Men	Women	Difference
White	0.824	0.799	0.0245***
	(0.381)	(0.401)	
Black	0.0129	0.0131	-0.000208
	(0.113)	(0.114)	
Asian	0.0602	0.0755	-0.0152***
	(0.238)	(0.264)	
Term Intro Econ is taken	2.171	2.439	-0.268***
	(1.734)	(1.844)	
Introductory Econ Grade	2.795	2.748	0.0470***
	(0.943)	(0.967)	
Term GPA (Excl. Intro Econ)	2.988	3.166	-0.177***
	(0.677)	(0.611)	
Final Major in Econ	0.127	0.0534	0.0731***
	(0.332)	(0.225)	
Entry Major: Econ	0.0304	0.00899	0.0215***
	(0.172)	(0.0944)	
Entry Major: Undecided A&S	0.334	0.315	0.0182**
	(0.472)	(0.465)	
Entry College: Arts & Sciences	0.564	0.652	-0.0878***
	(0.496)	(0.476)	
ACT Math	26.38	25.09	1.296***
	(3.675)	(3.613)	
ACT English/Reading	50.08	51.10	-1.024***
	(8.669)	(8.692)	
High School GPA	3.472	3.632	-0.160***
	(0.362)	(0.323)	
N	15,770	11,238	27008

***denotes difference is statistically significant at the 1 % level

Appendix Table A2: Main Results of Impact of Grades Within and Outside of Econ on Majoring in Econ. Graduates Only. Progressive controls.

	(1) Men	(2) Women	(3) Men	(4) Women	(5) Men	(6) Women	(7) Men	(8) Women
econA	0.0474***	0.0514***	0.0698***	0.0576***	0.0642***	0.0540***	0.0662***	0.0553***
	(0.00811)	(0.00705)	(0.00880)	(0.00723)	(0.00845)	(0.00729)	(0.00875)	(0.00747)
econB	0.0131*	0.0250***	0.0230***	0.0282***	0.0303***	0.0297***	0.0312***	0.0292***
	(0.00664)	(0.00486)	(0.00676)	(0.00484)	(0.00656)	(0.00481)	(0.00670)	(0.00487)
termA	-0.0987***	-0.0365***	-0.0729***	-0.0239**	-0.0690***	-0.0278***	-0.0720***	-0.0289***
	(0.0102)	(0.00921)	(0.0104)	(0.00967)	(0.0101)	(0.00953)	(0.0104)	(0.00976)
termB	-0.0736***	-0.0279***	-0.0628***	-0.0209***	-0.0543***	-0.0194***	-0.0566***	-0.0201***
	(0.00719)	(0.00641)	(0.00717)	(0.00666)	(0.00685)	(0.00674)	(0.00697)	(0.00686)
Observations	15,770	11,238	15,770	11,238	15,770	11,238	15,770	11,238
R-squared	0.010	0.007	0.021	0.013	0.138	0.110	0.149	0.130
Ability Controls	NO	NO	YES	YES	YES	YES	YES	YES
All Controls	NO	NO	NO	NO	YES	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO	YES	YES	NO	NO
Instr FE	NO	NO	NO	NO	YES	YES	NO	NO
Class FE	NO	NO	NO	NO	NO	NO	YES	YES
econ major average	0.127	0.0534	0.127	0.0534	0.127	0.0534	0.127	0.0534

Robust standard errors, clustered at the class level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Independent variables include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table A3: Subsample Results Estimating Impacts of Introductory Course Grades on Econ Major Outcome. Graduates Only.

	(1) Undecided A&S Men	(2) Undecided A&S Women	(3) Undecided A&S Men	(4) Undecided A&S Women	(5) Competing Courses Men	(6) Competing Courses Women	(7) Competing Courses Men	(8) Competing Courses Women
econA	0.0766***	0.0762***	0.0872***	0.0852***	0.0725***	0.0776***	0.0815***	0.0668***
	(0.0167)	(0.0146)	(0.0188)	(0.0170)	(0.0160)	(0.0133)	(0.0186)	(0.0142)
econB	0.0343***	0.0327***	0.0402***	0.0314***	0.00490	0.0517***	0.0152	0.0448***
	(0.0131)	(0.0110)	(0.0142)	(0.0116)	(0.0121)	(0.00995)	(0.0129)	(0.0103)
termA	-0.157***	-0.0512***	-0.159***	-0.0542**				
	(0.0210)	(0.0187)	(0.0221)	(0.0212)				
termB	-0.0957***	-0.0345***	-0.0900***	-0.0329**				
	(0.0124)	(0.0122)	(0.0130)	(0.0136)				
compA					-0.0616***	-0.0429***	-0.0279*	-0.0311**
					(0.0158)	(0.0147)	(0.0160)	(0.0156)
compB					-0.0390***	-0.0371***	-0.0193	-0.0246**
					(0.0134)	(0.0114)	(0.0130)	(0.0124)
Observations	5,261	3,544	5,261	3,544	5,288	3,702	5,288	3,702
R-squared	0.016	0.010	0.109	0.138	0.007	0.015	0.173	0.179
Other Controls	NO	NO	YES	YES	NO	NO	YES	YES
All Controls	NO	NO	YES	YES	NO	NO	YES	YES
Class FE	NO	NO	YES	YES	NO	NO	YES	YES
Mean Y	0.202	0.0801	0.202	0.0801	0.157	0.0713	0.157	0.0713

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Independent variables in columns 1-4 include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). In columns 5-8, term GPA indicators are replaced by the maximum grade in a competing introductory course within the same college (compA – max grade of A- or above, and compB – max grade between B- and B+). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table A4: Impacts of Relative Grades on Majoring in Economics. Robustness to Alternative Specifications, Graduates Only

	(1) Men	(2) Women	(3) Men	(4) Women
Panel A: AA/RT Robustness (econ major), full sample				
RelativeRatio_TGPA	0.0862***	0.0740***	0.0680***	0.0611***
	(0.0110)	(0.00908)	(0.0144)	(0.0118)
RR_top25			0.0115*	0.00599
			(0.00679)	(0.00596)
RR_bottom25			-0.0141	-0.0164**
			(0.0134)	(0.00783)
Observations	15,739	11,229	15,739	11,229
R-squared	0.151	0.131	0.151	0.131
Ability Controls	YES	YES	YES	YES
All Controls	YES	YES	YES	YES
Class FE	YES	YES	YES	YES
Mean Y	0.126	0.0533	0.126	0.0533
Panel B: Rask 2010 (econ major), full sample				
grade_pt	0.0341***	0.0265***	0.0454***	0.0292***
	(0.00357)	(0.00270)	(0.00390)	(0.00298)
T_GPA	-0.0749***	-0.0303***	-0.0608***	-0.0242***
	(0.00538)	(0.00488)	(0.00511)	(0.00509)
Observations	15,770	11,238	15,770	11,238
R-squared	0.016	0.009	0.154	0.132
Ability Controls	NO	NO	YES	YES
All Controls	NO	NO	YES	YES
Class FE	NO	NO	YES	YES
Mean Y	0.127	0.0534	0.127	0.0534

Robust standard errors, clustered at the class level, in parentheses *** p<0.01, ** p<0.05, * p<0.1
In panel A, RelativeRatio_TGPA which is the ratio of the introductory economics grade with the term GPA (econ grade excluded). RR_top25 and RR_bottom25 interact the ratio of grades with an indicator for the top 25% and bottom 25%. In Panel B, grade_pt is the numeric introductory economics grade and T_GPA is the term GPA with the economics grade excluded. Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table A5: Experiment Results for Responders

	(1) Men	(2) Women	(3) Men	(4) Women
Panel A: Responders - Econ Major Outcome				
Treatment Group 1	-0.0104	-0.160**	-0.0108	-0.171**
	(0.0968)	(0.0747)	(0.0987)	(0.0768)
Treatment Group 2	-0.0127	-0.0574	-0.0132	-0.0659
	(0.0696)	(0.0896)	(0.0699)	(0.0889)
Course Grade			0.00214	0.0559**
			(0.0415)	(0.0253)
Observations	81	82	81	82
R-squared	0.000	0.037	0.000	0.072
Mean Y	0.0864	0.0976	0.0864	0.0976
Panel B: Responders – Dropout Outcome				
Treatment Group 1	0.0208	0.0867	0.0249	0.110
	(0.0923)	(0.105)	(0.0931)	(0.0907)
Treatment Group 2	0.127	-0.0287	0.132	-0.0106
	(0.0788)	(0.0660)	(0.0793)	(0.0602)
Course Grade			-0.0235	-0.120***
			(0.0451)	(0.0418)
Observations	81	82	81	82
R-squared	0.034	0.026	0.038	0.206
Mean Y	0.123	0.0854	0.123	0.0854

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Treatment Group 1 consists of students that were asked for grades and their beliefs about their grades. Treatment Group 2 were asked for grades and beliefs and were provided information about their grades. Course Grade is a linear control for the numeric grade the student received in introductory economics.

Appendix Table A6: Experiment Results for Econ Major Outcome, Graduates Only

	(1) Men	(2) Women
Treatment Group 1	0.0448	-0.161*
	(0.132)	(0.0854)
Treatment Group 2	-0.0251	-0.0434
	(0.0939)	(0.0968)
Course Grade	0.0809*	0.0510**
	(0.0446)	(0.0254)
Observations	72	79
R-squared	0.041	0.057
Mean Y	0.125	0.101

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Treatment Group 1 consists of students that were asked for grades and their beliefs about their grades. Treatment Group 2 were asked for grades and beliefs and were provided information about their grades. Course Grade is a linear control for the numeric grade the student received in introductory economics.

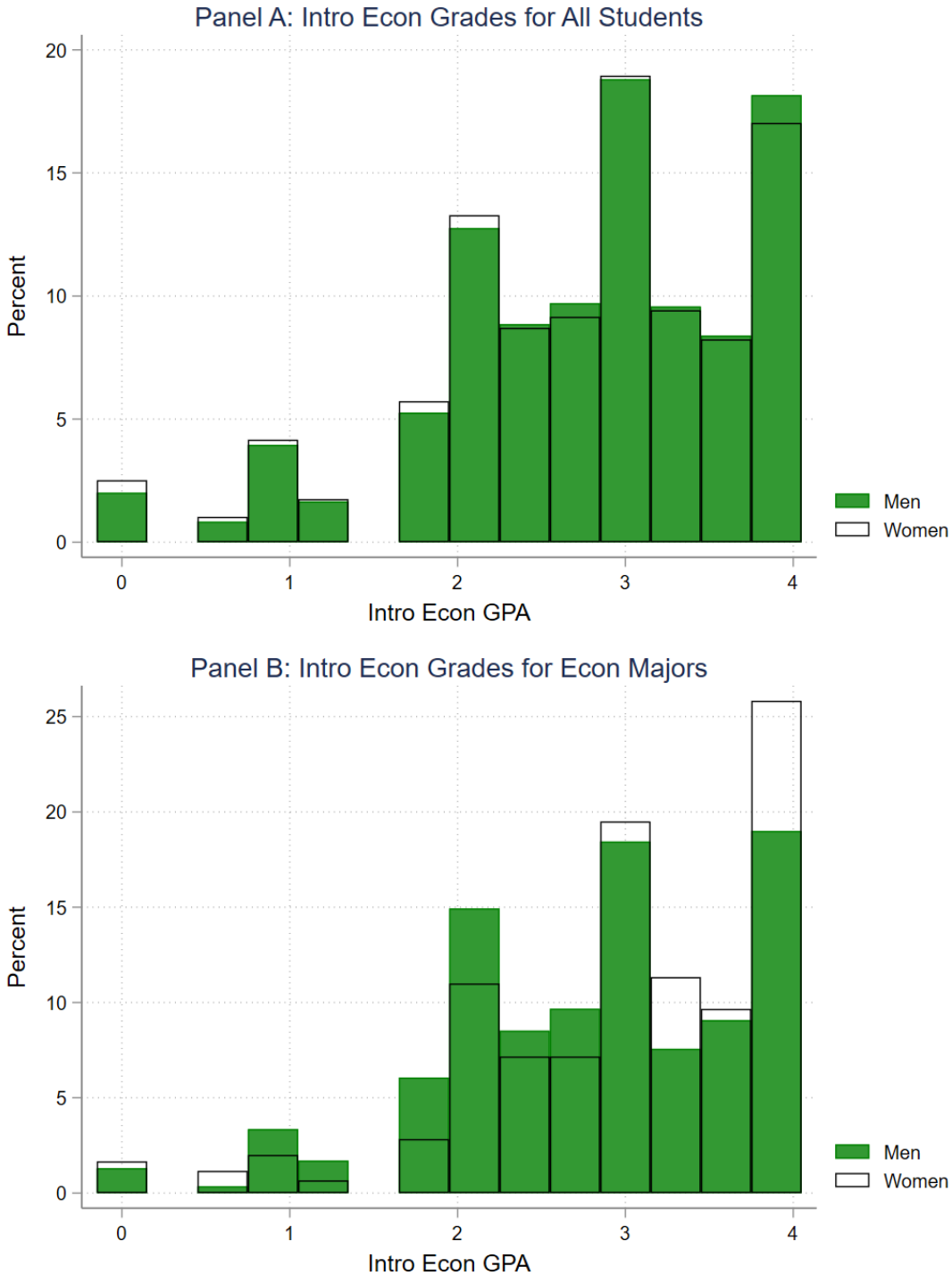
Appendix Table A7: Regression Estimates for Hypothetical Grading Policy Change

	(1) Men Graduate in 6 years or less Full Sample	(2) Women Graduate in 6 years or less Full Sample	(3) Men Econ Major Sample that graduate in 6 years or less	(4) Women Econ Major Sample that graduated in 6 years or less
econA	0.142***	0.0919***	0.0689***	0.0550***
	(0.0102)	(0.0116)	(0.00931)	(0.00755)
econB	0.118***	0.0778***	0.0325***	0.0307***
	(0.00719)	(0.00854)	(0.00694)	(0.00488)
termA	0.188***	0.164***	-0.0738***	-0.0271***
	(0.0118)	(0.0125)	(0.0107)	(0.0101)
termB	0.190***	0.162***	-0.0580***	-0.0178**
	(0.00746)	(0.0107)	(0.00739)	(0.00709)
Observations	19,950	13,244	14,354	10,569
R-squared	0.144	0.131	0.150	0.128
Ability Controls	YES	YES	YES	YES
All Controls	YES	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO
Instr FE	NO	NO	NO	NO
Class FE	YES	YES	YES	YES
Y average	0.719	0.798	0.126	0.0534

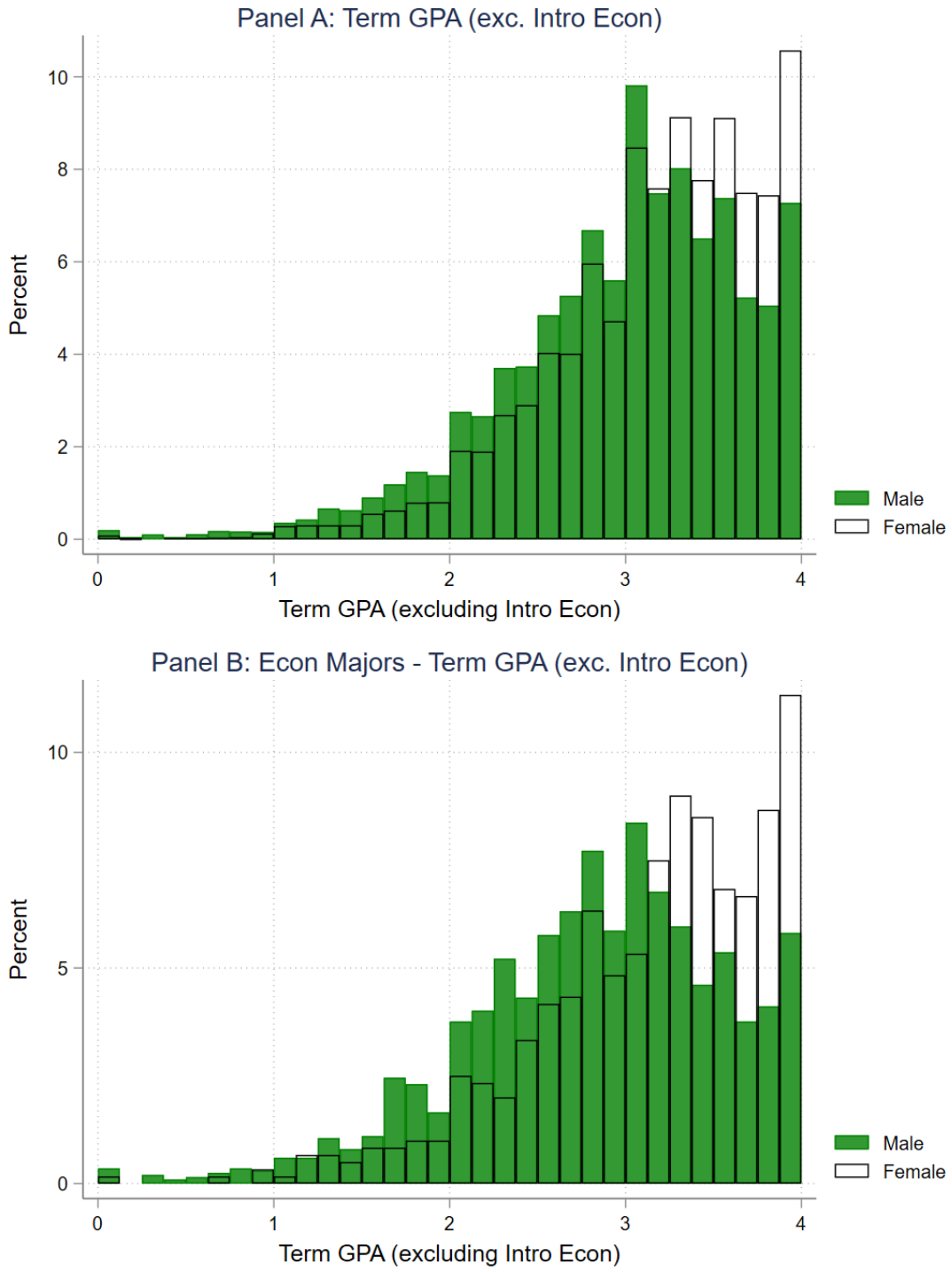
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Treatment Group 1 consists of students that were asked for grades and their beliefs about their grades. Treatment Group 2 were asked for grades and beliefs and were provided information about their grades. Course Grade is a linear control for the numeric grade the student received in introductory economics.

Appendix B Supplementary Figures

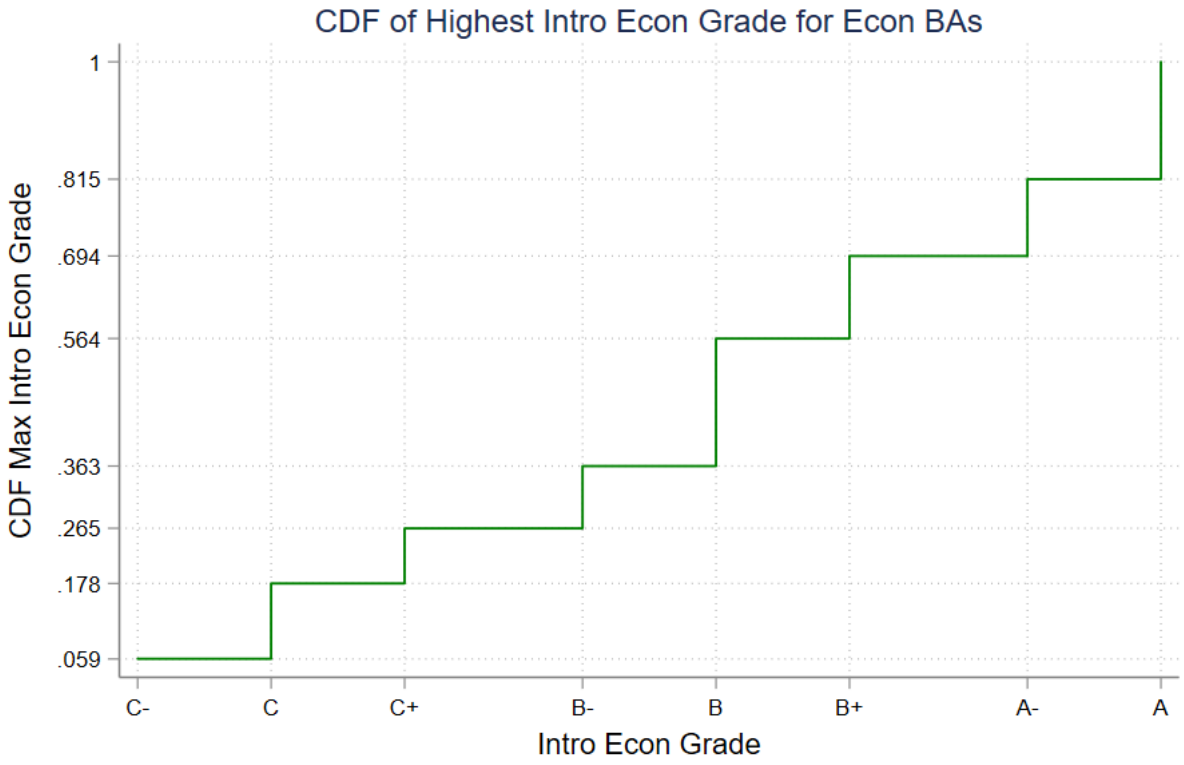
Appendix Figure B1: Introductory Econ Grades for Observational Study Sample, Conditional on Graduating



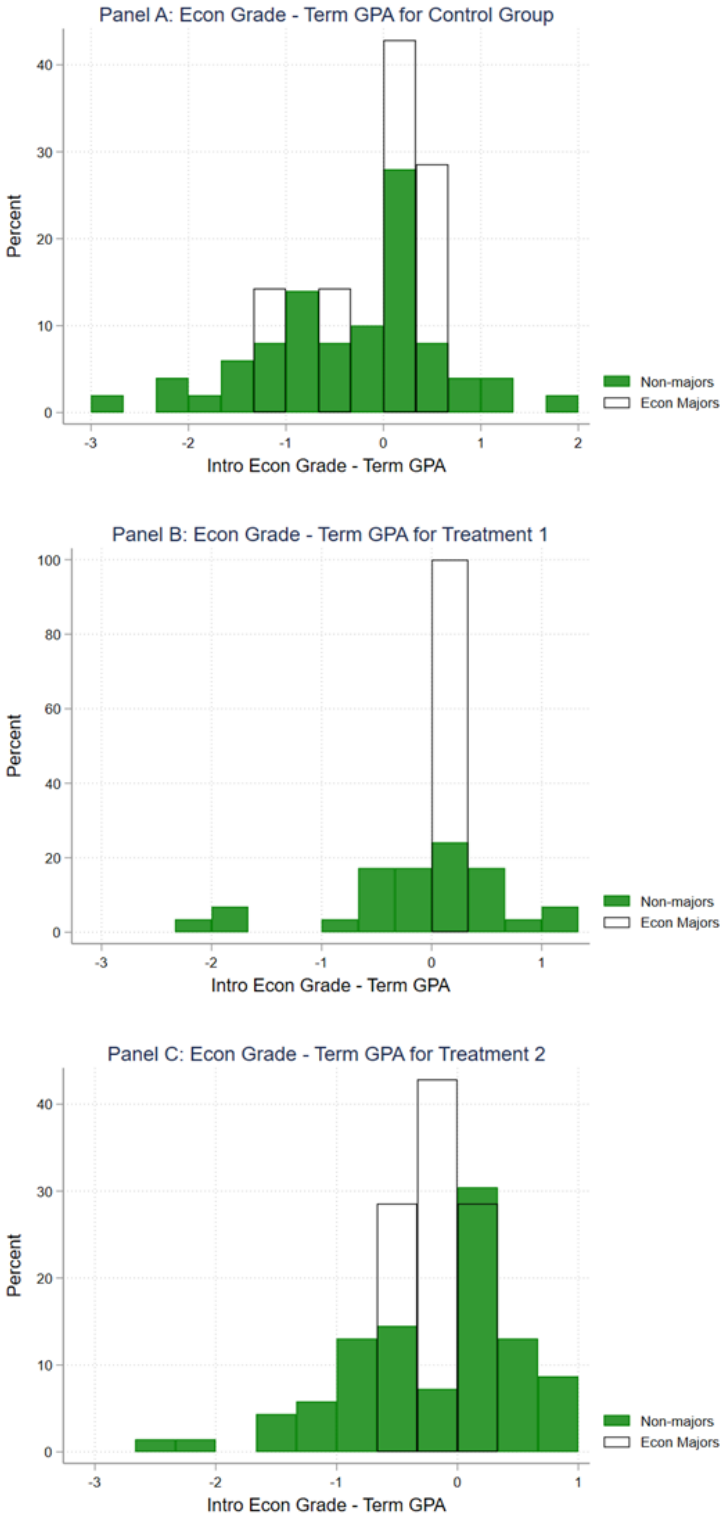
Appendix Figure B2: Term GPA for Observational Study Sample, Conditional on Graduating



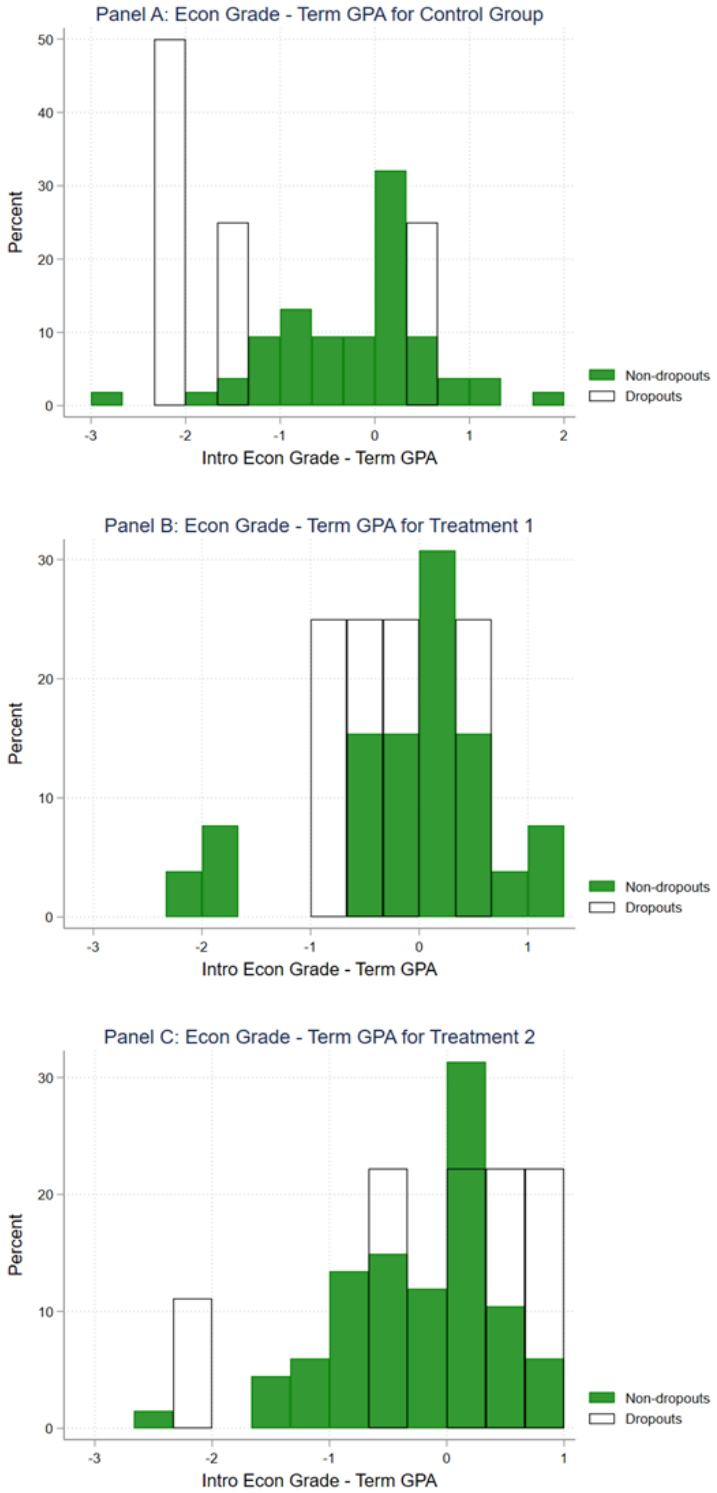
Appendix Figure B3: CDF of Highest Introductory Grade for Recent ECON Graduates



Appendix Figure B4: Difference in Econ Grade and Term GPA for ECON Majors and Non-Majors by Treatment Status in Experimental Group, Conditional on Responding



Appendix Figure B5: Difference in Econ Grade and Term GPA for Dropouts and Non-dropouts by Treatment Status in Experimental Study, Conditional on Responding



Appendix C: Text of Emails and Surveys for Experimental Study Participants

Students in Treatment Groups (Arm 1 and 2) received an email with a link to a Qualtrics survey. Students in Treatment Arm 1 (Elicit Prior Only) were only asked to answer Questions 1 and 2 while Students in Treatment Arm 2 (Elicit Prior + Provide Information) were asked to answer Questions 1 and 2 and then received the Information Text.
The specific name of the university as well as the course name were included as well, but have been redacted below.

Text of Email to Treated Students
Dear Student Name,
Earlier this fall you indicated your interest in participating in a study regarding your relative performance in Principles of Microeconomics (ECON XXXX). Please follow the link below to fulfill your role in the study. The 2 question survey should take about 1 minute to complete.
LINK to Qualtrics Survey

Qualtrics Survey Treated Students
State Your Full Name:
Indicate your University student email address here:

Indicate your University student ID number here:

Question 1: The grade you received in Principles of Microeconomics (ECON XXXX) in Fall 2015 should now be available to you. What grade did you receive in the course?

- o A
- o A-
- o B+
- o B
- o B-
- o C+
- o C
- o C-
- o D+
- o D
- o D-
- o F
- o Do not remember

Question 2: This question asks you to compare your performance in ECON XXXX in Fall 2015 with the performance in ECON XXXX of **recent Economics graduates from the University Name**.
Based on your grade in ECON XXXX in Fall 2015, how well do you believe you performed in ECON XXXX **compared with the ECON XXXX performance of students who went on to earn a degree in Economics from University Name**?

Please respond with what you think to be **your percentile rank**; that is, **approximately what percentage of grades do you think your grade exceeds in that distribution**?
For example, if you think you are in the 70th percentile, that means you think your grade in ECON XXXX is greater than or equal to 70% of **ECON XXXX grades earned by recent Economics graduates from University Name**.
Write in what you believe to be your percentile rank here (a number between 0 and 100, inclusive): __%

Information Text with Student-Specific Information Only Presented to Students in Treatment Arm 2 (Elicit Prior + Provide Information). Note that "Q" referenced below was replaced by the student-specific percentile information.
Based on our records, we have now compared the recorded grade you earned in ECON XXXX in Fall 2015 with the ECON XXXX grades of students who recently graduated with a degree in Economics from the University Name. Thus, the following information compares your performance with the performance of individuals who went on to successfully complete a degree in Economics.
Based on this comparison, we have determined that your grade in Principles of Micro places you in the Qth percentile of the distribution of Principles of Micro grades **earned by recent Economics graduates**. This means that your Principles of Micro grade was greater than or equal to approximately Q percent of the Principles of Micro grades **earned by Economics degree-holders**.

Appendix D

Appendix Table D1: Main Results on Impacts of Grades Within and Outside of Econ on Majoring in Econ. Full Sample including non-graduates. Progressive controls.

	(1) Men	(2) Women	(3) Men	(4) Women	(5) Men	(6) Women	(7) Men	(8) Women
econA	0.0577***	0.0496***	0.0726***	0.0537***	0.0676***	0.0514***	0.0699***	0.0521***
	(0.00650)	(0.00622)	(0.00707)	(0.00636)	(0.00680)	(0.00642)	(0.00702)	(0.00655)
econB	0.0258***	0.0248***	0.0325***	0.0271***	0.0376***	0.0281***	0.0387***	0.0275***
	(0.00506)	(0.00411)	(0.00515)	(0.00412)	(0.00506)	(0.00413)	(0.00518)	(0.00419)
termA	-0.0520***	-0.0217***	-0.0349***	-0.0128	-0.0301***	-0.0154*	-0.0326***	-0.0166**
	(0.00789)	(0.00758)	(0.00809)	(0.00793)	(0.00791)	(0.00785)	(0.00806)	(0.00798)
termB	-0.0291***	-0.0144***	-0.0217***	-0.00957*	-0.0150***	-0.00822	-0.0167***	-0.00859*
	(0.00503)	(0.00470)	(0.00505)	(0.00495)	(0.00493)	(0.00501)	(0.00499)	(0.00510)
Observations	20,828	13,685	20,828	13,685	20,828	13,685	20,828	13,685
R-squared	0.005	0.007	0.011	0.011	0.088	0.082	0.097	0.099
Ability Controls	NO	NO	YES	YES	YES	YES	YES	YES
All Controls	NO	NO	NO	NO	YES	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO	YES	YES	NO	NO
Instr FE	NO	NO	NO	NO	YES	YES	NO	NO
Class FE	NO	NO	NO	NO	NO	NO	YES	YES
Y average	0.0959	0.0439	0.0959	0.0439	0.0959	0.0439	0.0959	0.0439

Robust standard errors, clustered at the class level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Independent variables include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table D2: Subsample Results on Impacts of Grades Within and Outside of Econ on Majoring in Econ, including non-graduates.

	(1) Undecided A&S Men	(2) Undecided A&S Women	(3) Undecided A&S Men	(4) Undecided A&S Women	(5) Competing Courses Men	(6) Competing Courses Women	(7) Competing Courses Men	(8) Competing Courses Women
econA	0.0831***	0.0737***	0.0916***	0.0818***	0.0764***	0.0724***	0.0800***	0.0624***
	(0.0136)	(0.0127)	(0.0148)	(0.0146)	(0.0138)	(0.0121)	(0.0160)	(0.0126)
econB	0.0433***	0.0322***	0.0475***	0.0316***	0.0165*	0.0486***	0.0217**	0.0402***
	(0.00983)	(0.00901)	(0.0105)	(0.00946)	(0.00992)	(0.00888)	(0.0106)	(0.00898)
termA	-0.0877***	-0.0313**	-0.0903***	-0.0362**				
	(0.0168)	(0.0157)	(0.0177)	(0.0175)				
termB	-0.0362***	-0.0188**	-0.0328***	-0.0196**				
	(0.00887)	(0.00897)	(0.00932)	(0.00987)				
compA					-0.0139	-0.0231*	0.0147	-0.0124
					(0.0125)	(0.0121)	(0.0129)	(0.0128)
compB					0.00169	-0.0196**	0.0193*	-0.00740
					(0.00992)	(0.00875)	(0.0100)	(0.00969)
Observations	7,378	4,461	7,378	4,461	6,595	4,329	6,595	4,329
R-squared	0.013	0.012	0.076	0.115	0.007	0.014	0.128	0.157
Ability Controls	NO	NO	YES	YES	NO	NO	YES	YES
All Controls	NO	NO	YES	YES	NO	NO	YES	YES
Class FE	NO	NO	YES	YES	NO	NO	YES	YES
Mean Y	0.145	0.0639	0.145	0.0639	0.126	0.0612	0.126	0.0612

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Independent variables in columns 1-4 include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). In columns 5-8, term GPA indicators are replaced by the maximum grade in a competing introductory course within the same college (compA – max grade of A- or above, and compB – max grade between B- and B+). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other

student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table D3: Impact of Grades on Dropout outcome: Full Sample of Observational Study

	(1) Men	(2) Women	(3) Men	(4) Women	(5) Men	(6) Women	(7) Men	(8) Women
econA	-0.138***	-0.101***	-0.126***	-0.0807***	-0.121***	-0.0778***	-0.123***	-0.0798***
	(0.00863)	(0.00934)	(0.00928)	(0.0104)	(0.00929)	(0.0104)	(0.00936)	(0.0107)
econB	-0.112***	-0.0850***	-0.107***	-0.0745***	-0.102***	-0.0685***	-0.102***	-0.0677***
	(0.00657)	(0.00731)	(0.00679)	(0.00755)	(0.00651)	(0.00765)	(0.00648)	(0.00780)
termA	-0.176***	-0.162***	-0.160***	-0.141***	-0.161***	-0.134***	-0.162***	-0.134***
	(0.0110)	(0.0115)	(0.0113)	(0.0112)	(0.0112)	(0.0118)	(0.0115)	(0.0119)
termB	-0.181***	-0.154***	-0.173***	-0.143***	-0.169***	-0.137***	-0.169***	-0.138***
	(0.00717)	(0.0107)	(0.00730)	(0.0104)	(0.00702)	(0.0105)	(0.00710)	(0.0106)
Observations	20,828	13,685	20,828	13,685	20,828	13,685	20,828	13,685
R-squared	0.088	0.064	0.092	0.068	0.114	0.100	0.126	0.114
Ability Controls	NO	NO	YES	YES	YES	YES	YES	YES
All Controls	NO	NO	NO	NO	YES	YES	YES	YES
Semester-Year FE	NO	NO	NO	NO	YES	YES	NO	NO
Instr FE	NO	NO	NO	NO	YES	YES	NO	NO
Class FE	NO	NO	NO	NO	NO	NO	YES	YES
dropout average	0.241	0.178	0.241	0.178	0.241	0.178	0.241	0.178

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Independent variables include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).

Appendix Table D4: Subsample Results of Impacts of Grades Within and Outside of Econ on Dropping Out of College

	(1) Undecided A&S Men	(2) Undecided A&S Women	(3) Undecided A&S Men	(4) Undecided A&S Women	(5) Competing Courses Men	(6) Competing Courses Women	(7) Competing Courses Men	(8) Competing Courses Women
econA	-0.110***	-0.101***	-0.109***	-0.0879***	-0.0947***	-0.0756***	-0.0816***	-0.0453***
	(0.0148)	(0.0165)	(0.0173)	(0.0197)	(0.0132)	(0.0137)	(0.0146)	(0.0166)
econB	-0.0852***	-0.0758***	-0.0815***	-0.0600***	-0.0900***	-0.0738***	-0.0757***	-0.0465***
	(0.0108)	(0.0142)	(0.0111)	(0.0159)	(0.0105)	(0.0122)	(0.0109)	(0.0138)
termA	-0.155***	-0.143***	-0.132***	-0.123***				
	(0.0196)	(0.0195)	(0.0210)	(0.0214)				
termB	-0.150***	-0.111***	-0.136***	-0.101***				
	(0.0123)	(0.0160)	(0.0126)	(0.0168)				
compA					-0.215***	-0.174***	-0.207***	-0.150***
					(0.0143)	(0.0185)	(0.0157)	(0.0203)
compB					-0.186***	-0.153***	-0.176***	-0.143***
					(0.0130)	(0.0173)	(0.0137)	(0.0185)
Observations	7,378	4,461	7,378	4,461	6,595	4,329	6,595	4,329
R-squared	0.091	0.078	0.154	0.165	0.084	0.064	0.144	0.145
Ability Controls	NO	NO	YES	YES	NO	NO	YES	YES
All Controls	NO	NO	YES	YES	NO	NO	YES	YES
Class FE	NO	NO	YES	YES	NO	NO	YES	YES
Mean Y	0.283	0.204	0.283	0.204	0.195	0.143	0.195	0.143

Robust standard errors, clustered at the class level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Independent variables in columns 1-4 include indicators for introductory economics grade (econA receiving A- or above and econB receiving between B- and B+) and indicators for term GPA excluding economics (termA – GPA greater than or equal to 3.7, and termB – GPA between 2.7 and 3.7). In columns 5-8, term GPA indicators are replaced by the maximum grade in a competing introductory course within the same college (compA – max grade of A- or above, and compB – max grade between B- and B+). Ability controls include controls for high school GPA, ACT math score, ACT English and reading scores. All Controls includes indicators for race/ethnicity (black, white, Asian, Hispanic, non-resident alien), other student characteristics (indicator for first generation, term that the student took the class, entry college, entry major), and class characteristics (class size, proportion of the lecture that is female, indicator for instructor's gender, foreign status, and if he/she is white).