Gender, Grade Sensitivity, and Major Choice

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Abstract

It has been documented that the probability of women switching out of male-dominated majors – like STEM and business – is more sensitive to their performance in relevant courses at the beginning of their college career relative to men. However, the reasons why women and men react differently to grades during college, and how this behavior impacts their major choices, are not well understood. Using novel survey, I estimate students' sensitivity to grades and find that women value an extra GPA point about $3,000 more than men. I find that anticipated labor market discrimination in male-dominated fields is important to understand the gender gap in grade sensitivity. I provide evidence of the gender differences in beliefs about labor market discrimination in different fields, and show that beliefs about gender discrimination in the labor market account for 48% of the gender gap in grade sensitivity.

1 Introduction

It has been documented that women in STEM and other male-dominated fields such as Economics are more sensitive to grades than men, in the sense that the probability of women switching out of those fields is more strongly affected by their performance in introductory courses (Rask and Tiefenthaler, 2008; Ost, 2010; Goldin, 2015; Kugler et al., 2021). Although universities, governments, and policymakers are interested in closing the gender gap in these fields, designing effective policies that promote women's persistence in male-dominated fields has been challenging because the primary factors driving these gender differences in behavior remain poorly understood.[1] I investigate why women and men react differently to grades during college and how this behavior impacts their decision to remain in, or switch out of a given major. I provide evidence that anticipated labor market discrimination is important for understanding the gender gap in grade sensitivity.

Given that field of study is a key determinant of occupational choice and earnings (Gemici and Wiswall, 2014; Golan and Sanders, 2019; Patnaik et al., 2021) dropping out of STEM or business fields could have important implications for women's labor market outcomes and for the male-female earnings gap. This is because jobs in male-dominated fields such as STEM, Economics, and business pay higher wages than other areas (Altonji et al., 2012, 2014, 2016). Also, a higher rate of women dropping out of traditionally male majors is potentially consistent with a misallocation of talent and labor market inefficiencies (Hunt, 2016; Hammond et al., 2020). Therefore, understanding the reasons for women's propensity to drop out is essential to promote economic growth through an efficient allocation of talent across fields.

I document the grade sensitivity patterns among undergraduate students at Arizona State University (ASU), one of the largest public universities in the United States. I group majors into three broad categories: STEM, Business/Economics (BEC), and Social Sci-

[1] For example, in October 2021, the White House released the National Strategy on Gender Equity and Equality which "seeks to close gender gaps in STEM fields so that women and girls can shape the workforce of the future."

ences/Humanities (SSH).[2] Using ASU's administrative data, I calculate the probability that freshman students remain in their first-year major, conditional on their first-year GPA. I find that the gender gap in the propensity to stay in STEM and BEC majors increases as GPA decreases, whereas such a relationship is not observed in the SSH majors. Women's stronger sensitivity to their first-year GPA in STEM/BEC majors suggests they care about their grades more than men do.

Concerns about selection due to unobserved preferences limit the ability of administrative data to uncover the underlying mechanisms driving these gender differences. To address this, I employ data from an original survey designed to quantify students' sensitivity to grades and to investigate potential factors contributing to such gender differences.

I use hypothetical choice scenarios to quantify the gender differences in grade sensitivity.[3] This approach recovers students' preferences for key attributes of majors, such as average GPA at graduation, average weekly study time, and average post-graduation earnings at a full-time job. The survey includes 10 individual-specific scenarios. In each scenario, participants report the probability of choosing each major (SSH, BEC, STEM) based on the attributes in that scenario. This design generates a panel of probability choices, which allows me to estimate preferences at the individual level.

I find that on average, students prefer higher GPA at graduation, higher post-graduation earnings, and lower study time. Using the estimated GPA preferences, I calculate a willingness-to-pay (WTP) measure. This measure indicates the amount of annual earnings a participant is willing to forego for a one-point increase in the average GPA at graduation in a given major. I find that women are willing to pay $3,057 more than men for an extra GPA point, which is an indication of the gender gap in grade sensitivity. The gender gap is concentrated among STEM/BEC students, for whom the gender difference in WTP for GPA reaches $3,760.

[2] See Appendix B for the list of majors in each category.

[3] This methodology has been used in a wide variety of contexts, for example, to study preferences for reliable electricity services (Blass et al., 2010), political candidates (Delavande and Manski, 2015), workplace attributes including valuation of harassment risks at work (Wiswall and Zafar, 2018; Folke and Rickne, 2022), and neighborhood characteristics (Koşar et al., 2022) among others.

These findings align with the administrative data results: women in STEM and BEC majors are more sensitive to grades than men, while this is not the case in other majors.

A number of factors could explain these differences in grade sensitivity including gender differences in risk aversion (Paola and Gioia, 2012), willingness to compete (Buser et al., 2014), sense of belonging (Rainey et al., 2018; Hansen et al., 2023b), self-confidence (Ellis et al., 2016; Moakler and Kim, 2014), and misconceptions about academic performance in male-dominated majors (Owen, 2023). While the data allow me to test some of these hypotheses, a much less explored possibility and the primary focus of this paper is anticipated gender discrimination in the labor market (Steele et al., 2002; Alston, 2019).

There is evidence that women experience gender discrimination in the labor market and face higher standards in hiring and promotion, especially in male-dominated sectors.[4] Therefore, it is reasonable that female college students anticipate this gender discrimination, particularly in fields like STEM and business. Using a theoretical framework, I formalize how these beliefs can lead to gender differences in grade sensitivity and major choices. I show that if women anticipate a lower likelihood of STEM/BEC job placement due to differential treatment in the labor market, they are more likely to leave the STEM/BEC major than men who receive the same grades.

In the survey, I collect data on each respondent's perceived gender discrimination in each field. Participants report their predicted likelihood of experiencing difficulties finding a job because of their gender, and the likelihood of facing differential treatment by their boss or peers based on gender. Using their responses, I create an anticipated gender discrimination index for each major. Men believe they are less likely to experience gender discrimination in the labor market than women, regardless of their major. Women believe they are more likely to face gender discrimination in the STEM/BEC labor market than in SSH.

I also collect students' perceptions about the labor market standards. Specifically, students report their beliefs regarding the minimum GPA required to secure a full-time job

[4]See Foschi et al. (1994); Goldin and Rouse (2000); Quintero (2008); Williams et al. (2014); Funk and Parker (2018); Alam and Tapia (2020).

in each major.[5] Although women anticipate higher standards than men in all fields, they expect particularly elevated requirements in STEM and BEC compared to SSH. Perceived labor market standards and anticipated gender discrimination are positively related, especially among women.

I find that the beliefs about the labor market standards and anticipated gender discrimination reduce the gap in WTP for GPA by 48%, making it no longer statistically significant. This means that when men and women expect the same level of gender discrimination and similar hiring standards, on average there is no statistical difference in how much they value grades. These results highlight the importance of considering perceived labor market standards and gender discrimination to understand why women and men value grades differently, particularly in STEM and BEC majors.

This paper contributes to both the literature on grade sensitivity and gender discrimination in the labor market. However, its main contribution is to bridge these two branches of scholarly work. It demonstrates that anticipated gender discrimination in the labor market is important for understanding the gender gap in grade sensitivity. While anticipated discrimination may not be the only factor driving this gender difference, it suggests different policy implications than explanations based on inherent gender differences like risk aversion or self-confidence. If students' perceptions of gender bias match the reality of the labor market, policymakers should address this systematic discrimination. Conversely, information interventions could be a valuable tool if beliefs are inaccurate.

Most of the work on grade sensitivity remains agnostic about the mechanisms driving the gender differences in reaction to grades.[6]. Therefore, I also contribute to this literature by providing evidence that self-confidence and misconceptions about academic performance play a lesser role compared to anticipated discrimination in understanding the gender gap in grade

[5]College GPA is commonly used in the hiring process for entry-level positions (McKinney and Miles, 2009, Hansen et al., 2023a) and higher GPA is associated with higher chances of getting a job (McKinney et al., 2003; Quadlin, 2018; Kessler et al., 2019).

[6]One exception is Kaganovich et al. (2021) which finds that tastes for different majors are important to understand the gender differences in grade sensitivity.

sensitivity. Additionally, the administrative data results and the estimated gender gaps in WTP for GPA are consistent with the scholarly work that finds women are more responsive to grades than men, particularly in male-dominated majors (Rask and Tiefenthaler, 2008; Ost, 2010; Owen, 2010; Goldin, 2015; Kugler et al., 2021; Kaganovich et al., 2021; Ahn et al., 2022; Ugalde A., 2024). Some papers within this literature fail to identify any effect of grades on economics course-taking behavior or STEM graduation (Main and Ost, 2014; Bestenbostel, 2021), while others find significant effects that do not differ by gender (Astorne-Figari and Speer, 2019; Chizmar, 2000; Owen, 2021). The differences in results may arise because some studies estimate the causal effect of marginal changes in *letter* grades, while my study focuses on preferences for cumulative GPA. Additionally, some papers are purely correlational or rely on designs that assume selection on observable characteristics, potentially susceptible to omitted variable bias. In my case, identification comes from within-individual variation in stated preferences. This reduces concerns about selection and allows me to estimate the complete distribution of preferences.

Despite the considerable amount of research on gender discrimination, there is much less work on anticipated gender discrimination or its relationship with major choices.[7] In the psychology literature, Steele et al. (2002) documents that female undergraduate students in mathematics, science, and engineering majors anticipate encountering more discrimination in their careers compared to women in the arts, humanities, and social sciences. In economics, Alston (2019) is one of the first papers to study anticipated discrimination as a potential explanation for women's underrepresentation in certain occupations by investigating its effect on applicants' decisions to apply for a stereotypically male job. In contrast, I analyze the effect of anticipated discrimination on major choice, which happens earlier in life and impacts occupation decisions. Therefore, my findings enhance our understanding of the impact of gender discrimination on human capital investment decisions.

The rest of the paper is organized as follows. Section 2 describes the administrative data

[7] See Shen (2021) for a literature review on gender discrimination.

and documents gender gaps in grade sensitivity among ASU students. Section 3 introduces the survey and describes the sample, and section 4 describes students beliefs about each major. Section 5 presents the hypothetical scenarios from the survey and section 6 estimates the preferences and WTP for GPA measures. In section 7, I focus on anticipated discrimination as a driver of the gender differences in WTP documented in the previous section, and in section 8, I analyze the role of other factors. Finally, section 9 concludes.

2 Women are more sensitive to grades

In this section, I use anonymized transcript-level data for 180,000 first-time freshmen at Arizona State University (ASU), one of the largest public universities in the United States, to provide suggestive evidence that women are more sensitive to grades in STEM and Business majors. The approach in this section is similar to Kaganovich et al. (2021).

The administrative data set goes back to the year 2000 and traces the trajectory of students as they progress through their college careers, including all fields of study switches. Majors are grouped into three broad categories: STEM, Business/Economics (BEC), and Humanities/Social Sciences (SSH).[8] I refer to these categories simply as majors.

The probability that freshmen remain in their first-year major conditional on their first-year GPA is calculated from the logit estimation of model (1) for each major separately.[9]

$$\mathbb{1}(\text{Stay})_{ikt} = \delta_0 + \delta_1 Female_i + \delta_2 GPA_{ik} + \delta_3 GPA_{i-k} + \mathbf{M}_i + \mathbf{N}_i + \gamma_t + \epsilon_{ik} \tag{1}$$

where $k \in \{\text{SSH, BEC, STEM}\}$, $\mathbb{1}(\text{Stay})_{ikt}$ is an indicator variable equal to one when student i from cohort t registered in major k during their freshman year remains in major k during

[8] See Appendix B for the list of majors in each category. The SSH category includes any majors that could not be classified as STEM or Business/Economics.

[9] The sample for this exercise consists of students that stay enrolled in college at least until the end of their sophomore year. In other words, it does not include people that dropout at the end of their freshman year. However, the gender differences in the probability of persisting in a given major are robust to including dropouts.

their sophomore year. $Female_i$ is equal to one when student i is female. GPA_{ik} represents cumulative GPA for student i at the end of their freshman year in major k, and GPA_{i-k} is a vector that contains the cumulative GPA in the other majors besides k. To create GPA_{ik} and GPA_{i-k}, all courses were classified into one of the three major categories (SSH, BEC, STEM) and the respective GPA was calculated using only the courses that correspond to that major. $\mathbf{M}_i$ is a set of academic controls: ACT/SAT test scores, high school GPA, and indicators for honors and exploratory students.[10] $\mathbf{N}_i$ includes controls for minority, income, in-state student, and first-generation status. Finally, γ_t represents cohort fixed effects.

The results from this exercise are summarized in Figure 1. The bars represent the probability of staying in the major indicated at the top of each panel given the first-year GPA level on the horizontal axis. In panels (1b) and (1c), the probability of staying in STEM and BEC majors decreases as the GPA decreases, which means that students are more likely to switch out of these majors when they have low grades. Additionally, this pattern is sharper for women than for men, which illustrates the fact that women are more responsive to grades in these majors than men.[11] However, such a gender difference is not observed in SSH in panel (1a), where the gender gap in the probability of staying in that major remains constant regardless of first-year GPA.

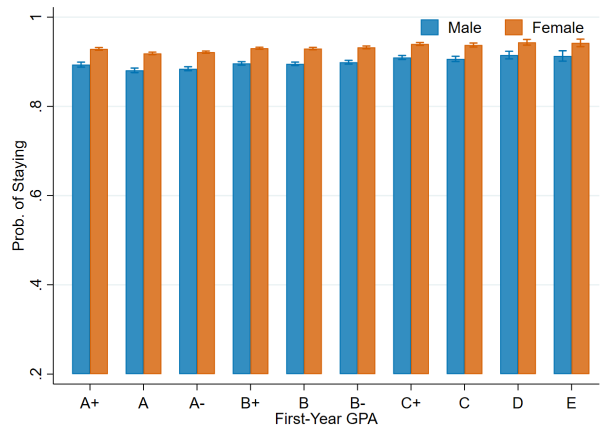
These results are consistent with previous literature on grade sensitivity (Rask and Tiefenthaler, 2008; Ost, 2010; Goldin, 2015; Kugler et al., 2021; Kaganovich et al., 2021), and suggest that women care about grades more than men, particularly in STEM/BEC majors. However, due to selection concerns and confounders like tastes for different majors, observational data alone have a limited ability to shed light on what exactly leads to these patterns. When I see people changing majors in the administrative data, it is impossible to

[10]The exploratory indicator identifies students that did not declare a major in their freshman year. However, exploratory students are enrolled in special programs that allow them to explore several majors within an area, which facilitates their classification in one of the three broad categories. The most common exploratory programs are health and life sciences; humanities, fine arts and design; mathematics, technology, engineering, and physics; and social and behavioral sciences.

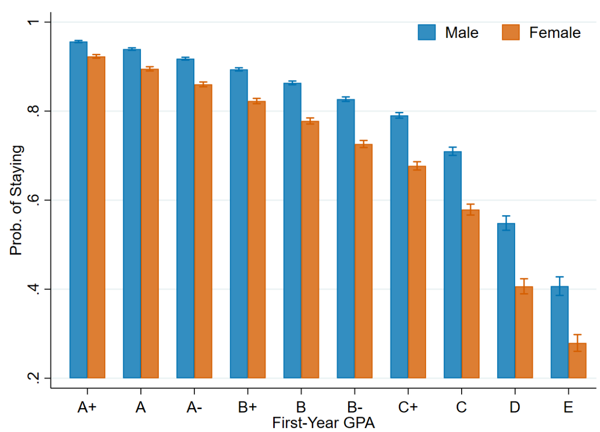
[11]The difference between the blue and orange bars is statistically different from zero at 1% for all GPA levels.

Figure 1: Probability of Persisting in a Major by First Year GPA

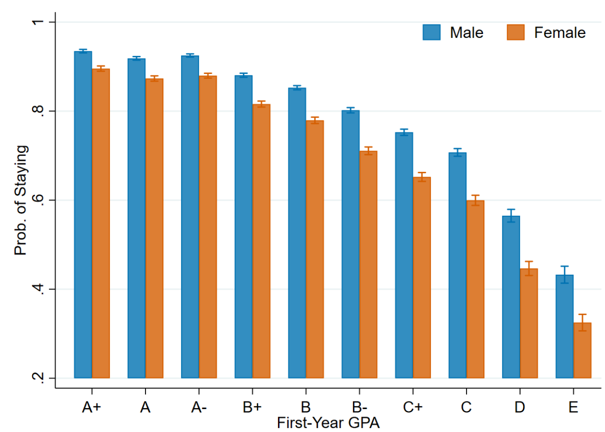
(a) SSH



(b) STEM



(c) BEC



Notes: Bars represent the probability of staying in the major indicated at the top of each panel given the first-year GPA level on the horizontal axis, estimated from a logit model that regresses an indicator for staying in the same major as in the first year on a female indicator, the GPA in that major, and the GPA in the other majors. All regressions control for minority status, family income, first generation, in-state, honors and exploratory status, ACT/SAT, high school GPA, and cohort FE. Spikes represent 95% CI.

know exactly why they are doing it and what is the role of grades in such decisions. For that reason, I designed a survey experiment that allows me to quantify student's sensitivity to grades in a cleaner way, and understand better why women and men could value grades differently and how those differences impact their decision to persist or switch out of a given major. I describe the survey in the next section. Given the similar patterns for STEM and BEC in Figure 1, for most of the analysis these two categories will be pooled into one.

3 Survey Data

3.1 Survey

The data come from an original online survey of undergraduate students at ASU. Students were directly invited to participate via email. Additionally, the study was advertised on the My ASU website, accessible only through the student's ASU ID and password. Students were invited to participate in a study about how they chose their major and the relationship between study time and grades, for which they would enter a lottery for one of 350 $20 eGift Cards. Data collection started on April 5th, 2021 and lasted for about two weeks.

The survey was programmed in Qualtrics. It also collected data on students' demographics, family background, major, academic performance, and study time. The survey instrument can be found here.

3.2 Sample

A total of 2,036 respondents completed the survey. 3% of participants that identify as non-binary or decided not to disclose their gender were excluded from the analysis. Additionally, responses in the 1st and 99th percentile of survey duration were excluded, leading to a final sample size of 1,936. The median completion time was 23 minutes (43 minutes on average).

Women comprise 64% of the sample. Although they are over-represented in the survey sample relative to ASU's student population (51% female), there is no differential selection on observables across genders (see Table 1). This suggests that, in terms of gender differences in background characteristics, the sample is a reasonable representation of ASU students.

Table 1: Sample Compared to ASU Population

	Survey			ASU			P-value[c]
	Female	Male	Diff.	Female	Male	Diff.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Black	0.05	0.03	0.02	0.04	0.03	0.01	0.134
White	0.66	0.70	-0.04	0.46	0.48	-0.02	0.498
Hispanic	0.23	0.18	0.05	0.29	0.23	0.07	0.284
First Generation[a]	0.29	0.23	0.06	0.31	0.23	0.08	0.263
Family Income[b]	102	109	-7.1	126	151	-26	0.181
Freshman	0.22	0.20	0.02	0.26	0.25	0.01	0.776
Sophomore	0.24	0.23	0.00	0.26	0.25	0.01	0.853
Junior	0.30	0.30	0.01	0.22	0.22	0.00	0.806
Senior	0.24	0.27	-0.03	0.26	0.28	-0.02	0.742
ACT	27.71	28.56	-0.85	23.98	25.62	-1.64	0.003
STEM	0.38	0.58	-0.20	0.25	0.46	-0.20	0.689
BEC	0.18	0.21	-0.03	0.18	0.27	-0.10	0.000
SSH	0.44	0.22	0.22	0.57	0.27	0.30	0.001
Sample Size	1,236	700		22,755	21,637		0.000[d]

Notes: ASU data includes everyone taking at least one class for credit during the Spring semester of 2021 and attending ASU as their first full-time university. Income and first generation variables for the ASU data are constructed with the first year of available data, which it is not the freshman year all the sample.
[a] Students with no parent with a college degree.
[b] Family income in thousands of dollars.
[c] P-value for whether the gender differences in the survey sample and the ASU population are different.
[d] P-value for the difference in females proportion between the survey sample and ASU population.

For the survey, majors were grouped into the same three broad categories: STEM, Business/Economics (BEC), and Humanities/Social Sciences (SSH).[12] I refer to these categories simply as majors. The last three rows in Table 1 show the proportion of women and men in

[12]The SSH category includes any majors that could not be classified as STEM or BEC.

each major. The sample includes fewer men in BEC and fewer students in SSH than ASU's student population. However, the gender gap in STEM is the same in the survey sample and the ASU student body (20% gap).

4 Major Attributes

As discussed in section 2, there is a relationship between students' grades and their persistence in certain majors. Therefore, in the survey, I asked participants to report their beliefs about certain major characteristics including average GPA. In particular, they provided their beliefs about three attributes: average GPA at graduation, average weekly study time, and average earnings at a full-time job after graduation.

Table 2: Beliefs about Major Attributes by Gender

	Av. GPA			Av. Study Time			Av. Earnings		
	Female	Male	P-value	Female	Male	P-value	Female	Male	P-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SSH	3.47	3.38	0.000	14.60	12.68	0.000	41.60	40.01	0.005
	(0.27)	(0.30)		(8.26)	(7.49)		(12.56)	(10.74)	
BEC	3.37	3.29	0.000	14.06	13.20	0.024	55.02	53.57	0.067
	(0.31)	(0.31)		(8.17)	(7.89)		(17.66)	(14.80)	
STEM	3.37	3.21	0.000	22.72	21.23	0.002	66.47	64.16	0.020
	(0.33)	(0.32)		(10.19)	(9.97)		(22.57)	(17.88)	

Notes: P-value from a difference in means test across genders. Earnings in thousands of dollars. SD reported in parentheses.

Table 2 reports the mean and standard deviation of participants' beliefs about each of these attributes for each major by gender. Participants believe that SSH has the highest average GPA at graduation relative to the other two majors. On average, women believe that GPA at graduation in BEC and STEM are similar (p-value=0.497), while men believe that grades in STEM are lower than grades in BEC (p-value<0.01). As column (3) reflects, women believe that the GPA at graduation is higher than what men believe, regardless of major.

Regarding weekly study time, women's beliefs are 1-2 hours per week higher than men's. However, the pattern across majors is similar by gender. Both men and women believe that SSH is the major where students study the least per week followed closely by BEC, and STEM is the major that requires weekly study time (8-9 hours on average per week more than SSH).

In terms of earnings, participants believe that average earnings are higher in STEM, at around $64,000 - $66,000, followed by BEC at $54,000 - $55,000. SSH is in last place with average earnings beliefs around $40,000 -$41,000. As illustrated by the p-values in Table 2 column (9), women's beliefs about earnings are higher than men's regardless of major by about $1,500 - $2,000.

Table 3: Proportion of Participants that Rank a Major Highest for a Given Attribute, by Gender

	Av. GPA			Av. Study Time			Av. Earnings		
	Female	Male	P-value	Female	Male	P-value	Female	Male	P-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SSH	0.33	0.46	0.005	0.02	0.02	0.995	0.01	0.01	0.443
BEC	0.26	0.22	0.397	0.01	0.03	0.058	0.12	0.11	0.235
STEM	0.41	0.32	0.043	0.97	0.96	0.180	0.87	0.89	0.174

Notes: For each attribute and by gender, the table reports the proportion of participants that report each major having the highest level of the attribute (highest earnings, GPA or study time). For instance, 0.87 of women believe that earnings in STEM jobs are higher than in BEC and SSH, but only 0.01 believe that SSH jobs pay higher earnings than STEM and BEC. P-value from a difference in means test across genders.

Differences between majors in beliefs about each attribute are further analyzed in Table 3. It presents the proportion of women and men that report each major having the highest attribute. For instance, 96% and 97% of men and women, respectively, believe that the average weekly study time is higher in STEM than in BEC and SSH. While only 2% of men and women believe that SSH majors require the highest study time. This suggests, that in general, students perceive STEM majors as requiring higher effort.

In terms of average earnings, 87% and 89% of women and men, respectively, believe that jobs in STEM areas pay on average higher earnings than SSH and BEC. However, 12-11% of women and men believe instead, that jobs in BEC pay higher wages than STEM and SSH. Only 1% of participants from each gender believe that SSH jobs pay higher earnings than the other two majors. These results imply that students expect big earning differences, particularly between SSH and the other areas.

Ranks in terms of average GPA at graduation are less extreme. A third of the women believe that average grades are higher in SSH, 41% believe that they are higher in STEM, and 26% believe that students in BEC graduate with the highest average grades. On the other hand, a higher share of men, 46%, rank SSH as having the highest grades at graduation, while 22% and 32% believe the same for BEC and STEM, respectively. Therefore, although there is a clear ranking of majors in terms of effort and earnings, the ranking is not as clear in terms of grades.

All the evidence in this section illustrates the variety of beliefs that students hold about major attributes, particularly in terms of grades across different majors. Beliefs about major characteristics like average grades, study time and earnings, tastes for each major, and shocks play a role when students decide to persist or switch out of a major. Since the administrative data do not provide information about any of these potential confounders, it has limited ability to shed light on the role that gender differences in grade sensitivity play in such decisions. Therefore, in the next section, I describe a survey experiment that allows me to quantify gender differences in grade sensitivity with a cleaner approach, by exogenously changing different major attributes, particularly average GPA at graduation.

5 Hypothetical Scenarios

To quantify gender differences in grade sensitivity, I use hypothetical scenarios to collect data that allows me to estimate students' preferences for different major attributes (Blass et al., 2010; Delavande and Manski, 2015; Wiswall and Zafar, 2018; Folke and Rickne, 2022;

Koşar et al., 2022; Fuster and Zafar, 2023). Specifically, the survey included a hypothetical scenarios module that presented students with 10 different scenarios. In each scenario, majors were characterized by three attributes: average GPA at graduation, average weekly study time, and average earnings at a full-time job after graduation. Scenarios appeared one at a time. Table 4 is an example of how each scenario was presented to the participants.

Table 4: Scenario Example

	Av. GPA	**Av. Study Hours per week**	**Av. Earnings after Grad. (full-time job)**
SSH	3.47	8.0	$24,000
BEC	2.23	7.0	$49,000
STEM	2.00	22.0	$46,000

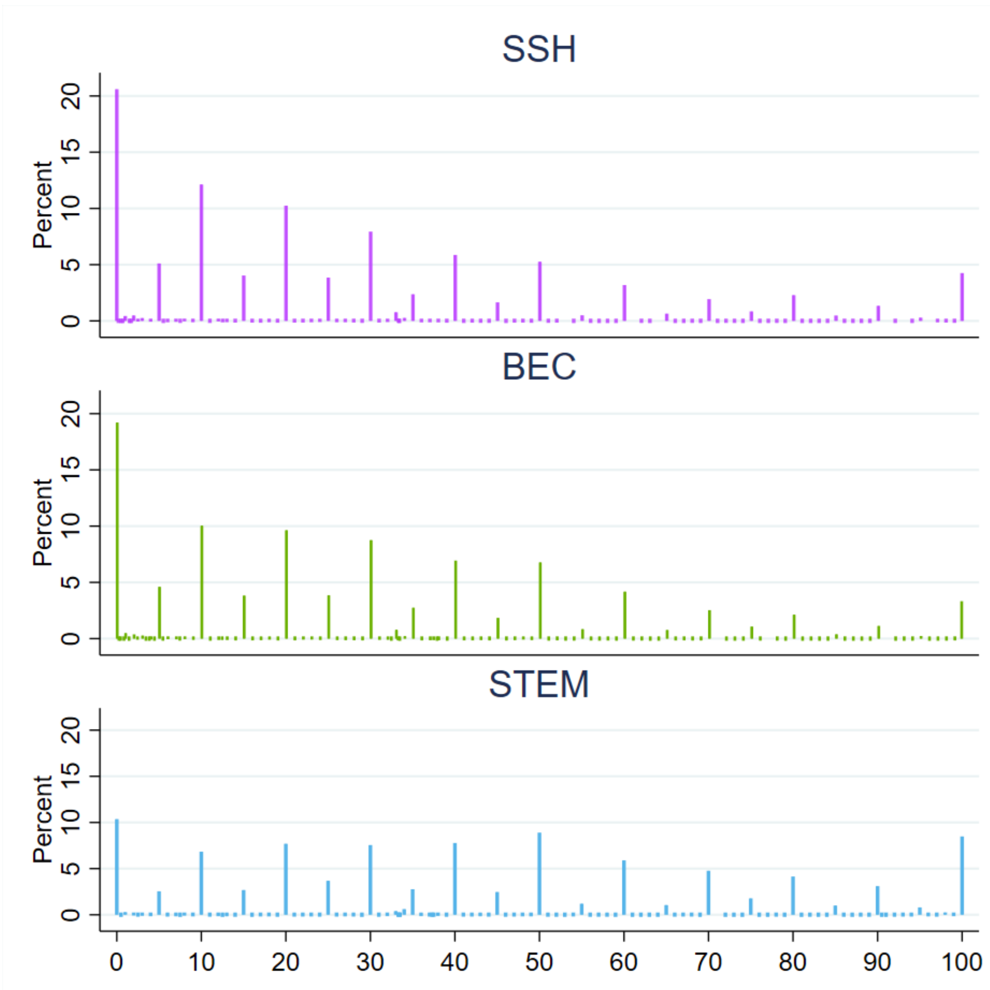
I exogenously vary the magnitude of the attributes to identify participants' preferences for each of them. Scenarios are individual-specific to guarantee that each situation presented the student with attributes for each major that are realistic given the student's beliefs. Concretely, each scenario is a perturbation of the student's beliefs about the average GPA at graduation, study time, and full-time earnings for each major.

In each scenario, students reported the probability that they would choose each of the three majors given the characteristics.[13] Participants were asked to report probabilities because the scenarios they were facing were not fully specified. Majors can be characterized by more than the three attributes included in the survey. Therefore, participants are allowed to express their uncertainty about what they would choose given the incompleteness of the scenarios. Figure 2 shows the histogram of elicited choice probabilities for each major pooled across the ten hypothetical scenarios. As is common for probabilistic belief data (Manski,

[13]The exact wording of the question was: *Imagine a situation in which you have not chosen a major yet and each major category is characterized as in the table below... What is the percent chance (or chances out of 100) that you would choose to graduate from each category given these characteristics?* See the survey instrument here for more details.

2004), responses tend to be multiples of 5 and 10, which likely reflects minor rounding bias.[14] Figure 2 also shows that responses covered the whole support and not only values like 0, 50, or 100, which would reflect a problem with gross rounding (Manski, 2004). Additionally, 86% of the participants reported interior probabilities (not 0 or 100) in all their responses, which underscores the importance of allowing participants to express uncertainty in their choices.[15]

Figure 2: Choice Probabilities by Major



Notes: Histograms of choice probabilities for each major pooled across all scenarios.

An important implicit assumption when eliciting choice probabilities in this way is that

[14]Section 6 explains how the rounding bias is handled.
[15]Only 3% reported that they would choose one of the majors with 100% probability in all scenarios.

stated choices reflect what the participants would choose in real-life scenarios. There is growing evidence that stated choices generated similar preference estimates as revealed preference approaches and that participants provide meaningful responses when the scenarios are realistic and relevant for them (Fuster et al., 2021; Fuster and Zafar, 2023). In this case, major choice decisions are certainly relevant for college students. Moreover, as mentioned earlier, the scenarios were created to be as realistic as possible given each participant's beliefs. Although I cannot test this assumption directly, it is reassuring that the results obtained from the hypothetical scenarios are consistent with the administrative data results in Figure 1 generated from actual choices, which suggests that participants provided meaningful responses (See section 6.2).

This design generates a panel of probability choices at the individual level, with 30 observations per participant, which allows me to estimate the distribution of preferences without any distributional assumptions. The next section describes the estimation procedure, and how the estimated preferences are used to calculate a measure of willingness-to-pay (WTP).

6 Preferences for Major Attributes

Similar to Wiswall and Zafar (2018), I use a simple model of expected utility of major choices that provides a framework to recover quantitative measures of WTP for the different major attributes. In particular, the model intends to recover how the utility of choosing a given major varies with GPA.

Let U_{ijs} denote the utility that student i gets from major j in scenario s. This utility is given by

$$U_{ijs} = X'_{ijs}\beta_i + \kappa_{ij} + \epsilon_{ijs} \tag{2}$$

where X_{ijs} is a vector that contains the attributes of the major: average GPA, average weekly study time, and the natural logarithm of the average earnings. β_i is the vector that represents the individual-specific preferences for each of the attributes. These preferences are not major-specific. κ_{ij} is a major-specific constant that captures tastes for the major.[16] Finally, since the scenarios in the survey are not fully specified, ϵ_{ijs} represents students' uncertainty about other attributes of the major at the time of the elicitation. I follow Blass et al. (2010) and Wiswall and Zafar (2018) in interpreting ϵ_{ijs} as resolvable uncertainty, which means uncertainty at the time of the data collection that individuals know would be resolved in the case of an actual choice. The key identifying assumption is that, conditional on major, $\{\epsilon_{ijs}\}_{j=1}^{J}$ represents idiosyncratic variation which is orthogonal to the major attributes included in $\{X_{ijs}\}_{j=1}^{J}$.

Then, student i's reported probability of choosing major j in scenario s is

$$p_{ijs} = \int \mathbb{1}\left\{U_{ijs} > U_{ij's} \quad \forall j' \neq j\right\} dH_i(\epsilon_{is}) \tag{3}$$

where $H_i(\epsilon_{is})$ represents i's belief about the distribution of $\{\epsilon_{i1s}, ..., \epsilon_{iJs}\}$. I assume these beliefs are i.i.d Type I extreme value for all individuals. Therefore, student i's reported probability of choosing major j in scenario s takes the following form:

$$p_{ijs} = \frac{exp(X'_{ijs}\beta_i + \kappa_{ij})}{\sum_{j'=1}^{J} exp(X'_{ij's}\beta_i + \kappa_{ij'})} \tag{4}$$

Applying the log-odds transformation to equation (4) results in the linear model in (5).

$$ln\left(\frac{p_{ijs}}{p_{ij's}}\right) = (X_{ijs} - X_{ij's})'\beta_i + (\kappa_{ij} - \kappa_{ij'}) \tag{5}$$

As is common in the literature (Blass et al., 2010; Wiswall and Zafar, 2018), I introduce measurement error to the model in (5) to account for the possibility of the minor rounding bias mentioned earlier. The assumption is that measurement error takes a linear-in-logs

[16] For estimation purposes the constant for SSH major is normalized to zero, therefore the tastes for other majors are relative to SSH.

form, therefore the reported log-odds ratio is

$$ln\left(\frac{\tilde{p}_{ijs}}{\tilde{p}_{ij's}}\right) = (X_{ijs} - X_{ij's})'\beta_i + (\kappa_{ij} - \kappa_{ij'}) + \omega_{ijs} \tag{6}$$

where $\tilde{p}_{ijs}$ is the reported choice probability that measures the true probability, p_{ijs}, with measurement error ω_{ijs}. Additionally, the measurement error has a median of zero conditional on X.

Therefore, (6) is estimated using the Least Absolute Deviations (LAD) estimator. Since the left-hand side variable in (6) is the logarithm of the ratio of probability choices, extreme answers like 0 or 100 must be changed such that the natural logarithm is always defined. The LAD estimator has the advantage of not being sensitive to the values used to replace these extreme probabilities.[17] Variation in major attributes and variation in participant's choice probabilities across the 30 observations per respondent allows identifying the vector β_i for each student i separately. This allows for a non-parametric characterization of the preferences distribution. However, β_i is not major-specific as there are only 10 observations per participant per major, which is not sufficient to identify preferences at that level.

6.1 Estimates of Preferences for Major Attributes

Table 5 reports the average β_i estimates from equation (6), bootstrapped standard errors are reported in parentheses.[18] The first column shows the average estimate for each attribute and tastes across all individual-level estimates. Columns 2 and 3 report the average estimates by gender.

The average estimates have the expected signs: estimates for GPA at graduation and log of earnings are positive, while the estimates for study time are negative. This means

[17] Probabilities of 0 were replaced with 0.001 and 100 with 99.9.

[18] Sample size is smaller because seniors are not included in the analysis of the hypothetical scenarios data since they are closer to graduation and their preferences for major attributes might be different than those of less senior students. However, all results are qualitatively the same if seniors are included. Additionally, I drop outliers with WTP for study time or GPA greater (as defined in the next subsection) than \$100,000 or less than -\$100,000 (5.5% of the sample).

that, on average, students prefer majors that pay higher earnings after graduation and have on average higher GPA, but lower weekly study time. By gender, the estimates for major attributes present the same qualitative patterns as the average estimates. Additionally, all attributes are statistically different from zero. In terms of tastes, on average, students prefer BEC and STEM majors less than SSH majors (the estimates are relative to SSH), although among men the average BEC and STEM taste estimates are not statistically different from zero.

Table 5: Estimates of Preferences for Major Attributes

	Overall	Female	Male
	(1)	(2)	(3)
GPA at Grad.	0.650***	0.689***	0.574***
	(0.064)	(0.079)	(0.118)
Study time (h/week)	-0.070***	-0.060***	-0.090***
	(0.007)	(0.009)	(0.014)
Log earnings	4.569***	4.058***	5.558***
	(0.154)	(0.182)	(0.291)
Taste for BEC	-0.430***	-0.557***	-0.184
	(0.085)	(0.105)	(0.143)
Taste for STEM	-0.078	-0.244**	0.244
	(0.096)	(0.113)	(0.175)
N	1,192	786	406

Notes: Table reports the average of the coefficientes across the relevant sample. Tastes for BEC and STEM are relative to SSH. Asterisks denote estimates that are statistically different from zero based on bootstrapped standard errors. *Significant at 10%, **5%, ***1%

Given the difficulty of interpreting the magnitudes in these estimates, the next subsection converts the estimates to a willingness-to-pay (WTP) measure in order to quantify the gender gap in grade sensitivity in an easily interpretable way.

6.2 Willingness-To-Pay Measures

In this section, I calculate WTP measures based on the estimated preferences. These estimates translate the differences in utility due to different amounts of a given attribute into the earnings that would make the student indifferent between the two attribute levels.

The thought experiment to compute the WTP is as follows: consider a change in the level of attribute X_k from $X_k = x_k$ to $X_k = x_k + \Delta$ with $\Delta > 0$. Given the linear utility function, it is possible to write the following indifference condition in terms of earnings Y:

$$x_k \beta_{ik} + \beta_{i1} ln\left(Y\right) = \beta_{ik}\left(x_k + \Delta\right) + \beta_{i1} ln\left(Y + WTP_{ik}\left(\Delta\right)\right) \tag{7}$$

Solving (7) for WTP gives the following expression:

$$WTP_{ik}\left(\Delta\right) = \left[exp\left(\frac{-\beta_{ik}}{\beta_{i1}}\Delta\right) - 1\right] \times Y, \tag{8}$$

which is individual i's willingness to pay for a Δ increase in attribute k. Equation (8) depends on the ratio of the student preferences for attribute k, β_{ik}, and preferences for earnings, β_{i1}. Additionally, given the log form in the utility for earnings, the WTP measure depends on the level of earnings Y. For the calculations, Y is the average earnings across all participants across all scenarios ($53,318). The objective of having the same level for all respondents is that any gender differences in WTP discussed later will reflect only differences in preferences, not differences in earnings. The WTP measure is not major-specific since it depends on β_i which is not major-specific.[19]

Table 6 shows the average and median WTP measures for one extra unit of the attribute. That is one whole GPA point at graduation (from 2.3 to 3.3 for example) and one extra hour of study time per week. All means and medians reported in Table 6 are statistically different from zero (p-value<0.01). Columns (1)-(3) present the WTP measures in dollars and the last

[19] As mentioned in section 6, there are only 10 observations per participant per major, which is not sufficient to identify preferences at that level.

Table 6: WTP Estimates

	Dollars			% of Av. Earnigs			
	Overall	Female	Male	Overall	Female	Male	P-value[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GPA at Grad.	8,309	9,089	6,799	15.58	17.05	12.75	0.099
	[6,608]	[7,790]	[4,882]	[12.39]	[14.61]	[9.16]	0.018
	(652)	(811)	(1,126)	(1.22)	(1.52)	(2.11)	
Study time	-1,479	-1,428	-1,579	-2.77	-2.68	-2.96	0.725
	[-638]	[-608]	[-714]	[-1.20]	[-1.14]	[-1.34]	0.234
	(196)	(241)	(355)	(0.37)	(0.45)	(0.67)	
N	1,192	786	406				

Notes: Table reports WTP mean, median in squared brackets, and bootstrapped standard errors in parentheses in dollars and as percentage of average earnings. All means and medians are statistically different from zero at 1%.
[a] P-value from a difference in means or medians test by gender.

three columns display the WTP as a percentage of average earnings. The stars in the male columns (3) and (6) represent the significance level from a difference in means (or medians) test by gender.

On average, students are willing to pay 16% of the average annual earnings for a one-point increase in the average GPA at graduation of a given major but must be compensated with an extra 3% in average annual earnings to study one more hour per week. By gender, women are willing to pay 17% of their annual earnings for the one-point increase in the average GPA at graduation, but men only 13% (p-value< 0.1). However, there is no gender difference in the average WTP for weekly study time.

I interpret the WTP for GPA as a measure of students' sensitivity to grades. Since the objective is to understand why women and men value grades differently and how this could impact their major choices, I focus on this measure henceforth.

Table 7 reports the gender gap in WTP for GPA at graduation conditional on background characteristics. In particular, Table 7 reports α_1 from:

$$WTP_{GPAi} = \alpha_0 + \alpha_1 Female_i + \mathbf{C}_i + \xi_i \tag{9}$$

where the outcome variable is participant i's WTP measure for GPA at graduation. $Female_i$ is an indicator equal to one when the participant is female. $\mathbf{C}_i$ includes controls for family income, parents' education, minority status, SAT/ACT scores, school year, and indicators for honors students and majors.

Table 7: Gender Gaps in WTP for GPA

	Overall	STEM/BEC	SSH
	(1)	(2)	(3)
Female	3,057**	3,760**	1,760
	(1,440)	(1,661)	(2,801)
Mean	8,309	9,414	6,307
R2	0.02	0.02	0.02
N	1,192	768	424

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority. Additionally, column (1) controls for major. Bootstrapped standard errors reported in parentheses. Columns (2) and (3) split sample by reported major of participants. *Significant at 10%, **5%, ***1%.

Column (1) reports the overall conditional gender gap at $3,057. This gap means that women are willing to forego $3,057 of average annual earnings more than men for an extra GPA point at graduation in a given major. I interpret this difference as the gender gap in grade sensitivity since women are willing to "pay" more for the point increase. In columns (2) and (3) the sample is split by major: STEM/BEC versus SSH.[20] From this, it is clear that the overall gender gap is driven by the gap among STEM/BEC students where the difference in WTP for GPA at graduation between genders reaches $3,760. The gap is smaller ($1,760) and not statistically different from zero among the SSH students. These results are consistent

[20]STEM and BEC majors are pooled together given the similar patterns in grade sensitivity observed in Figure 1.

with the administrative data evidence in Figure 1 discussed earlier: women in STEM/BEC majors are more sensitive to grades than men, but this gap is not observed in other majors.

7 What could be driving the gap?

There could be many potential mechanisms driving the gender differences in grade sensitivity documented in the previous sections. For example, the literature suggests gender differences in risk aversion (Paola and Gioia, 2012), willingness to compete (Buser et al., 2014), self-confidence (Ellis et al., 2016; Moakler and Kim, 2014), and misconceptions about academic performance in male-dominated majors (Owen, 2023).

Another possibility is anticipated labor market discrimination (Steele et al., 2002). There is evidence that men favor male candidates for engineering positions even when a female candidate performs better (Foschi et al., 1994), women face gender bias in symphony orchestra hiring (Goldin and Rouse, 2000), and harsher treatment in government recruitment processes (Quintero, 2008). Additionally, 50% of women in STEM jobs in the US report having experienced gender discrimination (Funk and Parker, 2018), and 64% of female scientists feel they must provide more evidence of competence to their colleagues (Williams et al., 2014).

Thus, it is reasonable that female students could anticipate facing gender discrimination in the labor market, and even have heterogeneous beliefs about the level of discrimination they could experience in different fields. These beliefs could impact their response to grades and major choices, and help to explain the gender gap in sensitivity for grades documented earlier. Therefore, the primary focus of this section is on beliefs about gender discrimination and labor market standards. I also collect data about self-confidence and beliefs about grades in different fields, however they do not seem to be systematically related to grade sensitivity. Therefore, I consider them later in section 8.

Despite the substantial amount of research on gender discrimination in the labor market, there is considerably less work on anticipated discrimination and even less on its potential effects on major choices (Steele et al., 2002; Alston, 2019). Therefore, studying this mechanism represents a significant contribution to our knowledge about the effects of gender discrimination in different spheres of life. Additionally, it is important to investigate mechanisms that do not rest on inherent differences between men and women (risk-aversion, self-confidence, willingness to compete), but instead rest on beliefs about the labor market, like anticipated gender discrimination, because providing evidence of their relevance would suggest different policy implications than other explanations.

In the next section, I present a theoretical model of major choices that incorporates potential discrimination in the labor market against women to develop intuition about the role of beliefs about gender discrimination in decisions about field of study. Then, I provide evidence of the gender gaps in beliefs about gender discrimination and labor market standards using the survey data. Finally, I provide evidence of the importance of those beliefs in explaining the gender differences in grade sensitivity documented earlier.

7.1 Conceptual Framework

In this section, I setup a theoretical framework to formalize the intuition behind how beliefs about gender discrimination in the labor market can lead to gender differences in grade sensitivity and major choices. I add the employer side from Coate and Loury (1993)'s model of labor market discrimination to a framework where students revise their major decisions after receiving grades. When students decide to stay or leave a major they take into account their study costs, beliefs about their ability, and potential gender discrimination in the labor market.

I incorporate the possibility of gender discrimination by making the utility from each major depend of the probability of finding a job, which could differ by gender given how students believe the labor market works. They believe that as in Coate and Loury (1993), if employers in a given field discriminate against women they impose a more rigorous hiring rule for them. Female students incorporate that differential treatment in their major decision as a lower probability of getting hired in that field.

The goal is to show that by allowing major choices to be affected by discrimination in the labor market, women and men that receive the same grades make different decisions about staying in or leaving a given major. The difference arises because they believe they will be treated differently in the labor market based on gender.

7.1.1 Environment

Consider a mass one of female (F) students and a mass one of male (M) students. Gender is denoted by $g \in \{M, F\}$. There are two majors (k): STEM/BEC denoted by S and SSH denoted by N. All students are initially enrolled in major S. Students can be high (h) or low (l) ability, but they do not observe their level of ability. There is a P proportion of high-ability individuals. Additionally, students have a heterogeneous marginal cost for an extra hour of studying $c_i \sim U(0,1)$.

Students receive grades which are noisy signals about their ability. Grades are drawn from $[0,1]$ according to the pdf $f_h(\theta)$ if the student is high ability or $f_l(\theta)$ if they are low ability. The corresponding CDFs are F_h and F_l, respectively. I assume that $f_h(.)$ and $f_l(.)$ satisfy the Monotone Likelihood Ratio Property (MLRP).[21] Thus, higher grades are more likely if the student is high ability.[22]

Students believe there is a separate labor market for each field, which means that students who graduate with a degree in major k participate in the labor market for field k. Additionally, they believe that employers behave as follows. Employers in a given field have a prior belief π_g^k about the fraction of high ability individuals in the pool of workers of gender g. Employers get $x_h^k > 0$ if they hire a high ability student and $x_l^k < 0$ if they hire a low ability student. They observe students' GPA (grades) at graduation, θ, which are a noisy signal of the student ability, and update their beliefs about that particular student being

[21] $\psi(\theta) = \frac{f_h(\theta)}{f_l(\theta)}$ is strictly increasing and continuous in θ for all $\theta \in [0,1]$

[22] MLRP implies that F_h FOSD F_l, and that, for a given prior, the probability of being high ability is increasing in the grades (signal).

high ability following Bayes rule. The posterior probability is denoted by:

$$p(\theta; \pi_g^k) = \frac{\pi_g^k f_h(\theta)}{\pi_g^k f_h(\theta) + (1 - \pi_g^k) f_l(\theta)} \tag{10}$$

7.1.2 Hiring Decisions

The firm will optimally choose to hire a student that provides signal θ if and only if

$$p(\theta; \pi_g^k) x_h^k - [1 - p(\theta; \pi_g^k)] x_l^k \geq 0 \tag{11}$$

Using (10) in the condition above, a firm hires a student if and only if:

$$\frac{f_h(\theta)}{f_l(\theta)} \geq \frac{1 - \pi_g^k}{\pi_g^k} \frac{x_l^k}{x_h^k} \tag{12}$$

The MLRP implies the existence of a unique $\tilde{\theta}_g^k \in (0, 1)$ such that (12) holds with equality.[23] This means that the employer follows a cutoff hiring rule. The firm will hire a student if their grade (signal) is higher than the cutoff, i.e. $\theta > \tilde{\theta}_g^k$.

Assume that $\frac{x_l^N}{x_h^N} < \frac{x_l^S}{x_h^S}$, i.e. the ratio of profit to losses is higher in S than in N. This is reasonable since the potential problems of hiring a low-ability worker in a more technological sector like S might be greater than in N. This assumption guarantees that the signal cutoff in the N sector is lower than in the S sector, $\tilde{\theta}_g^N < \tilde{\theta}_g^S$, for both genders. This conclusion is consistent with the average response in the survey about the labor market standards.

Additionally, it is the case that $\frac{d\tilde{\theta}_g^k}{d\pi_g^k} < 0$.[24] As the belief about the proportion of high ability workers in the pool of potential employees increases the firm uses a lower threshold for the grades in order to hire them; in other words a less rigorous standard. This property will be relevant later when considering perceived discrimination in the S labor market. Dis-

[23] If (12) does not hold with equality for any $\theta \in (0, 1)$, then $\tilde{\theta}(\pi_g^k) = 0$ if $\frac{f_h(0)}{f_l(0)} = \frac{1-\pi_g^k}{\pi_g^k} \frac{x_l^k}{x_h^k}$ or $\tilde{\theta}(\pi_g^k) = 1$ if $\frac{f_h(1)}{f_l(1)} = \frac{1-\pi_g^k}{\pi_g^k} \frac{x_l^k}{x_h^k}$. See Fang and Moro (2011) for more details.

[24] See Fang and Moro (2011) for proof.

crimination will be introduced as the belief that the proportion of high-ability (productive) women in the S labor market is lower than men, $\pi_F^S < \pi_M^S$. Therefore, $\tilde{\theta}_F^S > \tilde{\theta}_M^S$, which means that in the presence of perceived gender discrimination women will face a more rigorous standard than men since they need to provide a better signal (higher GPA) in order to get hired.

7.1.3 Revising Major Decisions

At the end of their first year, students receive their grades, θ_i, drawn from their respective distribution according to ability, $f_h(.)$ or $f_l(.)$. Given this new information, students update their beliefs about being high-ability following Bayes rule, and potentially revise their major choice. P is the proportion of high-ability students and the prior belief about being high-ability.

Given grades, θ_i, the posterior belief about being high-ability is

$$P'(\theta_i) = \frac{Pf_h(\theta_i)}{Pf_h(\theta_i) + (1 - P)f_l(\theta_i)} \tag{13}$$

After receiving the grades and updating their beliefs, students compare the utility of each major and choose the one with higher utility. Therefore, based on the new information they can stay in S or switch into N.

The utility of studying each major is given by the expected payoff of a job after graduation in that field minus the cost of studying. Jobs in S pay 1 and jobs in N pay $v < 1$. The expected payoff depends on the probability of finding a job, which depends on the probability that the GPA at graduation, θ_i, is above the cutoff in the corresponding field, $\tilde{\theta}_g^k$. This probability is:

$$P'(\theta_i)[1 - F_h(\tilde{\theta}_g^k)] + (1 - P'(\theta_i))[1 - F_l(\tilde{\theta}_g^k)] \tag{14}$$

Utilities for each major are as follows:

$$U_g^N(\theta_i) = vP'(\theta_i)[1 - F_h(\tilde{\theta}_g^N)] + v(1 - P'(\theta_i))[1 - F_l(\tilde{\theta}_g^N)] - \delta^N c_i \tag{15}$$

$$U_g^S(\theta_i) = P'(\theta_i)[1 - F_h(\tilde{\theta}_g^S)] + (1 - P'(\theta_i))[1 - F_l(\tilde{\theta}_g^S)] - \delta^S c_i \tag{16}$$

where δ^k represents the number of study hours required by major k. Major S requires more study time than N, $\delta^S > \delta^N$.

A student i of gender g chooses to stay in S if $U_g^S(\theta_i) \geq U_g^N(\theta_i)$. The MLRP implies that a reservation grade $\theta_i^* \in (0, 1)$ exists such that[25]

$$\begin{cases} U_g^S(\theta_i) \geq U_g^N(\theta_i), & \text{if } \theta_i \geq \theta_i^* \\ U_g^S(\theta_i) < U_g^N(\theta_i), & \text{otherwise} \end{cases} \tag{17}$$

Thus, a student decides to leave S if their grade is not high enough relative to their reservation grade θ_i^*.

It is the case that

$$\frac{\partial \theta_i^*}{\partial \tilde{\theta}_g^S} > 0 \tag{18}$$

which means that the higher the cutoff grade to get a job in S the higher the reservation grade to stay in S. The reservation grade is a function of both labor market cutoffs, $\tilde{\theta}_g^N$ and $\tilde{\theta}_g^S$, the payoff v in field N, the grade θ_i, the cost of studying c_i, and the study time in both majors δ_S and δ_N.

7.1.4 Anticipated Gender Discrimination in S

Consider the case in which female students expect to face gender discrimination in the labor market for major S. That means that they assume that in the S labor market employers believe that there is a higher proportion of high-ability men than women, $\pi_F^S < \pi_M^S$. Given

[25] See Appendix C for proof.

that employers follow a cutoff hiring rule (See 7.1.2), women believe they will face a higher cutoff than men in S labor market in order to get a full-time job, i.e. $\tilde{\theta}_F^S > \tilde{\theta}_M^S$.

Then, for an identical man and woman (same c_i and ability), and given (18)

$$\theta_i^*(\tilde{\theta}_F^S) > \theta_i^*(\tilde{\theta}_M^S) \tag{19}$$

This means that the woman requires a higher grade than the man to stay in S. In other words, if they both receive the same grade θ_i, such that $\theta^*(\tilde{\theta}_F^S) > \theta_i > \theta^*(\tilde{\theta}_M^S)$, then the man is going to stay in S and the women is going to leave S (switch to N). Notice that this is consistent with the patterns in grade responsiveness from Figure 1, where at every grade level women are more likely than men to switch out of STEM/BEC majors. Additionally, this framework provides a compelling explanation for how anticipated discrimination can affect students' WTP for grades differently depending on gender as discussed in section 6.2.

7.2 Anticipated Gender Discrimination: Empirical evidence

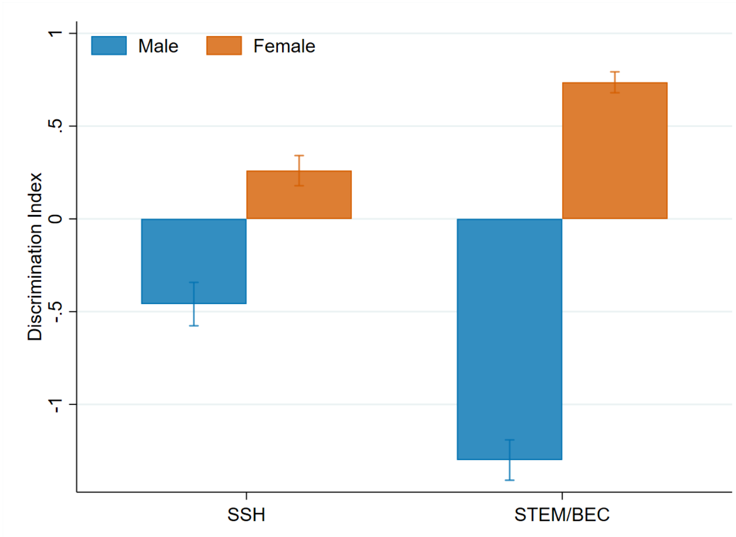
In this section, I document gender differences in students' beliefs about gender discrimination and hiring standards in the labor market using the survey data, and present evidence of the importance of those beliefs to understand the gender differences in grade sensitivity.

In order to measure beliefs about anticipated gender discrimination in the labor market, participants responded to a gender discrimination panel in the survey. They were asked, how likely (on a 5-point Likert scale) it would be that: (1) it is harder to find a job because of their gender, (2) their supervisor/boss would treat them differently because of their gender, and (3) their peers/coworkers would treat them differently because of their gender.[26] Given that beliefs about discrimination can be different for different majors or fields, the questions were asked for each major separately. Their responses for each major were combined using Principal Components Analysis (PCA) to create a major-specific index of anticipated gender

[26] Given the leading nature of these questions they were asked at the end of the survey.

discrimination.[27]

Figure 3: Gender Discrimination Index by Gender



Notes: Average gender discrimination index for each major by gender. The index calculated using PCA and the responses to how likely (on a 5-point Likert scale) it would be that: (1) it is harder to find a job because of their gender, (2) their supervisor/boss would treat them differently because of their gender, and (3) their peers/coworkers would treat them differently because of their gender. Spikes represent 95% CI.

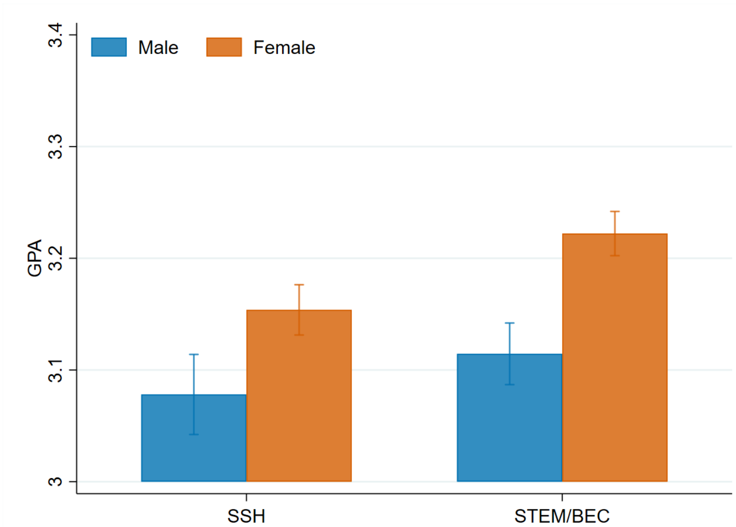
Figure 3 shows the average gender discrimination index by major and gender. By construction, each index has a mean of zero (and standard deviation of one), therefore negative (positive) numbers imply anticipated gender discrimination that is lower (higher) than average. Men anticipate facing less discrimination due to their gender in both fields than the average participant. The story is different for the female students. Female participants foresee facing more gender discrimination than average in both fields. However, women anticipate that they will face more gender discrimination in the STEM/BEC labor market than in the SSH labor market (p-value<0.01). This result is consistent with evidence of higher difficulties in the labor market for women in male-dominated fields (Foschi et al., 1994; Goldin and Rouse, 2000; Funk and Parker, 2018; Alam and Tapia, 2020).

College GPA is commonly used in the hiring process for entry-level positions since a higher GPA is associated with cognitive ability, job performance, and other characteristics that the recruiters consider important for the job (McKinney and Miles, 2009, Hansen et al.,

[27] All the results are qualitatively consistent if the major-specific indexes are constructed with a PCA algorithm that takes into account the discreteness of the variables.

2023a). Additionally, there is evidence that a higher GPA increases students' probability of getting a job (McKinney et al., 2003; Quadlin, 2018; Kessler et al., 2019). As the theoretical framework shows, a way in which discrimination could affect women's decisions is through beliefs that they need to provide more or better evidence of competence than men in order to be hired, especially in male-dominated fields. Therefore, participants were asked to report what they think is the minimum GPA at graduation that they will require to secure a full-time job in STEM/BEC (SSH) if they were to graduate with a degree in STEM/BEC (SSH). Each participant answered the question for each major, regardless of the major they report to be enrolled in.

Figure 4: Average Beliefs about Min. GPA Necessary for Full-Time Job in Given Field

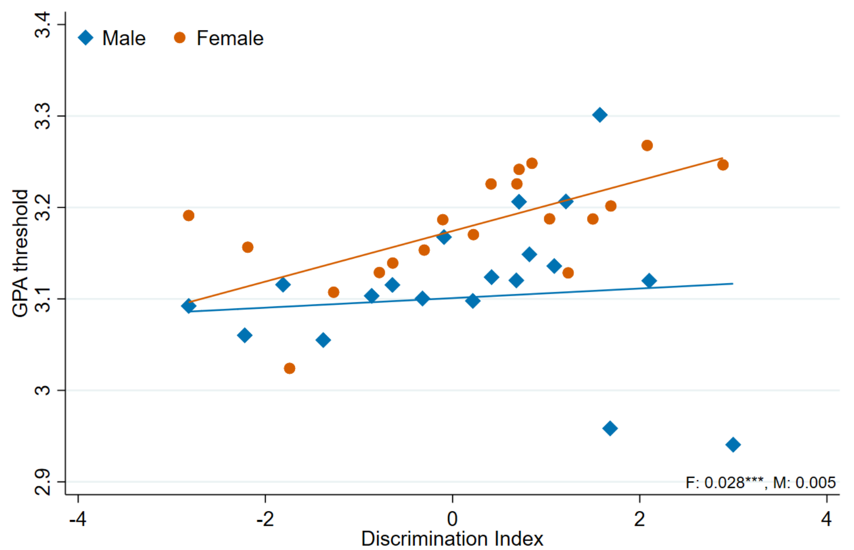


Notes: Average belief about the minimum cumulative GPA at graduation required to secure a full-time job in each field by gender. Spikes represent 95% CI.

Figure 4 shows the average GPA threshold for each major by gender. In general, participants believe they would need a lower GPA to secure a job in SSH than in STEM/BEC. For instance, on average women believe they would need a GPA 0.068 higher to get a job in STEM/BEC than in SSH (p-value<0.01). On average men believe they would need 0.036 extra GPA points at graduation to secure a job in STEM/BEC instead of SSH (p-value=0.014). Moreover, on average, women believe they need a higher GPA than men to secure a full-time job, regardless of the major they graduate from. The gender gaps in beliefs about the

GPA necessary to get an SSH or STEM job are 0.075 and 0.11, respectively (p-value<0.01 for both).[28] In summary, women believe they will need to provide a better signal of their competence in the labor market in the form of a higher GPA than their male counterparts, especially in order to secure a job in the STEM/BEC field.

Figure 5: Discrimination and Thresholds Relationship



Notes: Markers are from a binned scatter plot between GPA thresholds to get a full-time job and the anticipated discrimination index. Lines are fitted values from a regression of the GPA threshold on the discrimination index separately by gender and standard errors are clustered at individual level. Coefficients at the bottom left corner are the slopes of each line. *Significant at 10%, **5%, ***1%.

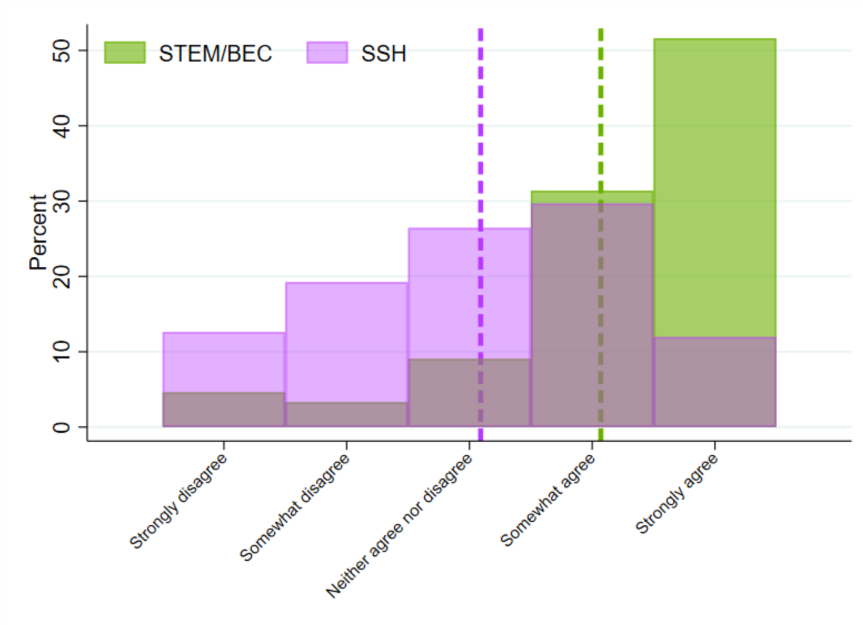
The binned scatter plot in Figure 5 shows the relationship between beliefs about anticipated gender discrimination in the labor market and beliefs about the GPA required to secure a job. There is a positive and significant relationship (p-value< 0.01) between the level of discrimination that a woman believes she is going to face and her beliefs about the minimum GPA at graduation required to secure a full-time job. However, this positive relationship is weaker for men, which is not surprising since men expect to experience less gender discrimination. Therefore, their beliefs about the GPA required to get a full-time job are not as strongly related to discrimination as they are for women.[29]

The fields where women expect to face more discrimination due to their gender are the

[28] These gender gaps are not statistically different from each other (p-value=0.25).

[29] However, there is a statistically significant positive relationship for men when dropping eight outlier observations with high discrimination index but low labor market standards.

Figure 6: Female Participants Agreement with "Women need a higher GPA to compete against similar man", by major



Notes: For each major, histogram of female participants responses to "How much you agree with: A woman competing for a job in this field would need a higher GPA than an otherwise similar man to be competitive." Dashed lines represent the average level of agreement by major.

fields in which they foresee they will need to provide a really strong signal about their ability in order to be competitive. In fact, I asked female participants how much they agree (on a 5-point scale) with the idea that a woman applying for a job after graduation in a given field would need a higher GPA than an otherwise similar man to be competitive. Figure 6 summarizes the responses. The dashed lines represent the average response per major. On average, the level of agreement with the idea of women requiring a higher GPA in order to be competitive is higher if applying for a STEM/BEC job than an SSH job (p-value<0.01). Moreover, almost 83% of the female participants somewhat agree or strongly agree with the statement in the case of a STEM/BEC job, whereas only 42% agree to the same extent in the case of an SSH job. These results reinforce the previous conclusions, women believe they will have a harder time in the STEM/BEC labor market.

Table 8 analyzes the role of anticipated discrimination and beliefs about GPA thresholds to secure a full-time job in explaining the gender gap in grade sensitivity. The first column duplicates column (1) in Table 7, which reports the conditional average gender gap in WTP for GPA at graduation, $3,057. Column (2) controls for beliefs about the necessary GPA to get a full-time job in STEM/BEC and SSH fields. Although the gender gap is still statistically different from zero, the point estimate decreases by 13% ($2,671). Therefore, beliefs about facing different standards in the labor market seem important to understand why women and men value grades differently.

Discrimination also plays a role in explaining the gender gap in WTP aside from its effects through the GPA thresholds as can be seen in column (3), which controls directly for the anticipated discrimination indexes in STEM/BEC and SSH. In this case, the gender gap is no longer statistically different from zero and the point estimate decreases by 36% to $1,965. This reduction suggests that anticipated discrimination is relevant for understanding the gender gap in grade sensitivity. Finally, column (4) includes controls for both discrimination indexes and GPA thresholds. In this case, the point estimated decreases to $1,600, a 48% reduction, and it is not statistically significant.

Table 8: Importance of Anticipated Discrimination and GPA Thresholds for the Gender Gaps in WTP for GPA

	(1)	(2)	(3)	(4)
Female	3,057**	2,671*	1,965	1,600
	(1,440)	(1,431)	(2,085)	(2,045)
Belief GPA Threshold STEM/BEC		5,548**		5,533**
		(2,433)		(2,406)
Belief GPA Threshold SSH		-499		-487
		(2,195)		(2,057)
Anticipated Discrimination STEM/BEC			620	613
			(729)	(742)
Anticipated Discrimination SSH			-261	-270
			(535)	(541)
Mean	8,309	8,309	8,309	8,309
R2	0.018	0.024	0.019	0.025
N	1,192	1,192	1,192	1,192

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority, and major. Bootstrapped standard errors reported in parentheses. *Significant at 10%, **5%, ***1%.

These results suggest that beliefs about anticipated gender discrimination and labor market standards are important to understand why women and men value grades differently. Additionally, they support the intuition formalized in the conceptual framework that highlights the role of beliefs about anticipated discrimination in women's major choices.

8 Other Explanations

Aside from beliefs about gender discrimination and labor market standards, there could be other mechanisms that contribute to explaining the gender gap in sensitivity to grades. Some examples include gender differences in risk aversion (Paola and Gioia, 2012), willingness to compete (Buser et al., 2014), sense of belonging (Rainey et al., 2018; Hansen et al., 2023b), self-confidence (Ellis et al., 2016; Moakler and Kim, 2014), and beliefs about what it takes to graduate from a male-dominated major (Owen, 2023).

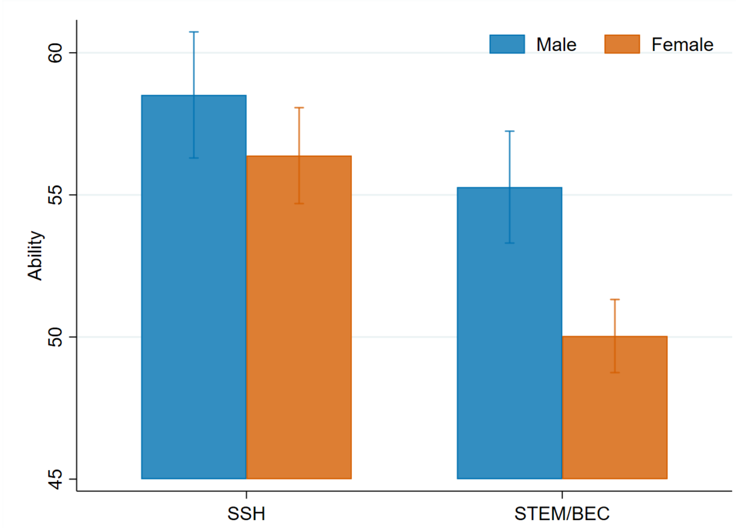
I collected data about some of the listed mechanisms. In this section, I focus on self-confidence, and beliefs about the grade distribution in different fields given that these measures exhibit gender differences that could contribute to explaining why women and men react differently to grades. I do not find gender differences in the importance of fitting with other students in the field as a reason for choosing (or not choosing) a major, which suggests that sense of belonging (at least in terms of fitting in) does not play a significant role in explaining the gender differences in grade sensitivity. Finally, even though I do not collect data about risk preferences recent evidence by Patnaik et al. (2022) suggests that gender differences in expectations about own-earnings, risk aversion, and patience cannot explain gender gaps in major choice.

8.1 Self-Confidence

There is evidence that women are less confident in their quantitative abilities than men. For example, Ellis et al. (2016) finds that women that take Calculus I start and end the term with less confidence in their mathematical abilities than men. Similarly, Moakler and Kim

(2014) finds that women report lower academic and mathematics confidence than men, and this is related to their lower chances of choosing a STEM major. Therefore, women could interpret less-than-stellar grades in STEM and BEC majors as confirmation of their lack of ability and subsequently switch out of them.

Figure 7: Average Beliefs about Ability in Each Major



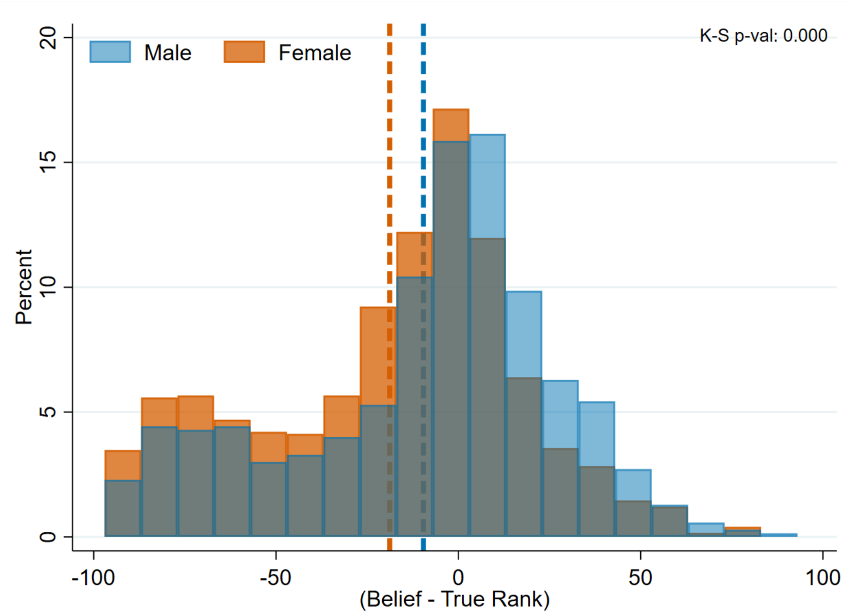
Notes: Average ability ranking in each major by gender. Rank is on a 1-100 scale where higher numbers represent higher ability. Spikes represent 95% CI.

In the survey, participants report beliefs about their SSH and STEM/BEC ability as their rank relative to peers on a 1-100 scale.[30] Figure 7 reports the average rank by gender and major. Students report higher beliefs about their ability in SSH than in STEM/BEC: on average women (men) report rankings 6.35 (3.24) points higher in SSH than in STEM/BEC (p-value<0.01 for both genders). On average, men report higher beliefs about both their SSH and STEM/BEC ability than women. However, only the gender gap in beliefs about STEM/BEC ability is statistically different from zero (p-value <0.01).

Figure 8 plots the distribution of the difference between participants' beliefs about their rank in their reported major and their "true" rank in that major (Belief - True Rank). True rank is calculated using the administrative data of students registered in each of the majors during the Spring of 2021. Specifically, in the administrative data, all students in a major

[30] The higher the number the better the ability relative to peers.

Figure 8: Ability Over/Under Confidence, by Majors



Notes: Histogram, by gender, of the difference between participants' beliefs about their rank in their reported major and their "true" rank in that major based on reported cumulative GPA. Dashed lines represent the mean of each respective distribution. K-S p-val: p-value from a Kolmogorov-Smirnov test for the equality of the distributions.

cohort are ranked based on their cumulative GPA and this ranking is used to assign the true rank to the survey participants based on the cumulative GPA they provided. Then, this difference (Belief - True Rank) is the error in participants' beliefs about their ability. If the error is positive (negative) participants are over (under) confident in their ability.

In Figure 8, the vertical dashed lines represent the mean of the distribution by gender and show that on average participants are under-confident in their ability. In other words, participants report a worse rank than their actual position based on their GPA. However, women are more under-confident than men as illustrated by the lower mean (p-value <0.01), and the extra mass below zero in the female histogram.[31,32]

Table 9 examines the role of over/under confidence in the gender differences in grade sensitivity. Column (1) reproduces the first column from Table 7, which reports the conditional average gender gap in WTP for GPA at graduation, $3,057. Column (2) controls for

[31] Based on the Kolmogorov-Smirnov test, female and male distributions are statistically different from each other in both panels of Figure 8 (p-value<0.01).

[32] Results are qualitatively the same if the distributions are analyzed separately for students enrolled in SSH and STEM/BEC. See Figure A1 in the Appendix.

Table 9: Importance of the Errors in Beliefs about Ability for the Gender Gaps in WTP for GPA

	(1)	(2)
Female	3,057**	2,905**
	(1,440)	(1,439)
Error in Beliefs about Ability		-18
		(20)
Mean	8,309	8,309
R2	0.018	0.019
N	1,192	1,192

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority, and major. Bootstrapped standard errors reported in parentheses. *Significant at 10%, **5%, ***1%.

the error in beliefs about ability as described before: belief - true rank. This error reduces the gender gap slightly (5%), but it remains statistically significant.

Despite the fact that the gender differences in self confidence have the expected patterns, theses results do not support the role of self-confidence as an important driver of the gender differences in sensitivity to grades.

8.2 Beliefs about Grade Distribution in Different Fields

Academic performance is one of the main reasons for changing majors (Wright, 2018). However, there is evidence that students sometimes hold erroneous beliefs about the grade distributions in different fields. For example, Owen (2023) finds that men are more likely to underestimate the median grade of students enrolled in STEM majors, while women overestimate it. If women overestimate the grades of the students graduating from STEM or BEC majors, they might believe that their less-than-stellar grades in the introductory classes are not good enough to succeed in those majors, and they might switch out. Therefore, erroneous beliefs about the grades at graduation in different majors seem like a potential explanation for the gender gap in grade sensitivity.

In the survey participants are asked to report what they believe is the average GPA of

Table 10: Average Beliefs about GPA at Graduation, and Actual Average GPA at Graduation by Gender and Major

	Actual GPA	Beliefs Female	Beliefs Male	p-value
	(1)	(2)	(3)	(4)
SSH	3.38	3.46	3.36	0.000
STEM/BEC	3.43	3.37	3.23	0.000

Notes: Column (4) is the p-value of a difference in means test across genders within major, columns (2) and (3).

students who graduate from each major. Table 10 reports the average response for each major by gender in columns (2) and (3). The fourth column reports the p-value from a difference in means test between genders. Regardless of major, women believe that the average GPA at graduation is higher than what men believe. All participants believe that the average GPA at graduation is lower among STEM/BEC students.

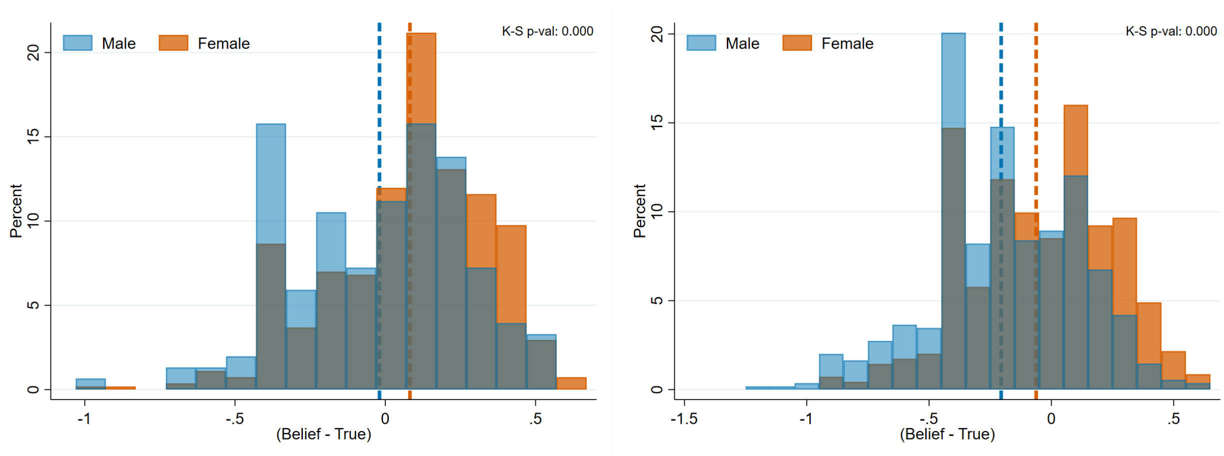
It is important to learn how close these beliefs are to the actual GPA of people graduating from each major. To do so, I use the administrative data described in section 2. In column (1) Table 10 reports the average GPA among the students that graduate from each major during the Spring of 2019.[33] Opposite to what participants believe, the average GPA of students graduating with a STEM/BEC degree is slightly higher than the GPA of students graduating with a SSH degree. Additionally, the average male belief in STEM/BEC is statistically lower than the actual GPA of people graduating with that degree (p-value<0.01). Although the average male belief about the grades in SSH is slightly lower than the actual average GPA in this major, the difference is not statistically significant (p-value=0.230). On the other hand, the average female belief for SSH is statistically higher than the actual GPA for SSH (p-value<0.01), and the opposite is true for STEM/BEC (p-value<0.01).

To further analyze the error in these beliefs, Figure 9 shows the distribution of the difference (error) between a participant's belief about the GPA at graduation for the major

[33] I use Spring 2019 instead of Spring 2020 or Spring 2021 because those are semesters affected by different grading policies implemented as a response to the COVID-19 pandemic. However, results are qualitatively the same if any of those semesters is used instead.

Figure 9: Error in Beliefs about Av. GPA at Graduation, by Majors

(a) SSH (b) STEM/BEC



Notes: Histogram, by gender, of the difference (error) between a participant's belief about the GPA at graduation for the major they report to be enrolled in and the corresponding average GPA at graduation from the administrative data (Spring 2019). Dashed lines represent the mean of each respective distribution. K-S p-val: p-value from a Kolmogorov-Smirnov test for the equality of the distributions.

they report to be enrolled in and the corresponding average GPA at graduation from the administrative data (Spring 2019). Negative (positive) numbers indicate that participants underestimate (overestimate) the GPA at graduation. The dashed lines represent the mean of each distribution.

On average, men in SSH majors tend to underestimate the grades of their graduating peers. However, on average, women in SSH hold correct beliefs about the GPA of their graduating peers.[34] In STEM/BEC, both women and men underestimate the GPA of the students graduating from those majors. Nonetheless, on average, women underestimate the grades of their graduating peers less than men (p-value<0.01 from a one-sided test). This means that women's beliefs are closer to the actual GPA of the Spring 2019 graduating class than men's.

Additionally, the distributions in each panel of Figure 9 are statistically different across genders as the p-value from the Kolmogorov-Smirnov test shows. Regardless of major, a higher share of women tends to overestimate the GPA of their graduating peers, as illustrated by the extra mass above zero in the female distributions relative to men's.

[34]The mean for women is statistically not different from zero, p-value=0.4540

Table 11: Importance of the Errors in Beliefs about GPA at Graduation for the Gender Gaps in WTP for GPA

	(1)	(2)
Female	3,057**	2,796*
	(1,440)	(1,446)
Error in Beliefs about GPA at Graduation		1,871
		(2,529)
Mean	8,309	8,309
R2	0.018	0.019
N	1,192	1,192

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority, and major. Bootstrapped standard errors reported in parentheses. *Significant at 10%, **5%, ***1%.

Table 11 evaluates the role that over or underestimation of the GPA at graduation plays in explaining the gender gap in grade sensitivity. Column (1) reproduces the first column in Table 7, which reports the conditional average gender gap in WTP for GPA, $3,057. Column (2) controls for the errors in beliefs about the GPA at graduation (the errors plotted in Figure 9). In this case, the gender gap estimate decreases by about 9% to $2,796.

These results do not provide strong support in favor of the hypothesis that holding erroneous beliefs about what is required to graduate from a given major is an important driver of the gender differences in grade sensitivity.

8.3 Relative Importance of Anticipated Gender Discrimination

The previous results imply that self-confidence and erroneous beliefs about grades in different fields do not play a significant role in explaining the gender gap in WTP for GPA. However, that analysis is done for each hypothesis independently. In this section, I provide suggestive evidence of the importance of anticipated gender discrimination relative to the other two explanations.

Table 12 analyzes the effect of each potential mechanism in explaining the gender gap in grade sensitivity when considered together. Column (1) presents the overall conditional average gender gap in WTP for GPA, $3,057. Column (2) controls for the error in beliefs about ability as described in section 8.1. Therefore, it reproduces column (2) in Table 9, where the point estimate decreases by about 5%. In column (3), I control for the errors in beliefs about the GPA at graduation in a given major as described in section 8.2. This reduces the point estimate by about 8%. This decrease is similar, in percentage terms, to the decrease in the gender gap in WTP for GPA when this hypothesis is considered separately. Lastly, column (4) controls for beliefs about anticipated gender discrimination. These measures decrease the estimated gender gap in WTP for GPA by around 46% relative to column (3), and the coefficient is no longer statistically different from zero. Overall, the gender gap in WTP for GPA decreases by 47%, from $3,057 to $1,437 when including all the controls.[35]

Table 12: Relationship between Gender Gaps in WTP for GPA and Pontential Mechanisms

	(1)	(2)	(3)	(4)
Female	3,057**	2,905**	2,664*	1,437
	(1,440)	(1,439)	(1,528)	(2,029)
Error in Beliefs about Own Ability		✓	✓	✓
Error in Beliefs about GPA at Graduation			✓	✓
Anticipanted Discrimination				✓
Mean	8,309	8,309	8,309	8,309
N	1,192	1,192	1,192	1,192

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority, and major. Bootstrapped standard errors reported in parentheses. *Significant at 10%, **5%, ***1%.

The results in table 12 indicate that anticipated gender discrimination is, quantitatively, playing a more important role than the other two mechanisms given that its inclusion generates a greater decrease in the estimated gender gap in WTP for GPA. The results from an Oaxaca-Blinder decomposition further support this conclusion.[36] 52% of the observed gen-

[35] See Table A1 in the Appendix for the coefficients of each of the different mechanisms.

[36] The Oaxaca-Blinder decomposition allows me to determine the portion of the gender difference in WTP for GPA that is explained by group differences in the level of observable explanatory variables, in this case for each of the three mechanisms considered (Rahimi and Nazari, 2021).

der gap in WTP for GPA can be explained by gender differences in beliefs about anticipated gender discrimination, 7% is due to gender differences in self-confidence, and another 6% is attributed to gender differences in erroneous beliefs about the GPA at graduation from different majors.

9 Conclusion

The probability of women continuing their studies in or switching out of male-dominated fields like STEM and Economics depends more on their performance in relevant courses at the beginning of their college career relative to men. This paper studies why women and men react differently to grades during college and how this behavior impacts their decision to persist or switch out of a given major. Understanding why talented women with the potential to succeed in male-dominated fields drop out because of less-than-stellar grades in an introductory class is important for closing the gender gap in these areas, improving the labor market outcomes of highly skilled women, and achieving an efficient allocation of resources across fields of study and occupations.

Using administrative data from Arizona State University, I document gender differences in reaction to grades among undergraduate students. I find that among STEM and business students, the gender gap in the probability of persisting in those majors is negatively related to first year GPA.

Due to the limited ability of the administrative data to shed light on the reasons that lead to those patterns, I use data from an original survey to quantify students' sensitivity to grades, and investigate the reasons why women and men react differently to grades. I estimate students' grade sensitivity using the hypothetical scenarios methodology. I find that, conditional on background characteristics, women are willing to pay about $3,000 more of average annual earnings than men for a one-point increase in the average GPA at graduation in a given major. This gender gap is primarily concentrated among STEM and business students.

I provide evidence that anticipated discrimination in the labor market of male-dominated fields is important to understand this gender gap in grade sensitivity. I find that women believe that they are more likely to experience gender discrimination in the labor market than men, particularly in STEM and business fields. Additionally, I find that women believe that they will face a higher standard in the labor market in terms of GPA in order to get a full-time job. I provide evidence that the beliefs about higher standards are related to beliefs about gender discrimination in the labor market. Furthermore, my results show that beliefs about gender discrimination in the labor market account for 48% of the gender gap in sensitivity to grades.

Also, I propose a theoretical framework that formalizes the intuition about how these beliefs can lead to the gender differences in persistence observed in STEM and business majors. I show that by allowing major choices to be affected by discrimination in the labor market, women and men that receive the same grades make different decisions about staying in or leaving a given major. The difference arises because they believe they will be treated differently in the labor market based on gender.

I acknowledge that there are other mechanisms that could contribute to explaining the gender differences in grade sensitivity that I document. However, anticipated discrimination represents an explanation not often considered, and my results provide evidence of its importance in this context. In fact, considering the role of such beliefs is crucial to designing policies that effectively encourage the participation of women in traditionally male-dominated fields. For example, if students' beliefs about gender discrimination are close to the reality of the labor market, then policymakers should aim to solve the discrimination issues in the labor market. On the other hand, if students hold inaccurate beliefs about the labor market, information interventions could be a valuable tool. Therefore, assessing the accuracy of these beliefs represent an important avenue for future research.

References

AHN, T., P. ARCIDIACONO, A. HOPSON, AND J. THOMAS (2022): "Equilibrium Grade Inflation with Implications for Female Interest in STEM Majors," *Working Paper*.

ALAM, A. AND I. S. TAPIA (2020): *Mapping gender equality in STEM from school to work*, UNICEF.

ALSTON, M. (2019): "The (Perceived) Cost of Being Female: An Experimental Investigation of Strategic Responses to Discrimination," *Working Paper*.

ALTONJI, J. G., P. ARCIDIACONO, AND A. MAUREL (2016): "The Analysis of Field Choice in College and Graduate School. Determinants and Wage Effects," *Handbook of the Economics of Education*, 5, 305–396.

ALTONJI, J. G., E. BLOM, AND C. MEGHIR (2012): "Heterogeneity in Human Capital Investments: High School Curriculum, College Major, and Careers," *Annual Review of Economics*, 4, 185–223.

ALTONJI, J. G., L. B. KAHN, AND J. D. SPEER (2014): "Trends in Earnings Differentials across College Majors and the Changing Task Composition of Jobs," *American Economic Review*, 104, 387–393.

ASTORNE-FIGARI, C. AND J. D. SPEER (2019): "Are changes of major major changes? The roles of grades, gender, and preferences in college major switching," *Economics of Education Review*, 70, 75–93.

BESTENBOSTEL, A. (2021): "Do Grade Signals Drive the Gender Gap in STEM? Evidence From a Regression Discontinuity," *Working Paper*.

BLASS, A. A., S. LACH, AND C. F. MANSKI (2010): "Using elicited choice probabilities to estimate random utility models: Preferences for electricity reliability," *International Economic Review*, 51, 421–440.

Buser, T., M. Niederle, and H. Oosterbeek (2014): "Gender Competitiveness, and Career Choices," *Quarterly Journal of Economics*, 129, 1409–1447.

Chizmar, J. F. (2000): "A Discrete-Time Hazard Analysis of the Role of Gender in Persistence in the Economics Major," *The Journal of Economic Education*, 31, 107–118.

Coate, S. and G. C. Loury (1993): "Will Affirmative-Action Policies Eliminate Negative Stereotypes?" *American Economic Review*, 83, 1220–1240.

Delavande, A. and C. F. Manski (2015): "Using elicited choice probabilities in hypothetical elections to study decisions to vote," *Electoral Studies*, 38, 28–37.

Ellis, J., B. K. Fosdick, and C. Rasmussen (2016): "Women 1.5 Times More Likely to Leave STEM Pipeline after Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit," *PLOS ONE*, 11.

Fang, H. and A. Moro (2011): "Theories of Statistical Discrimination and Affirmative Action: A Survey," *Handbook of Social Economics*, 1, 133–200.

Folke, O. and J. Rickne (2022): "Sexual Harassment and Gender Inequality in the Labor Market," *The Quarterly Journal of Economics*, 137, 1–50.

Foschi, M., L. Lai, and K. Sigerson (1994): "Gender and Double Standards in the Assessment of Job Applicants," *Social Psychology Quarterly*, 57, 326–339.

Funk, C. and K. Parker (2018): *Women and Men in STEM Often at Odds Over Workplace Equity*, vol. 9, Pew Research Center.

Fuster, A., G. Kaplan, and B. Zafar (2021): "What Would You Do with $500? Spending Responses to Gains, Losses, News, and Loans," *Review of Economic Studies*, 88, 1760–1795.

Fuster, A. and B. Zafar (2023): "Survey experiments on economic expectations," *Handbook of Economic Expectations*, 107–130.

GEMICI, A. AND M. WISWALL (2014): "Evolution of Gender Differences in Post-Secondary Human Capital Investments: College Majors," *International Economic Review*, 55.

GOLAN, L. AND C. SANDERS (2019): "Racial Gaps, Occupational Matching, and Skill Uncertainty," *Federal Reserve Bank of St. Louis Review*, 101, 135–153.

GOLDIN, C. (2015): "Gender and the Undergraduate Economics Major: Notes on the Undergraduate Economics Major at a Highly Selective Liberal Arts College," *Report*.

GOLDIN, C. AND C. ROUSE (2000): "Orchestrating Impartiality: The Impact of 'Blind' Auditions on Female Musicians," *American Economic Review*, 90, 715–741.

HAMMOND, A., E. R. MATULEVICH, K. BEEGLE, AND S. K. KUMARASWAMY (2020): *The Equality Equation: Advancing the Participation of Women and Girls in STEM*, World Bank.

HANSEN, A. T., U. HVIDMAN, AND H. H. SIEVERTSEN (2023a): "Grades and Employer Learning," *Journal of Labor Economics*.

HANSEN, M. J., M. J. PALAKAL, AND L. J. WHITE (2023b): "The Importance of STEM Sense of Belonging and Academic Hope in Enhancing Persistence for Low-Income, Underrepresented STEM Students," *Journal for STEM Education Research*, 1–26.

HUNT, J. (2016): "Why do women leave science and engineering?" *Industrial and Labor Relations Review*, 69, 199–226.

KAGANOVICH, M., M. TAYLOR, AND R. XIAO (2021): "Gender Differences in Persistence in a Field of Study," *CESifo Working Paper no. 9087*.

KESSLER, J. B., C. LOW, AND C. D. SULLIVAN (2019): "Incentivized resume rating: Eliciting employer preferences without deception," *American Economic Review*, 109, 3713–3744.

Koşar, G., T. Ransom, and W. V. D. Klaauw (2022): "Understanding migration aversion using elicited counterfactual choice probabilities," *Journal of Econometrics*, 231, 123–147.

Kugler, A. D., C. H. Tinsley, and O. Ukhaneva (2021): "Choice of majors: are women really different from men?" *Economics of Education Review*, 81.

Main, J. B. and B. Ost (2014): "The impact of letter grades on student effort, course selection, and major choice: A regression-discontinuity analysis," *Journal of Economic Education*, 45, 1–10.

Manski, C. F. (2004): "Measuring Expectations," *Econometrica*, 72, 1329–1376.

McKinney, A. P., K. D. Carlson, R. L. I. Mecham, N. D. D. Angelo, and M. L. Connerley (2003): "Recruiters' use of GPA in initial screening decisions: Higher GPAs don't always make the cut," *Personnel Psychology*, 56, 823–845.

McKinney, A. P. and A. Miles (2009): "Gender differences in US performance measures for personnel selection," *Equal Opportunities International*, 28, 121–134.

Moakler, M. W. J. and M. M. Kim (2014): "College Major Choice in STEM: Revisiting Confidence and Demographic Factors," *The Career Development Quarterly*, 62, 128–142.

Ost, B. (2010): "The role of peers and grades in determining major persistence in the sciences," *Economics of Education Review*, 29, 923–934.

Owen, A. L. (2010): "Grades, gender, and encouragement: A regression discontinuity analysis," *Journal of Economic Education*, 41, 217–234.

Owen, S. (2021): "Ahead of the Curve Grade Signals, Gender, and College Major Choice," *Working Paper*.

——— (2023): "College Field Specialization and Beliefs about Relative Performance An Experimental Intervention to Understand Gender Gaps in STEM," *Economics of Education Review.*

Paola, M. D. and F. Gioia (2012): "Risk Aversion and Field of Study Choice: The Role of Individual Ability," *Bulletin of Economic Research*, 64, 307–3378.

Patnaik, A., J. Venator, M. Wiswall, and B. Zafar (2022): "The role of heterogeneous risk preferences, discount rates, and earnings expectations in college major choice," *Journal of Econometrics*, 231, 98–122.

Patnaik, A., M. J. Wiswall, and B. Zafar (2021): "College Majors," *The Routledge Handbook of the Economics of Education*, 1.

Quadlin, N. (2018): "The Mark of a Woman's Record: Gender and Academic Performance in Hiring," *American Sociological Review*, 83, 331–360.

Quintero, E. (2008): *How are Job Applicants Disadvantaged by Gender Based Double Standards in a Natural Setting*, Ph.D. thesis, Cornell University.

Rahimi, E. and S. S. H. Nazari (2021): "A detailed explanation and graphical representation of the Blinder-Oaxaca decomposition method with its application in health inequalities," *Emerging Themes in Epidemiology*, 18.

Rainey, K., M. Dancy, R. Mickelson, E. Stearns, and S. Moller (2018): "Race and gender differences in how sense of belonging influences decisions to major in STEM," *International Journal of STEM Education*, 5, 1–14.

Rask, K. and J. Tiefenthaler (2008): "The role of grade sensitivity in explaining the gender imbalance in undergraduate economics," *Economics of Education Review*, 27, 676–687.

Shen, K. (2021): "Gender Discrimination," *IZA Discussion Papers 14897.*

Steele, J., J. B. James, and R. C. Barnett (2002): "Learning in a Man's World: Examining the Perceptions of Undergraduate Women in Male-Dominated Academic Areas," *Psychology of Women Quarterly*, 26, 46–50.

Ugalde A., P. (2024): "Low Performance in Math and English: Do Women React Differently than Men?" *Working Paper*.

Williams, J. C., K. W. Phillips, and E. V. Hall (2014): *Double Jeopardy? Gender Bias Against Women in Science*, Work Life Law.

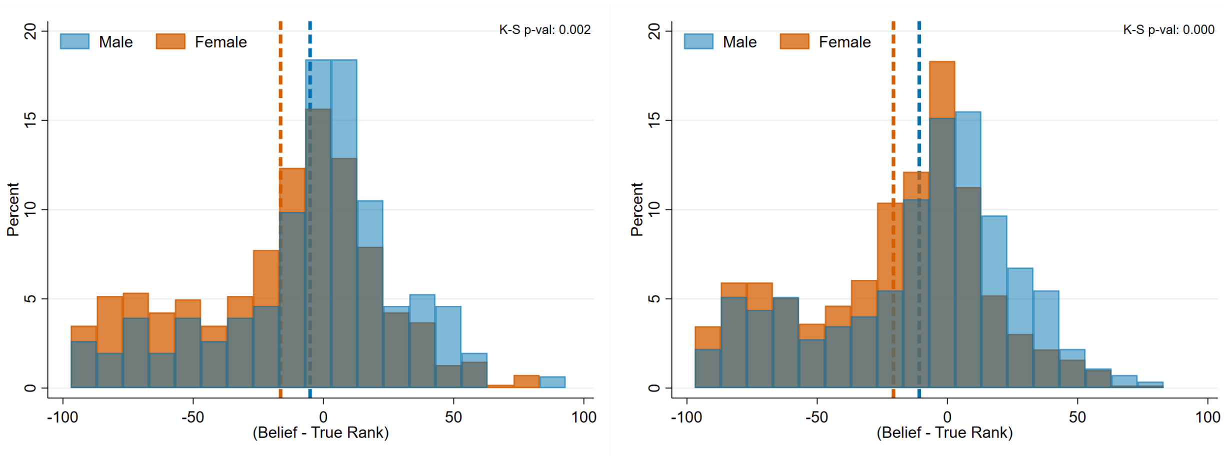
Wiswall, M. and B. Zafar (2018): "Preference for the workplace, investment in human capital, and gender," *Quarterly Journal of Economics*, 133, 457–507.

Wright, C. (2018): *Choose Wisely: A Study of College Major Choice and Major Switching Behavior*, Ph.D. thesis, Pardee Rand Graduate School.

A Appendix

Figure A1: Ability Over/Under Confidence, by Majors

(a) SSH (b) STEM/BEC



Notes: Histogram, by gender and major, of the difference between participants' beliefs about their rank in their reported major and their "true" rank in that major based on reported cumulative GPA. Dashed lines represent the mean of each respective distribution. K-S p-val: p-value from a Kolmogorov-Smirnov test for the equality of the distributions.

Table A1: Relationship between Gender Gaps in WTP for GPA and Pontential Mechanisms

	(1)	(2)	(3)	(4)
Female	3,057**	2,905**	2,664*	1,437
	(1,440)	(1,439)	(1,528)	(2,029)
Error in Beliefs about Own Ability		-18	-17	-15
		(20)	(20)	(20)
Error in Beliefs about GPA at Graduation			1,770	174
			(2,456)	(2,507)
Anticipated Discrimination SSH				-300
				(545)
Anticipated Discrimination STEM/BEC				636
				(742)
Belief GPA Threshold SSH				-464
				(2,062)
Belief GPA Threshold STEM/BEC				5,363**
				(2,457)
Mean	8,309	8,309	8,309	8,309
N	1,192	1,192	1,192	1,192

Notes: Outcome variable is WTP for an extra point in av. GPA at graduation. All columns control for household income, parents education, SAT/ACT, school year, honors, minority, and major. Bootstrapped standard errors reported in parentheses. *Significant at 10%, **5%, ***1%.

B Appendix

ASU Majors in Each Broad Category

Humanities/Social Sciences (SSH)

African and African American Studies
American Indian Studies
Anthropology
Applied Science
Applied Science (Applied Leadership)
Applied Science (Early Childhood Studies)
Applied Science (Emergency Management)
Applied Science (Food and Nutrition Entrepreneurship)
Applied Science (Graphic Information Technology)
Applied Science (Health Entrepreneurship and Innovation)
Applied Science (Health Sciences)
Applied Science (Medical Laboratory Science)
Applied Science (Project Management)
Applied Science (Technical Communication)
Architectural Studies
Art
Asia Studies
Asian Languages
Asian Pacific American Studies
Civic and Economic Thought and Leadership
Communication
Community Advocacy and Social Policy
Community Development
Community Health
Community Sports Management
Conflict Resolution
Counseling and Applied Psychological Science
Criminology and Criminal Justice
Dance
Design Studies
Dietetics
Digital Audiences
Digital Culture
Digital Media Literacy
Disability Studies
Early Childhood and Early Childhood Special Education
Educational Studies
Elementary Education
English
Environmental Design
Exercise and Wellness
Family and Human Development
Fashion
Film
Food and Nutrition Entrepreneurship
French
General Studies
German
Global Health
Global Studies
Graphic Design
Health Care Compliance and Regulations
Health Care Coordination
Health Education and Health Promotion
Health Entrepreneurship and Innovation
Health Sciences
Health Sciences (Health Policy)
Health Sciences (Healthy Lifestyles and Fitness Science)
Health Sciences (Pre-professional)
History
History of Science, Ideas and Innovation
Industrial Design
Innovation in Society
Integrated Studies
Integrative Health
Integrative Social Science
Interdisciplinary Arts and Performance
Interdisciplinary Arts and Sciences
Interdisciplinary Studies
Interior Design
International Letters and Cultures
International Public Health
Italian
Jewish Studies
Journalism and Mass Communication
Justice Studies
Landscape Architecture
Latin American Studies
Liberal Studies
Mass Communication and Media Studies

Music
Music Learning and Teaching
Music Therapy
Nonprofit Leadership and Management
Nursing
Nutrition
Nutritional Sciences
Organizational Leadership
Parks and Recreation Management
Performance
Performance and Movement
Philosophy
Philosophy, Religion and Society
Political Science
Politics and the Economy
Population Health
Prelaw
Psychology
Public Health
Public Service and Public Policy
Recreation Therapy
Religious Studies
Russian
Science of Health Care Delivery
Science, Technology and Society
Secondary Education
Secondary Education (Biological Sciences)
Secondary Education (Chemistry)
Secondary Education (Earth and Space Sciences)
Secondary Education (English)
Secondary Education (German)
Secondary Education (History)
Secondary Education (Mathematics)
Secondary Education (Physical Education)
Secondary Education (Physics)
Secondary Education (Political Science)
Secondary Education (Spanish)
Social and Behavioral Sciences
Social and Cultural Analysis
Social Justice and Human Rights
Social Work
Sociology
Spanish
Special Education
Special Education and Elementary Education
Speech and Hearing Science
Sports Journalism
Sports Science and Performance Programming
Technical Communication
Technological Leadership
Theatre
Theory and Composition
Tourism and Recreation Management
Tourism Development and Management
Transborder Chicana/o and Latina/o Studies
Urban and Metropolitan Studies
Urban Planning
Women and Gender Studies

Social Work
Sociology
Spanish
Special Education
Special Education and Elementary Education
Speech and Hearing Science
Sports Journalism
Sports Science and Performance Programming
Technical Communication
Technological Leadership
Theatre
Theory and Composition
Tourism and Recreation Management
Tourism Development and Management
Transborder Chicana/o and Latina/o Studies
Urban and Metropolitan Studies
Urban Planning
Women and Gender Studies

Science/Technology/Engineering/Mathematics (STEM)

Actuarial Science
Aeronautical Management Technology
Aerospace Engineering
Applied Biological Sciences
Applied Computing
Applied Mathematics
Applied Mathematics for Life and Social Sciences
Applied Physics
Applied Quantitative Science
Applied Science (Aviation)
Applied Science (Internet and Web Development)
Applied Science (Operations Management)
Astronomical and Planetary Sciences
Biochemistry
Biological Sciences
Biology
Biomedical Engineering
Biomedical Informatics
Biophysics
Biotechnology and Bioenterprise
Chemical Engineering
Chemistry
Civil Engineering
Computational Forensics
Computational Mathematical Sciences
Computer Information Systems
Computer Science
Computer Systems Engineering
Construction Engineering
Construction Management and Technology
Data Science
Earth and Environmental Studies
Earth and Space Exploration
Electrical Engineering
Engineering
Engineering Management
Environmental and Resource Management
Environmental Engineering
Environmental Science
Forensic Science
Geographic Information Science
Geography
Graphic Information Technology
Human Systems Engineering
Industrial Engineering
Informatics
Information Technology
Kinesiology
Manufacturing Engineering
Materials Science and Engineering
Mathematics
Mechanical Engineering
Medical Studies
Microbiology
Molecular Biosciences and Biotechnology
Neuroscience
Pharmacology and Toxicology
Physics
Software Engineering
Statistics
Sustainability
Sustainable Food Systems
Technological Entrepreneurship and Management

Business/Economics (BEC)

Accountancy
Business
Economics
Economics (Politics and the Economy)
Finance
Food Industry Management
Global Management
International Trade
Management
Marketing
Supply Chain Management

C Appendix

Existence of θ_i^*

Student i stays in major S iff

$$
\begin{aligned}
&U_g^S(\theta_i) \geq U_g^N(\theta_i) \\
&\iff P'(\theta_i)[1 - F_h(\tilde{\theta}_g^S)] + (1 - P'(\theta_i))[1 - F_l(\tilde{\theta}_g^S)] - \delta^S c_i \\
&\qquad \geq vP'(\theta_i)[1 - F_h(\tilde{\theta}_g^N)] + v(1 - P'(\theta_i))[1 - F_l(\tilde{\theta}_g^N)] - \delta^N c_i \\
&\iff P'(\theta_i) \geq \frac{c_i(\delta^N - \delta^S) + [F_l(\tilde{\theta}_g^N) - F_l(\tilde{\theta}_g^S)]}{v[F_l(\tilde{\theta}_g^N) - F_h(\tilde{\theta}_g^N)] - [F_l(\tilde{\theta}_g^S) - F_h(\tilde{\theta}_g^S)]}
\end{aligned}
$$

Let $\Xi_i = \frac{c_i(\delta^N - \delta^S) + [F_l(\tilde{\theta}^N) - F_l(\tilde{\theta}^S)]}{v[F_l(\tilde{\theta}^N) - F_h(\tilde{\theta}^N)] - [F_l(\tilde{\theta}^S) - F_h(\tilde{\theta}^S)]}$

By MLRP $P'(\theta_i)$ is continuous and increasing in $[0, 1]$, then $P'(\theta_i) \geq \Xi_i$ holds if and only if $\theta_i \geq \theta_i^*$, where the threshold θ_i^* is determined as follows.

- If $P'(0) \geq \Xi_i$ then $\theta_i^* = 0$
- If $P'(1) \leq \Xi_i$ then $\theta_i^* = 1$
- If $P'(0) < \Xi_i$ and $P'(1) > \Xi_i$, by the Intermediate Value Theorem $\exists \theta_i^* \in (0, 1)$ s.t.

$$P'(\theta_i^*) = \Xi_i \tag{20}$$

The first two cases imply the everyone stays in S, or switches to N, respectively. The third case is more intuitive,

- if $\theta_i \geq \theta_i^* \Rightarrow P'(\theta_i) \geq \Xi_i \Rightarrow U_g^S(\theta_i) \geq U_g^N(\theta_i)$, individual i stays in S
- if $\theta_i < \theta_i^* \Rightarrow P'(\theta_i) < \Xi_i \Rightarrow U_g^S(\theta_i) < U_g^N(\theta_i)$, individual i changes to N