Gender and major choice within economics: Evidence from Europe

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ABSTRACT

A large literature studies the underrepresentation of female students in economics majors in the United States. This paper adds to this literature by examining gender differences in major choice *within* an economics bachelor program at a European university. Using a large sample of major students, we document gender differences in the choice of subfields. Female students are strongly underrepresented in finance and overrepresented in accounting. We also test the grade sensitivity hypothesis, according to which the major choice of female students is more responsive to grades. For almost all subfields, major choice is significantly and positively related to the academic performance in the corresponding introductory course(s). The evidence that female students are more sensitive to grades is, however, weak.

1. Introduction

The underrepresentation of female students in undergraduate economics education is a well-established fact (Goldin, 2015). Emerson et al. (2012) find that female students are "less likely to take principles course, less likely to persist in studying economics beyond an introductory course and less likely to major in economics" (p. 350). In a more recent paper, Avilova and Goldin (2018) note that the low share of female students in undergraduate economics classes persists. A large literature has come up with explanations of why female students are less likely to choose economics during their bachelor program. Most studies pertain to the higher education context in the US and model the decision to major in economics.

In recent years, the issue of gender diversity in economics has widened to the choices that students make *within* the field of economics. According to The Economist (2017) "women in economics gravitate towards more people-oriented subdisciplines like health, education, development and labour". This newspaper also claims that men regard the study of economics as a path to a successful career in finance and that they are less discouraged from taking this path by a lack of aptitude than women. Empirical studies on gender differences across subfields that substantiate these claims are, however, scarce. For the UK, Bachan and Barrow (2006) examine the opposite trends in A-level examinations in economics and business studies. In addition to their finding that GSCE scores and mathematical ability can explain the downward trend in economics examinations, they find that females are less likely to choose economics over business studies. For undergraduate education, Bauer and Dahlquist (1999) and Worthington and Higgs (2003) document an underrepresentation of female students among finance majors. Finally, Zölitz and Feld (2018) report that majors in finance and IT management are male-dominated, whereas majors in organization and marketing are female-dominated. For majors in economics, accounting and strategy, they find a balanced gender composition. More recent research focuses on gender differences in research subfields. Using data from the NBER Summer Institute, Chari and Goldsmith-Pinkham (2017) find a large dispersion in the share of female participants across programs. The share of women is low in finance and macro, and relatively high in applied

microeconomics. Similar results are reported by Beneitoa et al., 2019 and Lundberg and Stearn (2019). However, these findings are not connected to the choices that students make at the undergraduate level.

This paper adds to the literature by examining the effect of gender on major choice for subfields *within* an economics bachelor program. Most of the research on economics major choice has been done within the US undergraduate context, in which a bachelor program covers a wide range of disciplines. In this context, economics departments typically offer principles courses to recruit students for an economics major (Allgood et al., 2015). In contrast, this paper uses the institutional setting that prevails in many European countries, which is based on mono-disciplinary bachelor programs (Monteiro and Ferreira Lopes, 2007). As students progress through these programs, they tend to specialize further in a subfield within a discipline. This setting allows us to explore gender differences in the major choice of subfields in economics, conditional on a student's choice for an economics bachelor program. This implies that all students in this dataset share an extensive and identical exposure to economics courses prior to choosing their major. In this aspect, the current study resembles Zölitz and Feld (2018), who study peer gender effects in the major choice within an Economics & Business program at a Dutch university.

A first objective of this paper is to document gender differences in choice of subfield in order to improve our understanding of the under- or overrepresentation of women in the subfields of economics. We pay special attention to a possible gender difference in the choice for a finance major, because of recent societal concerns that a male dominated finance industry may lead to excessive risk-taking. Nelson (2013) is an exponent of the view that a more balanced gender composition among leaders in finance might have mitigated or prevented the global financial crisis. Maclean (2016) confirms that the finance industry is dominated by men, both in the higher echelons and at the entry level, and makes the connection between risk-taking in the financial industry and masculine characteristics. Jianakoplos and Bernasek (1998) and Eckel and Grossman (2002) also report gender differences in attitudes towards financial risk. Sapienza et al. (2009) find that masculine risk-taking has a neuro-chemical cause. If a more equal gender balance in finance would contribute to a more stable financial system, female underrepresentation in finance majors is an issue that needs to be addressed.

A second objective is to add to the literature on major choice in the economics domain. This literature suggests a number of explanations for the gender gap in economics majors. The traditionally held view that female underrepresentation in economics is related to math aptitude has been debunked. While math aptitude is predictive of study success in economics, recent studies cast doubt on the presumed lower math aptitude of female students (Lindberg et al., 2010; Johnson et al., 2014). A recent study by Ahlstrom and Asarta (2019) suggests that the choice between a Bachelor of Arts (BA) and a Bachelor of Science (BS) in economics may be influenced by both math and verbal aptitude. For female students, a high score on verbal aptitude is positively related to the choice for a BA; for male students, a high score on math aptitude is positively related to the choice for a BS. A number of studies find that career opportunities and interest in the subject-matter may explain the gender gap in economics majors (Dynan and Rouse, 1997; Noble Calkins and Welki, 2006; Zafar, 2009; Bansak and Starr (2010); Li, 2017). A well-researched area is the potentially self-propagating effect of the lack of female role models in economics education (Ferber, 1995; Dynan and Rouse, 1997; Robb and Robb, 1999; Rask and Bailey, 2002; McCarty et al., 2006; Porter and Serra (2017); Emerson et al., 2018). The evidence on the importance of female role models is, however, mixed. Smaller subsets of the literature focus on the role of peer composition (Anelli and Peri, 2013; Zölitz and Feld, 2018), the role of mentoring and information (Li, 2018) and the teaching and learning environment (Walstad and Robson, 1997; Ashworth and Evans, 2001).

We finally discuss the literature on the relationship between academic performance and major choice, to which this paper aims to make a contribution. There is strong evidence that a student's performance is related to the choices that he or she makes during the program. This evidence is stronger for female students than for male students. Horvath, Beaudin, Wright (1992) and Emerson, McGoldrick & Mumford (2012) find that female students need higher grades to persist in economics. Owen (2010) uses a regression discontinuity design to examine the effect of letter grades on the decision to major in economics. She finds that the feedback embedded in letter grades encourages females, but not males, to persist in economics. Avilova and Goldin (2018) also report a higher grade sensitivity of female students; male students major in economics regardless of their principles grade. As students choose among a variety of courses, the grade relative to grades for alternative courses, rather than the absolute grade, may determine the major choice (Dynan and Rouse, 1997). Sabot and Wakeman-Linn (1991) find that a high relative grade in introductory economics increases the probability of taking a second economics course. Dynan and Rouse (1997) find that a better aptitude in alternative subjects may explain the underrepresentation of females among economics majors. Chizmar (2000) finds that after controlling for relative grades and credit hours, the survival of female economics majors is similar to their male counterparts. Rask and Tiefenthaler (2008) report gender differences in relative grade sensitivity, particularly at low grades.

Evidence of a positive relationship between academic performance and major choice does not imply a causal effect. Other variables may influence both grades and major choice. Possible explanations for gender differences in grade sensitivity include a greater interest in economics and a stronger focus on future earning power among male students, making them less sensitive to grades. In addition, higher female grade sensitivity may result from women being less confident of success and more in need of the external validation that grades may provide (Halperin and Abrams, 1978; Erkut, 1983). Related to this are gender differences in overconfidence. Analyzing differences between students' expected and actual grades, Nowell and Alston (2007) find that male students show greater overconfidence. In contrast, Grimes (2002) does not find a gender effect in overconfidence.

We examine whether the grade sensitivity hypothesis, according to which the major choice of female students is more responsive to grades, extends to major choice within an economics program. As both male and female students in our sample follow the same set of obligatory courses prior to choosing the major, our research setting overcomes any selection issues that may arise when students choose introductory courses based on their endowed strengths. Our estimates of grade sensitivity across subfields may shed some light on the underlying explanations.

We use a multinomial logit model to explain major choice. We estimate three specifications. The first specification includes gender only. The second specification includes grades for the introductory courses that correspond to the major. In addition, a third specification includes the grades for all other courses. We find substantial gender differences in the choice of subfields. Female students are strongly underrepresented in finance and overrepresented in accounting. For all majors except economics, the addition of grades in the second and third specification does not substantially lower these gender differences, implying that gender differences cannot be explained by differences in academic performance. For almost all subfields, major choice is significantly and positively related to the performance in the corresponding introductory courses. This evidence is strongest in the third specification, which includes all grades. These findings thus offer strong support for the notion that academic performance is related to major choice. We finally repeat the estimation of the second and third specification with the inclusion of interaction terms between gender and grades. This shows that the evidence that female students are more sensitive to grades is weak. In most cases, the marginal effects of grades on major choice do not differ significantly by gender.

This paper is organized as follows. The next section describes the institutional setting, the data and the empirical approach. Next, we discuss the empirical results. We close with a discussion and a number of conclusions.

1.1. Setting, data and method

This study is conducted at Erasmus School of Economics (ESE), which is part of Erasmus University Rotterdam, one of the research universities in the Netherlands. ESE is the largest school of economics in the Netherlands and offers a variety of programs in economics and econometrics. We use data from the main Economics & Business bachelor program. The nominal duration of this program is three years. Upon completion, students earn a BS in Economics and Business.

The structure of the curriculum is based on the view that students should first have a solid background in economics and business before specializing in a subfield. The first two years consist of obligatory courses, which include core courses such as microeconomics, macroeconomics, finance, accounting and marketing, and support courses in mathematics, statistics and academic skills. Table 1 provides an overview of the curriculum in the first two years. In the first half of their third bachelor year, students go on international exchange or follow a minor at another school. In the second half of their third year, students specialize by doing a major in a subfield of economics. Students can choose either a more business-oriented or a more economics-oriented subfield. The subfield consists of three small courses, one large course (labelled "seminar") and a thesis, all in the same subfield. The subfields are listed in Table 1, along with the corresponding major labels that are used in this study. We group the subfields into four majors, each containing a sufficient number of observations and being relatively homogeneous. The majors *Finance* and *Accounting* are both large business-oriented majors. The major *Economics* groups the subfields in microeconomics and macroeconomics, which share a common approach based on mathematical modelling. The final major is labelled *Marketing & Strategy* and groups the subfields marketing, strategy and urban, port and transport economics. Though this is arguably the most heterogeneous major, these subfields share a more qualitative approach compared to the economics major.

Most courses are delivered using a combination of large-scale plenary lectures and small-scale tutorials. During the period of investigation, no major changes in the educational system have taken place. All courses use criterion-referenced standard setting with pre-fixed cut-off rates in their final examinations. Grading follows the Dutch system, in which grades are determined on a continuous scale between 1 and 10. A grade of 8 or higher corresponds to an "A", a grade of 7 to a "B" and 5.5 is the cut-off score for passing. In the first bachelor year, each student receives a so-called binding study advice, based on the student's academic performance. A negative advice is given when the student shows insufficient progress. In that case, a student is not allowed to continue with the program.

We use data from seven cohorts (2009–2015). Data on study progress (courses and grades) are taken from the school's information system. Students' background characteristics are derived from the education research database of the university. The above-mentioned data were collected and then linked based on a student ID. After linking the data, the privacy of the students was

Table 1
Subfields within the economics & business curriculum.

Major	First-year courses	Second-year courses	Subfields
Finance		Finance	Financial Economics
Accounting	Introductory Accounting	Intermediate Accounting	Financial Accounting
			Management Accounting
Marketing & Strategy	Marketing		Marketing
	Organization and Strategy		Industrial Dynamics & Strategy
			Urban, Port & Transport Economics
Economics	Microeconomics	Applied Microeconomics	Economics of Markets & Organizations
	Macroeconomics	Introduction to Behavioral Economics	International Economics
		International Economics	Policy Economics
Support courses	Mathematics 1	Applied Statistics 2	
	Mathematics 2	Methods & Techniques	
	Applied Statistics 1	History of Economic Thought	
	ICT Skills	Economics & Taxation	
	Academic Skills	Research Project	

guaranteed by removing the student ID from the database. The dataset has the advantage of spanning a long time period and, at least for a single-institution study, of including many observations. The dataset also has a number of limitations. Unfortunately, student-level information on students' interest in the subfields of economics and in career opportunities is unavailable, which precludes us from investigating these factors. The professors who have been teaching core the courses in economics and business over the past decade are predominantly male. This lack of variation prevents us from examining the potential influence of female role models on major choice.

Our variable of interest is major choice. The categorical variable $Major_i$ is coded 1–4, indicating the choice of student i for respectively the majors *Finance, Accounting, Marketing & Strategy* and *Economics*. $Major_i$ is explained by means of a multinomial logit model which includes the following explanatory variables. Of primary interest is gender. The dummy variable $Female_i$ takes on the value one for female and zero for male students. In order to test the grade hypothesis, we construct for each major the variable $Grade_{i,j}$. $Grade_{i,j}$ is the (credit-weighted) grade average of student i for first-year and second-year courses in the subfield of major j.

Multinomial logit models are used when discrete dependent variables take on more than two outcomes that have no natural ordering and when a set of explanatory variables is used to predict the dependent variable. A multinomial logit model uses a combination of parameters and observations for the explanatory variables to estimate the probability of each outcome of the dependent variable, cf Eq. (1):

$$\Pr(Major_i = c) = \frac{e^{\beta_c * X_i}}{\sum_{k=1}^{K} e^{\beta_k * X_i}}$$

(1)

In (1), the probability that student i chooses major c out of K possible majors is modeled using the predictor function $\beta_c * X_i$, where X_i is a vector of independent variables and β_c is a vector of regression coefficients corresponding to outcome c. We estimate a multinomial logit model for $Major_i$ including $Female_i$ and $Grade_{i,j}$. We start off with a specification include $Female_i$ only. Next, we add the grades for the introductory first- and second-year courses that correspond to the major. The third specification includes the grades for all other courses. A separate set of results is reported including interaction terms between $Female_i$ and $Grade_{i,j}$. This allows us to examine the hypothesized greater responsiveness of female students to grades. For each specification, we will report the marginal effects of the explanatory variables on major choice. The marginal effect measures the effect on the probability of choosing major c when the explanatory variable increases by one unit. Since we use a non-linear model, the marginal effect will differ from individual to individual. We calculate average marginal effects, which result from computing marginal effects for each individual and then taking the average.

2. Descriptive Statistics

During the period 2009–2015, over 5000 students enrolled in the Economic & Business program, of which 28 % are female. Out of this group 37 % dropped out in the first year; the remaining 63 % have continued their bachelor study. The share of students that are proceeded to the second year is higher for females (65 %) than for males (62 %). This difference is significant at a 1% level. This serves as a first indication that, in our sample, female students do not academically underperform compared to male students. In the empirical analysis below, we focus on students who have progressed to the major. This leaves 3679 students that have have chosen one of the four majors. In the estimations reported below, the number of observations can be lower than 3679, due to the fact that some students did not complete all of their second-year courses before advancing to the major. For these students, data on $Grade_{i,j}$ are incomplete. For the sample of students that have chosen a major, Table 2 reports descriptive statistics. The share of females in this subsample (28.95 %) is higher than the share of females in total enrollment (28 %), reflecting higher first-year survival of female students. There is no significant age difference between male and female students in this sample.

Table 2
Descriptive statistics.

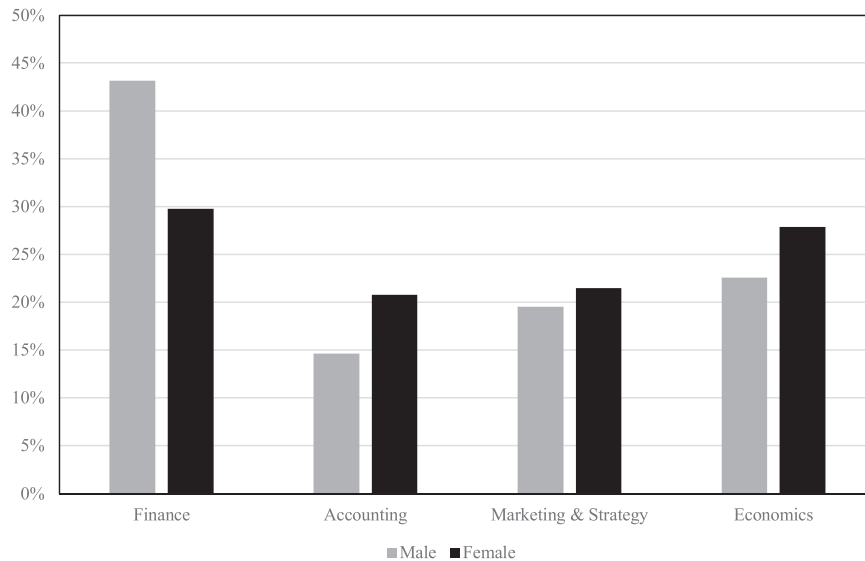|	Female students	Male students	p-value
Number of students	1065	2614	
Share of students (%)	28.95	71.05	
			t-test
Age at enrollment	18.69	18.79	0.052
			t-test
GPA Math courses	7.66	7.44	0.000
	(813)	(1890)	
GPA Introductory courses			
Finance	7.25	7.25	0.973
	(762)	(1787)	
Accounting	6.75	6.81	0.124
	(918)	(2253)	
Marketing & Strategy	7.04	6.89	0.000
	(883)	(2117)	
Economics	6.86	6.88	0.511
	(964)	(2381)	

Fig. 1. Share of students choosing each major.

Table 2 also summarizes grade information by gender. We have included the average of students' grades for the courses Mathematics 1 and Mathematics 2, denoted GPA Math, as a measure for math aptitude. Regarding math aptitude, our data dispel any notion of a negative performance gap between females and males. Female students score significantly higher grades for the mathematics courses than their male fellow students. For the introductory courses in the four subfields, the data show either the absence of significant gender differences or, in the case of *Marketing & Strategy*, a positive gender gap in favor of female students.

Fig. 1 shows the share of male and female students who choose each major. The share of students opting for a finance major is substantially lower among females. This finding corresponds to the similarly strong result in Zölitz and Feld (2018). In contrast, accounting and economics are more popular among females. This result differs from Zölitz and Feld (2018), who find a balanced gender composition for these majors. The female-domination of the marketing major in Zölitz and Feld (2018) is more pronounced than in our data. For *Finance*, *Accounting* and *Economics*, a χ^2-test indicates that the hypothesis that major choice and gender are independent can be rejected at a 1% significance level. To examine the possibility that gender differences in major choice have converged over time, Fig. 2 plots the evolution of the gender gap for each major over time, defined as the difference between the shares of female and male students choosing the major. Notwithstanding some year-by-year variation, no trend towards a closure of the gender gaps can be discerned. The large gender gap in the finance major remains high in later years.

As a first pass at examining the relationship between grades and major choice, Table 3 reports correlation coefficients between $Major_i$ and $Grade_{i,j}$, where $Grade_{i,j}$ measures the average grade for the introductory first- and second-year courses in the subdiscipline j that corresponds to the major j (cf. Table 1). The correlation coefficients are calculated by gender, to explore any differences in grade
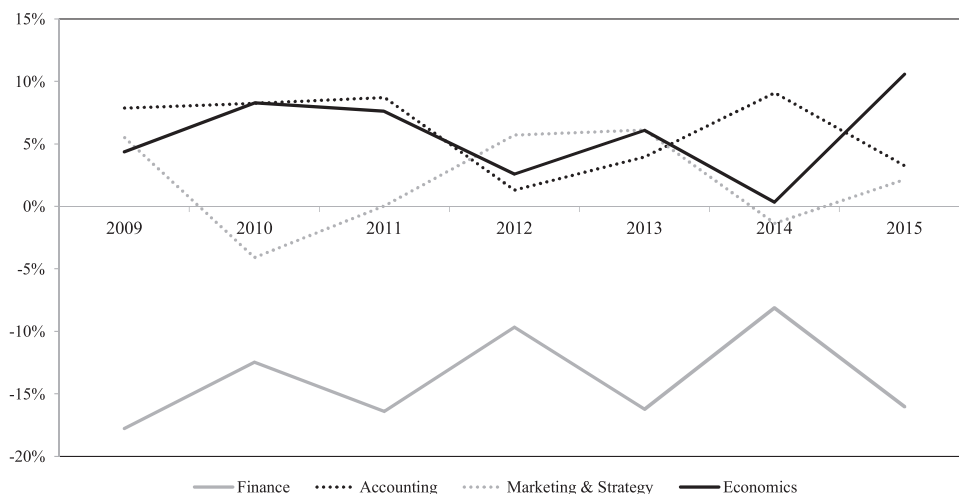

Fig. 2. Evolution of gender gaps over time by major.
Note: lines indicate the difference between the share of female students and the share of male students by major.

Table 3

Correlation between major choice and grades.

	Female students		Male students	
Finance	0.0645	**	0.0434	**
	(0.0306)		(0.0195)	
N	762		1787	
Accounting	−0.0137		0.0062	
	(0.0307)		(0.0196)	
N	918		2253	
Marketing & Strategy	0.0207		0.0361	*
	(0.0307)		(0.0196)	
N	883		2117	
Economics	0.1099	***	0.0940	***
	(0.0305)		(0.0195)	
N	964		2381	

Note: this table reports correlation coefficients between major choice and grades for the corresponding first- and second-year courses by major and by gender; standard errors are in parentheses; significance levels are indicated as * p < .10; ** p < .05; *** p < .01.

sensitivity between male and female students. For *Finance* and *Economics*, the correlation coefficients are positive and significant at a 5% level, indicating that higher grades for the introductory course(s) correspond to a higher probability that students choose the corresponding major. For *Accounting* and *Marketing & Strategy*, no significant positive correlation can be discerned. Regarding gender differences, the correlation coefficients for female students are somewhat higher for the *Finance* and *Economics* majors. However, these differences are small. An additional analysis not reported in the table revealed a large gender gap in the choice for *Finance* among students with low grades for the introductory finance course ($5.5 < Grade_{i,Finance} < 6.5$). In this group 41 % of male students has chosen the finance major, against just 17 % of female students. No such gender gap at low grades was observed for the other majors. This lends some support to the notion that the male finance majors are less easily discouraged by a lack of aptitude or a high risk of failure and are more attracted to finance as a pathway to success.

3. Empirical Results

We present two sets of estimation results for the multinomial logit model, one excluding and one including interaction terms between $Female_i$ and $Grade_{i,j}$. Table 4 reports the average marginal effects for the specifications excluding interaction terms. We first discuss the dispersion of the share of female students across subfields. Panel A shows the marginal effects for a bare specification including gender only. For all four majors, $Female_i$ is significant, indicating that gender differences in major choice exist. The marginal effects confirm the gender differences that we observe in Fig. 1. *Finance* has the strongest gender gap, with a negative

Table 4

Average marginal effects excluding interaction between gender and grades.

Variable	$Major_i$							
	Finance		Accounting		Marketing & Strategy		Economics	
Panel A: Model including gender only								
$Female_i$	−0.1430	***	0.0768	***	0.0315	***	0.0350	**
	(0.0171)		(0.0145)		(0.0098)		(0.0176)	
N	3679		3679		3679		3679	
Panel B: Model including gender and grades for corresponding first- and second-year courses								
$Female_i$	−0.1420	***	0.0731	***	0.0370	***	0.0433	**
	(0.0202)		(0.0155)		(0.0113)		(0.0185)	
$Grade_i$	0.0577	***	0.0226	***	−0.0239	***	0.0486	***
	(0.0079)		(0.0066)		(0.0064)		(0.0091)	
N	2549		3171		3000		3345	
Panel C: Model including gender and grades for all first- and second-year courses								
$Female_i$	−0.1350	***	0.0838	***	0.0309	***	0.0203	
	(0.0214)		(0.0184)		(0.0114)		(0.0219)	
$Grade_{i,Finance}$	0.0743	***	−0.0059		−0.0041		−0.0643	***
	(0.0106)		(0.0082)		(0.0051)		(0.0106)	
$Grade_{i,Accounting}$	−0.0025		0.1040	***	−0.0195	***	−0.0819	***
	(0.0153)		(0.0118)		(0.0076)		(0.0151)	
$Grade_{i,M\&S}$	−0.0413	**	−0.0400	***	0.0011		0.0802	***
	(0.0177)		(0.0138)		(0.0082)		(0.0174)	
$Grade_{i,Econ}$	−0.0116		−0.0847	***	−0.0218	**	0.1180	***
	(0.0192)		(0.0151)		(0.0096)		(0.0187)	
N	2256		2256		2256		2256	

Note: standard errors are in parentheses; significance levels are indicated as * p < .10; ** p < .05; *** p < .01.

marginal effect of -0.143, implying that a female student has 14.3 percentage point lower probability of choosing this major. *Accounting* has a strong positive difference of 0.077. For *Marketing & Strategy* and *Economics* the differences are smaller.

Panel B adds the grades for the introductory first- and second-year courses that correspond to the major in the specification. The addition of these grades does not reduce the gender differences. The finding that gender gaps are still present in a model including grades, suggests that gender differences in grade sensitivity cannot fully account for these gaps. Regarding the influence of academic performance on major choice, we find that $Grade_{i,j}$ has a significant positive relationship with the choice for major j for three out of four majors. The odd one out is *Marketing & Strategy*, which shows a significant negative relationship between $Grade_{i,M\&S}$ and major choice. A possible explanation for this deviation is that academically strong students do not choose this major even though their values for $Grade_{i,M\&S}$ may be high, as it is perceived as the least challenging major. As an additional explanation, the link between the introductory courses and the major is weakest in this subfield, content-wise.

Finally, Panel C reports results for the third specification, which includes the grades for all courses. The impact of the inclusion of all grades on the gender differences is small. The average marginal effects for $Female_i$ remain similar to those in Panel A for *Finance*, *Accounting* and *Marketing & Strategy*. The exception is the economics major, for which the marginal effect of $Female_i$ drops in size and becomes insignificant. The inclusion of other grades strengthens the link between major choice and the grades for the introductory first- and second-year courses that correspond to the major. For *Finance*, the marginal effect increases from 0.0577 in Panel B to 0.074 in Panel C. For *Accounting* and *Economics*, the increases in marginal effects are even stronger, from respectively 0.023 and 0.049 to 0.104 and 0.118. Grade sensitivity is highest for *Economics*. This could be due to its emphasis on mathematical modelling, which may nurture the impression among students that *Economics* is a challenging major requiring a strong academic track record. As in Panel B, we do not find a significant positive relationship between grades and *Marketing & Strategy*. Panel C also shows that in almost all cases $Grade_{i,j}$ is negatively related to the choice for another major (not corresponding to the introductory courses). The exception is $Grade_{i,M\&S}$, which has a significantly positive relationship with the choice for the economics major.

Based on Table 4, we can conclude that, although there is strong evidence for a relationship between academic performance and major choice, this relationship does not reduce the gender gaps for three out of four majors. Only for the economics major, the grade sensitivity reduces the gender difference to an insignificant level.

Table 5
Average marginal effects including interaction between gender and grades.

Variable		Finance		Accounting		Marketing & Strategy		Economics	
		Major$_i$							
Panel A: Model including gender and grades for corresponding first- and second-year courses									
$Female_i$		−0.1420	***	0.0731	***	0.0359	***	0.0431	***
		(0.0202)		(0.0155)		(0.0112)		(0.0185)	
$Grade_i$	Male	0.0547	***	0.0184	**	−0.0266	***	0.0467	***
		(0.0098)		(0.0075)		(0.0072)		(0.0104)	
	Female	0.0644	***	0.0330	**	−0.0183		0.0513	***
		(0.0133)		(0.0137)		(0.0131)		(0.0183)	
	t-value	0.588		0.935		0.555		0.219	
N		2549		3171		3000		3345	
Panel B: Model including gender and grades for all first- and second-year courses									
$Female_i$		−0.1330	***	0.0866	***	0.0284	**	0.0176	
		(0.0215)		(0.0187)		(0.0111)		(0.0219)	
$Grade_{i,Finance}$	Male	0.0662	***	−0.00518		−0.00949		−0.0515	***
		(0.0134)		(0.00954)		(0.00585)		(0.0132)	
	Female	0.0873	***	−0.00891		0.00677		−0.0851	***
		(0.0170)		(0.0163)		(0.00954)		(0.0178)	
	t-value	0.975		0.197		1.453		1.516	
$Grade_{i,Accounting}$	Male	0.00133		0.0923	***	−0.00838		−0.0853	***
		(0.0188)		(0.0132)		(0.00818)		(0.0181)	
	Female	−0.0116		0.1330	***	−0.0439	***	−0.0772	***
		(0.0259)		(0.0246)		(0.0151)		(0.0270)	
	t-value	0.404		1.458		2.068	**	0.249	
$Grade_{i,M\&S}$	Male	−0.0240		−0.0227		−0.00921		0.0559	***
		(0.0219)		(0.0157)		(0.00916)		(0.0211)	
	Female	−0.0775	***	−0.0797	***	0.0240		0.1330	***
		(0.0301)		(0.0285)		(0.0157)		(0.0302)	
	t-value	1.437		1.752		1.827		2.093	**
$Grade_{i,Econ}$	Male	−0.0290		−0.0895	***	−0.0138		0.1320	***
		(0.0235)		(0.0172)		(0.0103)		(0.0222)	
	Female	0.0312		−0.0738	**	−0.0367*	*	0.0793	**
		(0.0333)		(0.0311)		(0.0195)		(0.0348)	
	t-value	1.477		0.442		1.038		1.277	
N		2256		2256		2256		2256	

Note: standard errors are in parentheses; significance levels are indicated as * p < .10; ** p < .05; *** p < .01; t-values are for a test of equality of marginal effects by gender.

Table 5 reports a separate set of results for specifications including interaction terms between gender and grades and t-tests of the equality of marginal effects by gender. This allows us to examine the hypothesized greater responsiveness of female students to grades. To explore the presence of gender differences in grade sensitivity, Table 5 reports the average marginal effects of $Grade_{i,j}$ on major choice by gender. Panel A starts with the specification that includes only the grades for the introductory first- and second-year courses that correspond to the major. The results are very similar to Panel B in Table 4. For three out of four majors, there is a significant positive relationship between grades and major choice. This relationship does not, however, diminish the gender differences in major choice. In all cases, the marginal effects of $Grade_{i,j}$ do not significantly differ by gender. Panel B reports the results for the specification including grades for all first- and second-year courses. The main results again corroborate the findings reported in Table 4. For all majors except *Marketing & Strategy*, adding other grades increases the positive grade sensitivity for the introductory courses that correspond to the major. In most cases, the sensitivity of major choice to other grades remains negative. The finding that grade sensitivity does not substantially reduce the gender differences in major choice is confirmed in Table 5, again with the exception of the economics major. A notable difference between Panels A and B is that the gender differences in the marginal effects of grades for the introductory courses that correspond to the major are now more pronounced. For the finance major, the marginal effects of $Grade_{i,Finance}$ do not significantly differ by gender. Although the results for *Accounting* point to a significantly higher grade sensitivity for female students compared to male students, with marginal effects of respectively 0.133 and 0.092, these differences are not significant. For *Economics*, we find the opposite result, whereby grade sensitivity is higher among males (0.132 versus 0.079), but again the difference is not significant. The only significant gender differences in grade sensitivity are for the effect of $Grade_{i,Accounting}$ on the choice for *Marketing & Strategy* and for the effect of $Grade_{i,M\&S}$o on the choice for *Economics*. This leads to the conclusion that no clear pattern emerges regarding greater female grade sensitivity across all four majors. The absence of a uniform pattern of gender differences in grade sensitivity casts doubt on explanations based on a female trait, such as "lack of confidence".

In addition to the estimates reported here, we have conducted a number of robustness checks. We have estimated marginal effects including additional explanatory variables, such as the grades for math courses and the ethnic minority background of students. These estimates did not change our findings on gender differences in major choice and on grade sensitivity. We have also explored whether the grades for the introductory economics courses should be split in microeconomics and macroeconomics grades. This split showed that the sensitivity of major choice to $Grade_{i,Economics}$ is primarily due to the grades for microeconomics. The grades for the macroeconomics courses are not significantly related to the choice for any major. As an additional robustness check we have calculated all marginal effects at the means of the explanatory variables, instead of computing the marginal effect for each individual and then taking the average. This also did not change the results markedly. Finally, the inclusion of cohort effects did not have a meaningful effect on the outcomes.

4. Discussion and conclusions

This paper aims to make two contributions to the literature on gender diversity in undergraduate economics education. First, we provide evidence on the representation of female undergraduate students in subfields of economics. Second, we add to the literature on the relationship between grades and major choice in the economics domain. Using seven cohorts of student data from a large European research university, we explore major choice *within* an bachelor program in Economics & Business. This institutional setting allows us to examine gender differences in the major choice of subfields in economics, conditional on the choice for an economics bachelor. We use the data to test whether the grade sensitivity hypothesis, according to which female students are more responsive to grades than male students, extends to subfields within economics.

Our data point to substantial gender differences in the choice of subfield. In our dataset, finance majors make up by far the largest share of students. We also find strong results for this major. Compared to males, a much lower share of female students chooses a finance major. This finding is in line with previous studies on gender representation in finance (Bauer and Dahlquist, 1999; Worthington and Higgs, 2003; Zölitz and Feld, 2018). In contrast, females are strongly overrepresented in the accounting major and somewhat overrepresented in the majors *Marketing & Strategy* and *Economics*.

Based on our data, we can rule out gender differences in math aptitude as an explanatory factor for our findings. In our sample, female students show higher math aptitude than male students. Other explanations are less likely, but cannot be ruled out completely. The predominantly male staffing of education during the sample period implies that the potential influence of female role models is unlikely to explain the gender differences that we observe. For example, all introductory finance and accounting courses have been taught by male professors, yet the gender gaps for the finance and accounting majors have a different sign. As all courses adhere to a common educational philosophy, there is little variation in the teaching and learning environment across subfield. This suggest that differences in pedagogical approaches and techniques are unlikely to explain the observed gender differences. Here as well, a comparison between finance and accounting is instructive. All introductory finance and accounting courses combine plenary lectures with tutorials in which quantitative exercises are discussed. Yet the gender gaps are different.

This leaves three potential explanations that have been advanced in the literature. The low (high) share of females in finance (accounting) could arise from gender differences in the interest in the subfield. Related to this, the "alpha male"-culture in finance may put off female students (Hippel et al., 2015). Unfortunately, we cannot test this hypothesis, as information on students' interest in or aversion to subfields is unavailable. Lack of data also prevents us from testing the hypothesis that career opportunities or future earning power drive the gender difference. The final explanation is that academic performance, as measured by grades, is an important determinant of major choice.

Using a multinomial logit model, we find strong evidence that the grades for introductory courses in a subfield is positively related to a student's choice for a major in that subfield. These results thus offer strong support for the notion that academic performance is

related to to major choice. However, our estimates also show that the addition of grades to the model does not substantially lower the gender differences in major choice, with the exception of the economics major. This implies that gender differences in major choice cannot be fully explained by differences in academic performance.

Regarding grade sensitivity, the evidence in favour of the hypothesis that females are more sensitive to this variable is much weaker. More specifically, we do not find a systematic pattern that the marginal effects of grades on major choice are higher for females than for males. The lack of a uniform pattern of significant gender differences in grade sensitivity across majors stands in stark contrast to earlier studies reporting higher female grade sensitivity (Horvath et al., 1992; Emerson et al., 2012; Avilova and Goldin, 2018). A possible explanation for this deviation is offered by the institutional setting in which this study is conducted. The students in our sample underwent two years of training in economics before making their major choice. During this period, female students performed as well as male students in the core economics courses (and better in the mathematics courses) and may have noticed that they are not inferior to their male fellow students. The stronger immersion in the field that a mono-disciplinary bachelor offers, compared to the broad bachelor programs typically offered in the US, may have reduced any difference in confidence between male and female students. This explanation would suggest that gender differences caused by differences in confidence levels are not immutable, but can be changed by varying the setting.

As an exception to the general pattern, we find that females are less likely to choose the finance major than their male counterparts when they underperform in the corresponding introductory course. Our finding that 41 % of male students in the lowest grade category for the introductory finance course choose the finance major, against just 17 % of female students, is noteworthy. While this finding could point to gender differences in confidence among finance majors, it is also compatible with the view that male students regard a finance major as a pathway to success, and will pursue this path at all cost. This finding thus lends some support to the statement that "…a lot of men studying economics see it as a ticket to success in finance; they will stick with it despite a lack of aptitude in a way similarly able women do not" (The Economist, 2017).

Credit author statement

This is a single-authored paper.

References

Ahlstrom, L.J., Asarta, C.J., 2019. The gender gap in undergraduate economics course persistence and degree selection. AEA Papers Proc. 109, 255–260.

Allgood, S., Walstad, W.B., Siegfried, J.J., 2015. Research on teaching economics to undergraduates. J. Econ. Lit. 53 (2), 285–325.

Anelli, M., Peri, G., 2013. Peer Gender Composition and Choice of College Major. NBER Working Paper, No. 18744. .

Ashworth, J., Evans, L., 2001. Modeling student subject choice at secondary and tertiary level: a cross-section study. J. Econ. Educ. 32 (4), 311–320.

Avilova, T., Goldin, C., 2018. What can UWE do for economics? AEA Papers Proc. 108, 186–190.

Bachan, R., Barrow, M., 2006. Modelling curriculum choice at A-level: Why is Business Studies more popular than Economics? Int. Rev. Econ. Educ. 5 (2), 58–80.

Bansak, C., Starr, M., 2010. Gender differences in predispositions towards economics. East. Econ. J. 33 (1), 36–57.

Bauer, R.J., Dahlquist, J., 1999. Recognizing and eliminating gender bias in finance education. Financial Pract. Ed. 9 (1), 83–91.

Beneitoa, P., Boscá, J.E., Ferria, J., García, M., 2019. Women Across Subfields in Economics: Relative Performance and Beliefs. FEDEA Working Paper, 2018, 06. .

Chari, A., Goldsmith-Pinkham, P., 2017. Gender Representation in Economics Across Topics and Time: Evidence From the NBER Summer Institute. NBER Working Paper, No. 23953. .

Chizmar, J.F., 2000. A discrete-time hazard analysis of the role of gender in persistence in the economics major. J. Econ. Educ. 31 (2), 107–118.

Dynan, K.E., Rouse, C.E., 1997. The underrepresentation of women in economics: a study of undergraduate economics students. J. Econ. Educ. 28 (4), 350–368.

Eckel, C., Grossman, P., 2002. Sex differences and statistical stereotyping in attitudes toward financial risk. Evol. Hum. Behav. 23 (4), 281–295.

Emerson, T.L., McGoldrick, K., Mumford, K.J., 2012. Women and the choice to study economics. J. Econ. Educ. 43 (4), 349–362.

Emerson, T.L., McGoldrick, K., Siegfried, J.J., 2018. The gender gap in economics degrees: an investigation of the role model and quantitative requirements hypotheses. South. Econ. J. 84, 898–911.

Erkut, S., 1983. Exploring sex differences in expectancy, attribution, and academic achievement. Sex Roles 9 (2), 217–231.

Ferber, M., 1995. The study of economics: a feminist critique. Am. Econ. Rev. 85 (2), 357–361.

Goldin, C., 2015. Gender and the Undergraduate Economics Major: Notes on the Undergraduate Economics Major at a Highly Selective Liberal Arts College. manuscript, April 12 (2015). .

Grimes, P.W., 2002. The overconfident principles of economics student: an examination of a metacognitive skill. J. Econ. Educ. 33 (1), 15–30.

Halperin, M.S., Abrams, D.L., 1978. Sex differences in predicting final examination grades: the influence of past performance, attributions, and achievement motivation. J. Educ. Psychol. 70 (5), 763–771.

Hippel, Cvon, Sekaquaptewa, D., McFarlane, M., 2015. Stereotype threat among women in finance: negative effects on identity, workplace well-being, and recruiting. Psychol. Women Q. 39 (3), 405–414.

Horvath, J., Beaudin, B.Q., Wright, S.P., 1992. Persisting in the introductory economics course: an exploration of gender differences. J. Econ. Educ. 23 (2), 101–108.

Jianakoplos, N., Bernasek, A., 1998. Are women more risk averse? Econ. Inq. 36 (4), 620–630.

Johnson, M., Robson, D., Taengnoi, S., 2014. A metaanalysis of the gender gap in performance in collegiate economics courses. Rev. Soc. Econ. 72 (4), 436–459.

Li, H., 2017. Does better information reduce the gender gap in economics majors. In: AEA/ASSA Annual Meeting. Chicago. . Retrieved from https://www.aeaweb.org/conference/2017/preliminary/paper/KdzAsNYE.

Li, H., 2018. Do mentoring, information, and nudge reduce the gender gap among economics majors? Econ. Educ. Rev. 64, 165–183.

Lindberg, S.M., Hyde, J.S., Petersen, J.L., 2010. New trends in gender and mathematics performance: a meta-analysis. Psychol. Bull. 136 (6), 1123–1135.

Lundberg, S., Stearn, J., 2019. Women in Economics: stalled progress. J. Econ. Perspect. 33 (1), 3–22.

Maclean, K., 2016. Gender, risk and the Wall Street alpha male. J. Gend. Stud. 25 (4), 427–444.

McCarty, C., Padgham, G., Bennett, D., 2006. Determinants of student achievement in principles of economics. J. Eco. Educators 6 (2), 1–9.

Monteiro, H., Ferreira Lopes, A., 2007. A benchmarking of the undergraduate Economics major in Europe and in the United States. Int. Rev. Econ. Educ. 6 (2), 9–26.

Nelson, J.A., 2013. Would women leaders have prevented the global financial crisis? Teaching critical thinking by questioning a question. Int. J. Plur. Econ. Educ. 4, 192–209.

Noble Calkins, L., Welki, A., 2006. Factors that influence choice of major: why some students never consider economics. Int. J. Soc. Econ. 33 (8), 547–564.

Nowell, C., Alston, R.M., 2007. I thought I got an A! Overconfidence across the economics curriculum. J. Econ. Educ. 38 (2), 131–142.

Owen, A.L., 2010. Grades, gender, and encouragement: a regression discontinuity analysis. J. Econ. Educ. 41 (3), 217–234.

Porter, C., Serra, D., 2017. Gender Differences in the Choice of Major: the Importance of Female Role Models. Southern Methodist University, Department of

Economics.

Rask, K., Bailey, E., 2002. Are faculty role models? Evidence from major choice in an undergraduate institution. J. Econ. Educ. 33 (2), 99–124.

Rask, K., Tiefenthaler, J., 2008. The role of grade sensitivity in explaining the gender imbalance in undergraduate economics. Econ. Educ. Rev. 27 (6), 676–687.

Robb, R.E., Robb, A.L., 1999. Gender and the study of economics: the role of gender of the instructor. J. Econ. Educ. 30 (1), 3–19.

Sabot, R., Wakeman-Linn, J., 1991. Grade inflation and course choice. J. Econ. Perspect. 5 (1), 159–170.

Sapienza, P., Zingales, L., Maestripieri, D., 2009. Gender differences in financial risk aversion and career choices are affected by testosterone. Proc. Nat. Acad. Sci. U.S.A. 106, 15268–15273.

The Economist, 2017. Women and Economics. Christmas issue, December 19th 2017. .

Walstad, W.B., Robson, D., 1997. Differential item functioning and male-female differences on multiple-choice tests in economics. J. Econ. Educ. 28 (2), 155–171.

Worthington, A.C., Higgs, H., 2003. Factors explaining the choice of a finance major: the role of students' characteristics, personality and perceptions of the profession. Account. Educ. 12 (3), 261–281.

Zafar, B., 2009. College Major Choice and the Gender Gap. Federal Reserve Bank of New York Staff Report No. 364.

Zölitz, U., Feld, J., 2018. The Effect of Peer Gender on Major Choice. University of Zurich, Department of Economics Working Paper 270.