THE EFFECT OF THE E.U. PRIZE FOR WOMEN INNOVATORS ON THE SHARE OF FEMALE STUDENTS IN HIGHER EDUCATION

by
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Abstract

The gender wage gap is an important issue all over the world. In some occupations, in particular STEM (Science, Technology, Engineering, and Mathematics) occupations, the gender wage gap is closely linked to an enormous participation gap. My paper focuses on STEM major university students in Europe. I use education data between 2012 to 2017 and prize winner data between 2011 to 2018 from Eurostat and the European Commission to analyze the effect of highly visible EU prizes awarded to women innovators in STEM on the share of female students in higher institutions. The results suggest that for both STEM and non-STEM majors, EU prizes for women innovators do not have positive effects on the share of female students in higher education institutions.

Section 1: Introduction

The gender wage gap has remained a severe economic problem for decades. Despite many countries applying different policies aimed to reduce the gender wage gap, there are many remaining policy avenues to explore and much convergence yet to achieve. In this paper, I focus on the gender wage gap in Europe. According to Eurostat (2019), the average female worker's gross hourly earnings is about 16% lower than the average male worker's hourly earnings in the European Union and the Euro area in 2017. To be more specific, the gender wage gap ranges from 3.5% in Romania to 25.6% in Estonia ("Gender pay gap statistics", 2019). This problem is not specific to Europe. In 2017, the United States had a gender wage gap ranging from 11% in California to 31% in Louisiana (Vagins, n.d.). According to Deborah J. Vagins (n.d.), the senior vice president of public policy and researcher at the American Association of University Women (AAUW), almost all occupations and industries have a gender pay gap, the only difference is some occupations have smaller pay gaps than others.

One pathway for the gender wage gap is occupational selection. In some occupations, such as business and law, employers prefer workers who can work overtime or willing to travel frequently for business. However, men and women have different preferences for lengths of working hours and workplace flexibility. In the academic paper "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions", Claudia Goldin and Lawrence F. Katz (2000), suggest that women have a greater preference for a shorter workweek and higher flexibility due to many reasons. Fertility flexibility, and childcare, generally are the main reasons for this preference, they argue. This implies women are more likely to choose jobs with higher flexibility on the length of working hours and the workplace. This could explain why there are so few female employees in STEM-related fields, where STEM refers to science, technology, engineering, and mathematics. In STEM fields, employees need to complete research and operational tasks, such as supervisions and manage technical and operational parts for engineering operations. These job duties require long working hours, which, they argue, will attract fewer women. According to Panagiota Fatourou, Yota Papageorgiou, and Vasiliki Petousi (2019), in the EU, women represent less than 25% of science professionals and other STEM-related professionals (p.52). However, it is hard to tell whether women have different preferences for job selection due to their need for more flexibility at the workplace or due to the expectations of their parents and even from social norms.

Occupational selection relates to discrimination from employers, customers, and society as a whole. Gender stereotyping is one type of discrimination. For example, in the academic paper “Do Women Shy Away from Competition? Do Men Compete Too Much?”, the authors, Muriel Niederle and Lise Vesterlund (2007), suggest that with the same level of ability, men are more competitive and overconfident than women, and thus that men are more likely to advance quickly in business. Also, in many countries, old-fashioned stereotypes persist, and people commonly think women should work as a nurse or teacher because women are perceived to be more patient and tender. Under these circumstances, women’s parents and even the pressure from society as a whole will “force” them to work in certain occupations.

Beyond occupation selection, gender stereotypes will cause employers and customers to view female employees’ behavior differently and credit them differently than male employees. For example, in the research paper “Interpreting Signals in the Labor Market: Evidence from Medical Referrals”, Heather Sarsons (2017) finds that when primary care physicians (PCP) refer patients to surgeons, they are less likely to refer patients to female surgeons who have had bad outcomes because they think female surgeons are not good enough; while they think male surgeons who have had bad outcomes are just unlucky. Stereotypes contribute to discrimination from employers, customers, and social pressure, which prevents the gender pay gap from closing.

One potential solution for the gender wage gap is to increase visible gender representation in fields where women are underrepresented. In the academic research paper "Preferences and Biases in Educational Choices and Labor Market expectations: Shrinking the Black Box of Gender", Ernesto Reuben, Mathew Wiswall, and Basit Zafar (2013) point out gender differences in students' overconfidence and competitiveness influence about 18% of the gender wage gap in the future. They mention that students who are overconfident and more competitive are more likely to have higher future earnings. Another example is about economics. According to Catherine Poter and Danila Serra (2017), "Economics is with only 30% of bachelor degrees awarded to women – the same percentage as in the mid-1990s" (p.3). This implies Economics is one of the fields where women are underrepresented. In the article "Can Mentoring Help Female Assistant Professors? Interim Results from Randomized Trial", Blau et al. (2010) found that in economics mentoring programs, after senior female faculty mentor younger female faculties, the number of publications of junior female faculty and the number of grants awarded to them increase (p.351). According to Lim and Meer (2017), female students study harder and get a better grade when female math teachers teach them in middle school. Furthermore, they are more likely to choose STEM majors in college. This implies that a female professor is a role model for female students. Teaching from same-gender professors will likely motivate more female students to study in that field.

In my paper, I study the EU Prize for Women Innovators. The prize is given to women entrepreneurs who have developed and brought to market an outstanding innovation. When the winner is announced, their EU country is listed as having 'won' the prize in that year. The goal of the prize is, in part, to encourage more women to study STEM majors, and in the future, to work in STEM fields. Using data on enrollments in higher education in Europe, I will analyze how the EU prize affects the share of STEM majors that are women in the country of the prize winner.

Section 2: Data and Methods

Section 2.1: Data

We use two sources of data in this project: data on enrollments in higher education by country, major, and sex, and data on winners of the EU Prize for Women Innovators.

For the education information, we obtained data from Eurostat, the statistical office of the European Union. Observations are the counts of students who enroll in higher institutions (tertiary education levels 5-8) in European countries, which includes the 28 EU Member States (Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Ireland, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovak Republic, Finland, Sweden and United Kingdom), the EFTA/EEA countries (Iceland, Liechtenstein, Norway and Switzerland), the candidate countries (Albania, the FYR of Macedonia, Serbia and Turkey), as well as OECD Member States situated outside Europe (Australia, Canada, Japan, Korea, Mexico, New Zealand, United States) and other countries (e.g. Israel). The Eurostat data collection records students' enrolment by sex from 2013 to 2017, while only includes the enrollments of 2012 in Germany. The timing convention refers to the end of an academic year. For example, data from 2013 cover the 2012-2013 school year. The enrollments are counted as an average of several counting dates throughout one academic year.

For the prize information, we obtain data from the European Commission. The EU Prize for Women Innovators is given to women entrepreneurs who have developed and brought to market an outstanding innovation. Table 1 shows the first prize winner, second prize winner, and third prize winner respectively, with the corresponding year. Note, the first prize winner in 2017 includes both the United Kingdom and Croatia.

Table 1: Prize Winner

year	Winner1	Winner2	Winner3
2011	Germany	France	Italy
2014	Germany	Netherlands	Spain
2016	Portugal	Finland	Ireland
2017	United Kingdom, Croatia	Sweden	Germany
2018	Italy	Spain	Austria

The prize winner is announced in April of each year. This means that winning the 2014 prize could only effect the incoming class in Fall 2014, which is counted in the 2015 education data. Therefore, the prize variables will need to be lagged in when we estimate an effect of the prize on enrollments. When the two datasets are merged, it creates 1,652 observations at the country-major-year level.

Section 2.2: Methods

After merging the two datasets in STATA, I first run a regular OLS linear regression model to analyze the overall effect of winning any prize on the share of female students. Empirically, our model follows the form related below:

$$ShareF_{i,t} = \beta_1 + \beta_2 L.Prize_{i,t} + \beta_3 Year_t + \beta_4 STEM_i + \beta_5 STEMXYEAR_{i,t} + \beta_6 STEMXPRIZE_{i,t} + \varepsilon_{i,t}$$

where β_2 is the coefficient of L.Prize, and L.Prize represents the dummy variable that equals one if Country X wins the prize in the April before the corresponding academic year, and zero otherwise. β_3 is the coefficient of YEAR, and YEAR is a linear time trend variable that is equal to 0 in 2012. β_4 is the coefficient of STEM, where STEM is a dummy variable that equals one if an observation's major is one of the following majors: natural sciences, mathematics and statistics, information and communication technologies, engineering, manufacturing and construction. β_5 is the coefficient of STEMXYEAR, and STEMXYEAR is a separate linear time trend for STEM majors only. β_6 is the coefficient of STEMXPRIZE, and STEMXPRIZE denotes observations of STEM majors from countries which earned a prize –first, second, or third—in the April before the academic year.

An important concern about the OLS specifications is that countries that win the prize are more likely to be experiencing increases in women's STEM enrollment. Therefore, I run the regression with country fixed effects. With this model, we fix country as a constant and to analyze the effect on the share of female students to prize winner within one specific country. In this way, any omitted variable bias related to which country wins the prize, based on fixed country characteristics, is controlled for. Empirically, our model follows the form related below:

$$ShareF_{i,t} = \beta_{1i} + \beta_2 L.Prize_{i,t} + \beta_3 Year_t + \beta_4 STEMXYEAR_{i,t} + \beta_5 STEMXPRIZE_{i,t} + \varepsilon_{i,t}$$

In this regression, we change β_1 to β_{1i} because non-STEM major observations who are from countries not winning a prize in any year may show different average share of female students than prize winners and STEM majors.

Beyond considering whether winning any prize has an effect, we consider whether winning a prize as the first, second, or third place matters for the effect on share of female students in higher institutions. First, we run the OLS regression. Empirically, our model follows the form related below:

$$ShareF_{i,t} = \beta_1 + \beta_2 L.First_{i,t} + \beta_3 L.Second_{i,t} + \beta_4 L.Third_{i,t} + \beta_5 YEAR_t + \beta_6 STEM_i + \beta_7 STEMXYEAR_{i,t} + \beta_8 STEMXFIRST_{i,t} + \beta_9 STEMXSECOND_{i,t} + \beta_{10} STEMXTHIRD_{i,t} + \varepsilon_{i,t}$$

where $\beta_2, \beta_3, \beta_4$ are the coefficients of L.First, L.Second, L.Third respectively, and L.First, L.Second, and L.Third are dummy variables which equal one if a country wins the first prize, second prize, third prize respectively in the April before the corresponding academic year. β_8 is the coefficient of STEMXFIRST, and STEMXFIRST denotes observations that are STEM majors and also come from countries which win the first prize. β_9 is the coefficient of STEMXSECOND, and STEMXSECOND denotes observations that are STEM majors and also come from countries which win the second prize. β_{10} is the coefficient of STEMXTHIRD, and STEMXTHIRD denotes observations that are STEM majors and also come from countries which win the third prize.

Then I run the same regression but with fixed effects. Empirically, our model follows the form related below:

$$ShareF_{i,t} = \beta_{1i} + \beta_2 L.First_{i,t} + \beta_3 L.Second_{i,t} + \beta_4 L.Third_{i,t} + \beta_5 YEAR_t + \beta_6 STEMXYEAR_{i,t} + \beta_7 STEMXFIRST_{i,t} + \beta_8 STEMXSECOND_{i,t} + \beta_9 STEMXTHIRD_{i,t} + \varepsilon_{i,t}$$

In this regression, we change β_1 to β_{1i} because non-STEM major observations who are from countries not winning first, second, or third prize in any year show different average share of female students.

Section 3: Results

Section 3.1: Full-sample Regressions

Results1:

We first want to analyze how winning a prize affects the share of female students in higher institutions and compare the different effects when we include and exclude other explanatory variables such as year, STEM, STEMXYEAR, and STEMXLPRIZE. In Table 2, we want to find how these explanatory variables affect the outcome variable individually and interactively.

Table 2: OLS Regression Using Any Prize

	(1)	(2)	(3)	(4)
VARIABLES	shareF	shareF	shareF	shareF
L.Prize	-0.0275	-0.0297	-0.00632	-0.00433
	(0.0472)	(0.0478)	(0.0242)	(0.0245)
year		0.00181		-0.00166
		(0.00597)		(0.00301)
STEM			-0.285***	-0.294***
			(0.00776)	(0.0183)
STEMXYEAR				0.00347
				(0.00589)
STEMXLPRIZE			-0.0212	-0.0253
			(0.0468)	(0.0474)
Constant	0.326***	-3.322	0.611***	3.946
	(0.00784)	(12.02)	(0.00398)	(6.069)
Observations	435	435	1,652	1,652
R-squared	0.001	0.001	0.458	0.458

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 2, the regression in column (1) estimates the effect of winning a prize on share of female students in higher institutions when L.Prize is the only explanatory variable. We find that the expected share of female students in higher institutions decreases by around 2.75% for STEM majors if we only consider observations from countries that win the prize in the corresponding academic year in our regression. The regression in column (2) estimates the same model but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 2.97% for STEM major students from countries that not win the prize to STEM major students from countries that win the prize if we hold year constant. The regression in column (3) also estimates the effect of winning a prize on share of female students in higher institutions with STEM and STEMXLPRIZE as control variables. The addition of these explanatory variables allows the effect of winning the prize to be different for STEM and non-STEM majors. The expected share of female students in higher institutions decreases by about 0.632% for students from countries that do not win the prize relative to students from countries that win the prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a prize-winning country-year is 2.12% when we exclude the year variable. To consider the overall effect of prize winning on the STEM female student share, we take the sum of the L.Prize and STEMXLPRIZE variables: we find a decrease of 2.75% following a prize winning. The regression in column (4) adds YEAR and STEMXYEAR variables. We find the expected share of female students in higher institutions decreases by about 0.433% for non-STEM students who are from prize-winning countries, and we find a STEM-specific effect of a 2.53% decrease. Therefore, the overall decrease in the share female for STEM students after a prize win is 2.96%. The data indicates a small negative effect of winning a prize on the share of female students, although it is not statistically significant.

When we separate students to STEM and non-STEM majors, there are not big differences in the share of female students across major types. This doesn't depend on whether or not we include YEAR variable. The expected share of female students in higher institutions from non-STEM to STEM decreases by around 28.5% when we exclude YEAR variable. The expected share of female students in higher institutions from non-STEM to STEM decreases by about 29.4% when we include YEAR and STEMXYEAR variables. Both of these differences are statistically significant at the 1% level.

Columns (2) and (4) showed us interesting results when we consider year as an explanatory variable. The expected share of female students with one additional year increases by about 0.18% when we only consider STEM major students. However, when we separate STEM and non-STEM majors, the expected share of female students with one additional year decreases by about 0.166% in non-STEM majors, but increases by 0.181% for STEM majors. Therefore, the expected difference in the growth rates of the share of female students in higher institutions between non-STEM to STEM majors is about 0.347%.

Results2:

Now we run a regression with fixed effects to consider how winning a prize affects the share of female students when we only use the within-country variation in whether the STEM prize was won in the April before the corresponding academic year. We consider variations of the model when we include and exclude YEAR, STEM, STEMXYEAR, and STEMXLPRIZE as control variables. With fixed effects, we fix country as a constant variable and to analyze the effect on the share of female students to prize winner within one specific country. In this way, any omitted variable bias related to which country wins the prize, based on fixed country characteristics, is controlled for.

Table 3: Fixed Effects Regression Using Any Prize

	(1)	(2)	(3)	(4)
VARIABLES	shareF	shareF	shareF	shareF
L.Prize	-0.00300	-0.00483	0.000116	-0.000581
	(0.00495)	(0.00497)	(0.00480)	(0.00485)
year		0.00146**		0.000575
		(0.000584)		(0.000560)
STEMXYEAR				0.000887
				(0.00110)
STEMXLPRIZE			-0.00312	-0.00425
			(0.00930)	(0.00940)
Constant	0.326***	-2.619**	0.536***	-0.623
	(0.000748)	(1.177)	(0.000617)	(1.127)
Observations	435	435	1,652	1,652
R-squared	0.001	0.020	0.000	0.003
Number of Pannel	106	106	392	392

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 3, the regression in column (1) with fixed effects estimates the effect of winning a prize on share of female students in higher institutions when L.Prize is the only explanatory variable. We find that the expected share of female students in higher institutions decreases by around 0.3% for STEM majors if we only consider observations from countries that win the prize in the corresponding academic year in our regression. The regression in column (2) estimates the same model with fixed effects but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 0.483% for STEM major students who come from countries that not win the prize to STEM major students who come from countries that win the prize if we hold year variable constant. The regression in column (3) also estimates the effect of winning a prize on share of female students in higher institutions with STEM and STEMXLPRIZE as control variables. The addition of these explanatory variables allows the effect of winning the prize to be different for STEM and non-STEM majors. The expected share of female students in higher institutions increases by about 0.012% for students from countries that do not win the prize relative to students from countries that win the prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a prize-winning country-year is 0.312% when we exclude the year variable. To consider the overall effect of prize winning on the STEM female student share, we take the sum of the L.Prize and STEMXLPRIZE variables: we find a decrease of 0.3% following a prize winning. The regression in column (4) with fixed effects adds YEAR and STEMXYEAR variables. We find the expected share of female students in higher institutions decreases by about 0.058% for non-STEM students who are from prize-winning countries, and we find a STEM-specific effect of a 0.425% decrease. Therefore, the overall decrease in the share female for STEM students after a prize win is 0.483%. The data indicates with fixed effects, there is a small negative effect of winning a prize on the share of female students, although it is not statistically significant.

When we include control variable YEAR in Columns (2) and (4), there are no big differences on the share of female students. With fixed effects, the expected share of female students with one additional year increases by about 0.146% when we consider students with STEM majors, which is statistically significant at 5% level. When we separate STEM and non-STEM majors, the expected share of female students with one additional year increases by about 0.0575% in non-STEM majors. Therefore, the expected difference in the growth rates of the share of female students in higher institutions between non-STEM to STEM majors is about 0.0887%.

Result 3:

We want to analyze how winning the different prizes affects the share of female students in higher institutions and compare the different effects when we include and exclude other explanatory variables such as year, STEM, STEMXYEAR, STEMXLFIRST, STEMXLSECOND, and STEMXLTHIRD. In Table 4, we estimate how these explanatory variables affect the outcome variable individually and interactively.

Table 4: OLS Regression Using First, Second, and Third Prizes

	(1)	(2)	(3)	(4)
VARIABLES	shareF	shareF	shareF	shareF
L.First	-0.0186	-0.0207	-0.0124	-0.0102
	(0.0665)	(0.0669)	(0.0345)	(0.0347)
L.Second	-0.0390	-0.0430	0.0231	0.0268
	(0.0937)	(0.0947)	(0.0459)	(0.0463)
L.Third	-0.0340	-0.0344	-0.0272	-0.0268
	(0.0937)	(0.0938)	(0.0486)	(0.0487)
year		0.00185		-0.00185
		(0.00601)		(0.00302)
STEM			-0.285***	-0.295***
			(0.00777)	(0.0183)
STEMXYEAR				0.00369
				(0.00592)
STEMXLFIRST			-0.00612	-0.0106
			(0.0661)	(0.0665)
STEMXLSECOND			-0.0621	-0.0698
			(0.0917)	(0.0926)
STEMXLTHIRD			-0.00685	-0.00762
			(0.0931)	(0.0932)
Constant	0.326***	-3.394	0.611***	4.333
	(0.00786)	(12.10)	(0.00398)	(6.095)

Observations	435	435	1,652	1,652
R-squared	0.001	0.001	0.458	0.458

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 4, the regression in column (1) estimates the effect of winning first prize, second prize, or third prize on share of female students in higher institutions when there are no other control variables. We find that the expected share of female students in higher institutions decreases by around 1.86% for STEM majors if we only consider observations from countries that win the first prize in the corresponding academic year in our regression. The regression in column (2) estimates the same model but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 2.07% for STEM major students who come from countries that not win the first prize to STEM major students who come from countries that win the first prize if we hold year variable constant. The regression in column (3) also estimates the effect of winning first prize on share of female students in higher institutions with STEM and STEMXLPRIZE as control variables. The addition of these explanatory variables allows the effect of winning first prize to be different for STEM and non-STEM majors. The expected share of female students in higher institutions decreases by about 1.24% for students from countries that do not win the first prize relative to students from countries that win the first prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a prize-winning country-year is 0.612% when we exclude the year variable. To consider the overall effect of prize winning on the STEM female student share, we take the sum of the L.First and STEMXLFIRST variables: we find a decrease of 1.852% following with the first prize winning. The regression in column (4) adds YEAR and STEMXYEAR variables. We find the expected share of female students in higher institutions decreases by about 1.02% for non-STEM students who are from first prize-winning countries, and we find a STEM-specific effect of a 1.06% decrease. Therefore, the overall decrease in the share female for STEM students after winning the first prize is 2.08%. The data indicates a small negative effect of winning the first prize on the share of female students, although it is not statistically significant.

We get the similar results for observations from countries that win the second and third prizes. In column (1), we find that the expected share of female students in higher institutions decreases by around 3.9% for STEM majors if we only consider observations from countries that win the second prize in the corresponding academic year in our regression; while the expected share of female students decreases by 3.4% for STEM majors if observations from countries that win the third prize. The regression in column (2) estimates the same model but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 4.3% for STEM major students who come from countries that not win the second prize to STEM major students who come from countries that win the second prize if we hold year variable constant. And the expected share of female students in higher institutions decreases by around 3.44% for STEM major students who come from countries that win the third prize if we hold year variable constant.

However, when we exclude the control variable: YEAR, winning second or third prize leads to opposite effects on the share of female students. The regression in column (3) without YEAR and STEMXYEAR as control variables, the expected share of female students in higher institutions increases by about 2.31% for students from countries that do not win the second prize relative to students from countries that win the second prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a second-prize-winning country is 6.21% when we exclude the year variable. To consider the overall effect of second-prize winning on the STEM female student share, we take the sum of the L.Second and STEMXLSECOND variables: we find a decrease of 3.9% following with the second prize winning. For the third prize, in column (3), the expected share of female students in higher institutions decreases by about 2.72% for students from countries that do not win the third prize relative to students from countries that win the third prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a third-prize-winning country is 0.685% when we exclude the year variable. To consider the overall effect of third-prize winning on the STEM female student share, we take the sum of the L.Third and STEMXLTHIRD variables: we find a decrease of 3.4% following with the third prize winning.

When we include control variables: YEAR and STEMXYEAR into the regression in column (4), winning second or third prize still leads to opposite effects on the share of female students. We find the expected share of female students in higher institutions increases by about 2.68% for non-STEM students who are from second-prize-winning countries when we include Year and STEMXYEAR as control variables, and we find a STEM-specific effect of a 6.98% decrease. Therefore, the overall decrease in the share female for STEM students after winning the second prize is 4.3%. For the third prize, we find the expected share of female students in higher institutions decreases by about 2.68% for non-STEM students who are from third-prize-winning countries when we include Year and STEMXYEAR as control variables, and we find a STEM-specific effect of a 0.762% decrease. Therefore, the overall decrease in the share female for STEM students after winning the third prize is 3.4%. The data indicates a small negative effect of winning the first, second or third prize on the share of female students, although it is not statistically significant.

When we separate students to STEM and non-STEM majors, there are no big differences in the share of female students whether or not we include YEAR variable. The expected share of female students in higher institutions from non-STEM to STEM decreases by around 28.5% when we exclude YEAR variable. The expected share of female students in higher institutions from non-STEM to STEM decreases by about 29.5% when we include YEAR and STEMXYEAR variables. Both of these differences are statistically significant at the 1% level.

Columns (2) and (4) showed us interesting results when we include YEAR as an explanatory variable. The expected share of female students with one additional year increases by about 0.185% when we consider students with STEM majors. However, when we separate students with STEM and non-STEM majors, the expected share of female students with one additional year decreases by about 0.185% in non-STEM majors, but increases by 0.185% for STEM majors. Therefore, the expected difference in the growth rates of the share of female students in higher institutions between non-STEM to STEM majors is about 0.37%.

Result 4:

Now we run four regression models with fixed effects to consider how winning first prize, second prize, or third prize affects the share of female students when we only use the within-country variation in whether the STEM prize was won in the April before the corresponding academic year. We include and exclude YEAR, STEM, STEMXYEAR, STEMXLFIRST, STEMXLSECOND, and STEMXLTHIRD as control variables. With fixed effects, any omitted variable bias related to fixed country characteristics regarding whether they win a prize, and which prize they win, is controlled for.

Table 5: Fixed Effects for First, Second, Third prize

	(1)	(2)	(3)	(4)
VARIABLES	shareF	shareF	shareF	shareF
L.First	-0.00203	-0.00389	0.00319	0.00247
	(0.00703)	(0.00701)	(0.00691)	(0.00694)
L.Second	-0.00522	-0.00894	-0.00246	-0.00374
	(0.00994)	(0.00996)	(0.00921)	(0.00929)
L.Third	-0.00275	-0.00275	-0.00313	-0.00313
	(0.00994)	(0.00985)	(0.00977)	(0.00976)
year		0.00149**		0.000576
		(0.000589)		(0.000563)
STEMXYEAR				0.000913
				(0.00111)
STEMXLFIRST			-0.00522	-0.00636
			(0.0132)	(0.0133)
STEMXLSECOND			-0.00275	-0.00519
			(0.0184)	(0.0186)
STEMXLTHIRD			0.000387	0.000387
			(0.0187)	(0.0187)
Constant	0.326***	-2.674**	0.536***	-0.624
	(0.000751)	(1.187)	(0.000618)	(1.134)
Observations	435	435	1,652	1,652
R-squared	0.001	0.021	0.000	0.003
Number of Pannel	106	106	392	392

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 5, the regression in column (1) with fixed effects estimates the effect of winning first prize, second prize, or third prize on share of female students in higher institutions when there are no other control variables. We find that the expected share of female students in higher institutions decreases by around 0.2% for STEM majors if we only consider observations from countries that win the first prize in the corresponding academic year in our regression. The regression in column (2) also with fixed effects estimates the same model but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 0.389% for STEM major students who come from countries that not win the first prize to STEM major students who come from countries that win the first prize if we hold year variable constant. The regression in column (3) with fixed effects also estimates the effect of winning first prize on share of female students in higher institutions with STEM and STEMXLPRIZE as control variables. The addition of these explanatory variables allows the effect of winning first prize to be different for STEM and non-STEM majors. The expected share of female students in higher institutions increases by about 0.319% for students from countries that do not win the first prize relative to students from countries that win the first prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a first-prize-winning country is 0.522% when we exclude the year variable. To consider the overall effect of first prize winning on the STEM female student share, we take the sum of the L.First and STEMXLFIRST variables: we find a decrease of 0.2% following with the first prize winning. The regression in column (4) adds YEAR and STEMXYEAR variables. We find the expected share of female students in higher institutions increases by about 0.247% for non-STEM students who are from first prize-winning countries, and we find a STEM-specific effect of a 0.636% decrease. Therefore, the overall decrease in the share female for STEM students after winning the first prize is 0.389%. The data indicates with fixed effects, there is still a small negative effect of winning the first prize on the share of female students, although it is not statistically significant.

We get the similar results for observations from countries that win the second and third prizes. In column (1) with fixed effects, we find that the expected share of female students in higher institutions decreases by around 0.522% for STEM majors if we only consider observations from countries that win the second prize in the corresponding academic year in our regression; while the expected share of female students decreases by 0.275% for STEM majors if observations from countries that win the third prize. The regression in column (2) with fixed effects estimates the same model but adding one additional explanatory variable: year. The expected share of female students in higher institutions decreases by around 0.894% for STEM major students who come from countries that not win the second prize to STEM major students who come from countries that win the second prize if we hold year variable constant. And the expected share of female students in higher institutions decreases by around 0.275% for STEM major students who come from countries that win the third prize if we hold year variable constant.

In column (3) and (4), we analyze the effects on share of female students to second or third prize with fixed effects when we exclude and include YEAR variable. Then we find there is no big differences between the effect on share of female students to different prizes. In column (3), the regression without YEAR and STEMXYEAR as control variables, then the expected share of female students in higher institutions decreases by about 0.246% for students from countries that do not win the second prize relative to students from countries that win the second prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a second-prize-winning country is 0.275% when we exclude the year variable. To consider the overall effect of second-prize winning on the STEM female student share, we take the sum of the L.Second and STEMXLSECOND variables: we find a decrease of 0.521% following with the second prize winning. For the third prize in column (3), the expected share of female students in higher institutions decreases by about 0.313% for students from countries that do not win the third prize relative to students from countries that win the third prize if we consider only non-STEM majors. Considering STEM majors, the STEM-specific expected difference in the share of female students in higher institutions in a third-prize-winning country is 0.0387% when we exclude the year variable. To consider the overall effect of third-prize winning on the STEM female student share, we take the sum of the L.Third and STEMXLTHIRD variables: we find a decrease of 0.274% following with the third prize winning.

In column (4), we include control variables: YEAR and STEMXYEAR into the regression. With fixed effects, we find the expected share of female students in higher institutions decreases by about 0.374% for non-STEM students who are from second-prize-winning countries when we include Year and STEMXYEAR as control variables, and we find a STEM-specific effect of a 0.519% decrease. Therefore, the overall decrease in the share female for STEM students after winning the second prize is 0.89%. For the third prize, we find the expected share of female students in higher institutions decreases by about 0.313% for non-STEM students who are from third-prize-winning countries when we include Year and STEMXYEAR as control variables, and we find a STEM-specific effect of a 0.0387% decrease. Therefore, the overall decrease in the share female for STEM students after winning the third prize is 0.274%. The data indicates a small negative effect of winning the first, second or third prize on the share of female students, although it is not statistically significant.

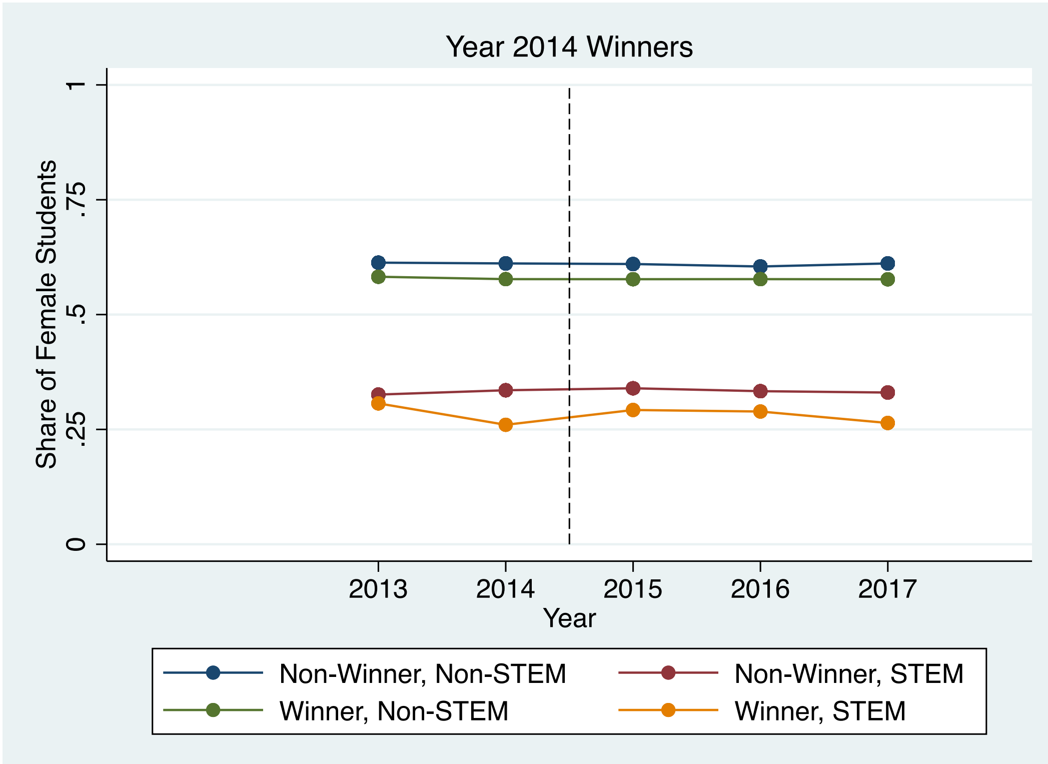
Columns (2) and (4) showed us the increasing rate on share of female students to additional year with fixed effects. When we include YEAR as an explanatory variable, the expected share of female students with one additional year increases by about 0.149% when we consider students with STEM majors, and the estimate is statistically significant at 5% level.

When we separate students with STEM and non-STEM majors, the expected share of female students with one additional year increases by about 0.0576% in non-STEM majors, but increases by 0.149% for STEM majors. Therefore, the expected difference in the growth rates of the share of female students in higher institutions between non-STEM to STEM majors is about 0.09%.

Since the above regressions do not have a big effect on the share of female students in higher institutions, we need to analyze from each academic year to see how winning a prize affects the share of female students in STEM majors. However, we only have prize winners from 2011, 2014, 2016, 2017, 2018. When we combine this data to the data about the share of female students from 2012/2013 to 2017/2018 academic year, we can only analyze the prize winners in 2014 and 2016.

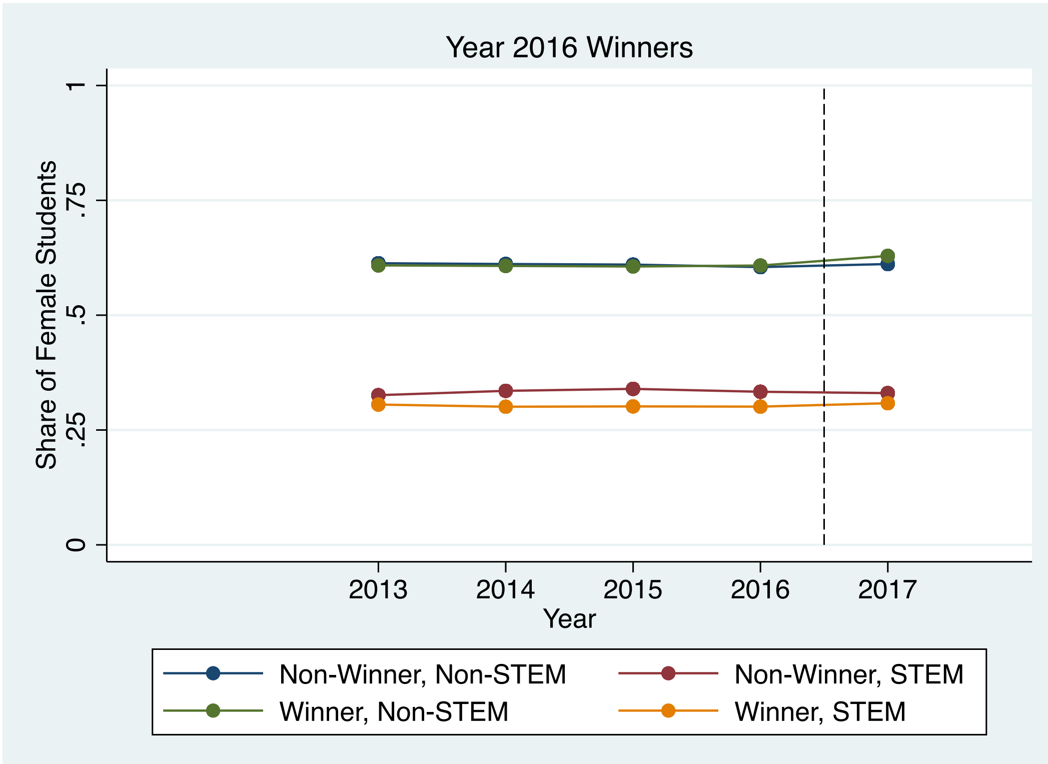
Section 3.2: Graphical Results

Figure 1: 2014 Prize Winners



From Figure 1, we can observe the different trends for prize winners and non-winners after the prize was announced in 2014. Then we find there are almost the same trend for winner and non-winner countries corresponding to non-STEM major students, which implies the innovation prize does not affect non-STEM majors. For STEM major students, we find the share of female students for STEM majors did not change over time when they come from non-winner countries. What interesting is that in winner countries, the share of female students in STEM majors decreased before the prize was announced, then the share of female students in STEM majors increased right after the prize was announced. However, the increasing rate only last for one academic year, then the share of female students in STEM majors went down. In 2017, in winner countries, the share of female students in STEM majors is even lower than in 2013.

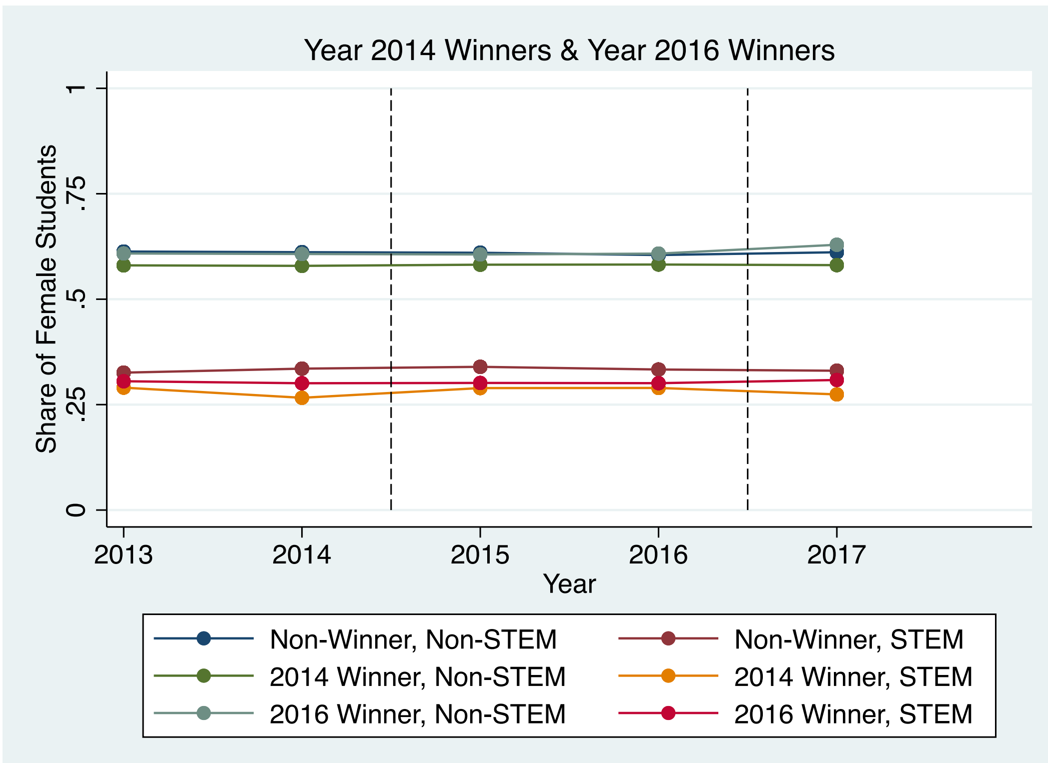
Figure 2: 2016 Prize Winners



From Figure 2, we can observe the different trends for prize winners and non-winners after the prize was announced in 2016. Then we find for non-STEM majors, there are almost the same trend for winner and non-winner countries before 2016. After 2016 prize announced, the share of female students increased a little for non-STEM major students from winner countries. However, we emphasis on the trend for STEM major students from winner countries. On the bottom line of the graph, we find the trend for STEM major students from winner countries almost did not change over time, which implies winning the prize does not affect STEM majors. For STEM major students in non-winner countries, the share of female students did not have a big change over time.

Figures 1 and 2 showed us the influence of prize in one specific year on the share of female students over time in two separate graphs. Now we can see the trends in one graph, which helps us to observe the different trends in a clearer way.

Figure 3: 2014 Prize winners & 2016 prize winners



From Figure 3, we see that there are no large, clear positive effect of winning the prize on the share of women enrolled in STEM majors. However, the small increases in a tight window around the prize suggest that we should run an additional regression model focused only on the before-after, winner-non-winner differences.

Section 3.3: Sub-sample Regression Results

Based on the graphical results, we run an additional OLS regression to observe the different effects on share of female students before and after prize was announced in 2014 and 2016. In other words, we zoom in on each of the prize announcements in the heart of our data range. Empirically, our model follows the form related below:

$$ShareF_{i,t} = \beta_1 + \beta_2 AfterPrize_{i,t} + \beta_3 STEM_i + \beta_4 AfterPrizeXSTEM_{i,t} + \beta_5 Winner_i + \beta_6 AfterPrizeXWinner_{i,t} + \beta_7 STEMXWinner_i + \beta_8 AfterPrizeXSTEMXWinner_{i,t} + \varepsilon_{i,t}$$

where β_2 is the coefficient of AfterPrize, and AfterPrize is a dummy variable that equals one in the school year after the prize was announced, and equals zero otherwise. β_4 is the coefficient of AfterPrizeXSTEM, where AfterPrizeXSTEM is also a dummy variable that equals one in the school year after prize was announced, and the major is STEM. β_5 is the coefficient of Winner, and Winner is a dummy variable that equals one if a country will win a prize. β_6 is the coefficient of AfterPrizeXWinner, and AfterPrizeXWinner is also a dummy variable that equals one for prize winner in the school year after the prize is announced. β_7 is the coefficient of STEMXWinner, which is a dummy variable equals one if the country will win a prize and the major is STEM. And β_8 is the coefficient of AfterPrizeXSTEMXWinner, where AfterPrizeXSTEMXWinner is also a dummy variable equals one for the prize winner in the school year after the prize is announced and the major is STEM.

We run four regression models that focus on the different growth rates for the share of female students before and after prize announced for winner countries in 2014 and 2016, where winner countries in 2014 are Germany, Netherlands, and Spain; winner countries in 2016 are Portugal, Finland, and Ireland.

Table 6: OLS Regression Using Before-After any Prize

	(1)	(2)	(3)	(4)
	2014 Winner	2014 Winner	2016 Winner	2016 Winner
VARIABLES	shareF	shareF	shareF	shareF
AfterPrize	0.00743	-0.00121	-0.0120	-0.00147
	(0.0244)	(0.0123)	(0.0287)	(0.0150)
STEM		-0.286***		-0.275***
		(0.0174)		(0.0171)
AfterPrizeXSTEM		0.00864		-0.0106
		(0.0239)		(0.0288)
Winner	-0.0629	-0.0359	-0.0310	0.00101
	(0.0575)	(0.0295)	(0.0560)	(0.0294)
AfterPrizeXWinner	0.0156	0.00399	0.0195	0.0224
	(0.0898)	(0.0454)	(0.0891)	(0.0467)
STEMXWinner		-0.0270		-0.0320
		(0.0566)		(0.0562)
AfterPrizeXSTEMXWinner		0.0116		-0.00290
		(0.0881)		(0.0895)
Constant	0.329***	0.615***	0.332***	0.607***
	(0.0179)	(0.00877)	(0.0171)	(0.00888)
Observations	196	743	151	558
R-squared	0.010	0.455	0.003	0.460

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column (1) and (2) showed us before-after-prize differences for 2014 winner countries and non-winner countries. The regression in column (1) gives us the effect on share of female students in higher institutions to before-after-prize in 2014 for STEM majors in prize winner countries and non-winner countries, while the regression in column (2) separates observations with STEM and non-STEM majors. In column (1), we find the expected share of female students in higher institutions for STEM majors increases by about 0.743% after prize was announced in 2014 in non-winner countries. However, the regression in column (2) shows us the expected share of female students in higher institutions decreases by about 0.12% for non-STEM majors after prize was announced in 2014 in non-winner countries. In column (2), we also find in non-winner countries, the expected share of female students in higher institutions decreases by 28.6% for STEM majors before any prize was announced in 2014, which is statistically significant at 1% level. After prize was announced in 2014, in non-winner countries, the extra effect on share of female students in higher institutions for STEM majors is 0.864% increasing. In column (1), we find in 2014 winner countries, the expected share of female students in higher institutions decreases by about 6.29% for STEM majors before prize was announced. However, the expected share of female students in higher institutions increases by 1.56% for STEM majors after prize was announced. In column (2), we find in 2014 winner countries, the expected share of female students in higher institutions decreases by about 3.59% for non-STEM majors before prized was announced. After prize was announced in 2014, the expected share of female students in higher institutions increases by 0.399% for non-STEM majors. For STEM majors, the expected share of female students in higher institutions decreases by 2.7% in winner countries before prize was announced in 2014. After prize was announced, the expected share of female students in higher institutions increases by about 1.16% for STEM majors in winner countries. This represents a 3.5% increase relative to the pre-announcement mean in STEM majors.

Column (3) and (4) showed us before-after-prize differences for 2016 winner countries and non-winner countries. The regression in column (3) gives us the effect on share of female students in higher institutions to before-after-prize in 2016 for STEM majors in winner countries and non-winner countries, while the regression in column (4) separates observations with STEM and non-STEM majors. In column (3), we find the expected share of female students in higher institutions for STEM majors decreases by 1.2% after prize was announced in 2016 in non-winner countries. However, the regression in column (4) shows us the expected share of female students in higher institutions decreases by about 0.147% for non-STEM majors after prize was announced in 2016 in non-winner countries. In column (4), we also find in non-winner countries, the expected share of female students in higher institutions decreases by 27.5% for STEM majors before any prize was announced in 2016, which is statistically significant at 1% level. After prize was announced in 2016, in non-winner countries, the extra effect on share of female students in higher institutions for STEM majors is 1.06% decreasing. In column (3), we find in 2016 winner countries, the expected share of female students in higher institutions decreases by about 3.1% for STEM majors before prize was announced. However, the expected share of female students in higher institutions increases by 1.95% for STEM majors after prize was announced. In column (4), we find in 2016 winner countries, the expected share of female students in higher institutions increases by about 0.1% for non-STEM majors before prized was announced, then after prize was announced, the expected share of female students in higher institutions increases by 2.24% for non-STEM majors. For STEM majors, the expected share of female students in higher institutions decreases by 3.2% in winner countries before prize was announced in 2016. After prize was announced, the expected share of female students in higher institutions decreases by about 0.29% for STEM majors in winner countries.

Section 4: Conclusion and Discussion

My study shows that the EU Prize for Women Innovators does not motivate female students to study STEM majors in college. There are even negative effects for STEM majors in winner countries in some years from 2012 to 2017. There are some improvements that should be made in future work on this topic. Since I only have access to a limited number of years of prize and education data, the dataset is too small to analyze the true causal effect of EU prizes on the share of female students in higher institutions. There might be different results when the number of observations gets larger. Also, gender stereotype is a big problem and takes a long time to change. Therefore, future work can focus on the impact of the prize on high-school coursework and test scores, and whether those earlier outcomes lead to an increase in the share of female students in higher institutions. In this way, we can reduce omitted-variable bias (stereotype) by looking at long-run impacts. Overall, this paper is a good start for analyzing how to motivate more female students to study STEM majors and choose STEM-related jobs in the future.

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