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Gendered Impacts of COVID-19 on University Enrollment and Major Choices*

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Abstract

The COVID-19 pandemic affected people's lives in several domains. This study provides evidence of the pandemic's gendered effects on university enrollment and major choices. Using novel administrative records of university students in Uruguay, we conduct a counterfactual exercise that demonstrates a negative correlation between the COVID-19 pandemic and university enrollment. Heterogeneities across fields reveal a positive effect on enrollment in Social Sciences, yet null or even negative effects in Health and Science. These results are driven by male students. For women, we observe an increase in enrollment, particularly in Science. Notably, women are more likely to opt for Science-related majors over Social Sciences. Our results suggest that the recent crisis helped reduce the gender gap in major choices.

JEL Classification: I21, I23, J16.

Key words: COVID-19, University enrollment, Major choices, Educational gender gap.

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Resumen

La pandemia de COVID-19 afectó las vidas de las personas en varios ámbitos. Este estudio proporciona evidencia de los efectos de género de la pandemia en la inscripción universitaria y las elecciones de especialidad. Utilizando registros administrativos novedosos de estudiantes universitarios en Uruguay, llevamos a cabo un ejercicio contrafactual que demuestra una correlación negativa entre la pandemia de COVID-19 y la inscripción universitaria. Las heterogeneidades entre áreas de estudio revelan un efecto positivo en la inscripción en Ciencias Sociales, sin embargo, se observan efectos nulos o incluso negativos en Salud y Ciencias. Estos resultados son impulsados por estudiantes masculinos. Para las mujeres en cambio, observamos un aumento en la inscripción, especialmente en Ciencias. En segundo lugar, nos basamos en un enfoque de doble diferencias para proporcionar evidencia sobre los impactos de género de COVID-19 en las elecciones de carreras.Las mujeres tienen más probabilidad de optar por especialidades relacionadas con las Ciencias sobre las Ciencias Sociales. Nuestros resultados sugieren que la crisis reciente ayudó a reducir la brecha de género en la elección de carreras.

1 Introduction

Major choices are key educational outcomes with relevant spillover effects on the labor market. Despite significant progress, women continue to be underrepresented in Science, Technology, Engineering and Mathematics (STEM) fields. Globally, only 35% of STEM-related tertiary students are women (UNESCO, 2017). This extends to the labor market. For instance, according to the US Bureau of Labor Statistics[1], women in the US represent 26.7% of the workforce in computer and mathematical occupations and 15% in engineering positions. These fields are associated with higher returns and therefore higher earnings, thus potentially playing an important role on the gender wage convergence (Bertrand, 2020; Sloane et al., 2019; Blau and Kahn, 2017; Black et al., 2008).

The COVID-19 pandemic had profound impacts on people's lives in several domains. Particularly, there is evidence of its impact on educational performance in the context of developed countries (Rodríguez-Planas, 2022a; Aucejo et al., 2020, among others), and on the differential effects by gender (Del Boca et al., 2022; Albanesi and Kim, 2021). However, the gender effects of the COVID-19 pandemic on major choices have been scarcely addressed in the literature. This paper analyzes whether educational choices of students in Uruguay shifted due to the pandemic. We explore gendered patterns of enrollment to STEM degrees, with special attention to engineering degrees which have high returns on education and low female participation (Bertrand, 2020).

There are multiple channels through which the COVID-19 pandemic could have influenced enrollment decisions differently for men and women. First, the shift towards online learning due to school closures could have had an effect on enrollment decision through peer effects. Enjoying coursework has been found a key determinant of major enrollment decisions, and also positively associated to beliefs about the proportion of females peers among women (Zafar, 2013). That is particularly true for engineering fields. Hence, online learning could have diminished the negative effect associated with male-dominated majors by altering the perceptions of the proportion of female peers. Second, COVID-19 altered job market conditions, particularly by making working from home a more prevalent alternative. Women commonly enroll in fields that offer greater flexibility to reconcile work and family responsibilities. Assuming that working from home helps balancing work and family life, the pandemic could have changed the non-pecuniary aspects of major choices and the relative valuation of different educational

[1]Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, OOH Data Access and Republishing Information through this link (visited February 25, 2024).

options. Third, the COVID-19 crisis could have impacted enrollment decision through unemployment. Previous evidence shows that higher unemployment rates are associated with lower gender gaps in major choices (Moorhouse, 2017). That is, unfavorable macroeconomic conditions could result in an opportunity, as long as they encourage women to enter male-dominated fields. Finally, a higher exposure to male role models in Science, Biology, or Health during the COVID-19 pandemic could have had differential effects on university enrollment in these fields (Breda et al., 2020; Patnaik et al., 2020; Porter and Serra, 2020). The greater exposure of women to men role models during the pandemic might have resulted in a reduction in female enrollment in science related degrees.

Using novel administrative data from Uruguay's main public university (*Universidad de la República*) we analyze university enrollment and major choices by gender. Firstly, we present trends in aggregate enrollment by gender both before and after the COVID-19 pandemic. To establish a counterfactual scenario without the pandemic, we use the prediction for enrollment in 2021 based on a model with time trends. Secondly, we compute a double difference strategy to estimate gender differences in the probability of opting into different majors among enrolled students. Additionally, we explore heterogeneities by socioeconomic and demographic characteristics.

Our results show a negative correlation between the effects of the COVID-19 pandemic and university enrollment. While the total enrollment increased 4% during 2021, our estimates point to an increase of 6% in the counterfactual scenario without the pandemic. This finding contradicts previous evidence, suggesting that the COVID-19 crisis exhibited distinct characteristics. Unlike previous crises, it was characterized not only by a significant deterioration in labor and social conditions, but also by a drastic reduction in mobility and an increase in online activities. The evidence provided in this paper suggest the unique characteristic of the crisis lead to distinct effects on tertiary education enrollment.

Results across fields indicate a positive correlation with enrollment in social sciences' majors, yet display null or even negative correlation in Health and Sciences' ones. However, these findings are different when considering gender heterogeneities. Our findings provide suggestive evidence that the COVID-19 crisis may have helped reduce the gender gap in Science-related fields. We observe that while women's enrollment increased by 9%, there was a decrease of 11% among enrolled men, despite both groups experiencing a similar predicted increase in enrollment in the counterfactual scenario (4% and 3%). Social Sciences' majors exhibit similar but less pronounced patterns: women enrollment increased by 6% and men's decreased by 5% (despite a predicted increase of 6% and 8%, respectively). In majors related to Health, both

women and men were expected to increase enrollment. However, enrollment after the pandemic was less than expected.

An in-depth analysis within STEM majors reveals a significant association between the COVID-19 pandemic and the likelihood of women opting for engineering. The proportion of women entering engineering increased by 2.8 percentage points (pp) and decreased by 1 pp in Social and Artistic. While this is likely to be the result of a positive pre-trend in the share of women in engineering, we can argue that the COVID-19 pandemic at least did not widen the gender gap in STEM fields. We provide suggestive evidence that this might be driven by the increase in high school completion rates among women, particularly in the areas of Maths, Biology and Science. This is a positive result considering the pandemic disproportionately affected women in other economic outcomes (Del Boca et al., 2022; Albanesi and Kim, 2021).

The contribution of this paper is threefold. First, to the empirical literature on the economics of education. This paper builds on previous studies analyzing the impact of economic recessions on college enrollment. There is evidence of a prevailing counter-cyclical behavior of higher education enrollment (i.e., a deterioration in macroeconomic conditions leads to an increase in high school enrollment) in the Latin American context, with the exceptions of Argentina, Honduras, Mexico and Peru (Arias Ortiz et al., 2021). In the case of Uruguay, there is evidence of a counter-cyclical behavior in secondary education attendance (González and Maier, 2011). However, the nature of the COVID-19 crisis may have had qualitatively distinctive effects. Unlike previous crises, the COVID-19 pandemic led to a significant deterioration in labor and social conditions, and also to a drastic reduction in mobility and an increase in online activities. This paper examines whether the impact of the COVID-19 crisis on tertiary education enrollment aligns with previous findings or if the unique characteristics of the crisis lead to distinct effects.

Second, this project contributes to the literature on gender segregation in major choices and enhance the understanding of the underlying mechanisms behind the persistent under-representation of women in STEM. Previous literature suggests that the gender gap in mathematics is small at early stages and widens over time. Therefore, segregation patterns cannot be explained by innate characteristics, but also by contextual differentials (Kahn and Ginther, 2017). In addition, several papers point out to comparative advantage as an explanation of major choices in different countries (Aucejo and James, 2021; Card and Payne, 2021; Delaney and Devereux, 2019; Loyalka et al., 2017; Speer, 2017). Additionally, secondary school performance and differential subject choices are also a relevant in explaining the gender gaps in major choices (Speer, 2023; Card and Payne, 2021; Delaney and Devereux, 2019). Understanding this phenomenon becomes particularly relevant when considering the potential of STEM-related occupations in

reducing the gender wage gap (Kahn and Ginther, 2017; Altonji et al., 2016). Indeed, emerging literature signals that segregation in educational choices are one of the main explanatory factors behind the persistence of gender wage gaps (Bertrand, 2020).

Third, this paper contributes to the literature on the impact of the COVID-19 crisis on tertiary education. In recent years, multiple contributions have been made from diverse disciplines. There is evidence of the pandemic leading to a decline in enrollment rates in tertiary education for the State of California, with students from lower socioeconomic backgrounds, and ethnic and racial minorities being disproportionately affected (Aucejo et al., 2020). There are strong heterogeneities by fields, with engineering, technology, education, interdisciplinary studies, and arts experiencing the highest drops in enrollment. There is also evidence of a drop in graduation rates, exhibiting the same heterogeneity by socioeconomic level. Rodríguez-Planas (2022a) uses administrative records from a college in New York to analyze differences across socioeconomic background. Lower-income students outperformed higher-income students. Rodríguez-Planas (2022b) uses the same data and additional information from an online survey collected in 2020, showing that the pandemic led to an increase in student drop-out rates and a reduction in freshman retention rates. Also using administrative data for the US, Bulman and Fairlie (2022) found a decline in student enrollment from 2019 to 2020 and from 2020 to 2021, as well as a decrease in course completion rates. On the other hand, Bonaccolto-Topfer and Castagnetti (2021) uses administrative data from an Italian university and finds no substantial effects of COVID-19 on teaching quality and academic performance measured by grades, graduation rates, and exam failure. Our contribution to the literature comes from a particular setting. The public university in Uruguay has no tuition fees and, in most cases, no quotas or admission restrictions. Previous studies have shown that drop-out rates of university students in Uruguay increased in 2020 and that students took fewer courses during the COVID-19 pandemic (Failache et al., 2022). In addition, the effects on enrollment were distinct among regions, with an increase in enrollment in those localities without a university campus (Failache, 2023).

The paper proceeds as follows. Section 2 describes the relevant institutional context. Section 3 describes the data, the estimation sample, and the criteria to group each major into fields of study. Section 4 presents some descriptive evidence on the trends of university enrollment by field before and after the pandemic, considering differentials by gender, socioeconomic background and other demographic characteristics. Section 5 describes the empirical strategy and the effects of the COVID-19 pandemic on major choices by gender. Finally, Section 6 concludes.

2 Institutional Context

The public university in Uruguay –*Universidad de la Republica*– concentrates 85% of university students. A particular feature of this setting is that the public university has no tuition fee and, in most cases, no quotas or admission tests. This university offers around 100 undergraduate and more than 200 graduate programs, comprised in more than 20 colleges. In 2020, there were around 169,000 undergraduate and 10,000 graduate students. The enrollment period starts in February and courses take place from March to December.

In Uruguay, the health emergency in response to the global COVID-19 outbreak was declared in March 13, 2020, i.e., after the enrollment period. Thus, university enrollment was unlikely to be affected by the pandemic. However, the new context forced the shift to online activities. To mitigate potential educational delays, the University implemented specific policies facilitating the transition from face-to-face to virtual programs. The rapid expansion of virtual classrooms and online platforms allowed the University to continue with all its programs as early as May 2020. Moreover, specific policies were implemented to provide technological devices to students from low socioeconomic background.

During the first semester, 96% of the courses adapted their content to a virtual format, excluding field, in-clinic, and lab-activities (Failache et al., 2022; Collazo et al., 2020). Moreover, 84% of the students declared they were able to engage with the virtual courses. The main challenges reported by the students for attending online activities were, emotional distress due to the pandemic, and limited access to internet and computer devices. Particularly, 10% of the students declared that they lacked the necessary devices to participate in the online courses.

Enrollment to the academic year 2021 was the first in being affected by the COVID-19 pandemic and the shift to online learning. By February 2021, the University's authorities had already announced that courses were going to be online, at least during the first semester. For this reason, in this paper we consider 2021's observed enrollment patterns to asses the potential impact of the COVID-19 pandemic.

3 Data

We use administrative records from students enrolled at Uruguay's main public University from 2015 to 2021. The information comes from the admission form, which is completed by students upon enrolling in each major. This includes information on year of enrollment, major

they enrolled, gender, city of origin, date of birth, and whether the high school the student attended was public or private (*proxy* for socioeconomic level). We combined this data with the university census providing information on other students' socioeconomic and demographic characteristics (e.g., working status and having kids). Despite being mandatory, the census' completion requirements were relaxed in 2020 due to the pandemic. Consequently, our baseline estimates only consider information from the university admission form.

Field of study. The University has their own definition and classification of colleges into three main areas. The Technologies and Sciences of Nature and Habitat Area (hereafter referred to as the Science Area) encompasses Agronomy, Architecture, Sciences, Engineering, Chemistry, and the Veterinary College. The Health Sciences Area (Health Area) comprises the Higher Institute of Physical Education, the School of Nutrition, and the schools of Nursing, Medicine, Odontology, and Psychology. Lastly, the Social and Artistic Area (Social Area) includes the Music School, the National School Institute of Fine Arts, the Schools of Economics and Administration, Social Sciences, Law, Information and Communication, and Humanities and Educational Sciences. Following this definitions, we categorize individuals into areas according the college they enrolled in.

Estimation sample. To estimate the effect of the COVID-19 pandemic and the shift to online learning on university enrollment, we restrict the sample to freshers. That is, to individuals who enrolled at the University for the first time.[2] As individuals have no restrictions on the number of majors they can enroll in each academic year, we consider as the unit of analysis the unique combination of (individual)-(college). For instance, if an individual enrolls in Social Sciences and Chemistry majors in the same academic year, they will count as two different observations, one for each field. If the same individual enrolls in more than one major in the same college in the same year, we prioritize the major in which the student had taken more courses.

Descriptive statistics. Appendix Table A.1 shows descriptive statistics of students' demographic characteristics in our estimation sample by enrollment year. Age at entry ranges between 20 and 21 years old, around 80% came from public high school, over 90% are single, and 93% are childless. The average student's household size is 4 people, 25% of students are working at the time of enrollment, and 45% have a parent with university education.

[2]It could be the case that someone enrolls in one major in 2018 and another in 2019. For the purpose of this study, we will only consider the first entry.

4 University enrollment

4.1 Descriptive Evidence

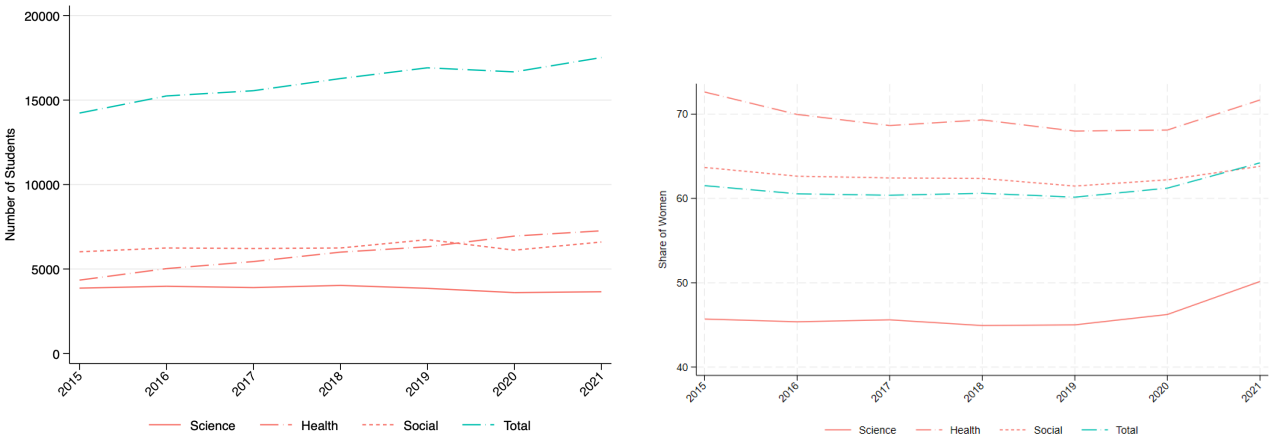
We start by documenting the evolution of university enrollment and its gender composition, before and after COVID-19. Panel (a) in Figure 1 shows an increase in university enrollment over the period of analysis, from around 15,000 students to over 17,000.[3] While the increase in enrollment has been consistent over time, its growth rate increased in 2021, rising from an average growth rate of around 3% per year during 2015–2020 to a rate of around 5% in 2021. This increase in the average growth rate is mainly explained by the important increase in enrollment in Social Science's majors.

Panel (b) in Figure 1 shows the share of women over total enrollment by year. Women represent around 60% of total university enrollment, and interestingly this has been increasing over time representing nearly 65% in 2021. Behind this average there is strong heterogeneity by field of study. While women represent more than 70% in Health-related majors, they barely overpass the 50% in Science-related by the end of the period. Appendix Table A.4 further shows that in specific STEM majors, like Engineering, women do not even represent 30% of total enrollment.

Appendix Tables A.2 and A.3 show the number of women and men enrolled at the university by major and year. Overall, the total number of enrolled women increased after COVID, particularly in Psychology, and Business and Economics. The only exceptions were Engineering, Nutrition, Dentist, Medicine and related majors, Music, and Humanities. Men overall enrollment also increased in 2021, with the exceptions of Agronomy, Science, Engineering, Sports, Nutrition, Odontology, Medicine and related majors, Psychology, Journalism, and Humanities. Appendix Table A.4 shows the share of enrolled women by major and year. As of 2020, women represent the majority of enrolled students in almost all majors, with the exception of Agronomy, Science, Engineering, Sports, and Music.

[3] As mentioned, the estimation sample do not have duplicates at individual-college level.

Figure 1: Total Enrollment and Share of Women by Field of Study



(a) Total Enrollment

(b) Share of Women

Notes: Panel (a) shows total enrollment by field of study. Panel (b) shows the share of women by field of study.

4.2 Counterfactual exercise

To explore the effect of the pandemic and the shift to online learning on university enrollment we estimate a counterfactual 2021 enrollment in an scenario with no pandemic. As detailed in Appendix Section A, we estimate a linear regression model for total enrollment using only data from before the pandemic and including a deterministic time trend in order to capture the enrollment growth rate. Table 1 shows observed enrollment for 2020 (column 1) and 2021 (2), and 2021 predicted enrollment (3) based on the estimated model. The difference between observed and predicted, aims to quantify the part of 2021 enrollment increase that can be attributable to COVID-19 and online learning. While observed enrollment exhibits a continuous increasing trend, the pandemic resulted in a 2% reduction compared to a counterfactual non-pandemic scenario. That is, university enrollment would have been higher in the absence of the COVID-19 pandemic and the shift to online learning. This is explained by a reduction of 12% in men enrollment and an increase of 5% in female enrollment.

Heterogeneous effects by gender and field of study are also evident. The positive impact of COVID-19 and online learning on women enrollment was stronger in Science-related majors, increasing it by 9%. On the other hand, the pandemic reduced men enrollment in Science majors by 11%. These results suggest that COVID-19 and online learning may have helped reduce the gender gap in Science-related majors. Though suggestive, this is an important result on the potential gender dimension of COVID-19 and online learning in University enrollment.

For Health-related majors, results show that the COVID-19 crisis negatively affected enrollment among all students, although of stronger magnitude among men. That is, in the counterfactual scenario enrollment would have been higher in this area. Finally, for Social Science's majors, our results point to an overall positive effect of the pandemic. As in other fields, this is the result of an increase in women enrollment (6%) and a decrease in men's (5%) due to COVID-19 and online learning.

Table 1: Observed and Predicted Enrollment by Gender and Field of Study

	2020	2021 Obs.	2021 Predicted	Δ 2021 Observed	Δ 2021 Predicted without Pand.	Δ 2021 Due to Pandemic
	(1)	(2)	(3)	((2)-(1))/(1)	((3)-(1))/(1)	(4)-(5)
All fields						
Total	17101	17840	18119	.04	.06	-.02
Women	10505	11479	10983	.09	.05	.05
Men	6596	6361	7136	-.04	.08	-.12
Science						
Total	3396	3444	3517	.01	.04	-.02
Women	1549	1724	1588	.11	.03	.09
Men	1847	1720	1929	-.07	.04	-.11
Health						
Total	6738	6735	7442	0	.1	-.1
Women	4633	4858	5015	.05	.08	-.03
Men	2105	1877	2440	-.11	.16	-.27
Social Science						
Total	5600	6097	5991	.09	.07	.02
Women	3454	3871	3665	.12	.06	.06
Men	2146	2226	2327	.04	.08	-.05

Notes: The table shows the observed and predicted values of total enrollment, women enrollment and men enrollment. Predicted values are derived form a linear regression model for enrollment using only data from before the pandemic and including a deterministic time trend in order to capture the enrollment growth rate. Data comes from university administrative records from 2015-2020. The observed 2021 variation is computed by subtracting enrollment in 2020 from observed enrollment in 2021 and dividing this variation by observed 2020 enrollment. The predicted 2021 variation without pandemic is computed by subtracting enrollment in 2020 from predicted enrollment in 2021 and dividing this variation by observed 2020 enrollment. The variation in 2021 due to the pandemic is the difference between the observed variation in 2021 and the predicted variation without the pandemic.

Finally, we also computed the 2021 counterfactual enrollment by demographic groups. Appendix Table A.5 shows the difference in observed enrollment and the one predicted in the absence of the COVID-19 crisis for students coming from public high schools, students with children and working students. Consistent with Rodríguez-Planas (2022a) our results suggest

that the pandemic had a positive effect on enrollment among more disadvantaged individuals. Among students coming from public high schools enrollment increased 2.1 pp more than those coming from private high schools. We also observed an increase in students with children by 2.4 pp more than those without children and for those who were employed by 3.1 pp more than those who were not working at the time of enrollment.

5 Effects on Major Choices

5.1 Empirical Strategy

In this section we document changes in major choices, and gender gaps by major and field of study. As mentioned, we focus on science majors, specially in engineering, where the gender gap is sizable and well documented in the literature.

We exploit the temporal exogeneity of the COVID-19 crisis and leverage the temporal and gender differences in the enrollment of each University's college c by estimating the following double difference model separately for each college:

$$Enroll_{i,t} = \alpha + \beta_1 Pandemic_t + \beta_2 Female_i + \gamma Pandemic_t * Female_i + \mu_t + X_i + \varepsilon_{i,t} \quad (1)$$

where $Enroll_{i,t}$ is a variable that takes the value 1 if student i enrolls in college c in year t and 0 if in another college. $Pandemic$ is a dummy variable that takes the value 1 if student i enrolls in 2021 and 0 if earlier.[4] $Female$ equals 1 when the individual is female and 0 otherwise. μ_t represents calendar year fixed effects. Finally, X_i is a set of control variables that includes the student's locality of origin, age at first enrollment year, and a binary variable that takes the value 1 if the student attended a public high school and 0 otherwise. These covariates are time-invariant since they are observed when the individual enrolls at the university for the first time. Our parameter of interest, γ, measures the consequence of COVID-19 pandemic on the college major choice c by gender. It represents the effect on the differential probability between men and women of choosing a college, conditional on enrollment. This allows us to quantify the variation in the gender composition across colleges in the post-pandemic period.

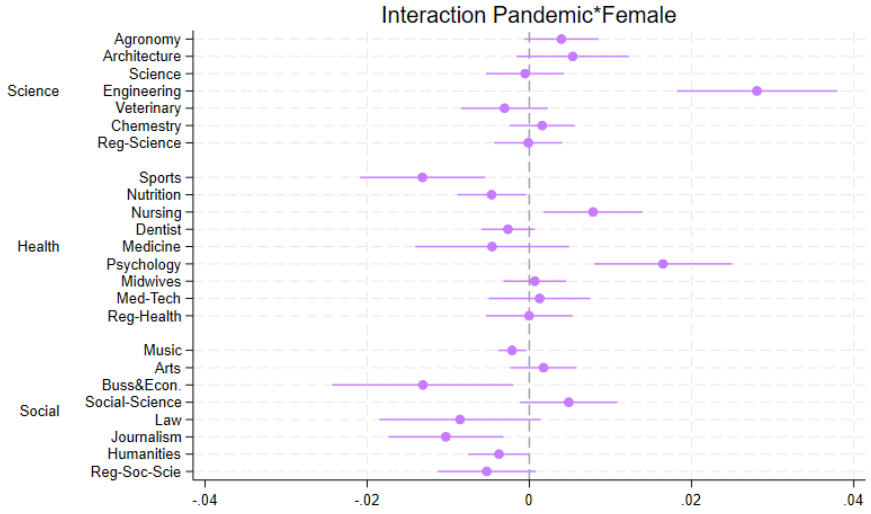
[4]The university allows students to enroll in July, but there are very few students enrolling at that period. In any case, we consider enrollment in July 2020 as pandemic and compute the indicator variable with value 1.

5.2 Results

Figure 2 shows the estimates of the interaction term of Equation 1 (γ), and Appendix Table A.6 further shows the results for *Pandemic* and *Female*. For science-related majors, our results show a positive and statistically significant effect of the COVID-19 pandemic and the shift to online learning on closing the gender gap in engineering majors. The pandemic had a negative effect of 2.2 pp on engineering enrollment but compared to a man, the likelihood that a woman will enroll in engineering increased 2.8 pp compared to pre-COVID-19 years. We also observe a positive effect of the pandemic for women in agronomy, another male dominated major, while no results are observed for men. No other significant effect is observed for other science-related major. For health-related majors our estimates suggest mixed results. On the one hand, the pandemic increased the probability of women choosing nursing and psychology majors, a female dominated option. On the other hand, it reduced the probability of choosing sports and nutrition, another female dominated major. We find no evidence of effects for men, with the exception of medicine for which enrollment was negatively affected both for men and women. Finally, for Social-related major we find a decrease in the probability of women choosing music, business and economics and journalism, while we do not observe and increase in women choosing any of the other Social majors.

Taken together, our results suggest the pandemic and the shift to online learning lead to a reduction of gender gaps in major choices. Women are less likely to choose traditionally feminized majors as the ones related to Social Sciences, and instead, more likely to chose traditionally masculine ones such as Engineering.

Figure 2: COVID-19 Effect on Gender Differences in Major Choices



Notes: Each dot represents the coefficient of the point estimate and the lines represent their respective 95% confidence intervals. Robust standard errors. Own elaboration based on data obtained from DGPLAN, Udelar.

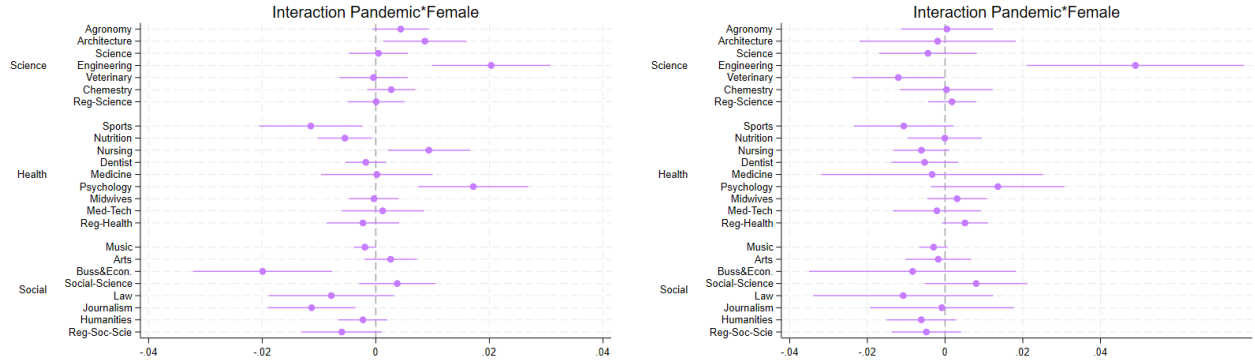
Next we turn to explore heterogeneity effects by socioeconomic level (public or private high school), employment status, and parental status.[5]

Panel (a) and (b) of Figure 3 show that there are no differential gendered effects of the pandemic for students from public or private high schools. However, estimates are higher for females from private high schools compared to males from private high schools, although less precisely estimated.

Figure 3: COVID-19 Effect on Gender Differences in Major Choices, by Type of Secondary Education

(a) Public High School

(b) Private High School



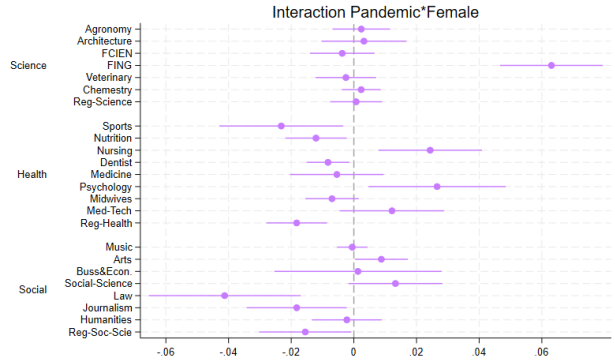
Notes: Each dot represents the coefficient of the point estimate and the lines represent their respective 95% confidence intervals. Robust standard errors. Own elaboration based on data obtained from DGPLAN, Udelar.

Figure 4 shows the relationship between gender gaps in major choices and the COVID-19 crisis by students' employment status. The comparative analysis of estimates for those that are employed (Panel a) and those who are out of the labor force (Panel b) suggests our baseline results are driven by students that were working at the time of enrollment. According to our results, the pandemic increased the probability that an employed woman enrolls in engineering by 6 pp. This effect reduces to 2 pp when considering non working students, both for men and women.

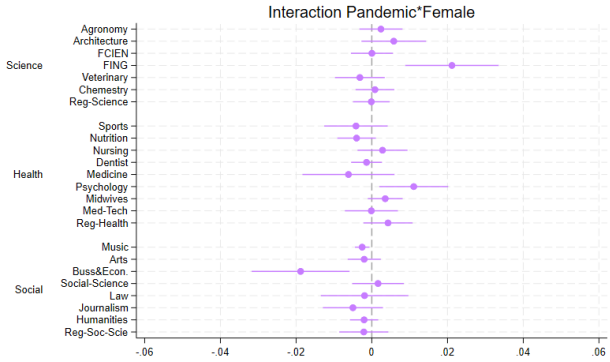
[5]As mentioned before, employment and parental information is available only for students who completed the university census.

Figure 4: COVID-19 Effect on Gender Differences in Major Choices, by Employment Status

(a) In the Labor Force



(b) Not in the Labor Force

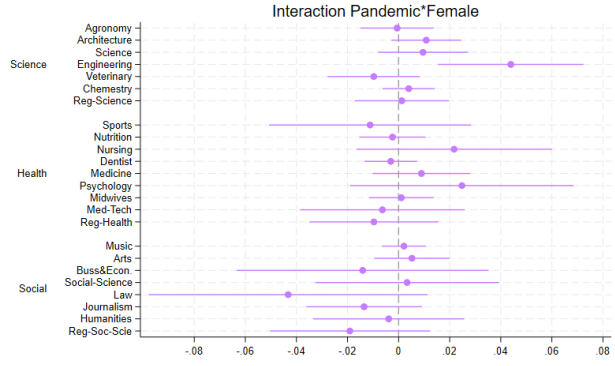


Notes: Each dot represents the coefficient of the point estimate and the lines represent their respective 95% confidence intervals. Robust standard errors. Own elaboration based on data obtained from DGPLAN, Udelar.

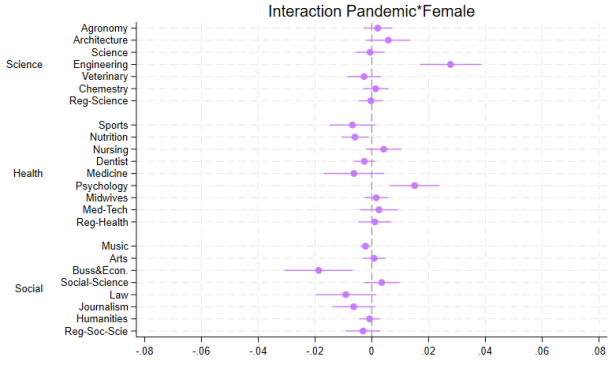
Finally, Figure 5 shows the same patterns in gender gap for students with and without children before and after the COVID-19 crisis. Panel (a) shows estimates of γ for students with children and Panel(b) for students without. As we do not observe many students with children in our estimation sample, our estimates of the γ parameter are not very precise in that case, as illustrated by the 95% confidence intervals in Panel (a). Yet, we still find a positive correlation between the COVID-19 pandemic and the probability that a women chooses an engineering major with respect to the probability a men choosing it.

Figure 5: COVID-19 Effect on Gender Differences in Major Choices, by Number of Children

(a) With Children



(b) Without Children



Notas: Each dot represents the coefficient of the point estimate and the lines represent their respective 95% confidence intervals. Robust standard errors. Own elaboration based on data obtained from DGPLAN, Udelar.

5.3 Causal Effect of COVID-19 and Online Learning

Taken together, our results provide suggestive evidence that the COVID-19 pandemic may have helped reduce the gender gap in science-related fields. Both the counterfactual analysis and the positive and significant γ find in our estimations for engineering major, show that the gap in the probability of a women choosing engineering relative to men was reduced after COVID-19. Yet, these correlations do not necessarily imply a causal relationship. If men and women were following the same trend before COVID-19, we could rely on the standard Difference-in-Difference assumptions and claim a causal interpretation of our estimate.

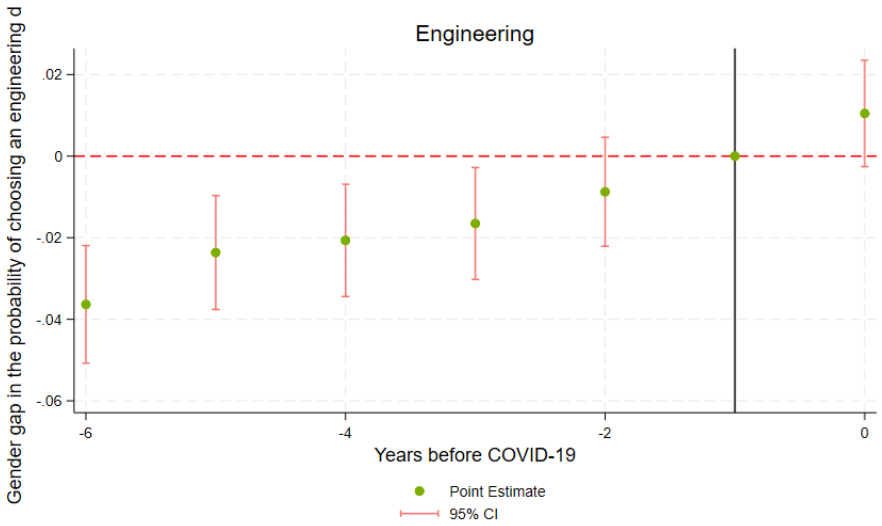
To assess that, we estimate the following model:

$$Enroll_{i,t} = \alpha_0 + \beta Female_i + \mu_t + \sum_{h=-a,}^{h=b-1} \gamma_h 1[K_{it} = h] + \gamma_b^i [K_{it} = b] + \epsilon_{i,t} \tag{2}$$

where $Female$ is a dummy variable that takes value 1 if the student is a woman and 0 otherwise, and μ_t is a set of dummy variables accounting for year fixed effects. Moreover, $a \geq 0$ and $b \geq 0$ are the numbers of included "leads" and "lags" of the event indicator, respectively. $E_{i,t}$ takes value 1 if student i enrolling in engineering at year t and is a women, and 0 otherwise. $K_{l,t} = t - E_I$ is the number of periods since the event date $E_{i,t}$, namely the relative time variable in an event study design. The coefficients on the leads are interpreted as pre-trend measures and the hypotheses that $\gamma_{-a} = \gamma_{-a+1} = ... = \gamma_{-2} = 0$ is tested visually and statistically. $\epsilon_{i,t}$ is the error terms in the model.

Figure 6 shows the event study estimates. Negative but significant estimations of γ indicate a reduction in gender gaps over the period. This makes it challenging to attribute a causal effect of the COVID-19 pandemic to the reduction of the gender gap in engineering. Nevertheless, considering these results together with the aggregated results, the evidence provided in this paper suggests that women's enrollment in engineering increased more than expected due to the pandemic.

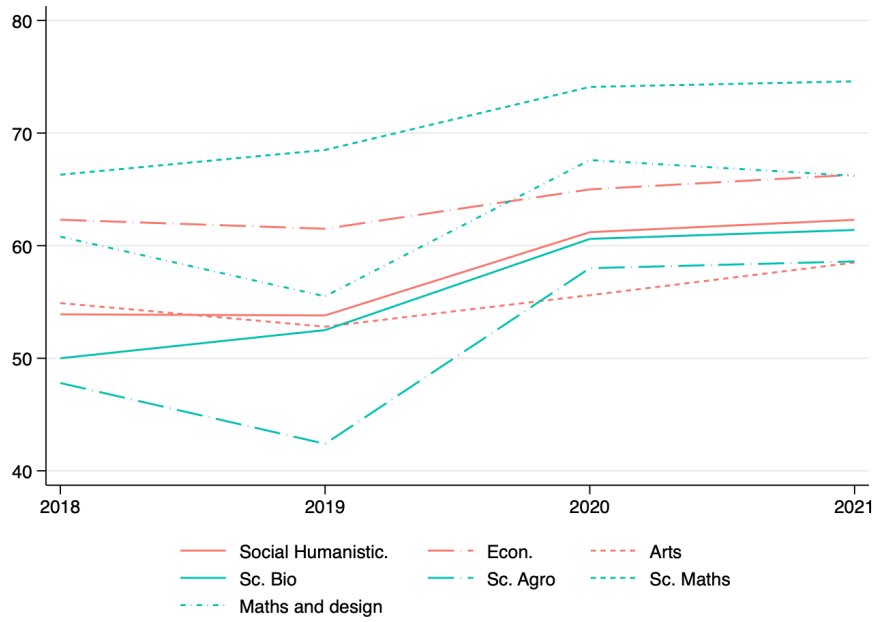
Figure 6: Event Study Estimates for Engineering Majors



Notes: Each dot represents the gender gap in the probability of choosing engineering and the vertical lines represent their respective 95% confidence intervals. Robust standard errors. Own estimates based on data obtained from DGPLAN, Udelar.

To explain the results on major choices, we also analyze the high school track choices. For instance, to enroll in science majors, students must have completed high school in Mathematical Science, Maths and design, or Biological Sciences tracks. Thus, an important driver potentially explaining the changes in major choices relates to the gendered trends in secondary school completion by fields. Figure 7 shows the evolution of the proportion of women graduating from the different tracks in secondary education. Two main finding arise. First, women represent the majority of graduates for almost all tracks and years, and the share increases over time. Second, the greatest increase are in the Biological Sciences and Agricultural Sciences (11 pp), and Mathematical Sciences tracks (8 pp). The differential graduation rates by track in the years 2020 and 2021 are likely channels behind the increase in women's enrollment in Sciences-related fields at the University.

Figure 7: Composition by Sex of Secondary School Graduates (% of Women), by Area



*Notes:*The orientations linked to the area of Sciences are represented in light blue. Own elaboration based on data obtained from the CES Observatory, 2018-2021

6 Conclusions

The empirical literature on the economics of education has shown a counter-cyclical relationship between economic crises and enrollment in higher education (Barr and Turner, 2015). However, the particularities of the crisis originated by the COVID-19 pandemic may have had qualitatively distinctive effects. In this paper we examine the effects of the COVID-19 pandemic on university enrollment by gender. We rely on administrative records from the main University in Uruguay, which is public, has no tuition-fee nor quotas, and comprehends 80% of students at the university level in the country. Our results indicate a negative effect of the COVID-19 pandemic on university enrollment. That is, increase in the enrollment rate observed in 2021 was lower than expected. However, enrollment rates exhibit heterogeneous behaviors by fields of study. While the COVID-19 pandemic resulted in an increase of enrollment in social sciences' majors, it displayed null or even negative effects in science and health's ones. In addition, gender heterogeneities are also relevant, particularly among science's majors. While departing from a similar counterfactual scenario (increase of 4% and 3% in enrollment), women's enrollment actually increased by 9% and decreased by 11% among men. In addition, our findings show a significant association between the COVID-19 pandemic and the likelihood

of women opting into engineering majors. Although this is related with a positive pre-trend in the share of women in engineering, the COVID-19 pandemic at least did not widen the gender gap in STEM fields. Taken together, our results show that the COVID-19 crisis could have helped reduce the gender gap in science-related majors. This is a positive result considering the pandemic disproportionately affected women in other economic outcomes (Del Boca et al., 2022; Albanesi and Kim, 2021). These findings point toward some positive consequences of the pandemic and online learning, particularly for women in male-dominated fields.

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7 Appendix

A Counterfactual 2021 Enrollment

Using then data from 2015 to 2020, both at the aggregate level (University-wide) and by field of study, we estimate the following model.

$$LogMatric_t = \alpha + \gamma Trend_t + \varepsilon_t \tag{3}$$

where $LogMatric_t$ is the number of students enrolled at the University in year t, in logs. $Trend$ is a deterministic time trend taking values from 1 to 6 for the years 2015 to 2020 respectively. Finally *varepsilon* is the idiosyncratic shock of the model. The parameter γ represents the annual enrollment growth rate for the years prior to the pandemic.

The time trend estimate is used to predict what the subsequent years' enrollment would have been if the growth rate had been held in the absence of COVID-19, all else constant.This regression is estimated for total enrollment, female and male enrollment, and by subject area.

B Tables and Figures

Table A.1: Descriptive statistics, by year

	2015		2016		2017		2018	
	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.
Women	0.62	14,570	0.61	15,553	0.60	15,814	0.61	16,577
Age	20.60	14,570	20.85	15,553	20.81	15,814	20.99	16,577
Public Highschool	0.77	14,411	0.78	15,301	0.78	15,553	0.80	16,196
Single	0.90	14,184	0.89	15,128	0.90	14,325	0.89	15,979
Children	0.06	14,182	0.06	15,124	0.06	14,323	0.07	15,979
Num. household members	4.37	14,184	4.30	15,128	4.30	14,325	3.95	15,979
Work	0.25	14,184	0.26	15,128	0.23	14,325	0.25	15,979
Father/Mother graduate	0.47	14,135	0.46	15,026	0.47	14,083	0.46	15,674
Observations	14570		15553		15814		16577	

	2019		2020		2021	
	Mean	Obs.	Mean	Obs.	Mean	Obs.
Women	0.60	17,296	0.61	17,101	0.64	17,840
Age	20.93	17,296	21.02	17,101	21.30	17,840
Public Highschool	0.80	16,841	0.81	16,477	0.84	17,839
Single	0.89	16,498	0.89	15,379	0.98	16,217
Children	0.07	16,497	0.07	15,377	0.09	16,740
Num. household members	3.98	16,498	3.91	15,379	3.64	16,740
Work	0.23	16,498	0.21	15,379	0.22	16,740
Father/Mother graduate	0.46	16,014	0.45	15,130	0.44	16,391
Observations	17296		17101		17840	

Notes: The Table shows the mean and number of observations for the relevant variables of the students enrolled at Udelar, according to year of enrollment. The Table considers those students who enroll each year in different services. The data regarding gender, first entry, age of entry and public high school come from the administrative records of Udelar. Data on marital status, having children, number of people in the household, employment status and education of mother and father come from the University Census. In 2017 and 2020, a lower proportion of people answering the Census is observed.

Table A.2: Number of Women Enrolled by College and Year

	2015	2016	2017	2018	2019	2020	2021
Agron.	135	145	123	98	100	57	69
Arch.	506	541	487	488	495	492	579
Science	132	143	161	130	142	165	175
Engineering	314	341	335	400	383	361	354
Vet.	337	339	363	358	294	300	313
Chem.	239	214	235	242	234	174	234
Reg-Science	141	117	122	141	122	156	150
Sports	192	189	219	246	224	263	270
Nutrition	159	185	256	182	228	257	237
Nursin.	225	382	381	557	483	570	660
Dentist	221	161	215	198	157	211	178
Med.	938	1,042	1,082	1,249	1,341	1,369	1,274
Psycho.	873	965	955	958	949	920	1,298
Med-Tech	272	274	252	386	638	702	625
Midwives	234	241	230	278	229	341	316
Reg-Health	116	201	196	195	192	291	414
Music	6	7	10	10	9	13	7
Arts	211	183	179	221	230	164	235
Buss&Econ.	1,307	1,371	1,304	1,178	1,194	908	1,044
Soc-Science	470	461	462	458	496	502	635
Law	1,000	942	1,024	1,112	1,177	1,092	1,322
Journalism	273	224	345	381	403	426	446
Human.	152	229	201	215	287	349	182
Reg-Social-Science	556	559	426	395	423	422	462

Notes: Own elaboration based on data obtained from DGPLAN, Udelar

Table A.3: Number of Men Enrolled by College and Year

	2015	2016	2017	2018	2019	2020	2021
Agron.	228	252	235	204	177	192	161
Arch.	318	307	317	295	288	265	272
Science	135	128	133	160	163	177	159
Engineering	1,049	1,088	1,089	1,135	1,129	996	896
Vet.	189	192	167	206	174	155	162
Chem.	81	92	96	118	88	62	70
Reg-Science	125	141	120	134	127	106	121
Sports	255	262	503	497	493	508	513
Nutrition	42	45	59	58	86	113	94
Nursin.	60	147	116	179	140	177	165
Dentist	43	37	48	42	55	59	40
Med.	383	445	485	496	609	590	511
Psycho.	279	366	303	326	325	370	322
Med-Tech	82	90	76	128	224	242	194
Midwives	36	31	28	31	35	46	38
Reg-Health	28	115	107	115	105	184	201
Music	19	15	13	9	24	15	27
Arts	103	73	72	86	96	77	75
Buss&Econ.	1,052	1,157	1,093	1,053	1,128	891	961
Soc-Science	136	124	150	129	141	135	146
Law	440	433	490	531	532	478	590
Journalism	174	189	211	268	301	394	358
Human.	65	101	95	101	162	156	69
Reg-Social-Science	239	267	245	200	264	208	216

Notes: Own elaboration based on data obtained from DGPLAN, Udelar

Table A.4: Share of Women by College and Year

	2015	2016	2017	2018	2019	2020	2021
Agron.	37.2	36.5	34.4	32.5	36.1	22.9	30.0
Arch.	61.4	63.8	60.6	62.3	63.2	65.0	68.0
Science	49.4	52.8	54.8	44.8	46.6	48.2	52.4
Engineering	23.0	23.9	23.5	26.1	25.3	26.6	28.3
Vet.	64.1	63.8	68.5	63.5	62.8	65.9	65.9
Chem.	74.7	69.9	71.0	67.2	72.7	73.7	77.0
Reg-Science	53.0	45.3	50.4	51.3	49.0	59.5	55.4
Sports	43.0	41.9	30.3	33.1	31.2	34.1	34.5
Nutrition	79.1	80.4	81.3	75.8	72.6	69.5	71.6
Nursin.	78.9	72.2	76.7	75.7	77.5	76.3	80.0
Dentist	83.7	81.3	81.7	82.5	74.1	78.1	81.7
Med.	71.0	70.1	69.0	71.6	68.8	69.9	71.4
Psycho.	75.8	72.5	75.9	74.6	74.5	71.3	80.1
Med-Tech	76.8	75.3	76.8	75.1	74.0	74.4	76.3
Midwives	86.7	88.6	89.1	90.0	86.7	88.1	89.3
Reg-Health	80.6	63.6	64.7	62.9	64.6	61.3	67.3
Music	24.0	31.8	43.5	52.6	27.3	46.4	20.6
Arts	67.2	71.5	71.3	72.0	70.6	68.0	75.8
Buss&Econ.	55.4	54.2	54.4	52.8	51.4	50.5	52.1
Soc-Science	77.6	78.8	75.5	78.0	77.9	78.8	81.3
Law	69.4	68.5	67.6	67.7	68.9	69.6	69.1
Journalism	61.1	54.2	62.1	58.7	57.2	52.0	55.5
Human.	70.0	69.4	67.9	68.0	63.9	69.1	72.5
Reg-Social-Science	69.9	67.7	63.5	66.4	61.6	67.0	68.1

Notes: Own elaboration based on data obtained from DGPLAN, Udelar

Table A.5: Difference Between Observed and Estimated Counterfactual Enrollment by Demographics Characteristics

	Total	Women	Men
Change in enrollment of students from public high schools, in perc.	2.1	2.1	1.5
Change in enrollment of students with children, in perc.	1.2	1.8	-.5
Change in enrollment of students in the labor force, in perc.	.9	1.2	.3

Table A.6: Estimated Coefficients from Equation 1

Collage	Interaction	Female	Pandemic
Agronomy	0.004*	-0.023***	-0.003
Architecture	0.005	0.006***	0.001
Science	-0.001	-0.009***	-0.000
Engineering	0.028***	-0.131***	-0.022***
Veterinary	-0.003	0.005***	0.002
Chemestry	0.002	0.009***	0.002
Reg-Science	-0.000	-0.007***	-0.000
Sports	-0.013***	-0.046***	0.006
Nutrition	-0.005**	0.011***	-0.001
Nursing	0.008**	0.020***	-0.003
Dentist	-0.003	0.012***	-0.002
Medicine	-0.005	0.043***	-0.008*
Psychology	0.016***	0.042***	0.003
Med-Tech	0.001	0.020***	-0.012***
Midwives	0.001	0.021***	-0.004***
Reg-Health	-0.000	0.002**	0.006***
Music	-0.002**	-0.002***	0.002**
Arts	0.002	0.007***	0.002
Buss&Econ.	-0.013**	-0.044***	0.018***
Social-Science	0.005	0.027***	0.001
Law	-0.009*	0.031***	0.019***
Journalism	-0.010***	-0.006***	0.005
Humanities	-0.004*	0.006***	-0.015***
Reg-Soc-Scie	-0.005*	0.008***	0.004

Notes: The Table shows the results of estimating the double difference model as in Equation 1. Robust standard errors. *** significant at the 1% level, ** 5% level, and * 10% level. Own elaboration based on data obtained from DGPLAN, Udelar.