Impact of COVID-19 on higher education: Evidence from Uruguay

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Resumen

El presente trabajo aporta evidencia empírica para Uruguay, sobre los efectos del COVID-19 en el desempeño educativo de los estudiantes de educación universitaria en su primer año de matriculación. Para ello utilizamos datos administrativos de la Universidad de la República desde el 2017 al 2020. Nuestros resultados muestran que los estudiantes matriculados en 2020 tienen mayor probabilidad de inactividad y de realizar menos cantidad de cursos, pero son más propensos a obtener mayores calificaciones al compararlos con las cohortes previas. Estos efectos son más pronunciados para los hombres, los estudiantes de Montevideo, aquellos sin una afiliación anterior con la UdelaR, y para los estudiantes de menor nivel socioeconómico. Adicionalmente, utilizando datos de una encuesta realizada durante el año 2020, encontramos que la falta de acceso a material bibliográfico, la falta de interacción con estudiantes y docentes y no contar con los recursos adecuados reduce la cantidad de cursos aprobados y está asociado con un puntaje promedio menor de calificaciones. Por último, las posibilidades de realizar cursos en cualquier momento, tomar clases desde el hogar y evitar los tiempos de viaje aumenta el número de cursos aprobados y las calificaciones obtenidas.

Keywords: Pandemia, Universidad, resultados educativos.
JEL Codes: I23, I24, I25

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Abstract

This article provides empirical evidence about the effects of COVID-19 on university students' educational outcomes in the first year of enrollment for a developing country, Uruguay. To do this, we use administrative microdata from the public university students from 2017 to 2020. Our findings show that students enrolled in 2020 are more likely to drop out and take fewer courses but are more prone to obtain larger scores than the previous generations. These effects are more pronounced for males and students from lower socioeconomic backgrounds. In addition, using survey data, we find that the lack of access to bibliographic material, the lack of interaction with teachers and students, and not having adequate resources is associated with a reduction in the number of approved courses, a less average score, and enrollment in fewer courses. Moreover, the possibility of having classes at any time, taking courses from home and avoiding the travelling time increase the number of approved courses and the average score. Finally, we observe that employed students do relatively worse than non-employed students.

1. Introduction

The educational system underwent significant changes due to the COVID-19 crisis and the suspension of face-to-face lessons. Higher education was not an exception. Studies for developed economies found that the Pandemic positively affected dropout rates (Aucejo et al., 2020; Bulman & Fairlie, 2022) and increased the gap between students from different backgrounds (Rodríguez-Planas, 2021). University students face additional challenges in developing countries due to the persistent and significant inequalities mostly related to technological issues (Vegas, 2020; Gonzales, 2016; Puckett, 2019; Bennett, Maton & Kervin 2009; Palfrey & Gasser, 2008; Sleicher, 2020). However, the study about the effects of the Pandemic in less developed economies on tertiary education students' is still scarce. Understanding the effects of COVID-19 on educational outcomes for these countries is fundamental, given the importance of education for growth and development.

In this study, we provide empirical evidence for a developing country, such as Uruguay, regarding the effects of COVID-19 on students' educational outcomes enrolled in the first year of university. We focus on students enrolled in the largest public university in Uruguay, Universidad de la República (UdelaR), covering more than 85% of university students. We exploit a rich dataset from different administrative records from UdelaR, containing information on first-year undergraduate students from 2017 to 2020. The data gives information on students' performance at university and sociodemographic and socioeconomic characteristics of students. Using Ordinary Least Square estimations, we compare the performance of students enrolled at the university for the first time in 2020 versus their peers enrolled in previous years in which face-to-face classes prevailed. Additionally, we do the analysis considering university students from different socioeconomic backgrounds, analyzing heterogeneous effects according to students' observed characteristics.

We find that first-year students from the 2020 cohort have a higher probability of dropout (close to 4 percentage points) compared to first-year students from previous generations. We also observe that the cohort in 2020 took fewer courses (0.2) and obtained higher average scores (0.6 out of 12) compared to previous generations. We observe similar effects when we separately analyze the educational performance by gender for different cohorts of students. However, the effects are more important for boys, showing higher dropout rates and fewer courses taken on average in 2020. We also

carry on the analysis for students from different parental educational backgrounds finding that students with less-educated parents were more affected by the Pandemic. In addition, we also perform a different analysis for students who had completed high school in a public institution and those who attended a private one. The increase in dropouts is observed for both groups of students, but the results for students from private institutions are weaker. This suggests that students from worse socioeconomic backgrounds suffered more during the Pandemic regarding educational outcomes. Finally, students from outside the country's capital, where the university is located, had lower dropout rates suggesting that online teaching could have helped them continue studying.

Finally, we use a student survey carried out in June 2020, during the COVID-19 Pandemic, to analyze different channels through which the Pandemic may have affected students' outcomes which could explain the effects found. First, we analyze the correlation between educational performance and students' difficulties during this period. We observe that the lack of access to bibliographic material and the lack of interaction with teachers and with students reduce the number of courses approved. Due to the difficulties in balancing study and work, students enrolled in 1 fewer course, approved on average 1.7 fewer courses, and reduced the average score by 1 point. In this case, it is important to note that unemployment increased during the Pandemic. Moreover, students reporting inadequate resources do relatively worse; they enroll in fewer courses, approve fewer courses, and obtain a lower average score. Further, students with emotional distress have more probability to dropout. Second, we evaluate the correlation between the educational outcomes and students' reported perceptions of the positive aspects of changing the teaching modality from face-to-face to online courses. The possibility of having classes at any time increases the number of approved courses and the average score. Furthermore, the possibility of taking the lessons from home and not traveling is positively correlated with the number of courses taken and approved.

Our study relates to the growing literature about the effects of COVID-19 Pandemic on tertiary education (Bulman and Fairlie (2022), Aucejo et al., 2020; Rodríguez-Planas, 2020; Rodríguez-Planas, 2021). These papers find that the Pandemic negatively influences the enrollment or graduation of but are mostly for developed economies. In addition, they show important differences by socioeconomic background. We differentiate from this literature in different ways. First, by considering a developing country. As it was mentioned, the effects in less developed economies could be different

than in developed economies. Understanding the effects of the Pandemic on tertiary education for developing economies is crucial because it could compromise the paths toward economic development. Uruguay is particularly important, as it is a developing country with a low percentage of university students and with high dropout rates. Second, we use a rich database containing 86% of the university students from the country being able to measure the situation at a national scale. Moreover, our institutional setting differs from the other papers by considering the case of a public university with free access.

The rest of the paper is organized as follows. Section two reviews the most relevant literature on this topic. The third section introduces the institutional framework of the Uruguayan university educational system. After describing the sources of information and the empirical strategy followed in section four, section five presents the main results of this study. Finally, section six exposes the outcomes found; the last section presents the final remarks.

2. Overview from the literature

The fact that the closure of schools can affect students' educational outcomes is not new. The economic literature has found adverse effects on academic, psychological, and labor market outcomes of students derived from the closure of educational centers due to, for example, seasonal and institutional changes, strikes, or holidays (Jaume & Willen, 2018; Shonkoff & Meisels, 2000; Cunha & Heckman, 2007; Pischke, 2007).

More recently, due to the exogenous shock of COVID-19 worldwide, the literature has focused on the COVID-19 effects on education. For school students, authors have found that COVID-19 increased the existing gap between students from different backgrounds, reduced social mobility, and negatively affected individuals' human capital accumulation (Bacher-Hicks, Goodman, and Mulhern, 2021; Chetty et al., 2020, among others).

Bulman and Fairlie (2022) use administrative college-level panel data from all 116 college California Community College system students. They found a decrease in enrolled students relative to the prior year, higher for Afro-American and Latin students, first-year students, basic skills course, and fields such as engineering/industrial technology, education, interdisciplinary studies, and art. Also, they observe lower completion rates and an increase in withdrawal rates and grades. At the same time, Aucejo et al. (2020) surveyed 1500 students in one of the largest institutions in the United States and found

that COVID-19 has led to delay graduation by 13%, dropping out of classes by 11%, and changing careers by 12%. In addition, around 50% of the sample report a decrease in study hours and academic performance. The data also shows that students from low socioeconomic backgrounds are more likely to postpone graduating.

In addition, Rodríguez-Planas (2022a) evaluates the short-term impact of COVID-19 on educational, financial, and personal burdens faced by students of a New York public University (Queens College). Her analysis shows that the pandemic hits academic and labor market expectations of college students in the US, especially the most disadvantaged. It reduced freshman students' retention rate by 26%, modified the graduation plans by 30%, and between 14% and 34% of low-income students considered dropping a class to avoid reducing their grades and jeopardizing financial assistance. She also found that half of those working lost their jobs, reduced their earnings, and the expected household income of 64%.

Using data from the same university, Rodríguez-Planas (2022b) studies how students from different economic backgrounds and academic pre-COVID performances were differently affected by the COVID-19 pandemic. Her results show that top-performing lower-income students experience a decrease in their GPA (5% less) and earned credits (11% less) during the spring 2020 semester relative to their higher-income peers. The author stresses that this worse performance may be driven by lower-income top-performing students experiencing more significant challenges with online learning than their higher-income peers. In contrast, lower-income and bottom-performing students obtained 9% more grading than their higher-income peers in the spring 2020 GPA. Plausible explanations the author provides point to students' concerns with maintaining financial aid.

Different results are found by Bonaccolto-Topfer & Castagnetti (2021). The authors use Italian administrative data and a difference-in-differences design comparing students' outcomes during the summer term of 2020 to those in the same term but of the previous years. Their results show no substantial effects of COVID-19 on teaching quality and academic performance measured by grades, graduation rates, and exam failure. In addition, these results are similar even considering different subgroups of the population as those from diverse family wealth, top-performance students, or gender.

However, the focus on the study of COVID-19 effects on university students in developing countries is scarce and has the challenge of considering greater inequalities of enrollment into university education due to access and quality to technology and internet

connections (Vegas, 2020; Gonzales, 2016), inequalities on technology usage abilities in students from different family backgrounds, (Puckett, 2019; Bennett, Maton & Kervin 2009; Palfrey & Gasser, 2008); and inequalities due to institutional adaptations to the pandemic (Sleicher, 2020). Hossain (2021) uses survey data from Ethiopia, India, Peru, and Vietnam to describe differences in the effects of remote schooling according to sociodemographic characteristics. The author finds that students from wealthier households, urban areas, and with internet access are more likely to access remote schooling. In addition, Jaeger et al. (2021) surveyed students in many countries, including Mexico. Considering respondents from all countries, in terms of educational outcomes, they found that 12% of the students withdrew from at least one course, and 41% were not sure about returning to school in the fall of 2020. In addition, 83% of students manifested the lack of contact with faculty or students as a challenge. For Mexico, an additional relevant problem was the need for a noiseless place to study or a lack of access to the internet or computer.

Understanding the effects of the pandemic in more vulnerable contexts is crucial to design public responses that minimize the negative effects on the students that suffered from COVID-19 but also to potential future similar situations.

3. Institutional context

As mentioned above, we analyze the effects of COVID-19 on educational outcomes in Uruguay. Uruguay's educational system has a distinctive characteristic: education is public and free access for everyone. This is also the case for the university, where there are no tuition fees, entrance exam tests, or limited slots for admissions.[6] The tertiary education students are concentrated in Universidad de la República (UdelaR), the main public university of the country, which covers 85% of university students and with around 100 undergraduate degrees and more than 200 postgraduate degrees. In 2020, more than 145.000 undergraduate and 10.000 postgraduate students were enrolled at UdelaR.[7] Another distinctive element of UdelaR is that it has been historically located in Montevideo, the country's capital. Although since 2007 a territorial decentralization process took place by progressively expanding the supply of degree programs in the rest

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[6] There are very few careers that are an exception because they have randomly assigned slots to enrolled students.
[7] Data obtained from the General Planning Office (*Dirección General de Planeamiento*, DGPlan),

of the country, the percentage of students studying in Montevideo is still the vast majority (around 85%).[8]

Another relevant fact from the institutional context we analyze is related to the timing of the pandemic and the academic calendar in the country. On the one hand, the academic year in Uruguay runs from March to December. Since February, graduated students from high school can enroll in the university, choosing and enrolling in those courses they would like to take within a career. Semester and annual courses coexist depending on the career, and in some cases, there is also the possibility of approving the course without attending it, only with an exam. Once courses end (in December), an exam period that closes the academic year starts. On the other hand, the first COVID-19 patient detected in Uruguay was on the 13th of March 2020; when courses at the university had just begun. At that date, the pandemic was already causing alarm around the world. Therefore, by mid-March, the university authorities decided to suspend courses for one month at the undergraduate and graduate levels.[9] As in-person classes were suspended for the academic year in most of the careers provided at UdelaR, by mid-April, virtual classes were implemented.[10] In order to carry on the virtual learning process, UdelaR used tools previously developed and incorporated new ones.[11] Specifically, 380 virtual teaching rooms were offered, with a capacity for 500-1000 students to be simultaneously connected and attending lessons. By May 2020 virtual tools were widespread and used in all university careers. Also, for students with a lack of access to technological devices, grants and equipment loans were provided to foster students' access to the internet and computers for personal use.[12]

The features mentioned before make Uruguay an interesting case of study in which the pandemic hit at the beginning of the academic year, but after students decided to enroll. In addition, the fact that UdelaR covers almost all university students in the country makes it easier to understand the effect of the pandemic on higher education in the country by analyzing the data from UdelaR.

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[8] Data obtained from the General Planning Office (Dirección General de Planeamiento, DGPlan)

[9] It is worth mentioning that in Uruguay the government did not impose the lockdown at any moment of the pandemic. In addition, during 2020 Uruguay did not have a high number of COVID-19 patients or deaths.

[10] In very few careers, some in-person courses were resumed by the end of the second semester. This implied that when the second semester started, courses were still virtual.

[11] Before COVID-19, Udelar had a virtual platform (EVA: Entorno Virtual de Aprendizaje) to be used together with in-person classes but there were significant differences in it use across faculties. During the pandemic, the use of EVA was extended, and in addition other platforms, such as Zoom or Teams were used for online teaching.

[12] A survey conducted at the beginning of the pandemic by UdelaR showed that 10% of the students did not have a microcomputer (laptop, pc, or tablet) to continue with their courses.

4. Empirical strategy

4.1 Data

To analyze the effect of COVID-19, we use a novel data set of administrative records of first-year students from UdelaR from 2017 to 2020. We merge different datasets extracted from the university's administrative system (*Sistema de Gestión Administrativa de la Enseñanza,* SGAE) and provided by the *Dirección General de Planeamiento* (DGPLAN). The first dataset contains information that students report at the beginning of the year when completing the enrollment form. The fulfillment of this form is compulsory; and comprises students' socioeconomic and sociodemographic characteristics, such as gender, age, place of residence, and high school institutional background. The second dataset contains the records of students' academic events, i.e., courses taken, courses approved, and grades. This information allows us to capture the academic trajectory of students over time. In addition, we also use a self-administered questionnaire collected yearly that provides additional information related to students' socioeconomic characteristics, such as parental education, parental occupation, students' parenthood, and household members, among others. Although completing this form is compulsory and must be fulfilled before the beginning of the second semester, due to COVID-19, this restriction was relaxed in 2020. Therefore, we do not have information from this questionnaire for all students because around 12% did not complete the form. Once we merge all the information, we obtain a student-career-year dataset with 120.563 observations from first-year students for each year from 2017 to 2020.[13] We restrict the data to all observations coming from students that are enrolled: (i) for the first time at the university;[14] (ii) in careers without changes in their curricula or without limited slots for enrollment; (iii) in careers with more than 100 students per year; and (iv) in careers taught all years between 2017 to 2020. As a result, our data contains 54.566 student-career-year observations.

At last, we exploit a survey carried out by UdelaR in the last week of June 2020, after the end of the first semester courses (*Students Survey, COVID-19*). This survey aimed to gather information about students' perceptions of the challenges imposed by COVID-19

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[13] We allow students to be enrolled in more than one career in the same year only if the careers are offered by different faculty. This decision is made to avoid duplicating information from students that are enrolled in joint tracks of different careers, but that will have the same academic trajectory in both cases because the first year is the same.

[14] Students may have been enrolled in a different career at the public university in a previous year, thus, not being a 'new' student at the UdelaR.

and regarding the new modalities of the courses. The survey is representative of all students enrolled at the university, with a stratification design considering the year of admission to the university (distinguishing between the 2020 cohort and previous cohorts). In total, 1.305 students were surveyed; 662 are from the 2020 cohort. We use this data to explore potential mechanisms through which COVID-19 could affect academic outcomes.

4.2 Methodology

To estimate the impact of the COVID-19 pandemic on university educational outcomes, we compare first-year enrolled students' performance in 2020 with their peers in previous cohorts. The equation to be estimated is the following:

$$(1) \quad Y_{i,j,t} = \beta_0 + \beta_1 Pandemia + \gamma' X_{i,t} + \mu_j + \varepsilon_{i,j,t}$$

where $Y_{i,j,t}$ refers to four alternative educational outcomes considered in the analysis for the individual i enrolled in the career j at the year t. The first outcome explored is a measure of dropout from the university that measures whether the student enrolled at the beginning of the year did or did not have any academic activity during the year (*Dropout*). This dummy variable equals 1 if the student did not take any final nor midterm exam during the academic year, and zero otherwise. We identify this dropout measure by considering those students who have completed the enrollment form but are not found in the administrative records of academic's activities. The second educational outcome analyzed is the number of courses students signed up for and for which they took at least one evaluation test (*Number of courses*). As third outcome we use the number of approved courses during the year (*Number of approved courses*).[15] We finally consider the average grade of all the exams taken during the year (*Mean Grade*) including the exam period of December 2020.[16]

The key independent variable of this study, *COVI-19*, is a dummy variable that takes the value 1 for year 2020 and 0 for 2017, 2018 and 2019. The coefficient of interest, β_1 captures the effect of the COVID-19 pandemic on different outcomes assuming that the

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[15] For *Number of courses* and *Number of approved courses* we do not consider students who dropout from the university.

[16] For this outcome we only consider the students that took exams.

year 2020 would have been similar to previous years if no COVID-19 pandemic would have happened. This is the case if other factors that could affect our educational outcomes are ruled out, such as cohort composition effects. Specifically, and as mentioned above, students' decision on whether to enroll at the university or not was taken before the pandemic appeared in the country, therefore, we should not observe differences in the composition of students across cohorts. In addition, we should observe similar results in the outcome variables before 2020, and a jump in that year. Table A. *1* and Table A. *2* presents the descriptive statistics of different student characteristics and the academic outcomes for the period analyzed and shows evidence in favor of the previous idea.

We also control for students' characteristics by adding a set of control variables $X_{i,t}$: gender, region of residence before attending university, age and high school institutional background.[17] We also include career fixed effects (μ_j) and we use clustered standard errors at the career level. In addition, other control variables such as parental occupation, whether at least one parent has a university degree or not are included in the robustness analysis. Moreover, we explore whether the COVID-19 differently affected students' performance according to different observed individuals' characteristics; by separately estimating the equation (1) by students' gender; parental educational background; high school institutional background; and region of birth.

Finally, we analyzed possible channels through which COVID-19 could have affected academic outcomes using students´ perceptions and opinions. We estimate the following model:

$$(2) \quad Y_{i,j,2020} = \beta_0 + \beta_1 StudentPercep._{i,2020} + \gamma'X_{i,2020} + \mu_j + \varepsilon_{i,j,2020}$$

where $Y_{i,j,2020}$ are the academic outcomes defined before for the individual i enrolled in the career j in the year 2020. We restrict the analysis to the year 2020 since the student perception survey is conducted only in that year. $StudentPercep$ are the independent variables referring to students perception and opinions of individual i in the year 2020: courses timetable overlapping, lack of access to bibliographic material, lack of interaction with other students and teachers, difficulty in combining study and work, overload of educational activities, emotional affectation, difficulties to participate in classes due to

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[17] We present the control variables in *Table A. 3*. The Table includes the control included in the main estimation and the extra controls included as robustness checks explained in Section **¡Error! No se encuentra el origen de la referencia.**.

connectivity problems, or difficulty due to not having adequate resources[18]. The Table A. 4 Variables referred to students perceptionin the annex describes the independent variables $StudentPercep$. The coefficient of interest, β_1 captures the correlation between students' perception and opinions and the academic outcomes. We also control for students' characteristics by adding the set of control variables $X_{i,t}$ used in the main analysis and for career fixed effects (μ_j). Again, we use clustered standard errors at the career level.

5. Results

5.1 Main estimations

Table 1 reports the annual first-year students' educational outcomes. Our first finding stresses that the pandemic increased the probability of dropout (being enrolled but not taking an exam during the year) by around 4 percentage points (pp). We do not find statistically significant differences between the 2020 and previous cohorts regarding the number of courses taken or approved. However, we find an effect regarding the mean score, with the 2020 cohort obtaining higher scores of around 0.67 points on a scale that goes from 0 to 12 compared to previous generations. These results suggest that the pandemic had an impact on the student decision to start the academic year, but once the students were engaged with the education process, the pandemic did not have a significant effect except for the increase in grades. As Rodríguez-Planas (2021) stressed, the increase in the mean grade could be related to more accessible evaluation tests and/or more lenient grading, less teacher supervision due to online evaluations that could be leading, for instance to greater students' cheating, or an improvement in students' learning process. Due to data limitations, we cannot fully address the potential mechanisms, but we are not aware of any university policy aiming to relax evaluation tests or grading, nor do we have information on cheating practices systematically implemented by students in online evaluations.

Table 1. Effect of COVID-19 on academic outcomes of first-year students

	(1)	(2)	(3)	(4)

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[18] We estimate the models considering one by one the independent variables, and as a robustness check we also regress the independent variables all together.

	Dropout	N.courses	N. subjects approved	Avg. grade
COVID-19	0.0415**	-0.218	0.219	0.665***
	(0.0196)	(0.149)	(0.186)	(0.215)
	0.0411	0.150	0.247	0.00389
Observations	52,781	46,613	46,613	39,829
R-squared	0.104	0.527	0.428	0.195

Notes: The table reports the OLS estimates for the COVID-19 coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

One of the main threats to the identification strategy is the possible pre-existing trends in the outcome variables, which confound the effect of the pandemic with other factors not attributable to the shock generated by the advent of COVID-19. That is, conditional on the career fixed effects, and after controlling for variables that can affect performance and could variate over time, the pandemic is assumed to be orthogonal to the error term. We perform the regression in the Event Study framework to address this issue. That is, instead of using the COVID-19 variable, we include a year fixed effect for each year of the considered period. The omitted variable is 2019; therefore, we check the existence of preexisting trends in the outcome variable. Table 2 shows that there were no statistically significant differences between 2019 and the previous years for any of the outcomes considered. In addition, in 2020 the dropout rate increased by close to 4.7 pp and the average grade in 0.72 points, like the results found before. In addition, for this specification, we observe an increase in the number of approved subjects, which could be consistent with the increase of the mean grade occurring at a relevant part of the grade distribution.

Table 2. Event study analysis for the academic outcomes of first-year students

	(1)	(2)	(3)	(4)
	Dropout	N.courses	N. subjects approved	Avg. grade
2017	0.0113	0.238	0.161	0.0645
	(0.0147)	(0.206)	(0.154)	(0.152)
	0.445	0.256	0.303	0.674
2018	0.00498	0.249	0.111	0.120
	(0.00807)	(0.154)	(0.134)	(0.211)
	0.541	0.113	0.413	0.574
2020	0.0469**	-0.0595	0.308**	0.724***

	(0.0191)	(0.106)	(0.131)	(0.132)
	0.0193	0.578	0.0238	3.57e-06
Observations	52,781	46,613	46,613	39,829
R-squared	0.104	0.527	0.429	0.195

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

In addition, we try two different specifications to analyze the robustness of the results. First, we perform the analysis without any control (Column 1, 3, 4 and 7 of Table 3). Second, we also include as control variables other variables related to the students' socioeconomic background: ethnicity, if the student works, the occupation of parents, and if at least one of the parents attended university. Including these variables allows us to check for omitted variables bias in our main estimation. However, we did not include these controls in our main estimation because of the missing data problem derived from the fact that answering the form was not mandatory in 2020 (Column 2, 4, 6 and 8 of Table 3). The results show that the coefficients remain stable in both specifications for the dropout rate and the average grade.

Table 3 Robustness Check without and with full control variables.

	(1)	(2)	(3)	(4)	(5) N. subjects approved	(6) N. subjects approved	(7) Avg. grade	(8) Avg. grade
	Dropout	Dropout	N.courses	N.courses				
COVID-19	0.0442**	0.0367**	-0.263*	-0.223	0.158	0.249	0.622***	0.710***
	(0.0208)	(0.0163)	(0.153)	(0.147)	(0.189)	(0.187)	(0.221)	(0.222)
	0.0407	0.0306	0.0937	0.138	0.409	0.193	0.00777	0.00293
Observations	54,566	37,093	47,830	34,042	47,830	34,042	40,724	29,854
R-squared	0.085	0.086	0.493	0.570	0.397	0.460	0.174	0.207

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

5.2 Heterogeneous effects

In this section we analyze heterogeneous effects of COVID-19 on students' educational outcomes. First, we consider all the students enrolled for the first time in a certain career, not excluding those who were previously enrolled in another career. Results are shown in Table 4. The dropout variable is of the same sign but lower magnitude than before and is non-significant. This means that the effects are less pronounced for students already linked with the university. The results for the mean grade are similar to those obtained for the main estimation in magnitude and significance, showing that the grade increase was observed for all students. This analysis is relevant because it shows that in terms of dropout, COVID-19 affected more students without a previous institutional affiliation with the university.

Table 4. Analysis considering all first-year students of the different careers

VARIABLES	(1) Dropout	(2) N.courses	(3) N. subjects approved	(4) Avg. grade
COVID-19	0.0266	-0.151	0.274	0.710***
	(0.0222)	(0.133)	(0.173)	(0.181)
	0.238	0.265	0.123	0.000390
Observations	80,712	67,585	67,585	55,756
R-squared	0.126	0.492	0.397	0.191

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

Table 5 reports the effects of COVID-19 on the alternative educational outcomes after running the estimations separately by students' gender. The results show that boys were more affected by the pandemic, being that in 2020 first years boys had 6.6 pp more dropouts than boys from previous cohorts and 0.3 fewer courses taken. For girls, the coefficients are of the same sign but one-third magnitude and non-significant. Again the increase in the average grade was observed for both genders and in similar magnitude.

Table 5 Academic outcomes by gender

	(1) Dropout	(2) N.courses	(3) N. subjects approved	(4) Avg. grade
Girls				

	COVID-19			
COVID-19	0.0265	-0.142	0.260	0.648***
	(0.0180)	(0.176)	(0.183)	(0.215)
	0.150	0.423	0.164	0.00478
Observations	32,975	29,151	29,151	25,725
R-squared	0.099	0.545	0.434	0.207
Boys				
COVID-19	0.0661***	-0.328**	0.171	0.705***
	(0.0226)	(0.126)	(0.222)	(0.241)
	0.00581	0.0130	0.448	0.00595
Observations	19,806	17,462	17,462	14,104
R-squared	0.122	0.478	0.401	0.180

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

Related to the socioeconomic background, we perform two analyses. First, we analyze the results by different parental educational backgrounds, comparing those students with both parents without a university degree and separately those students with at least one parent with a university education (Table 6).[19] We find that independently of the parental educational background, students in 2020 dropout more than in previous years. However, the analysis of the point estimates shows larger effects for students from a relatively worse-off parental educational background (4.1pp and significant at 95% versus 2.6pp and significant at 90%). Again, regarding the average score obtained during the first year of enrollment, we observe that independently of the parental educational background, students do better in 2020 compared to previous generations with the magnitude slightly higher for better-off students. This higher magnitude of the coefficient could explain the significant positive effect of the pandemic on the number of approved courses for this group of students.

Table 6 Academic outcomes by parental education

	(1)	(2)	(3)	(4)
	Dropout	N.courses	N. subjects approved	Avg. grade

[19] As mentioned before, this variable is collected in the form that was not compulsory in 2020. Therefore, the observations included are the same as in the robustness check of estimation with full control variables.

	(1)	(2)	(3)	(4)
Parents with university degree				
COVID-19	0.0255*	-0.145	0.270*	0.757***
	(0.0149)	(0.112)	(0.157)	(0.193)
	0.0960	0.204	0.0941	0.000390
Observations	9,797	9,109	9,109	8,198
R-squared	0.082	0.583	0.457	0.198
Parents without university degree				
COVID-19	0.0408**	-0.230	0.291	0.696***
	(0.0184)	(0.168)	(0.203)	(0.225)
	0.0327	0.179	0.160	0.00378
Observations	37,312	34,077	34,077	29,598
R-squared	0.087	0.558	0.451	0.190

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

In addition, we also consider differences according to the institutional background in high-school. Specifically, we analyze students from public secondary institutions and those from private ones. We first note that both groups of students decrease their activity in 2020 compared to previous years. The effect seems to be more pronounced for students from public institutions, but the confidence intervals overlap. One more time, both groups of students improve their mean score in 2020, but the effect is large for private institutions' students and seems to be in a relevant part of the distribution since we also observe an effect on the number of approved subjects for these students. Taking together both socioeconomic background analysis, results suggest that students from lower socioeconomic backgrounds could have been relatively more affected by the pandemic. This result goes in line with previous literature for other countries.

Table 7 Academic outcomes by institutional background in high-school

	(1)	(2)	(3)	(4)
				Avg. grade
	Dropout	N.courses	N. subjects approved	
Public high-school				

	(1)	(2)	(3)	(4)
COVID-19	0.0418*	-0.257	0.173	0.622***
	(0.0208)	(0.169)	(0.194)	(0.227)
	0.0521	0.138	0.379	0.00957
Observations	41,266	36,227	36,227	30,720
R-squared	0.104	0.530	0.434	0.190
Private high-school				
COVID-19	0.0392**	-0.0542	0.399**	0.811***
	(0.0181)	(0.0989)	(0.196)	(0.203)
	0.0376	0.587	0.0492	0.000307
Observations	11,515	10,386	10,386	9,109
R-squared	0.114	0.536	0.421	0.199

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

Finally, we present the analysis separately according to students' region of birth. We observe that students born in Montevideo in 2020 have worse academic outcomes compared with those born in Montevideo who enrolled the years before in terms of dropout and the number of courses. Regarding the average grade score, the effect is positive and slightly bigger in Montevideo. These results suggest that students not born in the capital were less affected by COVID-19, and one potential explanation could be related to the fact that classes were online. The virtual learning modality could have benefited these students by allowing them to stay at their places of birth.

Table 8 Academic outcomes by region of birth

	(1)	(2)	(3)	(4)
				Avg.
	Dropout	N.courses	N. subjects approved	grade
Montevideo				
COVID-19	0.0572**	-0.275**	0.236	0.745***
	(0.0234)	(0.135)	(0.209)	(0.209)
	0.0199	0.0499	0.265	0.00107
Observations	24,747	21,524	21,524	17,937
R-squared	0.126	0.506	0.423	0.205
Rest of country				
COVID-19	0.0274	-0.172	0.206	0.596**

	(0.0174)	(0.179)	(0.177)	(0.225)
	0.125	0.343	0.253	0.0120
Observations	28,034	25,089	25,089	21,892
R-squared	0.086	0.545	0.435	0.190

Notes: The table reports the OLS estimates for the pandemic coefficient on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

5.3 COVID-19 and potential channels

As large disruptions were caused by COVID-19, we would expect that students in 2020 did worse than previous generations. However, our previous findings show that although students in 2020 reported on average more dropouts, they did not significantly change the number of courses taken or approved while they obtained on average, higher grade scores than previous generations. In this section, we analyze the correlations between students' opinions and perceptions and the academic outcomes showed in the previous section to better understand the potential mechanisms behind this relationship.

Before showing the estimates of the possible channels, we present basic descriptive statistics of the variables included in the survey for our sample (

Table 9). We can observe that 76% of the students face emotional distress: demotivation, stress, and anxiety. Moreover, 63% reveal that COVID-19 generates academic tasks overload, and around 57% report that online learning affects their interaction with teachers. When we consider the advantages of online learning due to COVID-19, we observe that 82% of students consider that is a positive aspect the possibility of taking courses at any time, and 73% benefit from taking courses at home.

Table 9. Descriptive statistics

	Media	SD	N
Disadvantages from COVID-19 and online learning		-	-
Course overlapping	0.185	0.389	437
Access to bibliographic material	0.474	0.500	437

Lack of physical interaction with other students	0.421	0.494	437
Lack of physical interaction with teachers	0.574	0.495	437
Difficulties in balancing study and labor	0.231	0.422	437
Academic tasks' overload	0.627	0.484	437
Emotional affection	0.767	0.423	437
Connectivity problems	0.362	0.481	437
Not adequate resources for virtual lessons	0.130	0.337	437
Advantages from COVID-19 and online learning	-	-	-
Courses at anytime (recorded lessons)	0.817	0.387	437
More participation in online courses	0.364	0.482	437
Taking the courses from home (comfort)	0.725	0.447	437
Avoiding travel times	0.817	0.387	437
Increasing collaborative work	0.451	0.498	437
Greater self-evaluation	0.606	0.489	437

Source: Students´ perception survey and opinion

We begin by analyzing the correlation between educational performance and the difficulties that students face during the pandemic. Table 10 shows that the lack of interaction with other students negatively correlates with the number of approved courses (reducing the number in almost 1 course) and the average grade (0.6 points less). In addition, the lack of physical interaction with teachers also reduces the average grade in 0.5 points out of 12. Due to the difficulties for balancing study and work, students enrolled in 1.2 fewer courses, approved on average 1.7 fewer courses, and reduced the average score in 0.7 points. The negative effect on the academic outcomes was similar when the students reported not having adequate resources; they enroll in 1.4 less courses, approve an average of 1.5 fewer courses, and obtain 1 point less on their average score. Finally, students who face emotional distress are more likely to dropout in 4 percentage points.

Table 10. Difficulties faced by students

	(1) Dropout	(2) N. courses	(3) N. subjects approved	(4) Avg. grade
Course overlapping	0.0150	-0.0965	-0.368	-0.00768
	(0.0368)	(0.436)	(0.377)	(0.341)
R-squared	0.067	0.108	0.096	0.072
Access to bibliographic material	-0.0229	0.0214	-0.0396	-0.301
	(0.0199)	(0.357)	(0.356)	(0.242)

R-squared	0.069	0.108	0.095	0.075
Lack of physical interaction with other students	-0.00649	-0.708	-0.831**	-0.591***
	(0.0273)	(0.484)	(0.339)	(0.201)
R-squared	0.067	0.114	0.104	0.085
Lack of physical interaction with teachers	0.0389	-0.410	-0.467	-0.557**
	(0.0231)	(0.573)	(0.377)	(0.243)
R-squared	0.572	0.110	0.098	0.083
Difficulties in balancing study and labor	0.0239	-1.216*	-1.718***	-0.746*
	(0.0300)	(0.599)	(0.432)	(0.380)
R-squared	0.074	0.121	0.121	0.085
Academic tasks' overload	0.0142	0.417	0.0136	-0.193
	(0.0240)	(0.602)	(0.409)	(0.263)
R-squared	0.068	0.110	0.345	0.073
Emotional affection	0.0441*	0.155	-0.501	-0.322
	(0.0253)	(0.428)	(0.456)	(0.300)
R-squared	0.067	0.108	0.095	0.075
Connectivity problems	0.0236	0.128	0.0659	-0.212
	(0.0302)	(0.404)	(0.466)	(0.311)
R-squared	0.073	0.108	0.098	0.073
Not adequate resources for virtual lessons	0.0397	-1.444***	-1.479***	-1.044**
	(0.0367)	(0.493)	(0.415)	(0.402)
R-squared	0.069	0.120	0.095	0.089
Observations	426	405	405	378

Notes: The table reports the OLS estimates for the students´ perception outcomes on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

Table 11 reports the relationship between the alternative educational outcomes studied and students' reported perceptions of the positive aspects derived from changing the teaching modality from face-to-face to online courses. Our findings are summarized as follows. First, the possibility of having classes at any time increases the number of courses that students enroll in 1.3, in 1.2 the number of approved courses and increases the average score by 0.9 points. Furthermore, participation in online courses decreases the probability of dropout in 4.9 percentage points. Avoiding travel time positively

correlates with the number of subjects approved in around 1. Finally, the increase in collaborative work reduces the probability of dropout by 4 percentage points.[20]

Table 11 Positive aspects of change in educational modality

	(1)	(2)	(3)	(4)
	Dropout	N. courses	N. subjects approved	Avg. grade
Courses at anytime (recorded lessons)	-0.00994	1.310**	1.226***	0.866***
	(0.0355)	(0.637)	(0.392)	(0.285)
	0.067	0.122	0.107	0.089
More participation in online courses	-0.0493***	-0.0814	-0.0541	0.0912
	(0.0177)	(0.768)	(0.431)	(0.284)
	0.078	0.108	0.095	0.072
Taking the courses from home (comfort)	0.00881	-0.168	0.610	0.149
	(0.0255)	(0.565)	(0.517)	(0.307)
	0.067	0.108	0.099	0.072
Avoiding travel times	0.00422	0.510	1.008*	0.297
	(0.0347)	(0.589)	(0.509)	(0.301)
	0.067	0.110	0.103	0.074
Increasing collaborative work	-0.0409**	0.115	0.387	0.154
	(0.0195)	(0.732)	(0.619)	(0.300)
	0.075	0.108	0.097	0.073
Greater self-evaluation	-0.00881	-0.325	0.148	0.246
	(0.0177)	(0.629)	(0.461)	(0.274)
	0.067	0.109	0.095	0.074
Observations	426	405	405	381

Notes: The table reports the OLS estimates for the students´ perception outcomes on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.

6. Final considerations

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[20] Finally, in Table A.5 we extend the estimated correlations presented above by adding all the independent variables used in Section 5. Overall, the results are similar (in significance and magnitude) to the previous ones presented.

The COVID-19 pandemic generated several changes in the educational system worldwide. Uruguay was not the exception; the educational institutions closed, shifting their activities from face-to-face classes to virtual lessons. In this paper, we provide empirical evidence on the impacts of the COVID-19 crisis on students' educational outcomes in the first year of enrollment in a public university in Uruguay. We analyzed the effect of the pandemic on students' performance, such as dropout, number of courses taken, number of approved courses, and average score. Moreover, we explored heterogeneous effects according to students' socioeconomic characteristics.

We found that COVID-19 increased the number of students who, in the first year of enrollment in 2020, decided to drop out after enrollment. Additionally, those who continued studying had no effect on the number of courses taken and approved but obtained higher average scores in 2020 than previous. In addition, we also found disparities in the effects of COVID-19 according to students' specific observed characteristics. In particular, male students, students from relatively worse-off socioeconomic backgrounds, those without previous institutional affiliation with UdelaR, and students born in Montevideo, are relatively more affected by the pandemic. Our results are relevant to consider how the pandemic could have affected tertiary students in non-developed economies and, particularly, to understand the heterogeneous effects across groups. As the international evidence shows, dropout increased, particularly for students from worse socioeconomic backgrounds. This situation suggests the importance of following these students to understand the potentially long-lasting effects of the pandemic.

Finally, we use a *student survey* carried out during *COVID-19* to understand possible channels through which the pandemic could have affected academic outcomes. First, we analyze the correlation between educational performance and students' difficulties during the pandemic. We observe that the lack of access to bibliographic material, and interaction with teachers and with students, reduce the number of courses approved. Due to the difficulties in balancing study and work, students enrolled in less courses, approved fewer courses and reduced the average grade. Moreover, students reporting inadequate resources do relatively worse; they enroll in fewer courses, approve fewer courses, and obtain less on their average score. Second, we evaluate the correlation between the educational outcomes and students' reported perceptions of the positive aspects of changing the teaching modality from face-to-face to online courses. The possibility of having classes at any time increases the number of approved courses and

the average score. Furthermore, the possibility of taking the courses from home and not traveling are positively correlated with the number of courses taken and approved respectively.

Overall, the pandemic affected first-year students in different ways according to different characteristics. In addition, despite the disadvantageous situation caused by COVID-19, students highlighted positive aspects. The crucial role of tertiary education in developing economies demands to understand and follow the situation after the pandemic to minimize the adverse effects and take advantage of possible positive aspects.

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7. Appendix

7.1 Descriptive statistics

Table A. 1 Student characteristics across cohorts

	2017 (%)	2017 (N)	2018 (%)	2018(N)	2019(%)	2019(N)	2020(%)	2020
Girls	63	27557	63	29355	63	31480	63	3217
Birth in Montevideo	51	27050	50	28636	50	30684	48	3111
Age at enrollment	23	27557	23	29355	23	31480	23	3217
Public high-school	79	27050	80	28636	80	30684	81	3111
White people	81	14533	81	26366	80	28132	80	2665
Work	23	14533	37	26370	36	28344	34	2676
Parents with university deree	21	14287	20	25860	20	27564	20	2618

Source: Administrative records from the Public University. 2017-2020

Table A. 2 Student academic outcomes across cohorts

	2017(mean)	2017(N)	2018(mean)	2018(N)	2019(mean)	2019(N)	2020(
Dropout	0,12	13275	0,11	13328	0,11	13880	0
N courses	5,74	13275	5,84	13328	5,46	13880	5,
N subjects approved	3,70	13275	3,67	13328	3,53	13880	3,
Avg grade	5,19	10007	5,28	9995	5,12	10531	5,

Source: Administrative records from the Public University. 2017-2020

7.2 Control Variables

Table A. 3 Definition of control variables

Control Variables	Definition
Gender	Dummy that takes the value 1 for girls.

Region of residence	Region of residence in the previous year of enrollment including 19 administrative regions in the country.
Age	Numerical variable with the age of the student at the enrollment date.
High school institutional background	The types of institutions are: public, private, coursed high school in a foreign country.
Parents with college degree	Dummy equal to 1 if at least one parent has a college degree.
Father's occupation	Father's occupation among these options: public employee, private employee, member of a worker-managed firm, owner of a firm, self-employee, not working.
Mother's occupation	Mother's occupation among these options: public employee, private employee, member of a worker-managed firm, owner of a firm, self-employee, not working.

Table A. 4 Variables referred to students perception

Control Variables	Definition
Course overlapping	Dummy equal to 1 if students consider that their courses overlap
Access to bibliographic material	Dummy equal to 1 if students consider they have access to bibliographic material
Lack of physical interaction with other students	Dummy equal to 1 if students consider they have lack of physical interaction with other students
Lack of physical interaction with teachers	Dummy equal to 1 if students consider they have lack of physical interaction with teachers
Difficulties in balancing study and labor	Dummy equal to 1 if students consider they have difficulties in balancing study and labor

Academic tasks overload	Dummy equal to 1 if students consider they have academic tasks overload
Emotional affection	Dummy equal to 1 if students consider thay have emotional affection such as depression, desmotivation, stress, anxiety
Connectivity problems	Dummy equal to 1 if students have connectivity problems
Not adequate resources for virtual lessons	Dummy equal to 1 if students do not have adequate resources for online lessons
Courses at anytime (recorded lessons)	Dummy equal to 1 if students consider that it is a facility to take courses at any time.
More participation in online courses	Dummy equal to 1 if students consider that it is a facility to take courses online.
Taking the courses from home (comfort)	Dummy equal to 1 if students consider that it is a facility to take courses from home.
Avoiding travel times	Dummy equal to 1 if students consider that it is a facility to avoid travel times.
Increasing collaborative work	Dummy equal to 1 if students consider that increased collaborative work.
Greater self-evaluation	Dummy equal to 1 if students consider they have greater self-evaluation

Source: Students perception survey, 2020.

Table A. 5 Estimations with full set of independent control variables

VARIABLES	(1) Dropout	(2) N.courses	(3) N. subjects approved	(4) Avg. grade
Course overlapping	4.13e-06	0.179	-0.0439	0.280
	(0.0384)	(0.500)	(0.452)	(0.367)
Access bibliographic material	-0.0289	0.289	0.224	-0.283
	(0.0263)	(0.315)	(0.343)	(0.324)
Lack of physical interaction with other students	-0.0407*	-0.338	-0.219	-0.305
	(0.0233)	(0.349)	(0.342)	(0.241)
Lack of physical interaction with teachers	0.0318	-0.389	-0.166	-0.309
	(0.0213)	(0.443)	(0.465)	(0.252)

Difficulties in balancing study and labor participation	0.0173	-0.944*	-1.360***	-0.422
	(0.0282)	(0.514)	(0.416)	(0.341)
Academic tasks' overload	-0.00148	0.305	0.0972	-0.147
	(0.0240)	(0.474)	(0.422)	(0.266)
Emotional affectation	0.0338	0.127	-0.336	0.0117
	(0.0234)	(0.395)	(0.533)	(0.292)
Connectivity problems	0.0174	0.377	0.455	0.121
	(0.0272)	(0.375)	(0.458)	(0.326)
Not adequate resources for virtually	0.0249	-1.532**	-1.408***	-1.008**
	(0.0326)	(0.567)	(0.492)	(0.403)
Courses at anytime	0.00254	1.156	0.785	0.655**
	(0.0415)	(0.845)	(0.508)	(0.280)
More participation in online courses	-0.0385**	0.169	-0.176	-0.121
	(0.0151)	(0.483)	(0.342)	(0.328)
Taking the courses from home	0.0279	-0.823*	-0.0572	-0.184
	(0.0186)	(0.406)	(0.429)	(0.346)
Avoiding travel times	-0.000192	0.939	0.989*	0.351
	(0.0348)	(0.598)	(0.513)	(0.338)
Increasing collaborative work	-0.0371**	0.152	0.293	-0.0382
	(0.0171)	(0.764)	(0.821)	(0.379)
Greater self-evaluation	0.00442	-0.671	-0.346	0.00925
	(0.0220)	(0.587)	(0.618)	(0.324)
Constant	-0.0796	5.141***	3.814***	6.824***
	(0.104)	(1.426)	(1.300)	(0.518)
Observations	426	426	426	381
R-squared	0.105	0.158	0.148	0.126

Notes: The table reports the OLS estimates for the students´ perception outcomes on the dependent variables indicated in column headings. Robust standard errors clustered at the career level are reported in parentheses. Below the standard error, the p-value is reported. *, **,*** Estimate significantly different from zero at the 0.1 or 0.05 level or 0.01 level.