

Online supplementary material

A Further descriptive statistics and number of observations

Figure A.1 shows the cumulative distribution function of average grades by semester and academic year. The graph indicates that the differences in the distribution of average grades between the winter and summer terms are not significant. This observation holds true for the entire sample, as well as for both bachelor and master students.

Table A.1: Descriptive statistics by academic year and term, selected controls

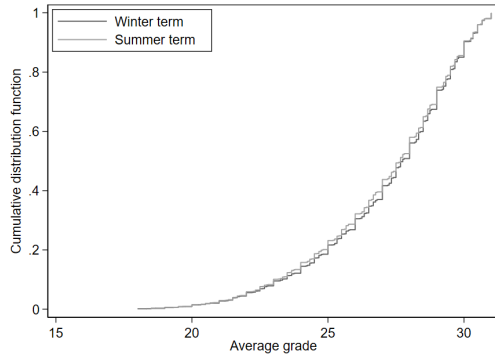
	2019/2020		2018/2019		Difference
	Mean	Std.dev.	Mean	Std.dev.	
<i>Summer term</i>					
Average grade	27.06	2,646	27.09	2,664	-0.030
Female (dummy)	0.610	0.488	0.603	0.489	0.007
Age (in years)	22.28	3.252	22.20	3,117	0.080
Freshmen (dummy)	0.238	0.426	0.237	0.425	0.001
ISEE bottom	0.224	0.417	0.224	0.417	0.000
ISEE medium bottom	0.263	0.440	0.265	0.441	-0.002
ISEE medium top	0.220	0.414	0.217	0.412	0.003
ISEE top	0.293	0.455	0.295	0.456	-0.002
Number of exams per term	3,239	1,011	3,232	1.050	0.007
Bachelor (dummy)	0.474	0.499	0.488	0.500	-0.014
Master (dummy)	0.268	0.443	0.270	0.444	-0.002
Observations	7,423		7,042		14,465
<i>Winter term</i>					
Average grade	27.09	2.664	27.20	2,638	-0.110
Female (dummy)	0.612	0.487	0.601	0.490	0.011
Age (in years)	22.31	3,281	22.26	3,164	0.050
Freshmen (dummy)	0.247	0.431	0.241	0.427	0.006
ISEE bottom	0.217	0.412	0.218	0.413	-0.001
ISEE medium bottom	0.256	0.437	0.258	0.438	-0.002
ISEE medium top	0.220	0.414	0.215	0.411	0.005
ISEE top	0.307	0.461	0.309	0.462	-0.002
Number of exams per term	3.224	0.991	3.231	0.956	-0.007
Bachelor (dummy)	0.456	0.498	0.440	0.496	0.016
Master (dummy)	0.302	0.459	0.293	0.455	0.009
Observations	7,018		6,569		13,587

Notes: Standard errors clustered at the individual level are used. Differences are not statistically significant at all conventional significance levels (10%-, 5%- and 1%-level).

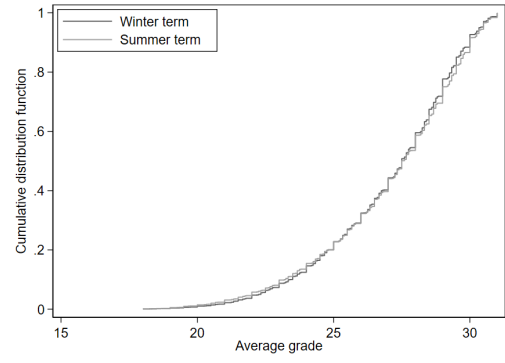
Table A.2: Number of observations

Sample	(1) Treated (before)	(2) Not treated (before)	(3) Total
Full sample	7,423 (7,018)	7,042 (6,569)	28,052
Full sample bottom	1,985 (1,886)	1,904 (1,665)	7,440
Full sample top	2,263 (2,170)	1,982 (2,139)	8,554
ISEE low	1,665 (1,520)	1,575 (1,432)	6,192
ISEE high	2,174 (2,152)	2,076 (2,028)	8,430
Female	4,530 (4,298)	4,243 (3,947)	17,018
Male	2,893 (2,720)	2,799 (2,622)	11,034
Bachelor students	3,521 (3,198)	3,433 (2,890)	13,042
Master students	1,993 (2,117)	1,898 (1,924)	7,932
Grade inflation full	3,760 (5,375)	3,450 (5,050)	17,635
Courses not changed full	6,790 (6,379)	6,464 (5,976)	25,609
Freshmen full	1,849 (1,738)	1,519 (1,254)	6,360
Mandatory courses full	5,877 (5,236)	5,849 (4,988)	21,950

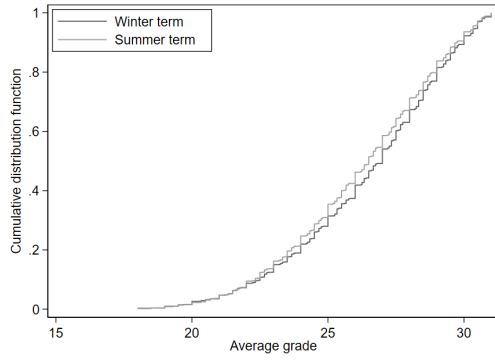
Notes: Column 1 contains the following information. ‘Treated’ refers to the cohort of students in academic year 2019/2020 in the summer term 2020, while ‘Treated (before)’ refers to the cohort 2018/2019 in the summer term 2019. Column 2 instead contains the following information. ‘Not treated’ includes the cohort of students in academic year 2019/2020 in the winter term 2019/2020. ‘Not treated (before)’ refers to the cohort 2018/2019 in the winter term 2018/2019. ‘Total’ is the sum of all four groups.



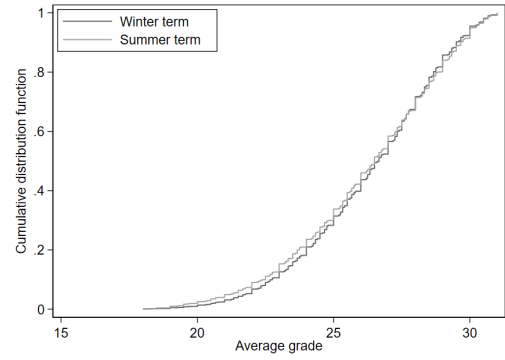
(a) Full sample 2018/2019



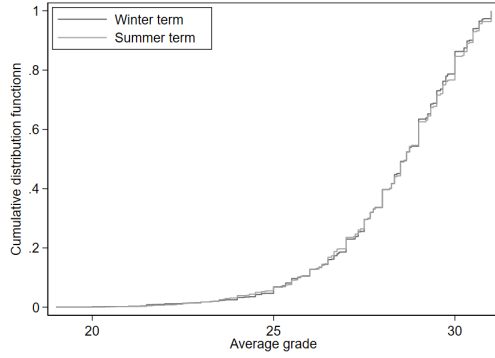
(b) Full sample 2019/2020



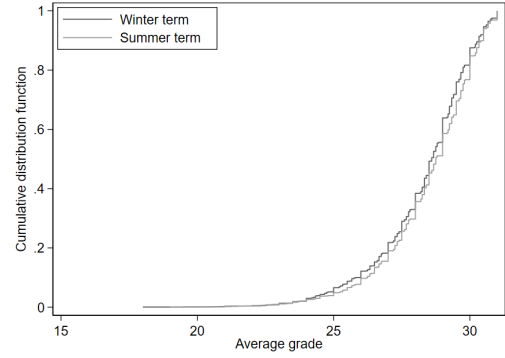
(c) Bachelor 2018/2019



(d) Bachelor 2019/2020



(e) Master 2018/2019



(f) Master 2019/2020

Figure A.1: Cumulative distribution function of average grades by term and academic year

B Details on departments

The University of Pavia consists of a total of 18 departments offering 104 degree programs. However, for the purpose of obtaining more robust estimation results in separate regressions by departments, we group six departments together. Specifically, the departments of medicine and engineering are composed of the departments of surgery, internal, experimental and molecular medicine, as well as civil and industrial engineering. This grouping is necessary as these six departments have a relatively small number of observations (less than 1,000 each).

As a result, we are left with a total of 14 distinct departments for our analysis. These departments include: Natural science, Chemistry, Physics, Law, Engineering (composed of civil and industrial engineering), Mathematics, Medicine (composed of surgery, internal, experimental and molecular medicine), Musicology, Pharmacy, Psychology, Geology, Economics and management, Political and social science, and Humanities.

C Further analyses

In this section, we replicate the primary analysis using different subsets of the university career data. First, we examine the results specifically for freshmen. Second, we narrow our focus to mandatory courses exclusively. For the sake of simplicity, we primarily concentrate on the specification that includes control variables.

Freshmen only

In this section, our focus is exclusively on first-year bachelor students. This subgroup represents a more homogeneous group compared to considering all students. At the University of Pavia, students have the option to enroll in both the winter and

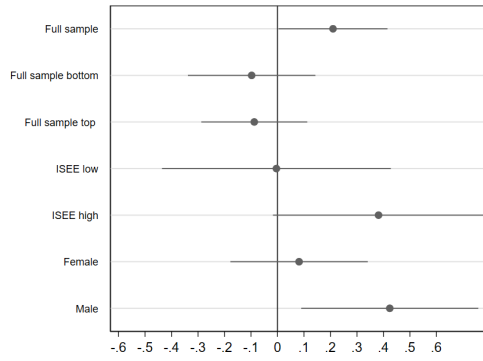
summer terms. Moreover, it's important to note that first-year bachelor's students lack prior comparable university experience from a previous degree. Therefore, to ensure a homogeneous sample, we restrict our analysis to students who enrolled in the academic years 2018/2019 and 2019/2020, within a bachelor's degree program.

As a result of this sample restriction, we assess the impact of the pandemic on average grades only for courses offered to first-year students. The empirical strategy remains unchanged. We still have two periods and two groups. The control group consists of students registered in the academic year 2018/2019, while the treatment group comprises students registered in the academic year 2019/2020. The treatment period coincides with the summer term of the academic year 2019/2020, which is when the university was impacted by the pandemic.

In Figure C.1, we present the results of the estimation using the specification with control variables specifically for freshmen. Consistent with the findings from the main analysis, we observe no significant effect of the COVID-19 pandemic on students' average grades. The results indicate that there are no negative effects observed for both top-performing and bottom-performing students. Additionally, there are no significant differences in the effects between students from lower-income and higher-income families. Furthermore, the analysis reveals no gender disparities in the observed effects. Therefore, these findings further reinforce our main analysis and other robustness tests, suggesting that the shift to online teaching as a result of the COVID-19 pandemic did not have a significant impact on student performance.

Mandatory courses only

In order to mitigate the potential bias arising from course selection by students, we conduct the analysis in this section focusing solely on mandatory courses. By restricting our analysis to mandatory courses, we aim to reduce the influence of stu-



(a) Bachelor

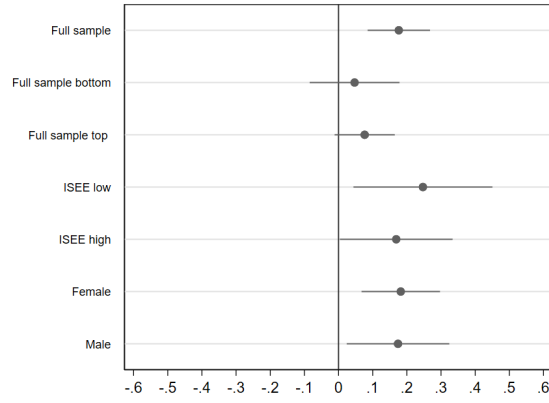
Notes: Estimates of the effects on students' average grades using a difference-in-differences methodology with controls for the sample of freshmen. The control variables used in the analysis include gender, age and indicators for ISEE (a socioeconomic indicator). Additionally, there are 13 department indicators (with the department of medicine serving as the reference category; see Appendix B for further details). The dependent variable is the student-level average of corrected grades $\tilde{v}_{ist}$. Standard errors are clustered at the individual level. Point estimates with 95% confidence intervals. Table A.2 shows the corresponding number of observations.

Figure C.1: Effects of Transition to Online Teaching on Freshmen's Average Grades (specification with controls)

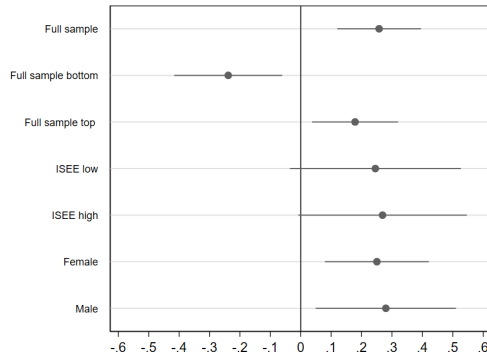
dents' course choices on the results. The empirical strategy and estimation approach remain unchanged.

Figure C.2 shows the conditional effects of the COVID-19 pandemic on student performance specifically for mandatory courses. The observed effects are slightly positive and statistically significant. However, it is important to note that the point estimate of 0.16 grade points for the full sample of mandatory courses represents only a 0.56% effect, given the average grades of 26.82 for mandatory courses. Confidence intervals overlap across different socioeconomic dimensions, except for low-performing bachelor students.

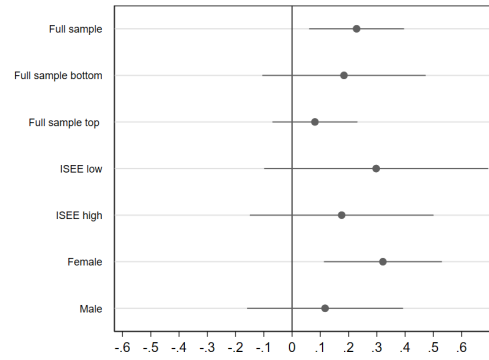
In summary, the findings for both bachelor and master students, as well as the results from the main analysis, align with the outcomes of this robustness test. Therefore, these results further support the main conclusion that the COVID-19 pandemic had little to no substantial impact on student performance.



(a) Full sample



(b) Bachelor



(c) Master

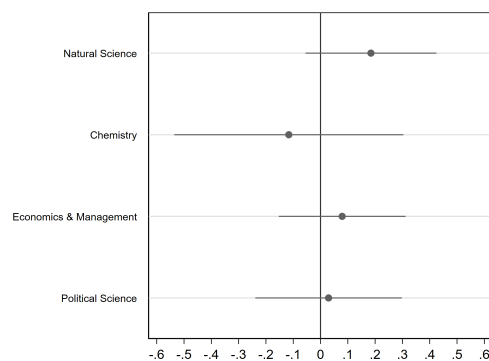
Notes: Estimates of the effects on students' average grades in mandatory courses resulting from a difference-in-differences analysis with controls. The analysis incorporates various control variables including gender, age, indicators for regular student status, ISEE (socioeconomic indicator), master's degree, 6-year degree or 5-year degree, and year of matriculation. Additionally, it includes 13 department indicators, with the department of medicine serving as the reference category (for further details, refer to Appendix B). The dependent variable is the student-level average of corrected grades $\tilde{v}_{ist}$. Standard errors clustered at the individual level are used. Point estimates with 95% confidence intervals. Table A.2 shows the corresponding number of observations.

Figure C.2: Effects of Transition to Online Teaching on Average Grades in Mandatory Courses (specification with controls)

Analysis for selected departments

Despite controlling in our regressions for department fixed effects, we run the analysis for selected departments in Figure C.3. The departments differed in their ability to switch to online teaching and learning. Therefore we run the regression, on the one hand, for the Economics and Management and Political Science Department, respectively. The intuition is that these two departments are examples of departments that do not require lab work or in-person experiments.

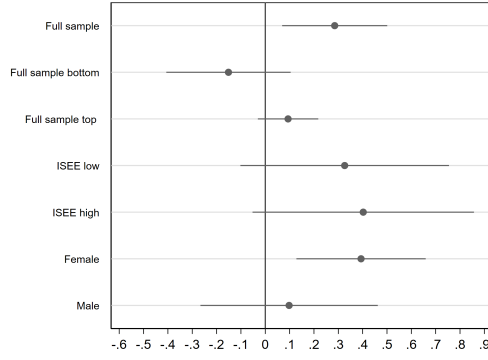
On the other hand, we run the regression for the Department of Natural Science as well as Chemistry and Physics. The results support our main finding of no significant association of the transition to online teaching on student performance.



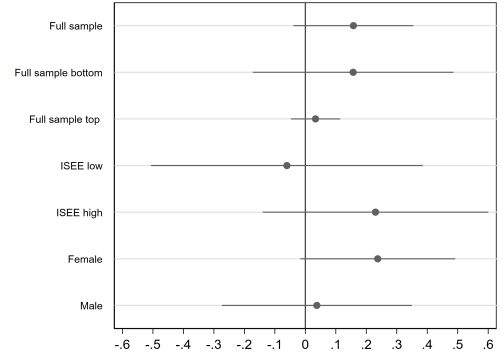
Notes: Estimates of the effects on students' average grades using a difference-in-differences methodology with controls. The control variables used in the analysis include gender, age, indicators for being a regular student, ISEE (a socioeconomic indicator), master's degree, 6-year degree or 5-year degree, and year of matriculation. Standard errors are clustered at the individual level. Point estimates with 95% confidence intervals. Regression based for the Chemistry and Physics department on 969 (682 and 287, respectively) observations, for the Natural Science Department on 2,671 observations, for the Economics and Management Department on 4,038 observations and for the Political Science Department on 3,040 observations.

Figure C.3: Effects of transition to online Teaching on average grades by selected departments (specification with controls)

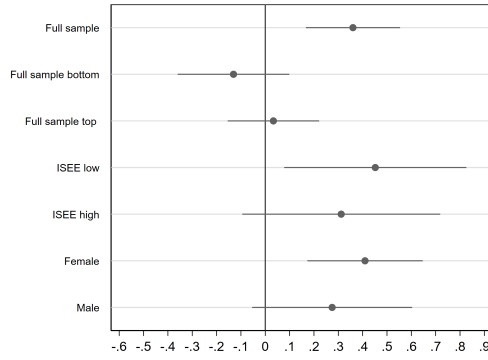
Accounting for potential grade inflation: Analysis by Bachelor and Master students



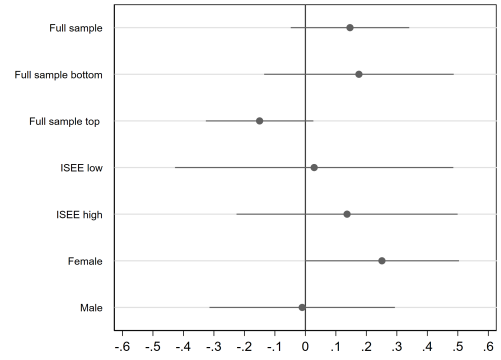
(a) Bachelor, average grade



(b) Master, average grade



(c) Bachelor, average grade free of lecturer FEs



(d) Master, average grade free of lecturer FEs

Notes: Effects on students' average grades of transition to online teaching (specification with controls) for students attending classes in the winter term and doing exams in the winter or summer term in academic years 2018/2019 and 2019/2020. Analysis run separately for Bachelor and Master students. The figure shows estimates of the effects on students' average grades from a difference-in-differences specification with controls. Control variables used are gender, age, dummies for being a freshmen, ISEE, 6-year degree or 5-year degree, 13 department dummies (department of medicine is the base category, see Appendix B for details). In panel (c) and (d), the dependent variable is the student-level average of corrected grades $\tilde{v}_{ist}$. Standard errors clustered at the individual level are used. Point estimates with 95% confidence intervals. Table A.2 shows the corresponding number of observations.

Figure C.4: Accounting for potential grade inflation – Effects on students' average grades of transition to online teaching (specification with controls), by Bachelor and Master students