Labour Economics 89 (2024) 102601

Contents lists available at ScienceDirect

Labour Economics

journal homepage: www.elsevier.com/locate/labeco

Medium-run effects of COVID-19 induced distant learning on students' academic performance☆

Barbara Pertold-Gebicka

Institute of Economic Studies, Faculty of Social Sciences, Charles University: Opletalova 26, 11000 Prague, Czech Republic

ARTICLE INFO

JEL classification:
I21
I23

Keywords:
Covid-19 pandemic
University students
Grade inflation
Graduation rates

ABSTRACT

Administrative data on bachelor students for 2014/15 to 2022/23 academic years are used to analyze their performance before, during, and – what is new in the literature – after the COVID-19 pandemic. The analysis reveals that both low- and high-ability students of all affected cohorts received better grades during the semesters when teaching and examinations were delivered online, with the effect on low-ability students continuing through the first after-COVID academic year. However, improved grades contrast with lower graduation rates, especially among high-ability students. Detailed analysis of graduation patterns coupled with ECTS credits take-up analysis suggests that high-ability students were often discouraged from studying during the pandemic. For low-ability students, the negative influence of COVID-19 was compensated by the lenient grading policy that allowed them to pass the compulsory exams and continue studying.

1. Introduction

The COVID-19 pandemic was a shock to almost every aspect of our lives. Stay-at-home orders and school and workplace closures were among the most limiting. There is vast research showing that school closures and the consequent switch to online education have adversely affected primary and secondary school students (e.g. Agostinelli et al. 2022; Engzell et al. 2021; Grewenig et al. 2021). However, research into the effects of COVID-19 on university students is scarcer and provides mixed results. Here, scholars find mostly positive effects on grades (Karadag, 2021; Iglesias-Pradas et al., 2021; Rodríguez-Planas, 2022a) but negative effects on (the planned) graduation rates and the learning process (Aucejo et al., 2020; Rodríguez-Planas, 2022b; Bonacini et al., 2023).

What is missing in this line of research is an analysis of longer-run effects on students that could reveal the consequences of a mixed battery of factors that affected the study process. Most of the papers published to date concentrate on students' outcomes during the Spring (Summer) semester of 2020, or at most till the end of the academic year of 2020/21. I complement this literature by analyzing students' grades and graduation patterns at a large Czech university until the end of the academic year of 2022/23. This allows me to track not only the immediate effect of lockdowns and the consequent switch to online education but also the effects on grades and the probability of graduating during the following academic years.

It has been shown that the switch to distance learning resulted in significant learning loss at all levels of study and was especially damaging for low-achieving students from low socio-economic backgrounds (see Agostinelli et al. 2022 for the effect on teenagers and Rodríguez-Planas 2022a for the effect on university students). Among the explanations, scholars most often mention limited support from school/university, limited contact with peers, and difficulties with self-organization. These might affect not only one semester's results but can also spill over to the whole course of study.

To uncover online education's medium-run effects, I analyze administrative data on full-time bachelor students enrolled at one faculty of a large Czech university during the academic years 2014/15 to 2022/23. This rich database allows for a within-student analysis to reveal the effect of COVID-19 on grades. It also allows studying graduation patterns while conditioning on students' performance during the first semester of study, a proxy for ability. Finally, I am able to identify potential channels that might drive the observed behavior by combining

☆ This work was supported by the NPO "Systemic Risk Institute" number LX22NPO5101, funded by the European Union - Next Generation EU (Ministry of Education, Youth and Sports, NPO: EXCELES). I would like to thank the Editor and two anonymous referees for all the valuable comments that greatly contributed to the current version of the paper, as well as the participants of the EALE 2023 conference and the SYRI WP9 workshop for helpful questions and suggestions. Adam Bruzl provided excellent research assistance for earlier versions of this paper.

E-mail address: gebicka@fsv.cuni.cz.

https://doi.org/10.1016/j.labeco.2024.102601
Received 15 November 2023; Received in revised form 28 June 2024; Accepted 1 July 2024
Available online 14 July 2024

the observed effect on grades with the effect on graduation conditional on being in the 1st year of study or in the 3rd year of study and with the analysis of ECTS (European Credit Transfer and Accumulation System) credits takeup.

In line with the earlier literature (Bonacini et al., 2023; Karadag, 2021; Iglesias-Pradas et al., 2021; Rodríguez-Planas, 2022a), this study shows that students earned better grades during the semesters with full online instruction. It further complements the literature by documenting that this effect is mainly driven by low-ability students and that their grades did not fully return to the long-run average once instruction was moved back to the classrooms. I interpret the observed improvement in GPA as a sign of grade inflation. This is supported by the anecdotal evidence from the studied faculty and the supplementary analysis of the ECTS credit take-up. The latter reveals that students were aware of the more lenient grading and committed to more ECTS credits (i.e., took more and/or more difficult courses), especially during the second semester affected by the COVID-19 pandemic.

Finally, this study shows that students affected by the pandemic graduate on time with a lower probability than their older peers. This effect is observed among both high-ability and low-ability students; however, it is most pronounced among high-ability students and for the cohort enrolling in the 2018/19 academic year. While some earlier studies have discussed the effect of COVID-19 on graduation (Aucejo et al. 2020; Rodríguez-Planas 2022b; Saw et al. 2020), they are based on student surveys and not on real graduation data. My research adds to the literature by comparing real graduation rates for students observed in the 1st year and those observed in the 3rd year (i.e., conditional on surviving till the 3rd year). It reveals that many high-ability students of the oldest COVID-affected cohort, who experienced the pandemic during their last study semester, delayed graduation by one year. However, among the students of the most affected cohorts, we observe some signs of dropping out due to the pandemic. Interestingly, this effect is stronger for high-ability than for low-ability students. This difference might be driven by more lenient grading, potentially combined with lower quality of instruction, which could have discouraged high-ability students while helping low-ability students to continue studying.

2. Related literature

This study is related to two large streams of literature: the pre-COVID literature comparing the effectiveness of online versus face-to-face instruction in higher education and the recent literature evaluating the effects of the COVID-19 pandemic on university students.

The pre-covid literature predominantly shows that students in online programs perform worse than students in traditional programs. Identification of the causal effect of online tutoring in this group of studies is complicated by selection bias. Nevertheless, the results are comparable among a set of studies using different identification strategies to deal with selection. Bettinger et al. (2017) compare students' performance at a for-profit university that offers the same courses in either online or in-person modes at several campuses across the U.S. To deal with selection, they instrument online participation with a variable that interacts the distance between a student's residence and her local campus with an indicator of whether the given course is offered in a face-to-face setting at the student's local campus. The authors show that taking a course online negatively affects grades not only in the currently taken course but also in future courses. Additionally, taking a course online is reported to decrease the probability of a student remaining enrolled in the following semesters. Cacault et al. (2021) conducted a randomized experiment on students attending a bachelor program in economics and management at the University of Geneva. The experiment consisted of live-streaming lectures and allowing a random part of students to access the streamed lectures while also having the opportunity to attend in-person lectures. The authors report that attending online lectures decreased grades for low-performing students but increased grades for high-performing students. The within-student analysis of community and technical college students in Washington State, carried out by Xu and Jaggars (2014), also points towards a similar conclusion. Taking a course online is shown to have a detrimental effect on grades, the most so for males, younger, and low-performing students. Finally, Coates et al. (2004) also show that students taking online classes perform worse than their colleagues taking in-person classes.

Based on the pre-covid literature, one can formulate a conclusion that online instruction is detrimental to students' outcomes. Those who lose the most from online instruction (could gain the most from in-person education) are the low-performing students. Given that online courses analyzed by this stream of literature were in advance planned as distance courses and thus might be of better quality than 'emergency online courses' delivered during COVID-19, I expect that pandemic-induced distance learning had negative effects on students' learning process[1].

In contrast to these expectations, the literature analyzing the effects of the COVID-19 forced move to online teaching on students' academic performance reaches different conclusions. Most of the studies report that in Spring 2020, i.e., during the time when all instruction was suddenly moved to the online world, students earned better grades than in earlier semesters. In the analysis closest to my paper, Rodríguez-Planas (2022a) uses administrative data of the City University of New York students spanning from Spring 2017 to Spring 2020. She shows that the average GPA increased significantly in Spring 2020 and that this increase was the highest among low-income, low-performing students, perhaps due to the flexible grading policy. A similar conclusion is reached by Gonzalez et al. (2020), who compare grades of the Universidad Autónoma de Madrid students for the academic year 2019/20 and the two preceding years, by Iglesias-Pradas et al. (2021), who test differences in academic performance across the academic years 2017/18, 2018/19 and 2019/20 at the School of Telecommunication Engineering (Spain), and by Karadag (2021) who analyzes data from five Turkish universities in academic years 2018/19 and 2019/20. Bonacini et al. (2023) also find that students taking online classes and being remotely examined during the 'covid times' received better grades. Moreover, these authors decompose the general result into the effect of grading (mode of testing and assessing test results) and the effect of studying (acquiring information). They conclude that students attending emergency online courses acquired less information than those attending courses delivered online even before the pandemic. Also Aucejo et al. (2020) report a negative effect of the COVID-19 pandemic on students. These authors asked students of the Arizona State University about their actual performance in Spring 2020 and about their expected performance had there been no pandemic. By taking the difference between an individual's actual GPA and expected GPA under the no-pandemic scenario, they conclude that "*GPA decreased with COVID-19 by 0.17 on average*". These authors further show that 13 % of students planned to delay graduation in the Spring semester of 2019/20 due to the COVID-19 crisis.

A similar result regarding delayed graduation is found by Rodríguez-Planas (2022b). The author analyses data from a survey that asked students, among others, whether the pandemic and the subsequent lockdown have changed their graduation plans. She finds that the share of students who planned to delay their graduation due to the COVID-19 crisis is approximately 4 %. Saw et al. (2020) surveyed STEM students across numerous institutions in the U.S. in June 2020. Results of this survey reveal that 18 % of master's and 7.6 % of bachelor's students delayed their graduation due to the COVID-19 pandemic. The survey also offers possible explanations for the delayed graduation. Among

[1] On the other hand, distance education might have been a better solution than the complete cancellation of courses due to COVID-19 regarding the quality of the learning process. This is indirectly implied by the study of Hardt et al. (2023), who show that students who were provided with online monitoring visibly outperformed students who did not receive such support.

those who delayed graduation, almost 62 % reported limited access to academic facilities and resources, slightly more than 45 % described declined mental or physical health, and nearly 41 % reported setbacks in degree-related tasks.

To conclude, the recent literature finds that in Spring 2020, i.e., during the first semester affected by the pandemic, university students mostly earned better grades than during pre-covid semesters. The usual explanation for this observation is grade inflation (Karadag, 2021; Iglesias-Pradas et al., 2021; Rodríguez-Planas, 2022a). However, some authors argue that better results observed in Spring 2020 can be attributed to real improvement in students' learning strategies (Gonzalez et al., 2020). The arguments in favor of the former explanation are based on the comparison between pre-pandemic evidence of how online teaching affects students' performance with the during-pandemic one, the fact that online education delivered in Spring 2020 was not well prepared (in contrast to courses initially designed to be taught online), and some evidence that it was easier to cheat during the improvised online exams (Balderas et al., 2020). The argument favoring the latter explanation is that students had more time to study and were less distracted by alternative activities.

The recent literature also suggests that students delayed graduation because of the pandemic. However, these findings should be interpreted cautiously because they are based solely on data obtained from online surveys. Foremost, Rodríguez-Planas (2022b) argues that it is possible that a certain part of the student population might have been more likely than others to participate in the survey due to feeling more affected by the pandemic. If this were true, the sample obtained from the surveys would not be representative, potentially leading to biased results. Additionally, the question of whether students' expectations are a trustworthy approximation of the state of the world under the assumption that there was no COVID-19 crisis is also relevant. It has been actually shown that individuals, especially young individuals, tend to give more weight to recent experiences (Malmendier and Nagel, 2016; Kuchler and Zafar, 2019).

My study adds to this literature by analyzing data on GPA and on actual graduation timing of students before the pandemic, during three semesters of purely online instruction (Spring of 2019/20, Fall of 2020/21, Spring of 2020/21), and two semesters after the pandemic when the majority of students attended in-class lectures and exams were conducted as usual.

3. Data and institutional setup

I analyze anonymized administrative data on nearly 4000 full-time bachelor students who enrolled at one faculty[2] of a large Czech university *before* the pandemic. Student outcomes are observed during each semester of academic years 2014/15 to 2022/23; these include ECTS[3] credits taken, ECTS credits fulfilled, GPA, and study status.[4] Additionally, I observe students' age, gender, and program of study.

Why does this study concentrate on bachelor students and only those who enrolled before the pandemic? The pandemic has affected not only teaching mode but also the maturity (high school leaving) and university entrance exams. To abstract from the effect of university entrance conditions, which might have changed the composition of students, only students who enrolled before the pandemic, i.e., in academic years 2014/15 to 2019/20, are analyzed. Bachelor programs at the analyzed faculty are designed as three-year (six semesters) programs. This means that students who enroll in the Fall semester of 2019/20 should graduate in the Spring semester of 2021/22. However, a considerable number of students take a longer time to graduate (see Table 1 for detailed statistics). Master programs are shorter, usually only four-semester programs which means that very few pre-COVID enrolled students were still studying during after-COVID semesters. This is why only bachelor-level students are included in the analysis.

Table 1
Summary statistics.

	1st year		2nd year		3rd year	
	1st sem.	2nd sem.	3rd sem.	4th sem.	5th sem.	6th sem.
GPA	2.73	2.86	2.85	3.03	3.18	3.25
	(0.71)	(0.63)	(0.69)	(0.63)	(0.65)	(0.66)
ECTS credits completed	32.7	34.8	33.3	33.1	23.1	17.5
	(10.3)	(11.2)	(11.1)	(10.4)	(9.2)	(10.0)
Share graduating within 3 years	0.44	0.48	0.53	0.55	0.58	0.57
	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)	(0.49)
Share graduating within 4 years	0.62	0.67	0.74	0.77	0.82	0.83
	(0.48)	(0.47)	(0.44)	(0.42)	(0.38)	(0.38)
Observations	3 929	3 580	3 063	2 952	2 575	2 374

Note: The table reports (1) the average GPA of all students who enrolled between 2014/15 and 2019/20 and were still studying during the respective semester, standard deviations in parentheses; (2) the average number of ECTS credits completed by students who were still studying during the respective semester, standard deviation in parenthesis; (3) the share of students who graduated within three academic years; and (4) the share of students who graduated within four academic years (including also those who graduate within three years), conditional on still studying during the respective semester. Standard deviations for means of dummy variables in the 3rd and 4th rows reported for completeness.

Newly enrolled students always start in the Fall semester. The Fall semester lasts from early October till early January and is followed by an evaluation period. The Spring semester starts in mid-February and lasts till mid-May. It is, again, followed by the evaluation period. To successfully graduate, students must complete courses worth 180 ECTS points in total and write and defend a bachelor's thesis. Completing a course means obtaining a passing grade. Students are evaluated on an A to F scale, with A being the best passing grade, E being the worst passing grade, and F being the failing grade. Course grades reflect students' work throughout the semester (class work, home assignments, midterm exams) and their performance in exams taken during the evaluation period. Each course is worth 3 to 10 ECTS points, depending on how (time-) demanding it is. When failing to complete a course for the first time, a student can take it for the second time during the next academic year. This may prolong the study period beyond the designed three years, especially if passing the re-taken course is a pre-requisite for taking another course. Students write their bachelor's thesis under the supervision of a lecturer or an advanced Ph.D. student during the last year of their study. The thesis can be defended only after completing all obligatory courses and collecting at least 180 ECTS points. Studying at the analyzed faculty is free of charge if the study process is completed within four academic years,[5] with each semester beyond this limit carrying a tuition fee. This creates a strong motivation to graduate within four years.

While in the Czech Republic the best grades (A and B) are counted as 1 and the failing grade as 4, I have decided to reverse the numbers to achieve consistency with international grading scales. Thus, in what follows, grades A and B correspond to 4, grades C and D correspond to 3,

[2] A faculty (for example, a Faculty of Law) is the largest organizational unit of a university; it corresponds to a school in the U.S. system of higher education.

[3] European Universities share a common course intensity measure, the credit worth. Each course is worth a specific number of credits, depending on its difficulty and time intensity. When receiving a passing grade in a subject, a student earns the designated number of credits.

[4] Study status is updated immediately after successful graduation, however it is often updated with delay for students who drop out.This is why the analysis presented in Section 4.2 relies only on the 'graduated' study status.

[5] The tuition-free limit was prolonged by six monts for all COVID-affected cohorts.

grade E corresponds to 2, and the failing grade F corresponds to 1. The grade point average (GPA) is the weighted average of grades obtained by the student in all courses taken during one semester, considering the ECTS credit worth of each course.

Table 1 summarizes the dataset used in the analysis. Note that the number of students becomes smaller each semester. This is driven by dropouts who either resign from studying or fail obligatory subjects. Among students who complete at least one course during the first semester, only 44 % graduate within three years, and 62 % graduate within four years. These numbers become considerably larger for students observed during further semesters of study. I do not consider the total graduation rate because some students enrolled in the academic year 2019/20 or 2018/19 might still be studying at the time of writing this paper.

The first COVID-19 case was registered in the Czech Republic on March 1, 2020. Although the increase in new cases was not as sharp as in some other countries, all schools and universities were closed until further notice on March 11. On March 14, 2020, all nonessential businesses, including shops, public bars, and restaurants, were closed. Universities remained closed till the end of the semester. This means that the Spring semester of the 2019/20 academic year at the analyzed faculty was running as usual for the first three weeks and was suddenly moved to the online mode in the middle of the fourth week. The studied faculty does not offer practical courses requiring in-person interactions, which means that all courses could be delivered online in the allocated time slots. Although the country's functioning was almost back to normal by the end of May, examinations during the Spring 2019/20 evaluation period were held online. This policy was introduced to allow equal treatment to all students, including those in quarantine or living abroad, as state borders were still closed.

The Fall semester of 2020/21 was expected to be taught in a hybrid mode. However, the number of new COVID-19 cases was dramatically increasing, and just one week before the semester started, it was announced that all teaching at the analyzed faculty would be moved to the online mode. During October 2020, the nonessential business operation was gradually restricted, culminating in a partial lockdown that lasted until early December. Ultimately, all courses were delivered online during the 2020/21 Fall semester. Similarly as in the preceding semester, examinations were held online during the Fall 2020/21 evaluation period.

The Spring semester of 2020/21 was the last semester during which teaching at the analyzed faculty was delivered and evaluated fully online. This time, the online mode was announced well before the start of the semester, as the number of new COVID-19 cases registered in early 2021 hit record-high values. The strictest lockdown in Czech history was introduced on February 26, 2021. It was partially eased on April 12, and the country's functioning was almost normal by the end of May.

The possibility of vaccination, easy access to testing facilities, and lower severity of infections motivated the Czech government not to introduce further lockdowns or intra-country travel restrictions, even though the number of infected people was again hitting records in the Fall of 2021. At that time, the core of anti-covid policy was vaccination and massive testing. Teaching during the Fall semester of 2021/22 was delivered in a hybrid mode. All lectures and tutorials were primarily taught in person, while online participation through live streaming or access to pre-recorded materials was available for those in quarantine. Students could participate in classes without wearing face masks if having a negative COVID test. Examinations were also organized in a hybrid mode. Nevertheless, only students in quarantine or those living abroad were allowed to take the exams remotely.

The pandemic calmed down in the Spring of 2022, and most preventive measures, including obligatory testing and mask wearing, were gradually withdrawn. Teaching in the Spring semester of 2021/22 was still delivered in a hybrid mode, as were the exams.

The academic year of 2022/23 was the first post-pandemic year with no restrictions, and the study process at the analyzed university returned to fully in-person mode. All students entering the bachelor program before the COVID-19 outbreak have been enrolled for at least 6 semesters by the Fall of 2022/23. Given that the official length of the bachelor program is 6 semesters, I do not follow students' grades and credits completion during the academic year 2022/23. This would be a highly selective sample of students who prolong the study process. However, I monitor thesis defenses and successful graduations until the end of the 2022/23 academic year.

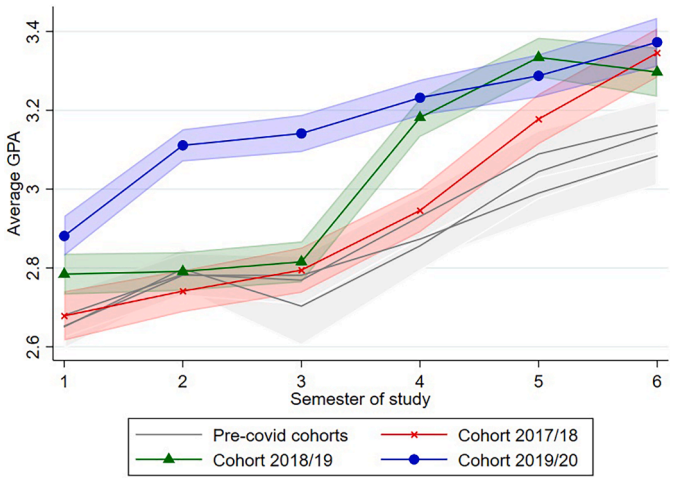

Fig. 1. Average GPA by cohort and semester of study
Note: Each line connects points corresponding to the average GPA for the given cohort in the given semester of study. Pre-covid cohorts (enrolled in 2014/15, 2015/16, and 2016/17) completed all 6 semesters of study before the pandemic outbreak. The cohort of 2017/18 experienced COVID-19 in the 6th semester; the cohort of 2018/19 was taught online in the 4th, 5th, and 6th semesters; the cohort of 2019/20 was taught online in the 2nd, 3rd, and 4th semesters, and experienced hybrid education in 5th and 6th semesters. Shaded areas correspond to 95 % confidence intervals.

4. Students' outcomes during and after the COVID-19 pandemic

This paper compares bachelor students' performance during and after the COVID-19 pandemic with the pre-pandemic long-run average. Two main measures of students' performance are analyzed: semester GPA and the probability of graduating (within three or four years since enrollment). Additionally, the number of ECTS credits fulfilled per semester is analyzed as an auxiliary measure. The three semesters directly following the COVID-19 outbreak are considered the during-pandemic semesters (Spring 2019/2020, Fall 2020/21, Spring 2020/21), and the following semesters are considered the after-pandemic semesters. This means that students enrolled in Fall 2017 were affected by the pandemic in their last semester of study (6th semester), students enrolled in Fall 2018 experienced the pandemic for the last three semesters of study (4th, 5th, 6th semester), and students enrolled in Fall 2019 were exposed to pandemic-related distance education at the early course of their study (2nd, 3rd, 4th semester), while teaching during their last official study year was delivered in a hybrid post-pandemic mode.

4.1. Grades

Previous literature provides evidence of COVID-related grade inflation at several universities around the World. Was grade inflation also observed in the Czech Republic? What happened to students' GPAs when teaching was moved back to classrooms? Plotting the average GPA by semester of study for pre-COVID and COVID-affected cohorts provides descriptive answers to these questions. Fig. 1 reveals a clear pattern of higher GPA in later semesters of study for all the analyzed cohorts. On top of that, a significant and persistent jump in the average

Table 2
Estimated effect of COVID-19 on students' GPA.

	(1) All	(2) Low-ability	(3) High-ability
2015/16 Fall	-0.018	-0.065**	0.027
	(0.021)	(0.031)	(0.027)
2015/16 Spring	0.013	0.008	0.006
	(0.021)	(0.031)	(0.028)
2016/17 Fall	-0.042**	-0.069***	-0.021
	(0.018)	(0.026)	(0.023)
2016/17 Spring	-0.035*	-0.075***	-0.005
	(0.018)	(0.027)	(0.024)
2017/18 Fall	-0.012	-0.032	-0.002
	(0.016)	(0.025)	(0.021)
2017/18 Spring	-0.022	-0.031	-0.017
	(0.017)	(0.025)	(0.021)
2019/20 Fall	0.039**	0.052*	0.025
	(0.019)	(0.029)	(0.024)
2019/20 Spring	0.204***	0.251***	0.160***
	(0.019)	(0.029)	(0.025)
2020/21 Fall	0.214***	0.314***	0.126***
	(0.025)	(0.037)	(0.032)
2020/21 Spring	0.169***	0.197***	0.149***
	(0.025)	(0.038)	(0.032)
2021/22 Fall	0.065*	0.173***	-0.028
	(0.034)	(0.053)	(0.044)
2021/22 Spring	0.084**	0.159***	0.025
	(0.036)	(0.054)	(0.047)
N	17665	8707	8883
R^2	0.121	0.192	0.078

Note: Table reports point estimates (standard errors in parentheses) of α_s coefficients from Eq. (1) with GPA as the dependent variable. Semesters with online instruction and examinations are highlighted. A positive coefficient corresponds to an improved GPA. Column (1) corresponds to all full-time students who started a bachelor's degree program prior to the outbreak of the COVID-19 pandemic Column (2) is the subsample of (1) with first-semester GPA being below the corresponding cohort and study program's median; column (3) is the subsample of (1) with first-semester GPA being above the corresponding cohort and study program's median. Each specification controls for the year of study fixed effects, and seasonality (Fall or Spring semester). Fixed-effects estimation.

GPA is observed in the semesters when respective cohorts first experienced COVID-19, a sign of grade inflation.[6] Even though the 2019/20 cohort spent most of their 5th and 6th semester study time in classrooms, they still received higher grades than pre-COVID cohorts.

Several earlier studies devoted to the effect of the COVID-19 pandemic on university students point towards heterogeneity along the socio-economic or ability margins (Aucejo et al. 2020; Rodríguez-Planas 2022a). Unfortunately, students' socio-economic status is not observed in the data at my disposal. However, the longitudinal structure of the data allows using the first semester GPA as the proxy for ability. Recall that all students included in the analytical sample enrolled before the pandemic, and their first semester results were unaffected by COVID-19. Thus, the first semester GPA should capture the same (ability) traits for all analyzed individuals. I divide the sample into low-ability and high-ability students by comparing their first semester GPA to the median first semester GPA in their cohort and field of study. Graphs of the average GPA within the samples of low-ability and high-ability students can be found in the Appendix (Figures A1 and A2). They reveal visible heterogeneity in the evolution of low- and high-ability students' grades during COVID-19. To some extent, this might be driven by the limited grading scale, as A-students could not get better grades. However, this might also indicate that the pandemic had a different bite on low- and high-ability students.

To provide more robust evidence of the effect of COVID-19 on grades, I leverage the panel structure of the data and analyze students' GPAs using the fixed effects event study approach specified in Eq. 1 below.

$$y_{it} = \alpha_0 + \sum_{s=2016/17F}^{2021/22S} \alpha_s I(t=s) + \gamma \cdot Spring_{it} + YOS_{it} + a_i + v_{it}, \quad (1)$$

where y_{it} is the GPA of the i-th student in semester t, $I(t=s)$ is a dummy

[6] Improved GPA might be a sign of grade inflation, but might be also (partially) driven by selection. The next section shows some evidence for higher probability of dropping out during COVID. If dropouts are negatively selected, their disappearance from the sample might lead to higher observed GPA.

variable equal to 1 if the t-th semester is equal to s, $Spring_{it}$ is a dummy for the Spring semester used to control for seasonality, YOS_{it} represents the year of study fixed effects, a_i stands for the student fixed effect and v_{it} is the unobserved disturbance.

Including students who started and completed their studies before the COVID-19 pandemic allows controlling for semester and year of study effects. These are crucial because only second- and third-year students are observed during the 2020/21 academic year, while only third-year students are observed during the 2021/22 academic year. As revealed in the summary statistics (Table 1), students in higher years of study usually receive better grades. Each student included in the analyzed sample started their study before the pandemic, i.e., in Fall 2019/20 at the latest. Thus, at least one pre-pandemic outcome is observed for every individual included in the analysis.

A full set of semester dummies is included to check whether student outcomes were stable before the pandemic. Including year of study and semester fixed effects means that the semester effects of two academic years must be excluded from the analysis to avoid collinearity. These are the semester effects of the first observed year (2014/15) and the last pre-pandemic year (2018/19), as is the usual practice in event studies. $\alpha_{2019/20S}$, $\alpha_{2020/21W}$, and $\alpha_{2020/21S}$ can be interpreted as the effects of the pandemic (all-inclusive: distant learning, lockdowns, remote examinations), while $\alpha_{2021/22W}$ and $\alpha_{2021/22S}$ can be interpreted as post-pandemic effects. The academic year 2022/23 is not included in the analysis of GPA because only fourth-year, i.e. prolonging, bachelor students are observed during that year.

Fixed effects event study estimates are presented in Table 2.[7] To account for possible heterogeneous effects by ability level, results for different samples of students are reported: a full sample of students (column 1), as well as samples of low-ability (column 2) and high-ability (column 3) students. It is evident from the table that pre-pandemic GPA was relatively stable over time; even though some statistically significant estimates can be observed, they are of an order of magnitude smaller than the estimates corresponding to the "COVID semesters". Once the pandemic stepped in, students' GPA significantly improved. Given the standard deviation of GPA of 0.65 (see Table 1), the estimated 'COVID effect' of 0.20 (column 1 of Table 2) corresponds to about one-third of the standard deviation. While the positive effect on GPA is observed for both low- and high-ability students (columns 2 and 3 of Table 2), there is some heterogeneity between these groups.

First, the effect on high-ability students is smaller in magnitude. To some extent, this might be driven by the limited grading scale, as A-students could not get better grades. However, this might also indicate that the pandemic had a different bite on low- and high-ability students. Second, low-ability students kept receiving higher grades even during the post-pandemic semesters, while grades of high-ability students returned to their long-run averages once in-person instruction and examination were restored. This could be driven by selection if the lowest achieving students were more likely to drop out during COVID than during the pre-COVID years. However, the graduation patterns analysis reported in the next section suggests that dropping out was more frequent among high-ability students. A more likely explanation is that students managed to pass most of the difficult subjects during the pandemic, and post-COVID GPA is composed of a different (easier) set of subjects than usual.[8] This is supported by the ECTS take-up analysis reported in Section 4.3.

The fixed effects specification summarized in Eq. (1) relies on the assumption that one can properly identify students' fixed effects, even if they are observed for only one pre-COVID semester. In an alternative approach, I explicitly control for students' ability using their first semester GPA as a proxy. As all students included in the sample started their studies before the pandemic, this proxy variable should capture the same traits for all analyzed individuals.

$$y_{it} = \alpha_0 + \sum_{s=2016/17S}^{2021/22S} \alpha_s I(t=s) + \beta \cdot firstGPA_i + Z_i\Lambda + \gamma \cdot Spring_{it} + YOS_{it} + v_{it} \quad (2)$$

This specification allows for inclusion of additional student-specific control variables (Z_i), such as gender, age at enrollment, and field of study fixed effects. Coefficients in this specification are estimated by OLS, and standard errors are clustered at the student level. Results of this alternative specification, which are comparable to the results of fixed effects estimation, are reported in Table 1A in the Appendix.

4.2. Graduation patterns

As discussed in earlier studies, better grades obtained by students during the COVID-19 pandemic might result from improved learning outcomes or grade inflation. To disentangle these, I zoom in on a study outcome that is much less affected by teachers' approach towards grading, that is, graduation. It takes three years (six semesters) to complete a bachelor's degree in regular time, and students can take up to four years (eight semesters) to complete the bachelor's degree without having to pay for their studies.[9] This is why further analysis concentrates on two indicators: whether a student graduates within three years (the official length of studies) and whether a student graduates within four years (the usual maximum length of studying free of charge). Final graduation rates cannot be analyzed (yet) because some students included in the sample might still be studying. The analysis of graduation patterns follows this specification:

$$g_i = \alpha_0 + \sum_{y=2015/16}^{2021/22} \alpha_s I(start_i = y) + \beta \cdot firstGPA_i + Z_i\Lambda + v_i, \quad (4)$$

where g_i is a dummy variable equal to one if student i graduated within three (or four) years; it is equal to zero for students who dropped out and for those who graduated later. $I(start_i = y)$ is an indicator for student's i starting academic year (i.e., cohort fixed effect), $firstGPA_i$ is student's i GPA from their first semester, used as a proxy for ability, Z_i is a vector of individual characteristics (gender, age at enrollment, and field of study), and v_i is the unobserved error. In the analysis of graduation rates, each student is observed only once, and fixed effects estimation is not feasible. Thus, I include first semester GPA to control for students' heterogeneous ability.

Coefficients α_s correspond to cohort fixed effects. Relying on the assumption that graduation rates are stable over time, one can interpret $\alpha_{2017/18}$, $\alpha_{2018/19}$, and $\alpha_{2019/20}$ as the deviation from long-run average graduation rates for cohorts that were affected by the pandemic. Note that the 2017/18 cohort was only affected during their last (official) study semester, cohort 2018/19 was affected during their last three semesters, while cohort 2019/20 was affected during their second, third,

[7] As a robustness check, Table 2A in the Appendix reports fixed effects event study estimates after excluding students enrolled in study programs offered in English. Mostly international students are enrolled in such programs. These students might have been differently affected by the COVID-19 pandemic due to international travel restrictions.

[8] Recall that only third-year students of the 2019/20 enrolment cohort are observed during the post-COVID semesters.

[9] The tuition-free limit was prolonged by six months for all COVID-affected cohorts. Anectodical evidence suggests that many students were not aware of this policy adjustment and behaved as if the limit was still four years. Nevertheless, I account for the prolonged tuition-free period in a robustness analysis reported in appendix Figs. 2A and 3A. These figures illustrate the analysis equivalent to the one described in this section, but instead of a variable"-graduated in four years," I construct a variable "graduated within the tuition-free period".

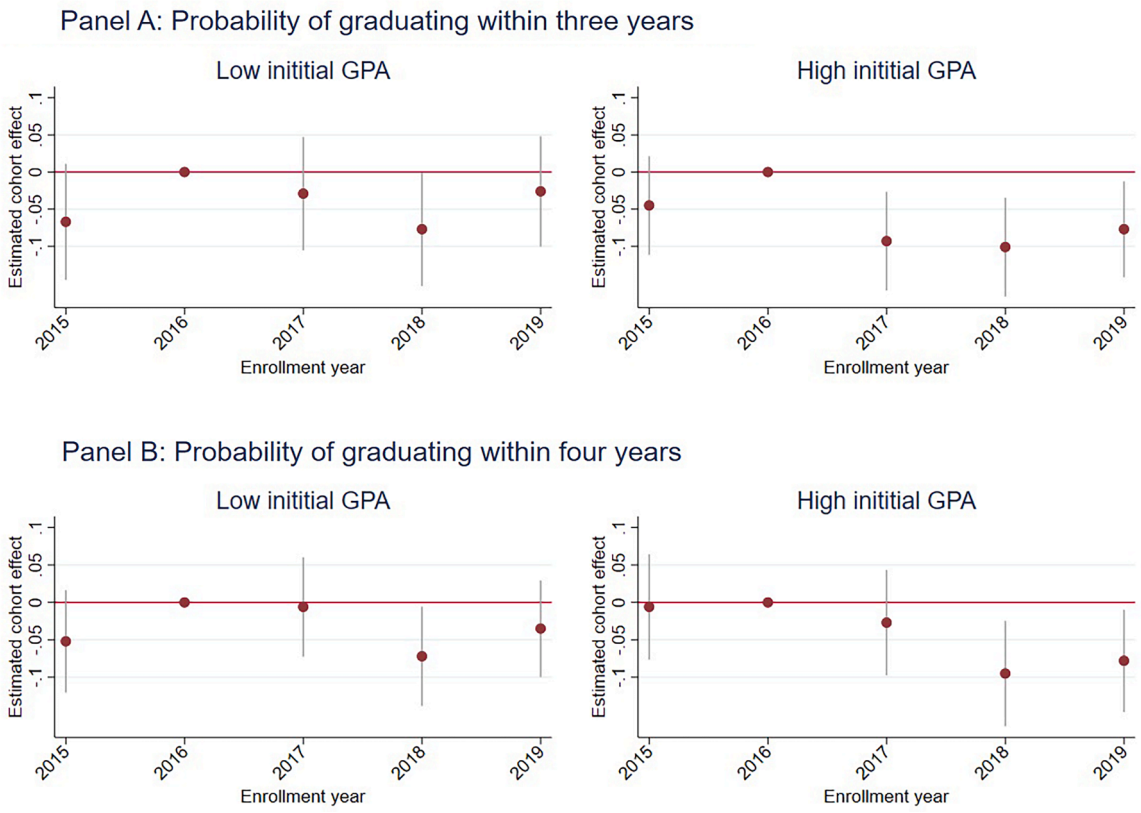

Fig. 2. Probability of graduation, conditional on being in the 1st year
Note: Each dot corresponds to the point estimate of the cohort effect (α_s) in equation (4), with the dependent variable being an indicator of whether a student graduated within three years (Panel A) or four years (Panel B). All students who completed at least one course during the first year of study are included in the estimation sample. The left column presents estimation results for the sub-sample of students with first-semester GPA below the corresponding cohort and study program's median; the right column presents estimation results for the sub-sample of students with first-semester GPA above the corresponding cohort and study program's median. Vertical bars correspond to 95 % confidence intervals.

and fourth semesters. This means that students in the 2017 /18 cohort went through most of the courses and exams in the usual mode but completed at least part of their bachelor's thesis without personal interactions with the supervisor. Students in the 2018/19 cohort went through half of their studies in the usual mode and were moved to the online mode for the second half of their study program. Choice of the bachelor's thesis topic, and most of the interactions with the thesis supervisor happened online. Students in the 2019/20 study cohort were taught online in the middle of their study program, but they could interact with the supervisor in the usual way while writing their bachelor's thesis. However, they might have never met their potential supervisor in person before choosing the topic of their bachelor's thesis.

Eq. (4) is estimated on four samples: low- and high-ability students observed in their 1st year and low- and high-ability students observed in their 3rd year. Naturally, the 3rd year sample is smaller, as it excludes all those who dropped out in the meantime. Thus, a comparison of the two sets of estimates should, to some extent, reveal how much of the observed effect is driven by dropouts and how much by delayed/unsuccessful thesis preparation.[10]

Figs. 2 and 3 below summarize these estimates. Students who enrolled in the 2016/17 academic year serve as the benchmark. The red circles correspond to the estimated difference between the conditional graduation rate of each of the remaining cohorts and the 2016/17 cohort, while the vertical lines represent the 95 % confidence intervals.

Figs. 2 and 3 reveal that graduation rates were stable before the pandemic; however, a visible drop is observed among the cohorts affected by the pandemic. The size and statistical significance of the estimated graduation effects depends on the ability group, graduation timing, and the chosen viewpoint (1st or 3rd year of study). It is striking that the strongest effects are estimated for the sample of high-ability students. From the point of view of first-year students, we observe a strong negative effect of COVID-19 on the probability of graduation within three years for all the affected cohorts of high-ability students (Fig. 2, top-right), and a lower probability of graduation within four years for the 2018/19 and 2019/20 cohorts of high-ability students (Fig. 2, bottom-right). This suggests that the oldest affected cohort of high-ability students, which experienced the pandemic during the 6th semester of studies, was 'just' delaying graduation – a result supporting the survey results reported by Aucejo et al. (2020) and Rodríguez-Planas (2022b).

For the 2018/19 cohort a similar pattern is observed for both low- and high-ability students. Lower graduation rates in all four graphs suggest that the observed drop in graduation is mostly affected by prolonging the study process (or not managing to complete the thesis at all), although some dropping out during the first two years can not be

[10] There still could be some dropouts during the 3rd year but, as Table 1 reveals, most of the dropping out happens earlier during the course of study.

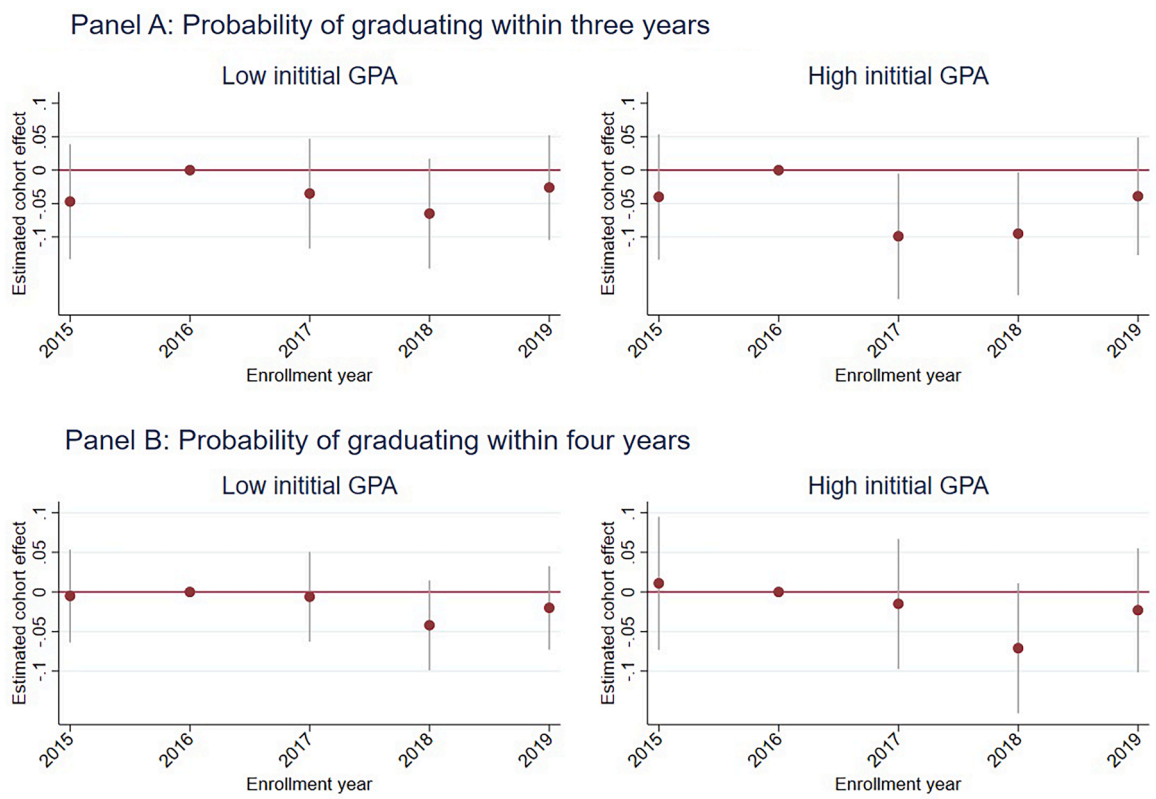

Fig. 3. Probability of graduation, conditional on being in the 3rd year
Note: Each dot corresponds to the point estimate of the cohort effect (α_s) in equation (4), with the dependent variable being an indicator of whether a student graduated within three years (Panel A) or four years (Panel B). All students who completed at least one course during the third year of study are included in the estimation sample. The left column presents estimation results for the sub-sample of students with first-semester GPA below the corresponding cohort and study program's median; the right column presents estimation results for the sub-sample of students with first-semester GPA above the corresponding cohort and study program's median. Vertical bars correspond to 95 % confidence intervals.

excluded.[11] Finally, for the youngest cohort of high-ability students, which was affected by the pandemic during the first two years of study, we observe a decreased probability of graduating when looking from the point of view of first-year students (Fig. 2, right), but conditional on getting to the third year, graduation rates appear to be comparable to those before COVID (Fig. 3, right). This suggests that within this cohort, most of the effect is driven by dropping out during the course of study. Students who made it past the pandemic (i.e., to the 3rd year) graduated at the same rate as the non-affected cohorts. No significant effect on graduation rates is observed among low-ability students of the 2019/20 cohort.

Graduation rate analysis suggests that the COVID-19 pandemic had only a slightly negative effect on the study success of low-ability students, while it strongly affected the study completion rates of high-ability students. Previous literature documents less acquired knowledge (Bonacini et al., 2023), an increased prevalence of burnout (Abraham et al., 2024), and mental health issues (Hu et al., 2022) among university students during the COVID-19 pandemic. All these could potentially lead to increased dropout rates and might be the reason why lower graduation rates are observed among high-ability students at the analyzed university. Why are almost no significant effects observed for low-ability students? I hypothesize that the potentially negative influence of COVID-19 on low-ability students was compensated by the grade inflation. The lenient grading policy let a higher than usual fraction of low-ability students pass the compulsory exams and continue studying. To verify this hypothesis, I turn to the analysis of ECTS credits takeout.

4.3. ECTS credits

The evolution of the GPA tells just part of the COVID story. We do not know whether better grades were obtained in the same number of courses or fewer/more courses than before the pandemic. Unfortunately, the anonymized dataset does not include information about which courses, when, and with what final grades students took. However, I observe the number of ECTS credits taken and completed each semester. Fig. 4 below plots the average number of credits completed by pre-COVID and COVID-affected cohorts in each study semester by low-ability (Panel A) and high-ability (Panel B) students. One can see that most of the COVID-affected cohorts behaved similarly to pre-COVID cohorts regarding credit completion.

The only exception is the cohort enrolling in Fall 2019/20, which was in their 2nd semester when COVID-19 hit the Czech Republic. These students took and completed significantly more credits than other cohorts in their 3rd semester, a pattern most pronounced among low-ability students. This suggests that they consciously viewed the pandemic times as letting them study more easily.

For the other two COVID-affected cohorts, no reaction in terms of credit take-up is observed because they did not have much space to adjust credit-wise. The cohort enrolling in Fall 2017/18 was in the middle of their final semester when the COVID-19 pandemic hit. The

[11] Robustness analysis reported in appendix Fig. 3A shows a slightly different pattern. When looking at 3rd year students, the probability of graduation within the tuition-free period for both low- and high-ability students of the 2018/19 cohort is similar to pre-COVID cohorts. Lower graduation rates for 1st-year students and unchanged graduation rates for 3rd-year students suggest an increased extent of dropping out within this cohort, especially among high-ability students.

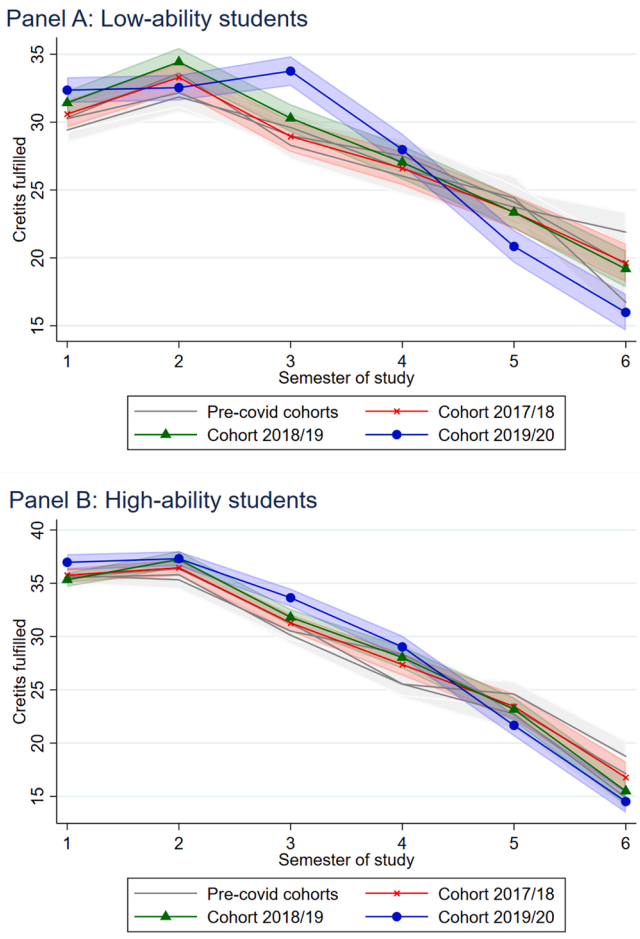

Fig. 4. Average number of ECTS credits completed by semester
Panel A: Low-ability students
Panel B: High-ability students
Note: Each line connects points corresponding to the average number of ECTS credits fulfilled by the given cohort in the given semester of study. Pre-covid cohorts (enrolled in 2014/15, 2015/16, and 2016/17) completed all 6 semesters of study before the pandemic outbreak. The cohort of 2017/18 experienced COVID-19 in the 6th semester; the cohort of 2018/19 was taught online in the 4th, 5th, and 6th semesters; the cohort of 2019/20 was taught online in the 2nd, 3rd, and 4th semesters, and experienced hybrid education in 5th and 6th semesters. Shaded areas correspond to 95 % confidence intervals.

cohort enrolling in 2018/19 was in their 4th semester when the COVID-19 pandemic hit. These students had only their final year to make potential COVID-related adjustments. However, by that time, they had already fulfilled most of their study duties (note that even before COVID-19, students took much fewer credits in their final year than in the first two years). There was no space for credit take-up adjustments.

The ECTS credits analysis suggests that low-ability students of the 2019/20 cohort took advantage of the COVID-19 pandemic and completed as many credits as possible during their second year of study, which was taught remotely. They consciously viewed the pandemic times as letting them study more easily. This might be the reason why a much weaker (if any) negative effect of the pandemic on graduation rates is observed for low-ability students than for high-ability students in this cohort. This might also be the reason why low-ability students received better grades during the post-COVID academic year. Many difficult (and potentially low-grade) courses were taken during the pandemic.

5. Discussion

This study analyzes students' grades, ECTS credits completion, and graduation patterns during several pre-COVID semesters, three COVID semesters, and two post-COVID semesters. Similarly to earlier studies, it points towards significant improvement in GPA during all semesters when teaching and examinations were delivered online. What is more, and new to the literature, I show that once COVID restrictions have been lifted and students returned to classrooms, grades of high-ability students moved back towards their long-run average, while grades of low-ability students stayed slightly above the long-run average. This might suggest that the effect of COVID-19 on the analyzed university students was positive (their grades were improved) and, to some extent, persistent. However, I argue that the positive relationship between GPA and COVID-19 is a sign of grade inflation through easier examination and more lenient grading rather than a positive sign of more acquired knowledge. First, following the arguments of Rodríguez-Planas (2022a) and based on pre-COVID studies, one expects that switching to online education would negatively affect the learning process, so under an unchanged grading policy, students should report a worse GPA. Second, I also find a negative effect of the pandemic on students, an effect revealed through dropping out and delayed graduation. This finding is in line with Bettinger et al. (2017), who show that taking a course online has a negative effect on the learning process not only in the currently taken course but also in future courses, even those taken in person. Additionally, taking a course online is reported to decrease the probability of a student remaining enrolled in the following semesters.

Documenting increased extent of dropping out and delayed graduation is new to the literature. I show that the probability of graduating on time was visibly lower among the cohorts affected by the pandemic. Interestingly, it is high-ability students for whom the strongest effects are observed. Comparing graduation rates conditional on being observed in the 1st year and conditional on being observed in the 3rd year suggests that the most affected was the cohort of 2018/19, for which we observe some signs of dropping out for both low- and high-ability students. On the other hand, for the cohort of 2019/20, visible differences are observed between low- and high-ability students. While there is a clear sign of increased dropout prevalence among high-ability students, no such effect is observed for low-ability students. The difference between low- and high-ability students might be driven by the grade inflation that 'just' improved the GPA for high-ability students discouraging some of them from further studying, while it might have helped low-ability students to continue studying as it saved them from failing certain courses. This interpretation is supported by the analysis of ECTS credits that reveals increased credit takeup and completion among the low-ability students of the 2019/20 cohort.

This study can be thus interpreted as a careful warning that students educated during the COVID-19 pandemic might differ from their older (or younger) colleagues in terms of acquired skills. It also opens the discussion on optimal exam passing thresholds. Lowering course requirements lets more students enter the final years of study. Many of them completed the remaining study requirements and defended a final thesis. Following these students during their further studies (Master-level) or during their labor market career is an avenue for further research. It might reveal whether the 'additional' graduates generated by the specific situation of lowered exams difficulty are comparable to the 'usual' graduates.

CRediT authorship contribution statement

Barbara Pertold-Gebicka: Writing – review & editing, Writing – original draft, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

The data that has been used is confidential.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.labeco.2024.102601.

References

Abraham, A., Chaabna, K., Sheikh, J.I., Mamtani, R., Jithesh, A., Khawaja, S., Cheema, S., 2024. Burnout increased among university students during the COVID-19 pandemic: a systematic review and meta-analysis. Sci. Rep. 14 (1), 2569.

Agostinelli, F., Doepke, M., Sorrenti, G., Zilibotti, F., 2022. When the great equalizer shuts down: Schools, peers, and parents in pandemic times. J. Public Econ. 206, 104574.

Aucejo, E.M., French, J., Araya, M.P.U., Zafar, B., 2020. The impact of COVID19 on student experiences and expectations: evidence from a survey. J. Public Econ. 191, 104271.

Balderas, A., Caballero-Hernández, J.A., 2020. Analysis of learning records to detect student cheating on online exams: case study during COVID-19 pandemic. In: ACM International Conference Proceeding Series, pp. 752–757.

Bettinger, E.P., Fox, L., Loeb, S., Taylor, E.S., 2017. Virtual classrooms: How online college courses affect student success. Am. Econ. Rev. 107 (9), 2855–2875.

Bonacini, L., Gallo, G., Fabrizio, P., 2023. Unraveling the controversial effect of Covid-19 on college students' performance. Sci. Rep. 13 (1), 15912.

Cacault, M.P., Hildebrand, C., Laurent-Lucchetti, J., Pellizzari, M., 2021. Distance learning in higher education: evidence from a randomized experiment. J. European Econ. Associat. 19 (4), 2322–2372.

Coates, D., Humphreys, B.R., Kane, J., Vachris, M.A., 2004. No significant distance" between face-to-face and online instruction: Evidence from principles of economics. Econ. Educat. Rev. 23 (5), 533–546.

Engzell, P., Frey, A., Verhagen, M.D., 2021. Learning loss due to school closures during the COVID-19 pandemic. Proc. Natl. Acad. Sci. 118 (17), e2022376118.

Gonzalez, T., De La Rubia, M.A., Hincz, K.P., Comas-Lopez, M., Subirats, L., Fort, S., Sacha, G.M., 2020. Influence of COVID-19 confinement on students' performance in higher education. PLoS One 15 (10), e0239490.

Grewenig, E., Lergetporer, P., Werner, K., Woessmann, L., Zierow, L., 2021. COVID-19 and educational inequality: How school closures affect low-and high-achieving students. European Econ. Rev. 140, 103920.

Hardt, D., Nagler, M., Rincke, J., 2023. Tutoring in (online) higher education: experimental evidence. Econ. Educat. Rev. 92, 102350.

Hu, K., Godfrey, K., Ren, Q., Wang, S., Yang, X., Li, Q., 2022. The impact of the COVID-19 pandemic on college students in USA: two years later. Psychiatry Res. 315, 114685.

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., Prieto, J.L., 2021. Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. Comput. Hum. Behav. 119, 106713.

Karadag, E., 2021. Effect of COVID-19 pandemic on grade inflation in higher education in Turkey. PLoS One 16 (8), e0256688.

Kuchler, T., Zafar, B., 2019. Personal experiences and expectations about aggregate outcomes. J. Finance 74 (5), 2491–2542.

Malmendier, U., Nagel, S., 2016. Learning from inflation experiences. Quarterly J. Econ. 131 (1), 53–87.

Rodríguez-Planas, N., 2022a. COVID-19, college academic performance, and the flexible grading policy: a longitudinal analysis. J. Public Econ., 104606

Rodríguez-Planas, N., 2022b. Hitting where it hurts most: COVID-19 and low-income urban college students. Econ. Educat. Rev. 87, 102233.

Saw, G.K., Chang, C.N., Lomelí, U., 2020. Fall enrollment and delayed graduation among STEM students during the COVID-19 Pandemic. Network Res. Evaluat. in Educat. (NREED) Data Brief (1).

Xu, D., Jaggars, S.S., 2014. Performance gaps between online and face-to-face courses: differences across types of students and academic subject areas. J. High Educ. 85 (5), 633–659.