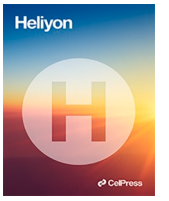
Heliyon 9 (2023) e16464

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



Research article

The effect of lockdown on students' performance: A comparative study between Italy, Sweden and Turkey

Giorgia Casalone [a,b,*], Alessandra Michelangeli [c,d], John Östh [e,f], Umut Türk [g]

[a] Department of Economics and Business, University of Piemonte Orientale, Vercelli, Italy
[b] Dondena Centre for Research on Social Dynamics and Public Policy, Italy
[c] Department of Economics, Management and Statistics (DEMS), University of Milan-Bicocca, Milan, Italy
[d] DEMS, CefES, CISEPS, Italy
[e] Department of Built Environment, Oslo Metropolitan University, Oslo, Norway
[f] Department of Social and Economic Geography, Uppsala University, Uppsala, Sweden
[g] Economics Department, Abdullah Gül University, Turkey

ARTICLE INFO

Keywords:
COVID-19 pandemic
Students' outcomes
Student's integration
Time-to-study
Difference-in-Differences

ABSTRACT

During the first months of the COVID-19 outbreak, countries adopted different strategies in order to mitigate the effects of the pandemic, ranging from recommendations to limit individual movement to severe lockdown measures. Regarding higher education, university studies were shifted to digital solutions in most countries. The sudden move to online teaching affected students differently, depending on the overall mitigation strategies applied. Severe lockdown and closure measures caused a disruption of their academic and social interactions. In contrast, recommendations to limit activities probably did not change students' life to a great extent. The heterogeneity of the policies adopted in three countries (Italy, Sweden and Turkey) gives us an opportunity to assess the effects of lockdown measures due to the COVID-19 pandemic on university students' performance. We employ a difference-in-differences approach by exploiting the fact that Italy and Turkey experienced national lockdowns, while Sweden never applied nationwide mandatory restrictive policies. We use administrative data from universities in the three countries to estimate the probability to pass exams after the spread of COVID-19 pandemic (and the shift to distance education), with respect to the previous comparable period. We find that the pass rate decreased with the shift to online teaching. However, lockdown measures, especially if very restrictive as those applied in Italy, helped to compensate such negative effect. A possible explanation is that students took advantage of the huge increase in the time available for their studies, given the impossibility to carry out any activity outside the home.

1. Introduction

COVID 19 pandemic hit the education systems worldwide, leading to school closures and rapid transition to online learning. The short and long-term effects of school disruption on students' achievement and educational inequalities are matter of debate and widely studied in the aftermath of pandemic [1] (European Commission 2022).

With regard to tertiary education, the higher age of the students (mostly adult), their full autonomy in addressing learning

* Corresponding author. Dipartimento di Studi per l'Economia e l'Impresa, Università del Piemonte Orientale, via Perrone 18, Novara, Italy.
E-mail address: giorgia.casalone@uniupo.it (G. Casalone).

https://doi.org/10.1016/j.heliyon.2023.e16464
Received 3 January 2023; Received in revised form 16 May 2023; Accepted 17 May 2023
Available online 23 May 2023

activities, the fact that they come from more advantageous social groups[1] would suggest that the closure of universities and colleges and the shift to the online was less troublesome. Nevertheless, the complexity of the topics addressed within university courses, the need to complement theory with practical activities (laboratories) in certain fields of study (medical studies, pharmacy, biology, chemistry, etc.), the organization of assessment activities which put a lot of responsibility on student motivation, raise doubts about the efficacy of an unprepared shift to the distance education.

Furthermore, students were affected by far-reaching changes in all aspects of their daily life during the outbreak of the pandemic. Some countries adopted mandatory containment (lockdown) measures forcing people to stay at home with no interactions apart from family components, other countries recommended responsible behavior. How did these "social" limitations interact with the university closures and the shift to the online learning?

On the one hand, lockdown measures determined a disruption of the social interactions on campus and during classes, which are a fundamental part of the academic experience [3–5] (Pascarella and Terenzini, 1979; Pascarella et al., 1986; Tinto, 1997).[2] A vast literature argues that any explanation of student outcomes should pay attention to the institutional and social context in which students behave [7] (Aljohani 2016). Students are more likely to stay enrolled when they are involved in campus activities and feel a sense of community in the institution [4,8–10] (Pascarella et al., 1986; Tinto 1993; Elkins et al., 2000; Flynn, 2014). All these dimensions of the students' lives came to an abrupt halt and this may have negatively affected their motivation. On the other hand, the closure of activities where young people spends leisure time or where students work part time (e.g. restaurants, cafés, etc.), had the unexpected effect of forcedly increasing the time available to study. Study time is, together with student ability, a determinant of educational achievements. Analyses carried out in the US, as an example, observe a decrease in the time spent attending classes and studying due to the fact that students work [11] (Scott-Clayton, 2012). Several contributions confirm that working negatively affects academic performance and that the time devoted to study is a main determinant of students' success [12,13] (Darolia 2014; Hovdhaugen 2015). The forced increase in the time available for studying due to lockdown measures could then have compensated the negative effect caused by the shift to online teaching and the disruption of academic and social interactions on campus.

To assess the overall effects of lockdown measures undertaken during pandemic, we compare the university student outcomes in three countries before and during COVID-19 emergency: Italy, Sweden and Turkey. Comparison across these countries is interesting because the three governments adopted very different strategies to address the emergency, while sharing similar measures as for higher education institutions.

Italy has been the first and hardest hit European country. On March 9, 2020, the Italian government imposed a national lockdown, restricting the movement of the whole population except for work needs, emergency and health circumstances. Italy started relaxing its lockdown on May 4, after almost two months. The Turkish government imposed a lockdown to the population over-65s and under-20s, with weekend curfews and the closure of bars, restaurants and other meeting places. Sweden adopted a different strategy compared to Italy and Turkey. No mandatory measures were taken to limit activities and people movements, but recommendations to avoid gatherings with too many people and to restrict mobility were communicated to the public [14] (Claeson and Hanson, 2020). In general, the strategy was successful in the sense that most individuals voluntarily restricted their mobility [15,16] (see for instance Dahlberg et al., 2020; Toger et al., 2021).

To better compare such strategies, we take advantage of the Oxford Covid-19 Government Response Tracker (OxCGRT).[3] Two indices are particularly useful to assess the severity of the containment measures: the "Stay at home requirements" and the "Movement restrictions" indices. Table 1 reports the sum of the daily indices recorded between January 1st and June 30th' 2020 in Italy, Turkey and Sweden together with the average value for all the 186 countries analyzed.

The Swedish "case" clearly emerges: the first index records a maximum value of 1 (out of 3), corresponding to a simple "Recommendation not leaving home", while for Italy and Turkey it scores the maximum (3), corresponding to "Require not leaving house with minimal exceptions", for several days. Although Italy and Turkey score the same in the "Stay at home requirements" index, Turkey applied strict containment measures only towards a portion of the population (over 65s and under 20s). University students were then only partially affected by the measures, therefore we can argue that lockdown measures were more severe and general in Italy than in Turkey.

In all the analyzed countries, nationwide containment measures have been accompanied by the closure of universities and by the rapid transition from face-to-face classes to on line teaching. However, in one case (Italy) they were also forced to stay at home, wholly isolated from other people. In another case (Turkey) they were compelled to stay at home (if under 20), or otherwise almost completely limited in their social life. Finally, in the last case (Sweden) they could continue their "usual" social life, to meet people (also within university libraries, study rooms, computer labs which remained open), make physical activity, go to bars and restaurants, etc. With mild limitations.

We look at COVID19 pandemic as a shock that abruptly changed the population habits and forced students to shift learning activities online, limiting or canceling their life on campus, thus hampering their relationships with peers and the faculty. Did the shift to

[1] "In all countries [….], individuals whose parents have not attained tertiary education are under represented among new entrants to bachelor's, long first degree or equivalent programmes" [2, p. 234].

[2] For a review of the determinants of student success see Ref. [6] Aina et al., 2021.

[3] https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker Accessed November 15, 2021. OxGRT collects information on policy measures that governments have taken to tackle COVID-19 since 1 January 2020. Policies are coded into 23 indicators, such as school closures, travel restrictions, vaccination policy. OxGRT records policies on a scale to reflect the extent of government action, and scores are aggregated into a suite of policy indices.

Table 1
Stay at Home and Movement Requirements indices.

	Italy	Turkey	Sweden	All countries (average)
Stay at home requirements index	221	220	98	149
Movement restrictions index	206	170	86	142

Source: Oxford COVID-19 Government Response Tracker, Blavatnik School of Government, University of Oxford. Stay at home requirements index: 0 - no measures; 1 - recommend not leaving home; 2 - require not leaving house with exceptions for daily exercise, grocery shopping, and essential trips; 3 – require not leaving house with minimal exceptions (eg allowed to leave once a week, or only one person can leave at a time, etc.). Movements restrictions index: 0 - no measures; 1 - recommend not to travel between regions/cities; 2 – internal movement restrictions in place.

online teaching and lockdown measures affect adult students' performance? Is there a relationship between the severity of the containment and closure measures and student outcomes? Are there differences across gender and field of study in the student response to lockdown measures?

To respond to these questions, we will employ a difference-in-differences approach by exploiting the fact that Italy and Turkey experienced national closures after the outbreak of the pandemic, while Sweden did not apply this measure. Italian and Turkish students will be the treated group, Swedish students the control group.

The remainder of the paper is as follows. Section 2 describes materials and methods. Section 3 presents the results which are discussed in Section 4. The last section concludes.

2. Materials and methods

2.1. Data

We employ student-level data from three public universities located in Sweden, Italy and Turkey.[4] For all universities, administrative data record information on students' gender, age, subject of study, the courses taken in the Spring terms both in 2018–2019 and 2019–2020 academic years (i.e. during the early months of 2019 and 2020 respectively), and finally pass/fail grades. The information we retrieve has the capacity of covering all student population studying in undergraduate courses of these three universities. Overall, our sample includes 231,232 student-semester observations with full coverage across all variables (see the Appendix for more details).

Albeit students are enrolled in different universities belonging to different countries, we argue that they are comparable for three main reasons. First, tertiary education is probably the most homogeneous and comparable educational sector across countries, given the long-established tradition of teachers' and students' mobility. Second, the three countries belong to the European Higher Education Area and adhered to the Bologna process in 2001. Bologna process was aimed "to bring more coherence to Higher Education systems across Europe".[5] In particular, they all agreed to: adopt a two-tier (Bachelor and Master) tertiary education system[6]; define student workload per course and to adopt the ECTS credit system; ensure the mutual recognition of qualifications and learning periods abroad (harmonization); implement a common system of quality assurance. Third, students are all enrolled in public generalist universities that did not provide online teaching before COVID19 pandemic, i.e. they did not have expertise in online teaching.

Students' performance is defined in a simple way, as the probability to pass an exam at the end of the corresponding term. This choice was dictated by the need to make comparable students' outcomes in different higher education systems. Italy, Sweden and Turkey have different organization of the students' assessment activities. In Sweden and Turkey, as in most higher education systems, students take the exams at the end of the term in which the course is taught, and they have only one possibility to "re-sit" if they fail the exam. The exams are scheduled in one date and students are compelled to take the exam in this date. Italy has a peculiar organization of the assessment activity. Students benefit from a lot of flexibility: for each course, teachers schedule several dates (7 in the analyzed university) in which students can take the exam during the entire academic year. Students choose the date when to take the exams, and they have the possibility to take the same exam up to three times during the calendar year.[7] Furthermore, in every examination session, students can take all exams, either those of the semester just ended, either those of previous semester or even of previous academic years that they have not yet passed. For instance, in the examination session of June 2020, Italian students could take an exam of the second semester 2019/2020 (just ended), but also of the first semester of the same academic year, or of previous academic years.

In order to make comparable such different organizations of the examination sessions, we have adapted Italian data to those of the other two countries. To each student, we have associated the list of exams she is supposed to pass at the end of each term, based on the study plan of the degree program where she is enrolled. We will have as many observations as the number of exams each student is supposed to pass in the first two years.[8] Besides the necessity to use comparable data, by this way we are sure that the exams passed in the Spring and Fall 2020 examination sessions refer to courses that were taught at least partially online since March 2020. For all

[4] Due to the ethics agreement, we cannot reveal the name of the Turkish university.
[5] https://ec.europa.eu/education/policies/higher-education/bologna-process-and-european-higher-education-area_en Accessed November 15, 2021.
[6] 3 + 2 years in Italy and Sweden and 4 + 2 in Turkey.
[7] They are also allowed to repeat an exam if they are not satisfied with the grade.
[8] In the first two years there are the most compulsory courses which are common to all students.

countries, the dependent variable is equal to 1 if the student passes the exam at the end of the corresponding semester, 0 otherwise.

Table 2 reports descriptive statistics available for the three countries, while Fig. 1 shows the pass rate, calculated as the average unconditional probability to pass the exams scheduled in the study plan, before and after the shift to online education and lockdown measures. The striking low Italian pass rate depends on the peculiar organization and regulation of the examination sessions described above.

2.2. Methods

In order to isolate the effect of restrictive measures that interested all activities that needed face-to-face interactions, we adopt a difference-in-differences (DiD) approach. The latter is a statistical technique used in econometrics and quantitative research in the social sciences that attempts to mimic an experimental research design using observational study data. This technique allows to estimate the differential effect of a treatment on a 'treatment group' versus a 'control group' in a natural experiment. More specifically, it calculates the effect of a treatment on an outcome by comparing the average change over time in the outcome variable for the treatment group to the average change over time for the control group.

In our analysis, the difference-in differences (DiD) approach is used to identify the causal effect of nationwide lockdown on educational outcomes in terms of probability of passing the exams.

Students hit by more or less strict national lockdown measures (i.e. Italian and Turkish students, the treated) are compared with students living in a country that implemented soft measures to tackle the pandemic crisis (i.e. Swedish students, the controls). The treatment is the forced isolation that especially Italian students, but also Turkish students to a lesser extent, had to bear with respect to Swedish students. The outcome is a binary variable *Pass* defined as:

$$Pass = \begin{cases} 0 \text{ if the student failed the exam} \\ 1 \text{ if the student passed the exam} \end{cases}$$

The comparison is made across time: the students' success rate in the summer and fall examination sessions 2020 (post COVID-19 lockdown) is compared with the students' success rate in the corresponding sessions 2019 (pre COVID-19 lockdown) in all treated and control groups.

We estimate the following simple model:

$$Pass = \beta_0 + \beta_1 TC + \beta_2 POST + \beta_3 (TC \times POST) + \beta_4 \boldsymbol{X} + \varepsilon \quad (1)$$

where *TC* is a dummy variable equal to 1 if the student is from a treated country (i.e. country under lockdown); *POST* is a dummy variable equal to 1 if the exam is in 2020 Spring term, i.e. after the application of the lockdown measures; $\boldsymbol{X}$ is a set of control variables at the student level (gender and age), as well as at course level, where we distinguish across STEM and non-STEM courses[9]; ε is the residual term. The coefficient of the interaction term between *TC* and the *POST* dummy captures the causal effect of the lockdown measures.

Given the binary nature of the variable of interest – the pass rate -, the natural choice would be to adopt a logit or a probit model. However, we recall that DiD estimators rely on the common trend assumption according to which, in absence of the treatment, the difference between control and treatment groups would be constant over time. This hypothesis fails to be satisfied in case of non-linear or GLM models. To cope with this problem and for sake of interpretation of the results, we estimate eq. (1) with a linear probability model.

It is not easy to anticipate the findings of such analysis. On the one hand, according to the sociological literature, a lower level of social integration (due to the forced isolation) should have a negative impact on students' achievements. On the other hand, according to the literature on study time, a greater availability of time due to the closure of all activities should have a positive effect on students' outcomes. What effect has prevailed is a matter of debate.

Among the treated group, we will then distinguish between Italian and Turkish students. This allows us to overcome a methodological issue (i.e. the fact that success rate in Italy and Turkey are very different) and to assess whether student performances are affected by the intensity of the containment and closure measures. We will run estimates separated by gender and by field of study, distinguishing STEM and non-STEM degrees to assess whether there are heterogeneous effects of lockdown measures.

3. Results

Table 3 reports outputs from the DiD estimates for the full population and subpopulations by gender and the type of degree. The treated group is represented by students enrolled in Italian and Turkish universities, while the control group are Swedish students. In the analysis, all standard errors are clustered by the course identifier, in order to take account of the non-independence of observations within the same course.[10] The controls added in estimations are intended to correct for the potential simultaneous correlation between demographics and treatment and passing rates. The common trend assumption is discussed in the following section.

[9] STEM stands for Science, Technology, Engineering and Mathematics. All other courses are considered as non-STEM.

[10] Students attending the same university course share the same teachers, the syllabus and assessment methods, and the difficulty of the topics covered. Moreover, there are potential peer groups' effects.

Table 2
Summary statistics.[a]

	Sweden		Italy		Turkey	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Pass rate[a]	.686	.464	.267	.442	.826	.379
Age	24.92	3.463	21.04	1.623	22.34	2.50
Female	.556	.497	.586	.492	.336	.473
STEM	.518	.499	.645	.478	.897	.304
Sample size	131,631		33,849		9027	

[a] Pass rate is the unconditional probability to pass exams. Sample size represents the number of exams students were expected to pass in the period under analysis (i.e. summer and fall exams sessions 2019 and 2020).

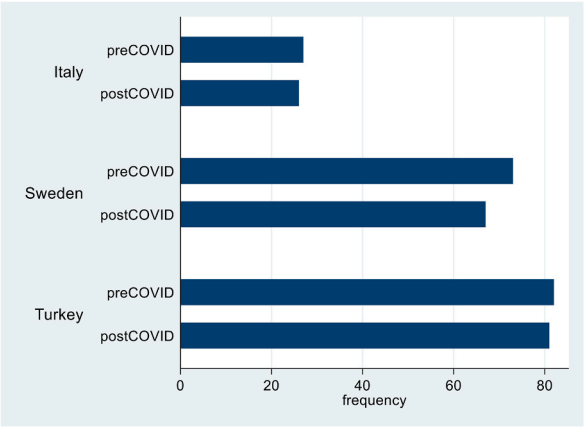


Fig. 1. Pass rate in the summer and fall examination sessions 2020 (post COVID-19 lockdown) and the corresponding sessions 2019 (pre COVID-19 lockdown).

Table 3
Effect of lockdown measures on pass rates (overall sample).[a]

	(1)	(2)	(3)	(4)	(5)
	Full model	Female Students	Male Students	STEM	Non-STEM
TC	−0.352*** (0.029)	−0.405*** (0.027)	−0.290*** (0.032)	−0.332*** (0.037)	−0.385*** (0.037)
POST	−0.063*** (0.007)	−0.069*** (0.008)	−0.057*** (0.007)	−0.077*** (0.010)	−0.049*** (0.009)
TC*POST	0.039 (0.026)	0.059** (0.025)	0.020 (0.029)	0.044 (0.034)	0.051* (0.026)
female	0.017** (0.007)			−0.023** (0.009)	0.069*** (0.007)
STEM	−0.047*** (0.015)	−0.081*** (0.015)	0.002 (0.017)		
age	0.052*** (0.013)	0.046*** (0.014)	0.049*** (0.014)	0.087*** (0.018)	0.006 (0.017)
age2	−0.001*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)	−0.002*** (0.000)	−0.000 (0.000)
Constant	0.251 (0.171)	0.370** (0.184)	0.243 (0.190)	−0.234 (0.235)	0.830*** (0.233)
Observations	174,507	96,055	78,452	98,156	76,351
R-squared	0.088	0.118	0.059	0.086	0.082

[a] Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

Treated group formed by Italian and Turkish students. Reference categories: Swedish students and 2019 exams' sessions (all models), males and Non-STEM degrees (full model).

Common to all regression outputs, the coefficient β_1 indicates that the Italian and Turkish pass rate was lower (35% points in the full model) than the Swedish one before the COVID-19 pandemic spread, on average. Coefficient β_2 shows that the pass rate dropped (by 6.3 p p. in the full model) after the spread of the pandemic in the control group (i.e. Swedish students). This coefficient usually represents, in DiD estimates, the pure effect of the passage of the time in the absence of any intervention (i.e. the time trend of the analyzed variable). In our case, the change of the POST variable from 0 to 1 does not represent only the passage of time but it also indicates the time of the spread of the pandemic, and the shift to distance education in all analyzed countries. Assuming that the pure

time trend is negligible in pass rates at university, a variable that it is not expected to change a lot in the short time, we argue that the coefficient can be interpreted as the effect of the spread of the pandemic and the shift to distance education in the control group (i.e. Sweden).[11]

The coefficient of interest in our analysis, β_3, is positive but not statistically significant in the full model and in males and STEM subpopulations. It is positive for females, for which lockdown measures have increased the probability to pass exams by 5.9 p. p. (significant at 5% level), and, to a lesser extent, for non-STEM (+5.1 p. p., significant at 10% level). Findings suggest that restrictive policies have compensated the negative effect of the shift to distance education for women and for students who attended courses in non-STEM degrees.

Turkey and Italy constitute the treated group as both these countries adopted national lockdown measures to cope with the spread of COVID19-pandemic. However, as explained in Section 3, Italy was the country that applied the most restrictive and generalized policies (probably in the world) in the first stage of pandemic (Spring 2020), as it was the first country, after China, to be heavily hit by the health crisis. Therefore, it seems reasonable to split the treated group by country, in order to estimate the effect of more or less strict lockdown measures. Moreover, Italy and Turkey have very different pass rates (very low in Italy and very high in Turkey), while Swedish pass rate stays between the two. This makes the β_1 coefficient poorly informative as its value depends on the weight of the Italian and Turkey samples, and all coefficients more difficult to interpret as a consequence. We then repeat the estimates on the two subsamples of Italy (treated) vs. Sweden (control) and of Turkey (treated) vs. Sweden (control). As for the first estimates (Table 4), findings confirm the sign and significance of β_1 and β_2 coefficients. The coefficient of the interacted term, in this case, is positive and always significant: the positive impact of containment measures in Italy has almost fully compensated the negative effect of distance education, captured by β_2.

Treated group formed by Italian students. Reference categories: Swedish students and 2019 exams' sessions (all models), males and Non-STEM (full model).

In the second estimates (Table 5), β_1 coefficient is positive as expected, as Turkey has a higher pass rate than Sweden, while the coefficient of the interaction term is positive but not significant, with the exception of non-STEM courses (6.6 p. p increase in the pass rate). In the case of Turkey, restrictive measures that reduced students' mobility did not fully compensate the negative effect of distance education, although the pass rate decreased very little.

Treated group formed by Turkish students. Reference categories: Swedish students and 2019 exams' sessions (all models), males and Non-STEM degrees (full model).

3.1. Common trend assumption

To test the common trend hypothesis of the DiD approach, which assumes the evolution of the variable of interest would have been the same for the treatment and the control groups without the lockdown, we estimate the following regression:

$$Pass = \alpha + \beta TC + \sum_{i=1}^{4} \gamma_i Term_i + \sum_{i=1}^{4} \delta_i (TCxTerm_i) + \vartheta \boldsymbol{X} + \varepsilon \tag{2}$$

We utilize four exam periods (Terms) observed in the dataset, where the last one (the fourth) defines the COVID-19 period. In the previous terms, the exam months are divided in three distinct exam periods, similarly defined in the three countries. We want to test the assumption that the interaction terms (*TCxTerm*) are not statistically different from zero, a part from the last one when changes occurred due to COVID-19 emergency and consequent confinement measures. The results clearly show that the differences in success rates between the treatment and control significant change only in the Post-COVID period (Table 6).

We also ran the same analysis for the three countries and predict the likelihood of success.[12] The results shown in Fig. 2 illustrate the similar differences between the countries in the Pre-COVID period. We observe a decline in the success rates in the Post-COVID period for all countries but the decline is steeper in Sweden. This also supports our findings.

3.2. Intra Class Correlations

To further the analysis conducted above, we also look for deviations in variations in passing grades before and during the pandemic. As a point of departure, we assume that there are courses that are easier to pass than others in both STEM and non-STEM fields, and for all of the three countries. This means that there will be variations between courses that could be measured statistically. We can also assume that if the educational system as well as students' preparedness are resilient, the between course variation in shares of pass grades will be similar both before and during the pandemic, as well as STEM and non-STEM fields. However, if the variation between courses grows over time, the results may indicate vulnerabilities in the grading of students. In order to test for this, we set up a series of empty multi-level analyses where we measure the Intra Class Correlation (ICC), i.e. the share of variation in passing grades that can be attributable to the course level and how much that remains at individual level. An empty multi-level regression can be formulated as follows:

[11] According to equation (1) β_2 is the difference between the outcomes of the students in the untreated country (Sweden) before and after the shift to online learning. A discussion about other possible interpretation of the β_2 coefficient is offered in Section 3.1.

[12] In this case, the specification is simply $Pass = \alpha + \sum_{i=1}^{4} \gamma_i Term_i + \vartheta \boldsymbol{X} + \varepsilon$.

Table 4
Effect of lockdown measures on pass rates (Italy vs. Sweden).[a]

	(1)	(2)	(3)	(4)	(5)
	Full model	Female Students	Male Students	STEM	Non-STEM
TC	−0.508*** (0.020)	−0.507*** (0.022)	−0.501*** (0.021)	−0.551*** (0.024)	−0.434*** (0.034)
POST	−0.063*** (0.007)	−0.068*** (0.008)	−0.056*** (0.007)	−0.077*** (0.010)	−0.049*** (0.009)
TC*POST	0.056*** (0.018)	0.062*** (0.020)	0.050*** (0.018)	0.064*** (0.022)	0.050** (0.026)
female	0.037*** (0.005)			0.019** (0.008)	0.069*** (0.007)
STEM	−0.071*** (0.013)	−0.093*** (0.014)	−0.044*** (0.014)		
age	−0.002 (0.011)	0.005 (0.013)	−0.011 (0.012)	0.003 (0.015)	−0.012 (0.017)
age2	−0.000 (0.000)	−0.000* (0.000)	−0.000 (0.000)	−0.000 (0.000)	−0.000 (0.000)
Constant	0.982*** (0.153)	0.938*** (0.175)	1.084*** (0.167)	0.872*** (0.207)	1.079*** (0.228)
Observations	165,480	93,010	72,470	90,097	75,383
R-squared	0.143	0.157	0.124	0.168	0.095

[a] Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 5
Effect of lockdown measures on pass rates (Turkey vs. Sweden).[a]

	(1)	(2)	(3)	(4)	(5)
	Full model	Female Students	Male Students	STEM	Non-STEM
TC	0.109*** (0.027)	0.129*** (0.026)	0.095*** (0.030)	0.097*** (0.029)	0.114*** (0.033)
POST	−0.063*** (0.007)	−0.069*** (0.008)	−0.057*** (0.007)	−0.077*** (0.010)	−0.049*** (0.009)
TC*POST	0.032 (0.026)	0.023 (0.023)	0.033 (0.031)	0.041 (0.030)	0.066** (0.029)
female	0.043*** (0.006)			0.025*** (0.008)	0.066*** (0.007)
STEM	−0.049*** (0.013)	−0.068*** (0.015)	−0.026* (0.014)		
age	0.029*** (0.010)	0.037*** (0.012)	0.021* (0.012)	0.032** (0.014)	0.028* (0.015)
age2	−0.001*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)
Constant	0.551*** (0.139)	0.500*** (0.163)	0.647*** (0.157)	0.490*** (0.186)	0.540*** (0.202)
Observations	140,658	76,210	64,448	76,297	64,361
R-squared	0.032	0.033	0.028	0.033	0.028

[a] Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 6
Test of the common trend assumption.[a]

	(1)
	pass
TC	−0.1009*** (0.0266)
2. Term	−0.0420*** (0.0104)
3. term	0.0004 (0.0292)
4.term	−0.2637***(0.0093)
1.TC*2.term	0.0398 (0.0262)
1.TC*3.term	0.0140 (0.0319)
1.TC*4.term	0.2458*** (0.0290)
STEM	−0.0574***(0.0119)
age	−0.0209*** (0.0069)
age2	0.0002 (0.0001)
female	0.0266*** (0.0056)
Constant	1.3552*** (0.0996)
Observations	116,256
R-squared	0.0757

[a] Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

$$Pass_{ij} = \beta_0 + u_j + e_{ij} \tag{3}$$

where u_j represents course-specific random effect and e_{ij} the individual-specific error. The ICC is calculated as $u_j/(u_j + e_{ij})$. In Tables 7–9 the results are shown for each country separately. The results indicate that there is a small increase in ICC in Sweden over time (Table 7), and even a slight decrease in ICC if we only compare before and during the pandemic for the non-STEM. The results are more different if we turn to Italy. In Table 8 the six empty models indicate that ICC for the full models (including both STEM and non-STEM courses) increase from 17.57% to 27.04% during the pandemic. However, in contrast to the Swedish case, the increase in variation comes from the non-STEM courses, while the STEM shows a decrease in ICC. A possible explanation might be that most STEM

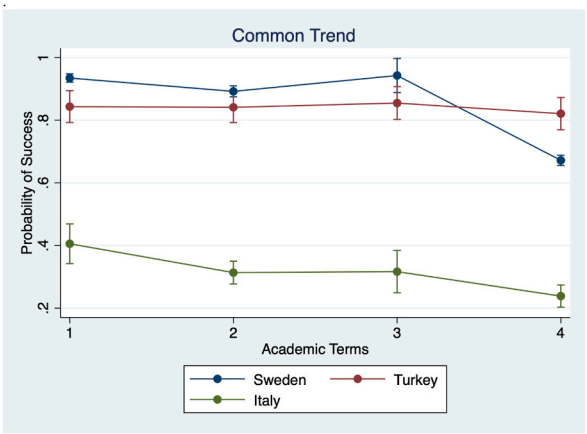


Fig. 2. Predicted probability of success by academic semesters and countries.

Table 7
Intra class correlations pre and post covid – Sweden.[a]

Sweden	PreCovid (Full)	PostCovid (Full)	PreCovid (STEM)	PostCovid (STEM)	PreCovid (Non-STEM)	PostCovid (Non-STEM)
Variables	pass	pass	pass	pass	pass	pass
Constant	0.6837*** (0.0057)	0.6279*** (0.006)	0.6996*** (0.0082)	0.63*** (0.0091)	0.6695*** (0.0079)	0.6259*** (0.0079)
Var(Residual)	0.1582	0.1724	0.1661	0.1796	0.1504	0.1648
Var(CourseID)	0.0552	0.0639	0.0512	0.0653	0.0588	0.063
ICC	0.2587	0.2704	0.2358	0.2667	0.2813	0.2765
Observations	67,979	78,278	33,947	40,070	34,032	38,208
Number of groups	2201	2280	973	992	1228	1288

[a] Standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

Table 8
intra class correlations pre and post covid – Italy.[a]

Italy	PreCovid (Full)	PostCovid (Full)	PreCovid (STEM)	PostCovid (STEM)	PreCovid (Non-STEM)	PostCovid (Non-STEM)
Variables	pass	pass	pass	pass	pass	pass
Constant	0.3204*** 0.0211	0.6279*** 0.006	0.2525*** 0.025	0.196*** 0.0091	0.398*** 0.0306	0.0442*** 0.0079
Var(Residual)	0.1694	0.1724	0.1518	0.1475	0.2018	0.1948
Var(CourseID)	0.0361	0.0639	0.027	0.02	0.0349	0.0442
ICC	0.1757	0.2704	0.1511	0.1195	0.1476	0.1851
Observations	16,390	17,885	10,615	11,376	5775	6509
Number of groups	85	87	45	45	40	42

[a] Standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

Table 9
Intra class correlations pre and post covid – Turkey.[a]

Turkey	PreCovid (Full)	PostCovid (Full)	PreCovid (STEM)	PostCovid (STEM)	PreCovid (Non-STEM)	PostCovid (Non-STEM)
Variables	pass	pass	pass	pass	pass	pass
Constant	0 .8608*** 0.0129	0.8250*** 0.0147	0.8538*** 0.0142	0.8045*** 0.0165	0.8744*** 0.0328	0.8755*** 0.0333
Var(Residual)	0.0988	0.1097	0.1009	0.1159	0.0387	0.0567
Var(CourseID)	0.0292	0.0380	0.0322	0.0425	0.0735	0.0485
ICC	0.2282	0.2576	0.2423	0.2684	0.3450	0.4611
Observations	4648	4379	4188	3871	460	508
Number of groups	283	247	254	217	55	59

[a] Standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

courses in Italy have kept parts of the tuition mandatory, such as lab-classes, which meant that students in most cases have been asked to remain close to the university, and have not been able to travel *home* in the same way that has been possible for non-STEM students.[13]

Finally, in Table 9, the results from the Turkish empty model regressions reveal that there is a degree of increase in ICC for all student groups, which suggests that online education has created significant inequalities in student success in Turkey, especially in the case of non-STEM students.

4. Discussion

Our analysis yields two main findings. First, the shift to online teaching negatively affected the probability to pass university exams. Second, when online teaching was coupled with strict national lockdown measures, that limited almost completely the students' mobility forcing them to stay at home, the negative effect vanished, especially for non-STEM courses.

As for the first finding, our study fits in the literature assessing the impact of the shift to online learning during the COVID 19 pandemic. Results are mixed. Among studies that find a negative effect, a couple of recent papers [17], Kofoed et al. (2021) and [18] Bird et al. (2022) estimate differences in student outcomes between online and in-person instruction during COVID-19. The latter applies two complementary difference-in-difference frameworks on Virginia's community college students. The former conducts a randomized control trial at West Point Military Academy. The results show modest negative impacts (three to six percent) – close to our finding (Table 3) - on course completion in Virginia, and a fall in final grades for online students by 0.215 standard deviations at West Point [19]. Aucejo et al. (2020) is based on a survey of some 1500 students at one US University to recover the causal impact of the pandemic not only on students' current performance but also expected outcomes. The negative effects are heavier for low-income students and this exacerbates socioeconomic disparities in higher education. A study involving students and faculty members from different countries [20] (Guppy et al., 2021) shows that difficult living situations created by closure and confinement measures - more than the digital divide - are associated with lower levels of confidence in learning. Given the objective of this study, aimed at measuring students' "feeling" about their learning capacity with online courses, it is difficult to compare such findings with above studies and with our analysis. Indeed, it is possible that distance learning weakens the confidence students have on their learning capabilities without affecting their actual outcomes.

Other studies find a positive effect [21]. Gonzalez et al. (2020) conduct a field experiment among 450 students at a Spanish university. Students are divided in two groups: a control group with students from the two academic years before COVID-19, i.e. 2017-2018 and 2018–2019; an experimental group with students from 2019 to 2020 who experienced confinement measures. They find a significant positive effect of COVID-19 confinement on students' performance and interpret this result as a consequence of a general change in the autonomous learning activity [22]. Rodriguez-Planas (2021) uses a large data set of close to 12,000 records from a college in New York city to determine whether existing higher-education inequalities between the lower- and higher-income students have been widened because of the digital divide in education and the uneven access to e-learning resources. She applies difference-in-differences models and event study analyses with individual fixed effects and finds a positive impact on lower-performing lower-income students. A possible interpretation of such a positive effect is the college capacity to implement policies able to counteract the negative shock of COVID-19 pandemic.

Mixed findings of the literature depend on the different contexts analyzed, and empirical strategies but also, we argue, on the fact that focusing on one country (or university) does not allow to disentangle the effect of the shift to online teaching from the effect of containment measures adopted by governments and that affected student life outside university. Our comparative analysis has the advantage, provided that the common trend assumption holds and the difference-in-differences estimates control for time-invariant country-specific characteristics, of estimating the two effects separately.

As for the second finding, a possible explanation is that lockdown measures, by closing all non-essential activities, had the unexpected effect of increasing the time to study which is one of the determinants of students' outcomes [23–25] (Nonis and Hudson, 2006 and 2010; Babcock and Marks, 2011). More time available for the study could have helped students to compensate the negative effect of the distance education.[14] The "compensating" effect is robust for non-STEM courses, probably because these courses do not necessitate practical activities to be carried out in presence in laboratories. The positive effect of lockdown measures mostly emerges in the comparison between Italy and Sweden, less when Turkey is compared with Sweden. We think this is due to the stricter containment measures adopted in Italy than in Turkey (and Sweden of course) that changed the student time allocation to a greater extent.

University students allocate their time between three broad activities: study (attending classes and studying at home), leisure and, possibly, work. We do not have information about the time allocated to leisure activities by university students in the two treated countries (Italy and Turkey). About work, the national data from the Italian Universities Consortium AlmaLaurea[15] report that 66% of

[13] Laboratories officially re-opened for teachers and researchers on May 4th, 2020, i.e. one month before the end of the semester. From then it was possible for teachers to organize activities for students at home. Also in the two months of closure of the laboratories, teachers organized activities that could help students to acquire practical competences useful to improve their preparedness. In general, the university sought to keep continuously in touch with the students' community.

[14] A study on doctoral and early career researchers [26] (Jackman et al., 2021) emphasizes that beside challenges arising from lockdown measures, there were also benefits in terms of increasing working time, better work-life balance, resulting in a productivity increase.

[15] AlmaLaurea is an Interuniversity Consortium supported by the Ministry of University and Research (MUR) and represents about 90% of Italian graduates.

Italian graduates from first cycle degrees have working experiences during their study, of which 9.5% in a full-time long-term job, 19.8% in a part-time long-term job, while the remaining did casual works [27] (AlmaLaurea, 2020). A survey from 2018 shows that 36% percent of university students in Turkey work in either full time or part time jobs, a share very similar to Italian data [28] (Şeker et al., 2020). Having a job allows students to support their monthly expenses, especially if they live in a city other than their parents. However, working reduces the possibility to attend university courses: full-time workers report that they attended, on average, less than 34% of the yearly classes, part-time students 68%, while full-time students around 80% [27] (AlmaLaurea, 2020). Turkey containment measures were less severe than in Italy: as an example, working-age adults had no movement limitations so not to stop the economy and they were allowed to pursue their activities.[16] We argue that students' use of time was affected to a lesser extent than in Italy.

As explained above, the comparative analysis, which has the advantage of disentangling the effect of the shift to online teaching from the effect of lockdown measures, may have a causal interpretation only if the common trend assumption holds. Although we proved that pass rates have a common trend before and after COVID 19 pandemic in the three countries (Fig. 2), the assumption is still debatable, as other events in the first semester 2020 could have affected the pass rate differently in the three countries (apart from lockdown measures). The proposed identification strategy relies on the assumption that such "other" events did not affect university students' achievements or that they affected them likewise in the three countries (being captured by the β_2 coefficient). This would imply that we can reasonably exclude time-variant country specific effects.

The first event to be considered is the COVID19 disease itself. The severity of the pandemic - at least in the early months of 2020 – was different in the three countries and this could have impacted differently on students' outcomes. However, especially in the initial phase, before the Delta variant became predominant (mid-2021), COVID19 affected severely mainly old people. According to Italian Health Institute (ISS) statistics, in the period March–September 2020, individuals who tested positive to COVID19 in the age range between 20 and 29 years amounted to less than 30.000, i.e. less than 0.5% of the corresponding population.[17] Moreover, the deaths were fortunately very limited in this age range (12 according to ISS), proving that young people were lightly hit by the COVID19 disease in the early months of the pandemic. As often affirmed by authorities and experts of infectious disease, lockdown measures were adopted specially to protect older people, and were perceived as a "sacrifice" that young people had to bear for the safe of the community. Therefore, our assumption is that COVID19 disease affected students mostly indirectly, as a result of the university closure, of the shift to online teaching and of the overall lockdown measures implemented in some countries. Finally, it has to be noticed that the potential direct negative effect of the disease, that we exclude for the reasons above expressed, should have hampered students' performance especially in Italy, the country most hit during early 2020 months. Since we find that Italian students performed better than their peers from Sweden (in relative terms, as compared with the same term of the previous year), we can be reassured about the fact that the disease itself did not negatively affect students' performance directly, but mainly through the authorities' responses.

The second relevant event in the early 2020 is the sudden and unexpected shift of university activities to distance education, and the higher education system reaction to these changes. Both teaching and assessments (exams) were carried out online. We argue that this change occurred in all three countries in a similar way, i.e. that it had the same effect on the university-specific pass rates, for three main reasons. First, the three analyzed universities are all public, generalist and did not have any previous experience in offering online courses. Therefore, we argue that the difficulties experienced by the academic staffs and the students were similar in the three cases. Second, they all decided to use the same publicly available platform for distance education (i.e. Zoom, GMeet, etc.), probably facing similar learning times. Third, in no case teachers received indications from their university authorities (or the Ministry of Education) to modify their assessment methods. On the contrary, there was a general consensus to be as consistent as possible with previous assessment methods and grading, in order to ensure students' results comparability over time. To check whether teachers actually adhered to these indications or, on the contrary, changed their grading, we take advantage of the Italian data which report the grades received by students in each exam passed.[18] Average grades assigned by teachers did not evidence any significant change in 2020 exams' session as compared to corresponding 2019 session (Table 10) and the *t*-test reject the null hypothesis that the pre-COVID19 and post-COVID19 average grades are different. Although we cannot rule out other changes in the behavior of teachers and students (for instance an increase in cheating or security issues), they have no impact on exam grades.

For all these reasons we are confident that our identification strategy allows us to disentangle the effect of the lockdown measures from the effect of other occurrences (i.e. the shift to online education) that were common to all countries.

5. Conclusions

Our estimates show that the COVID-19 pandemic with the shift to digital education had a negative impact on university students' pass rate. However, national lockdown measures, i.e. the closure of all non-essential activities and the limitation to individual mobility, partially compensated the negative impact of the sudden shift to distance education on students' success, at least where they were applied very strictly (Italy). According to the literature on students' outcomes, the time devoted to study is a determinant of the

[16] The Economist "What Turkey got right about the pandemic", June 6th, 2020 https://www.economist.com/europe/2020/06/04/what-turkey-got-right-about-the-pandemic.

[17] We report data for Italy which was the country most affected in terms of deaths across the three analyzed. These observations apply a fortiori to the other two countries.

[18] Exam is "passed" if student achieves a grade between 18 and 30.

Table 10
Average grades in 2019 (pre-COVID19) and 2020 (post-COVID19) summer and fall exams sessions.[a]

	Obs.	Mean	Std. Error	Std. Dev.	95% Conf. Interval	
Pre-COVID19	5729	24.386	0.0566	4.287	24.275	24.258
Post-COVID19	4937	24.378	0.0615	4.319	24.258	24.499

[a] Data refer to the Italian University. Grades range from 18 to 30.

students' success at university, although its effect is mediated by the individual ability and motivation. The adoption of lockdown measures forcedly deprived students from the possibility to spend their time in leisure activities, as well as to work to finance their studies. As a consequence, students suddenly had more time available for their studies: in this sense lockdown measures represent a kind of "natural experiment" to assess the effect of an increase in the time available to study on university student success. On the other hand, the sociological literature emphasizes that students' outcomes (in terms of persistence at university) depend on their level of integration with the institution where they are enrolled. Academic integration represents the student's level of identification with the academic system's attitude and values, and her capacity to meet the university's specific standard. Social integration refers to the extent and quality of the relationships with the faculty and peers. Such factors are key in the major studies of university dropout within the sociological approach. The shift to distance education paired with the impossibility to meet face-to-face the teachers and, especially, mates (peers) because of strict lockdown measures, determined a sudden rupture of students' social relationships. This would negatively affect students' attachment to the institution and their motivation, as well as their learning capacity if they were used to study with peers and to collaborate actively with them.

Our findings show that an abrupt and forced increase in the time students can devote to their studies improve their outcomes, and compensate the negative effect of the university closure and the difficulties arising from the new unexpected organization of the teaching activity. Results suggest that in a hypothetical education production function, more time available for the study can be a substitute for a loss of academic and social interactions, at least for adult students and in the short time. Our estimates indeed do not allow to assess whether the student success rate in an exam session will result in higher graduation rates. The substitution effect is almost complete for students enrolled in non-STEM courses that seem more easily shiftable to the online.

Data availability statement

The authors do not have permission to share data.

Additional information

No additional information is available for this paper.

Data transparency

For our analysis we use administrative data from three public universities located in Italy, Sweden and Turkey. We provide details about data and how the results were obtained in Section 2 (Materials and methods). Although data are from a proprietary data source that is not accessible to other researchers, we are certainly available to make them available for any reviewer.

Author contributions

Giorgia Casalone: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Alessandra Michelangeli: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

John Östh: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Umut Türk: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Acknowledgments

Umut Türk acknowledges the grant of the Scientific and Technological Research Council of Turkey-TUBITAK-project number: 120K273.

Appendix

[A] The data used in the analysis was collected as administrative data by three universities in Italy, Sweden and Turkey. The data collection procedure was as follows.

1. Student Registration: All students at the universities register on the University Information Systems (UIS) with their demographic information, department of study, and a full list of courses they were enrolled in for the following semester.
2. Syllabus and Exam Dates: The syllabuses and exam dates for each course were posted on the UIS.
3. Exam Administration: The exams were conducted, and the instructors announced the final grades on the UIS.
4. Data Collection: The UIS served as the register dataset and included information about all semesters in both the spring and fall.

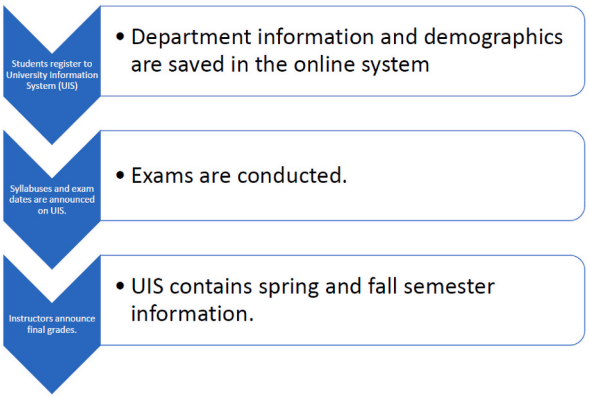


Fig. A1. Flowchart showing the information collection process in the three countries. Source: Elaborations by the authors.

(a) (b)

Fig. A2. Charts representing the distribution of university students by gender (*a*) and subject of study (*b*). Source: Elaborations by the authors.

References

[1] European Commission, Directorate-general for education, youth, sport and culture, in: Impacts of COVID-19 on School Education, Publications Office of the European Union, 2022. https://data.europa.eu/doi/10.2766/201112.
[2] OECD, Education at a Glance 2018: OECD Indicators, OECD Publishing, Paris, 2018, https://doi.org/10.1787/eag-2018-en.
[3] E.T. Pascarella, P.T. Terenzini, Student faculty informal contact and college persistence: a further investigation, J. Educ. Res. 72 (1979) 214–218.
[4] E.T. Pascarella, P.T. Terenzini, L.M. Wolfle, Orientation to college and freshman year persistence/withdrawal decisions, J. High Educ. 57 (2) (1986) 155–175, https://doi.org/10.1080/00221546.1986.11778760.
[5] V. Tinto, Classrooms as communities: exploring the educational character of student persistence, J. High Educ. 68 (6) (1997) 599–623, https://doi.org/10.2307/2959965.
[6] C. Aina, E. Baici, G. Casalone, F. Pastore, The determinants of university dropout: a review of the socio-economic literature, Soc. Econ. Plann. Sci. 79 (2021), 101102, https://doi.org/10.1016/j.seps.2021.101102.

[7] O. Aljohani, A comprehensive review of the major studies and theoretical models of student retention in higher education, High Educ. Stud. 6 (2) (2016) 1–18, https://doi.org/10.5539/hes.v6n2p1.
[8] V. Tinto, Leaving College: Rethinking the Causes and Cures of Student Attrition, second ed., University of Chicago Press, Chicago, IL, 1993.
[9] S. Elkins, J. Braxton, G. James, Tinto's separation stage and its influence on first-semester college student persistence, Res. High. Educ. 41 (2) (2000) 251–268, https://doi.org/10.1023/A:1007099306216.
[10] D. Flynn, Baccalaureate attainment of college students at 4-year institutions as a function of students engagement behaviors: social and academic student engagement behaviors matter, Res. High. Educ. 55 (2014) 467–493, https://doi.org/10.1007/s11162-013-9321-8.
[11] J. Scott-Clayton, What explains trends in labour supply among U.S. Undergraduates? Natl. Tax J. 65 (1) (2012) 181–210, https://doi.org/10.17310/ntj.2012.1.07.
[12] R. Darolia, Working (and studying) day and night: heterogeneous effects of working on the academic performance of full-time and part-time students, Econ. Educ. Rev. 38 (1) (2014) 38–50, https://doi.org/10.1016/j.econedurev.2013.10.004.
[13] E. Hovdhaugen, Working while studying: the impact of term-time employment on dropout rates, J. Educ. Work 28 (6) (2015) 631–651, https://doi.org/10.1080/13639080.2013.869311.
[14] M. Claeson, S. Hanson, COVID-19 and the Swedish enigma, Lancet 397 (2020), 10271, https://doi.org/10.1016/S0140-6736(20)32750-1.
[15] M. Dahlberg, P.A. Edin, E. Gronqvist, J. Lyhagen, J. Östh, A. Siretskiy, M. Toger, Effects of the COVID-19 Pandemic on Population Mobility under Mild Policies: Causal Evidence from Sweden, 2020 *arXiv preprint* arXiv:2004.09087.
[16] M. Toger, K. Kourtit, P. Nijkamp, J. Östh, Mobility during the COVID-19 pandemic: a data-driven time-geographic analysis of health-induced mobility changes, Sustainability 13 (7) (2021) 4027, https://doi.org/10.3390/su13074027.
[17] M.S. Kofoed, L. Gebhart, D. Gilmore, R. Moschitto, Zooming to Class?: Experimental Evidence on College Students' Online Learning during COVID-19, IZA Institute of Labor Economics Discussion Paper Series, 2021. No. 14356.
[18] K.A. Bird, B.L. Castleman, G. Lohner, Negative impacts from the shift to online learning during the COVID-19 crisis: evidence from a statewide community college system, AERA Open 8 (2022), https://doi.org/10.1177/23328584221081220.
[19] E.M. Aucejo, J. French, M.P. Ugalde Araya, B. Zafar, The impact of COVID-19 on student experiences and expectations: evidence from a survey, J. Publ. Econ. 191 (2020), https://doi.org/10.1016/j.jpubeco.2020.104271.
[20] N. Guppy, D. Boud, T. Hep, D. Verpoorten, U. Matzat, J. Tai, L. Lutze-Mann, M. Roth, P. Polly, J. Burgess, J. Agapito, S. Bartolic, Teaching and learning under COVID-19 public health edicts: the role of household lockdowns and prior technology usage, High Educ. 84 (2021) 478–504, https://doi.org/10.1007/s10734-021-00781-w.
[21] T. Gonzalez, M.A. de la Rubia, K.P. Hincz, M. Comas-Lopez, L. Subirats, S. Fort, G.M. Sacha, Influence of COVID-19 confinement on students' performance in higher education, PLoS One 15 (10) (2020), e0239490, https://doi.org/10.1371/journal.pone.0239490.
[22] N. Rodriguez-Planas, COVID-19 and College Academic Performance: A Longitudinal Analysis, 2021. IZA Discussion Paper No. 14113.
[23] S.A. Nonis, G.I. Hudson, Academic performance of college students: influence of time spent studying and working, J. Educ. Bus. 81 (3) (2006) 151–159, https://doi.org/10.3200/JOEB.81.3.151-159.
[24] S.A. Nonis, G.I. Hudson, Performance of college students: impact of study time and study habits, J. Educ. Bus. 85 (4) (2010) 229–238, https://doi.org/10.1080/08832320903449550.
[25] P. Babcock, M. Marks, The falling time cost of college: evidence from half a century of time use data, Rev. Econ. Stat. 93 (2) (2011) 468–478, https://doi.org/10.1162/REST_a_00093.
[26] P.C. Jackman, R. Sanderson, T. Haughey, C.E. Brett, N. White, A. Zile, K. Tyrrell, N.C. Byrom, The impact of first COVID-19 lockdown in the UK for doctoral and early career researchers, High Educ. (2021), https://doi.org/10.1007/s10734-021-00795-4.
[27] AlmaLaurea, Profilo dei laureati 2019, AlmaLaurea, Bologna, 2020. https://www.almalaurea.it/universita/profilo/profilo2020/volume.
[28] S.D. Seker, E.N. Ozen, A.A. Erdogan, *Jobs At Risk in Turkey: Identifying The Impact of COVID-19*. Social Protection and Jobs Discussion Paper N. 2004, World Bank, Washington, D.C, 2020. https://openknowledge.worldbank.org/handle/10986/34360 License: CC BY 3.0 IGO.