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The Effect of Lockdown on Students' Performance: A comparative study between Sweden, Italy and Turkey♦

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Abstract

During the start of the COVID-19 pandemic, different countries adopted different strategies in order to mitigate the effects of the pandemic. Regarding higher education, university studies were moved entirely to digital solutions in some countries, while other countries kept the universities open but restricted access. The sudden move to digital educational solutions affected students differently, and since different countries invented different mitigation strategies we got an opportunity to compare the effects of lockdowns due to the COVID-19 pandemic on university students' performance in Italy, Sweden and Turkey. 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 measures. 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.

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

JEL: I21; I28

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1. Introduction

The present work intends to investigate the effect of COVID-19 pandemic on students' learning outcome in higher education by focusing on three countries: Italy, Sweden, and Turkey. This comparison is interesting because the three governments adopted different strategies to address COVID-19 emergency. Italy has been the first and hardest hit European country since the beginning of March 2020. On 9 March 2020, the Italian government imposed a national lockdown, restricting the movement of population except for work needs, emergency and health circumstances. All non-essential business and industries were closed. Italy started relaxing its lockdown on May 4, after almost two months. However, schools and universities remained closed to students. The Turkish government imposed a lockdown to the population over-65s and the under-20s, with weekend curfews and the closure of bars, restaurants and other meeting places (but not of shops, although with a lot of limitations). 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 (Claeson and Hanson, 2020). In general, the strategy was successful in the sense that most individuals voluntarily restricted their mobility (see for instance Dahlberg et al, 2020; Toger et al., 2021). However, universities in Sweden remained open, and though higher education was turned into distance learning, facilities such as libraries, study-rooms, and computer labs were kept open to students which meant that students in Sweden had more options compared to peers in Turkey and Italy.

Our research question is how do these different limitations affect students' performance at university? How do containment measures affect countries with different family models (more or less traditional) and different gender stereotypes?

In these countries as elsewhere, there has been a rapid transition from face-to-face classes to online learning systems. This has determined, on one hand, a disruption of the social

interactions, which are a fundamental part of the academic experience (Aljohani, 2016; Pascarella &Terenzini, 1979; Pascarella et al. 1978; Tinto, 1997). On the other hand, students forcedly had the opportunity to devote more time to study. The amount of time dedicated to study is one of the determinants of students' outcomes (Babcock and Marks, 2011; Nonis and Hudson, 2006 and 2010).[1]

To respond to these questions, we will employ a difference-in-differences approach by exploiting the fact that Italy and Turkey experienced a (more o strict) national lockdown while Sweden never applied this measure. Italian and Turkish students will be the treated group, Swedish students the control group.

We will use administrative data from universities in the three countries. For all universities, administrative data record personal information on students (gender and age), on their field of study and the exams passed. We will compare the students' success rate in the summer and fall examination sessions 2020 (post COVID-19 lockdown) with the corresponding sessions 2019 (pre COVID-19 lockdown) in all treated and control groups. Among the treated group, we will then distinguish between Italian and Turkish students and we will run estimates separated by gender. The hypothesis we aim to test is whether in a more traditional society (Turkey), where gender stereotypes are enhanced and more persistent, girls have been spending more time to housework due to the lockdown and the university closure, thus disregarding their studies.

Our findings show that the shift to online teaching negatively affected the probability to pass exams. However, when online teaching was coupled with strict lockdown measures, that limited almost completely the students' mobility forcing them to stay all day long at home, the negative effect vanished. We argue that the sudden and huge increase of the time students can devote to their study, due to the closure of all non-essential activities and to the obligation to

[1] For a survey about the determinants of students' success see Aina et al. (2021).

remain at home, had the unexpected effect of helping them to deal with the difficulties of the distance education.

The remainder of the paper is as follows. In Section 2 we review the recent literature about the effect of COVID-19 on educational outcomes. Section 3 illustrated the measures applied in the three countries to deal with COVID-19 pandemic crisis. Section 4 describes data and variables. Section 5 discusses the empirical strategy, while Section 6 presents the results. The last section concludes.

2. Review of the literature

The state of facts in the empirical studies has a mixed picture about the effects of the pandemic on students' outcomes. The common feature that distinguishes them from our study is that they consider a single country.

Among studies that find a positive effect, 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 2019-2020 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. 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 that benefits more 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.

Among studies that find a negative effect, Aucejo et al. (2020) is based on a survey of some 1,500 students at one US University to recover the causal impact of the pandemic not only on students' current performance but also expected outcomes. Results show large negative effects in many dimensions: delayed graduation; loss of job, internship or job offer; lower expected future earnings. The negative effects are heavier for low-income students and this exacerbates socioeconomic disparities in higher education.

Our paper is not related only to the recent growing literature on the effects of distance education on students' outcomes. The difference among countries, which we aim to capture with the proposed methodology, are mainly related to the strictness of containment measures adopted that suddenly disrupted face-to-face relationships but, at the same time, forcedly increased the time devoted to study. The effect of the student time allocation and of social and academic relationships on students' outcomes are investigated in a vast literature. Analyses carried out in the US observe that the time spent attending classes and studying decreased over the past decades and that such reduction is often related to the fact that students work. Several contributions confirm that working negatively affects academic performance and that the time devoted to study is a main determinant of students' success (Darolia 2014; Hovdhaugen 2015). A vast literature argues that any explanation of student outcomes should also pay attention to the institutional and social context in which students behave (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 (Elkins et al. 2000; Tinto 1993; Pascarella et al. 1986). The main limit of this literature is that it does not account for the potential endogeneity of students' integration.

3. COVID-19 national measures

Comparing Italy, Sweden and Turkey is interesting because the three governments adopted different strategies to address COVID-19 emergency, while sharing similar measures as for higher education institutions.

Italy has been the first and hardest hit European country since the beginning of March 2020. On 9 March 2020, the Italian government imposed a severe national lockdown, restricting the movement of all population except for work needs, emergency and health circumstances. All non-essential business and industries were closed. Italy started relaxing its lockdown on May 4, after almost two months.

Turkish government imposed a lockdown only to the over-65s and the under-20s, weekend curfews and the closure of bars, restaurants and other meeting places (but not of shops, although with a lot of limitations). Working-age adults had no movement limitations so not to stop the economy.[2]

Sweden adopted a different strategy from Italy and Turkey. Government attempted to achieve herd immunity, allowing the virus to spread within the population relatively uncontrolled. No mandatory measures were taken to limit activities and people movements, only recommendations to avoid gatherings with too many people (Claeson and Hanson, 2020). In all these countries, nationwide containment measures have been accompanied by the closure of universities to students and teaching staff and by the rapid transition from face-to-face classes to on line teaching. Therefore, students were required to attend lectures and to take exams on line. 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

[2] 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

could continue their "normal" social life, to meet people, make physical activity, go to bars and restaurants, etc. with mild limitations.

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. We will compare students hit by more or less strict national lockdown measures (i.e. Italian and Turkish students, the treated) 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. 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.

4. Data

We utilize student-level data from three public universities located in Sweden, Italy and Turkey. [3] Administrative records from universities provide information on students' gender, age, subject of study, the courses taken in the Spring terms both in 2018-2019 and 2019-2020 academic years and finally pass/fail grades. The information we retrieve has the capacity of covering all student population studying in these universities.

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

[3] Due to the ethics agreement, we cannot reveal the name of the Turkish university.

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.[4] 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.[5] 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 countries, the dependent variable is equal to 1 if the student passes the exam at the end of the corresponding semester, 0 otherwise.

[4] They are also allowed to repeat an exam if they are not satisfied with the grade.
[5] In the first two years there are the most compulsory courses which are common to all students.

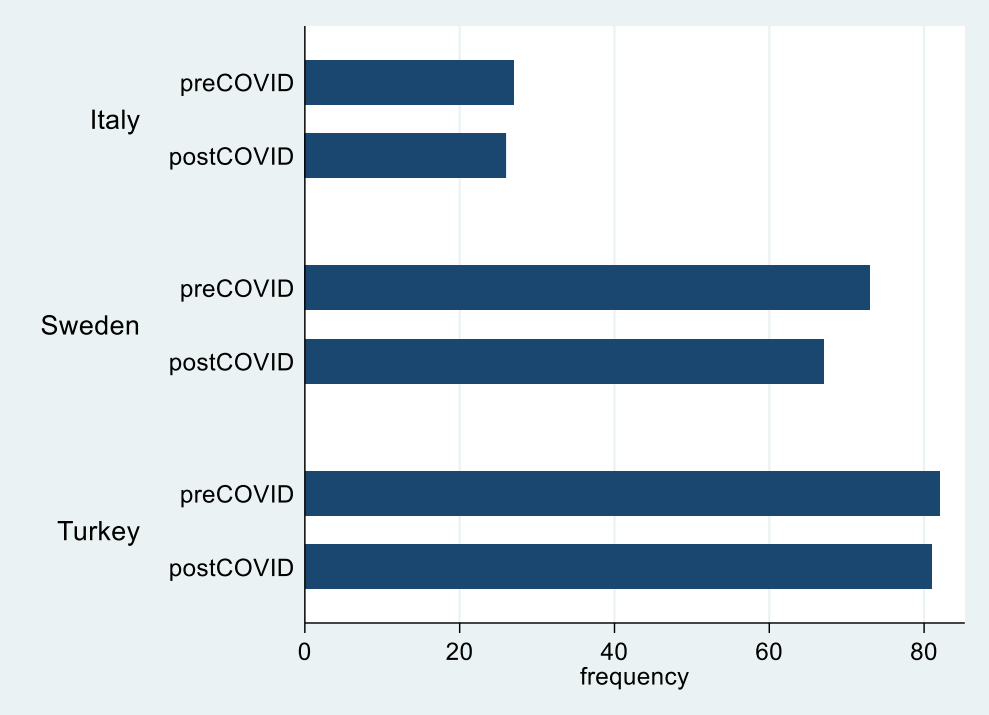
Table 1 reports descriptive statistics available for the three countries, while Figure 1 shows the pass rate, calculated as the average unconditional probability to pass the exams scheduled in the study plan, before and after the shift to online education and lockdown measures. The striking low Italian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

Table 1: Summary statistics.

	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
Hard sciences	.518	.499	.645	.478	.897	.304
Sample size	131,631		33,849		9,027	

[a]Pass rate is the unconditional probability to pass exams

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



5. Empirical strategy

We employ a difference-in differences (DiD) approach to identify the causal effect of nationwide lockdown on educational outcomes in terms of probability of passing the exams. DiD approach consists in comparing the changes in outcomes over time between students affected by the lockdown (the treatment group) and students who were not (the comparison group). In our case, Turkish and Italian students are the treatment group and Swedish students are the control group. The outcome is a binary variable *Pass* defined as:

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

We estimate the following simple model:

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

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 (hard or soft sciences degree); ε is the residual term. Our main variable of interest is the student nationality, where Italians and Turkish are the treatment group. 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.

6. Results

Table 2 reports the 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.[6] 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 Appendix.

Table 2. Effect of lockdown measures on pass rates (overall sample).

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Full model	Female Students	Male Students	Hard Sciences	Soft Sciences
TC	-0.352***	-0.405***	-0.290***	-0.332***	-0.385***
	(0.029)	(0.027)	(0.032)	(0.037)	(0.037)
POST	-0.063***	-0.069***	-0.057***	-0.077***	-0.049***
	(0.007)	(0.008)	(0.007)	(0.010)	(0.009)
TC*POST	0.039	0.059**	0.020	0.044	0.051*
	(0.026)	(0.025)	(0.029)	(0.034)	(0.026)
female	0.017**			-0.023**	0.069***
	(0.007)			(0.009)	(0.007)
hard_science	-0.047***	-0.081***	0.002		
	(0.015)	(0.015)	(0.017)		
age	0.052***	0.046***	0.049***	0.087***	0.006
	(0.013)	(0.014)	(0.014)	(0.018)	(0.017)
age2	-0.001***	-0.001***	-0.001***	-0.002***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.251	0.370**	0.243	-0.234	0.830***
	(0.171)	(0.184)	(0.190)	(0.235)	(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

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 soft-science degrees (full model).

[6] 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.

Common to all regression outputs, the coefficient β_1 indicates that the Italian and Turkish pass rate was lower (35 percentage 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 analysed 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 shift to distance education in the control group (i.e. Sweden).

The coefficient of interest in our analysis, β_3, is positive but not statistically significant in the full model and in males and hard-sciences 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 soft-sciences courses (+ 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 soft-sciences 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 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 3), 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 have almost fully compensated the negative effect of distance education, captured by β_2.

Table 3. Effect of lockdown measures on pass rates (Italy vs. Sweden).

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Full model	Female Students	Male Students	Hard Sciences	Soft Sciences
TC	-0.508***	-0.507***	-0.501***	-0.551***	-0.434***
	(0.020)	(0.022)	(0.021)	(0.024)	(0.034)
POST	-0.063***	-0.068***	-0.056***	-0.077***	-0.049***
	(0.007)	(0.008)	(0.007)	(0.010)	(0.009)
TC*POST	0.056***	0.062***	0.050***	0.064***	0.050**
	(0.018)	(0.020)	(0.018)	(0.022)	(0.026)
female	0.037***			0.019**	0.069***
	(0.005)			(0.008)	(0.007)
hard_science	-0.071***	-0.093***	-0.044***		
	(0.013)	(0.014)	(0.014)		
age	-0.002	0.005	-0.011	0.003	-0.012
	(0.011)	(0.013)	(0.012)	(0.015)	(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***	0.938***	1.084***	0.872***	1.079***
	(0.153)	(0.175)	(0.167)	(0.207)	(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

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Treated group formed by Italian students.
Reference categories: Swedish students and 2019 exams' sessions (all models), males and soft-science degrees (full model).

In the second estimates (Table 4), 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 soft-sciences courses (6.6 p.p increase in the pass rate). In the case of Turkey, restrictive measures that forced students to stay at home did not fully compensate the negative effect of distance education, although the pass rate decreased very little.

Table 4. Effect of lockdown measures on pass rates (Turkey vs. Sweden).

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Full model	Female Students	Male Students	Hard Sciences	Soft Sciences
TC	0.109***	0.129***	0.095***	0.097***	0.114***
	(0.027)	(0.026)	(0.030)	(0.029)	(0.033)
POST	-0.063***	-0.069***	-0.057***	-0.077***	-0.049***
	(0.007)	(0.008)	(0.007)	(0.010)	(0.009)
TC*POST	0.032	0.023	0.033	0.041	0.066**
	(0.026)	(0.023)	(0.031)	(0.030)	(0.029)
female	0.043***			0.025***	0.066***
	(0.006)			(0.008)	(0.007)
hard_science	-0.049***	-0.068***	-0.026*		
	(0.013)	(0.015)	(0.014)		
age	0.029***	0.037***	0.021*	0.032**	0.028*
	(0.010)	(0.012)	(0.012)	(0.014)	(0.015)
age2	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.551***	0.500***	0.647***	0.490***	0.540***
	(0.139)	(0.163)	(0.157)	(0.186)	(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

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Treated group formed by Turkish students.
Reference categories: Swedish students and 2019 exams' sessions (all models), males and soft-science degrees (full model).

6.1 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 soft and hard sciences, 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 in soft and hard sciences. However, if the variation between courses grow 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:

$$Pass_{ij} = \beta_0 + u_j + e_{ij} \quad (2)$$

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 5, 6 and 7 the results are shown for each country separately. The results indicate that there is a small increase in ICC in Sweden over time (Table 5), and even a slight decrease in ICC if we only compare before and during the pandemic for the soft sciences.

Table 5. Intra Class Correlations Pre and Post Covid – Sweden.

Sweden	PreCovid (Full)	PostCovid (Full)	PreCovid (Hard Science)	PostCovid (Hard Science)	PreCovid (Soft Science)	PostCovid (Soft Science)
VARIABLES	pass	pass	pass	pass	pass	pass
Constant	0.6837***	0.6279***	0.6996***	0.63***	0.6695***	0.6259***
	(0.0057)	(0.006)	(0.0082)	(0.0091)	(0.0079)	(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	2,201	2,280	973	992	1,228	1,288

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The results are more different if we turn to Italy. In table 6 the six empty models indicate that ICC for the full models (including both soft and hard sciences) increase from 17.57% to 27.04% during the pandemic. However, in contrast to the Swedish case, the increase in variation comes from the soft science courses, while the hard science shows a decrease in ICC. A possible explanation might be that most hard science 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 soft science students.[7]

Table 6. Intra Class Correlations Pre and Post Covid – Italy.

Italy	PreCovid (Full)	PostCovid (Full)	PreCovid (Hard Science)	PostCovid (Hard Science)	PreCovid (Soft Science)	PostCovid (Soft Science)
VARIABLES	pass	pass	pass	pass	pass	pass
Constant	0.3204***	0.6279***	0.2525***	0.196***	0.398***	0.0442***
	0.0211	0.006	0.025	0.0091	0.0306	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	5,775	6,509
Number of groups	85	87	45	45	40	42

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7. Intra Class Correlations Pre and Post Covid – Turkey.

Turkey	PreCovid (Full)	PostCovid (Full)	PreCovid (Hard Science)	PostCovid (Hard Science)	PreCovid (Soft Science)	PostCovid (Soft Science)
VARIABLES	pass	pass	pass	pass	pass	pass
Constant	0 .8608***	0.8250***	0.8538***	0.8045***	0.8744***	0.8755***
	0.0129	0.0147	0.0142	0.0165	0.0328	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	4,648	4,379	4,188	3,871	460	508
Number of groups	283	247	254	217	55	59

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Finally, in Table 7, the results from the Turkish empty model regressions reveal that there is a degree of increase in ICC for all student groups. In the case of soft science students, the

[7] 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.

increase of ICC is substantially higher, which suggests that there may be vulnerabilities in the way online education is conducted.

7. Conclusions and Discussion

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 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 to dedicate to their studies, and this should improve their performance. 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 evidence that females were more able to adapt to restrictive measures, thus signalling that forced isolation did not lead girls to neglect their studies to dedicate their time to housework or childcare, even in more traditional societies.

Appendix

We test the common trend assumption 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:

$$Pass = \alpha + \beta TC + \sum_{i=1}^{4} \gamma_i Term_i + \sum_{i=1}^{4} \delta_i (TCxTerm_i) + \vartheta \boldsymbol{X} + \varepsilon \qquad \text{(A1)}$$

We utilize four exam periods (Term) 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 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 the change in trend in the last period i.e. during the pandemic and that the differences in success rates between the treatment and control are significant only in the Post-COVID period (Table A1). We also ran the same analysis for the three countries and predict the likelihood of success[8]. The results shown in Figure A1 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.

Table A1: Test of the common trend assumption.

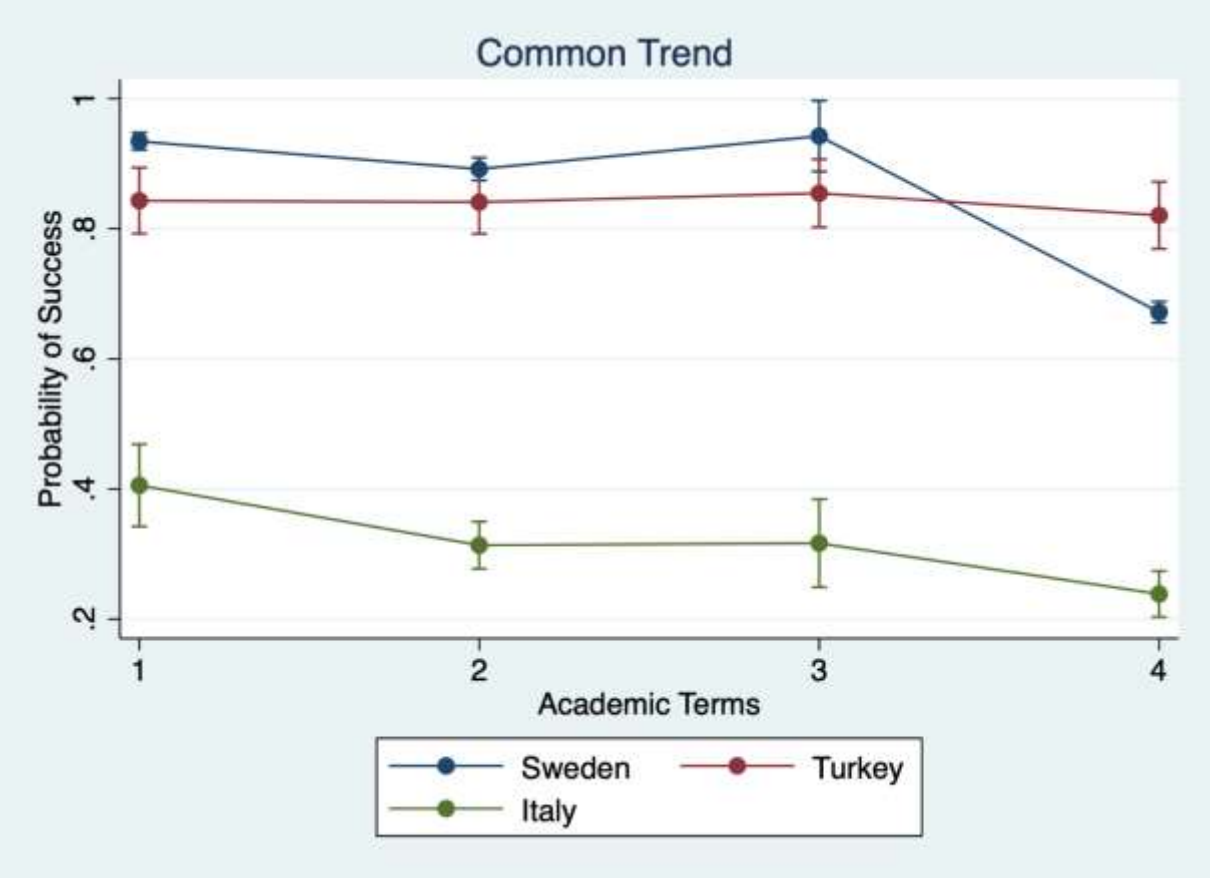
VARIABLES	(1) pass
treatment	-0.1009***
	(0.0266)
2. term	-0.0420***
	(0.0104)
3.term	0.0004
	(0.0292)
4.term	-0.2637***
	(0.0093)
1.treatment*2.term	0.0398

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

	(0.0262)
1.treatment*3.term	0.0140
	(0.0319)
1.treatment*4.term	0.2458***
	(0.0290)
hard_science	-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

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure A1: Predicted probability of success by academic semesters and countries.



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