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The impact of the COVID-19 Pandemic in Higher Education:

The case of Nova SBE undergraduate students

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Abstract

The COVID-19 Pandemic created a disruption in higher education like never seen before. While countries entered in lockdown, students and instructors had to suddenly adapt to online instruction. Through an event study analysis, this is one of the first studies to measure the impact of such disruption in a Portuguese institution – Nova SBE. We find significant evidence of heterogeneity in the effect of the Pandemic between courses taken at Nova SBE and slight evidence of differences between semesters.

Keywords: Higher Education, COVID-19 Pandemic, Online Learning, Students' Achievement, Event Study

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1. Introduction

The COVID-19 Pandemic, and the measures taken by Governments around the world to contain it, created some of the largest disruptions in our daily lives of which there is collective memory. Nearly all sectors of society were affected, from production to services, and education, in all levels, was no exception. The lockdowns imposed in most of the world forced schools to close, obliging many students of all ages and paths to abruptly move from face-to-face learning to remote classrooms, regardless of their and their educators' and institutions' preparation. This unforeseen situation, and its dire effects on learning, has led the World Bank, UNICEF and UNESCO to call it a "Global Education Crisis" at their report at the beginning of 2022.

Although such report, akin to much of the academic work produced in Economics of Education, focuses itself mostly on primary and secondary education the reality is that tertiary or higher education was not left unscathed throughout these times of uncertainty and sudden change.

In fact, education institutions in Portugal, be it primary, secondary or higher, had their in-person activities limited or forbidden for a great part of the 2019/2020 and 2020/2021 academic years – particularly for the Spring (January/February – May/June) semesters of 2020 and 2021.

Nova SBE, the higher education institution that this work project will be focusing on to measure the impacts of the Pandemic, is a public university in Portugal. Until the Pandemic almost all Bachelor-level courses were held completely in person with online platforms being used mostly for online resources and assignment submission. Most of its undergraduate students are Portuguese and enter through the "national admission programme", ranked by their admission grades.

In the case of Nova SBE, Spring 2020 saw the beginning of the Pandemic Crisis, as classes and exams were abruptly moved to a fully online format at the beginning of March, not

returning to in-person format until the following semester. The Fall 2020 was held entirely on-campus but, in most courses, there was a mix of in-person and online classes. The Spring 2021 semester began, again, with the great majority of classes being held online, with in-person activities – including exams – only returning to campus by mid-April.

In this work project, we intend to understand how the Pandemic disruption has affected higher education students' academic performance. We do so through an event study analysis comparing academic outcomes of undergraduate students at Nova School of Business and Economics both between courses and between Pandemic semesters. In the end, we find significant evidence of a heterogeneous effect of the Pandemic in certain courses and modest evidence of heterogeneity between semesters.

This is the first study of the type with Portuguese higher education data that considers and compares multiple courses in multiple semesters before and during the COVID-19 Pandemic.

In Section 2, we review the recent literature on the effects of the Pandemic Crisis at the higher education level and older literature on remote instruction. In Sections 3 and 4, respectively, we describe the Data and the Methodology used to calculate the results presented in Section 5. Section 6 discusses the results and concludes the Work Project.

2. Literature Review

Although the COVID-19 pandemic has disrupted higher education institutions, affecting students and faculty in many ways, one of its main effects was the sudden forced transition to virtual teaching.

The literature about the effects of online instruction on higher education students precedes the inception of the Pandemic Crisis. Ever since the turn of the 21st Century, when many American for-profit colleges started offering online options (Deming et al., 2012), economists

have been studying such novel modes of instruction to assess their potential compared to traditional face-to-face instruction.

In 2010, the US Department of Education produced a meta-analysis of some of the earlier experimental or quasi-experimental studies (from 1996 through 2008) on online learning where the authors defined the three different modes of instruction that remain the standard to this day – virtual, blended/hybrid and face-to-face.

A critical issue when studying online modalities of teaching is the self-selection of students into online or face-to-face classes, Coates et al (2004). Literature based on observational evidence attempts to address this issue either through matching methods (Xu and Jaggars, 2011) or through instrumental variables approaches. Xu and Jaggars (2013) and Bettinger et al (2017), using distance between students' homes and campus as IV for online teaching choice, have found negative Local Average Treatment Effects of online course taking relative to the conventional face-to-face setting.

Regarding experimental evidence, the following results have been identified: no significant difference in student performance between the traditional and hybrid format (Bowen et al, 2013 and Alpert et al, 2016); significant difference between online and traditional classes (Alpert et al, 2016), particularly for lower-achieving students (Figlio et al, 2013 and Cacault et al, 2021).

During the Pandemic, however, students did not select themselves into a given instruction modality. They were forced to take classes online. Course instructors also had no option but to teach online, regardless of their previous experience or preparation.

Through a Randomized Control Trial in a highly-controlled military setting, Kofoed et al (2021) finds a lower-bound negative effect of online instruction during the Pandemic, relative to face-to-face teaching, affecting disproportionally more the academically at-risk students. Orlov et al (2021), on the other hand, shows negative effects of the Pandemic on learning, as

measured by a low-stakes test, with heterogeneity across courses taken. The authors find that such differences between courses are mostly determined by pedagogical factors rather than student demographic ones.

Regarding observational evidence for the Pandemic Period, Bird et al (2022) compares students who selected themselves into online courses with those who preferred to take the same course in a conventional setting. Through a difference-in-differences methodology, it finds a negative effect of the forced transition to online on course completion, particularly for lower-achieving students, despite evidence of more lenient grading. It also concludes, unlike Orlov et al (2021), that such effect happened regardless of previous instructor experience with online teaching.

With a similar methodology, Altindag et al (2021) attempts to separate the effect of virtual instruction from other Pandemic effects and finds evidence that the face-to-face modality is superior to online instruction, only after accounting for instructor-specific characteristics, such as leniency in grading and "actions taken towards preventing violations of academic integrity". The paper reports, at the same time, an increase in grades in the Spring 2020 semester associated with changes in assessment methods and flexible grading policies.

Using difference-in-differences and event study analysis, Rodriguez-Planas (2022) found flexible grading policies to have a positive role in addressing the differential impact on achievement between higher-income and lower-income students due to the Pandemic.

3. Data

The data used is an anonymized administrative database with all course grades attained by bachelor students in Economics and Management at Nova SBE, from 2007/08 to 2020/21. The grades are stated at the 0-20 scale, for most courses, and as pass/fail for some exceptions. It also contains student information, such as gender, year of birth, zip code, parental education and occupation, scholarship status and admission grade.

Each observation represents a student observed in a given course, in a given year-semester. As they may be duplicated if a student attends both exam periods, we have only considered one grade per course, in a given semester, for each student; this way we have a clearer unit of analysis. In practice, we removed grade improvement attempts – regardless of being attempted in regular period or resit – and kept the observation with the highest grade a student attained between the regular phase and the resit within a given course and semester.

Each student can be identified by a Student Reference Code. The nature of the available data is such that for some students' demographics, such as scholarship status or address, the information is kept constant within the student panel across time. We use this information assuming it is a fair representation of the overall students' characteristics throughout the few periods they are observed. Address, in specific, is viewed as representing their true location at the time of first enrolment[1] at Nova SBE, before any displacement into the Lisbon area if the student is from elsewhere.

Courses were classified according to some characteristics: field of study (Economics, Management, Quantitative Methods or other areas), expected year in the program and status of the course according to the student's bachelor programme – mandatory or elective.

[1] Which takes place before the start of the 1st semester of the 1st year, with this information being replicated across time within the student panel by the administrative services.

To compare the period immediately before against the period during the Pandemic Crisis, we have focused on the semesters spanning from Fall 2018[2] to Spring 2021; thus, 3 semesters before Spring 2020 – when the first lockdown was enforced in Portugal – and 3 semesters afterwards. To simplify the analysis regarding academic outcomes between the two periods, we follow Orlov et al (2021) and standardize all grades using the pre-pandemic mean and standard deviation within each course.

Table 1 exhibits summary statistics for our main variables, grouped by the period to which they refer to, as well a standardized difference in means between the two groups (Imbens, 2015).

Table 1: Descriptive Statistics

	Pre-pandemic Semesters			Pandemic Semesters			Std Difference in Means
	N	Mean	Std Dev	N	Mean	Std Dev	
Displaced	15563	0.41	0.49	19140	0.38	0.49	-0.05
Female	15563	0.48	0.5	19140	0.49	0.5	0.02
Portuguese	15563	0.92	0.26	19140	0.91	0.29	-0.06
BSc Economics	15563	0.45	0.5	19140	0.45	0.5	0.01
Financial Aid	15563	0.09	0.28	19140	0.07	0.26	-0.08
Resit or Extra Season Exam	15563	0.16	0.36	19140	0.17	0.38	0.04
Failed Course in another semester	15563	0.13	0.33	19140	0.12	0.33	0.02
At least one of the two parents has college-level education	13653	0.84	0.37	16861	0.87	0.34	0.08
Standardized Admission Grade	13299	-0.05	1.02	16083	-0.04	1.02	0.01
Economics Course	15563	0.27	0.44	19140	0.28	0.45	0.04
Management Course	15563	0.29	0.45	19140	0.28	0.45	-0.01
Quantitative Methods Course	15563	0.28	0.45	19140	0.28	0.45	0.00
Outside Area Course	15563	0.16	0.37	19140	0.15	0.36	-0.03
First Year Course	15563	0.34	0.47	19140	0.37	0.48	0.06
Mandatory Course	15563	0.91	0.28	19140	0.9	0.3	-0.04
Exam Withdrawal	15563	0.09	0.28	19140	0.09	0.28	0.00
Standardized Course Grade	14190	0	1	17496	0.09	1.13	0.08

Note: The number of student-year-semester-course observations changes within the same set of semesters due to data availability. Admission grades standardized according to the student's year of admission while course grades were standardized regarding the pre-pandemic grades attained for the same course.

[2] Fall 2018 also marks when undergraduate classes were moved to the Campus in Carcavelos. Earlier data may not be straightforward to compare with post-Fall 2018 data as the campus move likely impacted students and faculty habits as well as Nova SBE services and infrastructure quality.

Regarding the student demographic information, the database has certain variables for which many observations are missing or coded as unknown. One such example is Admission Grade, for which around 16% of observations are missing. It is the average of a student's high school GPA and their national Mathematics exam grade, each with a 50% weight. Students for whom such observations are missing are most likely students who either arrived at Nova SBE from other universities or who were admitted through paths different from general admission. To improve comparability between years of enrolment, Admission Grade was standardized by the mean and standard deviation of the admission grades of the student's year of enrolment. The standardized version then gives the relative position of the student in the distribution of this baseline academic outcome of his/her cohort.

4. Methodology

Our goal is to understand and measure the impact of the Pandemic Crisis on the grades of Nova SBE's undergraduate students. Ideally, our first-best approach would be to have a group of students or courses not affected by the Pandemic which could be used as a control group to be compared with the group affected by it.

As this is not possible due to the systemic nature of the Pandemic which simultaneously affected every Nova SBE student, a second-best approach that other authors have used (Altindag et al., 2021 and Bird et al., 2022) would be a difference-in-differences methodology comparing grades from courses taken face-to-face with courses taken online, regardless of the Pandemic, and with courses who were forcefully moved to online. This methodology is meant to isolate the effect of the Pandemic from the effect of the transition to online learning. However, since there was virtually no offer of online undergraduate classes at Nova SBE before the Pandemic, we cannot apply this reasoning.

In the absence of such an ideal setting we apply an event study methodology to measure the impact of the Pandemic on the grades of the undergraduate students. This approach compares the grades obtained during the Pandemic Semesters to the grades obtained in the Pre-Pandemic period. It identifies the overall change in grades associated with the Pandemic resulting from the confluence of several possible mechanisms triggered by the latter. These mechanisms cannot be isolated per se. From the student side these may be: the transition to online classes, psychological and physical health effects from being confined at home, constrained communication to peers, different place and schedules to study. And from the teaching side: changes in pedagogy, in type of assessment and in evaluation criteria. This methodology allows one to obtain an overall vision of the impact which is not necessarily causal, as we have no control group unaffected by the Pandemic to compare.

We are also able to disentangle the overall pre-post Pandemic differences between courses and we consider the Spring 2020, Fall 2020 and Spring 2021 semesters to be "treatment" and the previous 3 semesters to be "pre-treatment".

4.1. Estimation of the Pandemic Impact on different courses

Our main model (Eq.1) is aimed at assessing the differential impact of the shock across courses. It considers, as an outcome, the grade student *i* attained for course *c* in semester *s* of year *t* (y_{icst}), standardized using the pre-pandemic average and standard deviation per course as previously explained, and, as main regressor, the interaction between the course fixed effect (μ_c) and the Pandemic treatment indicator ($Pandemic_{st}$), similarly to Orlov et al. (2021). The course level estimates δ tell us by how much each course grades have changed during the Pandemic compared to the pre-Pandemic average (in pre-Pandemic standard deviations).

$$y_{icst} = \mu_c + \delta\mu_c * Pandemic_{st} + \varepsilon_{icst} \quad (1)$$

$$y_{icst} = \mu_c + \delta\mu_c * Pandemic_{st} + \phi S_s + \sigma\mu_c * S_s + \varepsilon_{icst} \quad (2)$$

Equation 2 extends Equation 1 adding semester and semester-by-course fixed effects to account for both systematic and course-specific differences between Fall and Spring semesters across school years. It is meant to address the possible issue that, in our analysis, the two periods (pre-treatment and treatment) are not balanced regarding the amount of Fall/Spring semesters and that grades and types of students may vary in a systematic way between semesters of the same year.

$$y_{icst} = \mu_c + \delta\mu_c * Pandemic_{st} + \phi S_s + \sigma\mu_c * S_s + \beta X_{icst} + \gamma X_{icst} * Pandemic_{st} + \varepsilon_{icst} \quad (3)$$

In Equation 3, X_{icst} contains the student's gender, financial aid scholarship status, nationality (whether Portuguese or not), Bachelor's programme and residence status ("displaced" status if reported by the student or if his/her address at the moment of first enrolment is not in the Lisbon area, "non-displaced" otherwise). Furthermore, it also contains information on which exam period the student obtained the grade and on whether the student had tried to pass the same course in a previous semester to that analysed.

Following Orlov et al. (2021) we also include these controls interacted with the treatment indicator. Controlling for these individual characteristics of the students allows δ to identify each course pre-post treatment change comparing students that are comparable in terms of socio-demographics and previous ability. This way δ should not pick changes in course average grades induced by possible reshuffling of the types of students attending each course related to the onset of the Pandemic. Although the descriptive statistics point to negligeable changes in the shares of students enrolled in Economics, Management, Quantitative Methods, Outside Area, and Mandatory type of courses these demographics and past ability controls better insure against that. The added interaction also absorbs differential effects of being under a Pandemic that may accrue to different types of students.

$$y_{icst} = \mu_c + \delta\mu_c * Pandemic_{st} + \phi S_s + \sigma\mu_c * S_s + \beta X_{icst} + \gamma X_{icst} * Pandemic_{st} + \\ + \rho V_{ist} + \eta V_{ist} * Pandemic_{st} + \varepsilon_{icst} \quad (4)$$

In equation 4, two new controls, parental education and admission grade, were added. As previously stated, these variables are not available for all students in the database. Thus, their inclusion comes at the cost of decreasing the number of observations. These additional controls are represented by V_{ist} and are also interacted with the Pandemic indicator.

4.2. Estimation of the Pandemic Impact on different semesters

Another question which we intend to address in this Work Project relates to the heterogeneity of the Pandemic effect not only across the different courses but across the different Pandemic semesters as well.

For that purpose, we have substituted the interaction between the course fixed effect and the Pandemic indicator ($\mu_c * Pandemic_{st}$) in the Equations above, with the categorical variable, $PandemicSemester_{st}$, which identifies if the grade refers to the Pre-Pandemic period ($PandemicSemester_{st} = 0$) or to one of the Pandemic semesters – Spring 2020 ($PandemicSemester_{st} = 1$), Fall 2020 ($PandemicSemester_{st} = 2$) or Spring 2021 ($PandemicSemester_{st} = 3$). Furthermore, we have also added two binary variables to the X_{icst} set of controls – one that identifies Mandatory courses and another for first year courses.

This approach considers all courses simultaneously and yields estimates of the overall Pandemic effect specific to the 1st, 2nd, and 3rd semesters subject to the Pandemic. This way we can assess whether the overall Pandemic effects evolve as the students/faculty adapt to it.

5. Results

An initial exploratory analysis of the grades in both the Pre-Pandemic and Pandemic Period, shows a difference between the average grades in the two periods lower than one tenth of a Pre-

Pandemic standard deviation[3]. Nevertheless, this positive difference of 0.087 standard deviations between pre-treatment and treatment, points towards the idea of higher grades attained during the Pandemic than prior to it.

5.1. Estimation of the Pandemic Impact on different courses

As presented in Section 4.1, our main model uses the interaction between the Pandemic and Course indicators as to assess the differential impact of the Pandemic on the different courses. Figure 1 reports a plot with the estimated coefficients (δ) obtained through Equations 1 and 2. For convenience of exposition, such coefficients are grouped by the area of study each course relates to, according to Nova SBE's undergraduate programme. Moreover, standard errors are cluster-robust at the course-semester-year level (222 clusters).

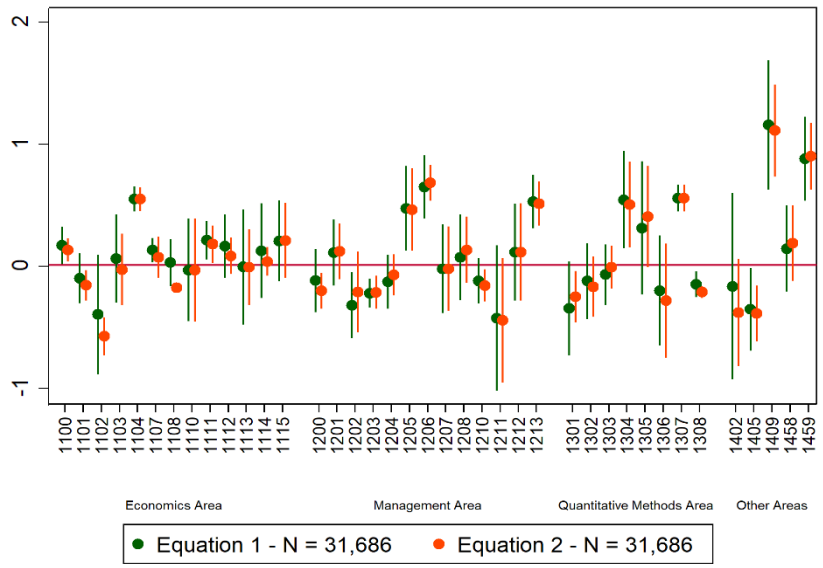

Figure 1: Regression coefficients δ obtained through Equations 1 and 2 with corresponding confidence intervals at the 95% level. Confidence intervals were obtained with cluster-robust standard errors with 222 clusters.

From the analysis of the coefficients, it is clear that the impact of the Pandemic is heterogeneous between courses, as well as between areas, and that there are little significant

[3] The table of Summary Statistics, Table 1, reports the standardized average grade for courses in the two periods.

differences arising from the inclusion of the Spring semester indicator on the coefficients – as reported by similarities between the results for both equations in the figure above.

Focusing solely on the results for Equation 1, 19 in 39 courses exhibit a Pandemic impact which is significant at the 5% threshold and, among these, 10 are positive. Considering a stricter level of significance (1%), these numbers decline, respectively, to 15 out of 39 and 8 courses with a positive and significant coefficient.

Out of the 39 courses analysed, a third (13) exhibit significant differences at the 5% threshold on both of the above specifications; a number that changes to 14, at the 10% level and to 10, at the 1%. Furthermore, within the universe of courses that exhibit significant differences according to both specifications at the 5% level, 10 present a positive difference and 3 a negative one.

Regarding Equation 3, in which Equation 2 was extended to include individual-specific controls, the results can be found in Figure 2, with the results from Equation 1 as a comparison.

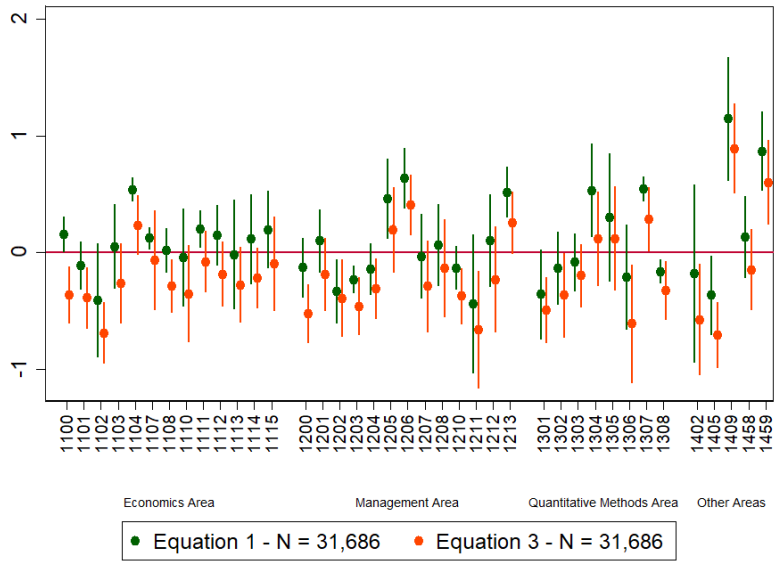

Figure 2: Regression coefficients for δ obtained through Equation 1 and 3, with corresponding confidence intervals at the 95% level. Confidence intervals were obtained with cluster-robust standard errors with 222 clusters.

The results from Equation 3, presented in Figure 2, may be considered significantly different from those observed for Equation 1. In fact, the point estimates for the same course are all strictly more negative with the more complete specification than when compared to the similar coefficient for Equation 1. There is even one course who was estimated to have a significant positive effect through Equation 1 that is estimated to have a significant negative effect through Equation 3.

Looking more in depth at the estimates, there are 20 courses in which a significant Pandemic effect (at the 95% level) can be identified – 4 of those positive and 16 of those negative. If we cross-reference these results with those obtained in Eq.1, it is possible to understand that all positive and significant effects calculated in (3) are significant and share the same sign in Eq.1 whilst that is true for only 9 of the significant and negative coefficients.

As for Equation 4, the estimates and corresponding 95% confidence intervals are presented in Figure 3, with the estimates obtained through Equation 1 as a reference.

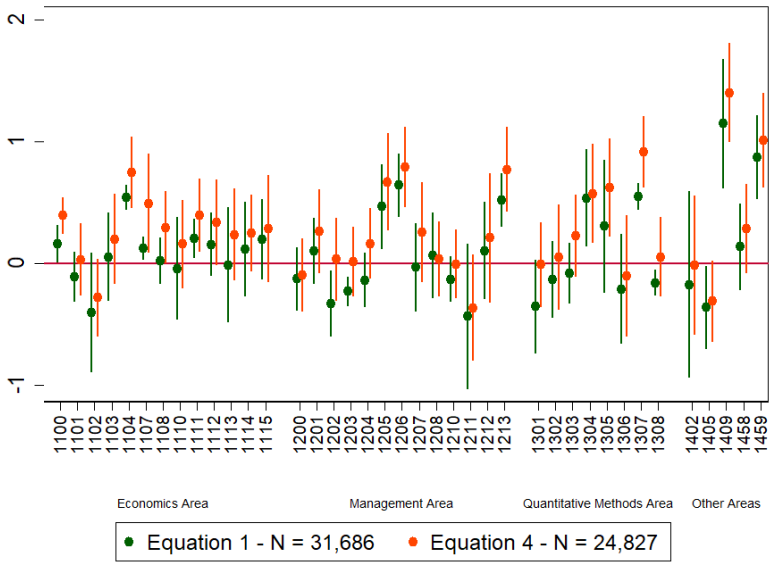

Figure 3: Regression coefficients for δ obtained through Equation 1 and 4, with corresponding confidence intervals at the 95% level. Confidence intervals were obtained with cluster-robust standard errors with 222 clusters.

Figure 3 clearly shows that the point estimates obtained from Equation 4 are more positive than the ones calculated through Eq.1. Nevertheless, they are not significantly different from one another, as the 95% confidence intervals for the estimates from Equation 4 contain the point estimate for Eq.1 for all but 3 courses.

Regarding the significance of the estimates, there are 13 courses who present a Pandemic Effect which is significant at the 5% level and all of which are larger than 0. Comparing with the results from Equation 1, 10 of the 13 coefficients are also significant at the 5% level and share the same sign.

To sum up the conclusions regarding the course-specific Pandemic Effect, we present the following table:

Table 2: Summary of course-specific Pandemic Effects

Course	Eq 1	Eq 2	Eq 3	Eq 4	Course	Eq 1	Eq 2	Eq 3	Eq 4	Course	Eq 1	Eq 2	Eq 3	Eq 4
1100	+	+	-	+	1200	-	0	-	0	1301	-	0	-	0
1101	-	0	-	0	1201	0	0	0	0	1302	0	0	-	0
1102	-	0	-	0	1202	0	-	-	0	1303	0	0	0	0
1103	0	0	0	0	1203	-	-	-	0	1304	+	+	0	+
1104	+	+	0	+	1204	0	0	-	0	1305	0	0	0	+
1107	0	+	0	+	1205	+	+	0	+	1306	0	0	-	0
1108	-	0	-	0	1206	+	+	+	+	1307	+	+	+	+
1110	0	0	0	0	1207	0	0	0	0	1308	-	-	-	0
1111	+	+	0	+	1208	0	0	0	0	1402	0	0	-	0
1112	0	0	0	+	1210	-	0	-	0	1405	-	-	-	0
1113	0	0	0	0	1211	0	0	-	0	1409	+	+	+	+
1114	0	0	0	0	1212	0	0	0	0	1458	0	0	0	0
1115	0	0	0	0	1213	+	+	0	+	1459	+	+	+	+

+: $p<0.05$ and $\beta>0$; -: $p<0.05$ and $\beta<0$; 0: $p>0.05$

Although there is variability in the significance and sign of the estimates obtained for the same course between the 4 equations, there are 11 courses whose Pandemic effect is always estimated to not be significantly different from 0. On the other hand, there are also 5 courses for which a significant (at 5%) Pandemic Effect was found by all four equations. In the case of 4 of these, the significant coefficients are all positive whilst, for the other, they are estimated to be positive according to Equations 1, 2 and 4 and negative according to Equation 3.

5.1.1. Robustness checks regarding the loss of observations

In Equations 3 and 4, respectively, the sets of controls X_{icst} and V_{ist} were introduced. While the former were not problematic, in the sense that they available for all students in the database, the latter, that include the variables for Parental education and Standardized Admission Grade, contain missing information – possibly not at random – for a portion of students. In this subsection, we attempt to understand if the course-specific results are robust to the inclusion of the observations which were taken out.

Comparing the columns of Table 2 regarding Equations 3 and 4, it is possible to see that, for almost two thirds of all courses, there is a mismatch between the sign or the significance of the estimates yielded by both Equations. The sole exceptions to these are the courses which are either consistently estimated to be positive and significant through all specifications or which are consistently estimated to not be significant according to any specifications.

The graph of Figure 4 compares the estimates obtained through both Equations.

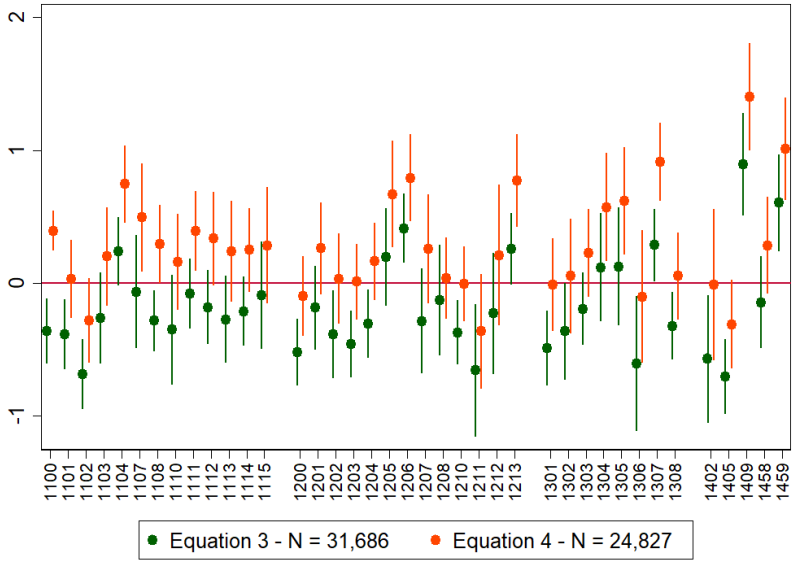

Figure 4: Regression coefficients for the interaction δ obtained through Equation 3 and Equation 4, with corresponding confidence intervals at the 95% level. Confidence intervals were obtained with cluster-robust standard errors with 222 clusters

This Figure shows not only a significant distance between the two groups of estimates – for most courses, although the confidence intervals overlap, the point estimate obtained through Equation 3 is not contained in the confidence interval of the estimate of Equation 4 – but it is possible to see that the results from Equation 4 (with more observations) are consistently lower than those of the original version.

Table 3 shows the coefficients for each of the controls present in the two specifications considered in Figure 4.

Table 3: Regression Results for the controls of Equations 3 and 4

	(3)	(4)
BSc Economics	-0.001	0.064*
BSc Economics # Pandemic	0.064	0.043
Financial Aid	0.093***	0.004
Financial Aid # Pandemic	0.023	0.060
Displaced	-0.098***	-0.086***
Displaced # Pandemic	0.040	-0.010
Female	-0.019	-0.020
Female # Pandemic	0.039	-0.005
Portuguese	0.522***	0.183
Portuguese # Pandemic	0.238*	-0.157
Resit or Extra Season Exam	-0.549***	-0.466***
Resit or Extra Season Exam # Pandemic	-0.139	-0.185*
Failed Course in another semester	-0.535***	-0.475***
Failed Course in another semester # Pandemic	-0.001	0.038
At least one parent has college-level education		0.000
At least one parent has college-level education # Pandemic		-0.027
Standardized Admission Grade		0.246***
Standardized Admission Grade # Pandemic		0.018
Observations	31686	24827

* p<0.05, ** p<0.01, *** p<0.001

The coefficients of the non-interacted terms represent differences in the grades in the pre-pandemic period while the coefficients of the interacted variables represent differential effects on grades in face of the Pandemic.

Regarding the first group, it is possible to see that the variable pertaining the study programme of the student, is only significant and positive in Equation 4. It suggests that, in the

Pre-Pandemic period, Economics students attained better grades than Management students. However, that result is not confirmed by the reduced model of Equation 3.

Furthermore, the results for Equation 3 suggest a positive and significant effect of eligibility to financial aid on Pre-Pandemic grades and a positive and significant link between the Portuguese nationality and the grades received, in both periods. However, while the effect of the former may be offset by the introduction of the parental education controls in (4) – usually strongly associated with financial aid eligibility – the latter is most likely due to the reduction in observations.

As most foreign students do not enter through the "national admission programme", they may not have an Admission grade in the database, while all Portuguese who enter should. In fact, that is supported by the fact that more than 98% of observations considered in Equation 4 are from Portuguese students, while for Equation 3 that share drops to about 92%.

Interesting considerations can also be made regarding Standardized Admission Grade. Although it appears to have a quite significant impact on the grades during the whole period it shows no significant difference for the Pandemic Period.

Regarding the variable identifying "displaced students", it is negative and significant on both specifications. Nevertheless, its interacted coefficient is never found to be significant at the 5% level.

It should also be noted that the estimate for the non-interacted variable for the exam period shows a negative effect on grades during the Pre-Pandemic period, regardless of the specification. However, Equation 4 captures an even more negative effect of taking exams in resit and special season during the Pandemic Period.

All in all, although there are similarities on the significance of some estimates for the control variables, they suggest that the universe of observations used by Equations 1 to 3 may be more than marginally different from that used by Equation 4.

To better understand if the differences in results between Equations 3 and 4 stem from the exclusion of relevant covariates or from differences in sample, we have ran Equation 3 on the sample of observations used by Equation 4. Figure 5 presents the results for the course-level coefficients for Equations 3, 4 and 3, with the sample implicitly used in Equation 4.

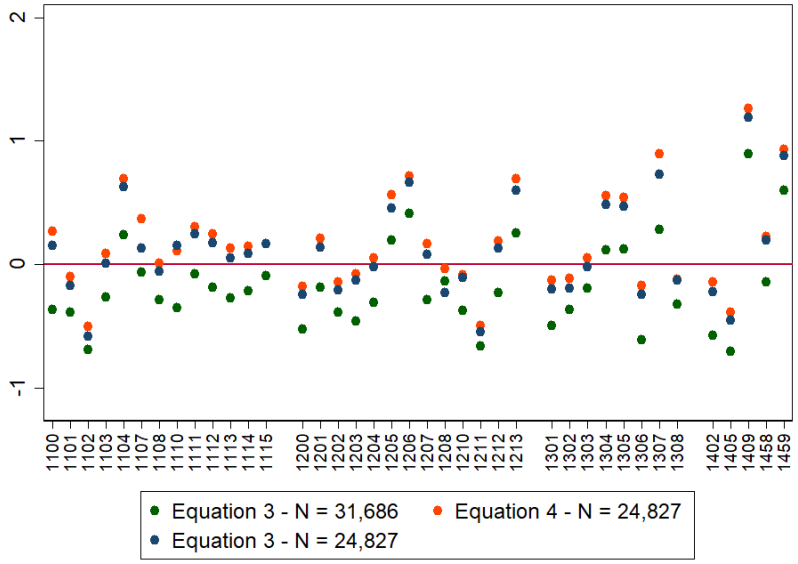

Figure 5: Regression coefficients for the interaction between μ_c and $Pandemic_{st}$ obtained through Equations 3, 4 and through 3 on the sample used by Equation 4.

As seen in Figure 5, the coefficients for the test regression are much closer to those of Equation 4, which uses the same sample but all controls. This points that the difference between the coefficients observed in Equations 3 and 4 are mostly due to the sample restriction Equation 4 imposes rather than the additional controls.

All in all, the results suggest that the model used in Equation 4 may be severely restricting the sample of students used and, thus, interpretation of the results as for the general population of undergraduate students at Nova SBE should be careful.

5.2. Estimation of the Pandemic impact on different semesters

As presented in Section 4.2, we have used a similar methodology as in Section 5.1 to attempt to capture the differences in grade outcomes between semesters during the Pandemic Period. The results are presented in Table 4.

Table 4: Regression results for the Semester Pandemic effects

	(1)	(2)	(3)	(4)
Spring 2020	0.162*	0.187*	0.025	0.138
	(2.31)	(2.07)	(0.21)	(0.97)
Fall 2020	-0.008	-0.017	-0.134	-0.058
	(-0.14)	(-0.36)	(-1.37)	(-0.47)
Spring 2021	0.100	0.129	0.016	0.125
	(1.35)	(1.47)	(0.13)	(0.95)
μ_c	YES	YES	YES	YES
S_s	NO	YES	YES	YES
X_{icst}	NO	NO	YES	YES
V_{ist}	NO	NO	NO	YES
Observations	31686	31686	31686	24827

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

The results presented at Table 4 appear to not point towards any definite conclusions regarding the existence of differential impacts between semesters during the Pandemic Crisis. Nevertheless, it opens the possibility for some heterogeneity between them.

Regarding the first semester, Spring 2020, which started in-person and was abruptly moved to online, two of the four specifications attribute it a positive and significant difference (at the 5% level) in the grades of courses taken during that period. This means that during that semester average grades were higher than the pre-Pandemic average grades.

As for the two semesters of the 2020/2021 Academic Year, little to no significant differences relative to the Pre-Pandemic period are found. If anything, Spring Pandemic semesters show average positive deviations from pre-Pandemic grades compared to the Fall Pandemic one. Indeed, in that Fall Semester, classes and evaluations mostly resumed on-campus, so more comparable to pre-Pandemic activities. While the Spring semesters, on the other hand, observed nationwide lockdowns and a potential need for faculty to adapt for different instruction methods and alternative assessment tools and criteria.

5.2.1. Heterogenous Effects

The results presented suggest some heterogeneity in the Pandemic effect between the different semesters. Nevertheless, these differences among different periods may also happen across course and student characteristics. For these analyses, we use the model described by Equation 4.

Table 5: Pandemic semester effects, conditional on course characteristics

	Optional	Mandatory	Economics Course	Management Course	Quantitative Methods	Other Areas
Spring 2020	0.084	0.333*	-0.037	-0.062	0.188	0.039
	(0.29)	(2.25)	(-0.17)	(-0.29)	(0.63)	(0.10)
Fall 2020	-0.146	0.138	-0.242	-0.142	0.126	-0.606
	(-0.48)	(1.14)	(-1.16)	(-0.82)	(0.44)	(-1.79)
Spring 2021	-0.143	0.337*	-0.042	-0.092	0.354	-0.294
	(-0.46)	(2.46)	(-0.21)	(-0.52)	(1.27)	(-0.72)
μ_c	YES	YES	YES	YES	YES	YES
S_s	YES	YES	YES	YES	YES	YES
X_{icst}	YES	YES	YES	YES	YES	YES
V_{ist}	YES	YES	YES	YES	YES	YES
Observations	2249	22578	6907	7258	6679	3983
Clusters	103	168	69	78	45	30

t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

Regarding optional and mandatory courses, there is a consistently positive effect across the Pandemic semesters for the latter. These effects appear to be most pronounced and significant (at the 5% level) for the Spring semesters during the Pandemic. The same cannot be said about

optional courses, however, as only the effect on the Spring 2020 semester is estimated to be positive – albeit not significantly different from 0.

As for the 4 course areas, it appears that there is a negative effect across all semesters for Economics and Management courses, which is more pronounced in Fall 2020. As for Quantitative Methods courses, grades seem to have increased in all semesters compared to the pre-Pandemic period with a more pronounced difference for Spring 2021. Lastly, regarding courses of other areas, there appears to be a quite sizeable negative impact on both semesters of the 2020/2021 Academic Year. All in all, however, none of the estimates for any area are significant at the standard 5% level of significance.

Concerning the heterogeneous effects with respect to student-level characteristics, Table 6 reports the results for both displaced and local students.

Table 6: Pandemic semester effects, conditional on students' residence status

	Not Displaced	Displaced
Spring 2020	0.148	0.197
	(0.81)	(1.10)
Fall 2020	-0.007	-0.065
	(-0.04)	(-0.37)
Spring 2021	0.170	0.132
	(1.00)	(0.74)
μ_c	YES	YES
S_s	YES	YES
X_{icst}	YES	YES
V_{ist}	YES	YES
Observations	14906	9921
Clusters	221	221

t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

The results for both samples of students replicate the main tendencies found for the whole universe of observations. That is, higher grades in the Pandemic Spring Semesters whereas a negative estimate in the Fall 2020 semester. However, all the estimated impacts are non-significant.

6. Conclusion

With this work project, we aimed to measure the impact of the disruption caused by the Pandemic Crisis on the grades of Nova SBE undergraduate students, with a particular focus on the differences between courses and across semesters. For this, we conducted an event study comparing the grades of students in the three semesters immediately before the onset of the Pandemic in Portugal (Fall 2018, Spring 2019 and Fall 2019) with the three immediately after, when the Pandemic created most disruptions.

It was impossible to disentangle the different effects playing a part in any change in grades from the Pre-Pandemic period to the Pandemic, as it was not possible to define a control group. We recognize that, on the student-side, changes in grades are not only the result of the sudden shift to online instruction – a modality which was previously not used at Nova SBE at the bachelor-level – but also a consequence of the uncertainty surrounding students' future and the abrupt changes in their daily lives that happened simultaneously.

At the same time, we acknowledge that there may also be instructor-side effects playing a part in any identifiable differences in grades. Much alike for students, the Pandemic forced course instructors to readily adapt their teaching methods and assessment procedures to the new reality of online teaching; all whilst being faced with similar sudden changes in their daily lives.

Overall, the results for the course-specific Pandemic effect show that most courses had no significant change in average grades between the Pre-Pandemic and the Pandemic periods. This may suggest that such students and course instructors were able to cope with the disruption adequately – meaning there were no significantly negative effects of the Pandemic – or that, on the other hand, the conflicting positive and negative effects of all changes are offsetting one another, instead.

There are still, however, a significant amount of courses, for which a significant effect of the Pandemic on students' outcomes was estimated. In the case of those whose effect is estimated to be negative, the evidence may point that, not only did the Pandemic significantly affect students, but that the changes put forth by instructors of such courses did not balance out such negative impacts. On the opposite end of the spectrum are courses with an estimated positive impact of the Pandemic; for such courses it appears that either students benefited from the disruption or that the changes in course delivery and assessment structure have more than offset any possible negative impacts of the Pandemic.

Since, according to the literature, traditional instruction is superior to the virtual modality regarding academic outcomes when both students are faced with similar exams, this positive difference is most likely driven by changes in assessment structure. The relevant question is, thus, to what extent should instructors have adapted their assessment criteria to compensate for the situation lived by students. Some may argue that it should have guaranteed that students obtained grades which were similar to other cohorts, conditional on the Pandemic situation, due to the importance of the GPA to students' future outcomes; while others may disagree and state that comparability of outcomes across cohorts should have been preserved. In the end, the answer to this question is mostly a policy decision which should be taken in conscience.

Regarding the Pandemic effect across the different semesters, little significant evidence is found. The only semester in which there is modest evidence of a significant difference is Spring 2020, the semester in which the Pandemic started. This is the first semester when students and instructors had to suddenly adapt to the disruptions caused by the Pandemic. In line with that discussed earlier in this Section, the novelty of the situation may have led to a non-neglectable increase in grades for that period, due to the sudden adaptation of course structures to compensate for the disruption.

All in all, with this work project, we contributed to the literature on the effect of the Pandemic on higher education by being one of the first attempts to study it at the undergraduate level for a whole university in Portugal and by introducing heterogeneity between courses and between semesters. Even so, it could be improved upon with further consideration of the instructor-side impacts and through the introduction of a theoretical framework. Such framework could have enabled a better understanding of the effects of the disruption caused by the Pandemic not only on higher education students' academic outcomes, but on their learning as well. In our setting, this would be relevant as it would be a measure of the impact of the disruption on students and it would enable us to identify the impact of changes solely in assessment practices.

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Appendix

Table 7: Estimates for the Course Pandemic impact for Equations 1-4

	(1)	(2)	(3)	(4)
DISCIPLINA_CODIGO=1100 # Pandemic	0.159*	0.122*	-0.365**	0.392***
DISCIPLINA_CODIGO=1101 # Pandemic	-0.110	-0.168**	-0.388**	0.031
DISCIPLINA_CODIGO=1102 # Pandemic	-0.407	-0.586***	-0.688***	-0.282
DISCIPLINA_CODIGO=1103 # Pandemic	0.052	-0.039	-0.267	0.199
DISCIPLINA_CODIGO=1104 # Pandemic	0.539***	0.539***	0.236	0.745***
DISCIPLINA_CODIGO=1107 # Pandemic	0.122*	0.061	-0.067	0.492*
DISCIPLINA_CODIGO=1108 # Pandemic	0.018	-0.188***	-0.286*	0.294
DISCIPLINA_CODIGO=1110 # Pandemic	-0.043	-0.043	-0.353	0.157
DISCIPLINA_CODIGO=1111 # Pandemic	0.202*	0.169*	-0.080	0.393*
DISCIPLINA_CODIGO=1112 # Pandemic	0.152	0.074	-0.184	0.333
DISCIPLINA_CODIGO=1113 # Pandemic	-0.016	-0.020	-0.276	0.235
DISCIPLINA_CODIGO=1114 # Pandemic	0.116	0.027	-0.216	0.247
DISCIPLINA_CODIGO=1115 # Pandemic	0.197	0.199	-0.093	0.282
DISCIPLINA_CODIGO=1200 # Pandemic	-0.129	-0.211**	-0.525***	-0.099
DISCIPLINA_CODIGO=1201 # Pandemic	0.100	0.111	-0.187	0.261
DISCIPLINA_CODIGO=1202 # Pandemic	-0.332*	-0.222	-0.390*	0.031
DISCIPLINA_CODIGO=1203 # Pandemic	-0.232***	-0.226**	-0.459***	0.010
DISCIPLINA_CODIGO=1204 # Pandemic	-0.139	-0.081	-0.309*	0.162
DISCIPLINA_CODIGO=1205 # Pandemic	0.463**	0.453**	0.194	0.667**
DISCIPLINA_CODIGO=1206 # Pandemic	0.639***	0.673***	0.411**	0.790***
DISCIPLINA_CODIGO=1207 # Pandemic	-0.032	-0.033	-0.288	0.256
DISCIPLINA_CODIGO=1208 # Pandemic	0.063	0.122	-0.133	0.036
DISCIPLINA_CODIGO=1210 # Pandemic	-0.131	-0.169*	-0.374**	-0.006
DISCIPLINA_CODIGO=1211 # Pandemic	-0.436	-0.456	-0.660*	-0.367
DISCIPLINA_CODIGO=1212 # Pandemic	0.103	0.104	-0.231	0.209
DISCIPLINA_CODIGO=1213 # Pandemic	0.517***	0.502***	0.256	0.770***
DISCIPLINA_CODIGO=1301 # Pandemic	-0.357	-0.262*	-0.494***	-0.013
DISCIPLINA_CODIGO=1302 # Pandemic	-0.133	-0.180	-0.367*	0.050
DISCIPLINA_CODIGO=1303 # Pandemic	-0.081	-0.020	-0.196	0.225
DISCIPLINA_CODIGO=1304 # Pandemic	0.535**	0.494**	0.116	0.571**
DISCIPLINA_CODIGO=1305 # Pandemic	0.302	0.396	0.121	0.618**
DISCIPLINA_CODIGO=1306 # Pandemic	-0.211	-0.295	-0.609*	-0.104
DISCIPLINA_CODIGO=1307 # Pandemic	0.546***	0.546***	0.284*	0.912***
DISCIPLINA_CODIGO=1308 # Pandemic	-0.161**	-0.224***	-0.326*	0.052
DISCIPLINA_CODIGO=1402 # Pandemic	-0.176	-0.392	-0.575*	-0.017
DISCIPLINA_CODIGO=1405 # Pandemic	-0.364*	-0.400***	-0.709***	-0.314
DISCIPLINA_CODIGO=1409 # Pandemic	1.147***	1.101***	0.894***	1.400***
DISCIPLINA_CODIGO=1458 # Pandemic	0.133	0.176	-0.147	0.283
DISCIPLINA_CODIGO=1459 # Pandemic	0.870***	0.891***	0.602**	1.010***
Observations	31686	31686	31686	24827

* p<0.05, **p<0.01, *** p<0.001