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Research paper

Persistent impacts of the COVID-19 pandemic on student outcomes in Italy[☆]

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ABSTRACT

The learning loss caused by the COVID-19 pandemic on students' outcomes is likely to have lasting effects, for which empirical evidence remains scarce. Using a difference-in-differences design augmented by a triple difference estimator, we identify the evolution of the COVID-19 pandemic's impact on Italian students' test scores in the two years following the outbreak. Our findings indicate a persistently negative effect on mathematics and reading scores for grade 5 and grade 8 students in 2021–22, two years after the pandemic began. The magnitude compared to the cohort that attended the same grades the year before (2020–21) varies by subject and grade. Our analysis highlights the pandemic's heterogeneous impact, especially in terms of geographical differences that have been exacerbated by the emergency.

1. Introduction

The COVID-19 pandemic, as well as the measures taken to contain the spread of this infectious disease, led to unprecedented changes in our contemporary societies. Beyond its effects on health, with nearly 7 million deaths to date, the COVID-19 pandemic and the resulting successive lockdowns have had major consequences in various domains, from the labor market to the environment, gender inequalities, etc. (Brodeur et al., 2021). In educational terms, the COVID-19 pandemic has created the greatest disruption of educational systems in human history, impacting more than 94% of the world's student population (Pokhrel and Chhetri, 2021). Recent research has increasingly confirmed the expected deleterious effects of COVID-19 on learning outcomes (see Betthäuser et al., 2023, for an extensive review of the literature).

Following the emergence of COVID-19 in China's Wuhan region in December 2019, Italy was the first country affected by the COVID-19 pandemic. As a consequence, it became the first country in the world to establish a national lockdown. Italian schools were closed beginning in late February 2020 until the end of the school year (June 2020). The COVID-19 emergency forced teachers and students to switch to a remote-only mode for several months to guarantee learning continuity.

A particularly prolific literature has highlighted the unprecedented negative effects of this lockdown on the learning of students in Italian schools. One of the first studies to examine the effects of the COVID-19 pandemic on students' learning loss is that of Contini

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et al. (2022), which investigates educational achievement in grade 3. Using longitudinal data collected in the province of Turin along with administrative data, they found that the pandemic decreased student performance in mathematics in primary education by -0.19 standard deviation (s.d.). They showed that this effect was greater for girls, for high-achieving students from low-educated families, and in schools with a disadvantaged social composition. Understanding the specific effects at the school level is one of the challenges taken on by the study of Bertoletti et al. (2023). Combining a survey of teaching practices during the crisis along with administrative data, Bertoletti et al. (2023) first highlight a learning loss in grade 5 ranging from -0.28 s.d. in English reading to -0.05 s.d. in mathematics, and in grade 8 from -0.16 s.d. in mathematics to -0.03 s.d. in English reading. Second, they explain the observed differences between schools in terms of teachers' ability to use digital tools and the leadership of school principals.¹ The effects of the COVID-19 pandemic on students in Italy are also corroborated by the work of Borgonovi and Ferrara (2023) and Carlana et al. (2023), who found effects ranging from -0.17 to 0.06 s.d. and -0.14 to -0.05 s.d. respectively. In complement to these results on primary and lower secondary students, Battisti and Maggio (2023), Bazoli et al. (2022) and Contini et al. (2023) also report significant negative effects of the COVID-19 pandemic on upper secondary students in Italy.

When it comes to the heterogeneity of such findings, evidence from the literature is particularly scattered, making this a topic that deserves further investigation. Considering differences in students' socioeconomic status (SES), Carlana et al. (2023) and Contini et al. (2022) find an increase in inequality, while Borgonovi and Ferrara (2023), Bazoli et al. (2022) and Contini et al. (2023) find stable effects across students SES, or even a certain reduction in inequality in primary education (Borgonovi and Ferrara, 2023). Findings on gender differences are also conflicting, as Borgonovi and Ferrara (2023) report a reduction in gender-based disparities, while Contini et al. (2022) report a more negative impact on girls. Bazoli et al. (2022) explore the heterogeneity across regions and provinces finding a high degree of variability across and within regions, and advocating for further investigation.

As a common trait, all existing studies primarily focus on the immediate effects of COVID-19, specifically the school year following the pandemic (2020–21). In this paper we are interested not only in the immediate effect of the COVID-19 pandemic, but also in its persistent impact (i.e., in its impact on two cohorts of students that experienced school closures and the following restrictions for different lengths of time).

In this paper, we extend this perspective by analyzing both the immediate impact of the COVID-19 pandemic—defined as its effects observed during the first school year after the pandemic (2020–21, hereafter group 2021)—and its persistent impact, which we define as the effects observed two school years later (2021–22, hereafter group 2022), capturing whether initial disruptions had lasting consequences on student performance. Following the initial shock of school closures, various remedial policies were introduced in 2020–21, including targeted interventions and support programs aimed at helping students recover lost learning. If, for the 2022 cohort, we still observe negative effects, this would indicate that remedial measures did not fully compensate for the learning disruptions, confirming the persistence of the pandemic's impact. Our approach explicitly accounts for differences in the duration of exposure to the pandemic and the timing of school closures across student cohorts. Specifically, we compare cohorts of students who experienced school closures and subsequent restrictions at different grades and ages, allowing us to identify not only immediate learning disruptions but also their persistence over time. It is important to stress that we refer to COVID-19 impact as we are not able to disentangle the specific impact of school closures from the general impact of the pandemic on the students' attitudes and well-being, that may in turn affect students' results in standardized tests. Using data that enables us to track student progress on standardized tests, we explore whether the pandemic's effects persist over time by examining the impact of COVID-19 in both the 2020–21 and 2021–22 school years. Through a difference-in-differences design that compares the progress of exposed and non-exposed cohorts between grades 2 and 5 and between grades 5 and 8, we estimate the causal impact of the pandemic on the entire population of Italian students. We employ a triple difference estimator to examine the evolution of the COVID-19's impact on student standardized test scores in the two school years following the start of the pandemic. Our findings indicate a persistently negative effect of COVID-19 on mathematics and reading scores for grade 5 and grade 8 students in 2021–22 by -0.02 s.d., despite a certain heterogeneity across grades and subjects.² In addition, our analysis reveals high levels of heterogeneity, as female students are more negatively impacted in the long run (group 2022), while high SES are more negatively affected than low SES students. Finally, existing geographical differences are likely to be exacerbated by the pandemic, as southern regions report much larger learning loss than northern ones.

This study contributes to the literature in two ways. First, we provide an analysis of the effect of COVID-19 in terms of learning loss on two cohorts of students that experienced the outbreak of the pandemic at different grades and its continuation for different lengths of time. Second, our study contributes to the literature on the heterogeneous effects of the pandemic, adding to the existing literature and raising relevant questions in public policy terms. The current literature provides contrasting evidence on the existence of a learning recovery after the first months of school closure. Using four waves of surveys of students aged 2–7 years in India, Singh et al. (2022a) find that while the effect of COVID-19 persists over time, a recovery effect of the order of 0.11 to 0.28 s.d. can nevertheless be observed six months after the reopening of schools. In the US, using data from students in grades 3 through 8, Kuhfeld et al. (2022) also report a recovery effect. However, despite improvements in math and reading over the course of the 2020–21 academic year, students remained below the usual (pre-pandemic) benchmarks in the spring of 2021, with a deviation of -0.26 to -0.16 s.d. in math and -0.11 to -0.06 s.d. in reading. The authors find that this impact was even more pronounced among

¹ See also Moulin and Soncin (2024) for an analysis of the interaction between teachers' digital instructional practices and principals' leadership on student performance during the COVID-19 pandemic.

² In the remainder of the study, we always refer to the variation observed between the two cohorts (2020–2021 and 2021–2022), reflecting a more or less pronounced impact of the pandemic on academic performance in 2022 compared to 2021, without individually tracking the same students due to the lack of available longitudinal data.

students with lower academic performance. An increasing learning deficit is instead reported by [Gambi and De Witte \(2023\)](#) for the Flemish region in Belgium. Analyzing 6-graders, the authors report -0.67 s.d. in Dutch language in 2022 compared to 2019, while the negative effect was smaller and equal to -0.40 s.d. the year before. Despite smaller in magnitude, the increasing learning loss is reported across all the subjects.

Part of the literature also addressed the long-term effects of the pandemic. For example, [Hanushek and Woessmann \(2020\)](#) estimate that students who have experienced school closures during the COVID-19 pandemic will have a 3% lower lifetime income, and that the lower long-term growth related to these losses will result in an average decline for nations of about 1.5 percent in annual GDP for the remainder of the century. By providing insights into the lasting effects of the pandemic, we contribute to the growing literature on the medium-term impacts of COVID-19, particularly regarding how the pandemic's effects have evolved over time and across different stages of schooling.

2. Background and data

The education system in Italy is structured into four stages: early childhood education and childcare, which is non-mandatory and is offered to children aged 0–5 years, the first cycle of education, which includes primary and lower secondary education and targets students aged 6–13 years, the second cycle of education, which is made of the upper secondary education characterized by a tracking system, and higher education. Compulsory schooling spans a duration of ten years, from the age of 6 to 16. Primary education starts at the age of 6 and continues for five years, covering grades 1 to 5. Lower secondary education begins at age 11 (grade 6) and continues for three years, concluding with grade 8. At the end of lower secondary education, students must pass an exam to be admitted to the subsequent phase of education. Upper secondary education starts at age 14 (grade 9) and spans five years to age 19 (grade 13). In upper secondary school, students can choose between different tracks (vocational, technical, or academic).

To assess the effect of the COVID-19 pandemic on students' test scores, we use data from national standardized tests administered by INVALSI (the Italian National Institute for the Evaluation of the Educational System). These tests are administered at the end of grades 2, 5, 8, 10, and 13 in mathematics and Italian language (hereafter reading).³ They are administered to all students of each cohort, with the exception of the 2019–20 school year, due to the COVID-19 pandemic.⁴ Given the full data availability, we measure the pandemic's effect on the results of pupils in primary and lower secondary school, using data from 2014–15 to 2021–22 school years for the entire population of Italian students. Given the possibility to follow students' performance over time, we focus on the last year of primary and lower secondary education (i.e., grades 5 and 8 respectively), tracking student performance in the previous test (i.e., in grade 2 and 5, respectively). Test scores are provided within the dataset with a mean of 200 and a standard deviation of 40 at national level. The final score is corrected by INVALSI using Rasch modeling to account for the difficulty of the test items ([Boone et al., 2013](#)). In addition to test scores, the administrative dataset contains several information at individual level that reports student socio-demographic characteristics. Those characteristics are collected through an ad hoc student questionnaire filled by students on top of the standardized tests. The information collected concerns (i) students' background, like gender or the foreign origin, and (ii) factors related to the socioeconomic condition of the family, like parental occupation, level of education and home possessions. Those items are used to create an index that proxies the student's SES called ESCS, which is computed following the same approach adopted by the OECD (Organization for Economic Cooperation and Development) in large scale assessments.

Summary statistics are shown in [Table 1](#). As we are interested in the progression of students between grades 2 and 5 and grades 5 and 8, the descriptive statistics cover control and treatment groups at these grade levels. We observe that the characteristics of the pre-COVID-19 cohort and the post-COVID-19 students are very similar at all grade levels. The sample size is between 872,639 and 953,884 students depending on grade and cohort.⁵ The sample is gender balanced. The proportion of students born in Italy from Italian parents is similar between cohorts and grades at around 89%. The level of education of the largest proportion of parents (both mothers and fathers, at 51–53% and 47–51% respectively) is an upper secondary diploma. The proportion of parents with tertiary education is lower, and higher for women than for men (19–25% for mothers and 15–17% for fathers). The majority of mothers are either in occupations in the “teacher, white-collar worker, military leader” category (35–37% on average across cohorts) or are stay-at-home mothers. The majority of fathers are in the “blue-collar worker or employed in the service industry” category (40–42% on average across cohorts). About 1% of students are a year behind by grade 5, compared to an average of 3% by grade 8 and thus are defined as late-enrolled (i.e., enrolled at an age that is different from the one expected at a given grade). Finally, the output of interest regards students' results on standardized national assessments. On average, student progression in the post-COVID-19 cohort is lower on average than in the pre-COVID-19 cohort.

³ There are also tests of English reading and listening, except for grade 2.

⁴ The test has been not administered also in 2020–21 school year for grade 10.

⁵ We exclude from our sample students for whom we do not have a score in at least one of the grades, i.e. those whose performance cannot be calculated. For the students in the pre-COVID cohort, this situation involves 24,089 students in mathematics and 26,382 students in reading between grades 2 and 5, as well as 16,048 students in mathematics and 15,367 students in reading between grades 5 and 8. Moreover, we only consider students who have enrolled in grade 5 (or grade 8) three years after having enrolled in grade 2 (or grade 5). For students enrolled in grade 2 or grade 5 in 2018–2019, this situation affects 804 and 9975 of them respectively. The loss of observations is primarily due to administrative issues when tracking the student identifier, given that grade retention is not applied in primary school and very limited in lower secondary school (1.5% of the students).

Table 1
Summary statistics.

	Grade 2 to Grade 5			Grade 5 to Grade 8		
	Pre-COVID-19 cohort	Post-COVID-19	<i>p</i> -value	Pre-COVID-19 cohort	Post-COVID-19	<i>p</i> -value
Gender						
Boys (ref.)						
Girls	49.29%	49.42%	0.084	49.49%	49.36%	0.095
Origin						
Native	89.75%	88.26%	0.000	91.08%	90.38%	0.000
Foreigner first generation	1.67%	1.87%	0.000	2.47%	2.08%	0.000
Foreigner second generation	8.59%	9.87%	0.000	6.45%	7.54%	0.000
Mother's educational attainment						
Elementary education	1.92%	1.66%	0.000	2.22%	1.81%	0.000
Lower secondary education	24.52%	21.86%	0.000	27.06%	24.55%	0.000
Upper secondary education	51.38%	51.95%	0.000	52.03%	52.94%	0.000
Tertiary education	22.18%	24.53%	0.000	18.69%	20.70%	0.000
Father's educational attainment						
Elementary education	2.35%	2.06%	0.000	2.62%	2.24%	0.000
Lower secondary education	32.82%	29.96%	0.000	34.81%	32.57%	0.000
Upper secondary education	48.32%	50.74%	0.000	47.47%	49.52%	0.000
Tertiary education	16.50%	17.24%	0.000	15.10%	15.66%	0.000
Mother's occupation						
Unemployed	5.81%	5.91%	0.012	4.77%	5.21%	0.000
Stay-at-home mother	30.97%	26.38%	0.000	32.47%	24.90%	0.000
Manager, university professor, civil servant	1.35%	1.62%	0.000	1.33%	1.80%	0.000
Entrepreneur, farmer owner	2.18%	2.66%	0.000	2.16%	3.18%	0.000
Employed professional, freelancer	11.47%	13.36%	0.000	10.77%	13.00%	0.000
Self-employed worker	11.04%	11.81%	0.000	11.52%	13.82%	0.000
Teacher, white-collar worker, military leader	35.78%	37.13%	0.000	34.69%	35.59%	0.000
Blue-collar worker, employed in service industry	21.64%	23.84%	0.000	21.26%	25.81%	0.000
Retired	0.12%	0.15%	0.000	0.15%	0.25%	0.000
Father's occupation						
Unemployed	5.06%	4.43%	0.000	4.56%	4.52%	0.215
Stay-at-home father	0.31%	0.33%	0.022	0.31%	0.35%	0.000
Manager, university professor, civil servant	3.50%	3.46%	0.155	3.74%	3.65%	0.006
Entrepreneur, farmer owner	7.10%	7.29%	0.000	7.11%	7.53%	0.000
Employed professional, freelancer	18.87%	19.21%	0.000	18.69%	18.93%	0.002
Self-employed worker	25.61%	23.82%	0.000	26.88%	25.14%	0.000
Teacher, white-collar worker, military leader	32.62%	33.35%	0.000	31.79%	31.73%	0.513
Blue-collar worker, employed in service industry	41.70%	42.55%	0.000	40.13%	41.11%	0.000
Retired	0.71%	0.70%	0.385	1.08%	1.09%	0.783
Indicator of regularity with respect to studies						
Regular or early (ref.)						
Later	1.11%	1.10%	0.663	3.45%	2.65%	0.000
Students' test scores						
Mathematics	207.26	200.69	0.000	203.39	196.36	0.000
Italian	204.63	204.73	0.100	203.72	199.31	0.000
Observations	872,639	875,332		880,219	953,884	

Notes: The table presents the mean values for socio-demographic characteristics and test scores.

Table 2
Empirical setting.

Progression	Grade in $t = 0$	Grade in $t = 1$	Treatment status	Group
Grade 5 to grade 8	Grade 5 – 2018–19	Grade 8 – 2021–22	Treated	2022
	Grade 5 – 2017–18	Grade 8 – 2020–21	Treated	2021
	Grade 5 – 2015–16	Grade 8 – 2018–19	Control	2021 & 2022
	Grade 5 – 2014–15	Grade 8 – 2017–18	Control	2021 & 2022
Grade 2 to grade 5	Grade 2 – 2018–19	Grade 5 – 2021–22	Treated	2022
	Grade 2 – 2017–18	Grade 5 – 2020–21	Treated	2021
	Grade 2 – 2015–16	Grade 5 – 2018–19	Control	2021 & 2022
	Grade 2 – 2014–15	Grade 5 – 2017–18	Control	2021 & 2022

3. Estimation strategy

We estimate the effect of the COVID-19 pandemic on student achievement by comparing the progression in test scores between grades 2 and 5 and between grades 5 and 8 of the cohorts of students who were either exposed to the pandemic or not. Our two COVID-exposed cohorts of students were enrolled in grade 5 or 8 in 2020–21 or 2021–22. Our control group is made by all the

Table 3
Main results.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>DID</i>				
Average effect	-0.012*** (0.004)	-0.022*** (0.004)	-0.023*** (0.002)	-0.031*** (0.002)
Group 2021	-0.007 (0.005)	-0.024*** (0.005)	-0.025*** (0.003)	-0.038*** (0.002)
Group 2022	-0.020*** (0.005)	-0.022*** (0.005)	-0.022*** (0.003)	-0.024*** (0.002)
<i>DDD</i>				
Group 2022–2021	-0.013** (0.006)	0.002 (0.005)	0.003 (0.003)	0.014*** (0.003)
Controls	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Observations	1,541,422	1,522,510	1,628,997	1,619,353

Notes: This table presents the estimates from a difference-in-differences model and a triple difference model of the impacts of the COVID-19 pandemic on student learning. Socio-demographic controls included gender, student's origin, and ESCS. The regression includes region fixed effects. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

students that were enrolled in grades 5 or 8 in 2017–18 or 2018–19, thus in the immediate years before the pandemic. The empirical strategy is summarized in Table 2. To estimate the effect of the pandemic on student learning, we use the following specification:

$$\Delta y_{i,r}^g = \alpha + \mathbf{X}_i' \beta + \delta T_i + \Theta_r + \epsilon_i \quad (1)$$

where $\Delta y_{i,r}^g$ is the variation in test score of the student i in the region r between the two grades (grade 2 to 5 or grade 5 to 8), \mathbf{X}_i is a set of student level socio-demographic covariates, T_i is a treatment indicator, Θ_r is a region fixed effect, and ϵ_i is the error term clustered at the classroom level. We estimate this equation for each group g ($g = 2021$ or $g = 2022$), and separately by grade (5 and 8) and subject (reading and mathematics). The assumption that cannot be tested here is that, given their previous abilities, the academic performance of children in the COVID-19-affected group would have been identical to that of the pre-COVID group if the pandemic had not occurred.

Our analysis investigates whether the effect of the pandemic on the cohort of students who were enrolled in grade 5 or 8 in group 2021 was stronger or weaker than its effect on those enrolled in the same grades in group 2022. In other words, we want to know whether the effect of the pandemic varies when looking at two cohorts that experienced the COVID-19 emergency for different lengths of time. Formally, we estimate the difference between the two cohorts g : $\Delta y_{i,r}^{2022} - \Delta y_{i,r}^{2021}$.

This difference can be estimated using a triple-difference model (see Olden and Møen, 2022) of the form:

$$DDD_{i,r} = \alpha + \mathbf{X}_i' \beta + \mathbf{X}_i' \gamma G_i + \delta T_i + \lambda T_i G_i + \Theta_r G_i + \epsilon_i \quad (2)$$

where, in addition to the elements defined as above for Eq. (1), G_i is a binary indicator of the cohort to which student i belongs. We estimate Eq. (2) separately by grade and subject. In addition the baseline models, we also investigate the variability of results by gender, SES and geographical area.

4. Results

4.1. Main estimates

By estimating the model outlined in Eq. (1), we assess the impact of the COVID-19 pandemic on individual student achievement. Table 3 presents the average learning loss for the two school years – i.e. group 2021 and 2022 – and the variation of that effect between the two cohorts. The results show an average negative effect of the pandemic by –0.01 s.d. in grade 5 and –0.02 s.d. in grade 8 for mathematics, and –0.02 s.d. in grade 5 and –0.03 s.d. for reading. These average effects conceal relevant disparities between cohorts.

One year after the pandemic, we estimate a learning loss in grade 5 of –0.01 s.d. in mathematics and –0.02 s.d. in reading, and in grade 8 of –0.03 s.d. in mathematics and –0.04 s.d. in reading. In terms of significance, all the coefficients are statistically significant except for mathematics in grade 5. However, that learning loss turns to be significant in the following cohort (group 2022), showing a worrying trend for cohorts exposed to COVID-19 for longer time in this subject in lower grades.⁶ The estimated

⁶ The lack of a significant effect of the COVID-19 pandemic on mathematics scores in grade 5 can be explained by the wide disparity in effects between regions (see Fig. A.1). Excluding certain regions from the analysis, indeed, the effect becomes significant and, in some cases, positive (as it is the case when removing Campania, where students performed particularly poor).

Table 4
Heterogeneity analysis by gender.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>Average effect</i> (ref. boys)				
Treated × girls	-0.039*** (0.003)	-0.111*** (0.003)	0.017*** (0.003)	-0.078*** (0.003)
<i>Group 2021</i> (ref. boys)				
Treated × girls	0.025*** (0.004)	-0.086*** (0.004)	0.063*** (0.003)	-0.089*** (0.003)
<i>Group 2022</i> (ref. boys)				
Treated × girls	-0.105*** (0.004)	-0.137*** (0.004)	-0.031*** (0.004)	-0.066*** (0.003)
Controls	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Observations	1,541,422	1,522,510	1,628,997	1,619,353

Notes: This table presents the estimates of the impact of the COVID-19 pandemic on student learning from a difference-in-differences model. Coefficient report interaction term between the treatment variable and gender (ref. boys). Socio-demographic controls included student's origin, and ESCS. The regression includes region fixed effects. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5
Heterogeneity analysis by socioeconomic status.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>Average effect</i> (ref. bottom quartile)				
Treated × 2nd quartile	-0.036*** (0.006)	-0.035*** (0.006)	-0.016*** (0.004)	-0.004 (0.004)
Treated × 3rd quartile	-0.047*** (0.006)	-0.052*** (0.006)	-0.034*** (0.004)	0.007* (0.004)
Treated × 4th quartile	-0.094*** (0.007)	-0.085*** (0.007)	-0.062*** (0.005)	0.009** (0.004)
<i>Group 2021</i> (ref. bottom quartile)				
Treated × 2nd quartile	-0.019** (0.008)	-0.016** (0.007)	-0.007 (0.005)	-0.003 (0.005)
Treated × 3rd quartile	-0.023*** (0.008)	-0.014* (0.008)	-0.022*** (0.005)	0.008 (0.005)
Treated × 4th quartile	-0.072*** (0.009)	-0.041*** (0.009)	-0.047*** (0.005)	0.016*** (0.005)
<i>Group 2022</i> (ref. bottom quartile)				
Treated × 2nd quartile	-0.054*** (0.007)	-0.051*** (0.007)	-0.026*** (0.005)	-0.006 (0.005)
Treated × 3rd quartile	-0.075*** (0.008)	-0.089*** (0.008)	-0.046*** (0.005)	0.007 (0.005)
Treated × 4th quartile	-0.117*** (0.009)	-0.127*** (0.009)	-0.079*** (0.006)	0.000 (0.005)
Controls	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Observations	1,541,422	1,522,510	1,628,997	1,619,353

Notes: This table presents the estimates of the impact of the COVID-19 pandemic on student learning from a difference-in-differences model. Coefficient report interaction term between the treatment variable and ESCS quartile (ref. bottom). Socio-demographic controls included gender and student's origin. The regression includes region fixed effects. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

effects for the group 2021 (the first school year following the COVID-19 outbreak) are slightly smaller than those presented in most previous studies on Italy. In grade 5, previously estimated negative effects range from -0.14 s.d. [Bazoli et al. \(2022\)](#) to -0.05 s.d. in mathematics ([Bertoletti et al., 2023](#)). Some studies have even reported positive effects on reading ([Bazoli et al., 2022](#); [Borgonovi and Ferrara, 2023](#)). For grade 8, previously estimated negative effects of the COVID-19 pandemic range from -0.29 in mathematics to -0.02 in reading ([Bazoli et al., 2022](#)).⁷ At the international level, our effects are in line with those in the literature. In their meta-analysis of 42 studies across 15 countries, [Betthäuser et al. \(2023\)](#) find a substantial overall learning deficit of -0.14 s.d., with estimates ranging from -0.65 to 0.07 s.d.

⁷ Aggregating data from students in grades 5, 8, and 13, [Battisti and Maggio \(2023\)](#) found an overall learning loss ranging from -0.20 to -0.15 s.d. in mathematics and from -0.13 to -0.09 s.d. in reading.

Table 6
Heterogeneity by geographical area.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>Average effect</i> (ref. north)				
Treated \times Center	-0.086*** (0.010)	-0.080*** (0.010)	-0.071*** (0.006)	-0.019*** (0.005)
Treated \times South	-0.249*** (0.011)	-0.242*** (0.010)	-0.115*** (0.006)	-0.042*** (0.005)
<i>Group 2021</i> (ref. north)				
Treated \times Center	0.097*** (0.013)	-0.059*** (0.012)	-0.081*** (0.007)	-0.009 (0.006)
Treated \times South	-0.339*** (0.014)	-0.205*** (0.013)	-0.152*** (0.007)	-0.030*** (0.006)
<i>Group 2022</i> (ref. north)				
Treated \times Center	-0.076*** (0.012)	-0.102*** (0.012)	-0.060*** (0.007)	-0.031*** (0.006)
Treated \times South	-0.161*** (0.013)	-0.279*** (0.012)	-0.079*** (0.007)	-0.056*** (0.006)
Controls	Yes	Yes	Yes	Yes
Region fixed effects	No	No	No	No
Observations	1,541,422	1,522,510	1,628,997	1,619,353

Notes: This table presents the estimates of the impact of the COVID-19 pandemic on student learning from a difference-in-differences model. Coefficient report interaction term between the treatment variable and region (ref. north). Socio-demographic controls included gender, student's origin, and ESCS. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The estimated effects for the group 2022 (students who were in grade 2 or 5 in 2018–19, and in grade 5 or 8 in 2021–22) are generally negative and comparable (or smaller) to those from one year earlier. The exception is in grade 5 mathematics scores, for which we find no effect in 2021 and a negative effect of -0.02 s.d. in 2022.

To determine whether these differences between cohorts are significant, we estimate the triple difference model in Eq. (2). Mathematically, the estimated effect corresponds to the difference between the estimated effects for each cohort. With the exception of mathematics in grade 5 (for which the learning loss becomes significant only in 2022), the results show non significant difference or smaller values in the magnitude of the learning loss over time (and a significant reduction of the learning loss in reading for grade 8). These findings indicate a scattered situation across grades and subjects, and generally show that the learning loss is still severe after two years from the beginning of the pandemic. While this result may be expected, given the various restrictions that were still in place in 2022 (like mask-wearing and rigid protocols) and that could affect the school environment, this is worrying given the time spent from the beginning of the pandemic, and thus the possibility for schools to organize learning recovery programs—as the one described by [Carlana and La Ferrara \(2021\)](#).

We verify the robustness of these results in two ways. The first robustness check does not take into consideration the control variables. The second uses the parents' occupation and level of education, in place of the ESCS index. The results, presented in [Tables A.1](#) and [A.2](#), do not differ from those presented above.

4.2. Heterogeneity analyses

To explore the heterogeneity of the effect of COVID-19, we (i) determine whether the differences between girls and boys are significant; (ii) explore the heterogeneity by SES by considering the quartiles of the socioeconomic index (ESCS); (iii) verify the differences at geographical level, considering three macro-areas across Italy (north, center, south). To perform these heterogeneity analyses, we add an interaction term to Eq. (1). Results are presented in [Tables 4–6](#).

First of all, on average, the pandemic seems to have affected girls more than boys in the group 2022, while the situation is more scattered in 2021. In detail, the average effect of the pandemic for girls is negative in 2022 in both grades and both subjects. In group 2021, girls were negatively affected by the COVID-19 pandemic in reading but not in mathematics. While girls generally perform better than boys in reading and less well in mathematics ([Contini et al., 2017](#); [Guiso et al., 2008](#)), in the first year after the COVID-19 outbreak, girls' reading scores were more affected than those of boys. While this result may sound counterintuitive, these mixed findings add to the unclear picture on gender effect that is emerging in Italy ([Borgonovi and Ferrara, 2023](#); [Contini et al., 2022](#)). Our findings show how, in the short term, the pandemic may have particularly affected those categories with a relative advantage (as girls in reading and boys in mathematics), while the persistence of the emergency may have been particularly challenging for girls. This aspect deserves further observation in the next cohorts.

The heterogeneity analysis by SES also points towards a harder impact of the pandemic on the category with a relative advantage, as shown in [Table 5](#). The high SES group is indeed the one for which the negative impact is the highest in magnitude. While this result may sound puzzling, similar findings have been reported by [Borgonovi and Ferrara \(2023\)](#).

A final heterogeneity analysis has been run by geographical macro-area (north, center and south of Italy). While the existence of a huge learning gap between the north and the south of the country is widely confirmed by the literature ([Agasisti and Vittadini,](#)

2012; Daniele, 2021), it is worrying to observe from Table 6 that the pandemic may have intensified this gap. The negative effect in southern regions is more pronounced than in the north by -0.34 to -0.03 s.d. and, in reading, more intense for the group 2022 than for 2021 for both grades. This evidence represents a urgent call to action to avoid the creation of educational sub-systems advancing at different pace within the same country.

5. Conclusion

The current research provides evidence on the magnitude and persistence of the negative effects generated by the COVID-19 pandemic on student achievement in Italy. While previous research primarily examines the immediate impacts of COVID-19 during the academic year following the pandemic, our study expands the temporal focus. Using a difference-in-differences design, we estimate the effect of the COVID-19 pandemic on students' test scores in Italy both in the school year following the COVID-19 pandemic (2020–21) and in the following year (2021–22). Employing a triple difference model, we check whether the effect of the pandemic has changed for the two cohorts. Our results demonstrate a significant and persistent adverse impact of the COVID-19 pandemic on mathematics and reading scores of both students in grades 5 and 8 during the 2021–22 school year. The results also highlight that the effect is less pronounced compared to the preceding year in grade 8 reading. The group 2022 shows instead an even larger negative effect in grade 5 mathematics, while similar learning loss are estimated across time for grade 5 reading and grade 8 mathematics. The findings point to a generally persistent learning loss, while signals of decreasing effects over time are emerging in international contexts (Singh et al., 2022a). It is worth to notice that, while the pandemic situation prevented the systemic opening of school in the summer 2020, the government supported the organization of summer programs in 2021 (in the period June–September), and this policy decision may affect the results observed in 2022, for example for grade 8 reading. In this respect, policy aimed at supporting the recovery have proved to be effective (Gambi and De Witte, 2023).

However, the effects have not been homogeneous. Our analysis underscores that girls have been negatively affected by the pandemic especially in group 2022, with a decline in their academic performance and an exacerbation of gender disparities that was not observed in group 2021 (at least in mathematics). The gender penalty observed in this article is even more alarming if combined with the findings of existing research on the labor market, which has demonstrated a “motherhood penalty” associated with COVID-19 (Couch et al., 2022) and worsening inequalities between men and women (Singh et al., 2022b). The findings by SES point towards a reduction in inequality due to the COVID-19 pandemic and deserves further future investigation, while the territorial differences that already divide the country has been accentuated by the pandemic. These results should alert public authorities to the need to design public policies that are more sensitive to such internal differences.

A possible extension of this paper would be to follow the two cohorts of students longitudinally, in order to assess whether the impact of the pandemic was effectively mitigated over time. In particular, tracking these students for several years would provide valuable insights into how initial learning losses translate into long-term educational trajectories, including their choice of pathways in upper secondary and higher education, their risk of dropping out, and their subsequent transition into the labor market. While the short-term impact of the pandemic on university dropout rates has already been documented (see Dagorn and Moulin, 2025), its long-term consequences on both educational attainment and subsequent labor market outcomes remain to be explored. Following these students beyond their school years would allow us to examine whether early educational disruptions and dropout translate into greater difficulties in accessing stable employment and career opportunities.⁸ It would also be important to assess whether the heterogeneous impact highlighted in this study continues to increase disproportionately over time.

CRedit authorship contribution statement

Léonard Moulin: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. **Mara Soncin:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing.

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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.

Appendix

See Tables A.1 and A.2 and Figs. A.1–A.3.

⁸ See, for example, Issehnane and Moulin (2024) for short-term effects on youth employment.

Table A.1
Main results without covariates.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>DID</i>				
Average effect	-0.009** (0.004)	-0.020*** (0.004)	-0.029*** (0.002)	-0.034*** (0.002)
Group 2021	-0.004 (0.005)	-0.020*** (0.005)	-0.028*** (0.003)	-0.040*** (0.002)
Group 2022	-0.016*** (0.005)	-0.020*** (0.005)	-0.030*** (0.003)	-0.030*** (0.002)
<i>DDD</i>				
Group 2022–2021	-0.013** (0.006)	0.000 (0.005)	-0.003 (0.003)	0.010*** (0.002)
Controls	No	No	No	No
Region fixed effects	Yes	Yes	Yes	Yes
Observations	1,621,157	1,608,433	1,759,011	1,744,797

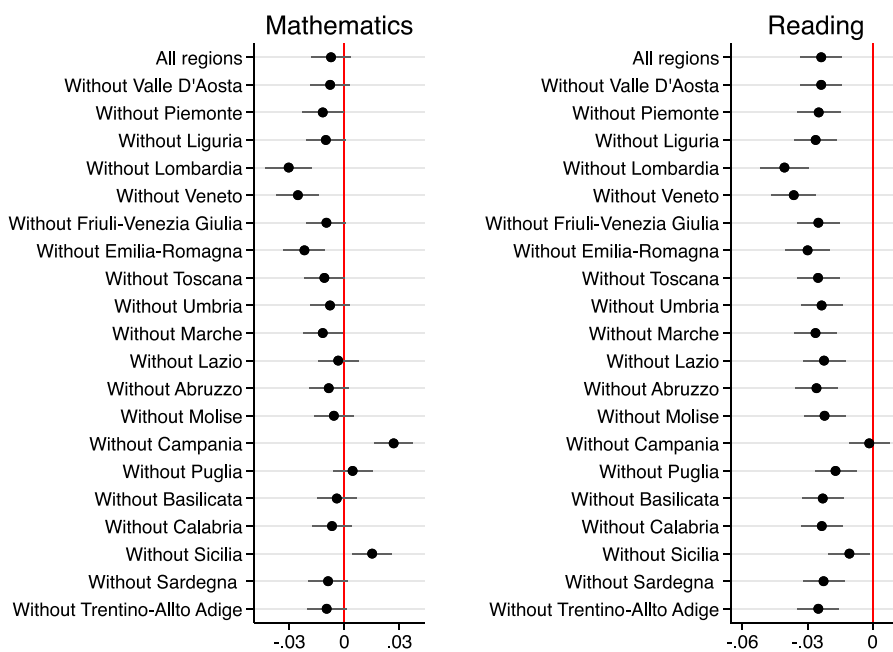
Notes: The table presents the estimates from a difference-in-differences model and a triple difference model of the impacts of the COVID-19 pandemic on student learning. The regression includes region fixed effects. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2
Main results with parent's level of education and occupation.

	$\Delta_{Grade5-Grade2}$		$\Delta_{Grade8-Grade5}$	
	Mathematics	Reading	Mathematics	Reading
<i>DID</i>				
Average effect	-0.010** (0.004)	-0.021*** (0.004)	-0.029*** (0.002)	-0.034*** (0.002)
Group 2021	-0.005 (0.005)	-0.022*** (0.005)	-0.030*** (0.003)	-0.041*** (0.002)
Group 2022	-0.017*** (0.005)	-0.020*** (0.005)	-0.028*** (0.003)	-0.027*** (0.002)
<i>DDD</i>				
Group 2022 - Group 2021	-0.012** (0.006)	0.002 (0.005)	0.002 (0.003)	0.014*** (0.003)
Region fixed effects	Yes	Yes	Yes	Yes
Observations	1,543,117	1,531,243	1,676,654	1,664,986

Notes: The table presents the estimates from a difference-in-differences model and a triple difference model of the impacts of the COVID-19 pandemic on student learning. Socio-demographic controls included gender, student's origin, parents' level of education (based on a binary indicator of whether or not least one has completed some higher education) and parents' occupation (based on a binary indicator of whether or not least one is in the category "Manager; university lecturer; military official or officer"). The regression includes region fixed effects. Standard errors (shown in parentheses) are clustered at the classroom level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

(a) Grade 5 - Grade 2



(b) Grade 8 - Grade 5

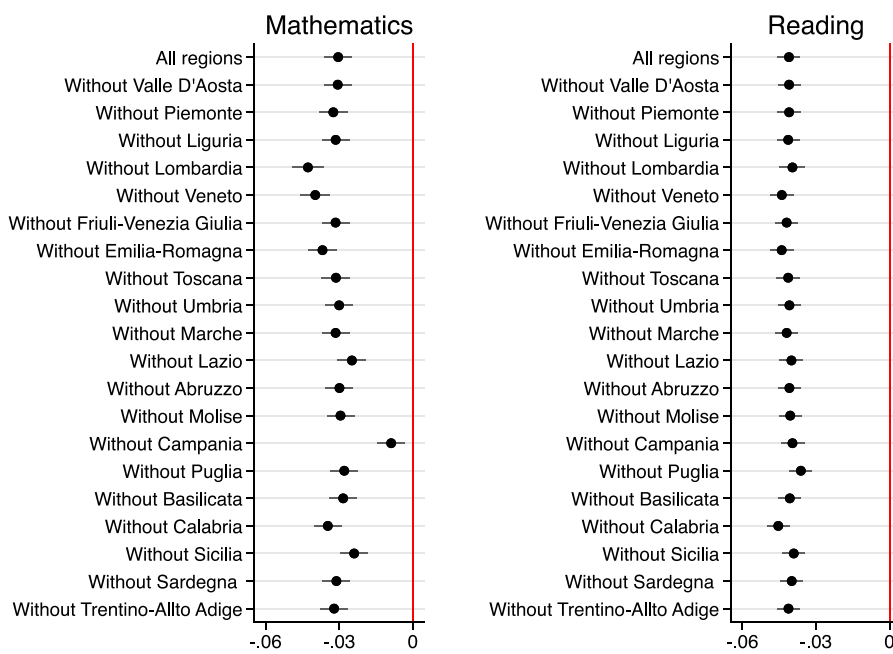
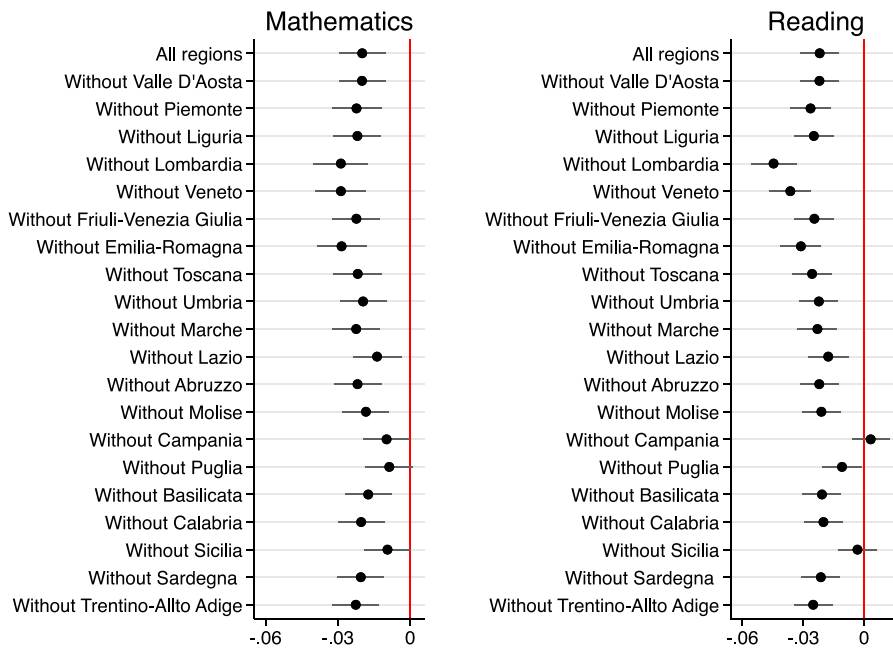


Fig. A.1. Main results excluding specific regions one at a time — group 2021. Notes: This figure presents the estimates of the impact of the COVID-19 pandemic on student learning in 2020–21 in each Italian region from a difference-in-differences model. Socio-demographic controls include gender, the student’s origin and ESCS. The regression includes region fixed effects. Standard errors are clustered at the classroom level.

(a) Grade 5 - Grade 2



(b) Grade 8 - Grade 5

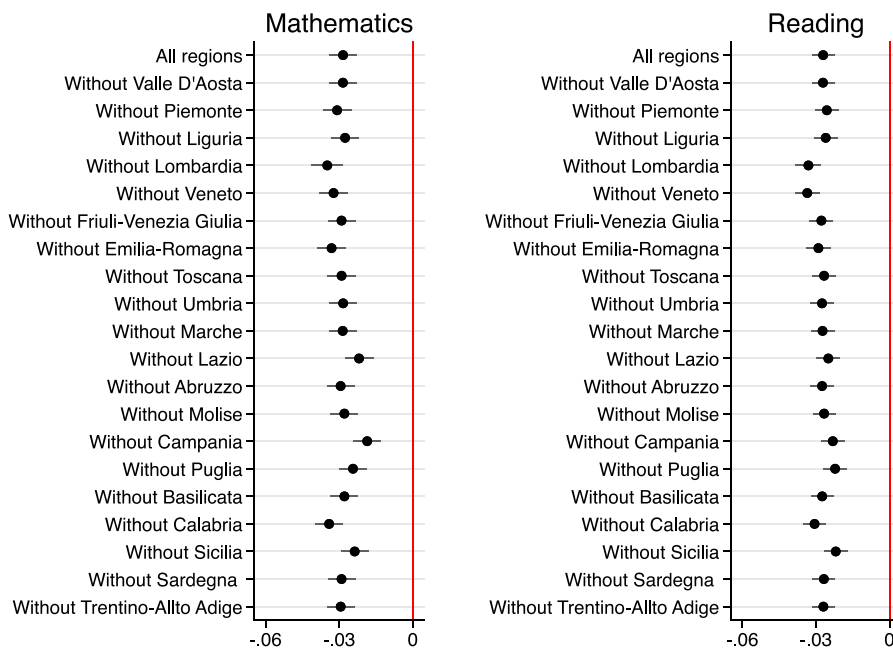
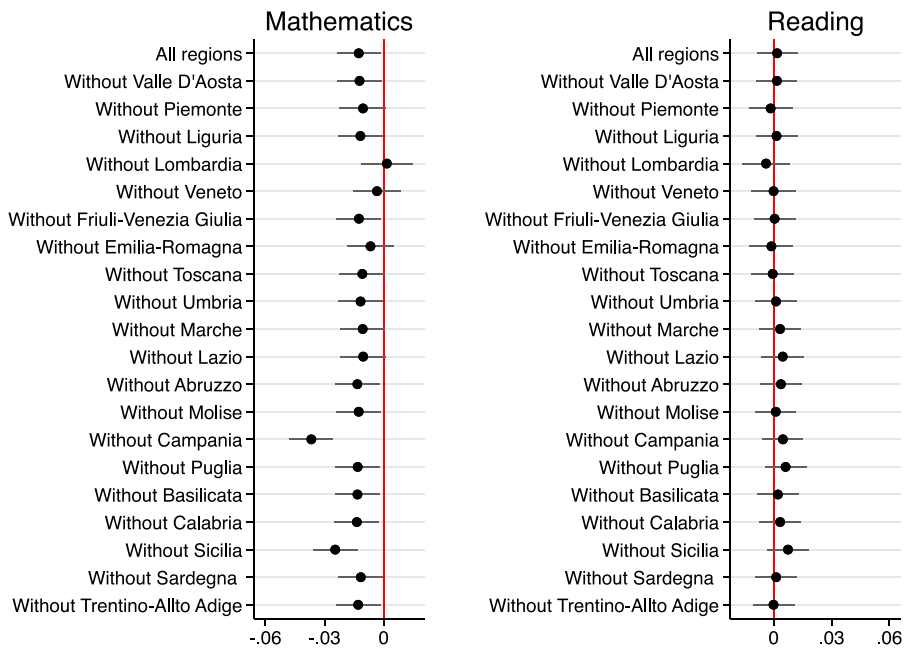


Fig. A.2. Main results excluding specific regions one at a time — group 2022. Notes: This figure presents the estimates of the impact of the COVID-19 pandemic on student learning in 2021–22 in each Italian region from a difference-in-differences model. Socio-demographic controls include gender, the student’s origin and ESCS. The regression includes region fixed effects. Standard errors are clustered at the classroom level.

(a) Grade 5 - Grade 2



(b) Grade 8 - Grade 5

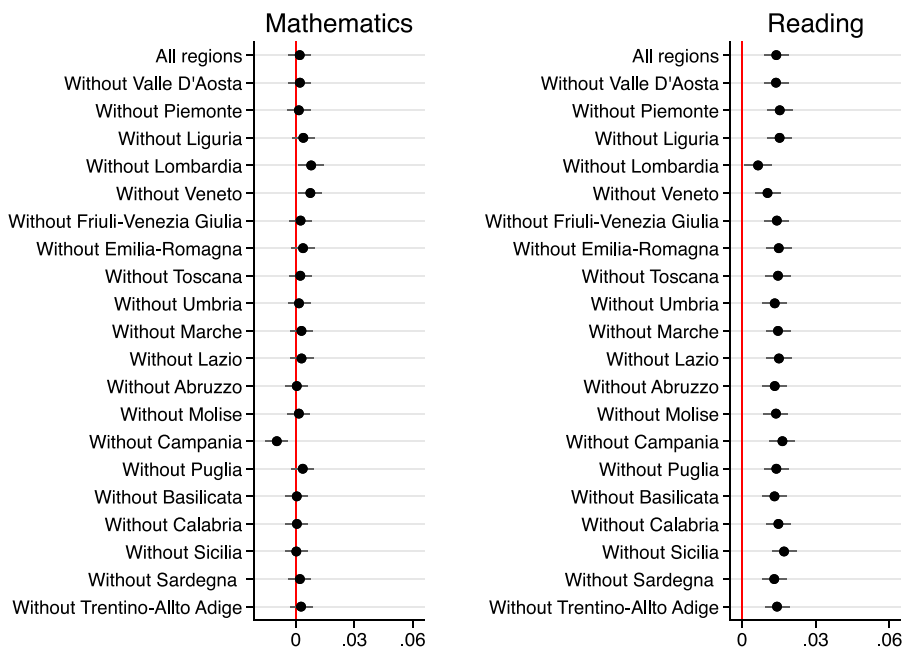


Fig. A.3. Main results excluding specific regions one at a time — DDD. Notes: This figure presents the estimated evolution of the impact of the COVID-19 pandemic on student learning between the 2020–21 and 2021–22 school years from a triple difference model. Socio-demographic controls include gender, the student’s origin and ESCS. The regression includes region fixed effects. Standard errors are clustered at the classroom level.

Data availability

The data can be made available to researchers via <https://www.invalsi.it>.

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