II. THE ECONOMIC IMPACT OF COVID-19 LEARNING DEFICITS

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Abstract: *The COVID-19 pandemic led to a temporary reduction in the quantity and quality of education, with school closures of varying degrees implemented across the globe. This chapter reviews the literature on learning deficits in compulsory education caused by the pandemic and their possible economic impact. Studies from different euro area and EU Member States show, on average, significant learning deficits in primary and secondary education, equivalent to almost 2 months of learning progress during a regular school year. The impact of the pandemic on learning outcomes varies widely by country as well as by students' age and socio-economic background. Labour market outcomes of recent graduates are historically strong, supported by a context of tight labour markets, but the long-term economic impact of learning deficits is likely to be non-negligible. Existing studies project small productivity losses for the coming years as a result of these learning deficits, but a larger impact in the long term, peaking in the second half of the 21st century, when all affected cohorts of students will have entered the labour market. According to the studies surveyed in this chapter, estimates of the aggregate, real-GDP effects of these learning deficits range between -0.1% and -1% by 2050, compared to a baseline without any learning deficits. These estimates are based on: (i) an average learning deficit of roughly one fifth of a school year; (ii) the number of affected cohorts of students corresponding to around one third of the future labour force at most; and (iii) an assumption that these losses are not recovered ([20]).*

II.1. INTRODUCTION

During the COVID-19 pandemic, euro area education systems were strongly affected by containment measures aimed at reducing the spread of the virus. Over the course of the pandemic, a reduction in the quantity and quality of education of varying degrees was observed between March 2020 and June 2021 across the euro area. In most Member States, schools were physically closed for several weeks or months, and classes at school were partly replaced by distance learning with self-study and online classes ([21]). After the first lockdown in 2020, partial physical school closures of shorter periods, and reduced hours for selected grade years or regions continued to be implemented. In the 2021-2022 school year, regular teaching activities resumed across the euro area, with some remote teaching practices remaining in place, particularly at universities.

Studies from different euro area and EU Member States show negative effects of these changes in schooling on both the level and the distribution of learning outcomes. A combination of students forgetting previously learned material ('learning loss') and new learning progressing at a slower pace than before ('lost progress') resulted in 'learning deficits'. These learning deficits were systematically greater for students from disadvantaged socio-economic backgrounds. Given these negative effects, which simultaneously affected a large number of age cohorts, the resulting reduction in human capital could negatively affect economic outcomes in the long run.

Estimates of the macroeconomic implications of learning deficits vary substantially in quantitative terms. The studies reviewed in this chapter suggest real GDP level effects of between -0.1% and -1% by

([20]) The authors would like to thank Leonor Coutinho, Aron Kiss, Géraldine Mahieu, Marco Montanari, Eric Ruscher, Anna Thum-Thysen, Alessandro Turrini, and Kristine Van Herck for useful comments.

([21]) Complete school closures (without provision of distance teaching or blended learning) only took place for short periods in some euro area Member States. In this section, the term 'school closure' is used to describe the suspension of face-to-face schooling, while in most cases learning activities (partly) continued remotely. Data on school closures by country or region can be found in European Commission/ EACEA/ Eurydice (2022), 'Teaching and learning in schools in Europe during the COVID-19 pandemic', Luxembourg: Publications Office of the European Union; and in UNESCO (2017), 'Dashboards on the Global Monitoring of School Closures Caused by the COVID-19 Pandemic', https://covid19.uis.unesco.org/global-monitoring-school-closures-covid19/.

2050 for a pandemic-induced learning deficit of one fifth of a school year, with structural model-based studies generally indicating smaller losses than projections based on empirical estimates with a looser theoretical structure.

This chapter summarises the evidence on COVID-19 learning deficits and provides an economic perspective on their possible long-term impact. Section II.2 reviews the literature on the effects of the COVID-19 pandemic on educational outcomes. Section II.3 assesses whether the pandemic's effects are visible in short-term labour market outcomes and describes estimates of the possible long-term impact of the learning deficits on output. Section II.4 concludes with a discussion of the policy implications.

II.2. EFFECTS ON EDUCATIONAL OUTCOMES IN PRIMARY AND SECONDARY EDUCATION

To date, the evidence on post-COVID-19 outcomes from standardised international tests, which are comparable across countries and years, remains limited. Assessments under these standardised international tests take place only every few years, and were in many cases postponed due to the pandemic. The first internationally comparative evidence on the post-COVID-19 reading performance of 10-year-olds comes from the 2021 Progress in International Reading Literacy Study (PIRLS). In total, 17 euro area and 6 additional EU Member States participated in this assessment ([22]). Out of these, 16 countries have comparable trend data available from previous assessment cycles. 12 countries and the Flemish community of Belgium experienced a significant decrease in the 2021 test scores compared with the 2016 assessment. This is a noticeable negative result, likely in part attributable to the COVID-19 pandemic, as 10 of these countries had a positive (i.e. with reading scores improving over time) or constant trend before 2016. Only three countries and the French community of Belgium recorded no significant change in test scores from 2016 to 2021, while no country achieved a significant positive change in test scores in this period. Correlations with national data on school closures for 29 countries globally show that longer school closures were negatively associated with reading scores, with a 1-year school closure resulting in a learning deficit of half a school year ([23]). However, the quality of the data behind these results is limited due to the variations of school closures within countries.

Lately, results from the PISA survey suggest there has been an unprecedented drop in average educational performance in the EU between 2018 and 2022. Part of the decline is likely related to the pandemic and the associated school closures. However, as learning outcomes were already showing a worsening trend before 2018, it is also plausible that other structural factors are at play ([24]). The PISA results suggest that students that were spared from longer school closures score higher in mathematics. At the same time, the PISA study underlines the difficulty of directly linking the length of school closures to changes in performance between 2018-2022.

Country-specific studies using national data provide a broader picture of the pandemic's impact in compulsory education. One year after the first school closures, early reviews of country-specific studies

([22]) See Mullis, I.V.S., von Davier, M., Foy, P., Fishbein, B., Reynolds, K.A., & Wry, E. (2023), 'PIRLS 2021 International Results in Reading', Boston College, TIMSS & PIRLS International Study Center. https://doi.org/10.6017/lse.tpisc.tr2103.kb5342. In 2021, the following EU Member States participated in PIRLS: BE (Flemish and French communities), BG, CZ, DK, DE, IE, ES, FR, HR, IT, CY, LV, LT, HU, MT, NL, AT, PL, PT, SI, SK, FI, SE. Two of these countries (HR, CY) did not participate in the previous 2016 edition and other countries do not have comparable time trend data due to other reasons, such as structural breaks.

([23]) Kennedy, A. I., & Strietholt, R. (2023), 'School Closure Policies and Student Reading Achievement: Evidence Across Countries', International Association for the Evaluation of Educational Achievement (IEA), Hamburg, Germany. For a survey on school closures and their consequences for learning with focus on the United States, see Jack, R. & Oster, E. (2023), 'COVID-19, School Closures, and Outcomes', Journal of Economic Perspectives 37(4), pp. 51-70.

([24]) OECD (2023) PISA 2022 Results (Volume II): Learning During – and From – Disruption, PISA, OECD Publishing, Paris, https://doi.org/10.1787/a97db61c-en.

consistently found that the COVID-19 pandemic led, on average, to significant learning deficits ([25]). This finding was confirmed in more comprehensive reviews 2 years after the outbreak of the pandemic ([26]).

A review of 42 studies from 15 countries around the world found a substantial average learning deficit of 35% of a regular school year's learning progress as a result of the school closures during the pandemic ([27]). For the EU Member States covered in the selected studies, an average loss of 20% of a school year's learning progress was recorded ([28]). Assuming a duration of a regular school year of 8-9 months, this would be equivalent to the loss of the learning progress of almost 2 months during a regular school year. This learning deficit is equivalent to an 8-score-point decrease on the OECD's PISA test (or 8% of a standard deviation), which is a large setback, given that only nine EU Member States were able to improve performance in reading in PISA from 2015 to 2018, and in each of these cases the improvement concerned less than 8 score points ([29]).

A scientific report commissioned by the European Commission (DG EAC) finds a larger average learning deficit of 30% of a regular school year's learning progress as a result of the pandemic in EU Member States ([30]). Similar results are found in a comprehensive meta-analysis by the European Commission's Joint Research Centre covering 21 OECD countries, which estimates the pandemic induced an average learning deficit of 30-40% of a regular year's learning progress, with a smaller learning deficit in OECD EU countries compared to OECD non-EU countries ([31]).

([25]) See for example Donnelly, R. & Patrinos, H.A. (2022), 'Learning loss during Covid-19: An early systematic review', Prospects 51, 601–609. https://doi.org/10.1007/s11125-021-09582-6; Hammerstein, S., König, C., Dreisörner, T., & Frey, A. (2021), 'Effects of COVID-19-related school closures on student achievement-a systematic review', Frontiers in psychology, 12, 746289; Storey, N., & Zhang, Q. (2021), 'A Meta-analysis of COVID Learning Loss', EdArXiv. https://doi.org/10.35542/osf.io/qekw2; Zierer, K. (2021), 'Effects of pandemic-related school closures on pupils' performance and learning in selected countries: A rapid review', Education Sciences, 11(6), 252.

([26]) See for example Patrinos, H.A., Vegas, E., & Carter-Rau, R. (2022), 'An Analysis of COVID-19 Student Learning Loss'; Moscoviz, L. & Evans, D.K. (2022), 'Learning Loss and Student Dropouts during the COVID-19 Pandemic: A Review of the Evidence Two Years after Schools Shut Down', CGD Working Paper 609. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/learning-loss-and-student-dropouts-during-covid-19-pandemic-review-evidence-two-years.

([27]) Betthäuser, B.A., Bach-Mortensen, A.M. & Engzell, P. (2023), 'A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic', Nature Human Behaviour. https://doi.org/10.1038/s41562-022-01506-4. The authors of the study conducted a systematic review of the literature and found a learning deficit of 0.14 standard deviations, which can be translated to a loss of 35% of a regular school year (see Box II.1).

([28]) This estimate, equal to 0.08 standard deviations, is obtained from the authors' own calculations based on the dataset and code provided by Betthäuser et al. (2023), restricting the sample to the 17 studies from seven EU Member States included in their sample (BE, DE, DK, ES, IT, NL, SE). It has to be noted that, due to limited data availability, this estimate is not an accurate estimate for the EU, as many Member States are not represented (e.g., Baltic, central and eastern European countries). The reported number is an unweighted average of all estimates.

([29]) OECD (2019), PISA 2018 Results (Volume I): 'What Students Know and Can Do', PISA, OECD Publishing, Paris. https://doi.org/10.1787/5f07c754-en.

([30]) De Witte, K. & François, M. (2023), 'Covid-19 Learning deficits in Europe: analysis and practical recommendations', EENEE Analytical report. https://doi.org/10.2766/881143. The report finds, on average, a learning deficit of 0.11 standard deviations for European countries, including the UK. Taking the subset of included studies from EU Member States, excluding the UK, gives an average of 0.12 standard deviations. The difference to Betthäuser et al. (2023) is possibly due to the strict selection by Betthäuser et al. (2023), which excludes studies with a critical risk of bias, e.g. due to confounding, sample selection, or missing data.

([31]) The included OECD non-EU countries were: Australia, Colombia, Mexico, Norway, Switzerland, Turkey, the UK and the US. Di Pietro, G. (2023a), 'The impact of Covid-19 physical school closure on student performance in OECD countries: a meta-analysis', Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/197242.

Box II.1: **Measures of learning progress**

In educational research, changes in learning outcomes are commonly measured in standard deviations (SD). This statistical measure allows comparing the effect sizes of outcomes with different scales and from different samples. It assumes a normal distribution of the test scores, clustered in a bell curve around the mean. Raw test scores are standardised by rescaling to a mean of 0 and a standard deviation of 1.

The standardised score (z-score) indicates how far an observation is lying above or below the mean. A score which is 1 standard deviation above (below) the mean is approximately equivalent to the 84th (16th) percentile, that is 34 percentile points above (below) the mean. Accordingly, a learning deficit of 0.1 (0.2) standard deviations shifts the distribution to the left, moving the student, who was at the median before the pandemic, down to the 46th (42nd) percentile.

Measured learning outcomes can be compared to benchmarks for the learning progress observed during a regular school year, as established in the educational literature ([1]). Learning deficits can then be expressed in terms of lost progress as a share of a regular school year. While school productivity varies in different education systems, grade levels and by other factors, an average learning gain benchmark of 0.2-0.5 standard deviations in one school year is commonly assumed ([2]). In this section, we use an average learning gain benchmark of 0.4 standard deviations for a regular school year ([3]).

On the scale of the OECD's PISA, which is normalised to have a mean of 500 score points and standard deviation of 100 score points, a change in learning outcomes by 10% of a standard deviation equals a 10-point difference ([4]).

(1) E.g., Bloom, H. S., Hill, C. J., Black, A. R. & Lipsey, M. W. (2008), 'Performance trajectories and performance gaps as achievement effect-size benchmarks for educational interventions', Journal of Research on Educational Effectiveness, 1, 289–328; Hill, C. J., Bloom, H. S., Black, A. R. & Lipsey, M. W. (2008), 'Empirical benchmarks for interpreting effect sizes in research', Child Development Perspectives, 2, 172–177.
(2) E.g., Azevedo, J. P., Hasan, A., Goldemberg, D., Iqbal, S. A. & Geven, K. (2020), 'Simulating the Potential Impacts of COVID-19 School Closures on Schooling and Learning Outcomes: A Set of Global Estimates', World Bank.
(3) As in Hill et al. (2008), op. cit.
(4) See OECD (2019), op. cit.

The observed decline in learning outcomes following the outbreak of the COVID-19 pandemic represents a combination of various effects, such as the loss in instruction time, the lower effectiveness of instruction in distance teaching, and the absence of peer effects. It comprises both the reduction in learning progress and the loss of knowledge gained before the start of the pandemic.

The learning deficits vary widely across countries. Students in middle-income countries experienced larger learning deficits than students in high-income countries, although studies on high-income countries are overrepresented ([32]) and cross-country differences are likely due to differences in the length (or intensity) of school closures ([33]). Among euro area countries, no impact of the COVID-19 crisis on learning outcomes was observed in Finland, while large negative effects were found in Greece. In EU non-euro area countries, no impact was found in the Nordic countries (Denmark, Sweden) while large negative effects were found in Poland ([34]).

([32]) Betthäuser et al. (2023), op. cit.

([33]) Di Pietro (2023a), op cit.

([34]) De Witte & François (2023), op. cit.

Questions remain as to how long the learning deficits will persist. While it is possible that students might catch up over time, educational research suggests that learning deficits can even accumulate over time ([35]). Many euro area countries have already increased spending on education and have taken remedial measures to reduce – and even reverse – the negative effects of the COVID-19 pandemic ([36]). However, the first assessments of the medium-term impact of the COVID-19 pandemic provide a mixed picture of post-pandemic trends in learning outcomes in euro area and non-euro area OECD countries, with constant or increasing learning deficits indicating that efforts to compensate for losses had not succeeded in reversing the negative trend by spring 2022 ([37]).

Graph II.1 summarises the findings on average learning deficits in selected euro area Member States plus Denmark and Sweden. The selection of countries was based on the availability of robust data. Across countries, no clear pattern of improvement over time becomes visible. In Germany and Belgium, the average learning deficits recorded in 2021 were even greater than those measured in 2020. This widening of the learning deficits in 2021 could be due to containment measures in schools having continued over this period or could result from an accumulation of missed learning progress.

Studies are difficult to compare, as they vary in many factors, such as the geographical context, length of school closure, type of distance teaching, test instruments, student samples, and methodologies. However, three factors likely affect the size of the learning deficits. Firstly, a longer duration of school closures is correlated with greater learning deficits ([38]). Secondly, a high level of digitalisation of education before the pandemic was associated with lower learning deficits ([39]). Finally, while most studies cover primary school students, some reviews observe a correlation with the age of students, with younger students more negatively affected than older students ([40]). However, this correlation could be driven by differences in the length of school closures, which often differed by grade year, and is found to be statistically not significant in other reviews ([41]).

It is likely that the learning deficits caused by the COVID-19 pandemic are exacerbating previous downward trends in learning outcomes. The methodological limitations of most studies make it difficult to disentangle the effects of COVID-19 from long-term trends, with most studies not controlling for the general time trend when using pre-pandemic results of previous age cohorts as a reference ([42]). The causal effects can be clearly disentangled in natural experiments ([43]) that allow to compare the learning progress of unaffected cohorts with the learning progress of pandemic-affected cohorts over the same time frame. For example, a study from the Netherlands records significant learning deficits of the same magnitude as the EU average reported above, based on such a natural experiment ([44]). Hence, the fact

([35]) A possible mechanism is that if the curriculum and the instruction are not adjusted to children's learning deficits following a schooling shock, the affected children may fall further and further behind. Kaffenberger, M. (2021), 'Modelling the long-run learning impact of the COVID-19 learning shock: Actions to (more than) mitigate loss', International Journal of Educational Development, 81, 102326.

([36]) De Witte, K., & Smet, M. (2021), 'Financing education in the context of COVID-19', EENEE Ad hoc report no. 03/2021.

([37]) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.

([38]) De Witte & François (2023), op. cit.; Di Pietro (2023a), op cit.; Patrinos et al. (2022), op. cit.

([39]) De Witte & François (2023), op. cit.

([40]) De Witte & François (2023), op. cit.

([41]) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.

([42]) De Witte & François (2023), op. cit.

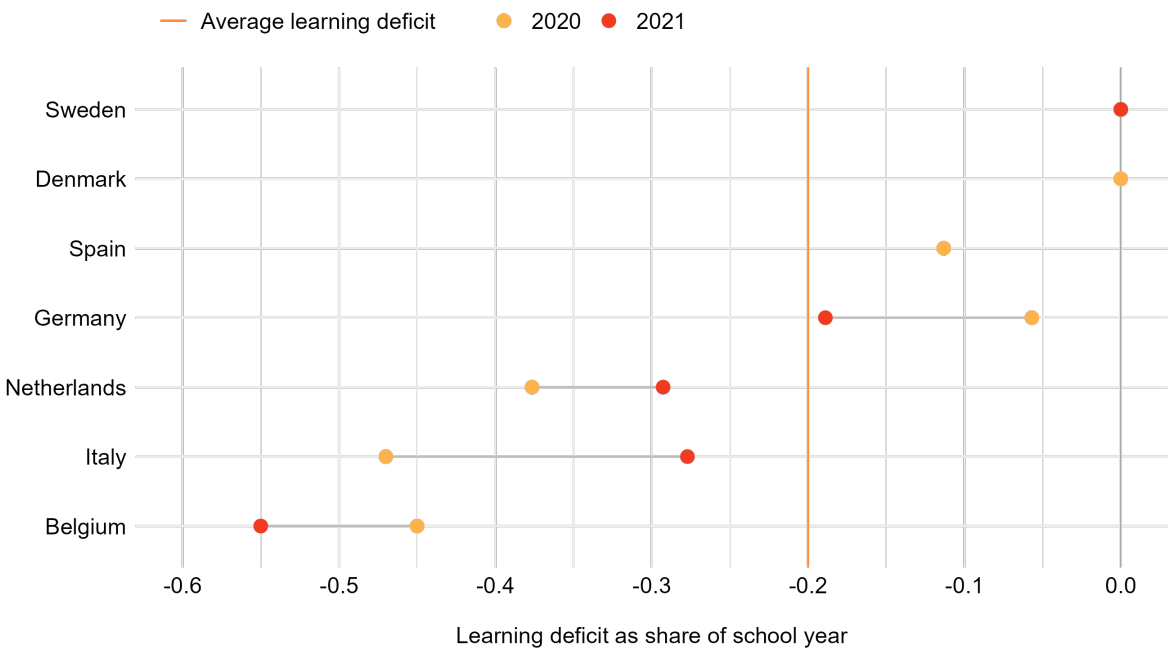
([43]) A natural experiment is a situation where the natural course of events (e.g. a policy change or a weather event) creates favourable conditions for an impact evaluation, e.g. due to the (almost) random assignment of the change or event to the treatment group; and the existence of an untreated control group.

([44]) Engzell, P., Frey, A., & Verhagen, M.D. (2021), 'Learning loss due to school closures during the COVID-19 pandemic', Proceedings of the National Academy of Sciences, 118(17), e2022376118.

that studies using different statistical methodologies yield comparable results suggests that the learning deficits uncovered do not mainly reflect previous downward trends in learning outcomes ([45]).

In addition to its effect on school-aged children, it is likely that the COVID-19 pandemic also impacted learning outcomes in early childhood, higher education, and adult learning. Evidence on learning outcomes in early childhood, before children enter primary education, is largely limited to qualitative evaluations and studies from outside the EU ([46]). The few existing comparable studies evaluating the effects of the pandemic in higher education show similar learning deficits at the tertiary level, as at the primary and secondary level ([47]).

Graph II.1: **Average learning deficits in selected euro area countries,** plus Denmark and Sweden



(1) This graph is based on computations by the authors, using the dataset provided by Betthäuser et al. (2023). It covers the subset of 17 studies from seven EU Member States included in their sample. Estimates are averaged across grades and subjects. The average learning deficit is computed as an average across all available EU estimates (separate by study, year, age, and subject). Learning deficits are expressed in negative numbers (lost share of a school year), with the largest learning deficits on the left side of the horizontal axis. The colour of the dots indicates the year of measurement of student outcomes (2020 in orange, 2021 in red). Values for the respective countries in 2020 and 2021 are generally based on different samples of studies, implying imperfect comparability.

Source: Authors' own compilation.

Most studies observe that not all students were equally affected by the COVID-19 pandemic. Firstly, increasing inequality within countries is observed through a widening spread in the distribution of test scores, with increasing differences between the best- and worst-performing students in a country ([48]).

([45]) De Witte & François (2023), op. cit.

([46]) Uğraş, M.; Zengin, E.; Papadakis, S.; Kalogiannakis, M. (2023), 'Early Childhood Learning Losses during COVID-19: Systematic Review', Sustainability 15(7): 6199. https://doi.org/10.3390/su15076199.

([47]) Di Pietro, G. (2023b), 'The impact of Covid-19 on student achievement: Evidence from a recent meta-analysis', Educational Research Review 39. https://doi.org/10.1016/j.edurev.2023.100530.

([48]) See, for example, evidence from Belgium (Flanders) in Maldonado, J.E., & De Witte, K. (2022), 'The effect of school closures on standardised student test outcomes', British Educational Research Journal, 48(1), pp. 49-94. The changes

These increases in inequality were found to be slowing down but remained present 3 years after the pandemic ([49]). Secondly, differences in test scores by background characteristics of students or schools have increased. The learning deficits caused by the pandemic strongly depend on students' socio-economic status ([50]) and previous performance level ([51]). These differences are found in primary and secondary education and were visible at each stage of the pandemic ([52]).

II.3. POSSIBLE MACROECONOMIC IMPLICATIONS

This section describes early evidence on the labour-market outcomes of cohorts that graduated during the pandemic and provides a tentative quantitative assessment of the effect of the observed learning deficits on potential output in the long term.

II.3.1. Short-term effects observed in the labour market

Data on the labour-market outcomes of young people immediately following the COVID-19 pandemic likely reflect the impact of the recession, rather than any disruption to learning that they experienced.

Literature suggests that, even in the absence of learning disruptions, young people who first enter the labour market during a recession may face negative consequences in terms of their socio-economic outcomes (including earnings) for up to 10-15 years after graduation ([53]). This may be less of a concern in the current context, where the pandemic-related increase in youth unemployment was nowhere near the large increase observed in the aftermath of the financial crisis. This is partly because the impact of the pandemic on the labour market was attenuated by substantial policy efforts to stabilise the economy during the pandemic (including through short-time work schemes), reducing the risk of scarring effects.

While job-finding rates are strongly driven by the business cycle, they could partly also reflect changes in students' performance. An empirical study by the Institute for Fiscal Studies shows that for young people who graduated during the pandemic-related school closures in the UK, the pandemic had a negative effect on employment rates in the short run; but it faded away relatively quickly ([54]). In particular, students who graduated in 2020 were less likely to find a job 3-6 months after graduation and more likely to start in lower-paid occupations than previous cohorts, but they recovered to similar outcomes compared with previous cohorts 9-12 months after graduation.

Data on euro area youth unemployment suggest that youth unemployment rates reached an all-time low just before the pandemic and picked up moderately (more so than prime-age unemployment rates)

in the distribution of test scores were measured by inequality indicators, such as the Gini coefficient and the 90/10 ratio.

([49]) Gambi, L., & De Witte, K. (2023), 'The uphill battle: The amplifying effects of negative trends in test scores, COVID-19 school closures and teacher shortages'.

([50]) Betthäuser et al. (2023), op. cit.; Di Pietro (2023a), op cit.; Patrinos et al. (2022), op. cit.

([51]) De Witte & François (2023), op. cit.; Patrinos et al. (2022), op. cit.

([52]) Betthäuser et al. (2023), op. cit.

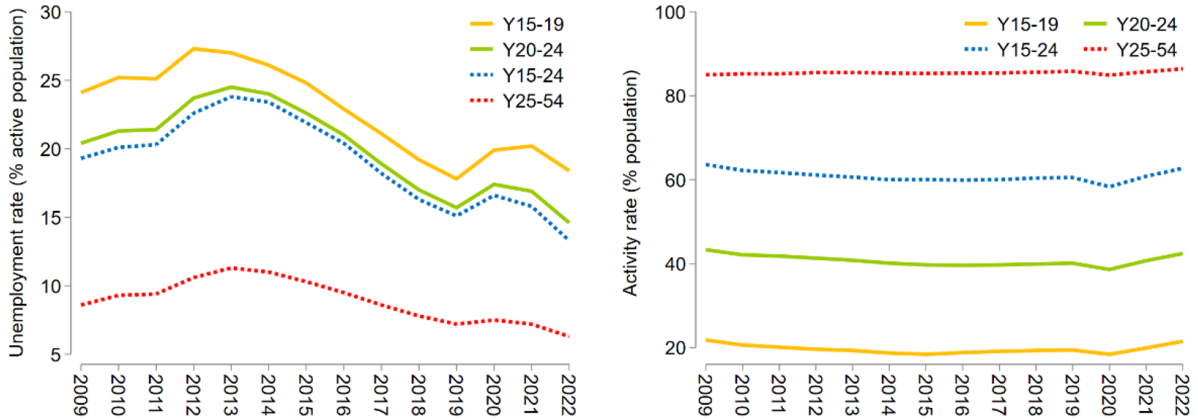
([53]) See Oreopoulos, P., Von Wachter, T. and Heisz, A., (2012), 'The short-and long-term career effects of graduating in a recession', American Economic Journal: Applied Economics, 4(1), pp.1-29; Schwandt, H. & Von Wachter, T., (2019), 'Unlucky cohorts: Estimating the long-term effects of entering the labor market in a recession in large cross-sectional data sets', Journal of Labor Economics, 37(S1), pp. S161-S198; Regan, M. (2020), 'Wage scarring among unlucky European cohorts', ESRI Working Paper 668, Dublin: ESRI, https://www.esri.ie/publications/wage-scarring-among-unlucky-european-cohorts.

([54]) Ray-Chaudhuri, S. & Xu, X. (2023), 'Are the kids alright? The early careers of education leavers since the COVID-19 pandemic', The Institute for Fiscal Studies, IFS Report R237.

in 2020 and 2021 (Graph II.2). These short-run impacts are more likely to reflect the direct impact of the recession on labour demand than any disruptions to learning caused by the pandemic. Young people may have been more affected by the pandemic as they are more likely to work on temporary contracts, and in contact-intensive sectors such as hospitality. In general, youth unemployment tends to be more sensitive to the business cycle than prime-age unemployment.

The euro area labour market recovered quickly, and by 2022 unemployment rates had declined below their pre-pandemic level for most age groups, bringing them to historically low levels. By 2022, unemployment rates remained slightly above their pre-pandemic level only for those aged 15-19; while participation rates exceeded their 2019 levels for all age groups considered, but even more so for young people than for prime-age cohorts. Demographic trends are likely to play a significant role in the future, as the euro area working-age population is shrinking and younger cohorts entering the labour market are significantly smaller than older cohorts retiring from the labour market.

Graph II.2: **Unemployment and activity rates by age group, EA20**



Source: EU-LFS [ESTAT variables lfsa_urgaed and lfsa_argaed].

In all, the tight labour market is likely to be masking or counteracting the possibly negative impact of the pandemic-induced learning deficits on employment and wages. Further research that relies on micro-level data would be required to assess more precisely the impact of the pandemic on labour market outcomes through learning disruptions.

Nevertheless, it is possible that learning gaps will have an impact on labour market outcomes of young people in the medium to long term. Lower levels of hard and soft skills and reduced learning on the job can also affect the long-term labour market outcomes of young people. For example, some companies in the UK report weaker performance of new employees who graduated during the pandemic ([55]).

Recently graduating cohorts, having completed most of their school years before the pandemic, are likely to be relatively less affected by school closures than the youngest cohorts. Economic models often assume either linearly decreasing or U-shaped marginal returns to education, with the latter suggesting the highest returns come from primary and tertiary education ([56]). Students experiencing interruptions of schooling and learning deficits during their first years at school, in which the largest learning progress is

([55]) O'Dwyer, M. (2023), 'Pandemic graduates struggle with teamwork, say Deloitte and PwC', in Financial Times, on 1 May 2023. https://www.ft.com/content/a8b20502-8238-4655-ba82-30d6243332d9?emailId=b26ba1c6-ae6e-441e-b040-463a45114f70&segmentId=22011ee7-896a-8c4c-22a0-7603348b7f22.

([56]) OECD (2022), 'Value for Money in School Education: Smart Investments, Quality Outcomes, Equal Opportunities', OECD Publishing, Paris. https://doi.org/10.1787/f6de8710-en.

commonly recorded ([57]), could potentially carry the resulting learning gaps throughout their school career and suffer the largest negative impact in the long term. Nevertheless, it remains possible that there will be some catching up of losses and compensation effects from entire cohorts being affected by the learning loss. To date, quantitative studies on the long-term economic impact of the learning deficits have drawn on simulation models, which are presented in the next section.

II.3.2. Modelling the long-term economic impact

The negative impact of the COVID-19 pandemic on students' learning is likely to affect macroeconomic outcomes through a reduction in individual lifetime earnings and skilled labour supply. It is well-established that high-quality education leads to higher earnings, better health, longer working lives, and improved quality of life. In addition, a skilled labour force contributes to economic growth through increased productivity and innovation, although the benefits of investment in education usually only take effect with a long time lag ([58]).

Historical evidence shows that school closures can have negative economic effects. Studies on teacher strikes and natural disasters find lasting economic effects for affected individuals ([59]). Similarly, learning breaks during long summer holidays also have negative long-term effects on individual economic outcomes ([60]). However, the situation during the COVID-19 pandemic – with far-reaching worldwide interruptions in face-to-face learning alongside the possibility of digital schooling – was very different from previous episodes of widespread school closures.

Both structural models and projection models have been used to predict the economic impact of the COVID-19 learning deficits. Structural models present a school-closure shock in terms of a reduction of public investment in education in calibrated macroeconomic frameworks. Projection models use established correlations between educational and economic outcomes to simulate the effect of learning deficits on economic growth. All estimates presented in this section make the assumption of no policy change (other than temporary school closures), i.e. they abstract from remedial measures, and they assume that learning deficits persist over time. Hence, one can understand these results as conditional (worst-case) projections in the absence of policy support, which may deviate from the best guess about actual policy responses.

Structural models predict real-GDP effects from a 1-year learning deficit of between –0.5% and –3.4% at the trough, which tends to occur after some decades, compared with a baseline without learning deficits. Structural models are a simplification of reality and attempt to specify (and quantify) the main transmission channels from shocks or policies to economic outcomes. The model parameters are estimated or calibrated to match empirical regularities of interest. Model results need to be interpreted against the background of underlying theory, assumptions, and parameter choices. Structural models make it possible to simulate counterfactuals ('what if') that illustrate the dependence of transmission channels and net outcomes on structural features of the economy and policy responses.

A school-closure shock of 1 year (for all students in primary and secondary education) yields average losses in the present discounted value of lifetime earnings of affected children of 2.1% in a partial-equilibrium life-cycle model (a type of structural model) with overlapping generations, calibrated to US

([57]) See Bloom et al. (2008), op. cit.; Hill et al. (2008), op. cit.

([58]) OECD (2022), op. cit.

([59]) See for example Winfree, P. (2023), 'The long-run effects of temporarily closing schools: Evidence from Virginia, 1870s-1910s', QUCEH Working Paper Series, No. 2023-02; Belot, M. & Webbink, D. (2010), 'Do Teacher Strikes Harm Educational Attainment of Students?', Labour, 24: 391-406. https://doi.org/10.1111/j.1467-9914.2010.00494.x.

([60]) Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020), 'Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement', Educational Researcher, 49(8), pp. 549-565. https://doi.org/10.3102/0013189X20965918.

data (Fuchs-Schündeln et al., 2022). This is equivalent to welfare losses of about 1.2% of permanent consumption and, when aggregated, to 3% of 2019 US GDP ([61]). In addition, this model finds large differences by children's age and background, with younger children affected more by school closures than older children, and children from the most disadvantaged households experiencing welfare losses that are four times greater than children from the most privileged households. The study is likely to overestimate the impact of school closures by ignoring schooling through distance teaching, i.e. ignoring that schooling of a different kind continued (to various degrees depending on the countries and age cohorts considered) when schools were physsically closed during the pandemic.

A similar structural-model framework, calibrated to the US economy (Jang and Yum, 2024), finds negative effects for aggregate output for up to 150 years, reaching a trough after 55 years, with an output decline at the trough of around 0.3%, 0.8% and 1.5% for full school closures of 0.5, 1 and 1.5 years respectively ([62]). In contrast to other research, this structural model suggests larger negative effects for older children, whereas younger children are assumed to be able to make up for pandemic-related losses over the longer remaining duration of their educational career ([63]). The model also suggests a significant decrease in the intergenerational mobility of educational attainment, as children become more dependent on parental input (and investment in private tutoring services) during school closures. Virtual schooling almost halves the aggregate impact of the learning deficits from school closures, but further increases inequality in their model. This result is in line with a structural model of skills formation, which suggests that the negative effects of school closures on human capital formation are highly unequal and persistent ([64]).

Simulations with a rich structural model (Penn Wharton Budget Model) on US data (Viana Costa et al., 2021) also suggest an impact of COVID-19-related learning deficits on labour productivity and output ([65]). In particular, the model simulations find a negative impact on both variables, which increases over the 45-year horizon displayed. For a learning deficit of 1 year, the results would translate into a 2.9% reduction in productivity and a 3.4% drop in output in 2050 compared to a no-COVID-19 baseline. This simulated output effect is significantly larger than the Jang and Yum (2024) result (which led to a 0.5% output loss after 30 years for a 1-year learning deficit) ([66]). This difference may be attributable to the assumption in Viana Costa et al. (2021) of separate labour-productivity effects by students' socio-economic background. Comparability with Fuchs-Schündeln et al. (2022) is limited by the fact that the latter do not report the dynamics of macro variables, but only present discounted aggregate losses ([67]).

([61]) Fuchs-Schündeln, N., Krueger, D., Ludwig, A. & Popova, I. (2022), 'The Long-Term Distributional and Welfare Effects of Covid-19 School Closures', The Economic Journal 132(645), pp.1647-1683. https://doi.org/10.1093/ej/ueac028.

([62]) Jang, Y. & Yum, M. (2024), 'Aggregate and Intergenerational Implications of School Closures: A Quantitative Assessment', American Economic Journal: Macroeconomics, forthcoming. The extreme persistence of the effect in Jang and Yum (2024), with output, labour and capital returning to the no-COVID-19 baseline only after 150 years, derives from the importance of private (parental) investment in child education. This investment depends on parental human capital and income, which provides the basis for some intergenerational transfer of learning deficits in their model.

([63]) The model-implied increase of individual losses with students' age does not account for the theory of human-capital accumulation, which supposes self-productivity in human capital and predicts the COVID-19 shock to affect both the current level of human capital and its future accumulation (see Schady, N., Holla, A., Sabarwal, S., Silva, J. & Yi Chang, A. (2023), 'Collapse and recovery: how the COVID-19 pandemic eroded human capital and what to do about it', World Bank. https://doi.org/10.1596/978-1-4648-1901-8).

([64]) Agostinelli, F., Doepke, M., Sorrenti, G. & Zilibotti, F. (2022), 'When the great equalizer shuts down: Schools, peers, and parents in pandemic times', Journal of Public Economics 206. https://doi.org/10.1016/j.jpubeco.2021.104574.

([65]) Viana Costa, D., Maddison, E. & Wu, Y. (2021), 'COVID-19 Learning Loss: Long-run Macroeconomic Effects', Update. University of Pennsylvania.

([66]) Jang & Yum (2024), op. cit.

([67]) Fuchs-Schündeln et al. (2022), op. cit.

The substantial differences in estimates between the structural models presented above are due to the strong influence of assumptions and modelling choices on the results. In general, the simulations differ in the transmission mechanisms and behavioural responses of students, parents, and teachers they consider, without exploring and including all possible channels.

Projection models suggest real-GDP effects of a 1-year learning deficit of up to 4.7%, compared with a baseline without learning deficits. This approach exploits regularities in the data, notably correlations between the variable of interest and possible determinants, without imposing a tight theoretical structure.

Based on a projection-model, Hanushek and Woessmann (2012) suggest that a reform bringing about an improvement in PISA scores of 25 points (equivalent to 25% of a standard deviation or 2/3 of the usual learning gain over a school year ([68])) would lead to an increase of 0.5 percentage points in the long-run real GDP growth rate in EU Member States, or a cumulative economic gain of EUR 35 trillion in present value until 2090 (corresponding to a 6.2% increase in discounted future GDP) ([69]). The authors correlate economic growth with measures of the quantity and quality of education in cross-country comparisons. In particular, they regress countries' average GDP growth on (i) student test scores from the PISA survey; (ii) years of schooling; and (iii) initial GDP per capita. The estimated 'growth coefficient' of PISA test scores is then used for projections of future growth, in the spirit of endogenous growth models ([70]). While the estimates could be biased by endogeneity or reverse causality, the authors show that the results are robust when controlling for potentially omitted variables (e.g. economic institutions, geographical location, political stability, capital stock, and population growth). Balart et al. (2018) find that the relationship between student test scores and economic growth is smaller but remains robust when accounting for non-cognitive skills ([71]).

By implication, and inverting signs, if the learning deficit in the EU equivalent to an 8-point decrease in PISA scores were to both persist and apply to the entire population, this would translate into a 0.2 percentage point reduction in the long-run growth rate. Given that the pandemic only implies a temporary negative shock on learning outcomes, which in the long run would affect at most one third of the working-age population, the impact of the pandemic would be more contained, but could still be substantial ([72]).

Drawing on their earlier studies with projection models, Hanushek and Woessmann (2020) simulate a temporary school closure of various lengths and find that a 1-year school-closure results in a permanent individual income loss of 7.7% over an affected student's lifetime ([73]). The estimates for lifetime income losses are the sum of lost individual returns to education. Hence, it is assumed that the income loss due

([68]) following Hill et al. (2008), op. cit.

([69]) Hanushek, E.A., & Woessmann, L. (2012), 'The Economic Benefit of Educational Reform in the European Union', CESifo Economic Studies, 58(1): pp. 73-109.

([70]) The authors also present an alternative projection model based on the neoclassical growth framework. The gains are somewhat smaller, but still substantial. In the neoclassical growth model, changes in test scores lead to higher steady-state levels of income, but they do not permanently affect the growth rate.

([71]) Balart, P., Oosterveen, M., & Webbink, D. (2018), 'Test scores, noncognitive skills and economic growth', Economics of Education Review, 63, pp. 134-153.

([72]) Assuming that the 12-16 age cohorts have been affected by schooling under COVID-19 conditions, and assuming a working life of around 50 years.

([73]) Hanushek, E. A., & Woessmann, L. (2020), 'The economic impacts of learning losses', OECD Education Working Papers, 225. https://doi.org/10.1787/21908d74-en.

to the learning deficits does not decrease if all students are affected simultaneously, which likely makes it an upper-bound estimate ([74]).

Drawing on data from a sample of 50 lower-middle-to-high-income economies, the same paper suggests that a 1-year learning loss would trigger a 4.3% loss in future GDP (discounted at an annual rate of 3%) on average each year for the remainder of the century, i.e. until 2100. By 2100, this would be equivalent to a cumulative GDP loss of the magnitude of 200% of current GDP (in present value). By 2100, the reduction in annual GDP would amount to 7.5% compared with a baseline without learning deficits, assuming 80 years with a lower-achieving labour force (corresponding to the average life expectancy of somebody born in 2020). By 2050, real GDP would be lower by around 4.7% compared to the no-loss benchmark ([75]). To arrive at those estimates, the authors assume that annual economic growth increases by about 2 percentage points per standard deviation increase in educational achievement of the labour force, an effect of similar magnitude as the assumption used by Hanushek and Woessmann (2012) ([76]). The estimates assume the complete loss of a school year, neglecting the mitigating effects of distance learning. Scaling the numbers to a learning loss of 20% of a school year would imply a GDP level 0.9% below baseline by 2050 ([77]).

Another projection model-based study for the US uses a similar approach, as it correlates US-specific standardised test outcomes to long-term growth. It considers in addition the effects of students dropping out of school ([78]). This study produces smaller estimates of GDP loss, i.e. –1.1% to –1.8% in GDP reduction by 2040 for a 1-year learning deficit.

Recent work by the OECD finds that expected productivity losses are initially small, but build up over time and peak after 45 years when affected cohorts are in the older part of the labour force, with a 1.1% overall productivity (TFP) loss at the peak for a 1-year school closure ([79]). These negative effects

([74]) Theoretically, it is possible that if other workers are affected to a similar extent, the wage penalty for a learning deficit is reduced compared to the situation where only a single or a few individual workers are affected, which would put them at a relative disadvantage compared to age cohort peers entering the labour market at the same time.

([75]) The value for 2050 is taken from the comparison in de la Maisonneuve, C., Égert, B. & Turner, D. (2022), 'Quantifying the macroeconomic impact of COVID-19-related school closures through the human capital channel', OECD Economics Department Working Papers No. 1729, OECD Publishing, Paris. https://doi.org/10.1787/eea048c5-en.

([76]) Hanushek & Woessmann (2012), op. cit.

([77]) A simple back-of-the-envelope calculation provides somewhat smaller magnitudes. Taking the value from Jones (2002) of an additional year of schooling raising labour productivity by 7%, missing a fifth of a year implies a productivity loss of 1.4% for the (future) workers concerned (see Jones, Ch. (2002), 'Sources of U.S. Economic Growth in a World of Ideas', American Economic Review 92(1): 220-239). As the age cohorts concerned will account at maximum for around one third of the labour force in the future, this would suggest aggregate income losses peaking at around 0.5%. The survey by Sianesi and van Reenen (2003) reports effects of a 1-year increase of average education on per capita output of 3-6% in a neoclassical growth specification, or a 1 pp. increase in the growth rate according to endogenous growth theories (see Sianesi, B. & van Reenen, J. (2003), 'The Returns to Education: Macroeconomics', Journal of Economic Surveys 17(2): pp. 157-200).

([78]) Dorn, E., Hancock, B., Sarakatsannis, J. & Viruleg, E. (2020), 'COVID-19 and student learning in the United States: The hurt could last a lifetime', McKinsey. See also the comparison in de la Maisonneuve et al. (2022).

([79]) de la Maisonneuve et al. (2022), op. cit. The authors of this study use a new measure of the human-capital stock and multivariate productivity regressions. The new measure is composed of the cohort-weighted average of past student test scores and mean years of schooling to reflect both the quality and quantity of education of the working-age population. The authors compute the effect of the pandemic on human capital as the sum of population-weighted averages for each of the 16 cohorts of school-aged children. The effect on productivity is derived from regressions, which (controlling also for other factors) suggest that a 1% decrease in human capital is associated with a more than 2% fall in long-term total factor productivity (TFP). The new measure was first proposed by Égert, B., C. de la Maisonneuve & D. Turner (2022) in 'A new macroeconomic measure of human capital exploiting PISA and PIAAC: Linking education policies to productivity', OECD Economics Department Working Papers, No. 1709, OECD Publishing, Paris. https://doi.org/10.1787/a1046e2e-en.

diminish when affected cohorts gradually retire from 2068 on, and they disappear when all affected cohorts will have retired in 2083. The timing of the peak impact derives from the assumption that all age cohorts are affected equally, with no possibility for younger students to catch up on learning deficits. If older students were affected more than younger students, who have more time to recover from the shock, the trough would be at an earlier point in time, when most affected cohorts are of core working age.

The estimated learning deficits for the EU of approximately 10% of a standard deviation, or 1/5 of a school year (see II.2 above), come closest to the lower-bound impact of a 12-week school closure in de la Maisonneuve et al. (2022). They translate this to a 0.2% reduction in overall human capital during the period from 2036 until 2067, when all affected cohorts are part of the labour force ([80]). This reduction in human capital is predicted to cause productivity losses until the retirement of the last affected cohort in 2083, peaking at a productivity loss (compared to a no-COVID-19 baseline) of 0.4% in 2067.

Table II.1 summarises the estimated effects of the COVID-19 learning deficits on economic output from both structural models and projection models.

Studies based on data from non-EU OECD countries could overestimate the potential economic impact of learning losses for EU Member States. For example, learning deficits were, on average, smaller in EU countries than non-EU OECD countries due to differences in: (i) the length of school closures; (ii) the level of digitalisation; and (iii) the quantity and quality of distance teaching. In addition, countries may differ in the channels of transmission from lower human capital to economic outcomes. Significantly higher individual returns to skills are found in the United States compared with European countries ([81]). Contributing factors could be higher union density in Europe, stricter employment-protection legislation, and larger public sectors, all of which are related to lower wage inequality and thus lower individual returns to skills ([82]), inversely implying a lower economic impact of decreasing skills. Therefore, studies based on US data could overestimate the economic impact of learning deficits for the EU, which may furthermore differ widely between EU Member States.

Finally, differences in remedial policies to compensate for learning deficits, which are not accounted for by any of the estimates presented, could diversify the economic impact across countries in coming years.

II.4. CONCLUSION

The evidence on the impact of the COVID-19 pandemic on educational records suggests significant average learning deficits for school-aged children in several EU Member States, which equal approximately 20% of a school year's learning progress. Importantly, large inequalities in the learning deficits, driven particularly by students' socio-economic status, could increase disparities in social and economic outcomes.

Although no immediate economic impact of these learning deficits has been observed to date, the associated reduction in human capital is likely to have a negative long-term impact on the economy as the affected age cohorts integrate in the labour market. Labour market outcomes of the 2020 graduating cohort seem to be resilient at the current juncture of tight labour markets, and simulations suggest small productivity losses for the coming years. A larger effect can be expected in the long term, peaking in the second half of the 21st century, when all affected cohorts of students will have entered the labour market.

([80]) de la Maisonneuve et al. (2022), op. cit.

([81]) Hanushek, E. A., Schwerdt, G., Wiederhold, S., & Woessmann, L. (2015), 'Returns to skills around the world: Evidence from PIAAC', European Economic Review, 73, pp. 103-130.

([82]) Hanushek et al. (2015), op. cit.

Table II.1: **Estimated effects of a 1-year learning deficit on economic output**

	Approach and sample	Dependent variables	Main results
Structural models			
Fuchs-Schündeln et al. (2022)	– Partial-equilibrium life-cycle model with overlapping generations – Calibrated to US data	Lifetime earnings of affected children	Present discounted earnings loss of 2.1% for affected children, on aggregate equivalent to 3% of 2019 US GDP
Jang & Yum (2022)	– General equilibrium model with overlapping generations (OLG) – Calibrated to US data – Younger students are assumed to catch up over time	Range of macroeconomic aggregates	Reduction of annual output during several decades with trough in 2080 at -0.7% (-0.5% in 2050)
Viana Costa et al. (2021)	– OLG macro model with rich heterogeneity across households in which an individual's labour productivity changes throughout lifetime and is affected by learning deficits – Calibrated to US data	Range of macroeconomic aggregates	Reduction of annual output, worsening during several decades until forecast horizon in 2056 (GDP effect -3.4% and labour productivity –2.9% in 2050)
Projection models			
Hanushek & Woessmann (2020)	– Regression of countries' average GDP growth on student test scores (PISA), years of schooling and initial GDP per capita; estimated 'growth coefficient' used in endogenous growth model (2% higher growth per standard deviation in educational achievement) – Data from OECD countries and emerging economies	Lifetime income Output growth	GDP –7.5% in 2100 (-4.7% by 2050) compared to no-COVID-19 baseline
Dorn et al. (2020)	– Hanushek & Woessmann (2008) correlation of academic achievement to GDP growth, combined with impact of school drop-outs due to the pandemic – Simulation for the US	Output in 2040	Output reduction of 1.1-1.8% of GDP in 2040 (no results reported for other years)
de la Maisonneuve et al. (2022)	– New measure of the human capital stock (cohort-weighted average of past student test scores and mean years of schooling of current cohorts) and multivariate productivity regressions (1-percent decrease in human capital associated with >2-percent fall in long-term TFP) – Assumes 16 cohorts to be affected equally, without catching up of younger students – Sample of OECD countries	Productivity (TFP)	Productivity losses until expected retirement of affected cohorts in 2083, peaking in 2067 at -1.1% TFP compared to no-COVID-19 baseline

(1) Note: The presented estimates are specific for the COVID-19 pandemic, as they assume all cohorts that are in school during the learning shock to be affected. For comparison purposes, reported effects for different lengths of school closure are proportionally translated into a learning deficit of 1 school year. Based on the estimates of learning deficits in the EU of, on average, 20% of a school year, the economic impact for the EU could be scaled to 20% of the numbers presented in this table.

Source: Authors' own compilation.

The estimated long-term (by the mid-century) real annual GDP effects for an average learning deficit of approximately 1/5 of a school year in the EU range from -0.1% to -1% by 2050, compared to a baseline without any learning deficits. Realisations are more likely to fall closer to the lower bound of this range in absolute value terms (-0.1%), since upper-bound estimates rest on assumptions of a very strong and persistent deterioration in the quality of the labour force, with no or little scope for compensating losses over time.

The estimates of learning deficits provided in this chapter are based on available studies for a small selection of EU Member States and have limitations. Currently available study results are possibly biased by the selection of non-representative samples, missing data and potential measurement errors ([83]).

The first set of internationally comparable data from the PIRLS 2021 reading assessment for 4th graders shows a decline in learning outcomes of a magnitude similar to the estimates put forward in this section, reinforcing previously recorded negative time trends. Recently published PISA results from the 2022 survey round suggest a more considerable overall deterioration in learning outcomes among 15-year-olds than the potential magnitude of the pandemic's effect considered in this chapter. Other comparative international studies are forthcoming and will contribute to a more comprehensive understanding of the recent development of learning outcomes and the extent to which negative developments can be reversed ([84]).

Monitoring the development of student achievement will be crucial to determine the persistence of learning losses over time. This will provide evidence on whether the affected cohorts are able to catch up over the duration of their remaining educational career, or whether, to the contrary, learning deficits are accumulating and increasing over time.

Compensatory policies, such as summer schools or tutoring programmes, have been shown to mitigate the learning deficits caused by the COVID-19 pandemic ([85]). De Witte and François (2023) further recommend that the curriculum – and corresponding investments – focus more heavily on the digitalisation of education, including by strengthening internet connectivity, access to information and communications technology tools, and the professional development of teachers ([86]). As all remedial actions require staff, addressing the teacher shortages currently observed in many EU Member States will be crucial to reverse the negative trend in learning outcomes ([87]).

On a positive note, the COVID-19 pandemic has been speeding up the digital transition in schools and given a stimulus to experimentation with new ways of teaching. The lessons learned during the pandemic and the progress in digitalisation can be used to improve the quality of education in the EU. Under the Recovery and Resilience Facility, Member States have planned measures worth EUR 51 billion to improve 'general education' and 'early childhood education and care', including investment in digital education and, for some Member States, targeted measures to mitigate learning deficits caused by the COVID-19 pandemic. The European Commission is also working with Member States through a recently created 'Learning Lab on Investing in Quality Education and Training' to help them design policies and programmes which can make the EU educational systems more effective and equitable ([88]).

([83]) The review of the empirical literature discussed in this section excluded studies with small sample sizes, with convenience samples, and without any statistical adjustment for confounding factors, limiting the influence of potential biases.

([84]) E.g., IEA TIMMS 2023 for mathematics and science, and IEA ICILS 2023 for digital skills are still underway. With the great advantage of providing comparable indicators, these large-scale international assessments of student achievement come with the disadvantage of being published with a delay and covering a varying selection of grade years and countries.

([85]) De Witte & François (2023), op. cit.

([86]) De Witte & François (2023), op. cit.

([87]) In the Flemish region of Belgium, average learning deficits in 2022 were larger in schools with high shares of teacher shortages: see Gambi & De Witte (2023), op. cit.

([88]) For more details, see https://education.ec.europa.eu/focus-topics/improving-quality/learning-lab.