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COVID-19 and the European Education Performance Decline: A Focus on Primary School Children's Reading Achievement between 2016 and 2021

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ABSTRACT

COVID-19 and the European Education Performance Decline: A Focus on Primary School Children's Reading Achievement between 2016 and 2021*

This study uses the Progress in International Reading Literacy Study (PIRLS) data, the only cross-national data having measured educational achievement during the COVID-19 pandemic, to investigate educational achievement decline of fourth graders across 21 European countries between 2016 and 2021. Learning decline estimated with PIRLS data is not only composed of learning loss due to COVID-19 but also European performance trends and national policy changes. The study illustrates the education performance decline in Europe by providing information on 20 year reading achievement trends, average performance declines and increasing number of the share of low performing students across European countries. Results of previous national counterfactual impact evaluation studies measuring learning decline in languages due to COVID-19 are compared to PIRLS reading achievement declines between 2016 and 2021. Furthermore, the study examines recent developments of educational inequalities within Europe by first comparing countries' education distributions between 2016 and 2021 and second by investigating changes in the share of children lacking important reading skills by socio-economic background.

JEL Classification: I21, I24

Keywords: COVID-19, pandemic, educational inequalities, school, PIRLS, Europe

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Introduction

The COVID-19 pandemic affected learning of 1.6 billion children in 190 countries across the world (United Nations 2020). In the 21 European countries that will be compared in this study, schools were fully closed for 14 weeks and partially closed for 21 weeks, on average. In addition to COVID-19 restrictions, countries differed in their implementation of online learning and other support provided to students to progress during the pandemic. It is widely acknowledged that COVID-induced physical school closure lead to considerable learning loss. This will clearly negatively impact on meeting the European Commission's EU-level target of decreasing the share of low achieving 15-year-olds to 15% by 2030 (in 2018, average levels of underachievement were around 23% in Europe, European Commission 2022).

In addition to the concern about the COVID-19 overall learning loss, the fact that the impact of physical school closures has been heterogeneous across students with different socio-economic backgrounds has led to even greater concerns about the social gradient of education outcomes. In particular, it appeared that, during the pandemic, the family into which the pupil was born gained even more importance for explaining educational outcomes than previously.

The learning loss during the pandemic and its heterogeneous effects would just reflect a short hick up not being worth investigating further, if research could show that pupils caught up in the aftermaths of the pandemic. However, empirical studies show that closing the gap might be difficult over time and long-term effects for career prospects like future earning losses could occur for the pandemic pupil cohorts (Psascharopoulos et al 2021).

The existing literature commonly defines the learning loss as the delay in expected learning progress. This 'learning loss' according to Angrist et al (2021) comprises forgotten learning, i.e. the deterioration of skills that students gained before school closure, and forgone learning, and hence what students did not gain since they missed or had less effective tuition. The first studies to put forward hypotheses about possible COVID-induced learning loss focused on forgotten learning during regular scheduled school closures, showing that its importance cannot be underestimated. However, as common in the predominant part of the literature, the study cannot differentiate between the two components, even though the respective contributions of the components to overall learning loss might be interesting for its long-term impact, since forgotten learning can probably be caught up with more rapidly than foregone learning.

Learning loss is generally measured by comparing the learning progress of previous cohorts with that of the COVID-cohort for children in the same school grade or age cohort. Consequently, at the country level, the causal impact of the pandemic on learning outcomes can only be measured if longitudinal or cross-sectional administrative data are available on student or school level educational outcomes briefly before and after the pandemic. Robust studies also rely on trend data going back to several years before the pandemic, to enable differentiating between learning trends of educational outcomes and the impact of the pandemic.

What do we know about the COVID-induced learning loss?

Experts have raised concerns on the impact of pandemic related physical school closure on learning outcomes already very shortly after the pandemic outbreak (e.g. Blasko and Schnepf, 2020). These concerns have been confirmed subsequently by an increasing number of robust

national studies that exploited administrative achievement data comparing pre- to post-COVID cohorts' educational outcomes using counterfactual impact analyses (e.g. Engzell et al 2021 for the Netherlands, Maldonado and de Witte 2020 for Belgium, Schult et al 2021 for Germany, Contini et al 2021 for Italy).

Clearly, these national studies use different achievement outcomes, varying in their scale. In order to make results comparable across countries, researchers calculate the so-called z-score of the learning loss, which is the difference in educational achievement between the pre-COVID and post-COVID average achievement divided by the standard deviation of the pooled achievement scores. This study will report the learning decline as well in standard deviations of the countries achievement distributions.

Meta-analyses on robust studies examining national learning loss

With the publication of more and more robust country studies, meta-analyses were conducted by averaging the national studies' identified learning loss expressed in standard deviations. Donnelly and Patrinos (2021) find an average learning loss of 0.13 standard deviations in seven high income countries, while Patrinos et al (2022) (35 studies representing 20 high and low income countries) find a learning loss of 0.17 standard deviations. Betthäuser et al (2023 with Fig 3 providing standard deviations by country study) consider 42 studies across 15 countries including also four lower income countries (Brazil, Colombia, Mexico, South Africa) where the COVID-19 impact on learning outcomes was considerably larger than in Europe. They find an average learning gap of 0.14 standard deviations. König and Frey (2022) estimate a 0.18 standard deviation learning gap based on 109 effect sizes estimated in 18 studies and conditioning for mode of learning, school type and timing of COVID-19 school closures. Di Pietro (2023) reviews 39 studies covering 19 countries and estimates an average pandemic induced learning deficit of 0.19 standard deviations, also highlighting that the learning loss was higher for math/science relative to other subjects and that students had not recovered more than one year after the pandemic outbreak. Closest to this study's geographical focus is De Witte and Francois (2022) who by examining 15 European countries find that, while there is considerable variation across countries, the average European learning loss is around 0.11 standard deviations. Consequently, given that students' educational achievement increases by around 0.3 to 0.4 standard deviations per year of schooling (Azevedo et al 2021, Patrinos et al 2022), European students lost out as much as between 28% to 36% ($0.11/0.3$ or $0.11/0.4$) of a year's worth of school progress due to physical school closures during the pandemic.

Results across meta-studies are similar, since they focus on mostly identical research studies covering the same countries with just slight variations in the number of studies and time of learning loss estimation considered. These variations between studies can be exploited in the meta-study design. For example, by linking the magnitude of estimated learning deficits and the date of measurement, Betthäuser et al (2022) show that while further learning loss was prevented over time, countries did not manage to reverse them. In addition, learning loss for maths are considerably higher than for reading and more difficult to catch up on. It is also widely agreed that countries opting for longer school closure paid the price of higher learning loss (De Witte and Francois 2022, Patrinos 2022 estimating that 1 week of additional school closure increases the learning loss by 0.01 standard deviations). The latter has also been shown by a study examining PIRLS reading outcomes and school closure length for 29 countries (Kennedy and Strietholt 2023). Furthermore, remote learning appeared to be more effective in later lockdown phases compared to spring 2020 (König and Frey 2022).

Heterogeneous learning loss during the pandemic

While learning improvements tend to benefit in general all pupils in school, past trends have revealed that learning decrease disproportionately affects disadvantaged students (Azevedo et al 2022). Educational inequalities were already very sizable before the pandemic. Data from the Programme for International Student Assessment (PISA) show that, on average, across 26 European Union member countries (excluding Spain) and in line with the OECD average, as much as 13% of the variation in reading performance of 15-year-olds could be explained by family background in 2018 (measured with an indicator capturing home possessions, parental education and occupation; see Table 1.1 in Reimers 2022).

The rationale behind disadvantaged students' faring worse during physical school closure lies in the equalising effect of schools, which - even though not providing uniform education opportunities - still offer collective education for all in a similar way (Blaskó et al 2022). Once schools are closed, families need to support children's education endeavours. However, the socio-economic background of families is associated with their provision of learning support for children and home learning resources like internet access, availability of digital devices, books at home and parental teaching skills.

Due to different operationalisations of socio-economic background measures (e.g. by focusing on parental education, occupation or income) and lack of standardised reporting of the gap between advantaged and disadvantaged students, it is more difficult to quantify how much the average European social gradient has changed during the pandemic. Nevertheless, all meta-studies cited above agree that disadvantaged students lost out more. For example, focusing on 20 country studies, 15 (12 of which European) present a greater learning loss among students or schools with lower socio-economic status, while the remaining five do not show a significant difference (Patrinos et al 2022). Studies also highlight that students struggling academically prior to COVID-19 lost out more (Betthäuser et al 2022). Consequently, the already substantial association of student background with learning has further more increased during COVID.

Why does this study use cross-national achievement survey data?

Given this background, this study examines learning deficit across European countries utilising data from the cross-national educational achievement survey PIRLS, which is the only survey that provides standardised achievement outcome measures also during the pandemic. As long as a researcher does not come up with a huge number of daring assumptions, cross-national achievement data cannot be used for measuring the impact of the COVID-19 pandemic on learning loss. The main reason for this is that the time intervals between data collection are too big (e.g. 5 years for PIRLS) for stating that learning deficit found between the 'recent two cycles' is due to COVID-induced physical school closure. Instead, any learning difference between the pre- and post-COVID cohorts could just reflect previous or new downwards learning trends or other kinds of consequences deriving from education policy changes introduced between the two different cohorts.

Why does this study then focus on COVID-19 using educational achievement survey data? The rationale is fivefold. First, educational achievement survey data aim to measure achievement in the same way in all countries. This is different to current country studies, which all refer to a country specific measure of education outcome. The choice of the education measure is likely to impact on the result, an important limitation of meta-studies that compare results deriving from single countries. Standardisation hides the problem but does not deal with it. Second, all available country studies providing information on pandemic

induced learning loss have one characteristic in common: they collect educational achievement data as administrative data. However, countries collecting educational achievement data might dedicate more attention and effort to improving education outcomes than countries that do not collect these data (and for which national studies are hence not available). Consequently, national studies might be based on a positive selection of countries. With PIRLS data used in this study, we can focus on 21 European countries having taken part in both the 2016 and the 2021 survey round. This reflects a European country sample bigger than that covered in any meta-study. Third, from a European perspective, the possibility to focus on a large group of European countries is beneficial. Fourth, the disadvantage of cross-national achievement surveys to allow only estimating education decline over a longer time span might equally well be interpreted as an advantage, since it sets the COVID-19 learning loss into perspective of education trends over time¹. Fifth, this study was written as contribution to the volume by Schnepf, Volante, Klinger, Giancola and Salmieri (2024) on ‘The pandemic, socio-economic disadvantage and learning outcomes. Cross-national impact analyses of education policy reforms’. This volume contains six national profiles (Belgium, England, Germany, Hungary, Italy and the Netherlands) which the study positions into the wider European picture of educational achievement and learning loss.

The value added of this study is twofold: first, we estimate educational achievement decline in Europe during 2016 and 2021 by exploiting educational achievement measures standardised across European countries and relate it to learning loss induced by COVID-19. Second, we provide insights on developments of educational inequalities and the social gradient. This is only possible since the survey measures family background equally across countries.

Consequently, this study does not focus directly on COVID-19 related learning loss but measures learning decline between 2016 and 2021. Only a part of this estimate, the size of which is unobservable, is likely to be due to COVID-19 education policies. In addition, this study focuses on cognitive learning outcomes only, not examining other important learning related outcomes COVID-19 impacted on. For example, school dropout has considerably increased during COVID-19 especially in low income countries (Moscoviz and Evans 2022). Furthermore, children’s mental health, which is closely linked to academic performance (Agnafors et al 2021), declined noticeably during the pandemic (Mazrekaj et al 2023).

Data

PIRLS administered by the International Association for the Evaluation of Educational Achievement studies (IEA), was introduced in 2001 and measures trends in reading comprehension at the fourth-grade level (generally 10-year-old children). Cross-sectional data are collected every 5 years, so that currently PIRLS provides trend data over 20 years (2001, 2006, 2011, 2016 and the most recent 2021 cycle). Similar to other educational achievement surveys, PIRLS collects a representative sample of schools at the first stage and then pupils within schools at a second stage. PIRLS measures reading literacy with a battery of questions and collects additional student information including socio-economic background and attitudes. In addition, in-depth information on pupils’ school, their teachers and their parents is covered. All survey items, like the measurement of education outcomes and family background, are the same across countries. While the 2021 data include less questionnaire items compared to previous cycles, new items specifically aiming to collect information on

¹ Nevertheless, how cross-national achievement data, such as those stemming from PIRLS and PISA, inform policy development and monitoring processes moving forward remains an open question (Klinger et al. 2022; Volante et al. 2022).

students' and schools' challenges encountered during the pandemic were added. While this information will not be exploited for this study focusing on the country level, it provides interesting material for future research.

The OECD decided not to run PISA during the pandemic in 2021 due to education disruption. PIRLS organisers conducted their 2021 cycle as planned but not without difficulties. While the pilot data collection was timely, this was not the case for the final data collection. 16 out of the 21 European countries we compare collected the assessment data towards the end of students' fourth year of schooling, similar to the 2016 cycle and hence between February to July 2021 (Austria, Belgium (Flemish and French part), Bulgaria, Czechia, Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain and Sweden). Hungary, Ireland, Latvia and Lithuania collected assessment delayed at the beginning of the fifth grade (September to December 2021). English data was collected one entire year later (April to July 2022). Consequently, for five of the countries we focus on, 2021 students' achievement estimates are likely to be upwards biased given the later collection of data. Nevertheless, even though data collection faced many disruptions due to the pandemic, PIRLS organisers state that 'most countries met the standards for high-quality data collection'. (PIRLS 2023a)

The PIRLS 2021 cycle incorporates two important design changes compared to previous rounds. First, 13 out of the 21 European countries (counting Belgium as one) across which we compare 2016 to 2021 achievement changes altered the data collection mode from the 2016 used paper administered tests to digital assessment (Flemish Belgium, Czechia, Denmark, Finland, Germany, Hungary, Italy, Lithuania, Portugal, Slovak Republic, Slovenia, Spain and Sweden). In those countries, the main country sample (about 4,500 students) received the new digital survey implementation while about 1,500 students received the booklets like in the PIRLS 2016 paper and pencil format. PIRLS organisers do not assume mode effects on trend results given that they state that the bridge samples 'were judged to be the same quality as their digital counterparts' (PIRLS 2023a). (It is important to note that a similar change from the paper pencil mode to computer assessment was implemented for PISA in 2015 leading to considerable mode effects that without adjustments threatened the comparability of results over time (Jerrim et al 2018).) The remaining eight countries plus one part of Belgium in our study sample (Austria, Belgium Flanders, Bulgaria, England, France, Ireland, Latvia, the Netherlands and Poland) kept the same mode of data collection, paper and pencil, also for the 2021 cycle. (Davies, M. et al 2023)

Second, PIRLS employed a 'group adaptive design' with the 2021 cycle aiming to improve reading assessment within countries by aligning the difficulty of the reading tasks with the students' average achievement in the country. In practice, students based in on average better performing countries received a higher share of difficult reading task booklets than students in countries with lower achievement. PIRLS organisers state that 'the group adaptive design in PIRLS 2021 led to a lower item non-response rate and more precise achievement estimates than the non-adaptive design in PIRLS 2016' (PIRLS 2023a). PIRLS organisers state that there is no impact on PIRLS trends, so that results can be compared over all cycles. (Davies et al 2023)

The study focuses on 4th grade children in primary schools who are around 10 years of age. Younger children require more parental support during online learning and home schooling and are more prone to suffer from lack of learning resources at home. Most studies therefore show that younger kids were more negatively affected by the pandemic (König and Frey

2022, Fuchs and Schündlen 2020). Consequently, our results cannot be generalised to the entire student population.

Results

Changes in education trends over time

Figure 1 provides trends in PIRLS reading achievement for fourth-graders for all European Union Member states plus England covered in PIRLS 2021 across two decades. (Among the 27 Member States of the European Union, Estonia, Greece, Luxembourg and Romania did not participate in PIRLS 2021, so that we focus on 23 European countries plus England. PIRLS data collects data for the Flemish and French part of Belgium separately. We merged the data into one measure for Belgium weighting by population size.) Countries are ordered by achievement in 2021.

- Figure 1 about here -

Countries covered in the volume for which this study is a contribution (Schneepf et al 2024) have a box around their three-letter abbreviation. These six countries focused on in this volume are well placed in the overall 2021 reading achievement distribution of European countries: while England is the country with second highest average reading performance, Belgium shows lowest performance given the country group focused on. Hungary and Italy present slightly higher than average and the Netherlands and Germany slightly lower than average reading performance results.

Looking at these country trends, would someone not knowing about the pandemic guess that education provision was seriously hampered throughout Europe (and beyond) after 2016? Probably not. We cannot find an uncharacteristic fall of average achievement from 2016 to 2021. While there seems to be a general trend, i.e. achievement decreased for the 2021 cycle, this is not always the case and often in line with the national previous trends.

Focusing on Sweden (where schools were not closed during the pandemic) and Finland, two countries for which counterfactual impact analyses show that the COVID-19 pandemic has not decreased education outcomes (Hallin et al. 2022 for Sweden and Lerkkannen et al. 2023 for Finland), we find a considerable decrease in reading performance between 2016 and 2021 (17 and 11 PIRLS points for Finland and Sweden, respectively). Nevertheless, this could be interpreted to be just in line with already decreasing education outcomes trends within these countries before 2016. Similarly, in Denmark, the Netherlands, Germany and Portugal the 2021 education decline is in line with previous trends of education performance decline. Furthermore, there are countries where education performance varies in different directions across waves and the decline between 2016 and 2021 appears in line with these changes (like Bulgaria, Czechia, Hungary, Italy, Austria, Spain and France). Only in the countries Latvia, Slovenia and to some degree Poland the decrease between 2016 and 2021 performance is completely uncharacteristic relative to what had happened before.

We also find that in two countries achievement improved between the last two cycles: Ireland and Malta. The latter increase is as big as 63 PIRLS points. Given that the survey design changes introduced between both cycles are likely to impact especially on Malta results

(Malta changed from paper pencil to digital collection of data as well as it received a higher share of easy task booklets compared to other European countries) we consider this result as too suspicious for further investigation in this study.

Figure 2 singles out reading performance results for the last two cycles for the 21 European countries covered in both PIRLS 2016 and PIRLS 2021 (excluding Cyprus and Croatia not covered in PIRLS2016, and excluding Malta for the reason explained above). We order countries by the performance decrease between 2016 and 2021: Latvia and Slovenia clearly stand out. The achievement increase or insignificant differences between the two cycles in Ireland, Lithuania and England could be due to the delayed data collection for the 4th grader cohort (which is likely to lead to upwards bias of the 2021 results).

For the 21 European countries displayed in Figure 2, i.e. those that have taken part in both PIRLS 2006 and 2021 waves, we can also express performance decline between 2016 and 2021 in standard deviations, by dividing the achievement differences between 2016 and 2021 by the standard deviation in 2016² (in line with the reporting of COVID-19 learning loss, as discussed above). On average across all 21 countries reading performance decreased by 0.068 standard deviations. This indicates that European students lost out as much as between 17% and 23% of one year of schooling (0.068/0.4; 0.068/0.3) during the 5 years of the PIRLS cycle.

This 5-year decline up to year 2021 is smaller than the COVID-induced learning loss of 0.11 standard deviations that De Witte and Francois (2022) find between pre- and post-COVID cohorts across 15 European countries. (We will compare reading achievement decline between 2016 and 2021 and learning loss due to COVID-19 at the country level later on in detail.)

- Figure 2 about here -

Up to this point, the focus was on changes in average reading achievement. Education experts are however most concerned about pupils falling behind. Figure 3 presents the share of children scoring below the intermediate international PIRLS reading benchmark (threshold score 475) for 2016 and 2021. When reading literary texts of medium or higher difficulty, these students struggle in locating, recognising and reproducing explicitly stated actions, events and feelings, making inferences and interpreting reasons (PIRLS 2023). Like Figure 2, countries are ordered by the changes between the last two PIRLS cycles, here the increases in low performing children.

- Figure 3 about here -

Looking at Figure 3, a researcher not aware of the pandemic would likely be puzzled whether something could have happened between 2016 and 2021. Out of 21 European countries covered, the percentage of low performers increases significantly in all countries with the exception of Bulgaria, Slovakia, France, Lithuania, England and Ireland (the latter three countries collected PIRLS 2021 delayed compared to 2016 which might have led to an upwards biased achievement performance in 2021 relative to 2016). In contrast to average

² The choice of which year to use for estimating the standard deviation, only 2016 or both years, 2016 and 2021, does not influence the results reported.

achievement, the focus on low performers always captures heterogeneity in learning loss more predominantly, since a greater share of low performing pupils come from disadvantaged families.

In line with the average achievement results, Latvia and Slovenia stand out: their shares of poor reading performers increased by 12 and 8 percentage points respectively. However, in addition, the share of low performing students increased by as much as 10 percentage points in the Netherlands. (It is interesting to note that the Netherlands is the only country for which the test was sat at two different time points by students, at spring 2021 and at fall 2021. The share of low performing students is 22% for the early assessment date and 13% for the later date, indicating that there might have been a catch up after COVID-19 related school closures. However, students were not randomly assigned to the assessment date, so that it is not possible to draw strong conclusions. Figure 3 reports the average value across both assessments.)

In Sweden and Finland, the share of low achievers increased by as many as 7 percentage points. For both countries, robust COVID-19 analyses show no significant impact of the pandemic on learning outcomes. Consequently, it is surprising that the learning decline in Sweden and Finland appears equally high than the European average which comprises results from countries experiencing considerable COVID-19 induced learning loss.

Looking at Table 1 would finally give certainty to a researcher not aware of the pandemic, that progress in education was severely impeded in Europe between the years 2016 and 2021. Table 1 compares significant changes in both PIRLS mean achievement scores and shares of low reading performers between two consecutive survey rounds since the start of the survey in 2001. Hence, we compare whether no significant change, an improvement or a decline in performance or low achievement took place between 2001 and 2006, 2006 and 2011, 2011 and 2016 and 2016 and 2021. We consider only the 21 European countries having taken part at least in the 2016 and 2021 cycles (excluding Malta due to the reasons discussed above). Since a considerable number of countries did not participate in the survey from its beginning, our country coverage is considerably lower for older PIRLS cycle comparisons.

- Table 1 about here -

While the number of countries with no significant change between consecutive survey cohorts remained relatively similar across the four comparison assessment periods (first column of Table 1), this is far from true once we focus on performance improvement (second column) and decline (third column). Regarding the latter, we find (taking variation in the country coverage into account, fourth column), that average reading performance declines took place in 25% of countries between 2001 and 2006, 43% between 2006 and 2011, 17% between 2011 and 2016 and in as many as 71% of countries between 2016 and 2021. The difference appears similar for the increase of students lacking basic reading skills: 17%, 21%, 22% and 71%.

While educational achievement data are not suitable to determine the exact impact of COVID-19 on learning outcomes as discussed above, results clearly indicate that COVID-19 induced physical school closure and learning impediments are very likely to have affected the unusual overall European decline in learning outcomes between 2016 and 2021.

Reading achievement decline between 2016 and 2021 and COVID-induced learning loss

Given that reading achievement decline between 2016 and 2021 should be partly influenced by COVID-19 induced learning loss, Figure 4 compares both. We use most recent national studies measuring the causal effect of the pandemic on learning outcomes as summarised in De Witte and Francois (2022). The comparability of national results with PIRLS results are, however, clearly limited. Obviously, the national studies measure achievement before and after COVID-19, while PIRLS data refer to a 5-year learning decline. Second, the year of measuring learning loss is similar between national studies and PIRLS by focusing on 2021, however the months of data collection differ. In addition, the Czechia study refers to 2020. Third, all reported results from national studies focus on language learning (in contrast to maths) in line with the focus of PIRLS' reading literacy. Nevertheless, the national measures of learning outcomes necessarily differ between countries and compared to the PIRLS operationalisation of reading achievement. Fourth, it is impossible to match the age group of the national COVID-19 studies to that of the PIRLS target population for all country studies. The note to Figure 4 explains important differences of the comparisons. Given these considerable limitations, results need to be interpreted with caution.

The y-axis of Figure 4 provides the standard deviation decline in PIRLS reading achievement between 2016 and 2021 (average results of this measure were already discussed above), while the x-axis presents the estimates of the COVID-19 induced learning losses for 10 European country studies (the references to the studies can be found in the note to Figure 4). A negative (positive) standard deviation reflects a decline (improvement) in reading performance. Country dots printed in blue in this figure and those to follow represent the national profiles discussed in the volume to which this study is a contribution. The average COVID-19 induced learning loss across the 10 country studies is 0.11 standard deviations (equal to between 28% and 38% of loss of one year schooling), which compares to a smaller learning deficit between 2016 and 2021 of 0.08 standard deviations (between 20% and 26% of a school year).

For England and Spain, the PIRLS and national measures produce a similar result on learning loss during COVID-19 and achievement decline between 2016 and 2021 (both countries' values are close to the diagonal line). However, for all other countries, COVID-19 learning loss is very different to reading achievement decline during the last two PIRLS cycles. Most striking is perhaps the Finnish case, where PIRLS learning decline is about 0.14 standard deviations compared to no COVID-19 impact on language learning (Lerkkannen et al 2022). This might indicate that educational achievement trends in some countries are much more important than COVID-19 related learning loss. Conversely, for Hungary and Poland national studies measure a COVID-19 learning loss close to 0.3 standard deviations, while with PIRLS we find only a slightly elevated learning decline compared to other European countries across 5 years. In sum, the estimates of the 5-year learning decline and COVID-19 induced learning loss are not correlated (correlation coefficient 0.09).

- Figure 4 about here -

Trajectories of educational inequalities in Europe

Up to now, the focus of this study was on average achievement decline and share of students falling behind in Europe. Among others, we found that the share of low performing students has considerably increased throughout Europe. Is the latter due to a shift of the education performance distribution to the left and hence to lower PIRLS performance scores while

keeping the overall distribution curve similar? Alternatively, do recent European education declines go in line with increases in educational inequalities in Europe?

An adequate question to ask is whether cross-national achievement scores can actually capture changes in educational inequalities properly. These scores are derived from Item Response Theory (IRT) models (a very accessible description of IRT models are provided by Jacob and Rothstein 2016). The models impose a distribution of educational achievement which is not immanent in the raw data, thus whether educational achievement scores based on cross-national surveys follow a normal distribution is not independent of how the raw data are modelled with IRT models. (Atkinson 1975; Schnepf et al 2023). Survey organisers do generally not provide insights on how the choice of IRT models impact on educational inequality results, but research shows that they clearly do (Brown et al 2007).

- Figure 5 about here -

With this note of caution, Figure 5 (A to D) investigates changes in educational inequalities during 2016 and 2021. Figure 5A provides the PIRLS reading achievement score at the 5th percentile of the education distribution (hence the score below which 5% of the other students' achievement falls) for 2016 on the x- and for 2021 on the y-axis for all countries. The diagonal line indicates where countries would lie in case the 5th percentiles were the same for both years. With the exception of Ireland, Lithuania, England, France and Slovakia, low performing students performed worse in 2021 compared to 2016. The 5th percentile value decreased by even more than 20 PIRLS points (about a fifth of a standard deviation) in Hungary, the Netherlands, Sweden, Finland and Latvia. Consequently, in 17 out of 21 countries we find that low performing students have lost out further since 2016. This explains a great part of the European average reading performance decline described above.

Did well-performing pupils loose out as well? Figure 5B compares the 95th percentile PIRLS achievement score for 2016 (x-axis) with that for 2021 (y-axis). At the top of the educational achievement distribution, most countries are placed close to the diagonal line, indicating that top performance did not change greatly between the 5 years. Nevertheless, in 10 out of the 21 European countries examined, the 95th percentile value declined significantly (Bulgaria, Germany, Finland, Hungary, Italy, Latvia, the Netherlands, Poland, Slovakia and Slovenia).

Given the pattern of top achievers slightly performing worse but low achievers experiencing considerably lower education outcomes, educational inequalities have undoubtedly increased over the last 5 years. This is shown in Figure 5C, which displays the difference between the 95th (P95) and 5th (5P) percentile of the PIRLS achievement distribution for both years. On average, across all countries, the P95-P5 value is 231 in 2016 and increases to 242 in 2021. In Bulgaria, Hungary and Sweden, a country generally renowned for high equality values, educational inequalities are highest (above 260 PIRLS points), while they are lowest for Italy and the Netherlands (around 200) in 2021. To double check that our results on increasing educational inequalities do not only derive from the choice of the percentile threshold, Figure 5D measures educational inequalities with achievement scores between the 90th and 10th percentile. The general pattern of raising education inequalities across Europe is confirmed.

Socio-economic disadvantage and performance decline

As discussed above, the literature indicates the pandemic having disproportionately affected students from lower socio-economic backgrounds (e.g. Betthäuser et al 2022). Figure 6 shows that this is also true for PIRLS reading achievement decline between 2016 and 2021.

- Figure 6 about here -

The figure displays the difference in the share of low performing students between 2021 and 2016 for students who have at least one parent having completed tertiary education (x-axis) and for those without any tertiary educated parent (y-axis) for all the countries covered in this study excluding England, for which the information on parental education is not available. A positive (negative) number shows that the share of low performing children increased (decreased). The diagonal line indicates where the country would lie, if the share of low performing pupils had equally increased or decreased independent of parental educational background.

Research suggests pupils can well report their parental education (Jerrim and Micklewright 2014). Nevertheless, there is a problem of non-response to the question on parental education, which is very heterogeneous across countries, ranging between 3% in Poland and Bulgaria and 47% in the Netherlands in 2016 and 4% in Bulgaria and 54% in the Netherlands for 2021. Research also shows that student non-response to parental background is not at random. Instead, students from lower socio-economic backgrounds tend to refuse to answer more. Indeed, we find that the share of low performing students is significantly (at the 5% level) higher among those in the non-responding sample compared to those with lower educated parents in 12 (out of 20) countries in 2016 and in 10 countries in 2021. In none of the countries, the non-responding sample performs better on average than the responding sample of pupils with lower parental background.

Figure 6 only includes those students who have responded to the parental education question. Consequently, there is – besides the normal sampling error – considerable unobservable non-response error around the estimates presented. Given that lower socio-economic background students are more likely to decline response and are performing worse, we assume that we actually underestimate the gap in achievement decline between students with and without tertiary educated parents.

Nevertheless, only in three (Ireland, Lithuania and Slovakia) out of 20 countries the share of low performing students increased less for the disadvantaged than for the advantaged students. In Sweden, socio-economic background does not play a role. In the other 16 countries, the disadvantaged students are much more likely to drop into low performance between 2016 and 2021 than their better off peers. The biggest gap appears in Latvia, where 9 percentage points more advantaged students slid into low performance compared to as many as 14 percentage points for disadvantaged students between 2016 and 2021.

Has the social gradient of PIRLS reading achievement changed between 2016 and 2021? For exploring this question, we use a pupil level ordinary least square regression pooling data on all 20 countries with the dependent variable ‘PIRLS reading achievement’ and the only explanatory variable a binary variable indicating parental higher education. We run the regression for 2016 and 2021 separately using the sample for the same 20 countries and including country fixed effects. In 2016, children with higher educated parents have approximately 41 PIRLS points higher achievement than children with less educated parents.

This increases to 44 points for the 2021 cohort. Consequently, the importance of parental education increased by 3 PIRLS points, an increase that is significant at the 10% level and which reflects a rise by 5 percent. (Regression results can be obtained from the authors.)

Conclusion

This study uses PIRLS data to investigate educational achievement decline of fourth graders across 21 European countries during the last 20 years and especially between 2016 and 2021. Learning decline estimated between 2016 and 2021 is not only composed of learning loss due to COVID-19 but also falling European performance trends and impacts of potential education policy changes. Results of trends of educational outcomes show that the COVID-19 pandemic happened, when educational achievement (measured by PIRLS reading scores) had been declining already over a longer period in Europe.

Comparing results of national studies measuring the impact of COVID-19 on learning loss with PIRLS reading achievement decline for ten European countries shows no correlation. For example, recent COVID-19 counterfactual impact studies show that COVID-19 did not lead to decreasing achievement in Sweden and Finland, a result that was outstanding positive in comparison to other European countries. However, PIRLS results indicate that both countries faced a concerning learning decline over the past 5 years. This indicates that while the COVID-19 induced learning loss is of importance, its significance might be meaningfully interpreted only in the context of longer period learning trends. In other words, education policy makers should not be relieved by studies showing a low impact of COVID-19 on learning outcomes, if overall pupils' education outcomes declined during a much longer time span. On the other hand, very concerning learning decline due to COVID-19 needs to be compared to the country's trends of learning outcomes over time.

In most countries, the share of low performers increased substantially between 2016 and 2021. The decline is worse for two countries for which national studies on the impact of COVID-19 on learning outcomes do not exist due to lack of administrative education outcome data, namely Latvia and Slovenia (respectively 12 and 8 percentage point more students move into the group of low performers). This evidence is surprising, since both countries had stable or improving educational outcomes over the past decades.

Even though the extent of the COVID-19 impact on learning loss is not quantifiable with PIRLS data, the COVID-19 induced physical school closures are likely to have augmented the European achievement decline found between 2016 and 2021. The average share of countries having faced a decline in reading achievement and an increase of poor performers is 20% and 30% between adjacent survey cycles until 2016. However, as many as 70% of European countries display performance declines of 10-year-olds between 2016 and 2021. This result justifies why the title of this study refers to 'European learning decline'.

While across half of the countries examined top performers achievement declined significantly, the European learning decline is mainly an effect of low performers falling considerably further behind. Consequently, in most European countries in 2021 educational outcomes are much more unequal than they were in 2016. This links to the result that the social gradient has slightly increased between 2016 and 2021, making parental background a more important determinant of education outcomes.

In sum, there is not a great encouraging picture to draw from the comparison of reading performance of fourth graders between 2016 and 2021. With the exception of Ireland, Europe's current cohorts of young children seem to have worse chances to learn and to acquire reading literacy than those in the previous cohort.

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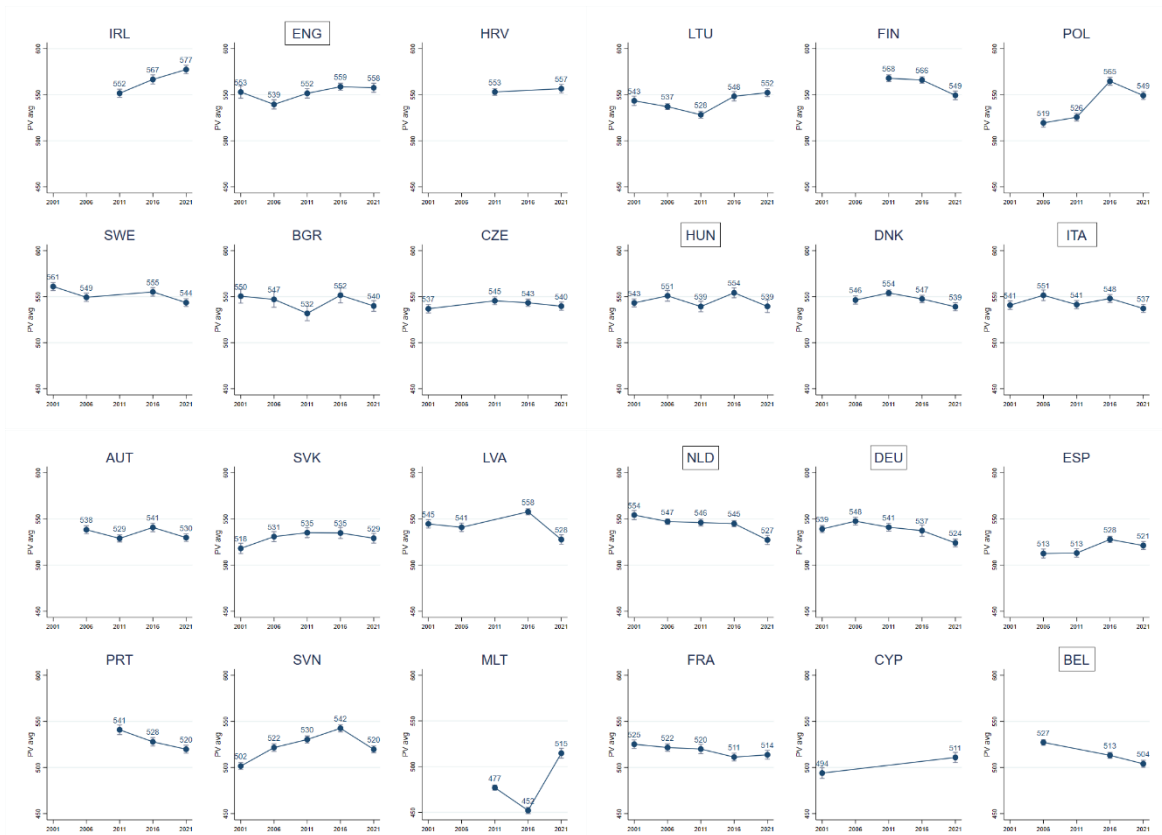
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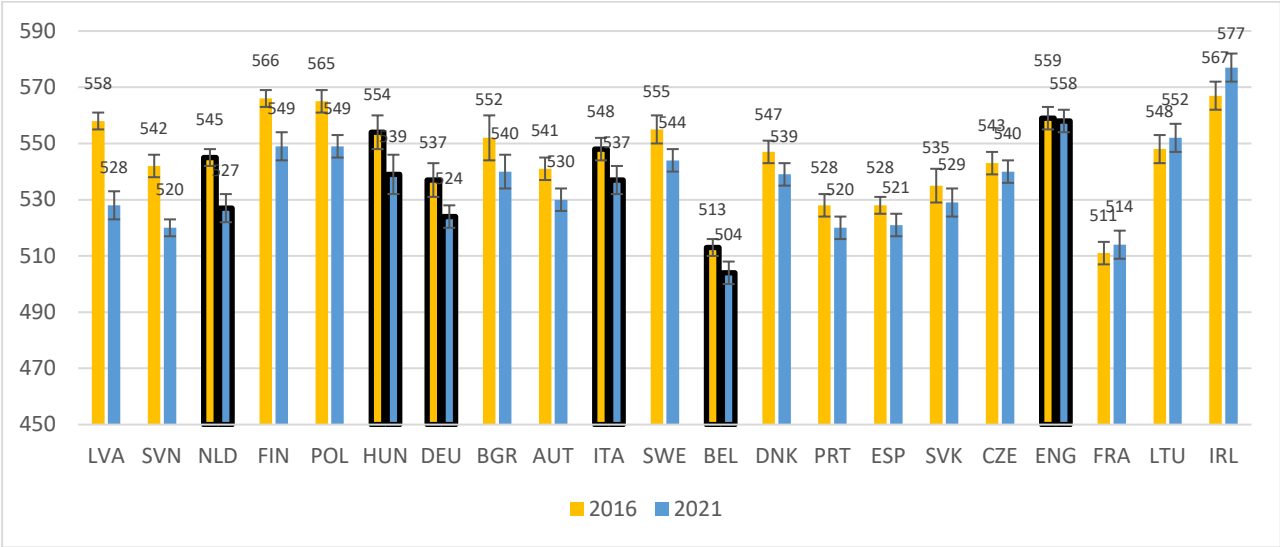
Tables and Figures

Figure 1. Mean reading achievement (PIRLS score) of 4th graders by year and country



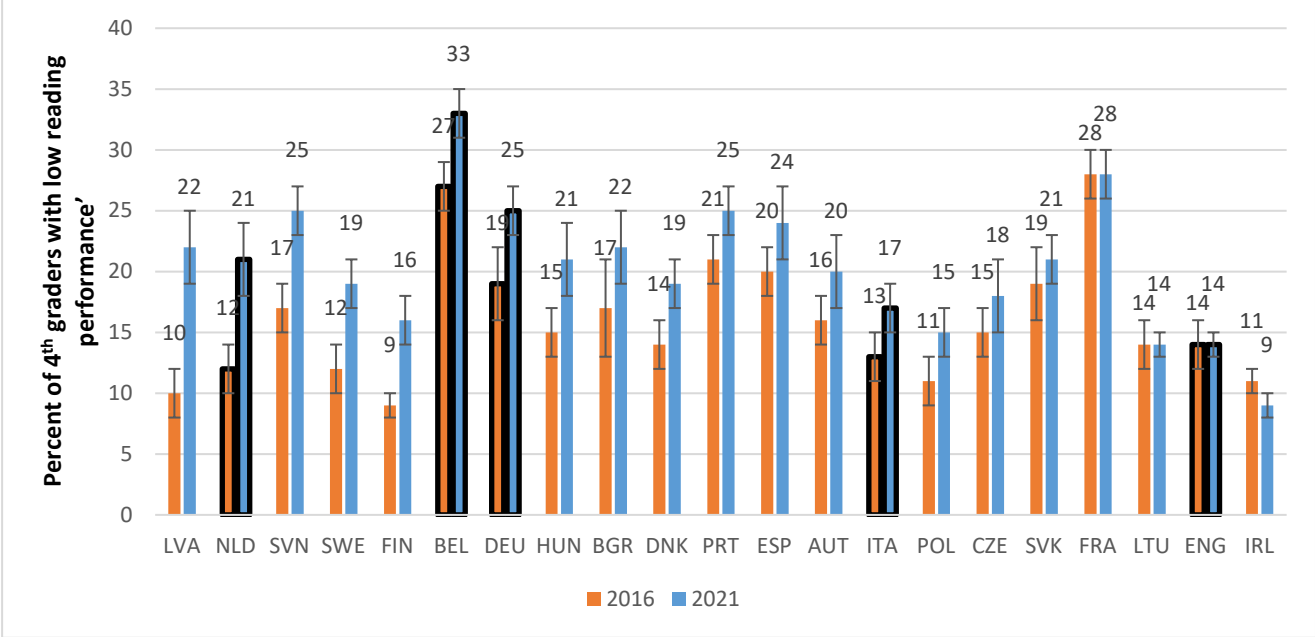
Source: PIRLS 2001 to 2021, authors' calculations. *Note:* Countries are ordered by their average achievement in 2021 (from high to low). 2001 to 2016 years refer to years prior to the COVID-19 pandemic, while 2021 refers to the year during the pandemic. The vertical lines through the mean PIRLS reading score display its 95% confidence interval. Means and standard error estimates take plausible values and weights into account.

Figure 2. Mean reading achievement (PIRLS score) of 4th graders in 2021 and 2016



Source: PIRLS 2016 and 2021 data, authors’ calculations. *Note:* countries are ordered by the decrease in PIRLS reading mean achievement between 2016 and 2021. Countries investigated in-depth in this volume are indicated with a bold bar. The 95% confidence interval of the mean reading score is shown. Plausible values and weights are taken into account for deriving the estimates.

Figure 3. Percent of children with low reading skills by year and country



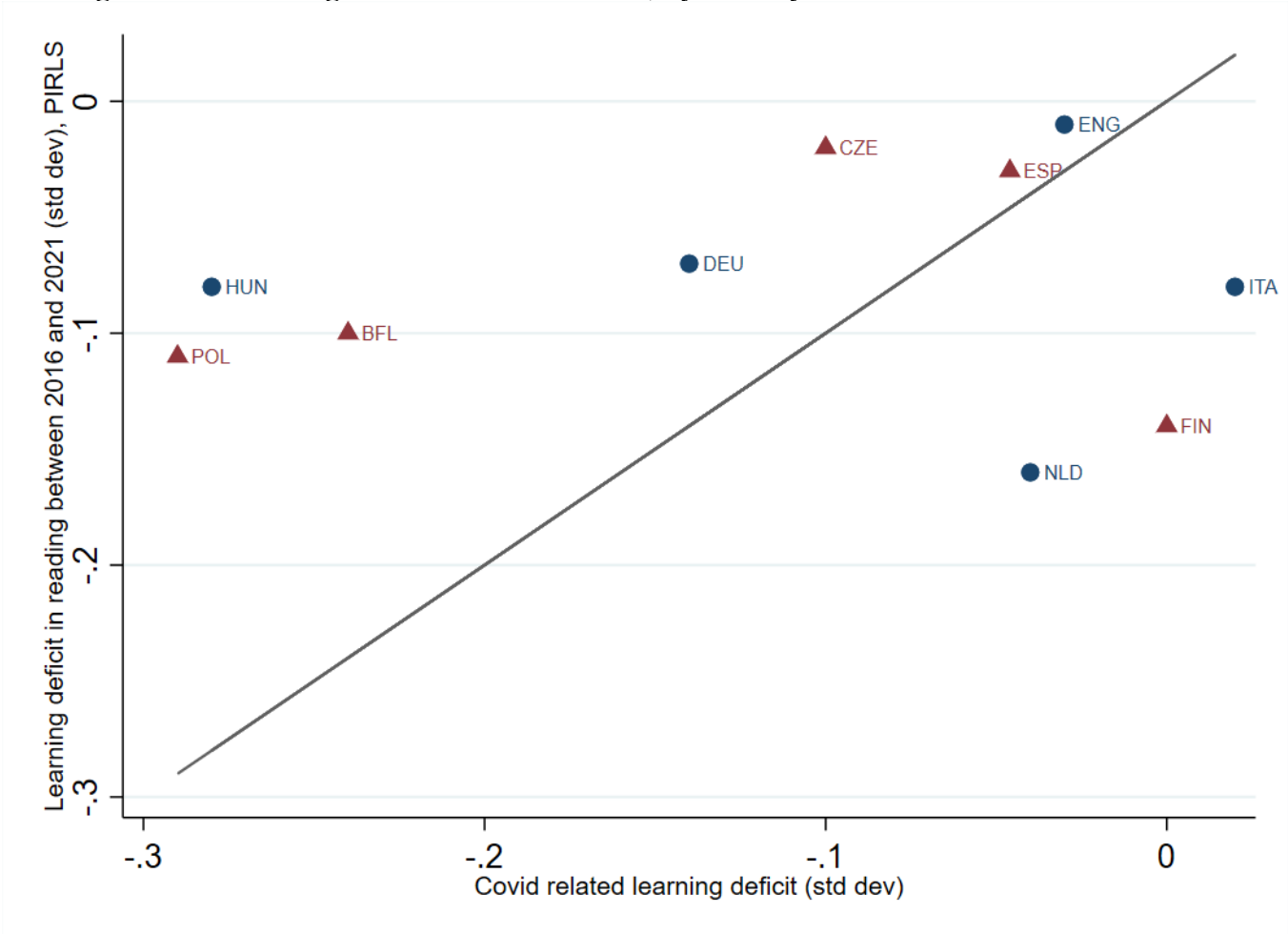
Source: PIRLS 2016 and 2021 data, authors’ calculations. *Note:* the bars show the percent of children scoring below the intermediate international benchmark for 2016 and 2021 (threshold score 475) by country. Countries are ordered by the increase in the percentage of pupils with poor reading outcomes between 2016 and 2021. Countries investigated in-depth in this volume are indicated with a bold bar. The 95% confidence interval of the share of poor performing students is shown. Plausible values and weights are taken into account for deriving the estimates.

Table 1. Changes in PIRLS mean achievement scores and share of poor reading performers between two consecutive surveys

	Survey years	Number of countries with no significant change between the consecutive survey cohorts	Number of countries with significant performance improvement in the consecutive survey cohorts	Number of countries with significant performance decline in the consecutive survey cohorts	Number of countries with performance decline expressed as percent of total number of countries covered	Total number of countries covered
Difference in PIRLS reading mean achievement	2001 and 2006	3	5	4	25%	12
	2006 and 2011	4	4	6	43%	14
	2011 and 2016	5	10	3	17%	18
	2016 and 2021	5	1	15	71%	21
Difference in percentage of students lacking basic reading	2001 and 2006	6	4	2	17%	12
	2006 and 2011	7	4	3	21%	14
	2011 and 2016	5	9	4	22%	18
	2016 and 2021	6	0	15	71%	21

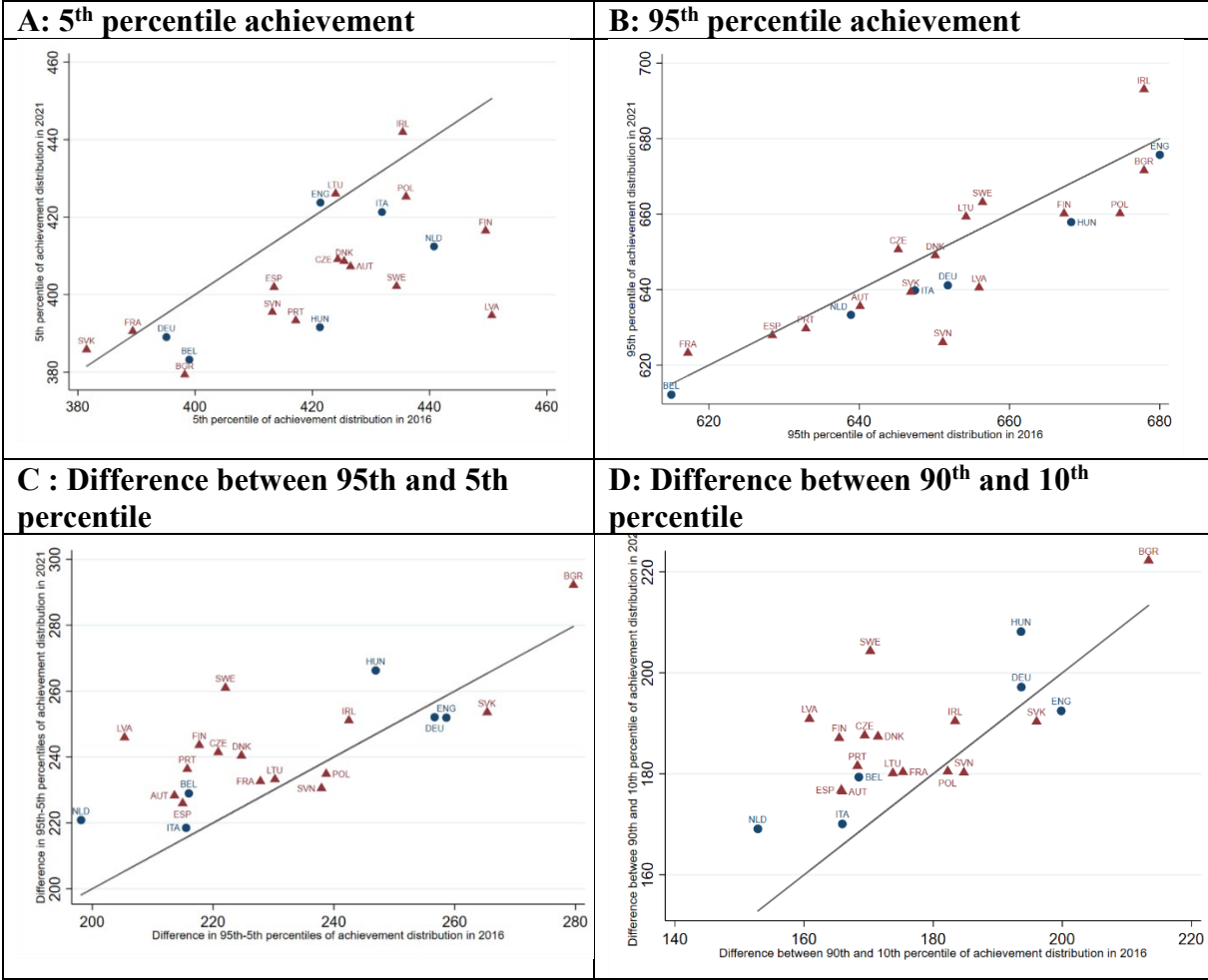
Source: PIRLS 2001, 2006, 2011, 2016 and 2021 data, authors' calculations. *Note:* Significant changes refer to the 5% significance level (taking weights and plausible values into account for standard error estimates). For mean achievement differences between two survey years (first four rows), decline and improvement are calculated by estimating the mean PIRLS achievement difference between the previous (e.g. 2016) and its consecutive cohort (e.g. 2021) and counting those countries with a significant difference at the 5% level. Students lacking basic reading skills are those whose achievement score is below the intermediate benchmark (475 PIRLS points) and who are consequently only able to locate, retrieve and reproduce explicitly stated information, actions or ideas from predominantly easy literary text (in contrast to texts of medium difficulty). For more details, see PIRLS 2023b.

Figure 4. Comparison of estimates of COVID-19 induced language learning loss and learning deficit in reading between 2016 and 2021, by country



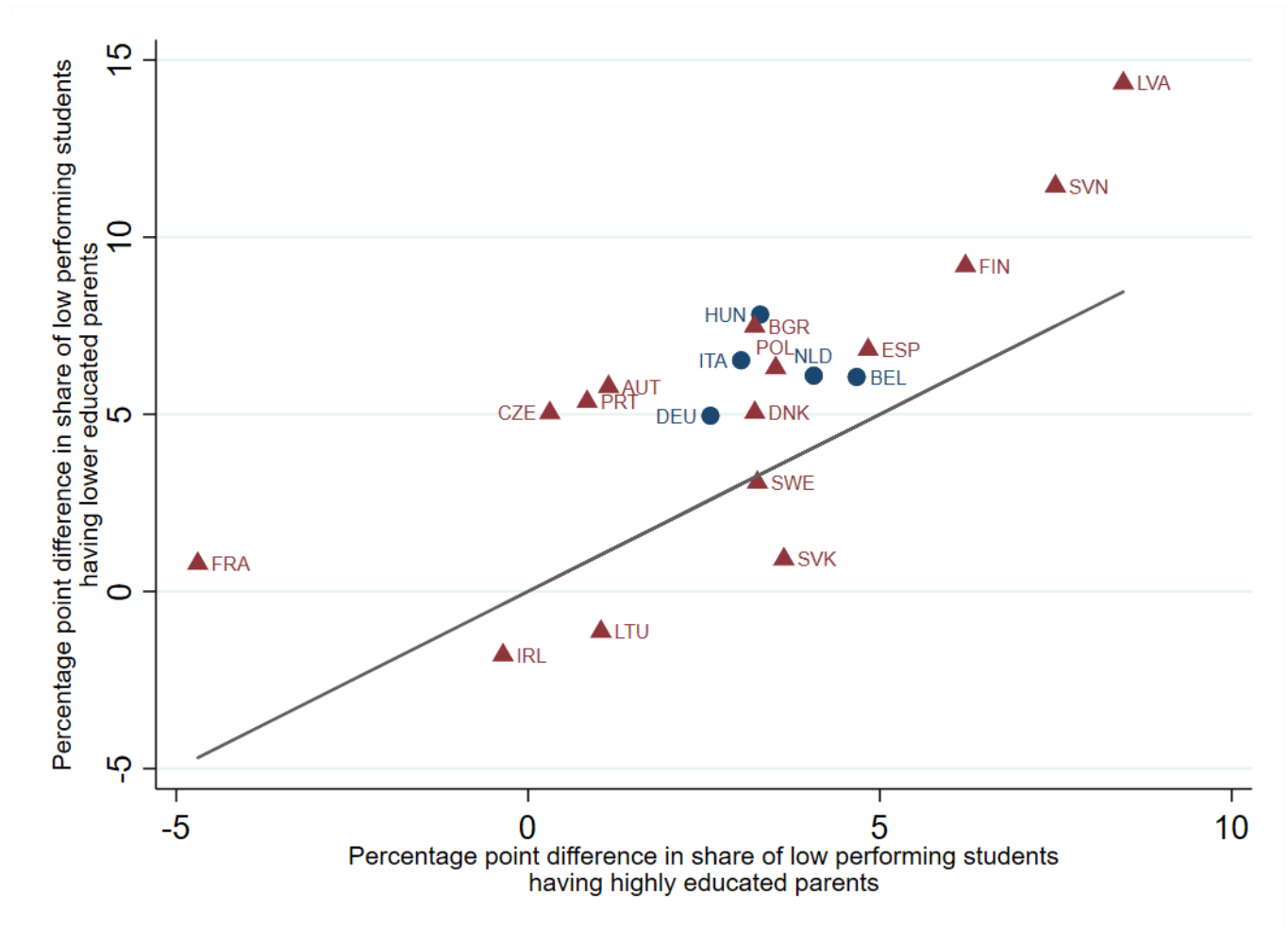
Source: PIRLS 2016 and 2021 data for y-axis values, authors’ calculations. For x-axis causal estimates of language learning loss due to COVID-19 induced school closure were used which derived from the following studies: for Belgium (Flanders) Gambi and de Witte (2021), for Czechia Korbel and Prokop (2021), for England Education Policy Institute (2021), for Finland Lerkkannen et al (2022), for Germany Ludewig et al (2022), for Hungary Molnár and Hermann (2022), for Italy Borgonovi and Ferrara (2022), for the Netherlands Haelerland et al (2022), for Poland Jakubowski and Wrona (2022) and for Spain (only the Basque region) Arenas and Gortazar (2022). *Note:* The graph shows PIRLS reading decline between 2016 and 2021 on the y-axis and learning loss due to the pandemic on the x-axis. All values are expressed in standard deviations of the underlying achievement distribution. The correlation between the two values is 0.09 and is not statistically significant at any conventional significance level. COVID-19 country studies for Belgium, Czechia, Finland, Germany and Italy focus on a similar age group to that of PIRLS. Hungarian data looks at slightly younger students. Dutch and English data refer to primary school pupils. Data for Poland and Spain focus on children in secondary school (3rd grade secondary and grade 8 respectively). For this graph, the Belgium figures refer to the Flemish community only. For more details, see De Witte and Francois (2022).

Figure 5. Distributional changes in educational achievement between 2016 and 2021 by country



Source: PIRLS 2016 and 2021 data, authors’ calculations. *Note:* plausible values and weights were taken into account for the estimates.

Figure 6. Difference in the percentage of students below the PIRLS intermediate international benchmark between 2016 and 2021 by parental education



Source: PIRLS 2016 and 2021, authors' calculations. *Note:* students having highly educated parents are those who have at least one tertiary educated parent, while students with lower educated parents do not have a parent who completed tertiary education. Pupils who did not provide information on parental education are excluded.