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Will the Covid-19 Pandemic Leave a Lasting Legacy in Children's Skill Development?*

It is a somewhat ironic observation that despite the fact that children were least affected by the coronavirus in terms of their physical health, it is becoming increasingly clear that the Covid-19 pandemic hit children and families particularly hard. With schools closed for several months and education systems facing unprecedented challenges around the world, children had to learn from home in modes ranging from self-study on provided worksheets to online schooling by video calls. Because of the isolation enforced by social-distancing rules, children could not meet friends or attend youth group meetings. Still, in designing policies to contain the pandemic, countries gave very different priorities to education and to the situation of children. In fact, the duration of school closures was not related to the intensity of Covid-19 transmission across countries (OECD 2021). In this policy brief, we summarize our review (provided in detail in Werner and Woessmann 2021) of what is known so far about how the Covid-19 pandemic affected the education and skill development of school children and about the long-run consequences due to missing skills required for successful participation in the future labor market.

The available evidence suggests that the cognitive and socio-emotional development of many children has been seriously impeded by the Covid-19 school closures and other lockdown measures. If remediation fails, these skill losses can be expected to have long-term repercussions, suggesting that there will be a strong persistent legacy of Covid-19 in children's skill development.

Substantial losses have been documented in the development of children's cognitive skills. These are highly unequal, however: children from low-SES families and children with low initial achievement are likely to be hit much more severely on average than their more advantaged counterparts, exacerbating future educational and economic inequality.

The Covid-19 restrictions also clearly interfered with the socio-emotional development of many children. Still, if children in general prove as resilient to the Covid-19 situation as to previous crises, serious

ABSTRACT

For school children, the Covid-19 pandemic brought school closures that challenged their learning experiences and social-distancing rules that impeded their peer interactions. Will these experiences have persistent effects on the development of children's cognitive and socio-emotional skills? We summarize the available evidence on how the pandemic affected the educational inputs provided by children, parents, and schools, how it impacted children's cognitive and socio-emotional development, and what this means for later economic outcomes. There is clear evidence that the Covid-19 pandemic seriously impeded the cognitive and socio-emotional development of many children. If remediation fails, these skill losses are likely to reduce skill development, lifetime income, and economic growth and increase educational and economic inequality in the long run.

medium- to long-term damage to their psychological development may be restricted to a smaller subgroup of children. With respect to the negative effects of limited social interactions, it remains to be seen whether certain phases turn out to be sensitive for the long-run development of social skills in broader parts of the affected cohorts.

WHAT DO COVID-19 SCHOOL CLOSURES MEAN FOR CHILDREN?

School closures can affect student outcomes in many dimensions and through a plethora of channels. To organize our thinking about what legacy Covid-19 may leave in children's education, we suggest a so-called education production function (e.g., Hanushek 2020) as a conceptual framework. Modeling the process of skill formation, the framework depicts the development of children's cognitive and socio-emotional skills as a function of the inputs by schools, families, and students.

In this framework, school closures can be thought of as a reduction in school inputs. A defining feature of school closures is that there is no teacher in the room to help students with their learning. In the absence of trained educators, students are missing out on key support, and their learning is left more to the

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discretion of themselves and their families. Self-regulated learning will be more effective for higher-ability students and for students with better support at home, so that the famous function of schools as the “great equalizer” will be impeded.



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With learning moved to the home, family inputs become much more important during the pandemic, including parents' time, effort, encouragement, and cognitive and pedagogical skills, as well as families' disposable income and home environment more generally. The extent to which families compensate for reduced school inputs likely depends on their socio-economic background. High-SES parents may have lower budget constraints, so that they may increase their family inputs more strongly. Their child's education may enter the utility function of high-SES parents more strongly, so that they may make sure that their child spends more time learning. And their own higher education may make high-SES par-

ents better substitute teachers on average, so that they may be in a better position—either financially or in terms of managing the curricular content—to support their child's learning activities.

A crucial feature of the educational production process is that students themselves are a key input factor. Without students' effort and engagement in learning, there will be no skill development. Behavioral responses of the children will therefore be an important mediator of how the school closures affect the development of their cognitive and socio-emotional skills. Because high-achieving students have a better skill base for self-regulated learning, the rate at which they achieve larger learning gains than low-achieving students will likely be faster in home schooling than in classroom teaching. As a consequence, school closures will widen educational inequality along the dimension of individual students' prior achievement (Grewenig et al. 2021).

Whether short-term impediments to children's skill development will translate into long-term skill losses will partly depend on whether there are sensitive periods in which certain skills are much easier to learn than at later stages (e.g., Cunha and Heckman 2007). If so, postponement of skill acquisition during school closures—e.g., missing out on developing basic reading, writing, and counting skills in the first years of primary schools or on social interactions during teenage years—may well have long-run repercussions

even if remedial measures are taken once schooling returns in person.

Overall, consideration of different inputs and outputs in the framework of an education production function suggests that many dimensions of child outcomes are likely to be affected by the Covid-19 pandemic, including cognitive skills, socio-emotional skills, and longer-run outcomes. Given the dynamic complementarities of learning (e.g., Cunha and Heckman 2007), the education crisis caused by the school closures threatens to leave a long-term legacy, with important heterogeneities expected for children with different family backgrounds and ability levels.

CHILD, PARENT, AND SCHOOL INPUTS DURING THE SCHOOL CLOSURES

Based on the conceptual framework of the education production function, the next three sections cover the available empirical evidence on effects of the pandemic (1) on the educational inputs provided by children, parents, and schools; (2) on the development of children's cognitive skills; and (3) on the development of children's socio-emotional skills.

A first approach to gain a better understanding of how students fared during the pandemic is to look at time-use surveys that show how much time children spent on school-related and other activities during and before the pandemic. We draw on two parental surveys that we fielded to cover the two phases of nation-wide school closures in Germany. After having implemented a first survey of over 1,000 parents during the first phase of school closures in spring 2020 (Grewenig et al. 2021), we fielded a second survey of over 2,000 parents during the school closures at the beginning of 2021 (see Werner and Woessmann 2021 for details). A longitudinal component allows us to track the situation of over 500 school children over time at the individual level, providing new evidence on how schools and families adapted to the pandemic situation over time.

During the school closures in spring 2020, school children spent an average of 3.7 hours on school-related activities—a dramatic decrease from an average of 7.5 hours per day before the school closures (see Figure 1). That is, the average learning time of children was cut roughly in half during the first school closures. During the second nation-wide school closures in early 2021, the time children spent on school-related activities increased slightly to 4.6 hours. This is close to one hour more than during the initial school closures in spring 2020, but still three hours less than during a typical school day before the Covid-19 pandemic.

Before the school closures, there was no noticeable difference in the time that low- and high-achieving students spent attending or learning for school. But during the first wave of school closures, low-achieving children spent a significant 0.5 hours per day less on school-related activities than high-achieving children

(Grewenig et al. 2021). The pattern is less clear during the second wave.

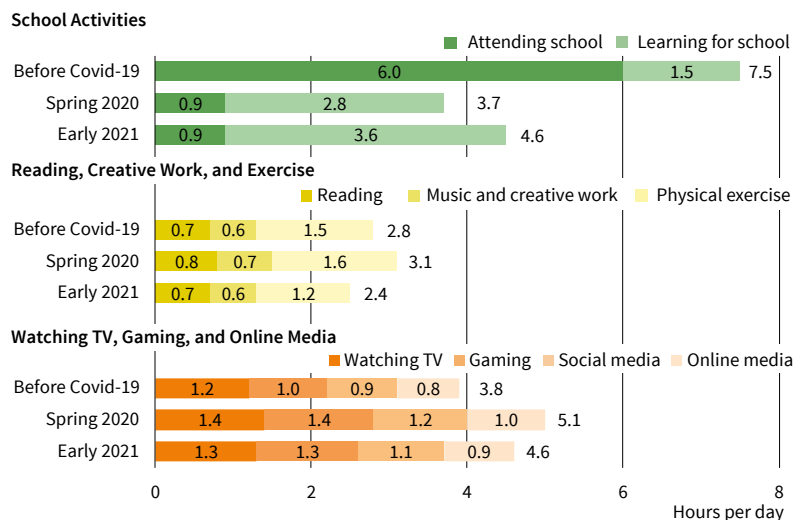
However, evidence from the second wave suggests that the quality of learning time differed significantly between low- and high-achieving students. Fifty-six percent of parents think that their child learns less per hour of studying at home than during regular instruction at school (see Figure 2). Such a difference in the effectiveness of learning per hour would imply that the reduction in learning time indicated above underestimates the reduction in acquired skills for most students. Interestingly, there is also a minority of 22 percent of parents who think that their child learns more per hour at home than in school, suggesting ample heterogeneity across students in their effectiveness of learning at home. Importantly, the share of parents reporting that their child learns less per hour at home than in school is 12 percentage points higher for low- than for high-achieving students, as well as for children of non-academic compared to academic parents. These results indicate that the same time investment may translate into lower skill growth for disadvantaged students.

The impact of school closures on children's skill development also depends on which other activities children substituted to instead of learning for school. The average hours that children engaged in activities which most parents consider productive—reading, being creative, and exercising—increased only slightly during the first phase of school closures in spring 2020. In contrast, the average time children spent on activities which most parents consider rather detrimental—watching TV, playing computer games, and spending time on social media and online media—increased markedly during the school closures. While it was 3.8 hours per day before the school closures, it increased to 5.1 hours each day during the first period of school closures. Results from the second survey wave show that a large part of the increase in time spent on detrimental activities persisted throughout the course of the pandemic. This shift towards more detrimental activities was particularly pronounced for low-achieving students.

When school closures reduced teachers' everyday delivery of education, the role of parents became ever more important. On average, parents report that they spent 1.2 hours per day on school-related activities with their children in both waves of the survey. Compared to the average of 0.5 hours prior to the school closures, parents more than doubled their time investment to support their children's distance-learning activities. However, parents of low-achieving students spent less time with their child learning for school than parents of high-achieving students, indicating that parental time investments did not compensate for differences between low- and high-achieving students. Substantial inequalities in the learning environment at home—whether children have their own room to study in, a reliable internet connection, or

Figure 1

Time Use of Students before and during the Two Phases of School Closures in Germany



Notes: Average hours spent in each activity on a typical workday.

Source: Werner and Woessmann (2021).

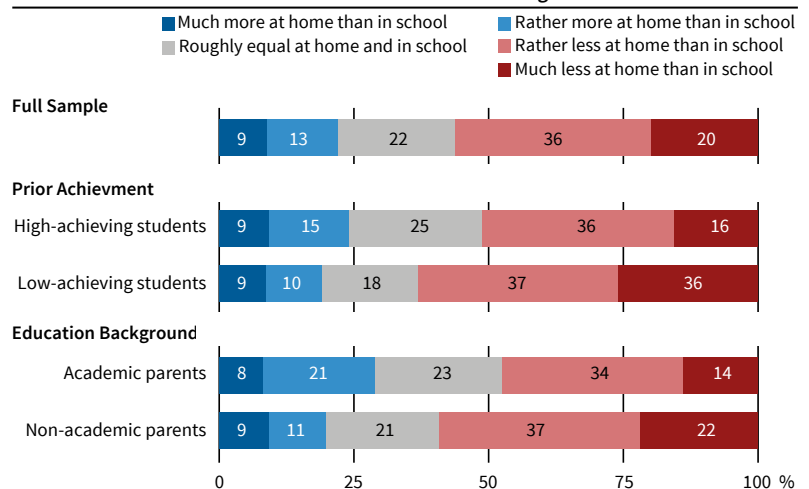
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a computer at home—may further contribute to inequalities in learning opportunities (Werner and Woessmann 2021).

Schools also differed widely in the intensity and type of distance-teaching activities provided to students. In our German survey, only 7 percent of parents report that their child's school offered daily lessons for the entire class, e.g., by video calls, during the first period of school closures (see Figure 3). Individual conversations between children and teachers were at an equally low level. Instead, the main activity of schools was to provide students with assignments for self-processing: more than 90 percent of parents report that their child received assignments for at-home study several times a week. Yet, only a subset of 64 percent of parents report that their child received feedback on their completed assignments at least once a week.

Figure 2

Parental Assessment of Effectiveness of Children's Learning Time at Home vs. in School



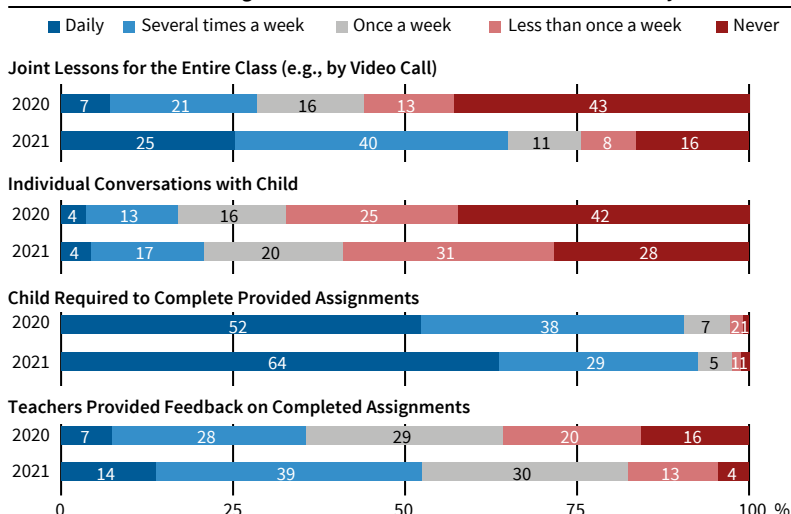
Notes: Parental response to the question, "How much do you think your child learns during one hour of learning at home compared to one hour of regular instruction at school? Per hour, child learns...".

Source: Werner and Woessmann (2021).

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Figure 3

Activities of Schools during the Two Phases of School Closures in Germany



Notes: Parental response to the question, "Which activities did your child's teachers or school engage in during the multi-week period of school closures?".
Source: Werner and Woessmann (2021).

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The intensity of online teaching increased markedly in the second wave. For early 2021, 25 percent of parents report that their child's school held daily online lessons, a substantial increase over the 2020 level. At the same time, even in the second year of the pandemic 35 percent of parents report that their child had online lessons at most once a week. In both survey waves, parents without academic education and parents of low-achieving children report less school engagements, suggesting that teachers were not able to differentially support children who were faced with potentially more challenging distance-learning circumstances.

Combining the information on students' learning time and schools' activities from the two survey waves, we find that learning time increased strongly when online class instruction was provided on a daily basis, but not at lower frequencies of online instruction or with any of the other school activities. The estimated value-added models exploit the panel dimension of our data to look at the *change* in learning time from the first to the second wave (see Werner and Woessmann 2021 for details). The results indicate that learning time during the second school closures increased by over one hour more for students whose school had implemented daily online teaching by that time compared to students whose school had not.

The pattern of differential pandemic effects on the learning opportunities of children from different backgrounds replicates in several studies in a variety of contexts, including time-use surveys in the United Kingdom and the United States (e.g., Andrew et al. 2020; Bansak and Starr 2021). Prior patterns of family life were often disrupted during the lockdowns, with altered work patterns, chore allocations, and household tensions among parents (e.g., Birol et al. 2021). Increasing evidence suggests that the burden of additional childcare responsibilities fell disproportion-

ately on mothers, with potential detrimental effects on their labor-market attachment and wellbeing (e.g., Zamorro and Prados 2021). Where school resources are lacking, evidence shows that many parents look for alternative ways to improve their child's access to education, such as online courses (Bacher-Hicks et al. 2021) or private schooling (Dee et al. 2021). Ample survey evidence from many countries thus indicates that learning inputs provided by schools, parents, and the children themselves all tended change due to the Covid-19 school closures in a way that particularly challenged students from disadvantaged backgrounds, aggravating patterns of educational inequality.

CHILDREN'S COGNITIVE DEVELOPMENT

An increasing number of studies look at how the school closures may have affected the development of children's cognitive skills, in particular their performance on achievement tests in academic subjects taught in school. While many tests were discontinued during and after the pandemic, some studies have access to data on students' performance on standardized tests.

We highlight two main methodological problems that complicate deriving the impact of the school closures from the testing data that are available. First, in most data it is difficult to disentangle any Covid-19 effect from usual cohort effects. As the school closures affected virtually all students, there is no convincing contemporaneous control group in cross-sectional data that could directly inform about the achievement in the absence of the closures. Most available studies therefore compare achievement of the affected cohort on a test after the closures to the achievement of previous cohorts who had taken the test in previous years. The problem is that the cohorts may have performed differently even without the school closures, a feature that is widely documented by countries' changing performance on international achievement tests. Such cohort effects would introduce bias into an interpretation of differences in average achievement across cohorts as effects of the Covid-19 school closures.

To address bias from cohort effects, one needs individual-level longitudinal data that allows observing how the students tested after the school closures had performed on tests before the school closures (compared to earlier cohorts). To our knowledge, only one study has access to this type of data in the Netherlands, where national tests in primary school take place twice a year, including in 2020 (Engzell et al. 2021). The study estimates the effect of the Covid-19 school closures as the difference in learning gains from January/February to June between the 2020 cohort affected by the closures and the three previous cohorts (2017–2019) for whom this period of learning was not disrupted by school closures. The study finds

an average learning loss equivalent to the average student learning of one-fifth of a school year, which is similar to the entire length of the school closures—implying that students made hardly any progress on average when learning at home. Losses are substantially larger for children from low-educated parents. Notably, the Dutch case is likely a best-case scenario with comparatively short school closures, equitable school funding, and world-leading broadband penetration.

The second, probably even more important problem is that substantial fractions of students did not participate in the testing during or after the closures. It seems likely that those students who are hardest hit by the pandemic, who discontinued learning the most during the closures, or who may not even have returned to school yet are most likely not to participate. If non-participation is concentrated at the bottom of the achievement distribution, it introduces substantial upward bias in repeated cross-sectional data—i.e., any loss in skills will be underestimated due to non-participation. To get an idea of the size of the bias, note that if one drops the lowest-achieving 10 percent of students from a population, the mean achievement will increase by the equivalent of 60–80 percent of an average school year of learning—and 120–160 percent if 25 percent are dropped. The approach of the Dutch study addresses this concern and provides additional evidence suggesting that it successfully removes the bias.

The problems of cohort effects and non-participation bias caution against far-reaching interpretations of results on achievement tests since the Covid-19 school closures presented in a series of additional studies in several countries, including England, Baden-Württemberg and Hamburg (Germany), Ohio and specific other US school districts, Switzerland, and New South Wales (Australia). A study in Flemish Belgium that is likely to still underestimate the learning losses because of these biases finds learning losses more than twice as large as the Dutch study (Maldonado and de Witte 2021).

Beyond the evidence for the initial closures of Dutch primary schools, our knowledge about the size of the loss in academic achievement due to the Covid-19 school closures is thus very limited. Still, recent reviews have concluded that overall, the available studies suggest that there are large negative effects of the school closures on student achievement (Hammerstein et al. 2021; Zierer 2021). Furthermore, bias from selective non-participation is likely to underestimate the true learning losses in many of these studies. In general, children from disadvantaged family backgrounds seem to be less successful in acquiring the appropriate skills during the period of school closures.

Only time will tell how the initial losses in academic achievement will translate into long-run losses in human capital. First, there is no evidence yet on effects of the continuing school closures. The initial

losses cannot be extrapolated linearly to the substantially longer closure experiences seen in most countries over the course of the pandemic. Second, it is unclear to what extent there will be persistence or fade-out of the short-run losses in the longer term as children move through other grades and graduate. However, prior evidence suggests substantial persistence of lost skills in adulthood outcomes.

The school closures are also likely to affect children's cognitive development beyond the curricular subjects. Given the experiences that students have had during home learning and online schooling, two specific aspects on which there may in fact be positive effects are their digital skills and their skills to engage in self-regulated learning. In our German survey, 66 percent of parents state that through the school closures, their child has learned to better handle digital technologies, e.g., computers, tablets, and the internet (Werner and Woessmann 2021). Fifty-six percent of parents report that through the school closures, their child has learned to independently acquire course material. But 35 percent disagree with this statement, indicating that there is substantial heterogeneity in the extent to which students have gained self-regulated learning skills during the school closures. Low-achieving students and children of non-academic parents are substantially less likely to have gained digital and self-regulated learning skills on this measure, likely exacerbating differences in learning trajectories in the future.

CHILDREN'S SOCIO-EMOTIONAL DEVELOPMENT

It is a major concern that the forced isolation of households may have had substantial detrimental effects on the socio-emotional development of children. In our German survey, 36 percent of parents in spring 2020 and 48 percent in early 2021 report that the situation during the school closures was a great psychological burden for their child (Werner and Woessmann 2021). Seventy-six percent of parents state that it was a great burden for their child not to be able to meet friends as usual during the pandemic, and 55 percent report that the school closures have harmed their child's social skills. The situation was thus clearly a huge psychological burden for many children, and most children suffered from the reduction in social interactions with peers.

Still, results from a richer measurement of children's socio-emotional wellbeing (SDQ items) in the 2021 survey provide a more mixed pattern of the impact of the school closures. Most parents report no change in most dimensions of their child's socio-emotional wellbeing during the school closures, and some even report improvements. The majority of children may thus in the end prove quite resilient to the situation. But there is substantial heterogeneity, and some children show clear negative developments in their socio-emotional wellbeing.

Two specific features stand out. First, many parents note a deterioration in their child's ability to concentrate. Second, as a positive development, there is evidence of reduced bullying, indicating that the move of the learning environment from schools to homes may in fact have been beneficial for the socio-emotional wellbeing of those students who are often bullied.

Several studies from different countries attempt to quantify the effects of the pandemic on the mental health, psychological wellbeing, and behavioral issues of children. They mostly have to rely on self- or parent-reported data in samples focused on narrow population subgroups. Results consistently point toward higher rates of anxiety, depression, and stress among adolescents due to the pandemic (Jones et al. 2021; Meherali et al. 2021). A representative longitudinal German study has found that children scored substantially lower on mental health and wellbeing in spring 2020 than cohorts surveyed before the pandemic and that the situation deteriorated further in early 2021 (Ravens-Sieberer et al. 2021). Students from disadvantaged backgrounds are consistently found to be more at risk of experiencing socio-emotional issues. There is some indication that worse mental health outcomes may be related to the time that students spend on passive screen activities (Champeaux et al. 2020) and on social media (Biroli et al. 2021).

The key question is to what extent children will be able to recover from the socio-emotional implications of the lockdowns in the medium to long term. Studies that track student outcomes over time report some improvement in socio-emotional wellbeing when restrictions are lifted (Blanden et al. 2021; Meherali et al. 2021). But if there were sensitive periods for socio-emotional development, children exposed to a negative shock during such periods might experience a persistent shift in their mental health. Evidence from past disasters shows that in many cases, most youths exposed to negative shocks are able to recover well within a number of years (Bonanno et al. 2010). It thus remains to be seen to what degree transient experiences of worse mental wellbeing will persist into long-term behavioral issues.

STRUCTURAL MODELS OF SCHOOL AND FAMILY EFFECTS

To study the potential longer-term implications of the school closures, a first approach is to use so-called structural models. These theoretical models of the production of human capital, calibrated to match relevant parameters in real-world data (usually of the US economy), help to further our understanding of the various mechanisms and behavioral responses that may give rise to the overall effects of school closures. The available models depict the behavior of schools and families (although not of the children themselves). One study models the change to online

education, changed peers, and parental responses as channels of how school closures affect adolescents' skill formation (Agostinelli et al. 2021). Another study models the extent to which the reduced public investment is mitigated by increased parental investment of money and time to depict effects on educational attainment, lifetime earnings, and welfare in the long run (Fuchs-Schündeln et al. 2021). A third study uses a similar approach to analyze effects on long-term macroeconomic output and intergenerational mobility (Jang and Yum 2020). The three studies have in common that the temporary school closures have important persistent effects and that they will increase educational inequality.

PROJECTIONS OF ECONOMIC OUTCOMES

A second approach to conjecture the long-run legacy of the pandemic is to use estimates of the economic returns to skills to project how the observed skill losses may affect future economic outcomes. Measures of cognitive skills have been shown to be strong predictors of individual income (Hanushek et al. 2015) and macroeconomic growth (Hanushek and Woessmann 2015). The projections suggest that students who lose the equivalent of one-third of a school year's learning would on average suffer a 2.6 percent loss in income over their working life (Hanushek and Woessmann 2020; see also Psacharopoulos et al. 2021). Larger skill losses would mean equivalently larger earnings losses. For the economy as a whole, the reduced growth from a learning loss of one-third of a school year for the current student cohort is projected to reduce GDP by 1.5 percent on average over the remaining century. While the growth reductions will only emerge in the long term, both the individual and aggregate projected economic losses due to the school closures can clearly be large unless the learning losses are effectively remediated.

POLICY CONCLUSIONS

The long-term legacy of the Covid-19 school closures will partly depend on the policy responses that countries take in the coming years, determining whether students will or will not be able to recoup some of the lost learning. Given the unequal pandemic experience of different groups of children, the chosen measures should particularly focus on the identified at-risk students. Part of the measures should be directed at equipping children with self-regulated learning skills that would allow them to better get through any phases of school closures that may occur in the future. Even if possibly limited in size, the group of students whose psychological development is severely impacted requires particular help.

Most likely, there is no silver bullet that can solve all problems at once, particularly when addressing the needs of disadvantaged students. Therefore, gov-

ernments should use strategies that combine various interventions and approaches to help make up for the lost development of children in the various dimensions. While some of the policy options clearly require additional funding, it seems likely that the costs of most policy measures that effectively mitigate the educational legacy of Covid-19 are easily outweighed by their long-term economic gains.

In the short term, a key lesson is that school closures should be avoided whenever possible. Closing schools should be the last measure of resort after others—which may put greater burden on adults—have been exhausted. If closures are unavoidable, it should be mandatory that schools implement universal daily online lessons with video interaction between teachers and students. As indicated by the results of our value-added model (Werner and Woessmann 2021), daily online instruction can be a key driver of students' learning engagement. To enable online teaching, policymakers need to ensure that all children have access to decent digital devices and internet connections at home. The same is true for teachers, who should be additionally supported by professional development and training in the use of digital technologies and distance-teaching pedagogy. The online-education concepts should have a particular focus on helping disadvantaged student groups—those from low-SES families and those with lower initial achievement levels. Even with closed schools, additional interventions by remote tools such as online tutoring by university student volunteers (Carlana and La Ferrara 2021) and instructional support for parents (Angrist et al. 2021) can significantly help children.

Beyond the time of school closures, various measures can be taken within and outside school to help affected students catch up. In school, small-group remedial education lessons instituted after normal school hours could be targeted at students who have shown the largest learning losses. Similarly, summer schools implemented during vacation times could help to make up for some of the lost development of disadvantaged children, although it may be hard to reach those students who are most in need with voluntary programs. To reach at-risk children, the overall intervention strategy will have to include components with low entry barriers that, e.g., depend as little as possible on the initiative of parents to apply for the respective program.

With luck, the pandemic experience could work as a catalyst for the digitalization of schools and the use of adaptive learning software more generally. Given increased inequality, pivoting to more individualized instruction may improve achievement across the entire distribution of students. With the increase in video-based instruction, matching the skills of the teaching force to the new range of tasks could also help to move schools to better performance. Any such measure will be helped if school systems resume suspended student assessments and school accountabil-

ity to better inform schools where individual students stand.

There are also various options outside school to mitigate losses in children's development. Governments could provide low-income families with vouchers to obtain tutoring—instructional programs to convey curricular skills on a one-on-one or small-group basis (e.g., Nickow et al. 2020)—if their children struggle with their learning. Likewise, mentoring—programs that offer children the sustained support and relationship of one-on-one mentors (e.g., Resnjanskij et al. 2021)—could help particularly affected children to reach a positive development trajectory more broadly.

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