



# Budget Model

## COVID-19 School Closures: Long-run Macroeconomic effects

An updated version of this analysis is available [here](#).

**Summary:** PWBM estimates that the learning loss from school closures reduced GDP by 3.6 percent in 2050. Extending the 2021-22 school year by one month would cost about \$75 billion nationally but would limit the reduction in GDP to 3.1 percent. This smaller reduction in GDP produces a net present value gain of \$1.2 trillion over the next three decades, equal to about a \$16 return for each \$1 invested in extending the 2021-22 school year.

### Introduction

During the 2020-2021 school year, schools across the U.S. operated with various levels of remote education approaches because of the COVID-19 pandemic. [Studies](#) have found that remote education reduces learning outcomes for students and infer that [current students are likely to earn less in future wages](#) as a result of lower labor productivity. Labor productivity is an integral component of the production of goods, services, and wealth in an economy. Current cohorts of students with reduced education and lower productivity will be a drag on the future GDP of the United States for decades in the future.

In our [previous study](#), we projected the effects of school closure policies on lifetime labor income of the affected students by race and family income. In this brief, we look at labor productivity effects from reduced in-person learning resulting from school closures and remote learning, broken out by current grade in school and by family economic background. Accounting for these differences between demographic subgroups, we project aggregate effects of school closures on the U.S. economy as the cohorts of affected children join the workforce.

### Differences across groups

In order to account for the income-related disparity in the level of in-person schooling, we take the definition of economically disadvantaged family background from the Institute for Education Sciences ([IES](#)), and divide

students into two demographic groups: those who are from an economically disadvantaged family background and those who are not. Based on the eligibility guidelines published by the [U.S. Department of Agriculture](#), we consider children from families with income below 185 percent of the federal poverty line as economically disadvantaged, a definition consistent with that of IES. According to the most recent [American Community Surveys](#) data, this group includes 34 percent of school aged children in the United States.

We further distinguish students by grade (grades K-5 and grades 6-12) in order to account for (1) the different levels of in-person schooling experienced by grade and (2) the relatively higher return to in-person schooling for younger children. The [IES 2021 monthly school reopening national survey](#) provides levels of in-person school exposure based on these group definitions.

The IES survey shows that economically disadvantaged students are less likely to attend school in person than students not from disadvantaged backgrounds. It reports that 4th graders from disadvantaged family backgrounds attended school in person 44 percent of the time on average compared to an average of 50 percent<sup>1</sup> for non-disadvantaged students. This is consistent with our Philadelphia area data where we found local average income is positively correlated with school openness when not controlling for race. According to our regional data, students from the bottom income quintile families attended school in person an average of 12 percent of the time in fall 2020 while the average for students from the top quintile was 17 percent during the same time.

The IES survey also indicates that primary schoolers were exposed to more in-person schooling than secondary schoolers. In January 2021, the average in-person schooling level was 48 percent for 4th graders versus 39 percent for 8th graders. These metrics align with observations from our Philadelphia area data; for example, in Pennsylvania's Centennial School District, primary schoolers averaged six in-person days in the first three weeks of November 2020 while secondary schoolers averaged four. Using the IES data on 4th and 8th grade public school students, we calculate average in-person school exposure and use those levels as assumed exposure for grades K-5 and grades 6-12, respectively.

To calculate each group's exposure to in-person schooling for the past year (mid-March 2020 to mid-March 2021), we assume that all students faced remote learning from mid-March 2020 until the end of the 2020 school year. Since IES does not provide historical national data, we use linear interpolation to connect the start of the school year's openness level in September 2020 to the level of school openness reported in January 2021 and February 2021. This linear increase in openness appears justified by the trend we observed in [our Philadelphia area school openness data](#).

We model the learning loss and the consequent productivity loss using the methodology we employed in [our previous work](#). We estimate the relative effectiveness of virtual learning versus in-person schooling using studies on the measured mathematics skills of students enrolled in different learning modes. With this estimate of learning loss from virtual schooling, we convert the amount of learning loss which particular groups of children experienced into a fraction of a year of lost school. Following the returns to schooling literature, we map learning loss to productivity loss by estimating that one less year of schooling decreases future labor income by 10 percent for grades 6-12 and by 13 percent for grades K-5.<sup>2</sup>

## Macroeconomic consequences

In standard economic models, each person in the economy has a level of labor productivity, which along with capital, technology, and labor hours worked determines that individual's output. More productive workers produce more output in the same amount of time as less productive workers. An individual's labor productivity is determined by factors such as innate ability, work experience, network effects and opportunities, and human capital investments such as education and job training.

In the PWBM model, labor productivity for an individual changes throughout their lifetime. An individual starts at a particular level of productivity, but this level changes as productivity follows a stochastic process. A lifecycle component in the process raises average productivity as a worker ages, peaking in late middle age, whereupon productivity declines until retirement. In order to implement the projected effects of learning loss, we apply a reduction to the level of productivity to model the effect of school closures on the current school-age cohort. We apply different reductions for individuals based on group: economically disadvantaged or not disadvantaged family background and whether the individual is currently in grades K-5 or 6-12. While this approach captures some heterogeneity, we are not able to address impacts such as the [difference in learning outcomes](#) between higher performing students versus lower performing students from remote schooling. Since higher ability and productivity students likely have a smaller reduction in productivity due to remote learning, our approach may overstate the aggregate productivity losses for the future U.S. workforce while understating future income inequality.

Table 1 shows projected economic effects of school closures relative to a counterfactual where learning was never disrupted by the pandemic. As the cohorts of affected students enter the workforce, average labor productivity decreases relative to the counterfactual. However, less productive workers are a small proportion of the economy's labor supply and younger workers tend to be less productive, so the aggregate effect is muted initially, with labor productivity decreasing by 0.6 percent in 2030 relative to the counterfactual scenario. As the affected cohorts age, making up a larger proportion of the workforce and approaching their peak earning years, the relative drop in labor productivity increases to 2.4 percent in 2040 and 3.3 percent in 2050.

**Table 1: Projected Percent Changes in Macroeconomic Indicators due to Learning Loss from COVID-19 School Closures**

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<b>Year</b>	<b>Output</b>	<b>Capital Stock</b>	<b>Labor Productivity</b>	<b>Hourly Wages</b>	<b>Hours Worked</b>	<b>Government Debt</b>
2030	-0.60	-0.53	-0.57	-0.53	-0.07	0.23
2040	-2.20	-1.92	-2.35	-2.21	0.01	2.23
2050	-3.57	-4.07	-3.27	-3.52	-0.06	5.22

A drop in productivity drags down economic growth and wages. Overall, we project that the productivity losses current K-12 students experience as a result of school closures lead to a 3.6 percent decrease in GDP and a 3.5 percent decrease in hourly wages by 2050 relative to the counterfactual where there had been no disruption to learning. Government tax revenues decline and, consequently, government debt cumulates more quickly. Higher

debt along with less total savings by individuals with lower incomes leads to a lower real capital stock, lowering wages and GDP further. By 2050, the nation's capital stock will be 4.1 percent lower and government debt will be 5.2 percent higher. Note that current primary schoolers will be aged 34 to 40 in 2050, so the drop in their productivity will continue to affect the economy for many years afterwards.

To see the effect on current students' future labor income and wealth, we calculate the average income and wealth for each sub-group of students in the counterfactual scenario with no learning loss and compare against the average for the same sub-group in the scenario with learning loss. We look at four sub-groups: current primary schoolers from disadvantaged backgrounds, current primary schoolers from non-disadvantaged backgrounds, current secondary schoolers from disadvantaged backgrounds, and current secondary schoolers from non-disadvantaged backgrounds.

Table 2 displays percent losses for each group in terms of labor income, measured as annual labor income, and wealth, measured as total savings held in that year.<sup>3</sup> Students currently in grades K-5 from disadvantaged backgrounds will have on average 10.9 percent lower labor income in 2050 than was expected before the closures, while those in grades 6-12 from disadvantaged backgrounds will have 8.2 percent less labor income. That difference in lost income by age arises because, although primary schoolers had more in-person learning than older students during the pandemic, there are higher returns to in-person school for younger students. Economically disadvantaged students' losses are higher than those of non-disadvantaged students, due to less exposure to in-person schooling—a student currently in grades K-5 *not* from a disadvantaged background will have 10.7 percent less labor income in 2050.

Table 2: Percent Change in Labor Income and Wealth for Current Primary and Secondary School Students due to Learning Loss from School Closures

[DOWNLOAD DATA](#)

Group	Labor Income			Wealth		
	2030	2040	2050	2030	2040	2050
Disadvantaged primary schoolers	-	-10.6	-10.9	-	-16.6	-15.2
Disadvantaged secondary schoolers	-8.2	-7.6	-8.2	-12.2	-11.2	-11.2
Non-disadvantaged primary schoolers	-	-10.0	-10.7	-	-15.8	-14.4
Non-disadvantaged secondary schoolers	-7.3	-7.3	-8.1	-11.3	-10.4	-10.7

In 2050, the labor income (wealth) percent change relative to the scenario where there were no pandemic school closures is -10.9 percent (-15.2 percent) for disadvantaged primary schoolers, -8.2 percent (-11.2 percent) for disadvantaged secondary schoolers, -10.7 percent (-14.4 percent) for non-disadvantaged primary schoolers, and -8.1 percent (-10.7 percent) for non-disadvantaged secondary schoolers.

## Policy interventions

Since various [policies](#) to address learning deficiencies are currently [under discussion](#),<sup>4</sup> we model the effects of some school year extension policies. [The Elementary and Secondary School Emergency Relief Fund provision of Biden's \\$1.9 trillion COVID relief bill passed in March](#) provides approximately \$123 billion to K-12 public education. A portion of these funds—approximately \$22 billion—is earmarked to address learning loss through summer school, extended school days, an extended school year, after-school programs, or other enrichment. The provision gives considerable discretion to states to determine how to allocate funds to address learning loss, leading to a wide variety of policy proposals ranging from summer school in North Carolina to nonprofit literacy programs in Connecticut to extended school days in New Mexico. Because there is no uniform federal school extension policy, we do not attempt to model this policy.

We instead examine three policy options, each of which starts the school year one month earlier (e.g., August 1 versus September 1), resulting in a one month extended school year:

- Policy A extends the 2021-22 school year and the 2022-23 school year.
- Policy B extends only the 2021-22 school year.
- Policy C extends only the 2021-22 school year and is targeted specifically at the economically disadvantaged sub-group.

Policy C has a lower cost since it provides extra schooling only to a portion of the school age population as opposed to all K-12 students. Although a real policy may not be able to target solely economically disadvantaged students, for this analysis, we assume this targeting is possible and accordingly assume the cost of providing the school extension for economically disadvantaged students to be proportional to the size of that subgroup.

Using [enrollment](#) and [expenditure data](#) from the U.S. Department of Education's National Center for Education Statistics, we estimate the cost to operate all public schools for all K-12 students for one additional month in 2021 to be \$75.4 billion. For our targeted policy, we estimate the cost of providing one additional month of school only for disadvantaged students to be \$25.6 billion. We assume the U.S. federal government provides these funds and finances the expenditures through increased debt.

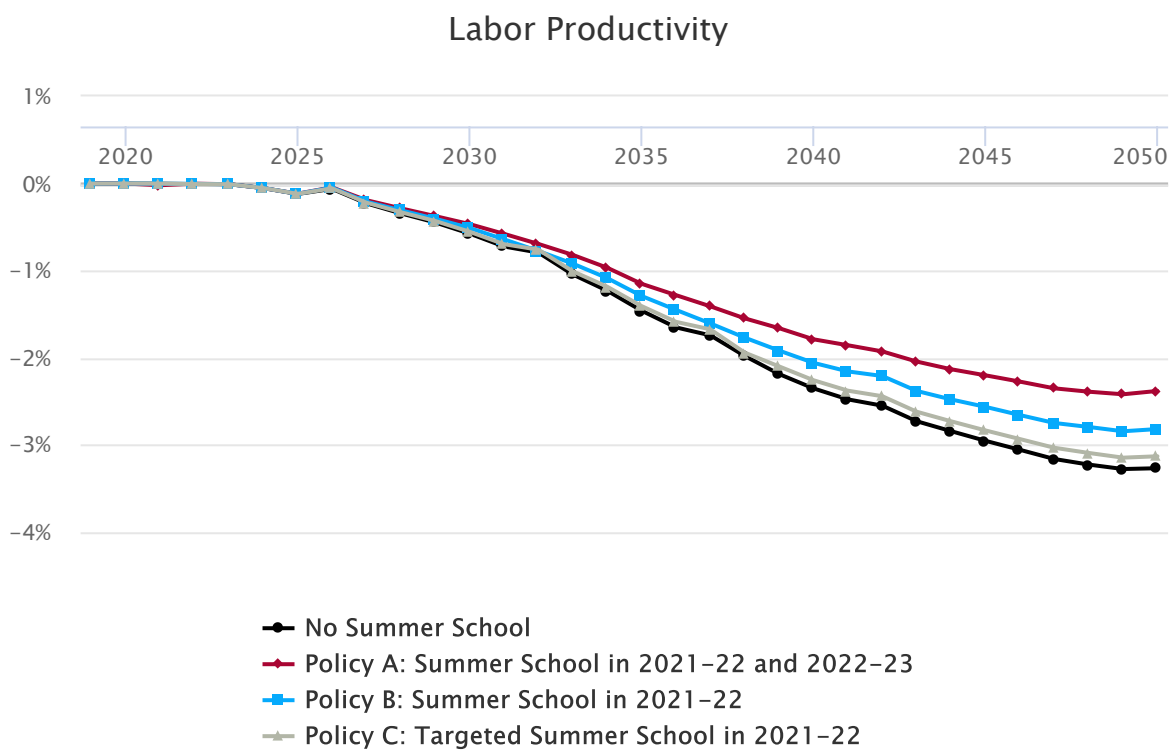
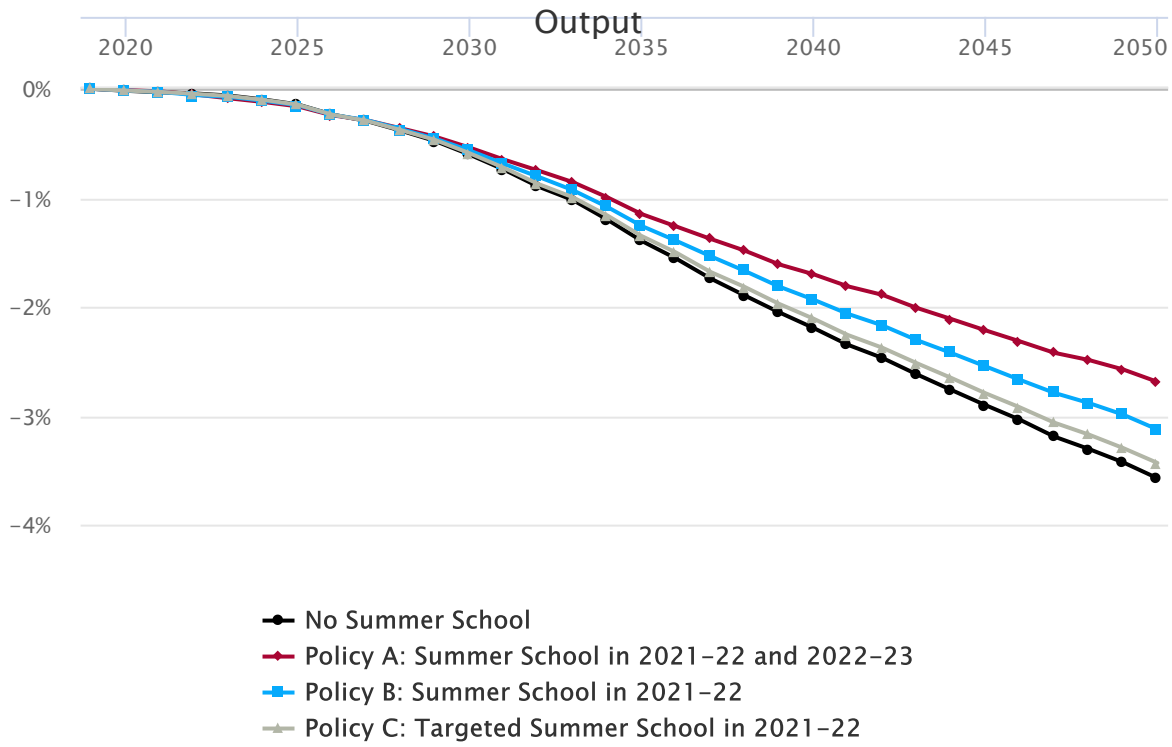
Figure 1 shows the macroeconomic results of the three school year extension policies in the PWBM dynamic model, as well as the scenario with un-ameliorated learning loss which represents the current state of the world. The percent losses shown are relative to a counterfactual scenario where schools had remained open and no learning loss occurred. The proposed school extension policies each reduce that disparity in 2050, with policy A limiting the loss in GDP to 2.7 percent, policy B to 3.1 percent, and policy C to 3.4 percent.

# Figure 1: Projected Macroeconomic Results of School Extension Policies

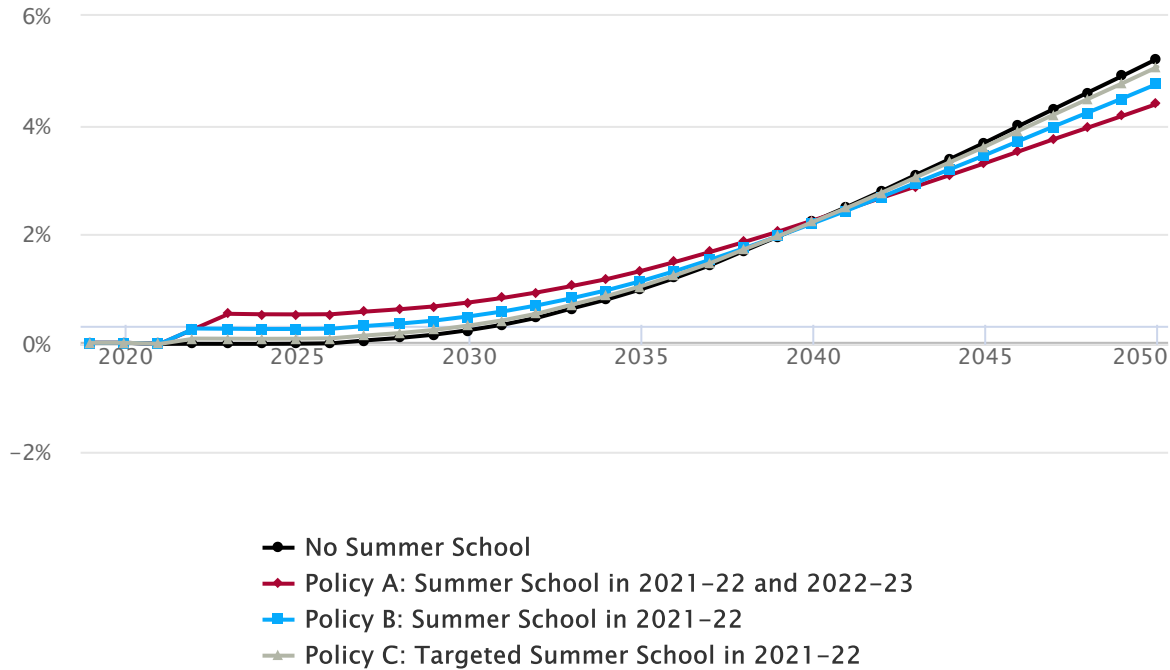
Percent Change from No Learning Loss Counterfactual Scenario

[DOWNLOAD DATA](#)

Output ▼



### Government Debt



At an aggregate level, policy A has the largest impact on reducing the decline in output, labor productivity, and government debt in the long run. Under policy A, initial costs are higher, which leads to higher government debt in the short run. However, by around 2040, higher labor productivity, higher economic growth, and the resulting expanded tax base produce lower debt under policy A than in the other scenarios. Although policies B and C also show improved economic outcomes relative to the no-intervention scenario, aggregate improvements are smaller than those seen under policy A.

Table 3 shows the changes to labor income and wealth for current students under each policy scenario. Under policies A and B, we see gains in labor income and wealth for each group of students relative to the no-policy scenario. By 2050, the sub-group of primary schoolers from disadvantaged backgrounds would recover 2.7 percent of their labor income (i.e., they would have 8.2 percent lower labor income, compared to 10.9 percent lower labor income in the no-policy scenario) and 3.9 percent of their wealth under policy A, and 1.4 percent of their labor income and 2.0 percent of their wealth under policy B. Under policies A and B, however, the current disparity in in-person schooling exposure by family background persists. As a result, the labor income and wealth gap between the disadvantaged group and the non-disadvantaged group does not shrink much as the duration of the school extension increases from policy B to policy A. Since policy C specifically remedies the difference in exposure, it decreases the gap between these two groups in terms of their future labor market performance. Under policy C, non-disadvantaged students maintain the same labor income losses as in the scenario with no school extension, while disadvantaged students' percent losses in labor income are similar to those under policy B. Wealth percent changes observed in policy C do not map to either the no-policy scenario or to policy B because of macroeconomic effects on wages and interest rates.

Table 3: Percent Change in Labor Income and Wealth for Current K-12 Students due to Learning Loss from School Closures under Different Policies

[DOWNLOAD DATA](#)

Percent Change in 2030						
Group	Labor Income			Wealth		
	Policy A	Policy B	Policy C	Policy A	Policy B	Policy C
Disadvantaged primary schoolers	-	-	-	-	-	-
Disadvantaged secondary schoolers	-7.1	-7.6	-7.6	-10.1	-10.7	-11.8
Non-disadvantaged primary schoolers	-	-	-	-	-	-
Non-disadvantaged secondary schoolers	-6.2	-6.7	-7.2	-10.4	-10.7	-11.1
Percent Change in 2040						
Group	Labor Income			Wealth		
	Policy A	Policy B	Policy C	Policy A	Policy B	Policy C
Disadvantaged primary schoolers	-7.9	-9.2	-9.2	-12.0	-14.0	-13.9
Disadvantaged secondary schoolers	-6.4	-6.9	-6.9	-9.5	-10.2	-10.2
Non-disadvantaged primary schoolers	-7.5	-8.7	-10.0	-11.8	-13.8	-15.9
Non-disadvantaged secondary schoolers	-6.0	-6.5	-7.3	-8.7	-9.4	-10.4
Percent Change in 2050						
Group	Labor Income			Wealth		
	Policy A	Policy B	Policy C	Policy A	Policy B	Policy C
Disadvantaged primary schoolers	-8.2	-9.5	-9.5	-11.3	-13.2	-13.1
Disadvantaged secondary schoolers	-6.9	-7.4	-7.4	-9.5	-10.2	-10.1
Non-disadvantaged primary schoolers	-8.0	-9.3	-10.7	-10.4	-12.4	-14.4
Non-disadvantaged secondary schoolers	-6.7	-7.3	-8.1	-8.9	-9.6	-10.7

With our projections for GDP changes under each learning loss remediation policy, we calculate the net present value gain<sup>5</sup> in GDP from government expenditures on school year extensions. Policy A has a net present value of \$2.3 trillion, policy B has a net present value of \$1.2 trillion, and policy C has a net present value of \$0.4 trillion. Per dollar spent, policy A provides a return of \$16.58, policy B a return of \$17.18, and policy C a return of \$15.80.



These calculated rates of return are modestly larger than those estimated by Heckman et al. (2010) for the returns to preschool education where the value of education per year is lower due to differences in learning ability by age.<sup>6</sup> Policy B provides the highest return since it remediates all students. Some harmed students age out of policy A's remediation, so the per dollar return is slightly lower. Policy C targets a subset of students and accordingly has a smaller macroeconomic impact and thus lower return. Since younger students are more affected by remote learning, policies targeting that subgroup are likely to have even higher returns on spending, though we did not model those policies here. Importantly, early interventions allow for more learning loss to be remediated before students age out from primary to secondary schools and lock-in larger losses.

*This analysis was conducted by Daniela Viana Costa, Maddison Erbabian, and Youran Wu under the direction of Efraim Berkovich. Prepared for the website by Mariko Paulson.*

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1. These numbers are calculated based on the distribution of 4th grade public school students by enrollment in instructional modes and the average number of in-person school days for hybrid students in the IES January 2021 survey report. ↩
  2. The returns to schooling we use are on the high end of the empirically estimated rates of return. We chose these rates of return since education is becoming relatively more important as the workforce becomes more educated and the U.S. economy becomes increasingly more knowledge-based. If we were to assume a lower return to schooling, the estimated productivity losses would decrease accordingly. ↩
  3. In 2030, current primary school students have not yet turned 21 years old—the age at which individuals join the workforce in the dynamic model. Hence, we cannot calculate losses for this group in 2030. ↩
  4. [https://www.washingtonpost.com/education/pandemic-summer-school/2021/04/21/bf71acf6-9882-11eb-a6d0-13d207aadb78\\_story.html](https://www.washingtonpost.com/education/pandemic-summer-school/2021/04/21/bf71acf6-9882-11eb-a6d0-13d207aadb78_story.html)  
<https://legiscan.com/NM/bill/HB184/2021>  
<https://www.the74million.org/article/states-target-learning-loss-with-summer-school-and-extended-days-but-some-parents-want-option-to-hold-kids-back/>  
<https://www.wxii12.com/article/north-carolina-covid-19-required-in-person-summer-school/36079009>  
<https://edsource.org/2021/california-schools-consider-extending-school-year-while-mental-health-remains-a-concern/647930>  
<https://www.cga.ct.gov/2021/TOB/H/PDF/2021HB-05435-R00-HB.PDF>  
<https://www.newsobserver.com/news/local/education/article250782509.html#:~:text=NC%20approves%20rules%20for%20new%20summer%20learning%20program.&text=School%20districts%20must%20offer%20students,to%20any%20student%2C%20space%20permitting>  
↩
  5. We discount nominal dollar differences in GDP between the no-policy and policy scenarios from 2021 to 2050. ↩

6. Heckman et al. estimate a social return of 7 to 12 dollars per dollar spent on pre-K, using a discount rate of 3 percent and accounting for dead-weight costs of taxes used to fund the program. That model also does not account for salutatory macroeconomic effects from higher labor productivity. ↩