

Methodology

The results of the literature on the effects of cognitive skills on economic growth are used to estimate the increase in the U.S. gross domestic product and tax revenues that would result from narrowing or closing the educational achievement gap between children from advantaged and disadvantaged family backgrounds.

As noted above, a growing body of research uses cognitive skills, as reflected in international test scores, as a measure of human capital. This research suggests that human capital accounts for a significant portion of the economic growth of economically advanced nations. The results of regression analyses conducted by Eric A. Hanushek and Ludger Woessmann found statistically significant and strong effects of cognitive skills—as measured by the internationally administered PISA test scores—on the economic growth of 24 nations in the Organization for Economic Co-Operation and Development from 1960 to 2000.⁶⁶ Specifically, Hanushek and Woessmann (2010) found that “an increase of one standard deviation in education achievement (i.e., 100 test-score points on the PISA scale) yields an average annual growth rate over 40 years that is 1.86 percentage points higher.”⁶⁷

Three simulations using the Hanushek and Woessmann regression estimate, one for each of three scenarios, are done to project the economic impact of closing or narrowing the educational achievement gaps between children from socioeconomically advantaged and disadvantaged families. The projection models follow closely the model developed by Hanushek and Woessmann in 2010, though several adjustments are made to account for factors specific to this study, such as the incorporation of estimates of future impacts on federal, state, and local government revenues. For all three scenarios, the 2012 U.S. PISA test scores in math and science are used as the baseline in the analysis.⁶⁸

We assume that the estimated impact of the PISA test scores on economic growth is causal, meaning that any policy that increases the test scores of students will result in faster economic growth. For the interested reader, Hanushek and Woessmann (2009) provide evidence that the association between cognitive

skills—as measured by the PISA test scores—and economic growth is indeed casual and reflects the effects of cognitive skills on growth. They use a variety of instrumental variables to test causality, use a difference-in-differences approach to compare country of origin-educated to U.S.-educated immigrants, and test whether countries that have improved their test scores have experienced commensurate growth rate improvements.⁶⁹

All three of our simulation scenarios use the PISA index of economic, social, and cultural status, or ESCS, to differentiate advantaged from disadvantaged families. The PISA index of economic, social and cultural status is based on the highest level of parental education, parental occupation, an index of home possessions related to family wealth, educational resources available in the home such as the number of books, and possessions related to culture such as works of art in the home.⁷⁰ We follow the OECD practice of defining students as socioeconomically advantaged if they are among the 25 percent of students from families with the highest PISA index of social, economic, and cultural status in their country. The parents of socioeconomically advantaged students have higher educational attainment and work in higher skilled jobs than do the parents of other children. More advantaged students have more books and educational resources, such as desks, dictionaries, computers, and Internet connections at home. Their homes also have more material possessions such as cars or rooms with a bath or shower.

Children from the most advantaged quartile of families scored an average of 532 on the math test, while children from the most disadvantaged three quartiles of families scored (in descending order by quartile) 494, 462, and 442, respectively. On the science test, children from the most advantaged top quartile of families scored 548 while children from the most disadvantaged bottom three quartiles scored 511, 480, and 456.

The first scenario assumes that the scores of children from the most disadvantaged bottom 3 quartiles of families are increased only enough to raise the average U.S. math and science scores to match the OECD average scores. Specifically, the difference between the average OECD math and science scores and the U.S. average math and science scores is calculated. For both math and science, the OECD-U.S. average score difference is divided by three quarters and the result is then added to the average score of students in each of the bottom three quartiles of the ESCS index. The math and science scores of the top quartile are assumed to remain constant.

The national average PISA math and science test scores are then recalculated for the nation as a whole. Aside from raising the combined math and science average U.S. score from 978 to 995 so that it matches the OECD average score, this scenario also narrows the achievement gaps between children from the most advantaged and most disadvantaged quartiles by approximately 13 percent. The average test score for the nation rises by 13 points in math and 4 points in science. The 13-point improvement in math and the 4-point improvement in science represent an increase of 0.09 standard deviations on the combined average score.

The second scenario raises the math and science scores of each quartile (by socioeconomic status) of U.S. students to match the math and science scores of Canadian students. This raises the combined average U.S. math and science scores from 978 to 1,044. It also improves the scores of the bottom three quartiles of students more so than for the top quartile of U.S. students, thereby narrowing gaps. The 66-point improvement in the combined math and science average test score is roughly an increase of 0.37 standard deviations on the combined score.

The third scenario assumes that the PISA test scores for children from the most disadvantaged bottom 3 quartiles of families are raised to equal the scores of children from the most advantaged quartile of families. In other words, the achievement gap between advantaged and relatively disadvantaged children is completely eliminated. The average PISA math and science test scores are then recalculated for the nation as a whole. This raises the combined average math and science score to 1080, which represents an increase of 0.54 standard deviations on the combined average score.

To assess the “reasonableness” of PISA test score increases of the sizes assumed in the three scenarios, the history of PISA test score increases was reviewed. Unfortunately, the PISA tests have only been administered at three-year intervals for a dozen years starting in 2000, and tests results have only been standardized and made comparable for the nine-year period between 2003 and 2012. This makes it difficult to compare actual increases in PISA scores to those in the three scenarios which take place over a longer time period: 20 years.

Nonetheless, several nations have experienced PISA test score increases that exceeded those of scenario one and roughly equaled those of scenario two. Germany and Italy, for example, experienced 33 and 27 point increases, respectively, in their combined average math and science score between 2003 and 2012, far exceeding the 17-point increase assumed in scenario one and roughly

matching the annual 3.3 point-increase assumed in scenario two, although short of the 66-point total increase. Poland's 6.3-point annual increase in its combined average math and science score between 2003 and 2012 is greater than the 5.1-point annual increase assumed in scenario three, although Poland's total increase over the nine years of 56 points is less than the 66 and 102 total point increases over twenty years of scenario's two and three. Thus, the cognitive ability increase assumed in scenario one is clearly achievable, while those of scenarios two and three may require an unprecedented sustained national effort.

All three simulations calculate the annual GDP growth-rate increases as the educational improvements are phased in fully. The cause of the educational improvement is not specified. In general, however, improvements in cognitive skills are not necessarily a function of educational reforms but, instead, could be the function of a variety of non-education and education policies. For instance, enhancements in educational achievement could result from the adoption of high-quality, universal pre-Kindergarten, class size reductions, improvement in the education of teachers, higher wages for teachers, child health and nutrition policies, better prenatal and post-natal care, criminal justice reforms that help lessen the detrimental effects of incarceration on the children of prisoners, reductions in racial and housing segregation, changes in work place policies such as those related to family leave or schedules or vacation time, or combinations of these and many other policies.

Whatever the source of the improvement in cognitive skills, the achievement gains are not assumed to be immediate but, instead, they are phased in linearly over a 20-year period. Thus, the cognitive skills improvements are assumed to be very small after one year, but they grow steadily year after year so that after 20 years, the achievement improvements are fully phased in.

Similarly, it is assumed that the economic impacts of enhanced cognitive skills are not felt until students with better skills enter the labor force. As these new, higher-skilled workers replace older, retiring workers, the average skill of the workforce progressively improves, productivity increases, and economic growth accelerates.

It is assumed that the average laborer works for 40 years.⁷¹ This means that it will take 60 years to feel the full economic effects of policies to improve cognitive skills—20 years to phase in the achievement improvements and 40 years until the full workforce reaches the higher skill level.

The simulations indicate the average annual increase in economic growth that results from the narrowing (scenarios 1 and 2) or gradual closing (scenario 3) of the educational achievement gap between children from more and less advantaged families and the subsequent upgrade in the skill level of the workforce. The annual estimated growth increase is then multiplied by Congressional Budget Office's long-term projections of real U.S. GDP to derive the annual increases in GDP over the years from 2015 to 2075 that result from closing or narrowing achievement gaps.⁷²

The Congressional Budget Office's long-term projections of real U.S. GDP do not already assume the cognitive achievement improvements built into scenarios one, two, and three. Nor should they. The results of the National Assessment of Educational Progress (NAEP), the largest nationally representative and continuing assessment of the educational achievement of children in U.S. schools, indicate little or no progress in the educational achievement of 17-year olds over the past forty years. For example, the NAEP math score for 17-year olds was essentially unchanged over the past forty years, varying slightly from 304 in 1973 to 306 in 2010.⁷³

To estimate the federal tax revenue impacts of GDP increases that are induced by closing education achievement gaps, the Congressional Budget Office's long-term projections of federal tax revenues as a percentage of GDP between 2015 and 2075 are used.⁷⁴ For other revenue projections, the historical record on state and local, Social Security, and Medicare revenues as a percentage of GDP over the past 30 years is reviewed and used as a guide.⁷⁵ Except for during the recession-affected years of 2002 and 2009, state and local revenues typically varied between 14 percent and 18 percent of GDP.⁷⁶ It is assumed that state and local revenues derived from future increases in GDP would sum to the middle of the historical range, or 16 percent of GDP. It is further assumed that additional Social Security taxes and Medicare revenues—among the most significant subcomponents of federal revenues—would equal 4.3 percent and 1.3 percent, respectively, of annual increases in GDP, which is consistent with their current levels. These rates are applied to the calculated increases in GDP to determine increases in revenues.

To compare the worth of these future increases in GDP and tax revenues to the current value of GDP and revenues, the common practice of discounting the future increases in GDP is followed to recognize that each dollar of GDP acquired in the future is less valuable than each dollar of GDP secured today. In general, a dollar earned sometime in the future is less valuable than a dollar earned today because of the interest-earning capacity of money. For instance, if the current interest rate is 3 percent, then 97 cents earned today and put aside in an interest-

bearing account would be worth approximately \$1 a year from now. This is equivalent to saying that a dollar earned a year from now would be worth only 97 cents today. The discounted future value, known as the present value, allows us to state the value of future benefits in present dollars so that they can be more easily compared to current values. Thus, we calculate the present value of these future GDP and tax revenue increases by assuming a standard 3 percent discount rate. All calculations are in real (inflation-adjusted) numbers, with 2015 as the base year.

To calculate the increases in lifetime earnings for children who complete their schooling 20 years from the start of the policy reforms, we used the OECD's estimate that 41 score points on the PISA math test is equivalent to about one year of schooling in the typical OECD country.⁷⁷ Consistent with the literature on the relationship between schooling attainment and lifetime earnings, we then assumed that for each year of additional schooling, students would experience a 10 percent increase in lifetime earnings. Thus, for example, under scenario three a student in the bottom quartile of socioeconomic status experiences a 90 point increase in their PISA math score, which is the equivalent to 2.2 years of additional schooling or a 22 percent increase in lifetime earnings.