Washington Center for Equitable Growth

The Economic and Fiscal Consequences of Improving U.S. Educational Outcomes

January 2015 Robert G. Lynch

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Preface

The Washington Center for Equitable Growth is committed to understanding whether and how economic inequality affects economic growth and stability. Our purpose is three-fold:

- Improve our understanding of equitable growth and inequality by encouraging new academic research and bringing together scholars to share their work.

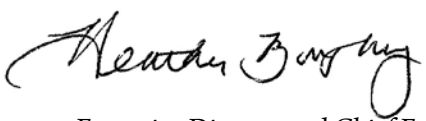
- Build a stronger bridge between academics and policymakers to help ensure that research on equitable growth and inequality is relevant, accessible, and informative to the policymaking process.

- Shape a rigorous, fact-based national debate on equitable growth and inequality.

This report explores ways of promoting faster and more widely shared economic growth by improving academic outcomes and narrowing achievement gaps among our children. It marks our first foray into analyzing the possible consequences of remedying economic inequality with an eye on fostering sustained economic growth and fiscal responsibility.

The Washington Center for Equitable Growth is committed to accelerating cutting-edge analysis into whether and how structural changes in the U.S. economy, particularly related to economic inequality, affect growth. We will be working with scholars across the United States and worldwide to reach a better understanding of the dynamics of economic growth and inequality and what policymakers can achieve in the way of equitable growth. We look forward to the debate.

Heather Boushey



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Improving educational outcomes and narrowing educational achievement gaps would significantly increase economic growth and raise government revenues.

Bronze

Scenario 1: If the U.S. matches the OECD average math and science achievement score	2050	2075
GDP would be	1.7% higher	5.8% higher
The cumulative increase in present value GDP would be	$2.5 trillion	$14 trillion
The cumulative increase in present value government revenues would be	$902 billion	$5.2 trillion

Silver

Scenario 2: If the U.S. matches the Canadian average math and science achievement score	2050	2075
GDP would be	6.7% higher	24.5% higher
The cumulative increase in present value GDP would be	$10 trillion	$57.4 trillion
The cumulative increase in present value government revenues would be	$3.6 trillion	$21.5 trillion

Gold

Scenario 3: If the U.S. matches the average math and science achievement score of the most advantaged quarter of U.S. students	2050	2075
GDP would be	10% higher	37.7% higher
The cumulative increase in present value GDP would be	$14.7 trillion	$86.5 trillion
The cumulative increase in present value government revenues would be	$5.3 trillion	$32.4 trillion

The consequences: annual economic and revenue growth

The average annual increases in present value GDP and government revenue indicate the size of public investments that would pay for themselves in the form of GDP growth or tax revenues over the next 35 (by 2050) and 60 years (by 2075).

Size of additional annual public investments in education that would pay for themselves in the form of

	GDP growth per year		Government revenues per year	
	Over 35 years	Over 60 years	Over 35 years	Over 60 years
	$72 billion	$234 billion	$26 billion	$87 billion
	$285 billion	$956 billion	$102 billion	$358 billion
	$420 billion	$1.4 trillion	$150 billion	$540 billion

For example if investments were made that raised U.S. math and science achievement scores up to the OECD average (Bronze scenario), then the U.S. would experience $72 billion more in GDP growth each and every year for the next 35 years. Thus, we should be willing to invest up to $72 billion per year for the next 35 years to raise U.S. achievement scores up to the OECD average.

Economic inequality reductions

Raising academic achievement and narrowing educational achievement gaps would also reduce income inequality by raising the lifetime earnings of the poorest 75 percent of children more than they raise the lifetime earnings of the richest 25 percent of children.

Increases in lifetime earnings for children once reforms are fully phased in.

	Poorest 4th	Second poorest 4th	Third poorest 4th	Richest 4th
	4.3%	4.3%	4.3%	0.0%
	10.9%	11.5%	8.5%	6.4%
	22.0%	17.0%	9.3%	0.0%

Note: Under the bronze and gold scenarios, the model assumes that the richest quarter of children experience no improvement in educational outcomes and therefore no improvement in lifetime earnings. But in fact, reforms that raise the educational outcomes of the bottom three quaters will also raise the academic outcomes and lifetime earnings of the top quarter of children. Thus the model understates increases in lifetime earnings.

Overview

This study addresses a key challenge confronting the United States—how to promote both widely shared and faster economic growth. It does so by analyzing and describing the effects of raising educational achievement, especially for those not at the top of the economic ladder. The results of this analysis, which are consistent with a large body of research across a variety of academic disciplines, demonstrate that improving the education of future workers accelerates economic growth and can promote more equal opportunity over the long run. The result: stronger, more broadly shared economic growth, which in turn raises national income and increases government revenue, providing the means by which to invest in improving our economic future.

Since the early 1970s, economic growth in the United States has been relatively slow and income inequality has risen rapidly. Over this same period, income growth has been so sluggish and unevenly distributed that families on the bottom and middle rungs of the income ladder experienced stagnating or declining incomes even as earnings among those at the top increased sharply. In contrast, the years immediately following World War II and continuing into the early 1970s were characterized by relatively rapid and broadly shared growth. Those at the top earned substantially more than those across the middle and bottom of the income spectrum, but high, middle, and low-income earners all saw their incomes grow at about the same rate.

A restoration, then, of the economic growth pattern that characterized the first three post-war decades would result in both greater and more widely shared economic growth—equitable growth. In order to address this key challenge confronting the United States, this study empirically quantifies the economic and tax benefits of raising the educational achievement of children from less advantaged socioeconomic backgrounds. In general, there are large gaps in the educational outcomes among children from families with lower and higher socioeconomic status. These gaps contribute to subsequent economic inequality, with the relatively poor performance of children from lower socioeconomic backgrounds

reducing U.S. economic growth. Thus, closing income or class-based educational gaps would promote faster and more widely shared economic growth.

The study shows the consequences of raising the educational achievement of children from the bottom three quarters of families who are most socioeconomically disadvantaged to more closely match those of children born into the top quarter of families. Observing the impact of three different scenarios that all have 2015 as their starting date, the analysis quantifies various outcomes over the next 35 years—to 2050, when the pressure of supporting the retired baby boomers will have largely abated—and over the next 60 years—to 2075, when the benefits of narrowing achievement gaps under the three scenarios will have been fully phased in.

Specifically, the study quantifies how much greater U.S. economic growth (measured by gross domestic product, or GDP, the total value of goods and services produced in our economy) and tax revenues would be. The analysis also assesses the reductions in economic inequality that result from the narrowing of education gaps.

In all three scenarios we use the 2012 scores on the Programme for International Student Assessment, or PISA, math and science achievement tests as our indicator of academic achievement.[1] For each scenario, a simulation model is used to estimate the economic effects of potential policy reforms that raise U.S. PISA scores—effects that improve the educational achievement of U.S. children and reduce disparities in educational outcomes among them. The results of this modeling suggest the extent to which appropriate policies could enhance economic growth, raise tax revenue, and reduce economic inequality. (See the Methodology section on page 45 for details on the simulation model and data used in this report.)

The three scenarios and the consequences for U.S. economic growth and fiscal stability

In the first and most modest scenario, we examine the consequences of simply raising the educational achievement of U.S. children so that it matches, instead of lags behind, the average of the 34 economically advanced nations who are members of the Organisation for Economic Co-operation and Development. Specifically, we raise the achievement scores of U.S. children from the bottom three quartiles of disadvantaged families just enough so that the national average educational achievement of all U.S. children on the PISA tests matches the average educational achievement of children from the OECD nations. This raises the com-

bined U.S. math and science PISA score from 978 to 995 (the OECD average) and improves the nation's relative ranking from 24th to 19th best out of the 34 OECD nations, or roughly to the middle of the pack on par with France. (See Table 1, and for a complete breakdown by OECD member country see table 6 on page 29.)

In the second, middle-range scenario, we explore the effects of raising the achievement of U.S. children to match that of the children of our neighbors to the immediate north in Canada. This adjustment lifts the combined U.S. math and science PISA score from 978 to 1044 (the Canadian average) and improves the nation's relative ranking from 24th to 7th, tied with Canada.

In the third and most ambitious scenario, the economic consequences of completely closing educational achievement gaps between U.S. children from lower and higher socioeconomic backgrounds are estimated. In particular, the PISA test scores of the bottom three quartiles of socioeconomically disadvantaged U.S. children are raised so that they match the PISA test scores of the most advantaged quartile of U.S. children. This increases the combined U.S. math and science score to 1,080 and raises the U.S. academic standing to third best among the OECD countries, behind only South Korea and Japan.

TABLE 1

Setting Targets to Improve U.S. Educational Outcomes

Educational improvements, measured by PISA scores, under three different scenarios, among the 34 member nations of the Organisation for Economic Co-operation and Development.

Country	Current score		Scenario 1:		Scenario 2:		Scenario 3:	
	No change		Matching OECD average PISA score		Matching Canadian PISA score		Matching top quatrile U.S. PISA score	
	PISA score	Rank	PISA score	Rank	PISA score	Rank	PISA score	Rank
OECD average	995		995		955		955	
U.S.	**978**	**24th**	**995**	**19th**	**1044**	**7th**	**1080**	**3rd**

Source: OECD (2014), PISA 2012 Results: What Students Know and Can Do—Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201118-en, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

The paper then summarizes the reductions in disparities in educational outcomes under each of the three scenarios. It reports the gap in outcomes on the PISA tests scores between children in the top and bottom quartile of family socioeconomic status as a percentage of the average PISA score. (See Table 2.)

TABLE 2

The Results of Reaching New Targets for U.S. Educational Outcomes

Changes in disparities in educational outcomes, measured by the PISA score gap, under three different scenarios.

Country	Current score		Scenario 1:		Scenario 2:		Scenario 3:	
	No change		Matching OECD average PISA scores		Matching Canadian PISA scores		Matching top quatrile U.S. PISA score	
	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank
OECD average	17.9%		17.9%		17.9%		17.9%	
U.S.	**18.6%**	**21st**	**16.0%**	**11th**	**13.2%**	**6th**	**0.0%**	**1st**

Source: Table M8. Average scores of 15-year-old students on PISA mathematics literacy scale, by national quarters of the PISA index of economic, social and cultural status (ESCS) and education system: 2012 available at http://nces.ed.gov/surveys/pisa/pisa2012/pisa2012highlights_3d.asp and Table S8. Average scores of 15-year-old students on PISA science literacy scale, by national quarters of the PISA index of economic, social and cultural status (ESCS) and education system: 2012 available at http://nces.ed.gov/surveys/pisa/pisa2012/pisa2012highlights_4f.asp, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

Under scenario one, the education gap is reduced from 18.6 percent to 16 percent, and the U.S. ranking on equity improves from 21st to 11th out of the 34 OECD nations. Under the second scenario, the gap falls to 13.2 percent and the U.S. ranking rises to 6th. The third scenario completely closes the educational achievement gap between students from different socioeconomic background, and the United States ranks first among the OECD countries in the equality of educational outcomes.

The paper then demonstrates how the reduction in educational achievement gaps in the United States translates into stronger economic growth over the next 35 years and 60 years. Tables 3 and 4 summarize the economic consequences of raising academic achievement and narrowing educational achievement gaps.

TABLE 3

The Economic Consequences of Improving U.S. Educational Outcomes Over the Next 35 and 60 Years

Changes in economic growth due to rising educational achievement under three scenarios, 2015 to 2050 and 2015 to 2075.

Outcomes	Scenario 1:	Scenario 2:	Scenario 3:
2050	Matching OECD average PISA score	Matching Canadian PISA score	Matching top quatrile U.S. PISA score
Increase in GDP in 2050 in %	1.7%	6.7%	10.0%
Increase in GDP in 2050	$678 billion	$2.7 trillion	$4.0 trillion
Cumulative increase of present value GDP growth* 2015-2050	$2.5 trillion	$10.0 trillion	$14.7 trillion

2075			
Increase in GDP in 2075 in %	5.8%	24.5%	37.7%
Increase in GDP in 2075	$4.1 trillion	$17.3 trillion	$26.7 trillion
Cumulative increase of present value GDP growth* 2015-2075	$14.0 trillion	$57.4 trillion	$86.5 trillion

* present value GDP growth is the current dollar value of future increases in GDP and allows for comparisons with GDP today.

Source: OECD (2014), "PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science" (2014 Volume I, Revised edition,). http://dx.doi.org/10.1787/9789264201118-en Calculations by the Washington Center for Equitable Growth based on 0.09, 0.37, and 0.54 standard deviation improvements in PISA scores (see methodology for details).

Under scenario one, the inflation-adjusted size of the U.S. economy in 2050 would be 1.7 percent, or $678 billion, larger. The cumulative increase in real GDP (after factoring in inflation) between 2015 and 2050 would amount to $2.5 trillion in present value, or PV, the current dollar value that is equivalent to the future GDP increases calculated by the model, which allows for a comparison of future values of GDP to current values of GDP.[2] This amounts to an average of over $72 billion per year. The economic effects of raising and narrowing achievement gaps build upon themselves so that over time the growth consequences are increasingly magnified. By 2075, when the effects of policy reforms required to reach this first scenario are fully phased in, the U.S. economy would be 5.8 percent, or $4.1 trillion, larger than it would otherwise be, and the cumulative increase in GDP over the 60-year period from 2015 to 2075 would amount to $14 trillion in present value, an average of $234 billion per year.

If American children matched the academic achievement of Canadian kids, then economic growth would be significantly larger. In 2050 the U.S. economy would be 6.7 percent, or $2.7 trillion, larger. The cumulative increase in GDP between 2015 and 2050 would amount to nearly $10 trillion in present value, $285 billion on average per year. In 2075, the real U.S. GDP would be 24.5 percent, or $17.3 trillion, larger, and the cumulative increase between 2015 and 2075 would sum to over $57 trillion in present value GPD, an average of $956 billion per year.

Finally, if achievement gaps between children from different socioeconomic backgrounds were completely closed, then the U.S. economy would be 10 percent, or $4 trillion, larger in 2050. The cumulative increase in GDP by 2050 would amount to $14.7 trillion in present value, or $420 billion per annum. In 2075, once policy reforms have fully taken effect, the real U.S. GDP would be 37.7 percent, or $26.7 trillion, larger, and the cumulative increase in present value GDP over 60 years would sum to $86.5 trillion, an average of over $1.4 trillion per year.

These results demonstrate that investments targeted at raising academic achievement and narrowing achievement gaps generate large returns in the form of economic growth. The increases in present value economic growth described above suggest the size of potential policy investments that would pay for themselves in the form of growth over the next 60 years and beyond.

Narrowing or closing achievement gaps would also have significant positive consequences for future federal, state, and local revenues. Over the first 35 years, these

TABLE 4

The Economic Consequences of Improving U.S. Educational Outcomes Over the Next 35 and 60 Years

Changes in government revenues, due to rising educational achievement, under three scenarios, 2015 to 2050 and 2015 to 2075.

Outcomes	Scenario 1:	Scenario 2:	Scenario 3:
2050	Matching OECD average PISA score	Matching Canadian PISA score	Matching top quatrile U.S. PISA score
Cumulative increase in all present value* federal and state and local revenues 2015-2050	$902 billion	$3.6 trillion	$5.3 trillion
Cumulative increase in Social Security revenues 2015-2050	$256 billion	$1.0 trillion	$1.5 trillion
Cumulative increase in Medicare revenues 2015-2050	$77 billion	$306 billion	$452 billion
2075			
Cumulative increase in all present value* federal and state and local revenues 2015-2075	$5.2 trillion	$21.5 trillion	$32.4 trillion
Cumulative increase in Social Security revenues 2015-2075	$2.5 trillion	$10.4 trillion	$15.8 trillion
Cumulative increase in Medicare revenues 2015-2075	$767 billion	$3.2 trillion	$4.8 trillion

* present value federal and state and local revenues is the current dollar value of future increases in revenues and allows for comparisons with revenues today

Source: OECD (2014), PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201118-en and calculations by the Washington Center for Equitable Growth based on 0.09, 0.37, and 0.54 standard deviation improvements in PISA scores (see methodology for details).

would sum to $902 billion in PV federal, state, and local revenues under scenario one, $3.6 trillion under scenario two, and $5.3 trillion under scenario three. Over 60 years, the consequences would be significantly larger. Federal, state, and local revenues would sum to $5.2 trillion (scenario one), $21.5 trillion (scenario two), and $32.4 trillion (scenario three), all expressed in present value. (See Table 4.)

Thus, public policy investments that raised academic achievement as described under the three scenarios and that cost less than an average of $87 billion, $358 billion, and $540 billion over each of the next 60 years would more than pay for themselves in budgetary terms. To put these revenue figures in perspective, consider that the entire budget for the federal Department of Education in 2013 was $72 billion. Keep in mind, as well, that these revenue increases are not a function of tax rate increases. Instead they are the additional revenues that would accrue to governments because U.S. GDP would be larger and Americans would be earning more income and paying taxes on their additional income.

The increased growth and subsequent revenue increases will enable us to more easily sustain public retirement benefit programs such as Medicare and Social Security. Improving educational outcomes, for example, would lift Social Security tax contributions by $256 billion, $1 trillion, and nearly $1.5 trillion under the three scenarios by 2050.[3] Similarly, Medicare tax revenues for the Hospital Insurance Fund would increase by $77 billion, $306 billion, and $452 billion under the three scenarios from 2015 to 2050, providing a substantial boost to Medicare solvency.[4] Revenues for Social Security and Medicare would be substantially larger by 2075.

TABLE 5

The Reduction in Income Inequality from Narrowing Educational Achievement Gaps

Increases in lifetime earnings, due to rising educational achievement, under three scenarios.*

Quartiles	Scenario 1:	Scenario 2:	Scenario 3:
	Matching OECD average PISA score	Matching Canadian PISA score	Matching top quatrile U.S. PISA score
Bottom quartile	4.3%	10.9%	22.0%
Third quartile	4.3%	11.5%	17.0%
Second quartile	4.3%	8.5%	9.3%
Top quartile	0.0%	6.4%	0.0%

* These effects are calculated under the three scenarios for children who complete their schooling 20 years from the start of the necessary policy reforms (in 2035) because it is assumed that it takes 20 years for the academic reforms to be fully phased in. Children who complete their schooling prior to 2035 would experience only a part of the increase in lifetime earning.

Source: OECD (2013), PISA 2012 Results: Excellence Through Equity: Giving Every Student the Chance to Succeed (Volume II), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201132-en, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

The benefits of closing educational achievement gaps also would reduce income inequality. These effects are calculated under the three scenarios for children who complete their schooling 20 years from the start of the necessary policy reforms (in 2035) because it is assumed that it takes 20 years for the academic reforms to be fully phased in. Children who complete their schooling prior to 2035 would experience only a part of the increase in lifetime earnings. (See Table 5.)

Under scenario one, the lifetime earnings of children from the bottom three quartiles of socioeconomic status would increase by an additional 4.3 percent. Under scenario two, all children would earn more, although the increases are smallest for children with the highest socioeconomic status and thus income inequality would be reduced. Finally, under the third scenario, the increase in lifetime earnings for children in the bottom three quartiles of socioeconomic status would be very large: 22 percent, 17 percent, and 9.3 percent respectively.

The benefits of closing educational achievement gaps would also reduce income inequality.

As explained in greater detail later in the report, these economic and tax benefit projections understate the impact of raising achievement gaps for at least four reasons. First, under scenarios one and three, they assume that educational achievement improvements are limited to children in the lower three quartiles of socioeconomic status, but in the real world policies that increase these children's educational achievement are likely to improve all children's achievement and further enhance growth.

Second, the model does not take into account any of the social benefits—such as better health outcomes—that are likely to occur as a result of educational improvement. Third, the model may be understating growth effects because it assumes that improvements in the educational achievement of children in the bottom three quartiles of socioeconomic status have the same impact on growth as do equal sized improvements in the educational achievement of the average child. Yet there is evidence that raising skills at the bottom improves growth more than raising skills at the top.[5] Finally, the model does not calculate the potential positive effects on children born to future parents who, because of improved academic achievement, will have higher incomes and thus be able to provide them better educational opportunities.

If the model properly accounted for all of these factors, the benefits of improving educational achievement would be larger than those estimated in this study. Yet by a similar logic, the projections overstate the reductions in economic inequality. Helping the most disadvantaged students improve their educational outcomes will likely

improve the educational outcomes of all children and thus raise the incomes of the most advantaged children as well as temper reductions in income inequality.

Closing the socioeconomic gaps in education

The potential economic gains described above illustrate in stark terms the waste of human talent and opportunity that we risk if achievement is not raised and gaps are not narrowed. They also suggest the magnitude of the public investments we should be willing to make now and in the decades to come to achieve these goals. Even from a narrow budgetary perspective, the tax revenue gains this study forecasts suggest that many investments to raise achievement and close educational achievement gaps could amply pay for themselves in the long run.

The report provides numerous examples of effective public policy strategies that promote equitable growth to illustrate that there are many ways of doing so, though their details are left to future research. Broadly, these public policy strategies fall into three categories:

- Early childhood care and education
- Criminal justice reform
- Family friendly workplaces

Completely closing socioeconomic-based educational achievement gaps will not happen instantly, but we can begin to narrow them immediately. As the report details, we already know many of the reasons these gaps exist and policies that can help close them. Thus, we can begin to experience some of the economic gains described in this report as policies that successfully narrow achievement gaps are implemented. Raising achievement and closing socioeconomic-based educational gaps is about not only reducing the degree of inequality in our society and promoting more widely shared economic growth but also inducing faster economic growth. In short, it is about promoting equitable growth.

Economic performance and socioeconomic-based educational achievement gaps

There are several measures of income and various datasets that can illustrate the relatively strong performance of the U.S. economy in the three decades immediately following World War II in contrast to its weaker performance over the past four decades. One of the most useful datasets for describing long-run trends is the U.S. Census Bureau's annual Current Population Survey because it provides statistics on family income that go back to 1947.[6] For the 27 years between 1947 and 1973, family incomes throughout the distribution—rich, poor and middle class families—roughly doubled in inflation-adjusted terms.

By comparison, for the 40 years between 1973 and 2013, inflation-adjusted average family income grew by about only one third, with that growth unevenly distributed. The average income of the bottom 20 percent of families fell by more than 8 percent, the average income of the middle 20 percent grew less than 15 percent, and the average incomes of the top 20 percent and top 5 percent grew by roughly 60 percent and 80 percent, respectively over the period.

Arguably, then, a restoration of the growth pattern that characterized the first three post-war decades would result in both greater and more equitably shared economic growth. But how can this restoration be brought about? A strong consensus among economists exists that educational achievement and attainment are key determinants of both overall economic growth and the earnings of individuals. And as Sean Reardon, a professor at Stanford University's Center for Education Policy Analysis, aptly notes, "the socioeconomic status of a child's parents has always been one of the strongest predictors of the child's academic achievement and education attainment."[7] Thus, addressing socioeconomic-based educational achievement gaps is one of the best ways to raise academic achievement and promote faster and more widely shared economic growth.

Researchers have long recognized the substantial positive association between socioeconomic status and student academic achievement. In 1966, the Coleman

Report identified family socioeconomic background—defined by various characteristics such as the occupation, educational attainment, and possessions of the parents—as a powerful predictor of a child's academic success.[8] The study generated and analyzed data that demonstrated wide gaps in the academic achievement of children from different socioeconomic backgrounds. In general, the report found that the lower a child's family socioeconomic status, the lower that child's academic achievement.

More recently, education professor Greg Duncan at the University of California-Irvine and co-author Katherine Magnuson at the University of Wisconsin-Madison, find that children in the bottom fifth of family socioeconomic status score more than "one standard deviation" lower on math and reading tests when they begin kindergarten than children from families in the top fifth of socioeconomic status.[9] This means these kids are the equivalent of several years behind in academic skills in comparison to their better-off classmates before they even begin formal schooling.

Duncan and Magnuson also report there is no evidence that these less-well-off children catch up with their peers once in school. They find these achievement gaps are not reduced by attending school at least through the 5th grade, suggesting that these gaps develop early in life and persist through their school years. Yet other research suggests that socioeconomic-based gaps in cognitive ability are insignificant among children who are less than one year of age. In recent analyses of tests of the cognitive ability of infants aged approximately nine months, reported in the Early Childhood Longitudinal Survey, economics professors Roland Fryer at Harvard University and Steven Levitt at the University of Chicago find that there were no statistically significant differences in the outcomes of children in the bottom and top quintiles of socioeconomic status.[10]

Specifically, the two researchers report that test score differences between children in the top 20 percent and bottom 20 percent of socioeconomic status were only 0.08 standard deviations apart, too small to be meaningful. These small differences are particularly notable given that low birth weights are more common among children with low socioeconomic status and are strongly associated with poor cognitive outcomes.[11] And in fact, when Fryer and Levitt control for low birth weight, the achievement gap differences become even smaller.

By age two, however, the cognitive ability gap between the top and bottom quintiles of toddlers by socioeconomic status grew to nearly 0.5 standard deviations, a substantively and statistically significant difference. These findings, when consid-

ered in combination with the findings of professors Duncan and Magnuson, suggest that socioeconomic-based cognitive achievement gaps may develop primarily after age one but before age five, when children enter kindergarten.

Socioeconomic-based achievement gaps have also been increasing over time. Stanford's Reardon recently analyzed data on the math and reading skills of U.S. children from 19 national studies that followed various generations of children born in the mid 1940s through 2001.[12] Consistent with the findings of Duncan and Magnuson, he found large, math and reading socioeconomic-based achievement gaps that exceeded one standard deviation for children born in the 1990s through 2001.

Socioeconomic achievement gaps have been increasing over time.

Moreover, Reardon finds that the math and reading achievement gaps widened substantially over time. For children born in 2001, achievement gaps were roughly 75 percent larger than they were for children born in the mid 1940s and 30 to 40 percent larger than they were for children born in the mid 1970s. Reardon reports that the income-based achievement gap among children born in 2001 was more than twice the size of the black-white achievement gap, whereas the gap was half its size 50 years earlier.

In addition, Reardon finds that the income-based achievement gap was stable across school-age children within these cohorts, suggesting that there is no narrowing or widening of socioeconomic-based achievement gaps as children progress through school from kindergarten through to their senior year of high school. Reardon's findings are consistent with the more age-limited findings of Duncan and Magnuson described above.

Yet the fact that test score differences between children from lower and higher socioeconomic status are large (over one standard deviation) and fairly constant from kindergarten through 12th grade does not necessarily imply that formal schooling has no positive (or negative) effects on the inequality of educational outcomes. On the contrary, schools may matter a great deal and it is possible that school policies have significantly lessened or intensified socioeconomic-based achievement differences.

Nor do stable test score differences from kindergarten through 12th grade necessarily mean that the practical implications of inequality in educational outcomes remain constant. Reardon reports that data from the National Assessment of Educational Progress show that the typical student gains 1.2 to 1.5 standard deviations in math and reading test scores between fourth and eighth grade but only 0.6 to 0.7 standard deviations in

math and reading scores between eighth and twelfth grade.[13] Hence, an achievement gap between low and high socioeconomic status children of 1.2 standard deviations may be the equivalent of four years of learning in the 8th grade but much more than four years of learning when children are in 12th grade.

In short, it is possible that socioeconomic achievement gaps have not only widened over the past seven decades, as Reardon documents, but also that these gaps may be effectively widening, measured in terms of years of learning, as children progress through school. By adversely affecting academic achievement, socioeconomic disparities weaken overall economic growth and undermine individual earnings.

Factors that cause educational achievement gaps

Educational achievement gaps between children with high and low socioeconomic status are large and growing. Children raised in poor, low-income families do worse on achievement tests than children raised in wealthy, high-income families—and the gap between them has been getting larger over the past seven decades. What are some of the factors that explain why children from wealthy families do better on achievement tests than do children from moderate or low-income families?

Researchers identify a multitude of reasons for the existence of these gaps, but they can broadly be explained by various inequalities that influence educational outcomes. Stanford University psychology professors Anne Fernald, Virginia A. Marchman, and Adriana Weisleder find significant differences in the vocabulary and language processing of 18-month-old infants among low- and high-income families.[14] They find that by age two, children from low socioeconomic backgrounds were already six months behind children from high socioeconomic backgrounds in skills critical to language development and subsequent learning.[15]

Similarly, in their 2003 book "Meaningful Differences in the Everyday Experiences of Young American Children," the late researcher Betty Hart and psychology professor Todd Risley, both at the University of Kansas, estimated that by age three, children from low-income families have heard 30 million fewer words than have children from upper-income families.[16] Low-income parents tend to have less education and thus a smaller vocabulary that they can direct at their infants and then engage with them as toddlers compared to higher-income parents.

What's more, low-income parents also have fewer means and opportunities to provide educationally stimulating environments outside of school. University of California-Los Angles sociologist Meredith Phillips finds that by age six, wealthier children have spent 1,300 more hours than poor children participating in a broad array of enrichment activities outside of school, such as music lessons, travel, and summer camp.[17] These activities are associated with greater educational achievement later in life.

Then there is the influence of home life on educational outcomes.

Then there is the influence of home life on educational outcomes. Researcher Petra Todd at the University of Pennsylvania's Population Studies Center, and Kenneth Wolpin, the chair of the university's economics department, examined the impact on test scores of conditions at a student's home—such as the number of books they own, how often mothers read to them as young children, how often students were taken to museums and theatrical performances, and how often they received lessons outside of school or participated in extracurricular activities involving sports, arts, drama, or dance. They found that these home inputs have a statistically significant and substantively positive impact on test scores.[18]

These home inputs are strongly correlated with socioeconomic status. Wealthier families invest more in their children than do poor families by investing in more of these inputs and spending more time in the care of their children. In addition, differences in the financial investments in children have become more pronounced over time. Education professors Greg Duncan at the University of California-Irvine and Richard Murnane at Harvard University recently examined this kind of spending between the early 1970s and 2006. They report that in the 1970s families in the top quintile of income spent $2,700 more per child, or about four times as much, on the enrichment of their children as did families in the bottom quintile of income ($3,536 versus $835). By 2006, the spending gap had nearly tripled to $7,500 per child, with families in the top quintile spending nearly seven times as much on the educational enrichment of their children as did families in the bottom quintile ($8,872 versus $1,325).[19]

A similar pattern emerges with respect to the investment of parental time in children. Economists Jonathan Guryan and Erik Hurst at the University of Chicago and University of Maryland's Melissa Kearney document that higher-earning and higher-educated parents spend more time engaging with their children, actively caring, teaching, and playing with them.[20]

Making matters worse, children from lower-income families receive less public investment in their schooling and experience less stimulating environments in school than do children from upper income families. In the 2011 report by the Organisation for Economic Co-operation and Development titled "Strong Performers and Successful Reformers in Education: Lessons from PISA for the United States," the OECD finds that the United States is one of three nations among the 34 OECD members

> *in which socio-economically disadvantaged schools have to cope with less favorable student-teacher ratios than advantaged schools, which implies that most*

disadvantaged students may end up with the least resources and the students who come to school with the greatest advantages get the most resources […] In addition, the United States is now virtually alone among the OECD countries in having a system in which its citizens can organize school taxing districts that set their own tax rates and in which […] it is the more advantaged students who tend to enjoy a higher proportion of better-qualified teachers and who tend to get the best of other resources as well.[21]

In general, low-income children educated in economically and geographically segregated schools with high percentages of other low-income children perform worse on achievement tests than do low-income children educated in less economically and geographically segregated, lower-poverty schools.

A case in point is a study by Rand Corporation researcher Heather Swartz, who studied low-income children in Montgomery County, Maryland. She found that low-income children who attended lower-poverty schools far outperformed low-income children who attended higher-poverty schools in math and reading.[22] Other researchers demonstrate that poor, segregated neighborhoods and schools have less access to key resources crucial to children's success, such as low crime rates, experienced and appropriately credentialed teachers, adequate schools, and parks and other green spaces.[23]

This array of educational inequalities aligns with other indicators of economic inequality. UC-Irvine's Duncan and George Farkas and co-author Katherine Magnuson at the University of Wisconsin find that children in the United States from poor families are two to four times more likely than children from wealthy families to have classmates in kindergarten through twelfth grade with low cognitive skills and behavioral problems,[24] attributes that are likely to complicate classroom management challenges for teachers and have negative effects on child learning. Moreover, children attending schools in low-income neighborhoods are less likely to be exposed to rigorous curricula, such as science and mathematics courses.[25]

Similarly, school and housing segregation by race and ethnicity, which are related to low socioeconomic status because children of color are disproportionately from lower-income families, weaken the academic achievement of black and Hispanic children. Researchers David Card and Jesse Rothstein at the University of California-Berkeley find that neighborhoods with higher levels of segregation experience greater gaps in white-black SAT scores. The authors conclude that the differences in the white-black test gap in unsegregated neighborhoods are more than 20 percent smaller than those in highly segregated neighborhoods.[26]

In addition to being more likely to be born into low-income families that reside in high-poverty neighborhoods and to attend high-poverty schools with less experienced and qualified teachers, children of color also suffer various forms of racial and ethnic discrimination that may further undermine achievement. In schools and in the justice system, for example, children of color often receive harsher penalties for the same rule violations than do white children.[27] Children of color are also less likely to be tested, diagnosed, and treated for illnesses and learning disabilities that influence their school performance.[28]

Children of color are less likely to be tested, diagnosed, and treated for illnesses and learning disabilities.

These inequalities in socioeconomic status and a multitude of other factors are closely intertwined in ways that affect academic achievement. Evidence from neuroscience and developmental psychology suggests that early childhood is an especially sensitive period for a child's brain development.[29] During this time, brain circuitry develops that underpins children's abilities for cognition, attention, and stress management. Research also establishes that children's experiences with their primary caregivers strongly influence the course of that brain development, with stressed, emotionally unavailable, and non-stimulating caregivers undermining it.[30]

Moreover, economic disadvantage in early childhood has strong associations with parents' psychological distress and the emotional support and cognitive stimulation they provide their young children.[31] The stress of low-income parents also is linked to the stress of living in relatively poor, high-crime neighborhoods.[32] Thus, income gaps contribute to gaps in effective parenting and to parents' psychological health, which lead to gaps in young children's social, psychological, and emotional development, as well as to gaps in their later-life educational outcomes.

In particular, stresses in the early childhood years can damage the capacity to develop a variety of personality traits, among them self control, persistence, tenacity, motivation, discipline, dependability, the ability to get along with others, and trustworthiness that can affect cognitive ability.[33] Indeed, there is a growing body of research that finds these non-cognitive social, psychological, and emotional skills, or so-called soft skills, may be just as important to success in life as are cognitive skills.[34]

This paper turns next to the importance of developing human capital through improved educational achievement and what that, in turn, can do to improve economic growth.

Human capital, educational achievement, and economic growth

Understanding the basis and sources of economic growth and the factors that bring about national affluence has been at the center of economic study for centuries. Indeed, understanding the meaning and causes of prosperity is at the heart of Adam Smith's seminal 1776 work, appropriately titled "An Inquiry into the Nature and Causes of the Wealth of Nations." Over the decades and across countries, theoretical and empirical investigations into the causes of long-run economic growth have produced a large and growing body of research that finds human capital to play a pivotal role in economic growth and the material well-being of people and nations.[35]

Human capital refers to people's knowledge, skills, health, and habits. Higher levels of human capital are associated with greater earnings and productivity. Thus, expenditures on education, training, and health care are considered investments in human capital, as they enhance humans' earnings and productive capacity. The largest economic effects of these investments are those associated with education. Many studies show that educational attainment—the number of school years completed—correlates closely with both individual earnings and economic growth.[36]

In general, more education is associated with higher individual earnings. In particular, studies within and across nations find that an additional year of schooling translates into a roughly 10 percent increase in annual individual earnings.[37] Aside from this individual benefit, there is further evidence that additional years of schooling provide social benefits in the forms of improved health, higher levels of civic participation, lower crime rates, and—most importantly for this analysis—greater economic growth. [38]

Increased educational attainment improves economic growth

The theoretical basis for the relationship between additional schooling and economic growth is straightforward. Educational attainment increases human capital, resulting in the enhanced productivity of a nation's workforce, increases the rate of

technological innovation, and facilitates the diffusion and adoption of new production techniques, all of which help boost economic growth.[39]

Empirical research supports these theoretical conclusions. Numerous studies over the years find statistically significant and positive associations between years of schooling and the economic growth of national economies. Each additional year of schooling is associated with greater long-run economic growth rates. Yet the magnitude of the impact that additional years of schooling have on economic growth varies considerably from study to study.[40]

Educational attainment versus educational achievement as measures of human capital

A drawback of studies and models that use years of schooling as proxies for human capital is that they implicitly assume that one year of schooling in every school in every country provides the same increase in human capital as one year of schooling in any other school in any other country. Moreover, such models assume that schools are the main or only source of the education and skills that lead to the expansion of human capital. They do not take into account the facts that school quality varies within and across countries, and that non-school factors—such as health, environment, access to opportunities, family characteristics, and community structure—have important effects on skills and, thus, human capital development.

Instead of using school attainment as a proxy for human capital, a number of researchers now propose using measures of cognitive skills as a more appropriate proxy. In theory, cognitive skills should more accurately reflect the learning and abilities of workers because cognitive skills should depend not only on the time people spend in schools and the quality of those schools but also the education people acquire outside of formal schooling. Hence, cognitive skills used as a proxy for human capital in regression models should provide more accurate estimates of the effects of human capital on economic growth. Indeed, a body of research developed over the past two decades suggests that cognitive skills are a better measure of human capital than years of schooling.[41]

Generally, this research proposes using scores on internationally administered achievement tests, such as the math and science tests from the Programme for International Student Assessment, or PISA, as indicators of cognitive achievement

and, thus, as proxies for human capital. This method of research then investigates the relationship between cognitive skills and economic growth.

When cognitive skills are included in regression models, the association between years of schooling and economic growth drops to nearly zero—and becomes statistically insignificant—while the association between cognitive skills and economic growth is highly significant, both in a statistical and economic sense. In other words, what appears to matter for economic growth is not how much time children spend in school but rather the knowledge, skills, and work habits they acquire both in and out of school. As Eric Hanushek, an economist and Senior Fellow at the Hoover Institute at Stanford University, and economist Ludger Woessmann at the University of Munich note in a recent paper, the strong, positive effect of cognitive skills on economic growth "dwarfs the association between quantity of education and growth."[42]

What matters for economic growth is not how much time children spend in school bur rather the knowledge, skills, and work habits they acquire both in and out of school.

These recent findings may be confusing to some who think of eliminating education gaps in the more traditional sense—as an exercise in giving children from lower income families the same educational attainment as children from higher income families. Equalizing educational attainment has often been defined as ensuring that disadvantaged children have as many years of schooling as advantaged children or that they graduate from high school or complete college at the same rates. The latest research suggests that what is important is academic achievement, which is related to educational attainment but also to a host of other factors, including income and wealth inequality, access to day care and preschool programs, the number of books in the home, nutrition, health, neighborhood safety, exposure to lead paint and other environmental factors, interaction with the criminal justice system, and the emotional and psychological stress of parents and children.

This implies that there is a wide range of policies that could be effective in closing educational achievement gaps. Before exploring some of the ways in which the United States could close these achievement gaps based on assessments of cognitive skills, this study first calculates the payoffs to narrowing or closing the socioeconomic-based cognitive skills gap.

The economic and fiscal consequences of improving U.S. educational outcomes

This report uses a simulation model to estimate the economic effects of potential policy reforms under three scenarios that would improve the educational achievement of U.S. children and reduce disparities in educational outcomes among them. (See Methodology on page 45 for the details about the model.) The results suggest the extent to which appropriate policies could enhance economic growth and reduce economic inequality.

In the first scenario, the Programme for International Student Assessment, or PISA, math and science scores of the three quarters of U.S. children living in the most disadvantaged families are improved just enough so that the average U.S. PISA scores match the OECD average PISA scores in math and science.[43] This scenario raises the combined U.S. math and science PISA score from 978 to 995 (the OECD average) and improves the nation's relative ranking from 24th to 19th best out of the 34 OECD nations, or to roughly the middle of the pack.

The second scenario assumes policy reforms that raise U.S. achievement to equal that of Canada. This adjustment lifts the combined U.S. math and science PISA score from 978 to 1,044 (the Canadian average) and improves the nation's relative achievement ranking from 24th to 7th, tied with Canada and among the top quarter of nations. The third scenario, which raises the PISA scores of U.S. children from the bottom three quartiles to equal the scores of U.S. children in the top quartile of socioeconomic status, increases the average U.S. math and science PISA score to 1,080 and raises the U.S.'s academic standing to third best among the 34 OECD nations, behind only South Korea and Japan. (See Table 6.)

TABLE 6

Setting Targets to Improve U.S. Educational Outcomes

Educational improvements, measured by PISA scores, under three different scenarios based on PISA scores among the 34 member nations of the Organization for Economic Co-operation and Development.

Country	Current Score		Scenario 1:		Scenario 2:		Scenario 3:	
	No change		Matching OECD average PISA scores		Matching Canadian PISA scores		Matching top quatrile U.S. PISA score	
	PISA score	Rank	PISA score	Rank	PISA score	Rank	PISA score	Rank
OECD Average	995		995		995		995	
Australia	1026	10	1026	10	1026	11	1026	11
Austria	1011	15	1011	15	1011	16	1011	16
Belgium	1020	12	1020	12	1020	13	1020	13
Canada	1044	7	1044	7	1044	7	1044	8
Chile	868	33	868	33	868	33	868	33
Czech Republic	1007	17	1007	17	1007	18	1007	18
Denmark	999	18	999	18	999	19	999	19
Estonia	1062	4	1062	4	1062	4	1062	5
Finland	1064	3	1064	3	1064	3	1064	4
France	994	19	994	20	994	20	994	20
Germany	1038	9	1038	9	1038	10	1038	10
Greece	920	31	920	31	920	31	920	31
Hungary	971	26	971	26	971	26	971	26
Iceland	971	27	971	26	971	26	971	26
Ireland	1024	11	1024	11	1024	12	1024	12
Isreal	937	30	937	30	937	30	937	30
Italy	979	23	979	24	979	24	979	24
Japan	1083	2	1083	2	1083	2	1083	2
Korea, Republic	1092	1	1092	1	1092	1	1092	1
Luxembourg	981	21	981	22	981	22	981	22
Mexico	828	34	828	34	828	34	828	34
Netherlands	1045	6	1045	6	1045	6	1045	7
New Zealand	1015	13	1015	13	1015	14	1015	14
Norway	984	20	984	21	984	21	984	21
Poland	1043	8	1043	8	1043	9	1043	9
Portugal	976	25	976	25	976	25	976	25
Slovak Republic	953	29	953	29	953	29	953	29
Slovenia	1015	14	1015	14	1015	15	1015	15

Spain	981	21	981	22	981	22	981	22
Sweden	963	28	963	28	963	28	963	28
Switzerland	1046	5	1046	5	1046	5	1046	6
Turkey	911	32	911	32	911	32	911	32
United Kingdom	1008	16	1008	16	1008	17	1008	17
United States	**978**	**24**	**995**	**19**	**1044**	**7**	**1080**	**3**

Source: OECD (2014), PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201118-en, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

Reductions in the inequality of educational outcomes

We then summarize the reductions in disparities in educational outcomes under each of the three scenarios by reporting the gap in outcomes on the PISA tests scores between children in the top and bottom quartile of family socioeconomic status as a percentage of the average PISA score, by nation. Under scenario one, the education gap is reduced from 18.6 percent to 16 percent, and the U.S. ranking on equity improves from 21st to 11th out of the 34 OECD nations. Under the second scenario, the gap falls to 13.2 percent and the U.S. ranking rises to 6th. The third scenario completely closes the educational achievement gap between students from different socioeconomic background, and the U.S. ranks first among the OECD countries in the equality of educational outcomes. (See Table 7.)

TABLE 7

The Results of Reaching New Targets for U.S. Educational Outcomes

Changes in disparities in educational outcomes, measured by the PISA score gap) under three different scenarios.

Country	Current Score		Scenario 1:		Scenario 2:		Scenario 3:	
	No change		Matching OECD average PISA scores		Matching Canadian PISA scores		Matching top quatrile U.S. PISA score	
	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank	75-25 gap (% of average)	Rank
OECD Average	17.9%		17.9%		17.9%		17.9%	
Australia	17.1%	14	17.1%	15	17.1%	15	17.1%	15
Austria	19.2%	24	19.2%	24	19.2%	24	19.2%	24
Belgium	20.6%	26	20.6%	26	20.6%	26	20.6%	26
Canada	13.2%	6	13.2%	6	13.2%	6	13.2%	7
Chile	22.2%	28	22.2%	28	22.2%	28	22.2%	28
Czech Republic	19.0%	22	19.0%	22	19.0%	22	19.0%	22

Denmark	17.5%	17	17.5%	18	17.5%	18	17.5%	18
Estonia	11.3%	1	11.3%	1	11.3%	1	11.3%	2
Finland	12.6%	3	12.6%	3	12.6%	3	12.6%	4
France	24.0%	32	24.0%	32	24.0%	32	24.0%	32
Germany	19.2%	25	19.2%	25	19.2%	25	19.2%	25
Greece	19.0%	23	19.0%	23	19.0%	23	19.0%	23
Hungary	23.4%	31	23.4%	31	23.4%	31	23.4%	31
Iceland	13.4%	7	13.4%	7	13.4%	8	13.4%	8
Ireland	16.9%	13	16.9%	14	16.9%	14	16.9%	14
Isreal	24.2%	33	24.2%	33	24.2%	33	24.2%	33
Italy	15.1%	9	15.1%	9	15.1%	10	15.1%	10
Japan	13.1%	4	13.1%	4	13.1%	4	13.1%	5
Korea, Republic	12.2%	2	12.2%	2	12.2%	2	12.2%	3
Luxembourg	23.3%	30	23.3%	30	23.3%	30	23.3%	30
Mexico	14.7%	8	14.7%	8	14.7%	9	14.7%	9
Netherlands	15.9%	10	15.9%	10	15.9%	11	15.9%	11
New Zealand	22.9%	29	22.9%	29	22.9%	29	22.9%	29
Norway	13.2%	5	13.2%	5	13.2%	5	13.2%	6
Poland	17.6%	18	17.6%	19	17.6%	19	17.6%	19
Portugal	21.1%	27	21.1%	27	21.1%	27	21.1%	27
Slovak Republic	27.1%	34	27.1%	34	27.1%	34	27.1%	34
Slovenia	17.8%	19	17.8%	20	17.8%	20	17.8%	20
Spain	17.4%	16	17.4%	17	17.4%	17	17.4%	17
Sweden	16.1%	11	16.1%	12	16.1%	12	16.1%	12
Switzerland	17.2%	15	17.2%	16	17.2%	16	17.2%	16
Turkey	16.5%	12	16.5%	13	16.5%	13	16.5%	13
United Kingdom	18.0%	20	18.0%	21	18.0%	21	18.0%	21
United States	**18.6%**	**21**	**16.0%**	**11**	**13.2%**	**6**	**0.0%**	**1**

Source: Table M8. Average scores of 15-year-old students on PISA mathematics literacy scale, by national quarters of the PISA index of economic, social and cultural status (ESCS) and education system: 2012 available at http://nces.ed.gov/surveys/pisa/pisa2012/pisa2012highlights_3d.asp and Table S8. Average scores of 15-year-old students on PISA science literacy scale, by national quarters of the PISA index of economic, social and cultural status (ESCS) and education system: 2012 available at http://nces.ed.gov/surveys/pisa/pisa2012/pisa2012highlights_4f.asp, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

The economic consequences of raising achievement and narrowing gaps

With the results of the calculations in Tables 6 and 7, this model can then summarize several economic consequences of raising academic achievement and narrowing educational achievement gaps.

Under scenario one, the inflation-adjusted size of the U.S. economy in 2050 would be 1.7 percent, or $678 billion, larger. The cumulative increase in real GDP (after adjusting for inflation) between 2015 and 2050 would amount to $2.5 trillion in present value, or PV, the current dollar value that is equivalent to the future GDP increases calculated by the model, which allows for a comparison of future values of GDP to current values of GDP. This calculation results in an average of $72 billion per year. The economic effects of raising and narrowing achievement gaps build upon themselves so that over time the growth consequences are increasingly magnified. By 2075, when the policy reform effects are fully phased in, the U.S. economy would be 5.8 percent, or $4.1 trillion, larger than it would otherwise be, and the cumulative increase in GDP over the 60-year period from 2015 to 2075 would amount to $14 trillion in present value, an average of $234 billion per year (See Table 8.)

TABLE 8

The Economic Consequences of Improving U.S. Educational Outcomes Over the Next 35 and 60 Years

Changes in economic growth due to rising educational achievement under three scenarios, 2015 to 2050 and 2015 to 2075.

Outcomes	Scenario 1:	Scenario 2:	Scenario 3:
2050	Matching OECD average PISA score	Matching Canadian PISA score	Matching top quatrile U.S. PISA score
Increase in GDP in 2050 in %	1.7%	6.7%	10.0%
Increase in GDP in 2050	$678 billion	$2.7 trillion	$4.0 trillion
Cumulative increase of present value GDP growth* 2015-2050	$2.5 trillion	$10.0 trillion	$14.7 trillion
2075			
Increase in GDP in 2075 in %	5.8%	24.5%	37.7%
Increase in GDP in 2075	$4.1 trillion	$17.3 trillion	$26.7 trillion
Cumulative increase of present value GDP growth* 2015-2075	$14 trillion	$57.4 trillion	$86.5 trillion

* present value GDP growth is the current dollar value of future increases in GDP and allows for comparisons with GDP today.

Source: OECD (2014), "PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science" (2014 Volume I, Revised edition,). http://dx.doi.org/10.1787/9789264201118-en Calculations by the Washington Center for Equitable Growth based on 0.09, 0.37, and 0.54 standard deviation improvements in PISA scores (see methodology for details).

If American children matched the academic achievement of Canadian kids then the impact on GDP growth would be significantly larger. In 2050 the U.S. economy would be 6.7 percent, or $2.7 trillion, larger. The cumulative increase in GDP between 2015 and 2050 would amount to nearly $10 trillion in present value, $285 billion on average per year. In 2075, the real U.S. GDP would be 24.5 percent, or $17.3 trillion, larger, and the cumulative increase between 2015 and 2075 would sum to over $57 trillion in present value, an average of $956 billion per year.

Finally, if achievement gaps between children from different socioeconomic backgrounds were completely closed, then the U.S. economy would be 10 percent, or $4 trillion, larger in 2050. The cumulative increase in GDP by 2050 would amount to $14.7 trillion in present value or $420 billion per year. In 2075, once policy reforms have fully taken effect, the real U.S. GDP would be 37.7 percent, or $26.7 trillion, larger, and the cumulative increase in GDP over 60 years would sum to $86.5 trillion in present value, an average of over $1.4 trillion per year. (See Table 8.)

Thus, investments that raise academic achievement and narrow achievement gaps generate large returns in the form of economic growth. The increases in present value economic growth described above suggest the size of potential financial policy investments that would pay for themselves in the form of growth.

The fiscal consequences of raising achievement and narrowing gaps

Narrowing or closing education achievement gaps would also have significant positive consequences on federal, state, and local government revenues. Federal tax revenues over the first 35 years would increase by $498 billion, calculated by present value, in scenario one, $2 trillion in scenario two, and $2.9 trillion in scenario 3. State and local government revenues in present value would increase by another $403 billion, $1.6 trillion or $2.4 trillion, respectively. Thus, government investments in raising achievement and reducing gaps that cost less than $902 billion or $26 billion per year (scenario one), $3.6 trillion or $102 billion per year (scenario 2), and $5.3 trillion or $150 billion per year (scenario three) would pay for themselves in budgetary terms. (See Table 9.)

TABLE 9

The Economic Consequences of Improving U.S. Educational Outcomes Over the Next 35 and 60 Years

Changes in government revenues, due to rising educational achievement, under three scenarios, 2015 to 2050 and 2015 to 2075.

Outcomes	Scenario 1:	Scenario 2:	Scenario 3:
2050	Matching OECD average PISA score	Matching Canadian PISA score	Matching top quatrile U.S. PISA score
Cumulative increase in all present value* federal and state and local revenues 2015-2050	$902 billion	$3.6 trillion	$5.3 trillion
Cumulative increase in Social Security revenues 2015-2050	$256 billion	$1.0 trillion	$1.5 trillion
Cumulative increase in Medicare revenues 2015-2050	$77 billion	$306 billion	$452 billion
2075			
Cumulative increase in all present value* federal and state and local revenues 2015-2075	$5.2 trillion	$21.5 trillion	$32.4 trillion
Cumulative increase in Social Security revenues 2015-2075	$2.5 trillion	$10.4 trillion	$15.8 trillion
Cumulative increase in Medicare revenues 2015-2075	$767 billion	$3.2 trillion	$4.8 trillion

* present value federal and state and local revenues is the current dollar value of future increases in revenues and allows for comparisons with revenues today

Source: OECD (2014), PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201118-en and calculations by the Washington Center for Equitable Growth based on 0.09, 0.37, and 0.54 standard deviation improvements in PISA scores (see methodology for details).

Over 60 years, the rise in revenues would be significantly larger. Additional federal, state, and local revenues would accumulate to $5.2 trillion (scenario 1), $21.5 trillion (scenario 2), and $32.4 trillion (scenario 3), all expressed in present value. Hence, public policy investments that improved and equalized academic achievement, as described under the three scenarios, and that cost less than an average of $87 billion, $358 billion, and $540 billion over each of the next 60 years, would more than pay for themselves in budgetary terms.

The benefits of raising cognitive achievement and closing educational achievement gaps would amount to more than just the increased GDP and tax revenues described above. The current generation of children would be better off when they are adults because they will have higher earnings, higher material standards of living, and, presumably, an enhanced quality of life. Future generations of children would be more likely to grow up in families that can offer them the enriching opportunities of a middle-class lifestyle—and would therefore be less likely to grow up in families struggling in poverty. Present day adults, whether working or in retirement, would benefit from the fact that higher-earning workers will be better able to financially sustain public retirement benefit programs such as Medicaid, Medicare, and Social Security.

The retirement of the Baby Boomers will put pressure on the federal budget in the coming decades, especially between now and 2050, as more retirees draw from these benefit programs. Investing in the nation's educational achievement will provide future budget relief as Americans earn more and, thus, pay more in taxes. Improving educational outcomes would lift Social Security tax contributions by $256 billion, $1 trillion, and nearly $1.5 trillion under the three scenarios by 2050.[44] Similarly, Medicare tax revenues for the Hospital Insurance Fund would increase by $77 billion, $306 billion, and $452 billion under the three scenarios from 2015 to 2050, providing a substantial boost to Medicare solvency.[45] The revenue impacts for Social Security and Medicare are substantially larger by 2075.

In short, strengthening the educational achievement of our youth will help provide economic security for us, our elderly, and our future generations.

Reductions in income inequality

The benefits of closing educational achievement gaps would also reduce income inequality. This report summarizes these effects under the three scenarios for children who complete their schooling twenty years from the start of the policy reforms (in 2035) because it is assumed that it takes 20 years for the academic reforms to be fully phased in. Children who complete their schooling prior to 2035 would experience only a part of the increase in lifetime earnings described in Table 10. (See Table 10.)

TABLE 10

The Reduction in Income Inequality from Narrowing Educational Achievement Gaps

Increases in lifetime earnings, due to rising educational achievement, under three scenarios.*

Quartiles	Scenario 1:	Scenario 2:	Scenario 3:
	Matching OECD average PISA scores	Matching Canadian PISA scores	Matching top quatrile U.S. PISA score
Bottom quartile	4.3%	10.9%	22.0%
Third quartile	4.3%	11.5%	17.0%
Second quartile	4.3%	8.5%	9.3%
Top quartile	0.0%	6.4%	0.0%

* These effects are calculated under the three scenarios for children who complete their schooling 20 years from the start of the necessary policy reforms (in 2035) because it is assumed that it takes 20 years for the academic reforms to be fully phased in. Children who complete their schooling prior to 2035 would experience only a part of the increase in lifetime earning.

Source: OECD (2013), PISA 2012 Results: Excellence Through Equity: Giving Every Student the Chance to Succeed (Volume II), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201132-en, and calculations by the Washington Center for Equitable Growth based on the PISA scores.

Under scenario one, the lifetime earnings of children from the bottom three quartiles of socioeconomic status would increase by an additional 4.3 percent. Under scenario two, all children would earn more, although the increases are smallest for children with the highest socioeconomic status and thus income inequality would be reduced. Specifically, children from the lowest or fourth quartile of socioeconomic status would see their lifetime earnings increase by 10.9 percent, those from the third quartile would experience an 11.5 percent increase, and children from the second quartile would observe an 8.5 percent increase in lifetime earnings, while children from the most advantaged quartile would experience a still substantial, but more modest, increase in lifetime earnings of only 6.4 percent. Finally, under the third scenario, the increase in lifetime earnings for children in the bottom three quartiles of socioeconomic status would be very large: 22 percent, 17 percent, and 9.3 percent respectively.

These economic and tax benefit projections understate the impact of raising achievement gaps for at least four reasons. First, under scenario one and three, they assume that educational achievement improvements are limited to children in the lower three quartiles of socioeconomic status. But in the real world, policies that increase these children's educational achievement are likely to improve all children's achievement and further enhance growth.

Second, the model does not take into account any of the social benefits—such as better health outcomes—that are likely to occur as a result of educational improvement. Third, the model may be understating growth effects because it

assumes that improvements in the educational achievement of children in the bottom three quartiles of socioeconomic status have the same impact on growth as do equal-sized improvements in the educational achievement of the average child. Yet there is evidence that raising skills at the bottom improves growth more than raising skills at the top.[46]

Finally, the model does not calculate the potential positive effects on children born to future parents who, because of improved academic achievement, will have higher incomes and thus be able to provide them better educational opportunities. If the model properly accounted for all of these factors, the benefits of improving educational achievement would be larger than those estimated in this study.

By a similar logic, the projections overstate the reductions in economic inequality under the first and third scenarios. Given that policy reforms, even those targeted at the most disadvantaged students, are likely to improve the educational outcomes of all children, they will raise the incomes of the most advantaged children and temper reductions in income inequality.

The potential economic gains described above illustrate in stark terms the waste of human talent and opportunity that we risk if achievement gaps are not raised and narrowed. They also suggest the magnitude of the public investments we should be willing to make now and in the decades to come to achieve these goals. Even from a narrow budgetary perspective, the tax revenue gains this study forecasts suggest that many investments to raise and close educational achievement gaps could amply pay for themselves in the long run. To those possible reforms we now turn.

The potential economic gains illustrate in stark terms the waste of human talent and opportunity we risk if achievement gaps are not raised and narrowed.

Conclusion

Many of the causes of socioeconomic-based educational achievement gaps are clear while others are becoming more evident as research into educational inequality from a variety of academic disciplines accumulates. These achievement gaps could be at least partially addressed by closing inequalities that exist in a wide variety of contexts. This could be done by decreasing income inequality, improving access to high-quality early education, reducing racial and ethnic segregation and other forms of discrimination, lessening housing segregation by income, equalizing home environments, reducing the impact of criminality on society, improving the quality of schools in low-income neighborhoods, and lessening parents' and children's' psychological distress.

All of these inequalities vary from location to location. Not surprisingly, then, educational achievement gaps already vary considerably by state. Two cases in point: the bottom 75 percent of children by socioeconomic status in Massachusetts have an average PISA math and science test score (1,003) that is higher than the U.S. average score (978) and exceeds the OECD average score (995) while the bottom 75 percent of children by socioeconomic status in Florida have an average score (917) well below the U.S. and OECD averages.

At the county level, too, differences in educational outcomes also are evident—sometimes in ways that demonstrate the advantages of addressing the achievement gap. After introducing all day kindergarten programs, reducing class size, investing in teacher development, lessening housing-based segregation in its schools, and a host of other reforms, Montgomery County, Maryland was successful in both improving average achievement test scores and reducing achievement gaps. The percentage of 5th graders reading at or above the proficient level on the Maryland State Assessment rose for all racial and ethnic groups between 2003 and 2009. In addition, gaps between the disproportionately lower-income black and Hispanic students and the disproportionately higher-income white and Asian students narrowed.[47]

So we already know that it is possible to significantly raise the scores of our most disadvantaged children. But what are the consequences of speeding up or drawing out these kinds of reform policies? And which policies would be most effective and efficient?

Let's first address the question of timing. Raising cognitive achievement while narrowing or closing socioeconomic-based academic achievement gaps would significantly boost economic growth and increase tax revenues. It would also take time. Raising achievement levels and fully phasing in the subsequent economic benefits of improved educational outcomes could take less, or more, years than our simulations propose. In general, the longer it takes to close achievement gaps and fully phase in the benefits of a better-educated population, the greater the cost in terms of the loss of potential economic benefits. A key finding of this study is that the costs of failing to close educational achievements gaps are enormous, and they will grow with time.

Raising cognitive achievement while narrowing or closing socioeconomic-based academic achievement gaps would significantly boost economic growth and increase tax revenues.

The benefits of tapering achievement gaps by improving the educational outcomes of children, particularly those on the lower rungs of the economic ladder, amount to more than just increased GDP and tax revenues. Investing in our children to improve cognitive skills has positive implications for both current and future generations of children as well as adults. The current generation of children will benefit from higher earnings, higher material standards of living, and an enhanced quality of life. Future generations will benefit because they will be more likely to grow up in families that can offer them the enriching opportunities of a middle-class lifestyle, and they will be less likely to grow up in families living in poverty. And adults—both those now working and in retirement—will eventually benefit from the fact that higher-earning workers will be better able to financially sustain our public retirement benefit programs such as Medicaid, Medicare, and Social Security.

The upshot: Strengthening the educational achievement of our youth will help provide lasting economic security for us, the elderly, and future generations—the sooner the better.

Completely closing socioeconomic-based educational achievement gaps will not happen instantly, but we can begin to narrow them immediately. We already know many of the reasons these gaps exist and policies that can help close them. Thus, we can begin to experience some of the economic gains described in this report as policies are implemented that successfully narrow achievement gaps.

Public policies to reduce educational achievement gaps

There are a wide variety of public policies that could help narrow educational achievement gaps. Many researchers have focused on improving schools through education reform. Specific recommendations that emanate from this research and that have been correlated with improved educational outcomes include extending learning time and improving teacher quality.[48]

But, school-specific solutions for socioeconomic-based achievement gaps are limited in what they can accomplish. First, as discussed briefly above and in more detail below, socioeconomic-based cognitive ability gaps develop early in life, become large before age five when children start formal schooling, and have lifelong consequences. Thus, school-specific reforms cannot get at the root problems that cause these gaps and thereby cannot stop achievement gaps from developing in the first place.

Second, as noted earlier, the evidence is clear that achievement gaps have not narrowed as children progress through school, despite reform efforts. It is of course possible that achievement gaps would be much larger in the absence of these school-based efforts, but they certainly have not eliminated the large socioeconomic-based achievement gaps. And where school reform policies have been most successful, such as in Montgomery County Maryland, they have been typically paired with broader reforms such as in housing policy or early childhood intervention policies. In other words, closing socioeconomic-based achievement gaps is a complicated problem whose resolution may require a variety of sustained interventions along many dimensions.

Fortunately, there are many other effective approaches that have been identified. A large and growing body of research demonstrates the academic, social, and economic benefits of high-quality early childhood interventions. Child and maternal health, conditions in the home and in the broader community, and the schooling environment are particularly important for young children's education and development. Targeted health, academic, social, and emotional interventions during the early childhood years can have profound influences on brain development, language skills, and learning. They also affect social relations and economic outcomes such as employment and earnings.

Below, three broad policy areas are discussed that could help reduce achievement gaps:

- Early childhood care and education
- Criminal justice reform
- Family friendly workplaces

This is far from an exhaustive list, but it nonetheless illustrates the wide diversity of policies that help to narrow achievement gaps and suggests that closing achievement gaps may require policies beyond those that simply promote education reform.

Early childhood care and education

One of the most effective ways to reduce education gaps is to provide access to high-quality, early child care and prekindergarten programs. Researchers find that investing in early childhood care, education, and health is one of the best ways to improve children's well-being, increase the educational achievement and productivity of both children and adults, and reduce social problems such as crime.[49] Research also shows that the academic skills children acquire by age five, when they typically enter kindergarten, are strongly correlated with their subsequent achievement in school and success in the labor market.[50]

In a thorough review of the academic literature on this topic, economists Douglas Almond of Columbia University and Janet Currie of Princeton University find that child and family characteristics at the start of formal schooling explain labor-market outcomes as much as educational attainment does.[51] In other words, the first five years of a child's life may be as important to success in the workplace as all subsequent years of formal education. Thus, a comprehensive and integrated set of early childhood support systems that encourage nurturing and stimulating early care could help close achievement gaps.

Assessments of high-quality early education programs establish that participating children are more successful in kindergarten through 12th grade and in life after school than are children not enrolled in such programs. In particular, children who participate in high-quality early education programs tend to score higher on math and reading achievement tests, have greater language abilities, require less remedial, or special, education, and are less likely to repeat a grade. They have

lower dropout rates, higher levels of schooling attainment, and graduate from high school and attend college at higher rates.

Because high-quality programs offer behavioral and health screenings, including vision, dental, and hearing screenings, children who attend them experience significantly less child abuse and neglect, have better health outcomes, and are less likely to be teenage parents. All of these factors also significantly improve children's educational outcomes.[52]

Both as juveniles and as adults, children who attend early education programs are less likely to engage in criminal activity. And once they enter the labor force, their employment rates and incomes are higher, as are the taxes they pay. While all children may benefit from high-quality pre-Kindergarten programs, public provision of such programs would disproportionately benefit children from families of low socioeconomic status. These children are currently less likely to attend any early child care or education programs, and the programs in which they do enroll tend to be of low quality.[53]

Criminal justice reform

Policies that reform the juvenile and criminal justice system may also help close achievement gaps. Low-income children, in general, and children of color in particular, are more likely to experience violence and have interactions with the juvenile and criminal justice systems. These interactions can damage future well-being.[54] Black children, for example, are 4.5 times more likely than white children to be apprehended for the same crime. Hispanic children are 2.5 times more likely than white children to be apprehended for the same crime.[55]

These children are also more likely to have an incarcerated parent, a circumstance associated with a variety of poor educational and economic outcomes.[56] Thus, policies that help address violence, reduce racial and ethnic bias in the justice system, eliminate unnecessary contact between youth and the juvenile justice system, support incarcerated parents, and guarantee quality educational and training opportunities for incarcerated youth can help reduce educational achievement gaps.

Family friendly workplace policies

Specific policies to support low-income parents and caregivers may also be effective at reducing educational achievement gaps. The health of pregnant mothers and the practice of breastfeeding affect the emotional and physical health of infants and their ability to learn.[57] Thus, comprehensive prenatal and postnatal care for pregnant mothers and their infants lead to healthier babies and children who are better equipped to learn.[58]

Research also shows that the amount of time parents spend with their children can influence academic achievement, enhance emotional well-being, reduce teen pregnancy, and lower high school dropout rates.[59] Therefore, family medical leave policies and paid sick days that allow workers to care for a newborn, adopted, or ill child alongside paid vacation time and flexible work schedules that enable parents and children to spend more time together could help reduce achievement gaps.

Likewise, studies find that the health and stress levels of parents and caregivers—especially those of pregnant mothers—affect children's development, ability to learn, and educational attainment.[60] Stress during the early childhood years, such as that brought on by parental unemployment or demanding jobs, can diminish children's subsequent academic and labor-market accomplishments.[61] Expanding health care coverage for physical and emotional health, particularly for low- and moderate-income families, could help reduce achievement gaps. The Affordable Care Act provides this type of coverage, and the expansion of Medicaid at the state level would especially benefit some of the most stressed out low-income parents and caregivers.

Likewise, public policies that promote higher wages, higher employment, and higher family incomes may reduce educational achievement gaps. There is a growing body of evidence that shows increases in family income improve the educational outcomes of children and can narrow achievement gaps. Several studies find that increases in family income due to public policies—such as expansions of the Earned Income Tax Credit and the Child Tax Credit—significantly improve test scores. [62]

Importantly, families use their higher incomes to improve their children's learning environment through higher-quality child care and increased participation in early education programs. [63] Thus, a higher minimum wage, anti-wage-theft policies, an expanded Earned Income Tax Credits and Child Tax Credits as well as broader macroeconomic policies that support higher employment and higher wages are examples of policies that could reduce educational achievement gaps.

Acting on the evidence and the data

These are only a few examples of the types of policies that could simultaneously help reduce socioeconomic-based achievement gaps and raise academic achievement. Many other effective strategies exist. Researchers Scott Carrell and Teny Maghakian at the University of California-Davis and James West at the U.S. Air Force Academy found that simply delaying the start time of the U.S. Air Force Academy by 50 minutes (from 7 am to 7:50 am) raised student achievement by the equivalent of roughly one standard deviation improvement in teacher quality.[64] A one standard deviation improvement in teacher quality, in turn, is equal to more than a 0.1 standard deviation improvement in student achievement test scores.[65] Improvement in achievement test scores of that magnitude is approximately the improvement assumed under scenario one of our simulations and roughly a quarter to one-fifth of the improvements assumed under scenarios two and three.

Some of these policies are costly to put into practice because they involve complex social, economic, and cultural considerations, but others, such as delaying the start time of high schools so that teenagers can get more sleep, are inexpensive and breathtakingly simple to implement. Although there are costs associated with implementing any of these policies, this report shows that they would be partly, totally, or more than totally offset over the long term by the economic and fiscal benefits of improving educational achievement.

The long-term solution is to invest in the health, education, skills, and social well-being of our most valuable resource—our people. Such investments simultaneously reduce economic disparities, strengthen ladders of opportunity, and generate the resources we need for future investments, creating a virtuous cycle of broadly shared economic expansion. Investments made today in the cognitive skills of people will help create pathways for more rapid and continuous growth and enhance future wealth and well-being. Raising educational achievement levels and closing socioeconomic-based educational gaps are about not only attenuating the degree of inequality and promoting more widely shared economic growth but also inducing faster economic growth.

In short, it is about promoting equitable growth.

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 Woesmann (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.

About the author

Robert Lynch is a Visiting Fellow at the Washington Center for Equitable Growth and the Everett E. Nuttle Professor of Economics at Washington College. He is also a Senior Fellow at the Center for American Progress and a Research Associate with the Economic Policy Institute. His areas of specialization include human capital, public policy, public finance, and income inequality. Lynch is the author of several works that have quantified the economic and social consequences of public investment in early childhood, assessed the economic effects of immigration reform, evaluated the adequacy and effectiveness of state and local government economic policies in promoting growth and creating jobs, analyzed the efficiency, fairness, and stability of state and local tax systems, and examined the definition and measurement of income inequality. Lynch previously taught at the State University of New York at Cortland. Lynch earned his Ph.D. and Master's in economics from the State University of New York at Stony Brook and his B.A. in International and Development Economics from Georgetown University.

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Endnotes

1 PISA is a test, administered by the Organization for Economic Cooperation and Development to its 34 member nations and roughly 30 other non-members nations, that assesses the scholastic performance of 15-year-old schoolchildren in mathematics, science and reading. See OECD (2013), PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy, OECD Publishing. http://dx.doi.org/10.1787/9789264190511-en.

2 The value in today's dollars of future revenues discounted at a specified rate of interest. In all of our PV calculations, a discount of 3 percent per year is applied to future values. See methodology for more details.

3 In the long run, the solvency of Social Security would improve by less than the increase in tax revenues because social security benefits increase with contributions. However, these increased contributions would ease the financial stress of the system because they take place precisely during the time period when the Social Security Systems is most financially stressed, due to the retirement of the Baby Boomers, and long before corresponding benefits would have to be paid out.

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