RESEARCH REPORT

The Economic Impact of Achievement Gaps in Pennsylvania's Public Schools

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Preface

In recent decades, various efforts to improve the performance of American public schools have been motivated by differences in student academic performance based on key characteristics, such as race-ethnicity or socioeconomic status. Whether measured by differences in student achievement tests during the K–12 years or other outcomes, such as high school graduation rates, achievement gaps have been the impetus for federal, state, and local education reforms. Although Pennsylvania ranks among the top ten states in average student performance, it too has persistent differences in student outcomes based on race-ethnicity, family economic status, or school district. While such differences are routinely measured and monitored, researchers have recently begun to quantify the economic costs of these differences in student performance. Such economic evidence provides policymakers and the public with estimates of the economic consequences of the student performance differences that currently exist, while also documenting the potential economic gains if policies can be implemented that lead to a narrowing of the existing gaps.

Within this context, the goal of this study is twofold:

- to document the magnitude of the gaps in education performance for Pennsylvania's public school students, as measured by achievement tests and high school graduation rates
- to estimate the economic costs of the measured education performance gaps.

The analysis examines achievement differences for Pennsylvania students defined by race-ethnicity and socioeconomic status, as well as differences across Pennsylvania school districts. The performance of Pennsylvania's students is also compared with other U.S. states and other countries using comparable measures of academic performance. The economic estimates are derived using several methods employed in other studies, with various sensitivity analyses.

The findings from this study will be of interest to stakeholders in the public and private sectors in Pennsylvania interested in the performance of students in the state's public schools, the economic consequences of gaps in student performance, and the potential economic gains from closing performance gaps.

This research was conducted in RAND Education. Additional information about the RAND Corporation is available at www.rand.org.

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Summary

Differences in academic performance across groups of students defined by race-ethnicity, socioeconomic status, and geographic location are a well-documented feature of the education landscape in the United States. Recent efforts to quantify the economic consequences of cross-group differences in student achievement and attainment demonstrate that there are substantial economic costs in terms of lost productivity and economic output when some groups of students lag in the skills and knowledge they bring to the labor market—shortfalls that are typically measured by scores on standardized achievement tests or in terms of educational attainment, such as the high school graduation rate. For instance, a 2009 study by McKinsey and Company (2009a, 2009b) estimated that race-ethnic gaps in student performance in the United States resulted in lost output equal to 2 to 4 percent of gross domestic product (GDP) as of 2008. The lost earnings for African-Americans and Latinos as a result of lower levels of academic achievement amounted to $120 billion to $160 billion in 2007.

The goal of this study is to document the magnitude of the gaps in student performance for public school students in Pennsylvania and then to estimate the economic consequences of those education performance gaps. For measures of student performance, the study relies on Pennsylvania standardized achievement tests administered in 2013 in eighth grade as part of the Pennsylvania System of School Assessment (PSSA). Data from the 2013 National Assessment of Educational Progress (NAEP) are used to compare the performance of students in Pennsylvania with the performance of students in other states. We also examine results from the 2012 Programme for International Student Assessment (PISA) to determine how Pennsylvania students are likely to compare with students in other developed countries. Student attainment is measured by the four-year adjusted cohort graduation rate (ACGR), a consistent measure of on-time graduation available for all 50 states and the District of Columbia as of 2013. The economic analysis builds on the estimates of the gaps in student achievement and attainment, employing and extending methods used in the McKinsey and Company study (2009a, 2009b) to generate estimates specific to Pennsylvania. The analyses are reported in ranges, given uncertainty about the magnitudes of several key economic parameters used to derive the estimates.

In this summary, we highlight our key findings with respect to the size of student performance gaps in Pennsylvania and the associated economic costs of existing gaps, as well as the potential economic gains from closing gaps in the future.

Size of Academic Performance Gaps in Pennsylvania

According to the statewide 2013 PSSA results, 74 percent of Pennsylvania eighth-grade public school students were classified as “proficient” or “advanced” in reading, meaning “satisfactory”

or “superior” academic performance, respectively. Seventy-seven percent reached proficiency or higher in math. Although the NAEP uses a descriptor similar to the one used by the PSSA to define proficiency, the cutpoint used in the NAEP to determine which students achieve proficiency results in a smaller share of Pennsylvania students in eighth grade being classified at this level in both reading and math (40 percent and 42 percent, respectively)—a common result when comparing student achievement based on state assessments versus the NAEP. Nevertheless, this result is strong enough to place Pennsylvania in the top ten states, according to the NAEP. In 2013, Pennsylvania ranked 15th among the states in terms of its four-year ACGR.

This overall strong performance, however, masks substantial differences across subgroups of Pennsylvania students (see Table S.1). Notably, our analysis shows the following:

- According to both the 2013 PSSA and the 2013 NAEP, there are sharp race-ethnic differences in Pennsylvania student achievement in eighth-grade reading and math. The share of white students achieving proficiency or above exceeds the share of African-American and Latino students by as much as 24 to 38 percentage points, depending on the assessment and subject. Measured in terms of student learning, African-American and Latino students in Pennsylvania are behind their white counterparts by the equivalent of about three years, according to the NAEP achievement score scales. These two lower-performing groups constitute nearly one in four students as of eighth grade.
- There are equally large differences, according to both the PSSA and NAEP, in student achievement based on family economic status, with gaps in the proficiency rate of 20 to 26 percentage points between students classified as economically disadvantaged (about 40 percent of eighth graders statewide) and those who are not (the remaining 60 percent). The NAEP scale scores show economically disadvantaged students in Pennsylvania behind in learning by two to three years on average when compared with their counterparts who are not economically disadvantaged.
- Differences in Pennsylvania student achievement by parent education are as substantial, a comparison possible only with the NAEP data. Differences in student proficiency reach about 25 percentage points when comparing students with one or both parents having a college education and students whose parents have not graduated from high school.

Table S.1. Student Performance Gaps: Pennsylvania in 2013

	Percentage-Point Gap in Proficiency				
Subgroup Comparison	**PSSA Reading**	**PSSA Math**	**NAEP Reading**	**NAEP Math**	**Percentage-Point Gap in Four-Year ACGR**
White–African-American	25	30	30	38	17
White–Latino	24	26	29	33	19
High–low economic status	25	26	20	25	14
High–low parent education	–	–	25	26	–

SOURCES: Author’s analysis of 2013 PSSA data, 2013 NAEP data for Pennsylvania, and 2013 four-year ACGR data for Pennsylvania.
NOTES: Proficiency is measured in the PSSA by the percentage at “proficient” or above. Proficiency is measured in the NAEP by the percentage at “basic” or above. – = Not available.

- Although Pennsylvania is one of the top-scoring states on the NAEP on average, the achievement gaps defined by race-ethnicity, family economic status, and parent education are among the largest in the country when compared with other states.
- The gaps in the four-year ACGR among Pennsylvania students are sizeable as well, reaching 17 to 19 percentage points by race-ethnicity and 14 percentage points by family economic status. In other words, whereas 86 percent of Pennsylvania students who enter ninth grade graduate on time four years later (after adjusting for students entering and leaving the cohort during the four years of high school), the graduation rate reaches 90 percent for white students but only 73 percent and 71 percent for African-American and Latino students, respectively. The graduation rate is 77 percent for economically disadvantaged students, substantially below the 91-percent rate achieved by those who are not economically disadvantaged.

Student performance gaps are also evident when outcomes are compared across Pennsylvania's 499 operating school districts. Excluding the bottom and top 10 percent of districts in terms of student performance, there is still a gap of about the same magnitude as race-ethnic and socioeconomic gaps (i.e., a gap in proficiency of 25 to 30 percentage points). District performance is generally higher in those districts with a lower share of African-American and Latino students and a lower share of economically disadvantaged students. But even in districts with a similar demographic makeup, considerable variation in student performance remains.

A series of gap-closing exercises demonstrates how much higher average statewide PSSA or NAEP scores would be if subgroup differences by race-ethnicity or socioeconomic status were eliminated by bringing low-performing groups up to the level of proficiency (or test score average) of the higher-performing group. These calculations show the biggest gain from closing economic status gaps; the smallest gain would be obtained by closing race-ethnic gaps. Closing gaps in student performance tied to parent education falls in between. These same gap-closing calculations show that the statewide four-year ACGR would rise from 86 percent to 90 percent if race-ethnic gaps were closed or to 91 percent if economic status gaps were eliminated. Notably, if gaps in NAEP reading and math scores by race-ethnicity were eliminated, Pennsylvania would score at about the same level as Massachusetts, the top-performing state on the eighth-grade NAEP. A similar result would follow if economic status gaps were eliminated.

Although Pennsylvania did not participate in the PISA as a stand-alone education system, benchmarking Pennsylvania's NAEP results against the three NAEP states that did participate in the PISA (Connecticut, Florida, and Massachusetts) shows that Pennsylvania would potentially be one of the top performers, likely ranking within the top ten among the 34 Organisation for Economic Co-operation and Development (OECD) countries. Pennsylvania's likely international ranking would rise even further if score gaps by race-ethnicity or economic status were eliminated.

Economic Impact of Academic Performance Gaps in Pennsylvania

The magnitudes of the student performance gaps provide the basis for estimating the economic consequences of those gaps. Like other studies that have generated such estimates for the U.S. economy, our estimates for Pennsylvania are based on a long-standing theoretical and empirical literature in economics that links the skills of the workforce, also known as human capital, to the productive capacity of the economy as measured by GDP. Student achievement test scores are assumed to capture cognitive skills that equate to individual productivity once students enter the workforce. Likewise, educational attainment, such as graduating from high school, represents a measure of the human capital an individual brings to the labor market. When subgroups of students do not achieve their full potential in terms of cognitive skills or educational attainment, there is a loss in the aggregate skill or human capital of the workforce and a corresponding shortfall in GDP. In addition, economic models based on endogenous growth theory posit that higher levels of human capital lead to a higher rate of innovation (or technological change). This, in turn, raises productivity and puts an economy on a path of continued economic growth. As a result, the positive impact of skill upgrading on GDP growth is compounded over time. Drawing on this framework and the documented student achievement gaps and graduation rate gaps, we provide several estimates of the economic consequences of low student performance based on alternative methods. Table S.2 summarizes the findings specific to gaps in student performance based on race-ethnicity and family economic status. (Calculations were also performed for gaps defined by parent education, with estimates falling between those for race-ethnicity and family economic status shown in Table S.2.)

First, two methods that we label A and B are replicated for Pennsylvania using a method employed by McKinsey and Company (2009a, 2009b) for the United States. The two methods can be viewed as estimating the cost to Pennsylvania's current workforce or the aggregate economy from existing academic performance gaps. The first approach, Method A, is based on the estimated relationship between student achievement and subsequent earnings and calculates the lost earnings for African-American and Latino workers in Pennsylvania implied by race-ethnic achievement gaps. Based on this method, we estimate that race-ethnic academic achievement gaps amount to an estimated annual cost of $1 billion to $3 billion in lost earnings, which equates to 6 to 15 percent of the earnings for African-American and Latino workers. The range of this estimate reflects the uncertainty in the parameter linking test scores to earnings, as well as the range of estimates for the size of the achievement gap by race-ethnicity, depending on which data source (PSSA or NAEP) and which assessment (reading or math) are used.

Table S.2. Summary of Results of Estimated Economic Value of Performance Gaps by Type of Gap and Method

Method	Type of Education Performance Gap: Race-Ethnic	Type of Education Performance Gap: Family Economic Status
Economic Burden of Current Gaps		
A. Estimate lost earnings for low-performing groups from current gaps	$1.3 billion to $2.9 billion gain in Pennsylvania individual annual earnings from closing achievement gaps in 2013	–
B. Estimate lost GDP from current gaps because of lower economic productivity and innovation	$0.9 billion to $2.0 billion gain in Pennsylvania GDP in 2004 from closing achievement gaps one year earlier —— $12 billion to $27 billion (2%–4%) gain in Pennsylvania GDP in 2013 from closing achievement gaps ten years earlier	$1.6 billion to $3.1 billion gain in Pennsylvania GDP in 2004 from closing achievement gaps one year earlier —— $22 billion to $44 billion (3%–7%) gain in Pennsylvania GDP in 2013 from closing achievement gaps ten years earlier
Economic Gains from Closing Gaps for Future Cohorts		
C. Estimate future lifetime earnings gains for single-year cohort if gaps are closed	$1.4 billion to $3.4 billion gain in 2013 present-value Pennsylvania individual earnings (2% discount rate)	–
D. Estimate future lifetime private and social gains for single-year cohort if gaps are closed	$2.8 billion to $4.2 billion gain in 2013 present value to society (2% discount rate)	$3.4 billion to $5.1 billion gain in 2013 present value to society (2% discount rate)

NOTE: – = Not applicable.

Method B provides another perspective on the current cost of achievement gaps. This approach imagines a hypothetical world in which achievement gaps were closed as of 2003, the base year. The effect on GDP is then traced over time for ten years until 2013, when GDP growth is assumed to be augmented from its observed time path, based on the estimated relationship between achievement scores (or labor force skill levels) and GDP growth. According to this approach, closing race-ethnic gaps in 2003 would have increased Pennsylvania GDP one year later by $1 billion to $2 billion, or 0.2 to 0.4 percent of actual GDP in that year. Further, accounting for the compounded effect on economic growth of reduced levels of workforce skill implied by endogenous growth theory, gaps in student performance defined by race-ethnicity constitute a loss to the economy over a ten-year horizon that equals $12 billion to $27 billion in lost GDP as of 2013, or 2 to 4 percent of the value of economic output in that year.

Two other methods provide a perspective on the gains to future cohorts of labor market entrants that would be realized if student performance gaps based on race-ethnicity or family economic status were closed. Viewed in terms of earnings alone and drawing on the same estimated relationship between achievement scores and earnings, each annual cohort would gain $1 billion to $3 billion in present-value lifetime earnings from closing race-ethnic gaps in student achievement (Method C). Based on cross-group differences in the high school graduation rate and the lifetime economic cost of being a high school dropout, we estimate a gain to society of $3 billion to $5 billion in present-value market and nonmarket benefits for each annual cohort from closing gaps based on student race-ethnicity or family economic status (Method D).

These aggregate impacts can be restated in terms of the gains per Pennsylvania student in the affected group. For example, the social gains from closing race-ethnic gaps equate to approximately $83,000 to $125,000 in present-value dollars per African-American or Latino student in each annual cohort. The gains from closing economic status gaps, which affect a larger share of students in each annual cohort, range from about $66,000 to $99,000 per economically disadvantaged student in Pennsylvania.

In Pennsylvania, the share of students with low economic status is larger than the share that is African-American or Latino, yet the magnitudes of the achievement and attainment gaps are similar. For this reason, the estimated magnitudes of the aggregate economic costs of existing socioeconomic gaps or the future gains from closing current socioeconomic gaps (i.e., those defined by family income or parent education) exceed the aggregate costs or gains associated with erasing the more commonly measured race-ethnic differences in student performance. At the same time, it is important to acknowledge that there is considerable overlap in these subgroups, as large shares of African-American or Latino students would also be classified as having low economic status or low parental education. Because of that overlap, if student performance differences by race-ethnicity, family income, and parental education could be simultaneously eliminated, the economic costs of existing gaps or the gains in the future from closing gaps would be less than the sum of the values we calculate when gaps are closed for one characteristic at a time.

Limitations of the Analysis

The estimated economic values summarized in Table S.2 are broadly consistent across the methods employed, but there are important limitations. These include the reliance on economic parameter estimates linking student achievement and educational attainment to earnings and economic growth that are derived from national populations or cross-national comparisons, which can only be viewed as approximations of the relevant (but unknown) parameters for Pennsylvania. In addition, there are a number of simplifying assumptions that, if relaxed, might result in lower estimates than those presented here. On the other hand, some of the economic estimates, such as those for GDP, exclude nonmarket benefits to higher achievement or educational attainment, such as improved health. Because of assumptions regarding causal linkages and generalizability, it is important to view these figures as approximate estimates of the true economic values for Pennsylvania. Nevertheless, the consistency in findings across alternative methods and the similarity in estimates for the country as a whole by McKinsey and

Company and others (adjusting for scale) provide greater confidence that the estimates are a valid gauge of the costs of achievement and attainment gaps in Pennsylvania.

Implications for Policy

The substantial economic costs we have documented for existing student performance gaps and the potential gains to be realized from closing those gaps naturally invite consideration of what policies, programs, or interventions might serve to raise student achievement for low-performing groups and thereby narrow or eliminate the measured gaps. Evidence-based policies that may be candidates for consideration include investments in early childhood programs, such as home visiting programs and high-quality early learning programs; K–12 investments and reforms that are linked to improved student performance; after-school and summer programs that extend the learning day or stem summer learning loss; and youth development programs designed to prevent school dropout and promote positive youth outcomes. Where these policy options and others can be demonstrated to improve academic achievement and educational attainment, there is the potential for narrowing the school performance gaps documented in this report. Our economic estimates could then be used to determine whether the economic benefits from closing those gaps would outweigh the costs of the policies required to achieve the improved outcomes, thereby bringing economic evidence to bear on decisionmaking regarding education-related investments in children and youth.

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Abbreviations

ACGR	adjusted cohort graduation rate
ACS	American Community Survey
AFQT	Armed Forces Qualifications Test
BEA	U.S. Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
CPI-U	Consumer Price Index for All Urban Consumers
CPS	Current Population Survey
FRPL	free or reduced-price lunch
GDP	gross domestic product
LEA	local education agency
NAEP	National Assessment of Educational Progress
NCES	National Center for Education Statistics
OECD	Organisation for Economic Co-operation and Development
PDV	present discount value
PISA	Programme for International Student Assessment
PSSA	Pennsylvania System of School Assessment
RUCA	Rural-Urban Commuting Area
SD	standard deviation
TANF	Temporary Assistance for Needy Families

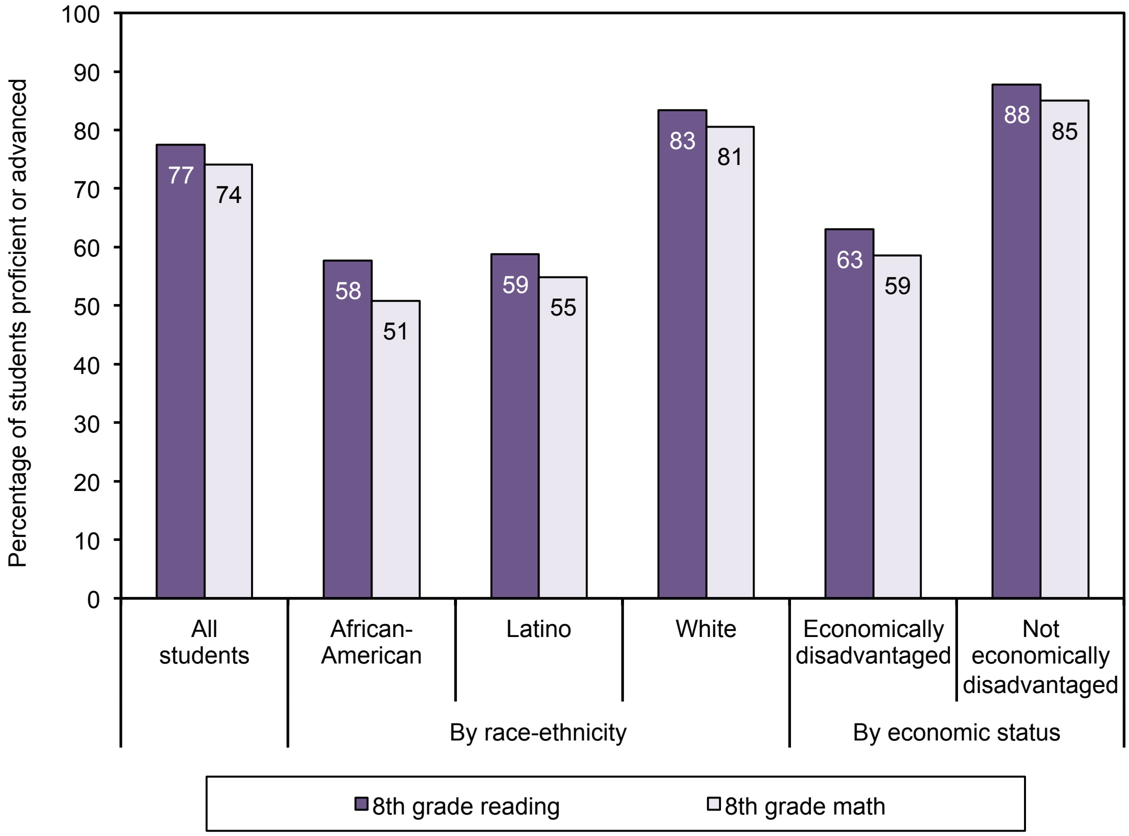
1. Introduction

Differences in student academic performance based on such key characteristics as race-ethnicity or socioeconomic status—known as achievement gaps—are an enduring feature of the U.S. education landscape. Such gaps may be manifested in differential performance on student achievement tests starting in the elementary grades or in later academic outcomes, such as high school graduation rates. An extensive research literature documents the magnitude of achievement gaps by race-ethnicity (Jencks and Phillips, 1998; Kao and Thompson, 2003; Clotfelter, Ladd, and Vigdor, 2006; Reardon and Galindo, 2009), while more recent studies suggest that achievement differences by income may be even more salient (Reardon, 2013). New data have further documented that the achievement differences evident when students are first assessed using standardized tests in the elementary grades have earlier roots: Similar gaps in school readiness by race-ethnicity or socioeconomic status are present when children first enter school (Cannon and Karoly, 2007) and even in measures of early development before school entry (Halle et al., 2009).

Pennsylvania is no exception when it comes to persistent differences in academic outcomes across students of different backgrounds. Figure 1.1 shows the percentage of students classified as proficient or above in reading and in math according to the 2013 statewide student assessments, the Pennsylvania System of School Assessment (PSSA). Statewide, 74 to 77 percent of eighth-grade students in Pennsylvania public schools are classified as proficient in either subject. However, when viewed by race-ethnicity, the share of students achieving proficiency reaches at most 58 percent for African-American students (depending on the subject) and at best 59 percent for Latino students, in contrast to proficiency rates of 83 percent at most for white students—differences of as much as 30 percentage points. The gap in reading and math proficiency is about as large—25 to 26 percentage points—when comparing economically disadvantaged students to their counterparts who are not economically disadvantaged.

Data for the 2013 National Assessment of Educational Progress (NAEP), which allows comparisons of public school student performance across states based on a common assessment in fourth or eighth grade, show that Pennsylvania, in aggregate, ranks among the top ten scoring states. At the same time, as shown in Table 1.1, Pennsylvania has one of the highest race-ethnic achievement gaps among the states. For example, there is a gap of 30 to 35 scale points in reading and math scores as of eighth grade between African-American or Latino students and their white counterparts. Those differences place Pennsylvania in the top five states based on the magnitude of the white-Latino gap and in the top ten states based on the size of the white–African-American gap. The NAEP data further show sizeable gaps in academic achievement between Pennsylvania students based on economic status (as measured by eligibility for free or reduced-price lunch [FRPL]) and based on parent education.

Figure 1.1. Percentage of Eighth Graders Achieving Proficiency: PSSA Reading and Math in 2013



SOURCE: Author's analysis of 2013 PSSA data.

While there is a long history of documenting the magnitude and trends in achievement gaps, researchers have only recently begun to quantify the economic consequences of the sizeable differences in student performance across subgroups or across geographic units (examples discussed later in this chapter include McKinsey and Company, 2009a, 2009b; Hanushek and Woessmann, 2010; and Lynch and Oakford, 2014). These studies draw on a long-standing theoretical and empirical literature in economics that examines the factors contributing to economic growth, including physical capital, human capital, and other factors. Such studies link the skills of the workforce, as a measure of human capital, to the productive capacity of the economy, typically measured by gross domestic product (GDP) (Welch, 1970; Topel, 1999; Barro and Sala-i-Martin, 2004; Aghion and Durlauf, 2005; Hanushek and Woessmann, 2008). These studies posit that student achievement test scores capture cognitive skills that equate to individual productivity once students enter the workforce. Likewise, high school graduation (or degree completion at higher levels), as a marker of educational attainment, represents a measure of the human capital an individual brings to the labor market. When subgroups of students do not achieve their full potential in terms of cognitive skills or educational attainment, there is a loss in the aggregate skill or human capital of the workforce and a commensurate shortfall in GDP.

Table 1.1. Eighth-Grade NAEP Mean Scale Scores and Rank of Score Gaps by State: 2013

	Mean Scale Score		Rank of Reading Score Gap			Rank of Math Score Gap		
State	Reading	Math	White–African-American	White–Latino	High–Low Economic Status	White–African-American	White–Latino	High–Low Economic Status
Massachusetts	**277**	**301**	4	2	3	19	5	3
New Jersey	**276**	**296**	24	19	11	30	27	12
Connecticut	**274**	285	19	6	2	11	2	2
Vermont	**274**	**295**	41	–	33	6	–	20
New Hampshire	**274**	**296**	–	4	35	–	7	44
Maryland	**274**	287	27	23	20	28	29	22
Pennsylvania	272	290	6	3	17	8	3	10
Montana	272	289	–	29	42	–	44	45
Washington	272	290	36	8	15	40	22	33
Colorado	271	290	3	11	7	7	12	8
Minnesota	271	**295**	7	5	10	5	9	13
Wyoming	271	288	–	31	48	–	39	51
Idaho	270	286	–	15	45	–	14	49
Kentucky	270	281	17	43	24	42	38	28
Utah	270	284		22	46	–	4	43
Iowa	269	285	20	26	31	9	15	30
Maine	269	289	–	–	51	25	–	42
Nebraska	269	285	16	13	25	3	10	24
Ohio	269	290	21	46	12	33	31	15
North Dakota	268	**291**	40	–	32	41	–	38

SOURCE: Author's analysis of 2013 NAEP data.
NOTES: See Table B.1 in Appendix B for results for all states and the District of Columbia. States are sorted from highest to lowest by the NAEP reading score and only the top 20 states are shown. States with mean scale scores above Pennsylvania are shown in bold text. – = Not available because subgroup scale scores are not reported for one or both subgroups in the state when the subgroup size is too small.

Moreover, economic models derived from endogenous growth theory hypothesize that higher levels of human capital lead to a higher rate of innovation (or technological change), which in turn raises productivity and puts an economy on a path of continued economic growth (Lucas, 1988; Romer, 1990; and Aghion and Howitt, 1998). Consequently, the positive effects of improvements in the skills of the workforce on GDP growth are compounded over time.

Given the size of the education performance gaps faced by Pennsylvania, policymakers and the public would benefit from having credible estimates of the economic consequences of those gaps in order to gauge to costs to the economy from existing gaps and the potential benefits from policies that would seek to raise the academic outcomes for those groups of students whose performance is lagging. With that motivation, this study has two objectives:

- to document the magnitude of the gaps in education performance for Pennsylvania's public school students, as measured by achievement tests and high school graduation rates
- to estimate the economic costs of the measured education performance gaps.

We accomplish the first goal by examining differences in achievement test scores and high school graduation rates for Pennsylvania students defined by race-ethnicity and socioeconomic status, as well as differences across Pennsylvania school districts. We also compare the performance of Pennsylvania's students with other U.S. states and other countries using comparable measures of academic performance. The second goal is achieved by using several methods to quantify the economic costs in terms of lower individual earnings and reduced GDP from the reduced levels of academic performance of minority students and students with low socioeconomic status. Alternatively, these estimates can be viewed as the economic gain that would accrue from closing student performance gaps. However, viewed in terms of the potential gain, it is important to acknowledge that the estimates we generate do not account for the cost of the interventions, programs, or policies that would be required to close the achievement or attainment gaps. Thus, if policymakers aim to base decisions, at least in part, on economic grounds, a full policy analysis would require a comparison of the economic costs to achieve the gap closings with the economic gain that would result. Beyond the economic calculus presented in this study, policymakers or the public may choose to invest resources with the aim of reducing achievement gaps for reasons of equity or social justice.

In the remainder of this introductory chapter, we first describe the sources of data and measures used in our analyses of student performance. We then summarize the findings from prior studies that have quantified the economic costs of achievement gaps. A final section provides a road map for the remainder of the report.

Data Sources and Measures of Student Performance

We examine two measures of student academic performance: student standardized achievement test scores and the high school graduation rate. Both student achievement and high school graduation are important outcomes of the public education system, and both receive attention when considering education policy. As we discuss later, both are also linked to later labor market performance and thus can be associated with economic outcomes. For this reason, we maintain a dual focus on both achievement and attainment throughout the report.

In the remainder of this section, we discuss the data sources for these two indicators in turn. Additional information about these data sources and measures is found in Appendix A.

Achievement Test Scores

As shown in Table 1.2, we rely on (1) student achievement data specific to Pennsylvania, (2) student achievement data administered to a national sample that allows comparisons between Pennsylvania and the other U.S. states, and (3) comparable cross-national student achievement data. For student achievement tests, our focus is assessments of public school students in reading and math as of eighth grade. However, we have included other grades and assessments for some of our descriptive analyses.

To measure academic achievement for public school students in aggregate and subgroup differences within Pennsylvania, we assembled data from the PSSA (Pennsylvania Department of Education, 2015). Although we focus on the most recent student assessment results for 2013, specifically for reading and math achievement tests for students in eighth grade, we assembled

Table 1.2. Sources and Features of Data Employed on Student Achievement

Feature	PSSA	NAEP	PISA
Population	Public school students in Pennsylvania and in each school district[a]	Representative samples of public school students in the United States and in each state	Representative samples of public and private school students in 65 economies (including the 34 OECD countries) and public school students in three U.S. states (Connecticut, Florida, and Massachusetts)
Years	2004–2013 (annual)	2003–2013 (odd years)	2012
Ages/grades	Grades 3 to 8, 11[b]	Grades 4, 8	15-year-olds[e]
When assessed	Spring	January to March	October to November
Subjects assessed[c]	Reading Math Science Writing	Reading Math	Reading Math
Measures	Mean scale scores Achievement levels	Mean scale scores Achievement levels	Mean scale scores Achievement levels
Subgroups	Race-ethnicity • White • African-American • Latino • Asian Economic status • Not economically disadvantaged[d] • Economically disadvantaged	Race-ethnicity • White • African-American • Latino • Asian Economic status • Not eligible for FRPL • Eligible for FRPL Parent education • Less than high school • High school graduate • Some college • College or higher • Missing parent education	–

SOURCE: Author's analysis. See Appendix A for additional information about the data sources.
NOTES: – = not applicable for purposes of this study. OECD = Organisation for Economic Co-operation and Development.
[a] In some districts, test-takers may include private school students.
[b] Assessments in grade 3 began in 2005, and assessments in grades 4, 6, and 7 began in 2006.
[c] Students may have been assessed in other subjects.
[d] Outcomes for this subgroup are not reported but were calculated by the author.
[e] Sample consists of students between ages 15 years and 3 months and 16 years and 2 months at the beginning of the testing period in grades 7–12.

data covering grades 3 to 8 and 11 across four PSSA subjects from 2004 to 2013 (see Table 1.2). Aggregate PSSA student data are reported as mean scale scores (where the scale scores, after conversion from raw scores, usually range from as low as 700 to as high as 2400 depending on the assessment) and the percentage of students scoring in four achievement levels: advanced, proficient, basic, and below basic (see Text Box 1.1). The data provide statewide results in aggregate and for student subgroups defined by race-ethnicity and economic status. For the former, we focus on the four largest groups: whites, African-Americans, Latinos, and Asians. The latter differentiates economically disadvantaged and not economically disadvantaged

Text Box 1.1. Student Achievement Levels in the PSSA and NAEP

In analyzing the PSSA and NAEP data, we report on student performance in terms of both mean scale scores (where the scales differ between the two sources) and the distribution of student results according to the proficiency standard defined for each assessment. As shown in the table below, both assessments use cut scores to classify students into one of four achievement levels: advanced, proficient, basic, and below basic. Both assessments define "proficiency" in terms of "satisfactory" or "solid" academic performance, whereas "advanced" means "superior" performance and "basic" or below indicates "marginal" or "partial" knowledge.

Despite these similarities, in most states, there is a divergence in the share of students deemed proficient and above according to the NAEP assessment results and the state's own achievement test, with the "proficient" level in most states equal to the "basic" level in the NAEP (NCES, 2011). As of the latest benchmarking exercise by the National Center for Education Statistics (NCES), this was the case for Pennsylvania, and that is evident in the results presented in the next chapter.

Achievement Level	PSSA Definition (as of 2001)	NAEP Definition (as of 1993)
Advanced	**Superior academic performance** indicating an in-depth understanding and exemplary display of the skills included in Pennsylvania's Academic Standards	**Superior performance** beyond Proficient
Proficient	**Satisfactory academic performance** indicating a solid understanding and adequate display of the skills included in Pennsylvania's Academic Standards	**Solid academic performance** for each grade assessed Students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter
Basic	**Marginal academic performance**, work approaching, but not yet reaching, satisfactory performance Performance indicates a **partial understanding** and limited display of the skills included in Pennsylvania's Academic Standards, and the student may need additional instructional opportunities and/or increased student academic commitment to achieve the Proficient Level	**Partial mastery** of prerequisite knowledge and skills that are fundamental for proficient work at each grade
Below Basic	**Inadequate academic performance** that indicates little understanding and minimal display of the skills included in the Pennsylvania Academic Content Standards There is a major need for additional instructional opportunities and/or increased student academic commitment to achieve the Proficient Level	Reported but not defined

SOURCES: Zwerling (2003) and NCES (2015).

students, as determined by school districts.[1] We also accessed student achievement data for the same subjects and grades for Pennsylvania's school districts.

To compare public school student achievement in Pennsylvania with other states, we relied on the NAEP (NCES, 2015), which is also available for reading and math in two grades—fourth and eighth grades—as of 2013, with historical data for the biennial assessment from 2003 onward.[2] The NAEP is based on nationally representative samples of public school students in each state, with assessments given every other year. As for the PSSA, NAEP aggregate results are reported as mean scale scores (where scale scores range from 0 to 500) and according to achievement levels, where the same four levels are defined: advanced, proficient, basic, and below basic (see Text Box 1.1). Also, as for the PSSA, the NAEP results are available disaggregated by race-ethnicity, and we focus on the same four groups as the PSSA. Economic status is defined by eligibility for the FRPL program. In addition, based on student reports, results for the eighth-grade NAEP assessments are available by the highest education level of the students' parent(s): less than high school degree, high school graduate, some college, and college degree or higher. We also include a fifth group to capture those students with missing information on parent education.

Finally, to place Pennsylvania student achievement in an international context, we examined data from the OECD's 2012 Programme for International Student Assessment (PISA) (OECD, undated), one of several comparable student assessments administered across multiple countries. The 2012 PISA includes reading and math assessments administered to 15-year-old public and private school students in 65 national or subnational economies, including the 34 OECD member countries (which includes the United States). In addition, public school students in three U.S. states—Connecticut, Florida, and Massachusetts—participated in the PISA for the first time in 2012 as separate education systems in order to have comparable results. Thus, although Pennsylvania did not participate in the 2012 PISA, by benchmarking the performance of Pennsylvania public school students on the NAEP with the three PISA states, we can estimate how Pennsylvania public school students are likely to compare with students (public and private) in other OECD countries.[3] As with the PSSA and NAEP, PISA reports mean scale scores (on a scale of 0 to 1000, with the mean set to 500) and the distribution of students by proficiency level.

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[1] In Pennsylvania, school districts determine whether a student is classified as economically disadvantaged. Districts are able to use several indicators of low income or disadvantage, including eligibility for FRPL (income below 185 percent of the poverty level), receipt of cash aid through Temporary Assistance for Needy Families (TANF), receipt of Medicaid, living in an institution for neglected or delinquent children, and living in foster care.

[2] As of 2003, all of the states were participating in the NAEP fourth- and eighth-grade assessments. The NAEP assessment framework was updated in 2009, but NCES has determined that the assessments from earlier years were still comparable (NCES, 2014a, 2014b).

[3] Although students in Pennsylvania are included in the PISA sample for the United States, the PISA sample is generally not designed to permit state-specific estimates of student performance. The separate estimates for Connecticut, Florida, and Massachusetts in 2012 were made possible by oversampling students in those states.

Given our focus on differences at the national level, we do not examine subgroup results in the PISA.

High School Graduation Rate

Table 1.3 shows the sources of data for the high school graduation rate as another measure of public school student performance. For both Pennsylvania and all other states, the common metric we employed is the four-year adjusted cohort graduation rate (ACGR).[4] Essentially, the ACGR begins with the cohort of students entering ninth grade for the first time and adds the number of students moving into the jurisdiction (e.g., school district or state) during the four-year period (transfers in) and subtracts the number of students leaving the jurisdiction during the same time frame for another jurisdiction or who emigrate or die (transfers out). This is the adjusted cohort size, which then becomes the denominator for calculating the graduation rate (number graduated with a regular high school diploma within four years divided by the adjusted cohort size multiplied by 100). Thus, the four-year ACGR indicates the percentage of students who received a regular high school diploma within four years of starting ninth grade for the first time. The Pennsylvania ACGR is available for 2011 to 2013 from the Pennsylvania Department of Education, while the cross-state estimates cover the same time period, although we focus our comparison on the 2013 results compiled by the NCES. The sources also disaggregate results by student race-ethnicity and economic status (see Table 1.2).[5]

Table 1.3. Sources and Features of Data Employed on Student Attainment

Features	Pennsylvania Department of Education	NCES
Measures	Adjusted four-year cohort graduation rate	Adjusted four-year cohort graduation rate
Population	Cohort of public school students entering ninth grade in Pennsylvania and in each school district	Cohort of public school students entering ninth grade in the United States and each state
Years	2011–2013	2013
Subgroups	Race-ethnicity • White • African-American • Latino • Asian Economic status • Not economically disadvantaged[a] • Economically disadvantaged	Race-ethnicity • White • African-American • Latino • Asian Economic status • Not economically disadvantaged[a] • Economically disadvantaged

SOURCE: Author's analysis. See Appendix A for additional information about the data sources.
[a] Outcomes for this subgroup are not reported but were calculated by the author.

[4] States also calculate and report the five-year and six-year adjusted cohort graduation rate.

[5] For cross-national comparisons, the OECD's *Education at a Glance 2014* report (OECD, 2014) includes a measure of the successful completion rate of upper secondary programs, to the final stage of secondary education in most OECD countries. The completion rate measures the percentage of students who enter an upper secondary program for the first time and who graduate from it. Given differences with the ACGR, we have not included the cross-national graduation rate in our analyses.

Prior Research on Economic Valuation of Achievement Gaps

Several recent studies have estimated the cost to national economies of academic performance gaps, either based on differences in student achievement or on differences in high school graduation rates (see Table 1.4). One of the first studies of this type, by McKinsey and Company (2009a, 2009b), examined the economic impacts of achievement gaps for the United States in terms of lost earnings to individuals and economywide losses in GDP, accounting for different dimensions of the achievement gap. In particular, drawing on data from the NAEP, PISA, and other sources, McKinsey and Company consider

- closing the U.S. race-ethnic gap by increasing average test scores for African-American and Latino students to the average level of their white counterparts
- closing the income gap by raising average achievement for students with income below 125 percent of the poverty level to the achievement attained by students with income above that level

Table 1.4. Summary of Prior Studies Estimating Economic Costs of Academic Performance Gaps

Study	Method	Findings
McKinsey and Company (2009a, 2009b)	Estimate gain in U.S. GDP in 2008 if gaps were closed in 1998	Estimated gain in U.S. GDP in 2008 if gaps were closed in 1998: • Race-ethnic gap: 2–4% of GDP or $310 billion to $525 billion in 2008 • Income gap: 3–5% of GDP or $400 billion to $670 billion in 2008 • School systems gap: 3–5% of GDP or $425 billion to $700 billion in 2008 • International gap: 9–16% of GDP or $1.3 trillion to $2.3 trillion in 2008
	Estimate gain in individual earnings if race-ethnic gap were closed for all African-Americans and Latinos in the labor market in 2007	Estimated gain in individual earnings in 2007 if gaps were closed in 2007: • Race-ethnic gap: $120 billion to $160 billion in 2007
Hanushek and Woessmann (2010)	Estimate gain in U.S. GDP from raising student achievement over a 20-year phase-in period, with projections to 2090	Estimated gain in U.S. GDP in 2010 if gaps were closed over 20 years: • 100% PISA proficiency: $72 trillion cumulative present-value GDP until 2090 • Finland's PISA average: $103 trillion cumulative present-value GDP until 2090
Lynch and Oakford (2014)	Estimate gain in U.S. GDP up to 2050 if gaps were closed for each entering cohort; gaps fully eliminated after 40 years	Estimated gain in U.S. GDP in 2014 if gaps were closed by 2050: • Race-ethnic gap: $2.3 trillion or 5.8% in 2050 • Race-ethnic gap: $8.4 trillion cumulative present-value GDP until 2050 or $228 billion per year on average Estimated gain in U.S. tax revenue in 2014 if gaps were closed by 2050: • Race-ethnic gap: $3.0 trillion cumulative present-value tax revenue until 2050 or $82 billion per year on average

SOURCE: Author's analysis of cited studies.

- closing the U.S. school systems gap by raising the average achievement of students in states below the national average to the U.S. average
- closing the international achievement gap by raising the average achievement of U.S. students to the average for students in Korea, one of the top-scoring PISA countries.

In one estimation method, McKinsey and Company (2009a, 2009b) assume that a given achievement gap was closed as of 1998 and then forecast what GDP would have been ten years later, as of 2008. The forecast is based on the estimated relationship, from cross-national data, between student achievement scores and the growth in GDP per capita (in accord with endogenous growth models). The difference in actual GDP in 2008 and the simulated GDP is a measure of the economic cost of the achievement gap. As seen in Table 1.4, this analysis shows that the largest impact results from the international achievement gap, an estimated cost to the United States of 9–16 percent of GDP, or $1.3 to $2.3 trillion as of 2008. Smaller, but still economically meaningful costs were associated with the race-ethnic achievement gap (2–4 percent of GDP), the income achievement gap (3–5 percent of GDP), and the school systems achievement gap (3–5 percent of GDP).

Using a second method, the McKinsey study estimated the cost of achievement shortfalls for African-Americans and Latinos in the current workforce in terms of individual earnings, drawing on research that estimates the relationship between student achievement and labor market earnings. That exercise showed an estimated cost of the race-ethnic achievement gap in terms of forgone earnings for the current workforce ranging from $120 billion to $160 billion in 2007 dollars.

Hanushek and Woessmann (2010), in a study for the OECD, also examined the economic impacts of achievement gaps on an international scale, quantifying the gains in GDP that would accrue from improvements in achievement scores in developed countries or from narrowing cross-national score gaps. Drawing on PISA data and the same body of evidence of the relationship between student achievement and GDP growth used in the McKinsey study, the authors model the dynamics of GDP growth to 2090 that would result from boosting student performance over current levels, assuming a 20-year linear phase-in period to achieve the test score gains. Assuming a 40-year work life, the impact of the gap closing occurs over a 60-year period (20 years of gap closing and 40 annual cohorts until the entire workforce has no gaps). Future gains in GDP are discounted to 2010 dollars using a 3-percent discount rate. For example, the authors estimated that cumulative U.S. GDP through 2090 would increase by $72 trillion in present-value 2010 dollars if the performance of all U.S. students were bought up to the lowest score deemed as proficient (400 points on the PISA) over a 20-year period. Another simulation estimated that the cumulative increase in U.S. GDP in 2010 present-value dollars would reach $103 trillion if U.S. students performed at the level of Finland (546 points on the PISA on average), the top-scoring PISA country (see Table 1.4).

More recently, Lynch and Oakford (2014) focused on the economic impact of race-ethnic achievement differences in the United States, also based on PISA data. They adopt a similar approach as Hanushek and Woessmann (2010), with a 20-year phase-in of the gap closing and another 40-year period before all labor market cohorts benefit from the gap closing. The simulation also allows for the projected demographic shift in the distribution of race-ethnic groups in each successive cohort. Results are projected to 2090, but most results are presented as aggregates up to 2050. As summarized in Table 1.4, the Lynch and Oakford (2014) estimates show that closing race-ethnic achievement differences would mean that U.S. GDP in 2050 would be $2.3 trillion (6 percent) higher. Viewed cumulatively in present-value 2014 dollars using a 3-percent discount rate, the GDP gain is estimated to be $8.4 trillion. They also calculate the effects in terms of tax revenue, estimating a present-value gain of $3.0 trillion through 2050.

While differences in methodology mean that the estimates for the studies in Table 1.4 vary to some extent, the analyses represent an effort to quantify the costs to individuals and the economy of the shortfalls in student performance or, conversely, to place a value on the private and social economic benefits that would accrue from narrowing achievement differences across subgroups or across jurisdictions (e.g., state or country). Such estimates can be viewed as the "shadow prices" or economic values that can be attached to policies that would serve to reduce differences in education performance by race-ethnicity, by socioeconomic status, or by jurisdiction (Karoly, 2008). The estimates of economic benefits can then be compared to the costs of the policies, programs, or interventions that would be required to achieve the gap closings using benefit-cost analysis methods to determine whether there are favorable economic returns. The national-level estimates from these recent studies suggest that the gains from narrowing achievement differences are likely to be substantial, with the potential to exceed the costs of the interventions or policy changes that would be required to actually close the existing gaps.

Road Map for the Report

To set a baseline for our analysis, we begin in Chapter Two with a review of the Pennsylvania statewide level and trends in public school student academic performance, considering patterns at a point in time and over time by grade and test subject according to the PSSA and the NAEP. Chapter Three centers on our primary interest in differences in academic performance between subgroups of Pennsylvania students defined by race-ethnicity and socioeconomic status, again using both data sources. We also examine differences across Pennsylvania school districts based on PSSA data. For this chapter, we limit our analysis to eighth-grade reading and math scores, as well as the high school graduation rate. In Chapter Four, we place student performance in Pennsylvania in the context of other U.S. states and other countries, based on the comparable data in the NAEP and PISA, again focusing on academic achievement in eighth-grade and high school graduate rates. Chapter Five provides the economic analysis of the costs of the student performance gaps for Pennsylvania measured in Chapter Three. The estimates rely on several different analytic approaches for either capturing the economic cost of existing gaps or projecting the gains from closing current gaps. A final chapter summarizes the findings and draws out the policy implications.

2. Student Performance in Pennsylvania: Levels and Trends

In this chapter, drawing on the data sources described in the prior chapter, we present aggregate results for the levels and trends in student performance—achievement test scores and high school graduation rates—in Pennsylvania. Considering student performance in aggregate provides a context for understanding the differences in student achievement described in the next chapter. Where we consider time trends, our aim is to be descriptive: We do not seek to explain the patterns over time and the contribution of various factors, such as demographic shifts, as well as the potential role of policy changes.

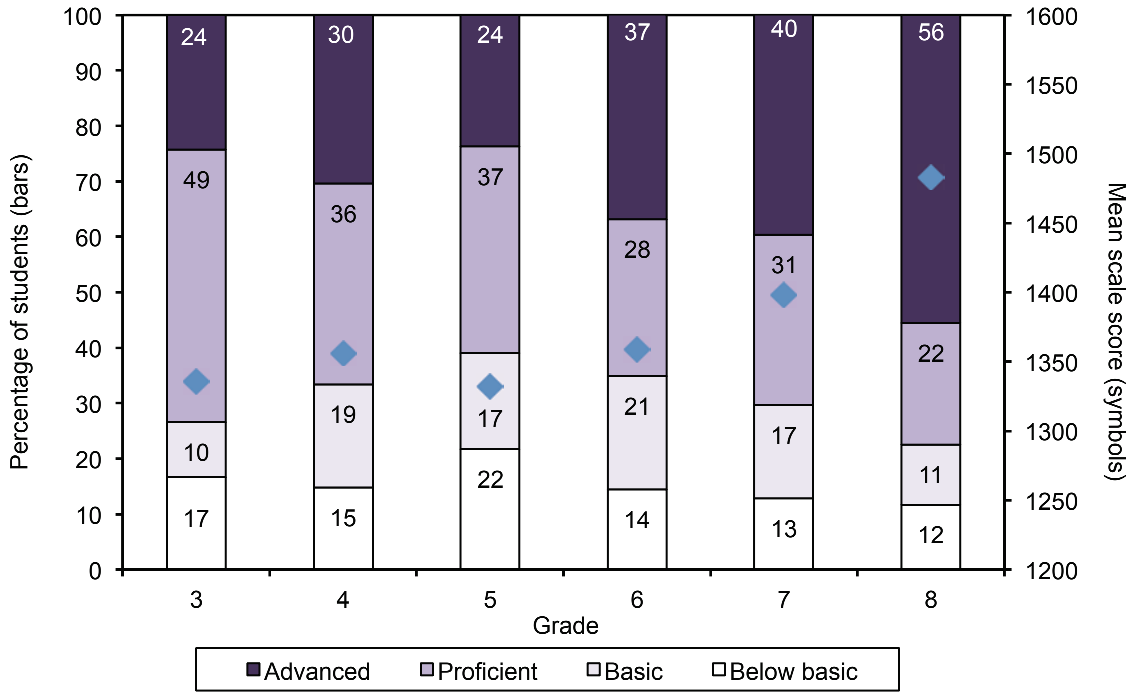
We begin by describing the basic patterns in student achievement based on the PSSA and then contrast those findings with the patterns evident in the NAEP. Results for the four-year ACGR are presented in a final section. These analyses lead to the following key findings:

- According to the statewide PSSA in 2013, 78 percent of eighth graders were proficient or advanced in reading, and 74 percent were proficient or advanced in math. For third to seventh grade, the share of students who achieved proficiency was higher in math than in reading.
- When assessed using the NAEP in fourth and eighth grades, a smaller share of Pennsylvania students were classified as proficient or above in reading and math compared with the PSSA results in the same grades and subject areas. Fewer than half (40 to 44 percent) of Pennsylvania fourth and eighth graders reached proficiency in reading and math according to the 2013 NAEP.
- The share of students achieving proficiency on the PSSA began to increase in 2005 or 2006, depending on the grade and subject, but the trajectory reached a plateau starting in 2010 to 2011. Student performance on the PSSA was generally lower in 2013 compared with recent years. In contrast, the NAEP shows continued improvement in reading and math scores, albeit modest, through 2013.
- Following the progression of PSSA scores for a given cohort through time, there is some evidence that later cohorts—such as the cohort that will graduate in 2017—performed modestly better on the PSSA than earlier cohorts—such as the one that graduated in 2011, although the pace of improvement slowed in the most recent cohorts. This slight cohort upgrading is also evident in the NAEP.
- Pennsylvania's four-year adjusted cohort graduation rate reached 86 percent as of 2013. This is a 3-percentage-point increase over the rate of 83 percent recorded in 2011.

Student Achievement Measured by the PSSA

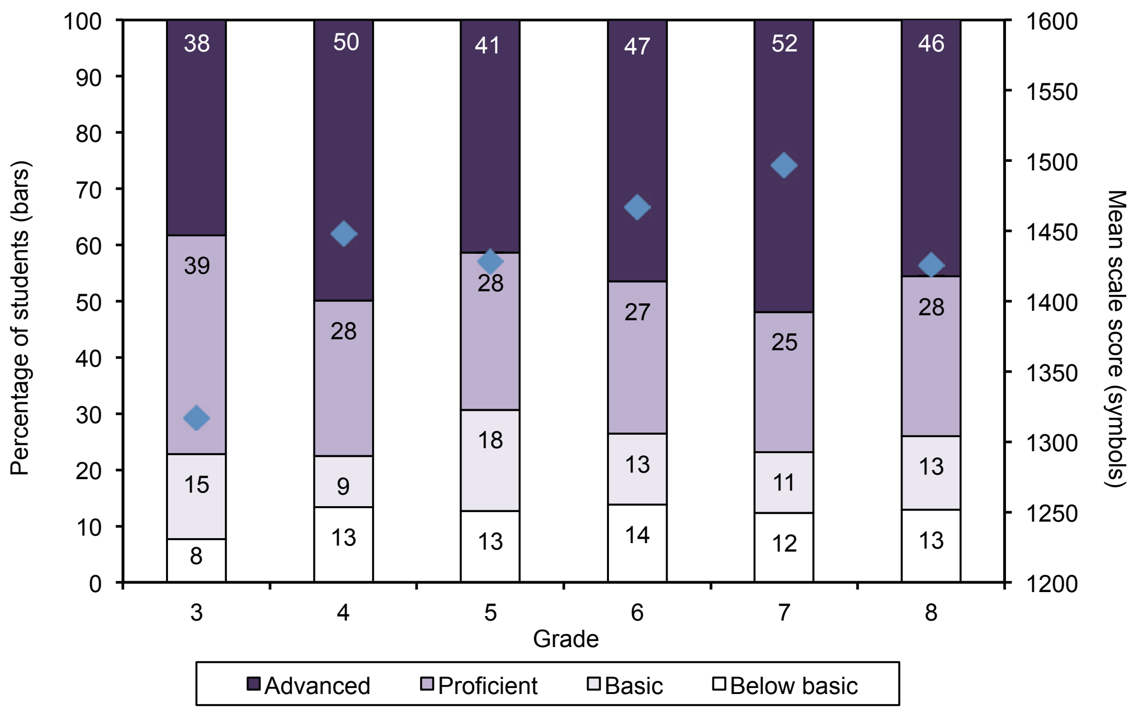
Figure 2.1 charts the pattern of PSSA assessment results in 2013 for reading across grades 3 to 8. Figure 2.2 shows the equivalent results based on the PSSA math assessment. In both figures, we graph, on the left axis, the percentage distribution of students according to the achievement level they attain: Starting from the bottom of the bars with the share below basic (no shading),

Figure 2.1. Mean Scale Score and Proficiency Distribution by Grade: PSSA Reading in 2013



SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Percentages may not total 100 due to rounding.

Figure 2.2. Mean Scale Score and Proficiency Distribution by Grade: PSSA Math in 2013



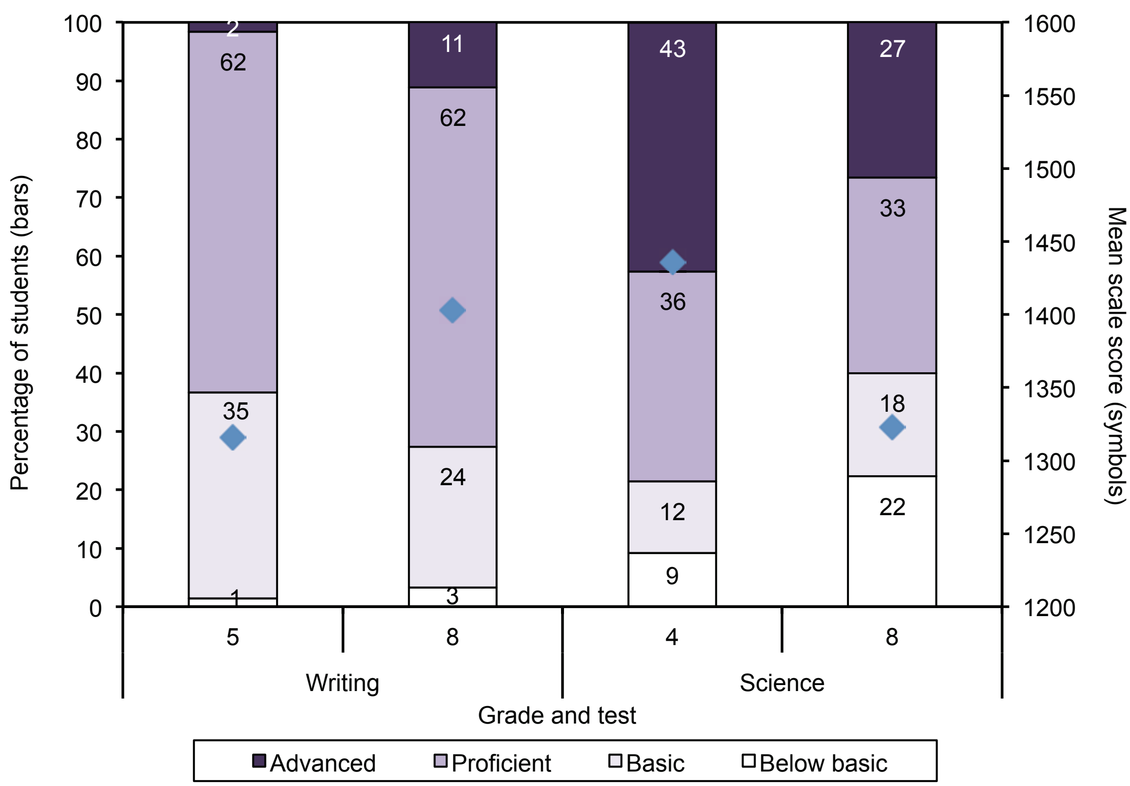
SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Percentages may not total 100 due to rounding.

then the share at the basic level, then the share proficient, and finally the share at the advanced level (darkest shading). The diamond symbols mark the mean scale score at each grade (right axis).

In the case of the PSSA reading assessment in 2013 (Figure 2.1), 73 percent of third graders reached the proficient or advanced level, compared with 78 percent of eighth graders. The share proficient or above was at a minimum in fifth grade (61 percent). The pattern of mean scale scores is effectively the mirror image of the share at the advanced level. Both are lowest in third and fifth grades and highest in eighth grade. For the PSSA math assessment in the same year (Figure 2.2), attainment at the proficient or advanced level was highest in third, fourth, and seventh grades (78 percent). With the exception of eighth grade, the share of students proficient or advanced is higher for the PSSA math assessment than for the reading assessment.

Figure 2.3 shows results for two other assessments in 2013: writing, assessed in fifth and eighth grades, and science, assessed in fourth and eighth grades. According to the writing assessment, 64 percent of students are proficient or advanced in fifth grade, a figure that reaches 73 percent in eighth grade. The pattern is reversed with the science assessment, where the share proficient or advanced is 79 percent in fourth grade and 60 percent by eighth grade.

Figure 2.3. Mean Scale Score and Proficiency Distribution by Grade: PSSA Writing and Science in 2013



SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Percentages may not total 100 due to rounding.

We also consider the pattern of student assessments through time, focusing on the results for eighth-grade students from 2004 to 2013. Results for the reading and math assessments are reported in Figures 2.4 and 2.5, respectively. For the reading assessment, the share proficient or advanced in eighth grade increased steadily from 2005 to 2010 and 2011, reaching a peak of 82 percent, before declining in 2012 and 2013. In the case of the math PSSA, after a series of increases, the peak was attained in 2011, with 77 percent proficient or advanced.[6]

We further examine the pattern of PSSA scores following the same cohort of students through time, considering their third-grade result in one year, their fourth-grade result in the following year, and so on through time, up through grade 11. We do this for four cohorts—2011, 2013, 2015, and 2017—in order to match the cohorts we can observe with the NAEP. We label each cohort by their year of high school graduation, assuming on-time completion.[7] As shown in Figures 2.6 and 2.7 for PSSA reading and math assessments, respectively, we can follow the 2015 and 2017 high school graduation cohorts through grade 8 with the 2004 to 2013 PSSA results. The 2013 graduation cohort can be followed starting in grade 5. The 2011 graduation cohort covers the same grades, but there is no result for grade 6 (given when the PSSA assessments in that grade began).

In the case of the PSSA reading assessment, this cohort perspective shows that the average cohort performance is about level between grades 3 and 5, increases to grade 8, and then drops in grade 11. The PSSA math assessments exhibit more of a U-shaped pattern for each cohort, with a peak in grade 7. (These patterns are similar to what was seen in the 2013 cross-section by grade plotted in Figures 2.1 and 2.2.) Further, the results seem to suggest that each successive cohort, moving from 2011 to 2013 and then 2015, did better at each grade than the prior cohort, although that performance improvement is less evident when comparing the 2015 and 2017 cohorts. Nevertheless, in both reading and math, the 2017 cohort generally had higher performance in fifth, seventh, and eighth grades (the three grades for which the comparison is possible, given the time frame we examine) compared with their counterparts in the 2011 cohort.

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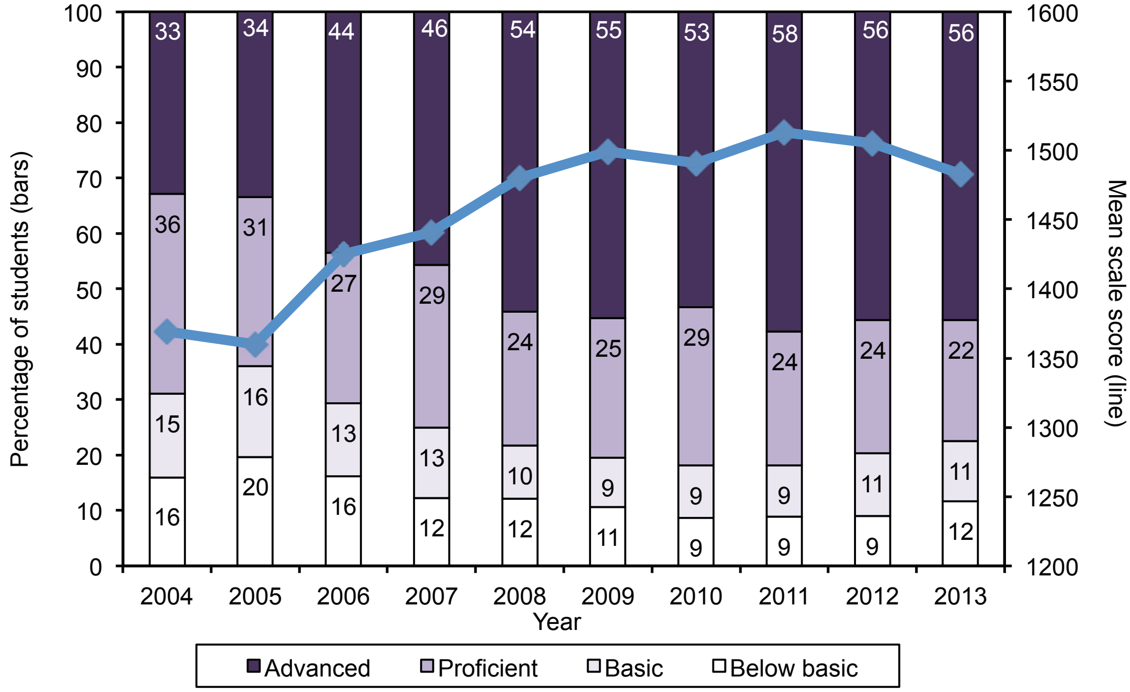
[6] Similar patterns are found over time in the reading and math PSSA assessments in grades 3 to 7. In each case, the percentage proficient or advanced reached a peak somewhere during the 2010 to 2012 period and then dropped to the level reported for 2013 in Figures 2.1 and 2.2.

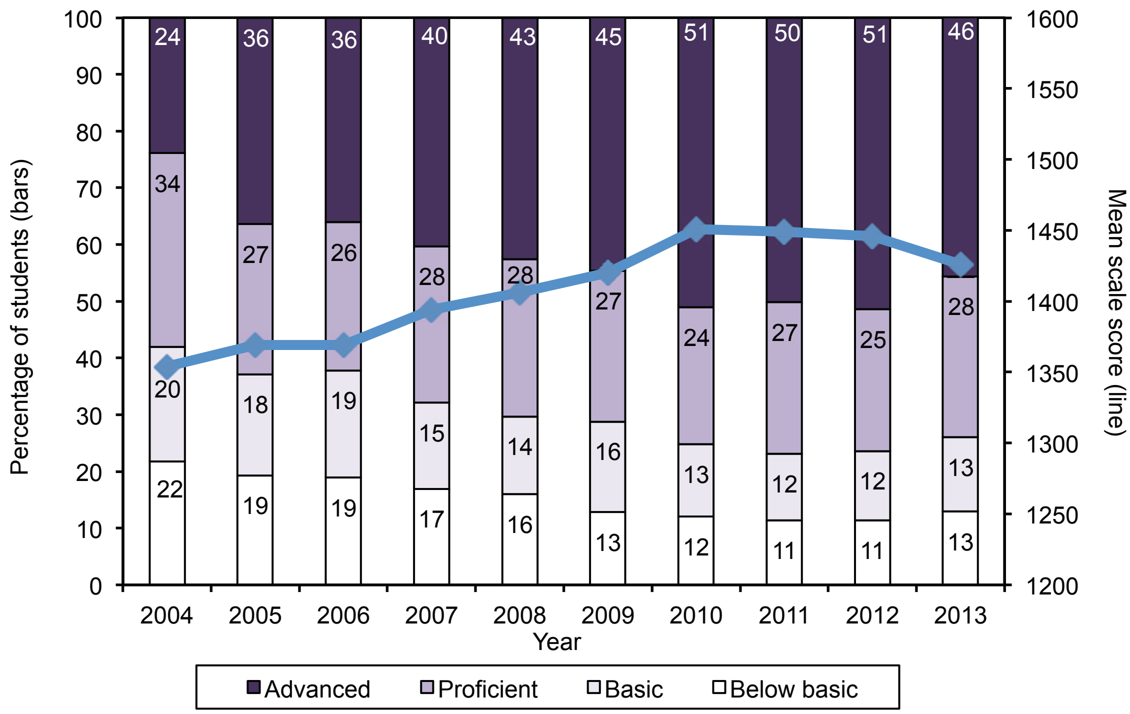
[7] For example, the eighth graders in 2013 are labeled as the 2017 cohort, as they would be expected to graduate four years later at the end of the twelfth grade. Similar patterns are seen when we examine the 2012, 2014, 2016, and 2018 cohorts.

Figure 2.4. Mean Scale Score and Proficiency Distribution by Year: PSSA Eighth-Grade Reading from 2004 to 2013



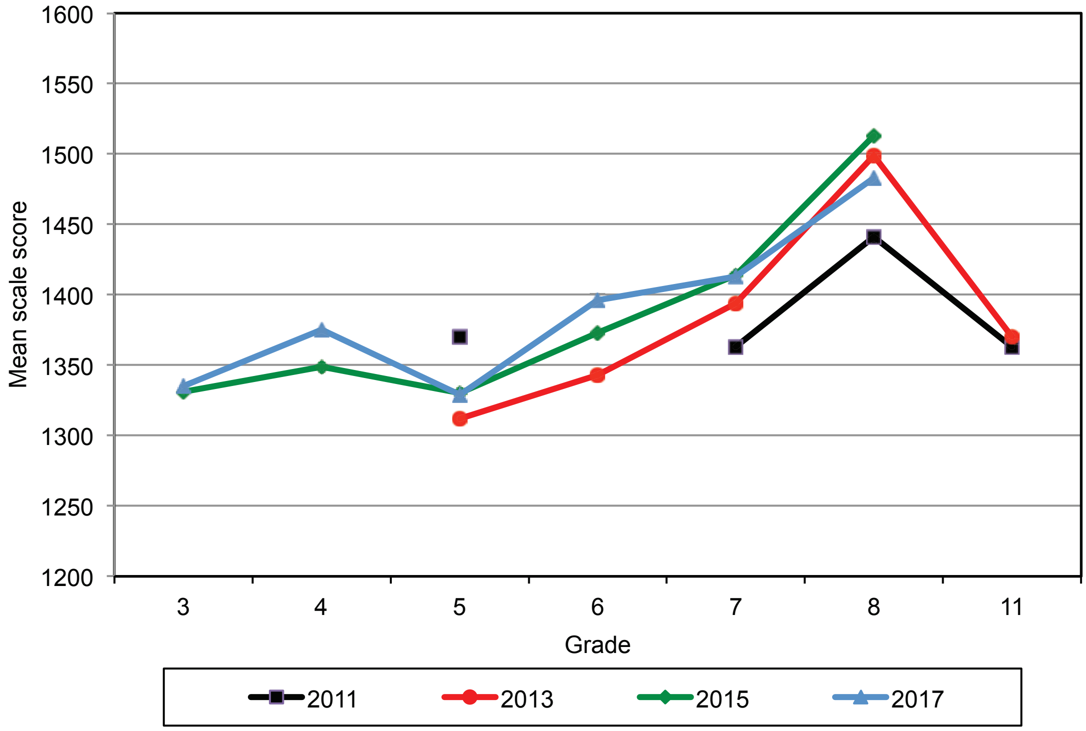
SOURCE: Author's analysis of 2004–2013 PSSA data.
NOTE: Percentages may not total 100 due to rounding.

Figure 2.5. Mean Scale Score and Proficiency Distribution by Year: PSSA Eighth-Grade Math from 2004 to 2013



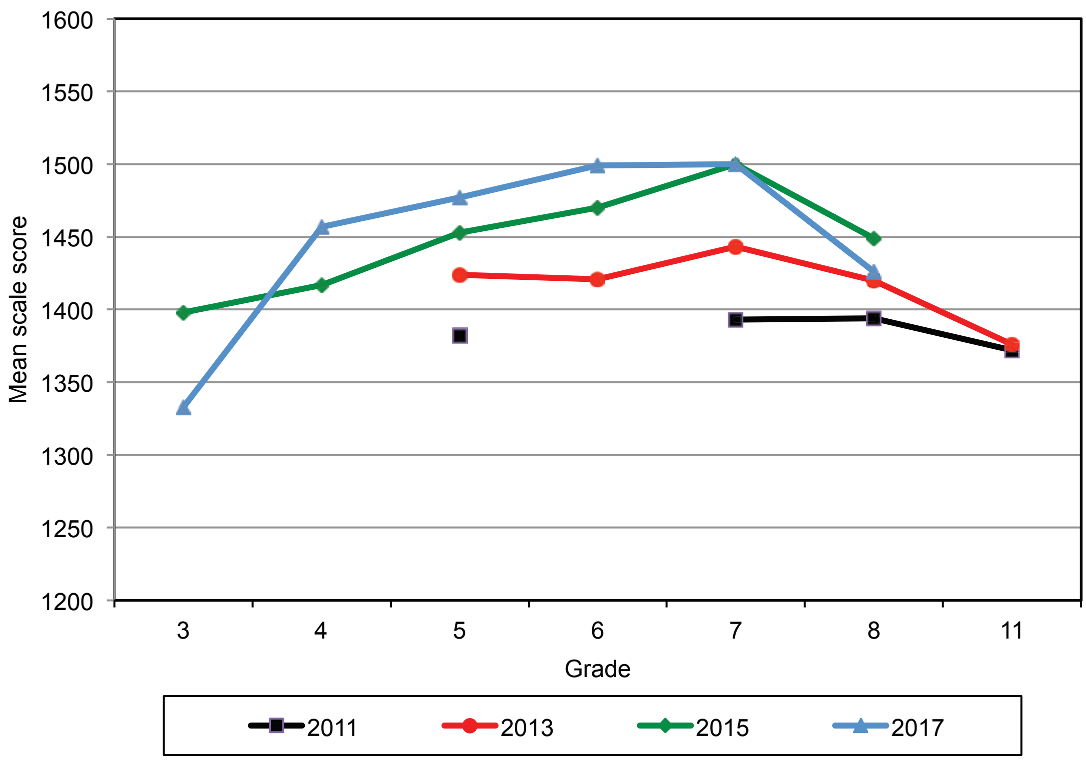
SOURCE: Author's analysis of 2004–2013 PSSA data.
NOTE: Percentages may not total 100 due to rounding.

Figure 2.6. Mean Scale Score by High School Graduation Cohort by Grade: PSSA Reading



SOURCE: Author's analysis of 2004–2013 PSSA data.

Figure 2.7. Mean Scale Score by High School Graduation Cohort by Grade: PSSA Math



SOURCE: Author's analysis of 2004–2013 PSSA data.

Student Achievement Measured by the NAEP

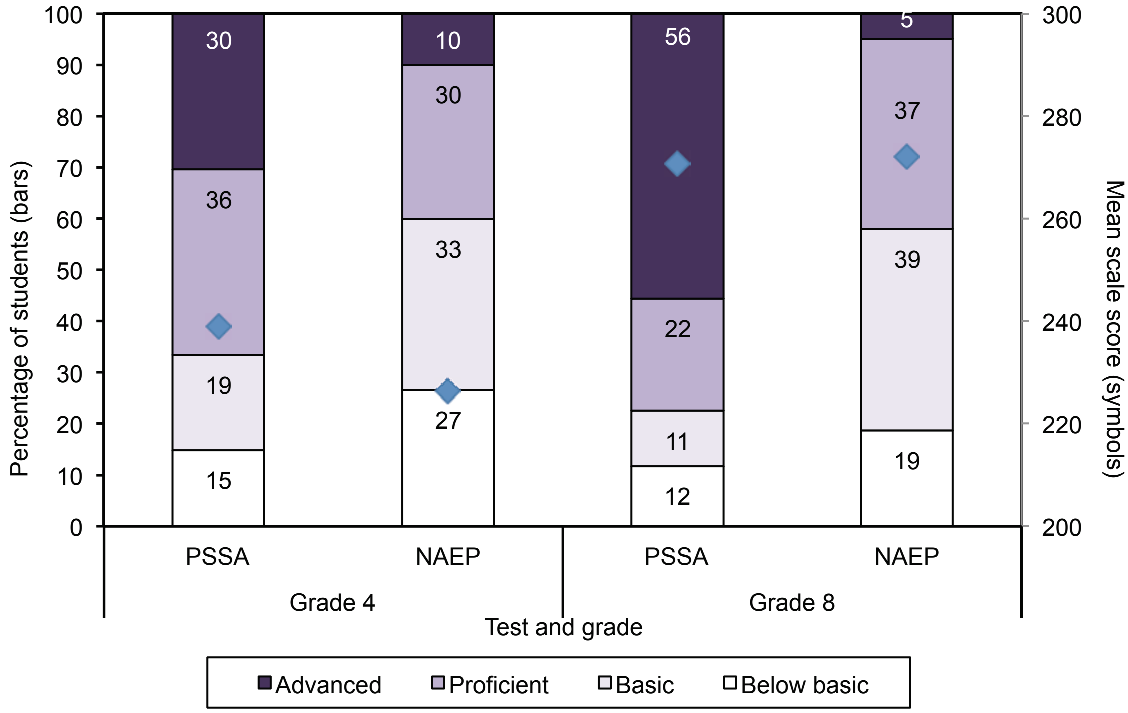
Results from the NAEP at grades 4 and 8 provide additional perspective on the performance of Pennsylvania students, and the same aggregate patterns by grade, through time, and across cohorts can be observed. Figure 2.8 contrasts the distribution of students by reading achievement level for the PSSA and NAEP in 2013. Figure 2.9 provides the same comparison for the math assessments. In both figures, scores in fourth grade for the two assessments are plotted on the left side of the chart, and scores in eighth grade are shown on the right side. As with prior charts, we display both the distribution of students by achievement levels (left axis) and the mean scale score (right axis). (Note that the PSSA scores have been transformed to fall in the same range as the NAEP scores.[8])

For both subjects and both grades, the NAEP assessments record a smaller share of students at the proficient or advanced level compared with the PSSA. (See Text Box 1.1 for a discussion of the differences in the achievement levels between the two tests.) For example, in eighth-grade reading, the NAEP records 42 percent of students as proficient or advanced, whereas the PSSA places 78 percent of students at those two achievement levels. Indeed, the advanced level of the PSSA has about the same share of students as the proficient and advanced levels of the NAEP. As noted in Text Box 1.1, this is a well-known feature of the proficiency levels as determined by state assessments versus the NAEP.

As of 2013, then, the NAEP indicates that fewer than half (a range of 40 to 44 percent) of Pennsylvania students in the fourth or eighth grades achieved proficiency (or above) in either reading or math. Further, the NAEP shows very little improvement in student performance between fourth and eighth grade in both reading and math, with little change in the percentage proficient or advanced (although mean scale scores do increase). This pattern is also evident in the PSSA.

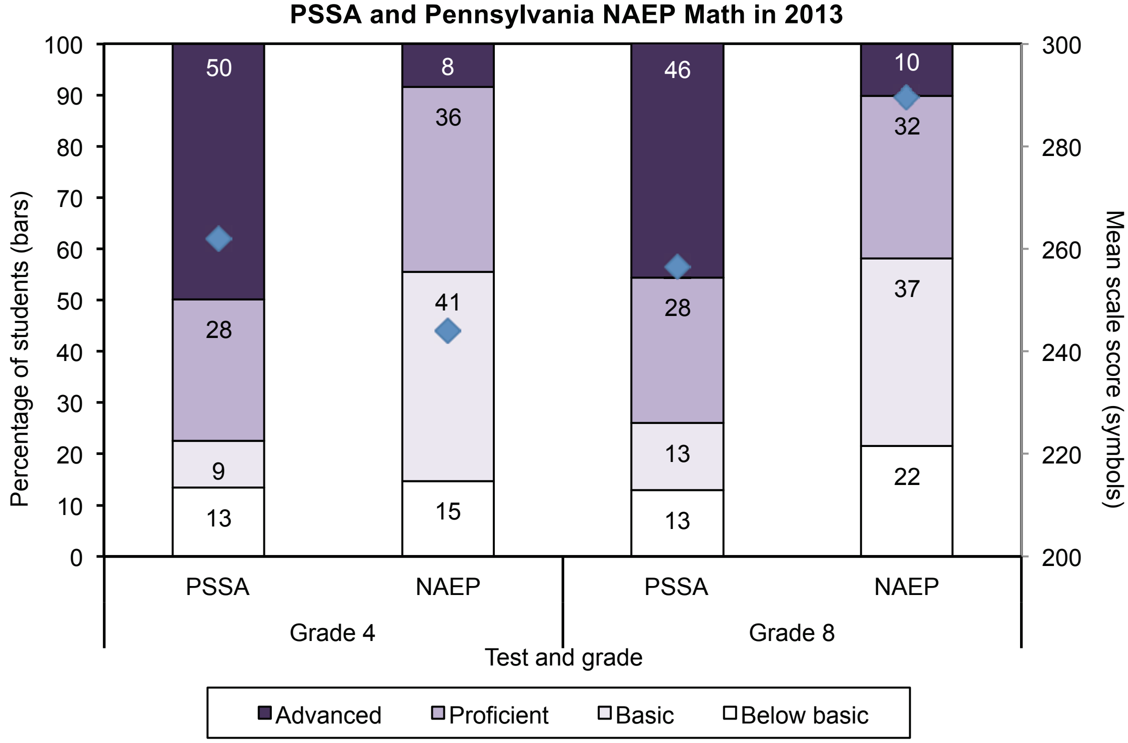
[8] The PSSA mean scale score is divided by four and then reduced by 100.

Figure 2.8. Mean Scale Score and Proficiency Distribution in Fourth and Eighth Grades: PSSA and Pennsylvania NAEP Reading in 2013



SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTES: PSSA scores have been transformed to plot on the NAEP scale. The rescaled PSSA mean scale score = (PSSA mean scale score/4) – 100. Percentages may not total 100 due to rounding.

Figure 2.9. Mean Scale Score and Proficiency Distribution in Fourth and Eighth Grades: PSSA and Pennsylvania NAEP Math in 2013



SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTES: PSSA scores have been transformed to plot on the NAEP scale. The rescaled PSSA mean scale score = (PSSA mean scale score/4) – 100. Percentages may not total 100 due to rounding.

Figures 2.10 and 2.11 examine the trend in NAEP scores at eighth grade from 2003 to 2013, as Figures 2.4 and 2.5 did for PSSA scores. For both reading and math, the NAEP mean scale scores increased from 2003 to 2009, dipped in 2011, and increased again in 2013. In both subjects, given the margin of error, the mean scale scores in 2009 and 2013 were not statistically different.[9] Thus, the NAEP confirms the pattern in the PSSA of a leveling off of the gains in proficiency and average performance since 2009 or 2010.

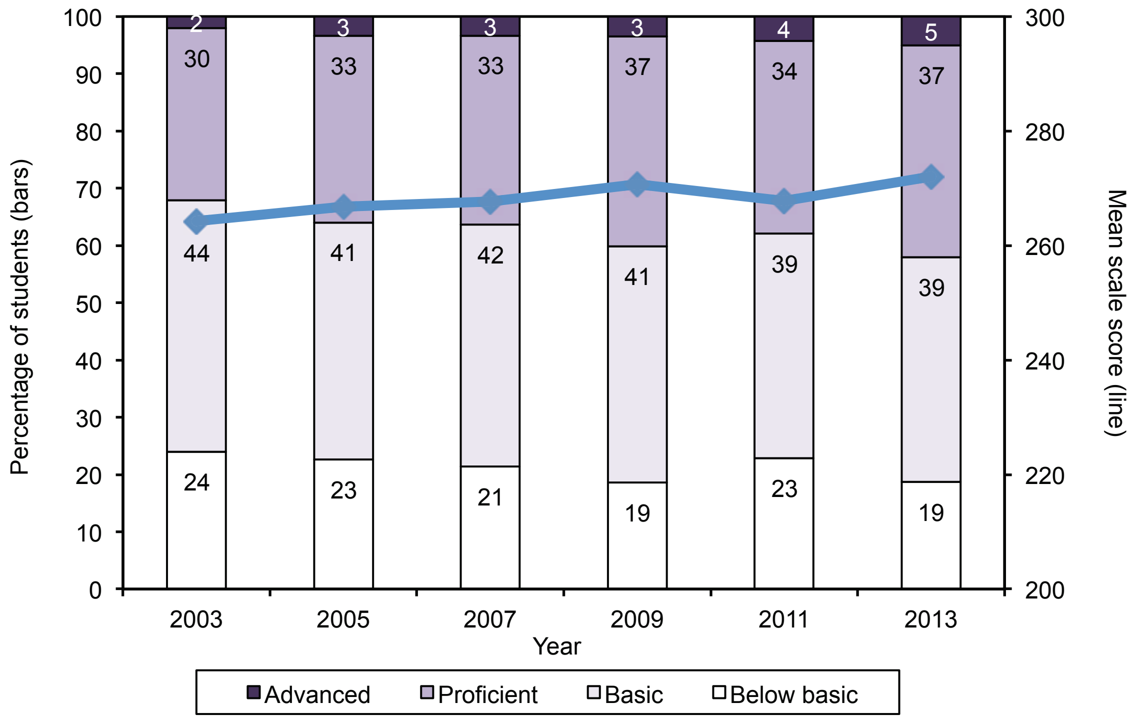
The cohort patterns for the NAEP shown in Figures 2.12 and 2.13, mirroring those for the PSSA in Figures 2.6 and 2.7, indicate that the 2017 cohort outperformed the 2011 cohort in fourth and eighth grades (by 5 and 4 scale points in reading at fourth and eighth grade, respectively, and by 8 and 4 scale points in math at the same two grades). This is consistent with the pattern seen earlier for the PSSA.

Student Attainment Measured by High School Graduation Rates

Our second measure of academic performance is the four-year adjusted cohort graduation rate. Figure 2.14 plots this rate for Pennsylvania from 2011 to 2013, the years currently available. The figure shows that as of 2013, 86 percent of those entering ninth grade (adjusted for those who leave the state and enter the state) graduated within four years. The rate stood at 83 percent as of 2011, so there is an apparent upward trend in the three-year time series.

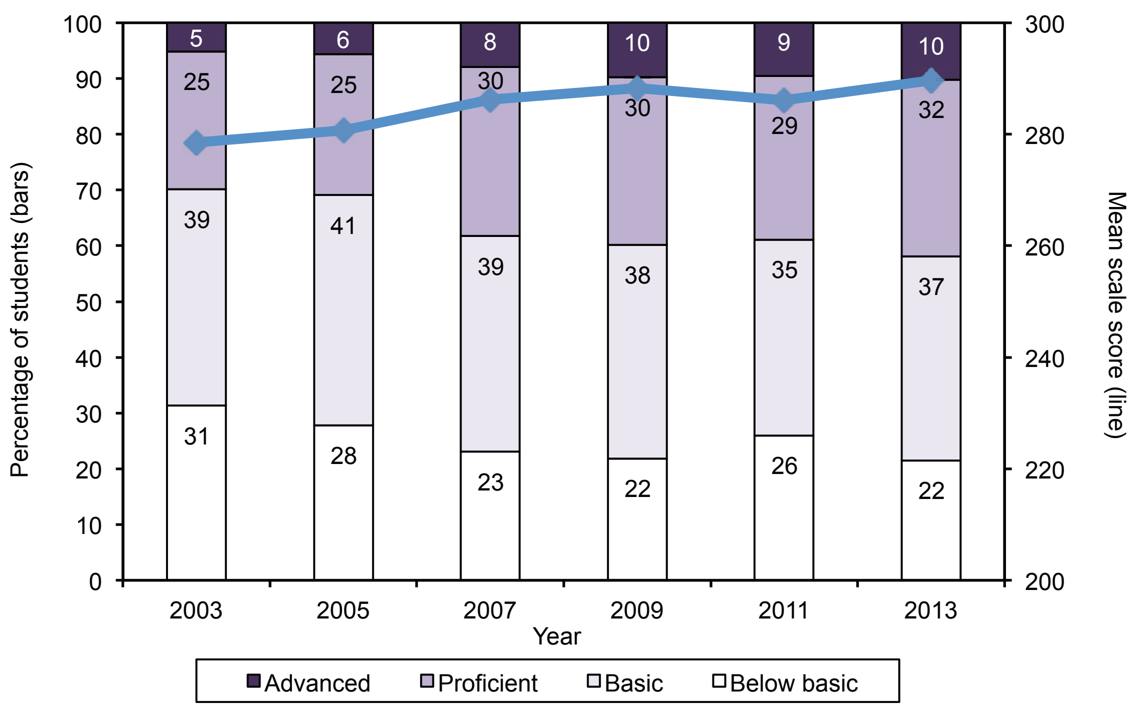
[9] For both reading and math, the Pennsylvania NAEP mean scale score in 2013 is significantly different (at the 5-percent level) from the scores in 2003 to 2007 and 2011 (i.e., 2009 is the exception).

Figure 2.10. Mean Scale Score and Proficiency Distribution by Year: Pennsylvania NAEP Eighth-Grade Reading from 2003 to 2013



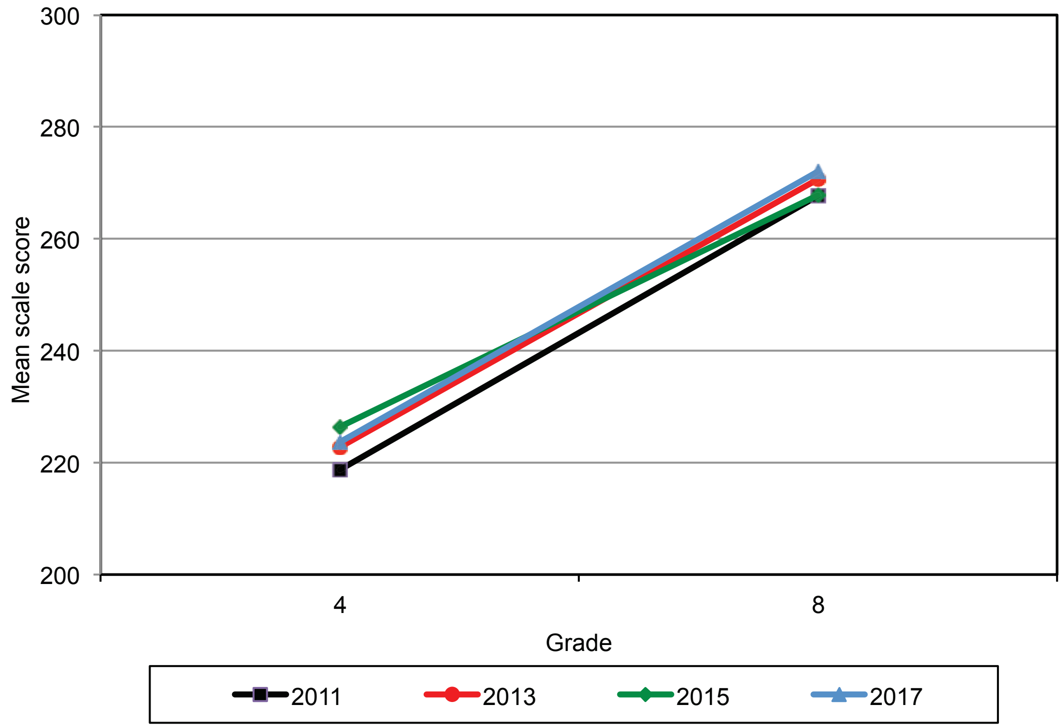
SOURCE: Author's analysis of 2003–2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

Figure 2.11. Mean Scale Score and Proficiency Distribution by Year: Pennsylvania NAEP Eighth-Grade Math from 2003 to 2013



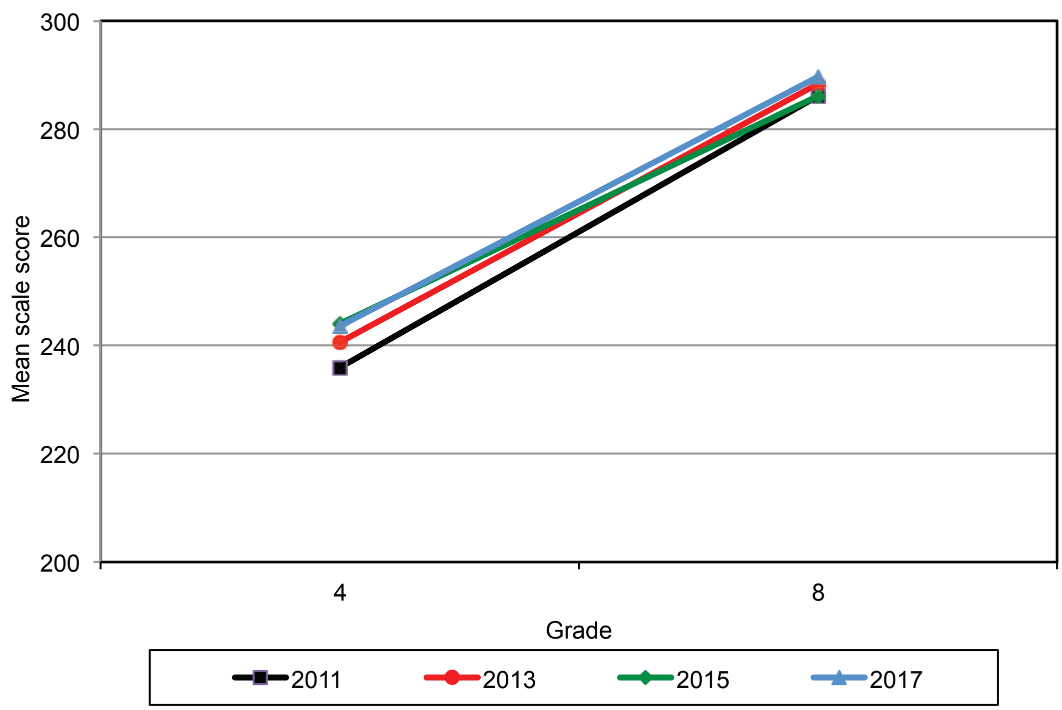
SOURCE: Author's analysis of 2003–2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

Figure 2.12. Mean Scale Score by High School Graduation Cohort by Grade: Pennsylvania NAEP Reading



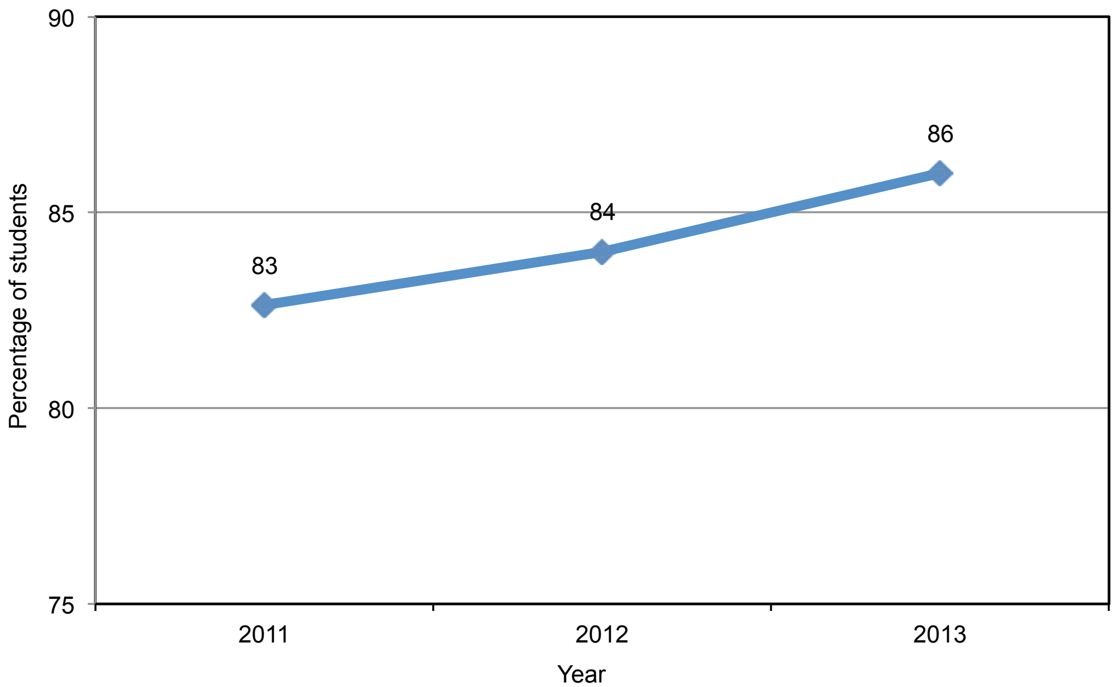
SOURCE: Author's analysis of 2003–2013 NAEP data for Pennsylvania.

Figure 2.13. Mean Scale Score by High School Graduation Cohort by Grade: Pennsylvania NAEP Math



SOURCE: Author's analysis of 2003–2013 NAEP data for Pennsylvania.

Figure 2.14. Pennsylvania Cohort Four-Year Adjusted Cohort Graduation Rate: 2011 to 2013



SOURCE: Author’s analysis of 2011–2013 four-year ACGR data for Pennsylvania.

3. Academic Performance Gaps in Pennsylvania

Our primary interest is in differences in student academic performance, on both achievement tests and in terms of the high school graduation rate. In this chapter, we focus on the following performance gaps in reading and math for students in eighth grade:

- gaps by *race-ethnicity*, where we contrast the performance of non-Hispanic white students with their African-American and Latino counterparts
- gaps by *family economic status*, where we examine differences in academic performance between students who are classified as higher income (not economically disadvantaged in the case of the PSSA and the graduation rate; not FRPL eligible in the case of the NAEP) and those who are classified as lower income (economically disadvantaged or FRPL eligible)
- gaps by *parent educational attainment*, available only for the NAEP
- gaps across Pennsylvania *school districts*, available only for the PSSA.

We examine each of these four types of academic performance gaps in the sections that follow.

Before doing so, we note that Pennsylvania has a diverse student population in terms of race-ethnicity, family economic status, and parental education. Table 3.1 summarizes the distribution of students taking the eighth-grade PSSA and NAEP assessments in 2013 in terms of race-ethnicity, economic status, and parental education (NAEP only). The two sources show very similar distributions in terms of race-ethnicity and economic status, despite using different measures for the latter. Overall, the majority of Pennsylvania public school students in eighth grade are non-Hispanic whites (72 to 74 percent). African-Americans constitute 14 to 15 percent of the student population, while Hispanics or Latinos make up the third-largest demographic group, at 7 to 8 percent. Asians and other race-ethnic groups, such as American Indians, form the remaining 5 percent.

In terms of economic status, according to the PSSA, 42 percent of eighth-grade public school students are classified by their school as economically disadvantaged. The share is almost identical in the NAEP, where low economic status is defined as being FRPL eligible. Finally, based on student reports, the share of students in the NAEP with at least one college-educated parent is 54 percent. Nearly equal shares of students have a parent with some college education or who is a high school graduate. The smallest group is students whose parent(s) have not completed high school. About 8 percent do not report parent education, a group that, as discussed later, has an average NAEP score similar to those in the dropout category.

In the sections that follow, we quantify the size of performance differences by race-ethnicity, economic status, and parent education. We also describe differences across Pennsylvania school districts in student performance as another type of performance gap. In the final section, we simulate the impact on student test scores and the graduation rate from closing various school performance gaps. Key findings that emerge from these analyses include the following:

Table 3.1. Demographics of Pennsylvania Public School Students Taking Eighth-Grade PSSA and NAEP Assessments

Characteristics	Percentage of Eighth-Grade PSSA Test-Takers	Percentage of Eighth-Grade NAEP Test-Takers
Race-ethnicity (percentage distribution)		
White	71.9	74
African-American	14.7	14
Hispanic or Latino	8.4	7
Asian	3.1	3
Other	1.9	2
Economic status[a] (percentage distribution)		
Higher economic status	58.4	59
Lower economic status	41.6	40
Unknown	–	1
Highest education of parent(s) (percentage distribution)		
College graduate	–	54
Some college	–	16
High school degree	–	18
High school dropout	–	4
Unknown	–	8

SOURCES: Author's calculations based on the 2013 PSSA and 2013 NAEP for Pennsylvania.
NOTES: Demographics are based on students in eighth grade completing the PSSA or NAEP reading assessment. Results are very similar when the distributions are based on students completing the math assessment. – = Not available.
[a] Defined as not economically disadvantaged versus economically disadvantaged in the PSSA, and not FRPL eligible versus FRPL eligible in the NAEP.

- According to both the 2013 PSSA and 2013 NAEP, there are sharp race-ethnic differences in student achievement in eighth-grade reading and math. The share of white students achieving proficiency or above exceeds the share for African-American and Latino students by as much as 24 to 38 percentage points, depending on the assessment and subject. Measured in terms of student learning, African-American and Latino students in Pennsylvania are behind their white counterparts by the equivalent of about three years.
- There are equally large differences in student achievement based on family economic status, with gaps in the proficiency rate of 20 to 26 percentage points. The scale scores show economically advantaged students in Pennsylvania ahead in learning by two to three years on average when compared with their economically disadvantaged counterparts.
- The gaps in the four-year ACGR among Pennsylvania students are equally large, reaching 17 to 19 percentage points by race-ethnicity and 14 percentage points by family economic status.
- The PSSA data also document substantial differences in student performance across the state's 499 operating school districts. Excluding the bottom and top 10 percent of districts, there is still a gap of about the same magnitude as race-ethnic and socioeconomic gaps. District performance is generally higher in those districts with a lower share of African-American and Latino students and a lower share of economically disadvantaged students. But even in districts with a similar demographic makeup, there is still considerable variation in student performance.
- A series of gap-closing exercises demonstrates how much higher average statewide PSSA or NAEP scores would be if subgroup differences by race-ethnicity or socioeconomic

status were eliminated. These calculations show the biggest gain from closing economic status gaps (equal to 0.3 standard deviation units) compared with closing race-ethnic gaps (equal to about 0.2 standard deviation units). Closing gaps in student performance tied to parent education falls in between.

- Bringing all school districts in the lower half of the test score distribution up to the median district would have about the same effect as closing race-ethnic gaps. If all districts in the bottom 75 percent of the distribution were raised to the 75th percentile, the effect on aggregate test scores would be about the same as closing economic status gaps.
- These same gap-closing calculations show that the statewide four-year ACGR would rise from 86 percent to 90 percent if race-ethnic gaps were closed or to 91 percent if economic status gaps were eliminated. The statewide rate would go even higher if school districts in the bottom half of the distribution had the median district graduation rate.

Performance Differences by Race-Ethnicity

Figures 3.1 and 3.2 show the differences in student achievement in eighth grade by race-ethnicity according to the 2013 PSSA and 2013 NAEP for reading and math, respectively. Results are summarized in tabular form in Table 3.2. For summary purposes, in addition to showing the scale score gap (absolute difference in scores), we also report a standardized gap size (where the subgroup difference in scale scores is divided by the pooled standard deviation to generate an effect size). Finally, we show the gap in the percentage of students achieving proficiency or above, where we calculated the percentage point gap between the share proficient and above in the PSSA and the share at basic and above in the NAEP.

The figures and summary table demonstrate that there are sharp contrasts in the PSSA and NAEP results for white and Asian students compared with their African-American and Latino counterparts. For example, the NAEP assessment shows white–African-American and white–Latino gaps equal to 29 scale points in reading and 33 to 35 scale points in math.[10] Ten scale points on the NAEP is usually interpreted as a year of learning, so the gaps between white students and their African-American and Latino counterparts are sizeable. The race-ethnic gaps according to the PSSA are about 0.7 to 0.8 of a standard deviation. The magnitudes of the gaps are even larger based on the NAEP, with effect-size gaps in the 0.9 to 1.0 range. Overall, the estimated magnitudes of the race-ethnic achievement gaps for eighth-grade students are very similar regardless of whether we base our estimate on the PSSA or the NAEP with either the reading assessment or the math assessment.

Figure 3.3 likewise shows that there is a substantial gap in the graduation rate (i.e., the four-year ACGR) by race-ethnicity, with white students graduating at a rate of 90 percent in contrast to a rate of 73 percent for African-Americans and 71 percent for Latinos (see also Table 3.2, where the percentage point gaps are summarized).

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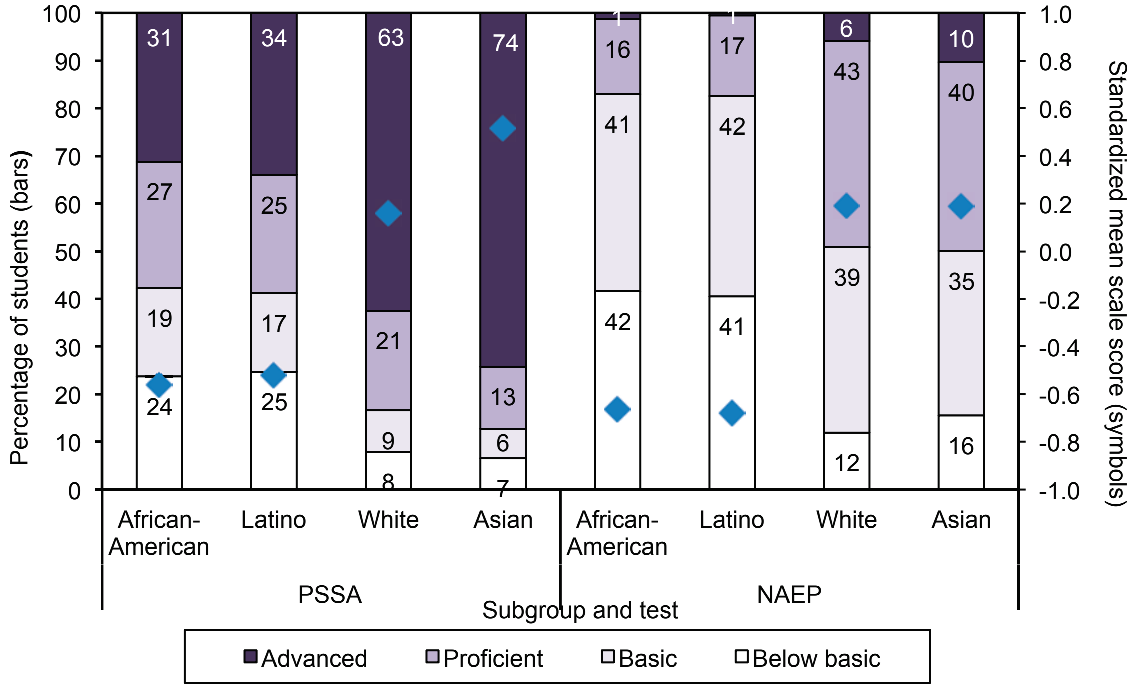
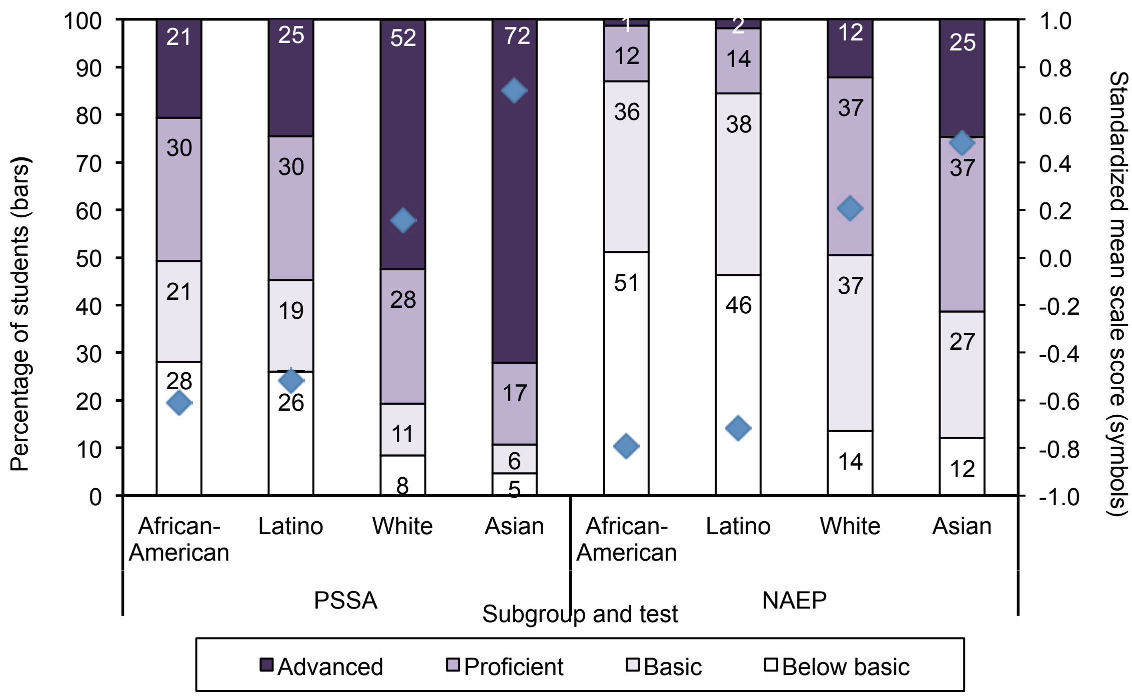
[10] The differences in the mean scale scores in the NAEP by race-ethnicity are statistically significant at the 5-percent level.

Figure 3.1. Mean Scale Score and Proficiency Distribution by Race-Ethnicity: PSSA and Pennsylvania NAEP Eighth-Grade Reading in 2013



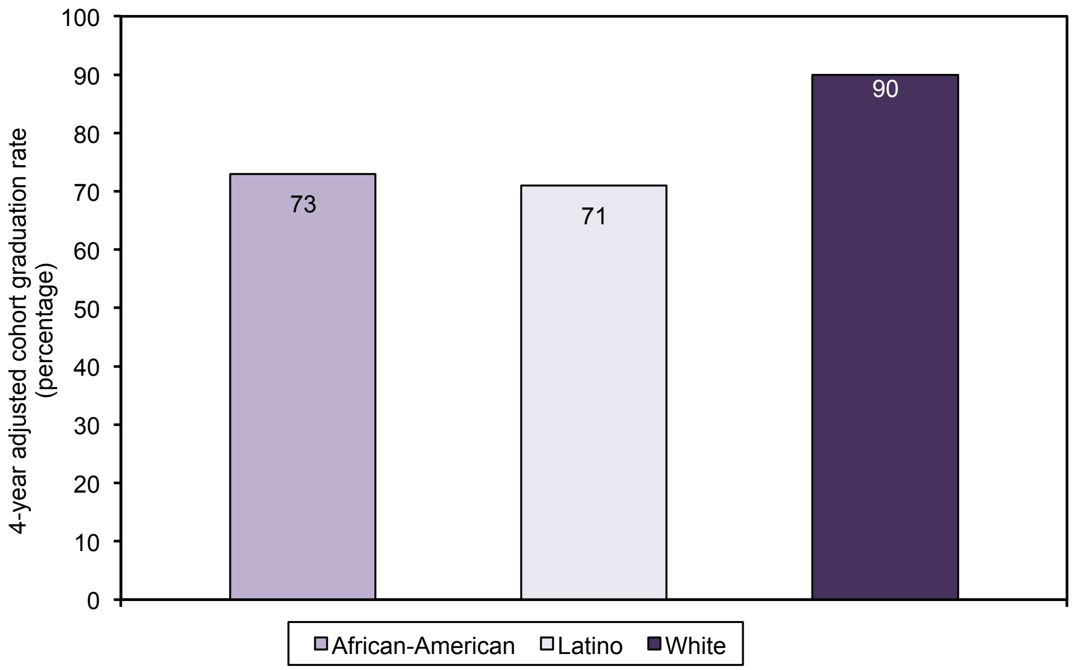
SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

Figure 3.2. Mean Scale Score and Proficiency Distribution by Race-Ethnicity: PSSA and Pennsylvania NAEP Eighth-Grade Math in 2013



SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

Figure 3.3. Pennsylvania Four-Year Adjusted Cohort High School Graduation Rate by Race-Ethnicity: 2013



SOURCE: Author's analysis of 2013 four-year ACGR data for Pennsylvania.

Table 3.2. Student Performance Gaps by Race-Ethnicity: Pennsylvania in 2013

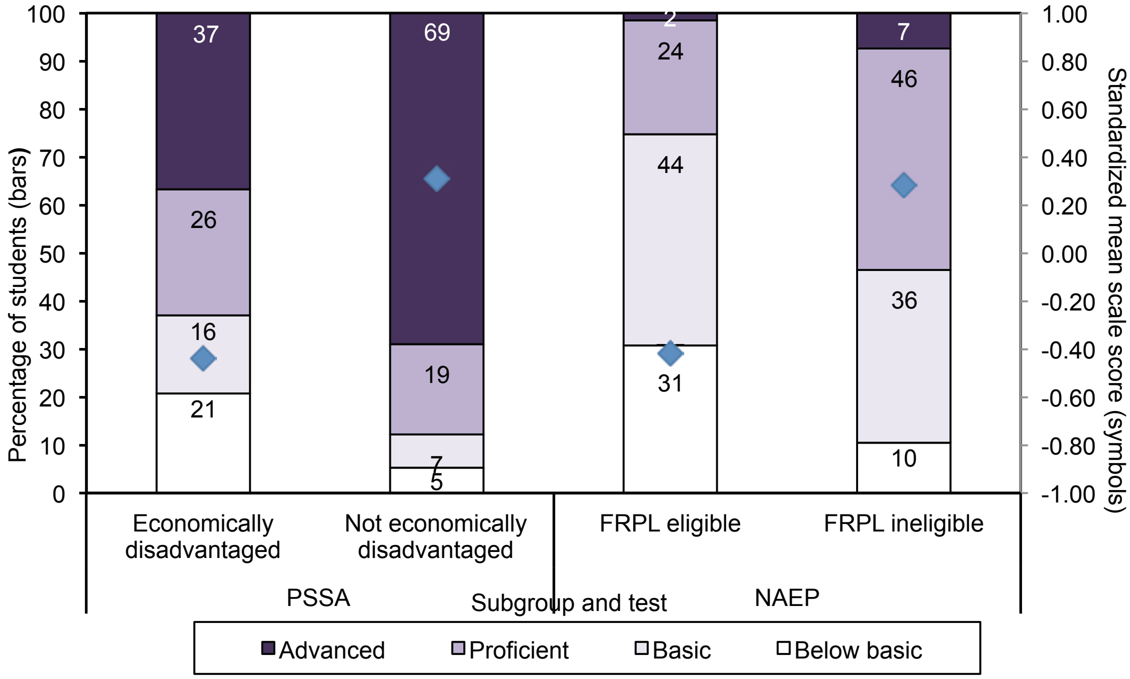
	White–African-American			White–Latino		
Measure	**Reading**	**Math**	**ACGR**	**Reading**	**Math**	**ACGR**
	a. Eighth-Grade PSSA					
Scale score gap (points)	189	170	–	179	150	–
Scale score gap (effect size)	0.72	0.77	–	0.68	0.68	–
Proficiency gap (percentage points)	25	30	–	24	26	–
	b. Eighth-Grade NAEP					
Scale score gap (points)	29	35	–	29	33	–
Scale score gap (effect size)	0.85	1.01	–	0.87	0.92	–
Proficiency gap (percentage points)	30	38	–	29	33	–
	c. Four-Year ACGR					
High school graduation gap (percentage points)	–	–	17	–	–	19

SOURCES: Author's analysis of 2013 PSSA data, 2013 NAEP data for Pennsylvania, and 2013 four-year ACGR data for Pennsylvania.
NOTES: Proficiency is measured in the PSSA by the percentage proficient or above. Proficiency is measured in the NAEP by the percentage at basic or above. – = Not applicable.

Performance Differences by Socioeconomic Status

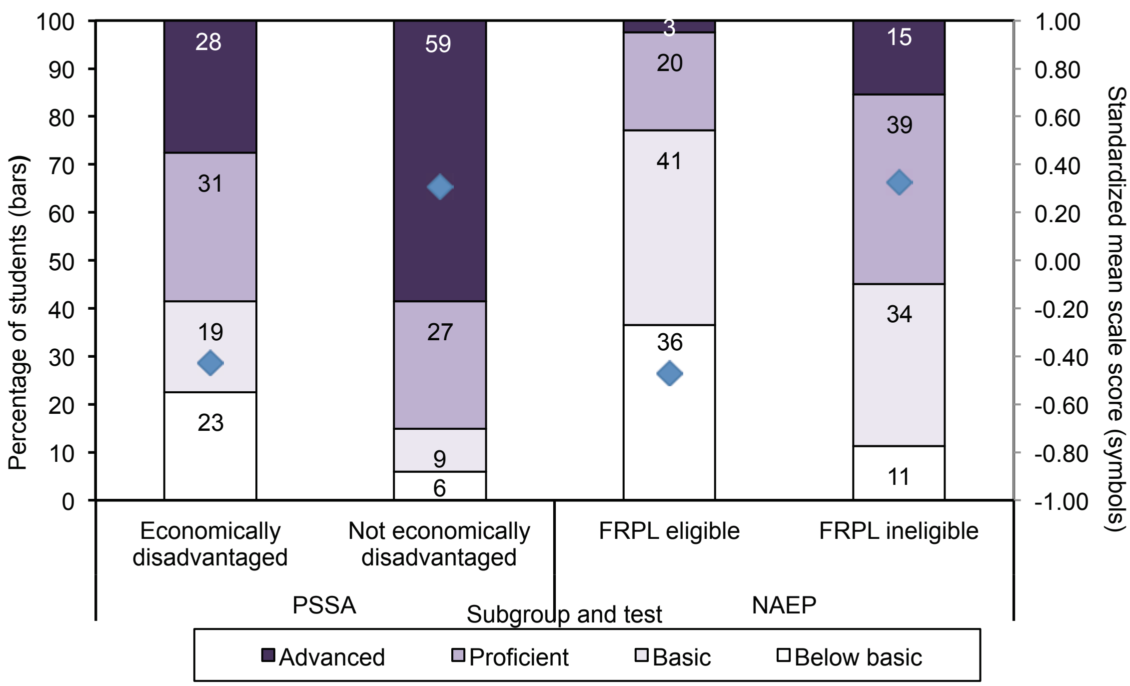
As seen in Figures 3.4 and 3.5 for reading and math respectively (and summarized in Table 3.3), there are also sizeable gaps in student performance based on family economic status. The contrast between high and low economic status equates to gaps ranging from 0.7 to 0.8 standard

Figure 3.4. Mean Scale Score and Proficiency Distribution by Economic Status: PSSA and Pennsylvania NAEP Eighth-Grade Reading in 2013



SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

Figure 3.5. Mean Scale Score and Proficiency Distribution by Economic Status: PSSA and Pennsylvania NAEP Eighth-Grade Math in 2013

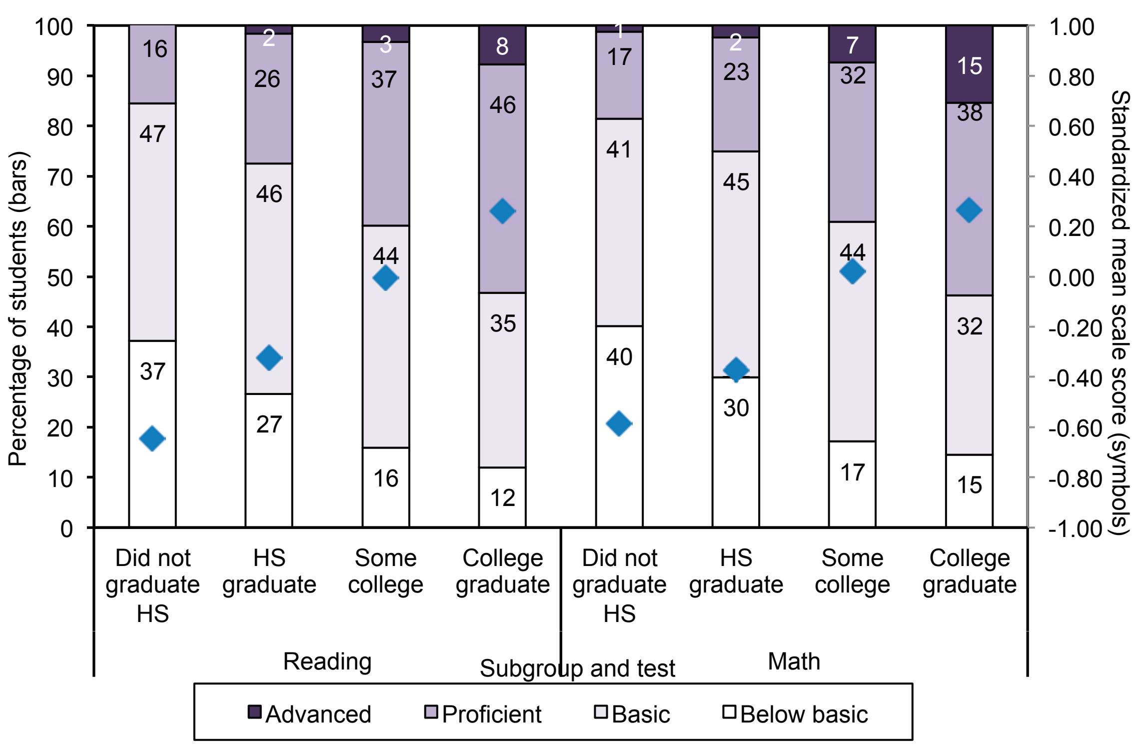


SOURCES: Author's analysis of 2013 PSSA data and 2013 NAEP data for Pennsylvania.
NOTE: Percentages may not total 100 due to rounding.

deviation units on the PSSA and NAEP.[11] The NAEP scale score gaps of 24 to 28 scale score points equate to two to three years of learning. The gap in the graduation rate is 14 percentage points, as the rate is 77 percent for the economically disadvantaged versus 91 percent for the nondisadvantaged.

For the NAEP, we can also quantify the differences in student performance in eighth grade based on parent education level, a measure available only in the NAEP data (see Figure 3.6 and Table 3.3). Here again, we see meaningful (and statistically significant) differences in the share who achieve proficiency and in the standardized scale score gap, with a steady increase in proficiency and scale scores in moving from the lowest to the highest education level. Contrasting the highest parent education level (college graduate) with the lowest (high school dropout), the difference in the share achieving proficiency ranges from 25 to 26 percentage points. The standardized scale score gap reaches 0.9.

Figure 3.6. Mean Scale Score and Proficiency Distribution by Parent Education: Pennsylvania NAEP Eighth-Grade Reading and Math in 2013



SOURCE: Author's analysis of 2013 NAEP data for Pennsylvania.
NOTE: HS = high school. Percentages may not total 100 due to rounding.

11 Again, the subgroup differences in the NAEP scores are statistically significant at the 5-percent level.

Table 3.3. Student Performance Gaps by Socioeconomic Status: Pennsylvania in 2013

Measure	High–Low Economic Status			High–Low Parent Education		
	Reading	Math	ACGR	Reading	Math	ACGR
a. Eighth-Grade PSSA						
Scale score gap (points)	197	163	–	–	–	–
Scale score gap (effect size)	0.75	0.73	–	–	–	–
Proficiency gap (percentage points)	25	26	–	–	–	–
b. Eighth-Grade NAEP						
Scale score gap (points)	24	28	–	31	30	–
Scale score gap (effect size)	0.70	0.80	–	0.90	0.85	–
Proficiency gap (percentage points)	20	25	–	25	26	–
c. Four-Year ACGR						
High school graduation gap (percentage points)	–	–	14	–	–	–

SOURCES: Author's analysis of 2013 PSSA data, 2013 NAEP data for Pennsylvania, and 2013 four-year ACGR data for Pennsylvania.

NOTES: Proficiency is measured in the PSSA by the percentage proficient or above. Proficiency is measured in the NAEP by the percentage at basic or above. Economic status is defined in the PSSA by being economically disadvantaged or not. Economic status in the NAEP is defined as having FRPL eligibility or not. Low parent education is defined as not completing high school, and high parent education is defined as receiving a college degree. – = Not applicable or not available.

Performance Differences Across School Districts

Beyond differences in student performance based on personal characteristics, we also consider the variation that existed across Pennsylvania's 499 operating school districts as of 2013. Results are based on the PSSA for students assessed with the eighth-grade test. The high school graduation rate is also available across districts. Here again, we see substantial differences in student performance in math and reading and in on-time graduation. Results are summarized in Table 3.4.

Panel (a) in Table 3.4 first shows the mean and standard deviation of the PSSA eighth-grade reading and math assessments (both as scale scores and proficiency shares), as well as key points on the score distribution, including the median, minimum and maximum, and key percentile points (10th, 25th, 75th and 90th). The high school graduation rate is shown as well. Because PSSA scale scores are difficult to interpret on their own, we also show key points on the distribution relative to the median in panel (b) and measured in standard deviation units (scale score gaps divided by the state-level standard deviation) in panel (c). Contrasting the bottom to the top of the distribution (10th and 90th percentiles), the difference in scale scores reaches about 0.8 to 0.9 scale score points on the reading and math assessments. The gap in proficiency from the 10th to 90th percentile is about 25 to 30 percentage points. The 90–10 gap in the high school graduation rate reaches about 15 percentage points.

To further illustrate the variation in PSSA performance across districts, Figures 3.7 and 3.8 show the differences in district PSSA scores in reading and math in 2013, where the color shading denotes the distance of the district mean scale score from the overall district mean:

Green shading indicates how far a district is above the mean, and purple shading indicates the distance below the mean. It is important to note that low-performing districts are distributed across the state in urban settings and in more-rural ones.

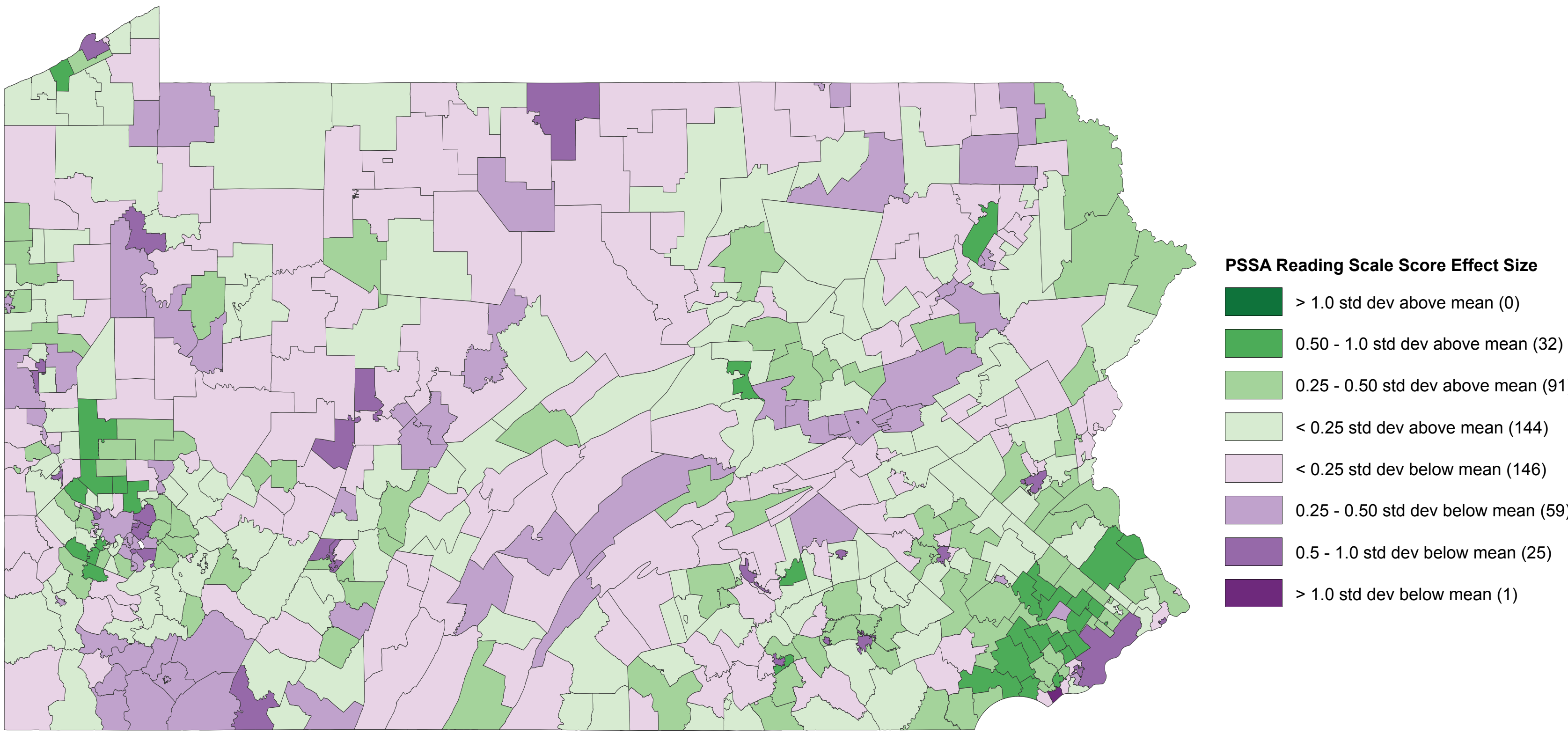
Some of the variation in school district performance may be attributable to differences in student demographics. For example, Figures 3.9 and 3.10 plot for all 499 operating school districts the mean scale score on the reading or math assessment against the percentage of

Table 3.4. Variation in Student Performance Across School Districts: Pennsylvania in 2013

	Eighth-Grade PSSA Scale Score		Eighth-Grade PSSA Proficiency		
Measure	**Reading**	**Math**	**Reading**	**Math**	**Four-Year ACGR**
a. Levels					
Mean	1493	1437	80	77	89
Standard deviation	84	75	10	12	8
Distribution					
Minimum	1201	1194	33	26	36
10th percentile	1390	1342	67	60	82
25th percentile	1445	1388	75	71	87
Median	1492	1441	82	80	91
75th percentile	1547	1485	87	86	94
90th percentile	1598	1536	91	91	97
Maximum	1710	1655	100	100	100
b. Gaps Relative to Median					
Distribution					
Minimum	–291	–247	–49	–54	–55
10th percentile	–102	–99	–15	–20	–9
25th percentile	–47	–53	–7	–9	–4
75th percentile	55	44	5	6	3
90th percentile	106	95	9	11	6
Maximum	218	214	18	20	9
c. Gaps Relative to Median in Standard Deviation Units					
Distribution					
Minimum	–1.11	–1.11	–	–	–
10th percentile	–0.39	–0.45	–	–	–
25th percentile	–0.18	–0.24	–	–	–
75th percentile	0.21	0.20	–	–	–
90th percentile	0.40	0.43	–	–	–
Maximum	0.83	0.96	–	–	–

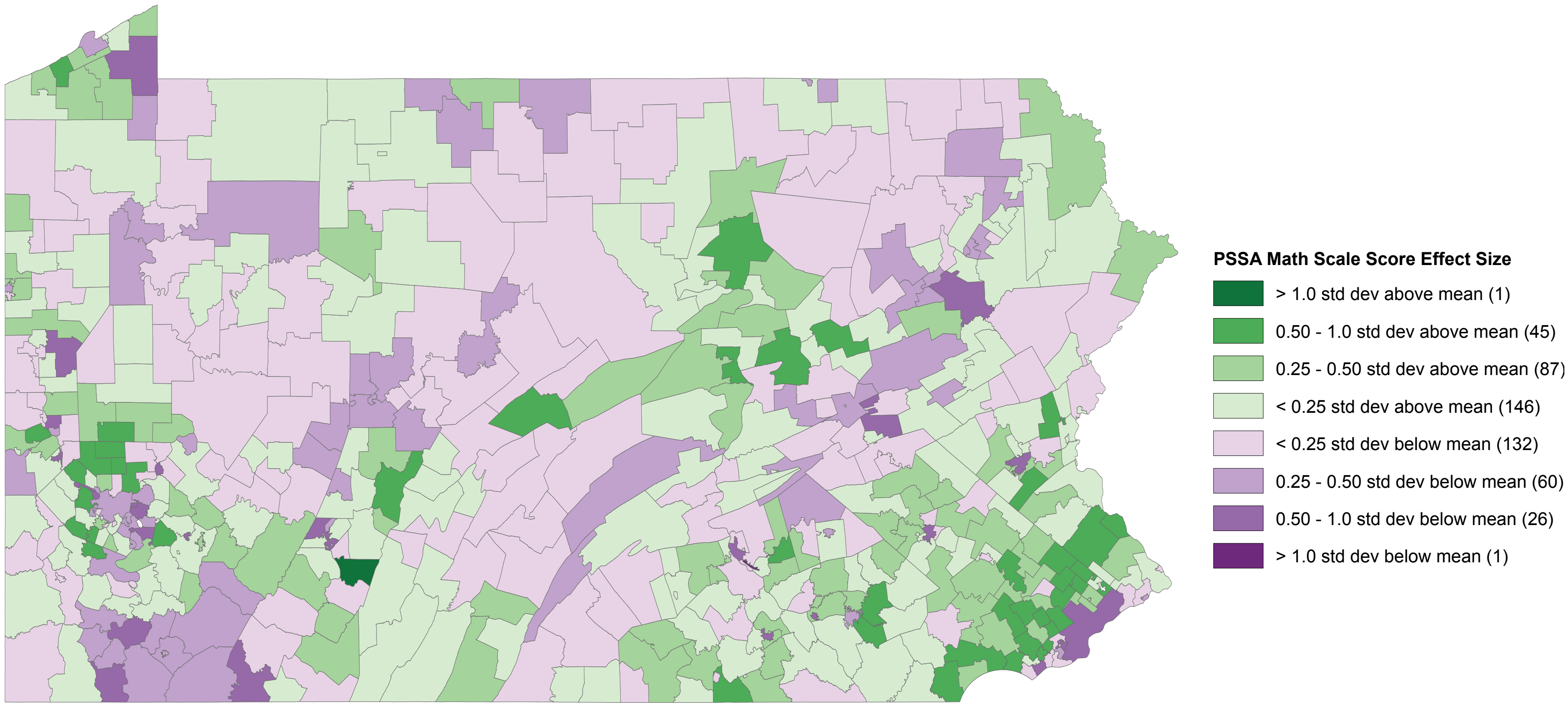
SOURCES: Author's analysis of 2013 PSSA data and 2013 four-year ACGR data for Pennsylvania.
NOTES: Proficiency is measured in the PSSA by the percentage proficient or above. Mean scale scores and proficiency are not reported for one urban school district because the number of students is too small. – = Not applicable.

Figure 3.7. Variation in School District PSSA Mean Scale Scores: PSSA Eighth-Grade Reading in 2013



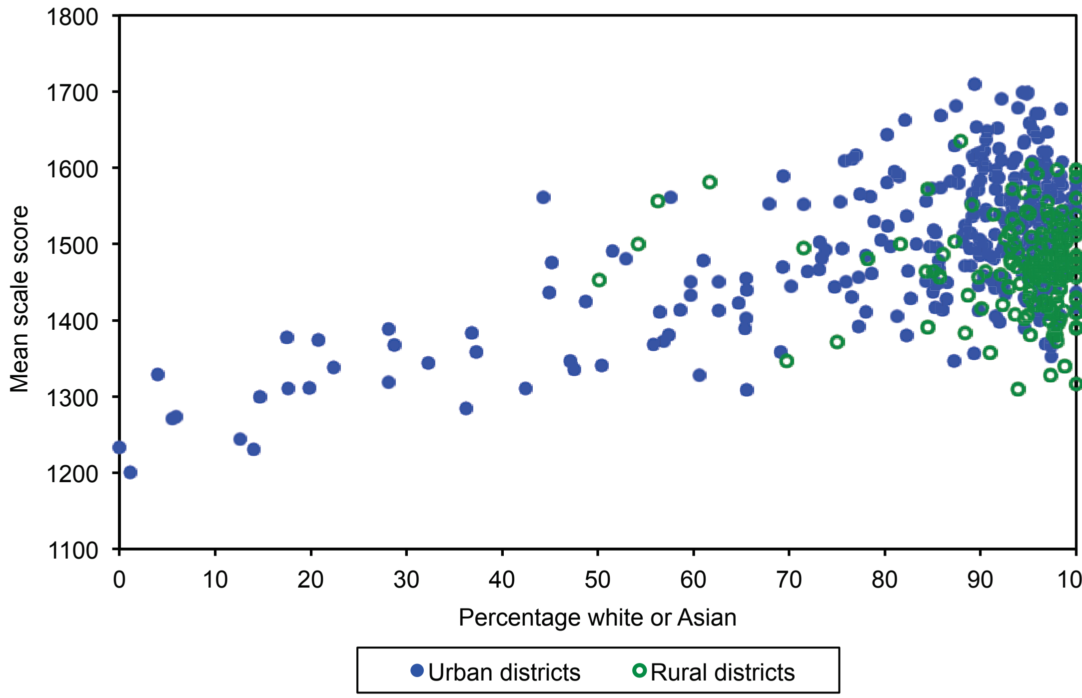
SOURCE: Author’s analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

Figure 3.8. Variation in School District PSSA Mean Scale Scores: PSSA Eighth-Grade Math in 2013



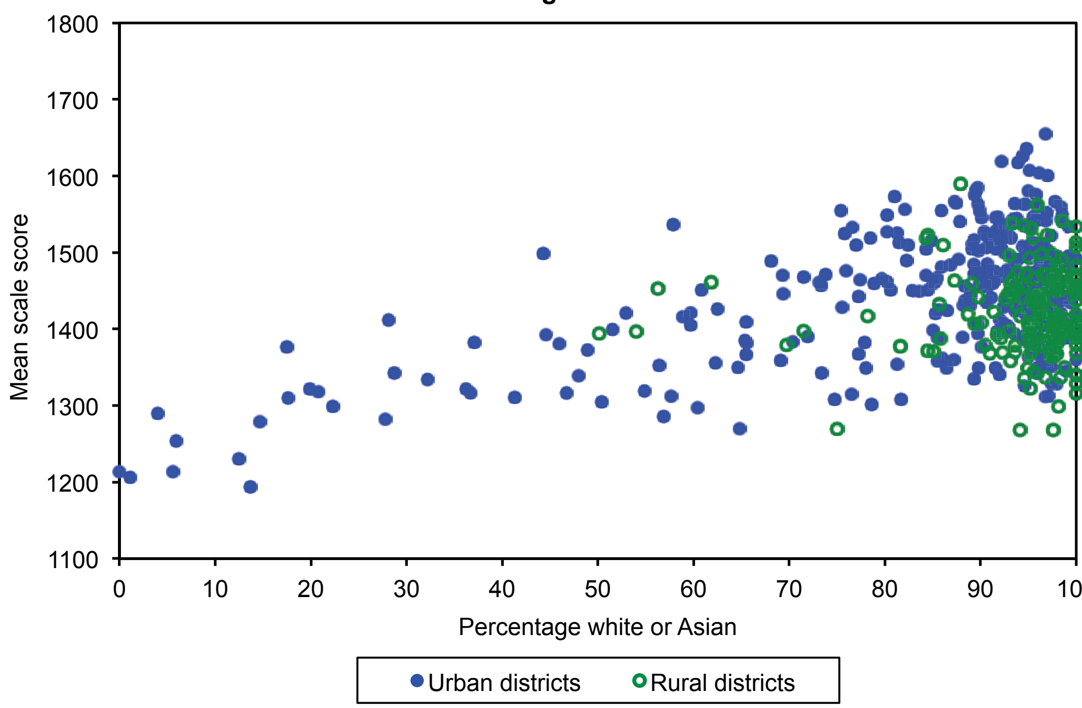
SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

Figure 3.9. Relationship Between District Mean Scale Score and Percentage of Students Who Are White or Asian: PSSA Eighth-Grade Reading in 2013



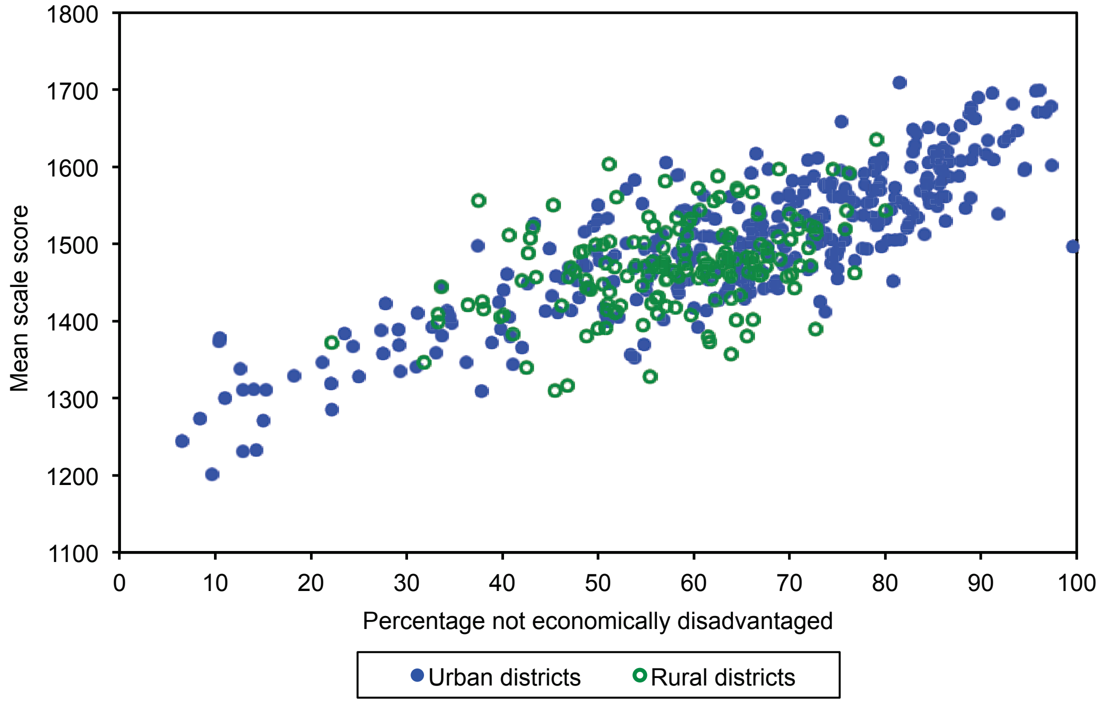
SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

Figure 3.10. Relationship Between District Mean Scale Score and Percentage of Students Who Are White or Asian: PSSA Eighth-Grade Math in 2013



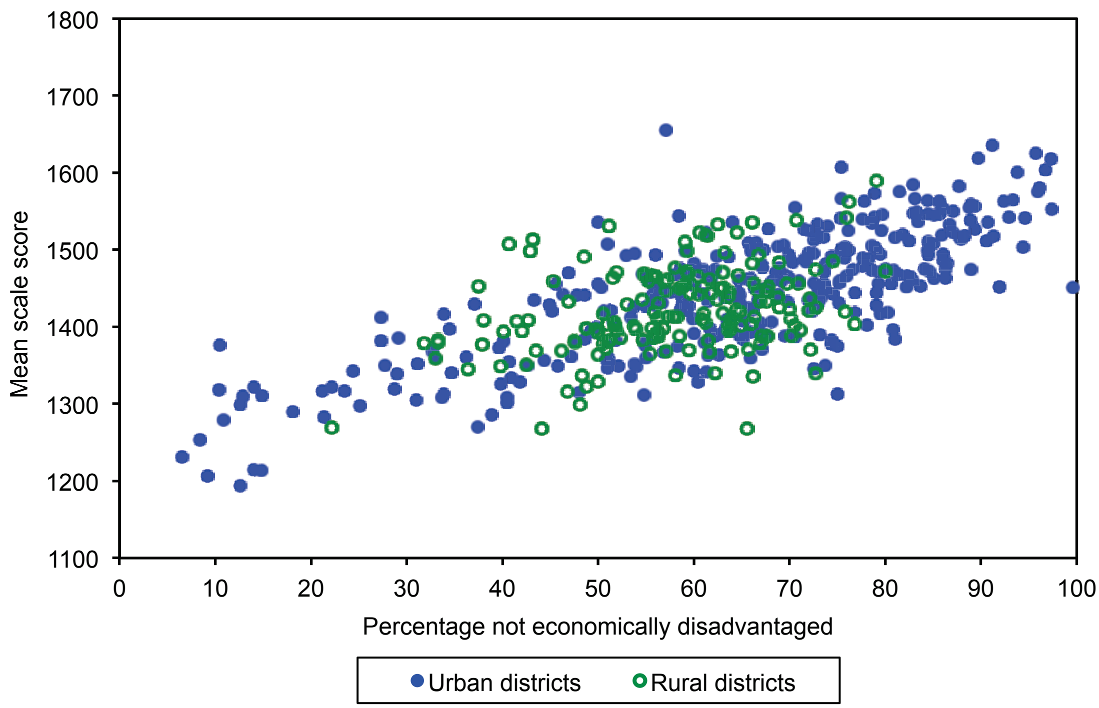
SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

Figure 3.11. Relationship Between District Mean Scale Score and Percentage of Students Who Are Not Economically Disadvantaged: PSSA Eighth-Grade Reading in 2013



SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

Figure 3.12. Relationship Between District Mean Scale Score and Percentage of Students Who Are Not Economically Disadvantaged: PSSA Eighth-Grade Math in 2013



SOURCE: Author's analysis of 2013 PSSA data.
NOTE: Mean scale scores are not reported for one urban school district because the number of students is too small.

students who are white or Asian. Blue dots indicate urban areas; green dots (open circle) indicate rural areas.[12] While there is an upward gradient, indicating that the district mean PSSA scale score increases as the share of minority students (African-Americans and Latinos) declines, there is considerable variation across districts with the same share of white or Asian students. A similar pattern is evident in Figures 3.11 and 3.12, where we have now plotted the share not economically disadvantaged on the horizontal axis. Again, there is a strong upward gradient indicating rising test scores as the economic status of the students increases, but it suggests that there is much variation that is not attributable to district demographics.

Impact of Closing Gaps on School Performance

Given the gaps in student performance that we have quantified—gaps by race-ethnicity, family economic status, and parent education, as well as variation across districts—we can calculate what the change would be in PSSA and NAEP test score outcomes and high school graduation rates if the observed gaps were closed. For example, we can set the mean scale score on a given assessment for African-American and Latino students to equal the mean scale score for white students and then use the actual population shares across the groups to calculate what the aggregate test score would be if the subgroup differences were eliminated. The new score will be a function of the size of the score gaps that are closed and the share of the student population in the groups where the gaps are closed.

Table 3.5 summarizes the results of a series of these "gap-closing" exercises. The first panel in the table shows the results based on the PSSA and for the high school graduation rate. The second panel shows results based on the NAEP. For each gap-closing exercise involving a test score, we report the actual score, the score with a given gap closed, and the score gain measured in standard deviation units. When the gap closing involves the graduation rate, we report the actual rate, the rate with the gap closed, and the percentage-point gain.

To illustrate, the first row in panel (a) shows that the eighth-grade PSSA mean score for reading would increase from 1483 to 1511 if the average test score for African-American students were equal to that for white students. The score gain of 28 points is equal to a 0.11 standard deviation change. The same exercise to close the white–Latino gap results in an overall score gain of 15 points, or 0.06 standard deviation units. Even though the white–Latino score gap is similar to the white–African-American gap (see Table 3.2), the overall effect is smaller

[12] Pennsylvania's 499 operating school districts are classified as urban or rural based on the Rural-Urban Commuting Area (RUCA) codes, Version 2.0, developed by the University of Washington Rural Health Research Center for the federal Health Resources and Service Administration (University of Washington Rural Health Research Center, undated). RUCA codes classify census tracts based on the Bureau of Census Urbanized Area and Urban Cluster definitions, in combination with work commuting information. We use the zip code version of the codes and Categorization C, defined by the University of Washington Rural Health Research Center, to convert the detailed RUCA codes into the urban and rural groups. The urban group includes suburban areas.

Table 3.5. Gains in Student Performance with Gap Closing: Pennsylvania in 2013

Gap Closed	Reading: Actual Score	Reading: Score with Gap Closed	Reading: Score Gain in SD Units	Math: Actual Score	Math: Score with Gap Closed	Math: Score Gain in SD Units	Four-Year ACGR: Actual Rate	Four-Year ACGR: Rate with Gap Closed	Four-Year ACGR: Percentage Point Gain
a. Eighth-Grade PSSA and Graduation Rate									
White–African-American	1483	1511	0.11	1426	1451	0.11	86	88	2
White–Latino	1483	1498	0.06	1426	1439	0.06	86	87	1
Combined	1483	1526	0.16	1426	1464	0.17	86	90	3
High–low economic status	1483	1565	0.31	1426	1494	0.31	86	91	5
High–low districts (to 50th percentile)[a]	1484	1530	0.17	1426	1472	0.20	85	93	8
High–low districts (to 75th percentile)[a]	1484	1564	0.30	1426	1499	0.33	85	95	10
b. Eighth-Grade NAEP									
White–African-American	272	276	0.12	290	295	0.14	–	–	–
White–Latino	272	274	0.06	290	292	0.07	–	–	–
Combined	272	278	0.18	290	297	0.21	–	–	–
High–low economic status	272	282	0.28	290	301	0.33	–	–	–
High–low parent education	272	281	0.26	290	299	0.27	–	–	–

SOURCES: Author's analysis of 2013 PSSA data, 2013 NAEP data for Pennsylvania, and 2013 four-year ACGR data for Pennsylvania.
NOTES: Economic status is defined in the PSSA by being economically disadvantaged or not. Economic status in the NAEP is defined as having FRPL eligibility or not. Combined effect size score gains may not add up because of rounding. – = Not applicable. SD = standard deviation.
[a] The analyses by school district are based on test score and graduation rate data for the 499 operating school districts and exclude other types of local education agencies (LEAs), such as comprehensive career and technical centers, occupational career and technical centers, charter schools, and state juvenile correctional institutes. For this reason, the actual state average result for the school district gap-closing exercise will not necessarily equal the actual state average result when students in all LEAs are included as they are for the gap-closing exercises by race-ethnicity and economic status.

because Latinos are a smaller share of the population than African-Americans. The combined effect of having both African-American and Latino students achieve the same average score as white students is to increase the overall PSSA score by 0.16 standard deviation units (i.e., the effects are additive). This same exercise based on the PSSA math assessment produces almost the same result of a 0.17 standard deviation unit change. In the second panel, the same gap-closing exercise based on the NAEP reading and math scores produces effects of 0.18 and 0.21 standard deviation units. This exercise would also bring the graduation rate up to 90 percent.

Table 3.5 also reports on the results from closing economic status gaps by bringing the performance of economically disadvantaged students up to the level of their economically advantaged peers. According to the PSSA and NAEP, this results in an even larger overall score gain compared with closing race-ethnic gaps: 0.31 standard deviation units based on the PSSA reading and math assessments and 0.28 and 0.33, respectively, based on the NAEP. As we will see in the next chapter, these simulated test score mean values on the NAEP of 282 on the reading assessment and 301 on the math assessment would be enough to place Pennsylvania at the top of all the states and among the top countries internationally. For the high school graduation rate, closing economic status gaps would bring the rate to 91 percent.

With the NAEP, it is also possible to calculate the change in student performance on the NAEP from closing parent education gaps (i.e., bringing all students on average up to the level for students with college-educated parents). The overall effect of this gap closing is not quite as large as closing economic status gaps but is larger than closing race-ethnic gaps.

It is important to note that these gap-closing exercises based on student characteristics examine race-ethnicity, economic status, and parent education as separate factors. In reality, there is considerable overlap in these demographic and socioeconomic groups; for instance, large shares of African-American and Latino students have low family income or low parental education. Because of that overlap, if student performance differences by race-ethnicity, family income, and parental education could be simultaneously eliminated, the improvement in overall achievement scores would be less than the sum of the effects we calculate when gaps are closed for one characteristic at a time.

Finally, based on the PSSA, we also calculate the effect on the Pennsylvania average PSSA scale scores of closing gaps across school districts. We consider two scenarios: (1) bringing all districts below the 50th percentile (or median) up to that level and (2) bringing all districts below the 75th percentile up to that level. As seen in Table 3.5, the first case has an aggregate effect on PSSA scores of about the same magnitude as that calculated for closing race-ethnic gaps (0.17 and 0.20 standard deviation unit score gains in reading and math, respectively). The larger gap closing in the second scenario produces an aggregate score gain of 0.30 and 0.33, about the same as that estimated for closing economic status gaps. Therefore, in Chapter Five, we do not provide separate calculations for closing gaps across districts, but we acknowledge that the scenarios we considered (using the 50th and 75th percentiles) would be bounded by the effects we calculate for closing race-ethnic gaps and economic status gaps.

4. Pennsylvania Student Performance in the National and International Context

Although our primary interest is in student performance differences within Pennsylvania—gaps defined by race-ethnicity, family economic status, parent education, or school district—we also consider differences in how Pennsylvania public school students perform compared with their counterparts in other U.S. states and relative to students in other countries. For cross-state comparisons, we rely on the 2013 NAEP data, again focusing on reading and math assessments in eighth grade. We also examine differences between Pennsylvania and other states in the four-year ACGR. To assess international differences in student performance, we turn to the 2012 PISA results, based on comparable assessments in reading and math given to 15-year-olds. Recall from Chapter One that separate PISA results for Pennsylvania are not available, but the cross-state comparisons in the first part of the chapter allow us to benchmark the performance of Pennsylvania students against the three states that do have PISA results: Connecticut, Florida, and Massachusetts.

We begin by considering the cross-state comparisons in student achievement and high school graduation rates, first as reported and then accounting for differences in the demographic composition of Pennsylvania's students versus that of other states. The gap-closing exercise in the prior chapter also allows us to forecast where Pennsylvania would rank among other states if academic performance gaps were closed. We then turn to the international comparisons and show how Pennsylvania's 15-year-olds are likely to perform relative to those from other countries based on current achievement levels and if achievement gaps were closed. These analyses produce the following findings:

- On average, Pennsylvania is one of the top-performing states on the NAEP, with rankings in 2013 in the top ten states as measured by eighth-grade reading and math scores. The four-year ACGR for Pennsylvania placed it in the top 15 states in the country.
- As with districts, some of the cross-state differences in student performance can be accounted for by demographics. But differences still remain after controlling for variation across states in the share of students by race-ethnicity or economic status. Notably, the higher performance of Massachusetts and New Jersey compared with Pennsylvania cannot be attributed to a more favorable race-ethnic mix of students in those states.
- If gaps in NAEP reading and math scores by race-ethnicity were eliminated, Pennsylvania would score at about the same level as Massachusetts, the top-performing state on the eighth-grade NAEP. A similar result would follow if economic status gaps were eliminated.
- Although Pennsylvania did not participate in the PISA as a stand-alone education system, benchmarking Pennsylvania's NAEP results against the three NAEP states that did participate in the PISA (Connecticut, Florida, and Massachusetts) shows that

> Pennsylvania would potentially be one of the top-performing OECD countries, likely ranking within the top ten countries among the 34 OECD countries. Pennsylvania's international ranking would rise even further if score gaps by race-ethnicity or economic status were eliminated.

Student Performance in Pennsylvania Versus the United States and Other States

Figures 4.1 and 4.2 show, for the 50 states and the District of Columbia, the 2013 eighth-grade NAEP mean scale score on the reading and math assessments, respectively. The states are ordered from highest score to lowest. Pennsylvania's result is highlighted in dark purple, the national average is shown shaded black, and states that border Pennsylvania have patterned bars. The three PISA states are shaded orange. State scale scores that are significantly higher or lower than Pennsylvania's are marked with an asterisk.

These figures indicate that Pennsylvania had the seventh-highest reading scale score and the ninth-highest math scale score on the 2013 NAEP. Accounting for the confidence interval around each state score (because the NAEP provides a sample-based score), Pennsylvania's reading result was significantly lower than those of Massachusetts and New Jersey and significantly higher than those of Nebraska and all other lower-ranked states (with the exception of Ohio). The top five states scored significantly higher than Pennsylvania on the math assessment (Massachusetts, New Jersey, New Hampshire, Vermont, and Minnesota), while Pennsylvania's math result was significantly higher than that for Idaho and all the states below. On the reading assessment, Pennsylvania falls below two PISA states—Massachusetts and Connecticut—but above the third PISA state—Florida. Pennsylvania ranks above both Connecticut and Florida on the math assessment, but again below Massachusetts.

Figure 4.3 documents differences across states in the four-year ACGR as of 2013.[13] In that year, Pennsylvania's high school graduation rate of 86 percent placed it at a rank of 15, 5 percentage points above the national rate of 81 percent. Connecticut is tied with Pennsylvania, while Massachusetts is one-half of a percentage point lower. Iowa topped the list of states, with a 90-percent graduation rate.

Accounting for Demographic Differences

Given differences in student performance by such characteristics as race-ethnicity and family income, some of the cross-state variation in student performance may be the result of cross-state differences in the demographic composition of public school students. Table 4.1 illustrates the extent of demographic variation as reported in the 2013 NAEP data for the eighth-grade test-takers. States are ranked by reading mean scale score, which is reported along with the math mean scale score. The table also shows the percentage of students in each of the four main race-

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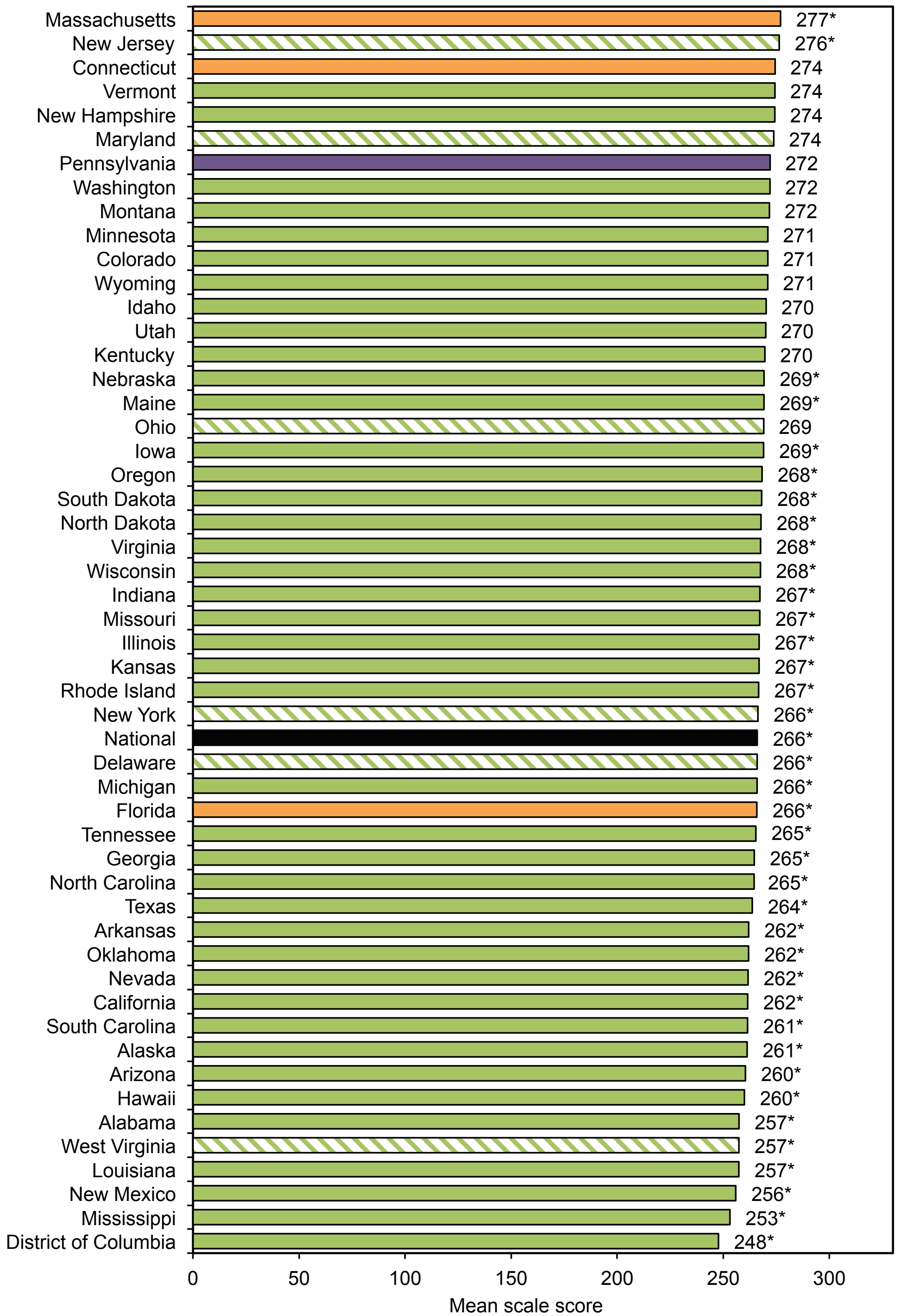
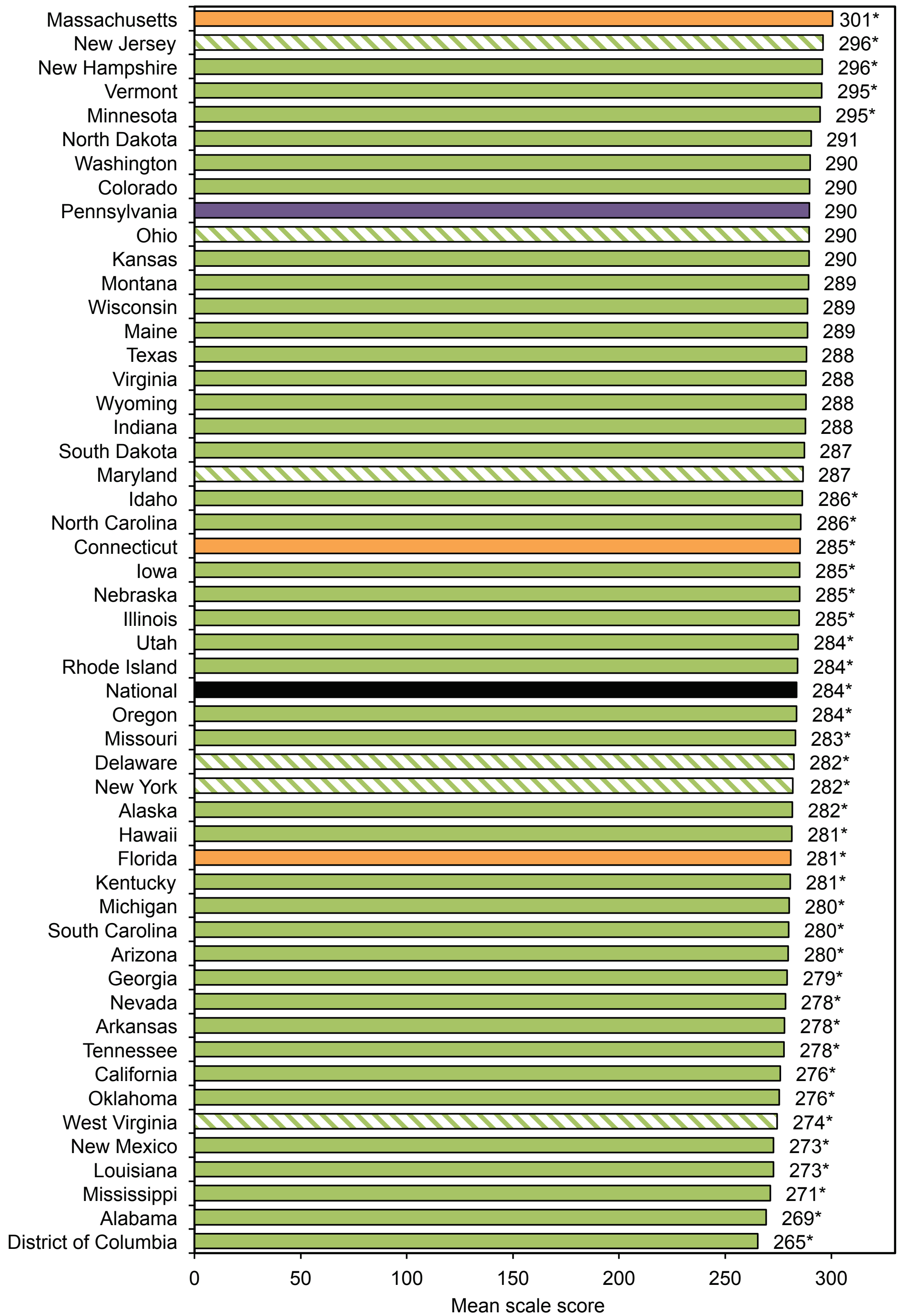
[13] Results were not available for Idaho.

Figure 4.1. Mean Scale Score by State: NAEP Eighth-Grade Reading in 2013



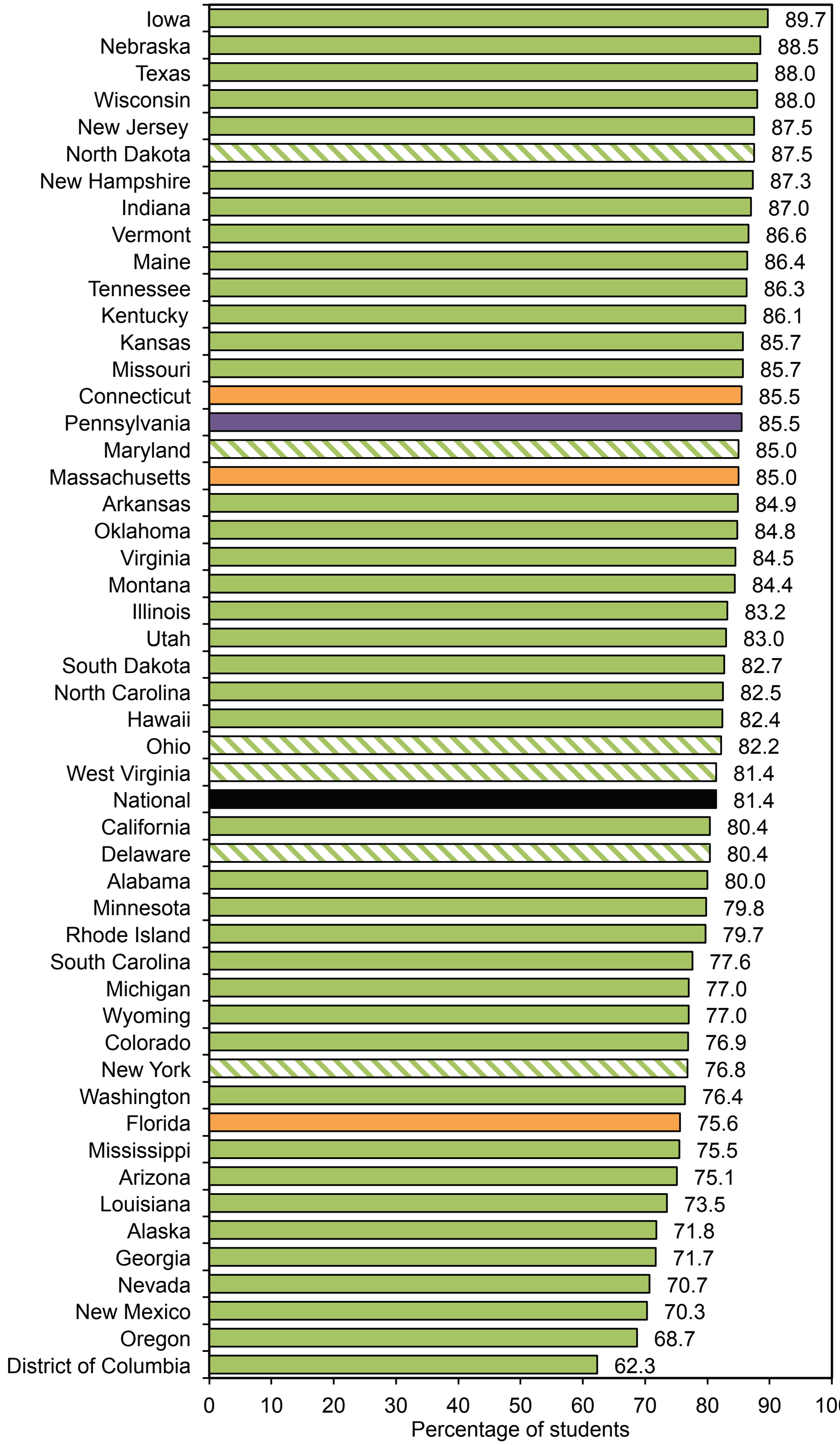
SOURCE: Author's analysis of 2013 NAEP data.
NOTES: States are ranked from highest to lowest score based on mean scale scores reported with 12 significant digits (to the right of the decimal point), although we show mean scale scores rounded to the nearest integer. Asterisks denote state mean scale scores that are significantly different from Pennsylvania's score.

Figure 4.2. Mean Scale Score by State: NAEP Eighth-Grade Math in 2013



SOURCE: Author's analysis of 2013 NAEP data.
NOTES: States are ranked from highest to lowest score based on mean scale scores reported with 12 significant digits (to the right of the decimal point), although we show mean scale scores rounded to the nearest integer. Asterisks denote state mean scale scores that are significantly different from Pennsylvania's score.

Figure 4.3. Four-Year Adjusted Cohort Graduation Rate by State: 2013



SOURCE: Author's analysis of 2013 four-year ACGR data.
NOTES: Data are not reported for Idaho. States are ranked from highest to lowest based on the ACGR reported to the nearest tenth of a percentage point. States with the same ACGR are listed in alphabetical order.

Table 4.1. Eighth-Grade NAEP Mean Scale Scores and Student Demographics by State: 2013

	2013 Eighth-Grade NAEP Mean Scale Score		Race-Ethnicity (% distribution)				
State	Reading	Math	White	African-American	Latino	Asian	FRPL Eligible (%)
Massachusetts	**277**	**301**	67	9	16	6	38
New Jersey	**276**	**296**	56	17	19	8	34
Connecticut	**274**	285	63	12	19	4	34
Vermont	**274**	**295**	92	2	2	2	37
New Hampshire	**274**	**296**	90	2	4	3	26
Maryland	**274**	287	45	35	11	6	41
Pennsylvania	272	290	74	14	8	3	41
Washington	272	290	59	4	22	7	44
Montana	272	289	80	1	4	1	39
Minnesota	271	**295**	74	8	7	7	32
Colorado	271	290	58	5	30	3	40
Wyoming	271	288	81	1	12	1	36
Idaho	270	286	79	1	15	2	46
Utah	270	284	77	1	16	3	38
Kentucky	270	281	83	10	4	1	49
Nebraska	269	285	70	6	17	2	43
Maine	269	289	92	3	2	2	42
Ohio	269	290	76	15	3	2	42
Iowa	269	285	82	5	8	3	38
Oregon	268	284	65	2	22	4	54
South Dakota	268	287	79	2	3	2	36
North Dakota	268	**291**	85	3	2	1	30
Virginia	268	288	56	23	11	6	35
Wisconsin	268	289	75	9	10	4	40
Indiana	267	288	74	11	9	1	46
Missouri	267	283	74	18	4	2	47
Illinois	267	285	52	17	24	5	46
Kansas	267	290	68	7	16	2	45
Rhode Island	267	284	65	8	20	3	44
New York	266	282	49	19	23	8	47
Delaware	266	282	50	31	13	3	48
Michigan	266	280	72	16	6	3	46
Florida	266	281	44	21	29	3	56
Tennessee	265	278	71	21	6	2	53
Georgia	265	279	45	38	11	4	59
North Carolina	265	286	53	28	13	3	54
Texas	264	288	32	12	49	4	56
Arkansas	262	278	65	21	10	2	58
Oklahoma	262	276	54	10	13	2	53
Nevada	262	278	37	9	40	7	56
California	262	276	28	6	53	12	58
South Carolina	261	280	55	36	5	2	54
Alaska	261	282	48	4	7	10	45
Arizona	260	280	41	5	43	3	56
Hawaii	260	281	13	2	6	71	52
Alabama	257	269	60	33	4	1	56
West Virginia	257	274	92	6	1	1	57
Louisiana	257	273	46	46	4	2	65
New Mexico	256	273	25	2	60	1	70
Mississippi	253	271	50	46	3	1	69
District of Columbia	248	265	5	79	13	1	77

SOURCE: Author's analysis of 2013 NAEP data.
NOTE: States are sorted from highest to lowest by the NAEP math score.

ethnic groups, as well as the share classified as economically disadvantaged (based on FRPL eligibility). While there is no state that is an exact match for Pennsylvania's student demographics, such states as Massachusetts, Ohio, Indiana, Missouri, and Michigan (all shaded in light purple) have a similar share of white students and economically disadvantaged students. With the exception of Massachusetts students, eighth-grade students in Pennsylvania perform better than students in these other demographically similar states.

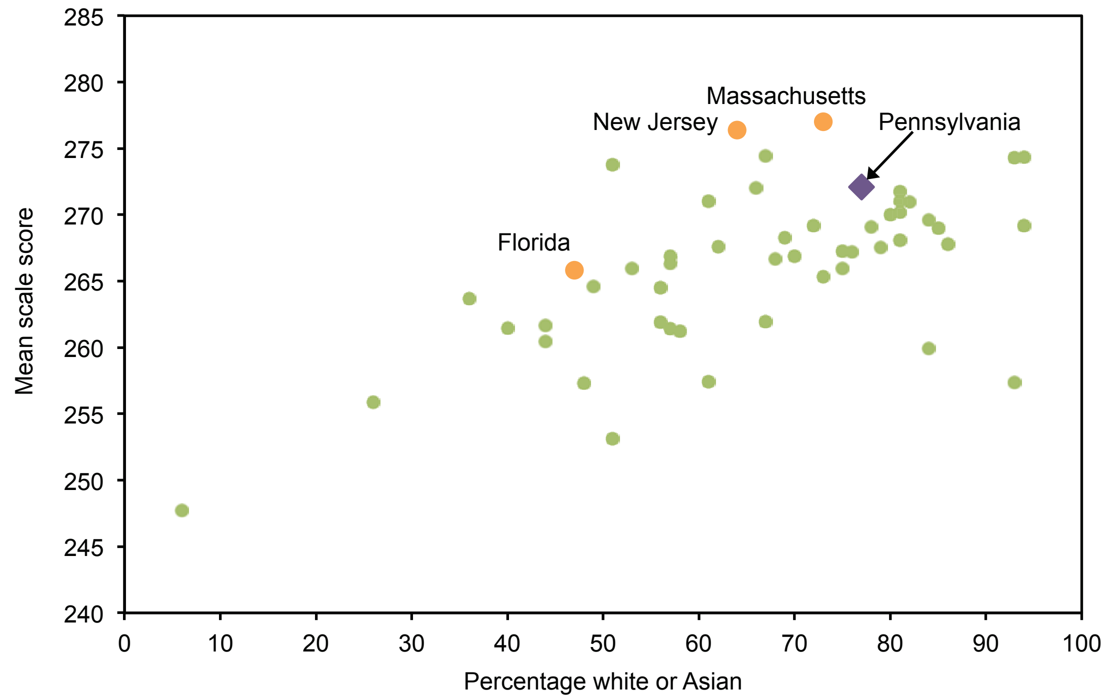
The relationship between student demographic characteristics and eighth-grade NAEP scores is shown graphically in Figures 4.4 to 4.7, where Figures 4.4 and 4.5 show results for reading and math plotted against the percentage of white or Asian students, and Figures 4.6 and 4.7 show parallel results plotted against the percentage not economically disadvantaged as measured by FRPL eligibility. As with the pattern observed across Pennsylvania school districts (see Figures 3.9 to 3.12), NAEP scores are generally higher in states with a higher share of white and Asian students and in states with a higher share of students who are not economically disadvantaged. However, even in states with similar shares of students in the higher-scoring groups, there is still considerable variation in NAEP scores. The general pattern is that Pennsylvania scores about in the middle of other states with a similar percentage of white and Asian students or percentage who are not economically disadvantaged. By comparison, Massachusetts and New Jersey, the two highest-scoring NAEP states in both reading and math, have the highest scores among other states with similar demographics. Thus, once again, demographics explain some of the differences across states, but there is still variation that remains among states with similar demographic profiles.

To further illustrate this point, we calculated the NAEP reading and math scores for all other states after applying the same demographic shares as Pennsylvania. Results are shown in Table 4.2 for eighth-grade reading scores in panel (a) and eighth-grade math scores in panel (b). Results are shown for all states that rank above Pennsylvania and a subset of states that rank below. Results for all states are reported with the supplemental tables in Appendix B (Table B.2).

Table 4.2 first shows the actual state reading or math scale score and the score gap with Pennsylvania. We first apply Pennsylvania's race-ethnic composition to all other states and show the resulting mean scale score for all other states and the adjusted gap with Pennsylvania. For some states, the share of students in all four race-ethnic groups (white, African-American, Latino, and Asian) is not reported because of small cell sizes, so those states do not have adjusted results. These adjusted state scale scores and adjusted gaps with Pennsylvania are also calculated by applying Pennsylvania's share of students that are economically disadvantaged or not and the share of students based on parent education.

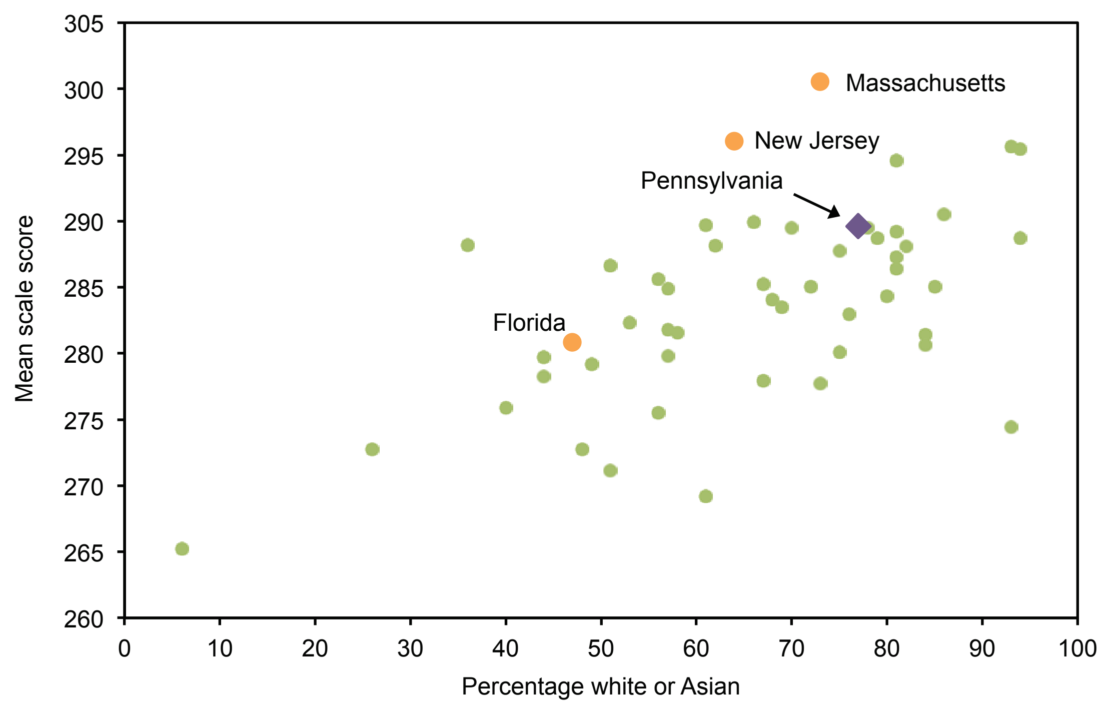
To interpret these results, consider first the case of Massachusetts. If that state had the same race-ethnic composition as Pennsylvania, the NAEP eighth-grade reading score would be 278 instead of 277, so the gap with Pennsylvania would essentially be the same. Likewise, the state's math score would be effectively unchanged. Thus, the higher performance of Massachusetts compared with Pennsylvania cannot be attributed to a more favorable race-ethnic mix of students. The same result follows if Massachusetts had the same mix of students by economic

Figure 4.4. State NAEP Eighth-Grade Reading Mean Scale Score by Percentage of Students Who Are White or Asian: 2013



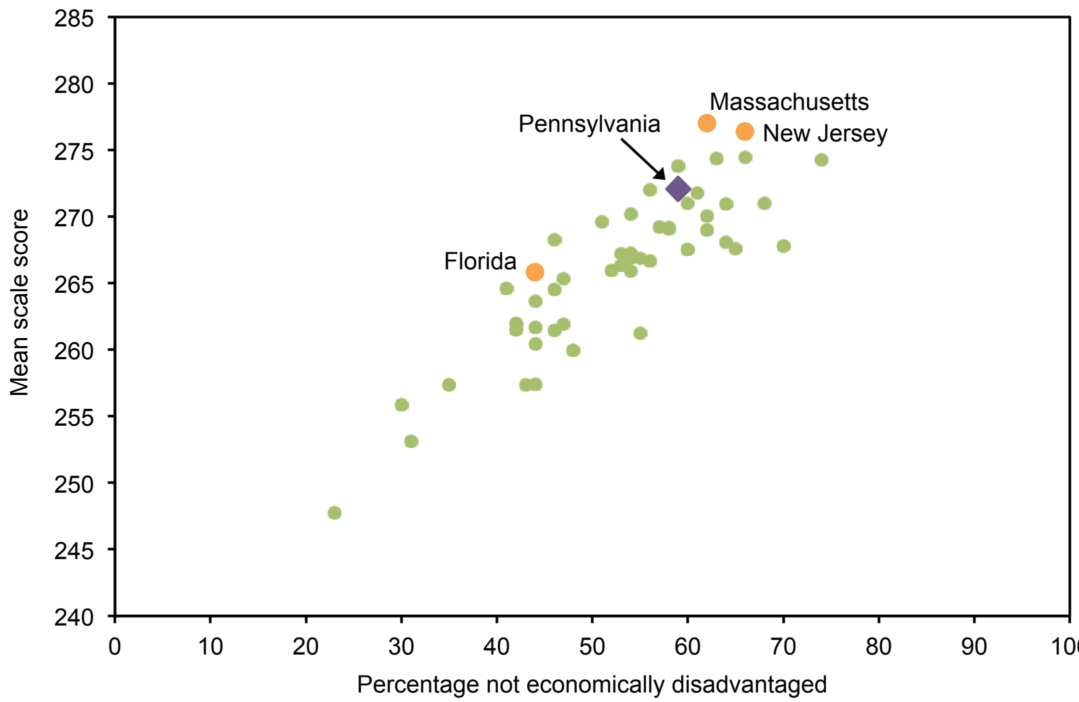
SOURCE: Author's analysis of 2013 NAEP data.

Figure 4.5. State NAEP Eighth-Grade Math Mean Scale Score by Percentage of Students Who Are White or Asian: 2013



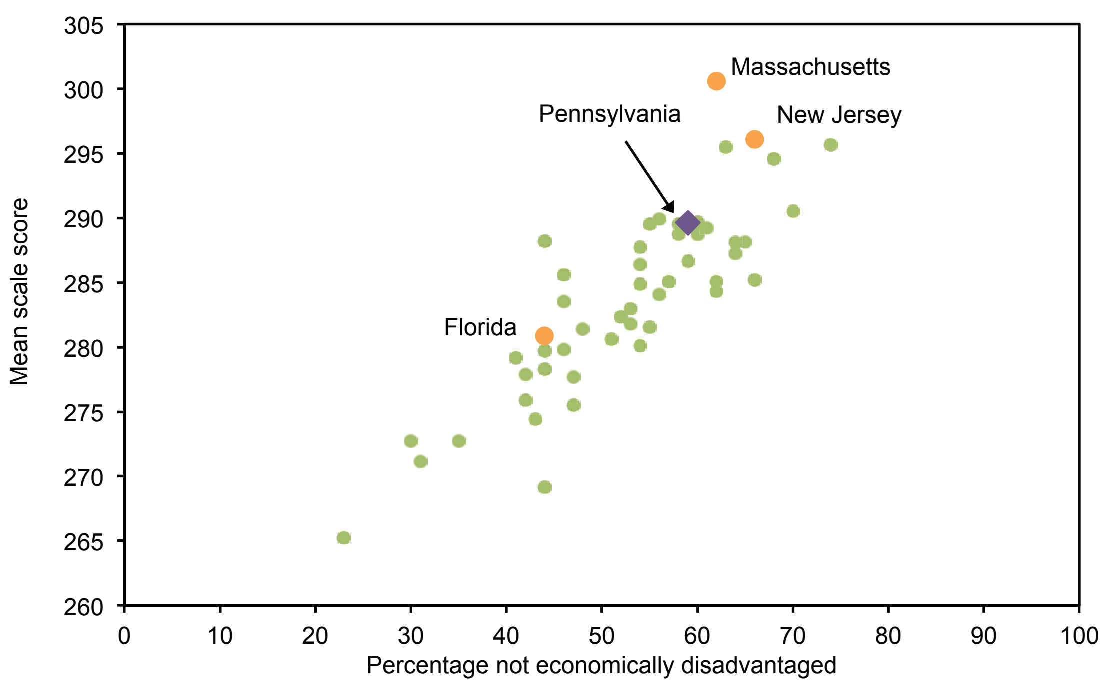
SOURCE: Author's analysis of 2013 NAEP data.

Figure 4.6. State NAEP Eighth-Grade Reading Mean Scale Score by Percentage of Students Who Are Not Economically Disadvantaged: 2013



SOURCE: Author's analysis of 2013 NAEP data.

Figure 4.7. State NAEP Eighth-Grade Math Mean Scale Score by Percentage of Students Who Are Not Economically Disadvantaged: 2013



SOURCE: Author's analysis of 2013 NAEP data.

Table 4.2. Adjusted Mean Scale for Pennsylvania to Match Demographics of Other States: NAEP Eighth-Grade Reading and Math in 2013

	State Scale Score		Adjusted State Scale Score and Adjusted Gap: Adjusted for Race-Ethnicity		Adjusted for Economic Status		Adjusted for Parent Education	
	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA
a. Eighth-Grade Reading								
Massachusetts	277	5	278	6	276	4	278	6
New Jersey	276	4	276	4	275	3	277	5
Connecticut	274	2	274	2	273	0	276	4
Vermont	274	2	–	–	274	2	276	4
New Hampshire	274	2	–	–	271	–1	276	3
Maryland	274	2	278	6	273	1	275	3
Pennsylvania	272	0	272	0	272	0	274	2
Minnesota	271	–1	267	–5	269	–3	271	–1
Colorado	271	–1	273	1	271	–1	274	2
Nebraska	269	–3	–	–	270	–2	272	0
Ohio	269	–3	269	–3	269	–3	272	–1
New York	266	–6	268	–4	267	–5	269	–3
Delaware	266	–6	267	–5	267	–5	268	–4
Florida	266	–6	270	–2	269	–3	269	–4
West Virginia	257	–15	–	–	260	–12	262	–10
Mississippi	253	–19	–	–	260	–12	256	–16
District of Columbia	248	–24	–	–	259	–13	253	–19
b. Eighth-Grade Math								
Massachusetts	301	11	301	12	300	10	302	12
New Jersey	296	6	295	6	294	4	296	7
New Hampshire	296	6	–	–	292	2	296	7
Vermont	295	6	–	–	295	5	297	8
Minnesota	295	5	290	0	292	2	295	5
North Dakota	291	1	–	–	288	–1	290	1
Washington	290	0	291	1	291	1	294	4
Colorado	290	0	292	3	290	0	293	3
Pennsylvania	290	0	290	0	290	0	292	2
Ohio	290	0	289	0	290	0	292	3
Maryland	287	–3	294	4	287	–3	289	0
Connecticut	285	–4	286	–4	283	–7	286	–4
Delaware	282	–7	286	–4	284	–6	285	–5
New York	282	–8	284	–5	283	–7	284	–5
Florida	281	–9	286	–3	284	–5	284	–5
West Virginia	274	–15	–	–	278	–12	278	–11
Mississippi	271	–18	–	–	278	–12	274	–16
District of Columbia	265	–24	–	–	279	–11	270	–19

SOURCE: Author’s analysis of 2013 NAEP data.
NOTES: See Table B.2 in Appendix B for results for all states and the District of Columbia. Adjusted gaps are calculated by applying Pennsylvania subgroup shares to the mean scale scores for a given state. – = Adjusted gap cannot be calculated because mean scale scores are not reported for one or more subgroups in the state when the subgroup size is too small. PA = Pennsylvania.

status or parent education. New Jersey shows a similar pattern, with score gaps compared with Pennsylvania that show little change if the state had the same demographic makeup as Pennsylvania. In these two cases, the better NAEP performance is the result of higher NAEP scores for demographic subgroups relative to Pennsylvania, not simply a different demographic mix.

At the other extreme, if jurisdictions with the lowest scores, such as Mississippi or the District of Columbia, had the same demographic mix as Pennsylvania, they would score closer to Pennsylvania. For example, Mississippi has a 19-point score gap with Pennsylvania in reading that would drop to 12 points if the state had the same share of economically disadvantaged students as Pennsylvania. The gap closing is not quite as large when adjusted for the distribution of students by parent education. A similar pattern holds for the math score. Thus, in those cases, a less favorable demographic mix can explain part, but not all, of the score gap with Pennsylvania.

How Pennsylvania Would Rank If Performance Gaps Were Closed

In Chapter Three, we showed the effects of closing score gaps on Pennsylvania's state-level eighth-grade NAEP reading and math scores (Table 3.5). Our calculations showed that closing race-ethnic gaps would increase the Pennsylvania NAEP reading score from the actual value of 272 to 278. The maximum score attained was 282 for closing economic status gaps. A score of 281 would be realized if gaps by parent education were closed. For the math score, closing gaps would produce a score that ranged from 297 to 301.

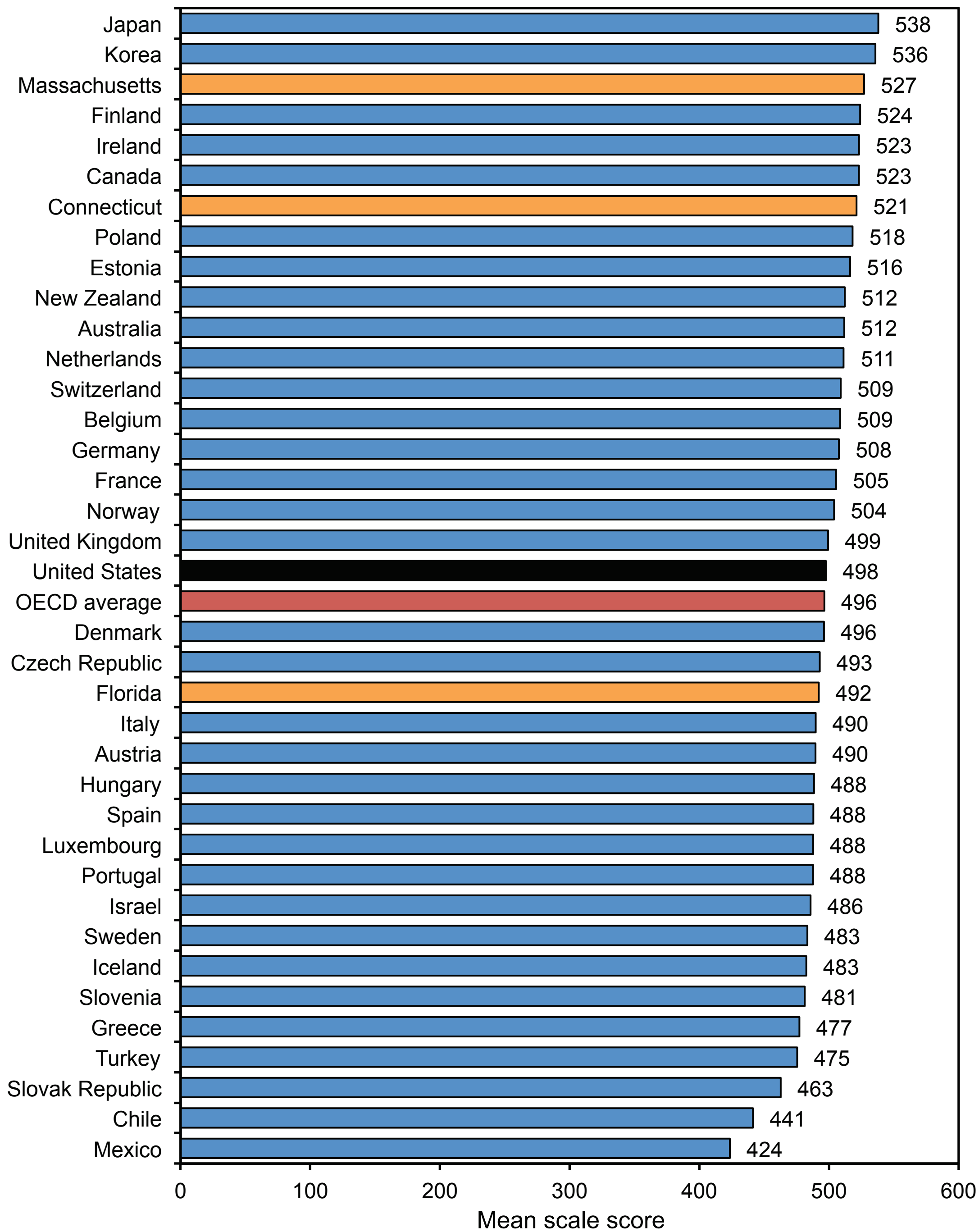
Viewed in the context of other state NAEP scores (Figures 4.1 and 4.2), closing student achievement gaps in Pennsylvania would make it one of the highest-scoring states on the NAEP. The reading range of 278 to 282 if gaps were closed would place Pennsylvania above Massachusetts (a score of 277). The math range of 297 to 301 if gaps were closed would just exceed New Jersey (at 296) and potentially reach the score for Massachusetts (301).

Table 3.5 also showed that Pennsylvania's four-year graduation rate would increase from its 2013 value of 86 percent to 88 percent if race-ethnic gaps were closed and to 91 percent if economic status gaps were closed. The rate would be even higher—93 to 95 percent—if the district gap-closing scenarios we posited were realized (all districts reach either the median or the 75^{th} percentile). Viewed in comparison with other states (Figure 4.3), these outcomes would also place Pennsylvania among the states with the highest graduation rates.

Student Performance in Pennsylvania Versus Other Developed Countries

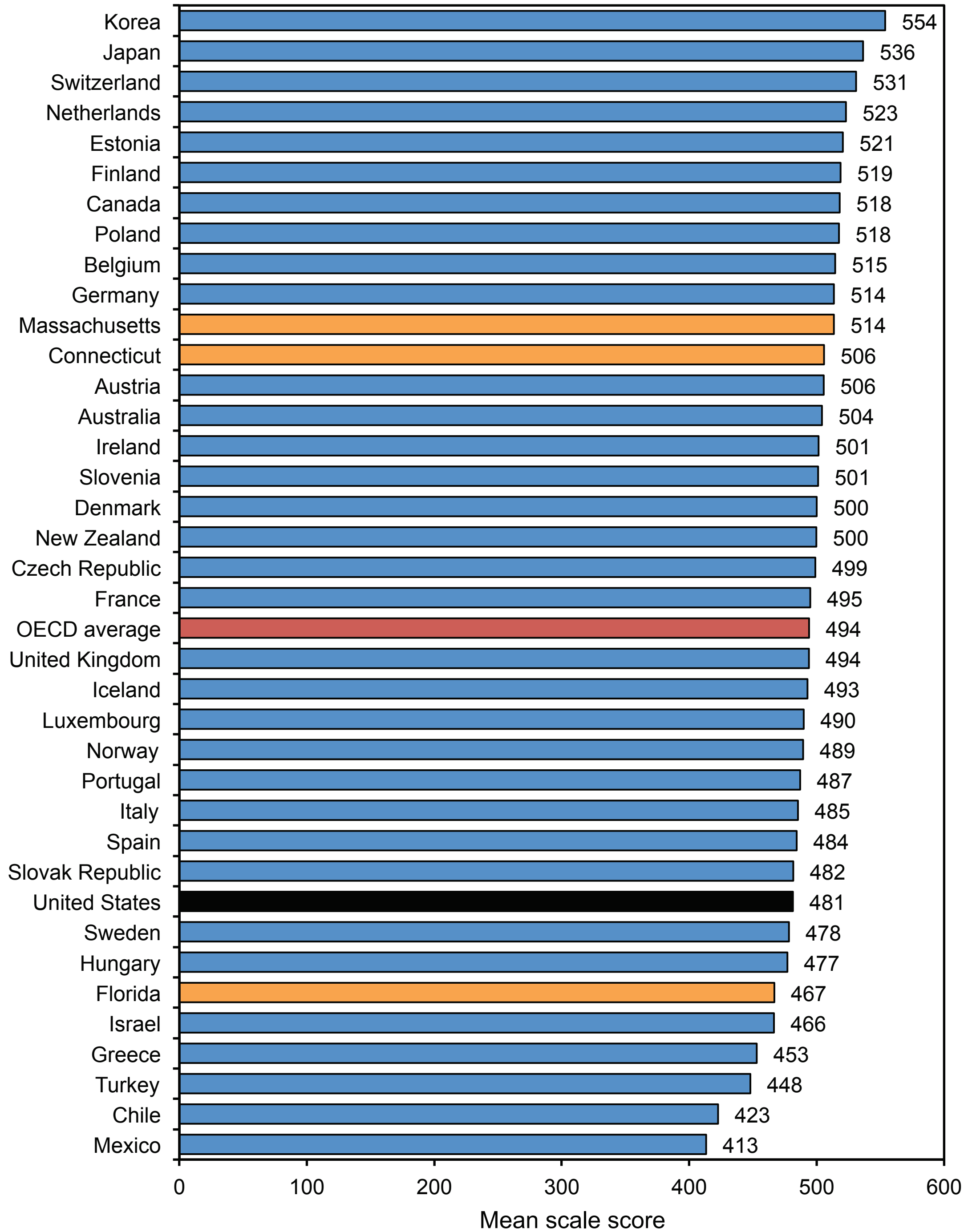
Figures 4.8 and 4.9 show the 2012 PISA eighth-grade reading and math scores, respectively, for the 34 OECD countries (including the United States), along with the OECD average. The results for Connecticut, Florida, and Massachusetts are plotted as well. Overall, 15-year-olds in the United States performed just above the OECD average on the PISA reading assessment (a rank of 17 among the 34 OECD countries), with an average score close to those of France, Norway, the United Kingdom, and Denmark. However, the U.S. students scored considerably below the OECD average on the PISA math assessment (a rank of 27 out of 34 OECD countries), with an average score just below Spain and the Slovak Republic but just above Sweden and Hungary.

Figure 4.8. Mean Scale Score by Country: PISA Age 15 Reading in 2012



SOURCE: Author's analysis of 2012 PISA data.

Figure 4.9. Mean Scale Score by Country: PISA Age 15 Math in 2012



SOURCE: Author's analysis of 2012 PISA data.

Consistent with the NAEP scores, the PISA reading and math scores for Massachusetts always rank above those for Connecticut, and both states exceed the U.S. PISA average. Florida, in contrast, falls below the U.S. average on both the reading and math PISA assessments. Recall that, according to the NAEP in reading (Figure 4.1), Pennsylvania falls below Massachusetts and

Connecticut but above Florida, so we would expect a similar result if Pennsylvania students were to be scored on the PISA. In the NAEP math, Pennsylvania students have a relatively higher rank, falling between Massachusetts and Connecticut (Figure 4.2). Using linear interpolation based on the NAEP scale spread and applying it to the PISA distribution, we would expect Pennsylvania to be among the top-performing countries, with a PISA reading score of about 514 scale points and a PISA math score of about 508 scale points. Thus, Pennsylvania would likely rank within the top ten OECD countries in both reading and math. If achievement differences in Pennsylvania by race-ethnicity or socioeconomic status were closed, the state's international ranking would likely be even higher, closer to that achieved by Massachusetts, with which its average score would be comparable.

5. Estimated Economic Impact of Academic Performance Gaps

The prior chapters have documented the substantial gaps in student performance in Pennsylvania, specifically when measured by eighth-grade achievement tests in reading and math and by the four-year ACGR. We have also demonstrated that closing those gaps would elevate Pennsylvania to one of the highest-performing U.S. states in terms of student achievement and place the state among the top-performing OECD countries. In this chapter, we estimate the economic value of the achievement gaps we have documented. Drawing on the approach taken in several prior studies that quantified the economic consequences of student performance gaps (see the review in Chapter One), we use several methods to value the cost of existing gaps in terms of current economic performance and to value the benefits that would accrue in the future from closing current gaps.

In reporting our results, it is important to keep in mind that we make a number of simplifying assumptions to generate the economic estimates. The economic values we generate are intended to provide an approximate gauge of the magnitude of the economic costs associated with existing gaps and of the economic benefits that would flow from closing those gaps. Given the range of potential values for most of the key parameters we employ to generate our estimates of economic impact, we typically report a range of estimates, from a lower bound where key parameters are set to their lowest estimate to an upper bound where all parameters are set to their maximum value.

It is also important to emphasize that our estimates of the economic gains from closing achievement differences do not account for the costs of the interventions, programs, or policies that would be required to actually narrow or eliminate such achievement gaps. Thus, as we discuss in the closing chapter, the estimates we provide ultimately can be compared with the costs associated with closing achievement gaps to determine whether the costs to eliminate academic performance differences generate a return to society from the investment.

We begin the next section with a brief overview of our approach to generating the economic estimates and of our key assumptions. (Additional detail on the estimation methods is found in Appendix C.) We then detail our findings from two strategies for estimating the cost of existing academic performance differences and two strategies for estimating the future gain from closing existing gaps. The estimation exercises we report on in this chapter produce the following key findings:

- Viewed from the perspective of the cost to Pennsylvania's current workforce and economy, academic performance gaps amount to an estimated annual cost of $1 billion to $3 billion in lost earnings (Method A) or $1 billion to $2 billion in reduced GDP (Method B).

- Accounting for the compounded effect on economic growth of reduced levels of workforce skill, gaps in student performance defined by race-ethnicity or socioeconomic status constitute a loss to the economy over a ten-year horizon that equals $12 billion to $44 billion in annual lost GDP, or 2 to 7 percent of the value of economic output (Method B).
- Two other methods provide a perspective on the gains to future cohorts of labor market entrants that might be realized if student performance gaps based on race-ethnicity or family economic status were closed. Viewed in terms of earnings alone, each annual cohort in Pennsylvania would gain $1 billion to $3 billion in present-value lifetime earnings from closing race-ethnic gaps in student achievement (Method C).
- Based on cross-group differences in the high school graduation rate, we estimate a gain to society of $3 billion to $5 billion in present-value market and nonmarket benefits for each annual cohort from closing gaps based on student race-ethnicity or family economic status (Method D). Viewed per student in the affected groups in each annual cohort, the social gains from closing race-ethnic gaps equate to approximately $83,000 to $125,000 in present-value dollars per African-American or Latino student in Pennsylvania. The gains from closing economic status gaps, which affect a larger share of students in each annual cohort, range from about $66,000 to $99,000 per economically disadvantaged student in the state.
- In Pennsylvania, the share of students with low economic status or low parental education is larger than the share that is African-American or Latino, yet the magnitudes of the achievement and attainment gaps are similar. For this reason, the estimated magnitudes of the aggregate economic costs of existing socioeconomic gaps or the future gains from closing current socioeconomic gaps exceed the aggregate costs or gains associated with erasing the more commonly measured race-ethnic differences in student performance.
- The estimated economic values are broadly consistent across the methods employed, but there are important limitations. These include the reliance on economic parameter estimates derived from national populations or cross-national comparisons, which can only be viewed as approximations of the relevant (but unknown) parameters for Pennsylvania. In addition, there are a number of simplifying assumptions that, if relaxed, might result in lower estimates than those presented here, such as accounting for migration and mortality in the cohort-based estimates.

Overview of Approach and Key Assumptions

We focus in this chapter on the three types of student performance gaps listed in Table 5.1, all of which were documented in Chapter Three. For each type of gap, our goal is to estimate the economic value associated with current gaps or with eliminating the gaps. In these scenarios, the measure of education performance may be based on achievement scores or on the high school graduation rate. In the case of race-ethnic gaps, the gap-closing scenario means raising the level of student achievement or attainment of African-American and Latino students to the level reached by their white counterparts. In the case of family economic status, we assume that economically disadvantaged students would have the same academic outcomes as students who are not economically disadvantaged. Closing parent education gaps means that students whose

Table 5.1. Scenarios for Estimation of the Economic Value of Education Performance Gaps

Gap to Estimate	Scenario Assumption
Race-ethnic gap	Raise the educational outcome for African-American and Latino students in Pennsylvania to the outcome for white students in Pennsylvania
Family economic status gap	Raise the educational outcome for lower-income students in Pennsylvania to the outcome for higher-income students in Pennsylvania
Parent education gap	Raise the educational outcome for Pennsylvania students whose parents have low education to the outcome for Pennsylvania students whose parents have high education

parents have less than a college degree boost their performance to the same level as those whose parents have a college degree or higher.

Recall that in Chapter Three we documented that closing gaps across school districts by bringing all districts below the median up to the median district would have the same impact on aggregate test scores as closing race-ethnic gaps (see Table 3.5). Alternatively, if all districts below the 75th percentile reached that level of achievement, the impact would be equivalent to closing economic status gaps. Thus, while we do not explicitly model those gap-closing scenarios, we are implicitly calculating their likely impact as comparable to the three types of gap-closing scenarios we do consider.

Estimating Economic Costs of Gaps

Our approach replicates two methods employed in the McKinsey and Company study (2009a, 2009b) of U.S. achievement gaps. We view these two methods, labeled A and B, as providing estimates of the economic costs of existing gaps (see Table 5.2). Method A generates an estimate of the lost earnings experienced by low-performing student groups (e.g., African-Americans and Latinos). This approach recognizes the private costs to individuals who, because they have lower academic skills or lower educational attainment, realize lower earnings. As shown in Table 5.2, this approach can be used to value the cost of race-ethnic gaps but not family economic status gaps or parent education gaps.[14] The approach considers the share of the current workforce that is in the low-performing group (African-Americans and Latinos, in this case) and their earnings, and it calculates the boost in earnings that would be expected if their academic performance had equaled that of their white counterparts. For this reason, the estimate from Method A can be considered an estimate of the lost earnings experienced by today's workforce because of the existence of race-ethnic achievement gaps.

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[14] This is because this approach requires that we have estimates of the current labor market earnings of the low-performing groups. While we can do this for African-Americans and Latinos, we do not have data on the earnings of individual workers based either on their family income when they were in eighth grade or on their parents' education.

Table 5.2. Methods for Estimating the Economic Value of Performance Gaps by Type of Gap

Method	Type of Education Performance Gap		
	Race-Ethnic	Family Economic Status	Parent Education
Economic Costs of Current Gaps			
A. Estimate lost earnings for low-performing groups from current gaps	✓	–	–
B. Estimate lost GDP from current gaps because of lower economic productivity and innovation	✓	✓	✓
Economic Benefits of Closing Gaps for Future Cohorts			
C. Estimate future lifetime earnings gains for single-year cohort if gaps are closed	✓	–	–
D. Estimate future lifetime private and social gains for single-year cohort if gaps are closed	✓	✓	–

NOTE: – = Not applicable.

The second approach, Method B, can be applied to all three types of academic performance gaps of interest. In this case, we draw on endogenous growth theory (as did the other studies listed in Table 1.4) and estimate the lost GDP for Pennsylvania caused by the lower productivity and reduced levels of innovation experienced in an economy in which students do not reach their full skill potential or achieve higher educational attainment. Like McKinsey and Company (2009a, 2009b), we are assuming that prior empirical research has identified a causal link between the cognitive skills of the workforce, as a measure of the stock of human capital, and innovation and economic growth. The estimation approach assumes that all gaps are eliminated in a base year (2003, in our case) and forecasts the increase in GDP that would result because of the increased stock of human capital. Assuming that the higher rate of growth of GDP is compounded over time, we can estimate the boost to GDP at various points in time in the future. Like McKinsey and Company, we choose a ten-year horizon and estimate the impact on Pennsylvania GDP as of 2013.

Extending beyond the McKinsey study, we employ two additional estimation methods, each of which considers the implications of gap closing for a single-year age cohort that will enter the labor market at age 20 and realize a stream of future earnings gains as a result of higher academic skill or higher educational attainment. For Method C, we focus on the lifetime gain as earnings alone. For Method D, the estimates account for both earnings and fringe benefits (i.e., total compensation), as well as the broader societal nonmarket benefits associated with a workforce with higher skill or education (e.g., reductions in crime). In both cases, because we are accounting for streams of future benefits over an individual lifetime, we discount the future earnings to present-value dollars to account for the fact that a dollar in the future is worth less than a dollar today. These two types of cohort estimates are useful for considering the economic benefits from eliminating academic performance gaps one labor market entry cohort at a time.

Key Parameters and Assumptions

The four methods we employ rely on three key economic parameters summarized in Table 5.3, each of which is derived from prior empirical research on the linkage between academic performance and labor market outcomes, other social indicators, or the value of economic output. Methods A and C require an estimate of the link between academic achievement and adult earnings. Based on an extensive literature that has examined this relationship, we assume that a one-standard-deviation increase in student achievement leads to a 9- to 15-percent increase in earnings. This is a somewhat broader parameter range than that employed by McKinsey and Company (1999a, 1999b) and reflects even more recent estimates in the literature.

Table 5.3. Economic Parameters Used in Estimating Economic Value of Performance Gaps

Economic Parameter	Parameter Value	Source
Linkage between student academic achievement and adult earnings (Methods A and C)	A one-standard-deviation increase in student achievement leads to a 9- to 15-percent increase in earnings	Mulligan (1999) Murnane et al. (2001) Lazear (2003) Duckworth et al. (2012)
Linkage between student academic achievement and GDP growth (Method B)	A one-standard-deviation increase in student achievement leads to a 1.2- to 2.0-percent increase in the growth of GDP per capita	Hanushek and Woessman (2008)
Linkage between high school graduation and lifetime gain in wages, fringe benefits, and social benefits (Method D)	PDV lifetime cost of high school dropout (lost wages, fringe benefits, nonmarket value) is \$470,000–\$710,000 (in 2013 dollars at age 18 using a 2-percent discount rate)	Cohen and Piquero (2009)

NOTE: Cohen and Piquero's (2009) estimate is valued in 2007 dollars and converted to 2013 dollars using the Consumer Price Index for All Urban Consumers (CPI-U). PDV = present discount value.

Following McKinsey and Company (1999a, 1999b), to implement Method B, we adopt Hanushek and Woessman's (2008) assessment of the empirical literature that a one-standard-deviation increase in student achievement leads to a 1.2- to 2.0-percent increase in the growth of GDP per capita. This parameter range is based on multiple studies that have used cross-national data to estimate the causal effect of the level of student achievement on the growth of GDP per capita. This parameter range is robust to alternative methods for estimating the causal parameter.

Finally, Method D is based on an estimate by Cohen and Piquero (2009) of the lifetime cost of a high school dropout, relative to a high school graduate, in terms of lost earnings, fringe benefits, and nonmarket factors (e.g., health, child rearing).[15] The Cohen and Piquero (2009) estimates are presented as present discounted lifetime values discounted to age 18 using a 2-

[15] The Cohen and Piquero (2009) estimate employed here does not account for other societal costs associated with high school dropouts, such as higher rates of crime and substance abuse, except to the extent that those behavioral factors lead to a reduction in lifetime earnings. Indeed, the Cohen and Piquero (2009) estimate of the present-value cost at age 18 of a high-risk youth is \$2.6 million to \$5.3 million in 2007 dollars. For further discussion of the economic, social, and fiscal cost of high school dropouts, including state-specific estimates, see Belfield, Hollands, and Levin (2001); Fogg, Harrington, and Khatiwada (2007); and Sum, Khatiwade, and McLaughlin (2009a, 2009b).

percent discount rate. Their estimates indicate that the present value of lost earnings from a high school dropout equates to $280,000, while the present-value fringe benefits are calculated to be $70,000. Because of uncertainty around the private and public nonmarket returns to education, the residual component is presented as a range from $70,000 to $280,000 (i.e., 25 to 100 percent of the lost wage productivity).[16] We convert their estimates in 2007 dollars to 2013 dollars based on the CPI-U.

As is typical with such modeling exercises, our analyses rest on a number of key assumptions. Across all four estimation methods, these assumptions include the following:

- *Causal linkages.* We assume that the parameters summarized in Table 5.3 provide causal estimates of the relationship between academic achievement or attainment and individual earnings, other nonmarket returns to education, and the growth of economic output. In other words, we are assuming that if we could close achievement differences between students defined by race-ethnicity, economic status, or parent education, the groups of students that were previously low performing would realize improved labor market outcomes and contribute to economic productivity and growth. While the parameters used for Methods A, C, and D have a robust basis in the literature, there is more uncertainty around the application of the parameter linking test scores and GDP growth for Method B. This is especially true given that the parameter is based on cross-national data but is being applied in the context of a state economy. For this reason, some caution is warranted in the interpretation of the results for Method B.
- *Generalizability*. The estimated parameters in Table 5.3 are typically general estimates that we are assuming apply equally well to populations in Pennsylvania and specifically to racial and ethnic minorities and those with lower socioeconomic status. While generalizability may be an issue, in fact, there is reason to believe that the parameters estimated for general populations may be too small when considering the returns to human capital among those in more disadvantaged groups (Henderson, Polachek, and Wang, 2011).
- *General equilibrium effects*. The gap-closing empirical exercises in this chapter posit a statewide change in student outcomes that results in the elimination of academic performance gaps by race-ethnicity, family income, and parent education. According to Table 3.1, these changes potentially affect 25 percent of new labor market entrants if race-ethnic gaps are closed and an even larger share if gaps are closed by economic status or parent education. The increased supply of skilled workers, whether measured by test scores or high school graduation rates, would have the potential to put downward pressure on wages for more highly skilled or educated workers. As a result, the earnings gains that we estimate may not be fully realized. Prior studies of the economic cost of achievement gaps have generally not addressed this issue.

[16] This is consistent with other research suggesting that the nonmarket benefits of additional education could be as large as the value of the market return (Wolfe and Haveman, 2002). These nonmarket benefits include improved health status, better consumer choices, improved fertility decisionmaking, and higher educational attainment for the next generation.

Additional Data

Our approach builds on the estimates of the magnitude of academic achievement and attainment gaps by race-ethnicity, economic status, and parent education documented in Chapter Three. In the results presented below, we reference the specific gap estimates on which we rely. In addition, as documented in Appendix C, we draw on several other sources of data to complete our estimates. Specifically, for Method A, we employ data from the American Community Survey (ACS) and Current Population Survey (CPS) for measures of the Pennsylvania workforce and earnings by race-ethnicity. These surveys are also used for Method C to estimate the cross-section age-earnings profile for African-Americans and Latinos in the Pennsylvania workforce. In addition, we employ historical data on Pennsylvania GDP available from the U.S. Bureau of Economic Analysis (BEA) to implement Method B. For Methods C and D, our estimates of the size of each annual age cohort entering the labor market and the shares that are African-American and Latino come from the Pennsylvania Department of Education data on the adjusted size of the high school entry cohort that graduated in 2013 (i.e., the denominator of the 2013 four-year ACGR).

Results: Economic Costs of Existing Gaps (Methods A and B)

We begin with estimates based on Methods A and B. Again, these can be considered estimates of the cost to the economy of existing achievement gaps. Table 5.4 shows the results from Method A, which indicates that race-ethnic gaps in student achievement, when applied to the current Pennsylvania workforce of approximately 552,000 African-Americans and 284,000 Latinos (see Appendix C), imply an aggregate annual loss of $1.25 billion to $2.89 billion. For the affected groups—African-Americans and Latinos—this amounts to earnings shortfalls of 6 to 15 percent. The range of estimates reflects the uncertainty in the parameter linking test scores to earnings (see Table 5.3), as well as the range of estimates for the size of the achievement gap by race-ethnicity, depending on which data source (PSSA versus NAEP) and which assessment (reading or math) is used.

Table 5.4. Method A Estimated Value of Lost Earnings for Low-Performing Groups

Performance Gap	Size of Test Score Achievement Gap for Affected Groups	Aggregate Value of Lost Earnings in Billions of 2013 Dollars [Percentage Change]	
		Lower Bound	Upper Bound
Race-ethnic gap	0.72–1.01 standard deviation gap in achievement scores for African-Americans; 0.68–0.92 standard deviation gap in achievement scores for Latinos	$1.25 [6.4%]	$2.89 [14.7%]

SOURCE: Author's estimates.
NOTES: Achievement gap parameters are based on the ranges reported in Table 3.2. See Appendix C for additional detail.

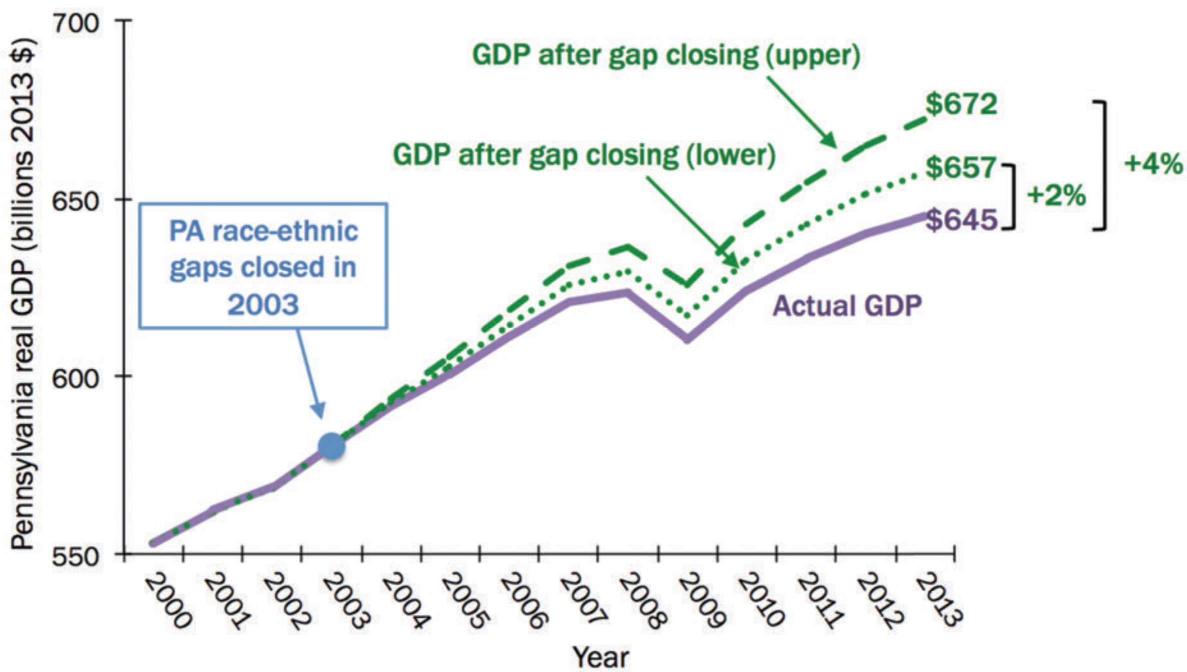
Method B provides another perspective on the current cost of achievement gaps (see Table 5.5 and Figures 5.1 and 5.2). This approach assumes that achievement gaps are closed in 2003, the base year. The effect on GDP is then traced over time through 2013, where GDP growth is assumed to be augmented, based on the parameter linking achievement scores (or labor force skill levels) to GDP growth (see Table 5.3). Thus, the effects of a skill boost are compounded over time. Based on the implications for statewide test score gains from closing achievement gaps (see the second column of Table 5.5 based on Table 3.5), we would expect the smallest economic cost to be associated with race-ethnic gaps (Figure 5.1) and the largest with economic status gaps (Figure 5.2). And that is indeed the case. According to these estimates, closing race-ethnic gaps would increase Pennsylvania GDP one year later by $0.9 billion to $2.0 billion, or 0.2 to 0.4 percent of actual GDP in that year. Looking ten years beyond the gap-closing date, GDP growth in 2013 is higher by 2 to 4 percent, or $12 billion to $27 billion. At the upper end of the range, closing economic status gaps produces an immediate GDP boost of 0.3 to 0.6 percent ($2 billion to $3 billion) and a gain ten years later in 2013 of 3 to 7 percent ($22 billion to $44 billion). Closing gaps in achievement based on parent education has effects that fall in between these two other scenarios. Note that the initial boost in GDP from closing race-ethnic gaps of approximately $1 billion to $2 billion is similar to the range reported in Table 5.4 of the one-year gain in earnings from the same gap-closing exercise.

Table 5.5. Method B Estimated Value of Lost GDP from Achievement Gaps

Performance Gap	Size of Weighted Population Achievement Test Score Gap	Pennsylvania GDP Gain from Closing Gaps in 2003 in Billions of 2013 Dollars [Percentage Change]	
		Gain After First Year (2004)	Gain After Ten Years (2013)
Race-ethnic gap	0.16–0.21 standard deviation gap	$0.9–$2.0 [0.2%–0.4%]	$12.4–$27.4 [1.9%–4.2%]
Economic status gap	0.28–0.33 standard deviation gap	$1.6–$3.1 [0.3%–0.6%]	$21.8–$43.5 [3.4%–6.7%]
Parent education gap	0.26–0.27 standard deviation gap	$1.5–$2.6 [0.3%–0.5%]	$20.3–$35.4 [3.1%–5.5%]

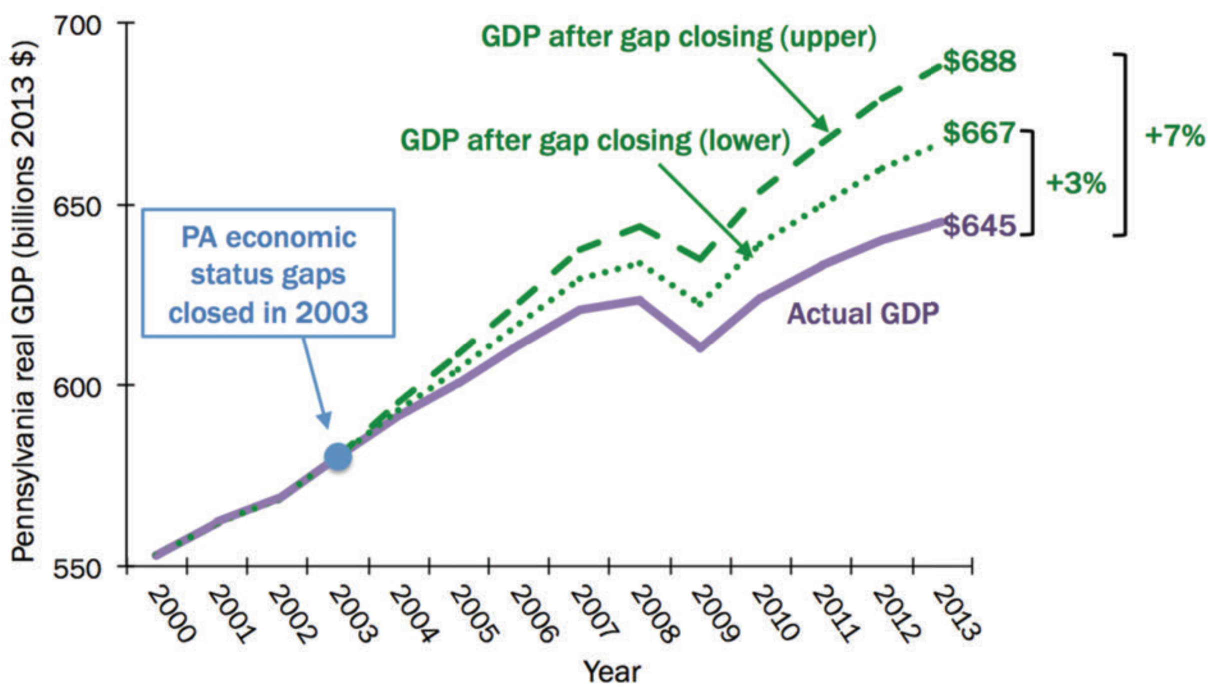
SOURCE: Author’s estimates.
NOTES: Achievement gap parameters are based on the ranges reported in Table 3.5. See Appendix C for additional detail.

Figure 5.1. Method B Estimated Value of GDP Trajectory If Race-Ethnic Gap Is Closed



SOURCE: Author's estimates.

Figure 5.2. Method B Estimated Value of GDP Trajectory If Parent Education Gap Is Closed



SOURCE: Author's estimates.

Results: Economic Gains from Closing Gaps in Future Cohorts (Methods C and D)

Method C is the first of two methods taking a cohort perspective. It is closely related to Method A in calculating the earnings gain for the share of the Pennsylvania workforce in the low-performing groups. Because we look at earnings over the work life from age 20 to 64, the future stream of earnings gains are discounted using either a 2-percent or 3-percent rate (the former to match the discount rate used in Method D). With either discount rate, these estimates, reported in Table 5.6, indicate that future cohorts of Pennsylvania workforce entrants would gain approximately $1 billion to $3 billion in present-value lifetime earnings if race-ethnic gaps in achievement were eliminated for that cohort. This range for a future cohort is very similar to the range calculated for the current workforce if race-ethnic gaps were closed (Method A, Table 5.4).[17]

Table 5.6. Method C Estimated Present Value of Lifetime Earnings Gains for Low-Performing Groups in Each Annual Cohort

Performance Gap	Size of Test Score Achievement Gap for Affected Groups	Present-Value Lifetime Gain in Earnings for Each Annual Cohort in Billions of 2013 Dollars [Percentage Change]	
		Lower Bound	Upper Bound
Race-ethnic gap (2-percent discount rate)	0.72–1.01 standard deviation gap in achievement scores for African-Americans; 0.68–0.92 standard deviation gap in achievement scores for Latinos	$1.44 [6.4%]	$3.33 [14.7%]
Race-ethnic gap (3-percent discount rate)		$1.19 [6.4%]	$2.74 [14.7%]

SOURCE: Author's estimates.
NOTES: Achievement gap parameters are based on the ranges reported in Table 3.2. Earnings from age 20 to 64 are discounted to age 18. See Appendix C for additional detail.

The Method C estimates in Table 5.6 are limited to earnings alone, but the higher earnings would be expected to be accompanied by higher overall compensation, as well as nonmarket gains that result from higher human capital. These additional benefits are accounted for in Method D, with results reported in Table 5.7 for closing race-ethnic gaps and economic status gaps (using a 2-percent discount rate). Since Method D is based on closing educational attainment gaps, we first show the estimated effects on earnings alone to compare with

[17] In the cross-section estimate for Method A, African-Americans and Latinos constitute about 14 percent of the current workforce. For new cohorts entering the labor market, these two groups make up about 23 percent of each cohort. Thus, the earnings gains in Method B (based on the same parameter as Method A) apply to a larger share of the workforce, but the value of the gains shrinks after discounting to the present-value estimate. This accounts for the similarity between the cross-section approach in Method A and the discounted present-value cohort approach of Method C.

Table 5.7. Method D Estimated Present Value of Lifetime Earnings and Social Gains for Low-Performing Groups in Each Annual Cohort

Performance Gap	High School Graduation Rate Gap for Affected Groups	Present-Value Lifetime Gain in Earnings, Fringe Benefits, and Social Value for Each Annual Cohort in Billions of 2013 Dollars	
		Lower Bound	Upper Bound
a. Gain in Earnings Only			
Race-ethnic gap (2-percent discount rate)	17-percentage-point gap in high school graduation rate for African-Americans; 19-percentage-point gap in high school graduation rate for Latinos	$1.85	
Economic status gap (2-percent discount rate)	14-percentage-point gap in high school graduation rate for economically disadvantaged	$2.29	
b. Gain in Earnings, Fringe Benefits, and Social Value			
Race-ethnic gap (2-percent discount rate)	17-percentage-point gap in high school graduation rate for African-Americans; 19-percentage-point gap in high school graduation rate for Latinos	$2.78	$4.16
Economic status gap (2-percent discount rate)	14-percentage-point gap in high school graduation rate for economically disadvantaged	$3.43	$5.14

SOURCE: Author's estimates.
NOTES: Attainment gap parameters are based on the figures reported in Tables 3.2 and 3.3. See Appendix C for additional detail.

Method C, and the estimates are very similar: The $1.85 billion present-value earnings gain from closing race-ethnic gaps in the high school graduation rate (see Table 5.7) falls within the estimated range of $1 billion to $3 billion present-value earnings gain from closing race-ethnic achievement gaps (see Table 5.6). When full compensation and other benefits are accounted for, the estimated gains reach a range of $3 billion to $4 billion in present value from closing race-ethnic gaps. As expected, the gain in earnings alone or full compensation and nonmarket benefits from closing economic status gaps exceeds the equivalent estimates for closing race-ethnic gaps, with an estimated gain in total compensation and nonmarket benefits ranging from $3 billion to $5 billion in present value from closing economic status gaps for future cohorts.

The Method C and D estimates, because they apply to each annual cohort of Pennsylvania students, can be viewed in terms of the value of the economic or social gains per student in the affected groups. Taking the gain in earnings, fringe benefits, and social value from Method D, the total gain from closing race-ethnic gaps equates to approximately $83,000 to $125,000 in present-value dollars per African-American or Latino student in Pennsylvania in each annual cohort. The gains from closing economic status gaps, which affect a larger share of students in each annual cohort, range from about $66,000 to $99,000 per economically disadvantaged student in the state. Thus, viewed on a per student basis, the gains from closing economic status gaps appear to be somewhat smaller.

Summary of Estimates Across Methods and Limitations

The results across the four methods are summarized in Table 5.8, with results shown for each type of academic performance gap that could be closed. Overall, the results are very consistent across the alternative estimation methods. Viewed from the perspective of the cost to Pennsylvania's current workforce and economy, academic performance gaps amount to an estimated annual cost of $1 billion to $3 billion in lost earnings (Method A) or reduced GDP (Method B). Accounting for the compounded effect on economic growth of reduced levels of workforce skill, gaps in student performance defined by race-ethnicity or socioeconomic status constitute a loss to the economy over a ten-year horizon that equals $12 billion to $44 billion in annual lost GDP, or 2 to 7 percent of the value of economic output (Method B). Given the larger share of the population affected by gaps associated with family economic status and parent education, the estimated magnitudes of the aggregate economic costs of these socioeconomic gaps exceed those associated with the more commonly measured race-ethnic differences in student performance.

Two other methods provide a perspective on the gains to future cohorts of labor market entrants that would be realized if student performance gaps based on race-ethnicity or family economic status were closed. Again, results are very consistent across the two methods we employ. Viewed in terms of earnings alone, each annual cohort would gain $1 billion to $3 billion in present-value lifetime earnings from closing race-ethnic gaps in student achievement (Method C). Based on cross-group differences in the high school graduation rate, we estimate a gain to society of $3 billion to $5 billion in present-value market and nonmarket benefits for each annual cohort from closing gaps based on race-ethnicity or family economic status (Method D). Again, the economic value of closing economic status gaps exceeds that associated with closing race-ethnic gaps.

Our estimates focus on the aggregate gains in economic performance as measured by GDP or in individual earnings or compensation, but such gains would result in increased tax revenue in Pennsylvania. In 2013, Pennsylvania total state-level tax revenue reached just over $28 million, or 4.4 percent of state GDP. The personal income tax rate is currently 3.07 percent. These tax rates can be applied to the estimates in Table 5.8 to calculate the consequences for state tax revenue from closing student performance gaps.

As noted earlier in this chapter, the derivation of the economic value of student performance differences rests on a number of key assumptions. Because of assumptions regarding causal linkages and generalizability, it is important to view these figures as approximate estimates of the true economic values for Pennsylvania. For example, we have relied on key economic parameters to measure causal linkages that are based on national samples of individuals or even on cross-national empirical studies, so it is possible that the parameters might differ for the Pennsylvania labor market and economy.

Table 5.8. Summary of Results of Estimated Economic Value of Performance Gaps by Type of Gap and Method

Method	Type of Education Performance Gap: Race-Ethnic	Family Economic Status	Parent Education
Economic Burden of Current Gaps			
A. Estimate lost earnings for low performing groups from current gaps	$1.3 billion to $2.9 billion gain in Pennsylvania individual annual earnings from closing achievement gaps in 2013	–	–
B. Estimate lost GDP from current gaps because of lower economic productivity and innovation	$0.9 billion to $2.0 billion gain in Pennsylvania GDP in 2004 from closing achievement gaps one year earlier ——— $12 billion to $27 billion (2%–4%) gain in Pennsylvania GDP in 2013 from closing achievement gaps ten years earlier	$1.6 billion to $3.1 billion gain in Pennsylvania GDP in 2004 from closing achievement gaps one year earlier ——— $22 billion to $44 billion (3%–7%) gain in Pennsylvania GDP in 2013 from closing achievement gaps ten years earlier	$1.5 billion to $2.6 billion gain in Pennsylvania GDP in 2004 from closing achievement gaps one year earlier ——— $20 billion to $35 billion (3%–6%) gain in Pennsylvania GDP in 2013 from closing achievement gaps ten years earlier
Economic Gains of Closing Gaps for Future Cohorts			
C. Estimate future lifetime earnings gains for single-year cohort if gaps are closed	$1.4 billion to $3.4 billion gain in 2013 present-value Pennsylvania individual earnings (2% discount rate)	–	–
D. Estimate future lifetime private and social gains for single-year cohort if gaps are closed	$2.8 billion to $4.2 billion gain in 2013 present value to society (2% discount rate)	$3.4 billion to $5.1 billion gain in 2013 present value to society (2% discount rate)	–

SOURCE: Author's analysis presented in Tables 5.4 to 5.7.
NOTE: – = Not applicable.

In addition, several factors suggest that the estimates in Table 5.8 may be upper bounds of the estimated economic values we seek to estimate. First, for the cohort-based analyses of future gains from closing student performance gaps (Methods C and D), we do not account for the effect of mortality or cross-state migration for the affected groups of individuals who experience increased earnings because of the gap closing. Both factors would reduce the number of individuals in a given single-year cohort who generate economic benefits in the state of Pennsylvania. The attenuation of benefits from these sources depends on the age-specific migration and mortality rates for the affected demographic groups in Pennsylvania (i.e., African-Americans and Latinos), which are not readily available. As an approximation, if we use the Pennsylvania average annual outmigration rate and the U.S. national annual mortality rate, we estimate that the dollar estimates reported in Table 5.6 for Method C would be 60 percent as large (a range of about $0.9 billion to $2.0 billion using a 2-percent discount rate).[18] The attenuation of benefits to Pennsylvania as a result of outmigration would be a benefit that accrues to the other U.S. states in which the outmigrants reside.

Second, the issue of general equilibrium effects was noted earlier in the chapter. Economywide increases in the skill level of the labor force or new labor market entrants as a result of closing student performance gaps could place downward pressure on earnings or total compensation for more highly skilled or more educated workers, which would diminish the magnitude of the effects we have estimated. More sophisticated economic modeling would be required to estimate the potential consequences for our estimates of such general equilibrium effects, which is one reason such effects are typically not accounted for in benefit-cost studies.

[18] The 2013 American Community Survey indicates that approximately 1.95 percent of Pennsylvania residents migrate out of state each year (U.S. Census Bureau, undated). The annual mortality rate in the U.S. is about 800 per 100,000 persons (Centers for Disease Control and Prevention, 2014).

6. Conclusions and Policy Implications

In this study, we set out to achieve two goals: to document the size of the gaps in student performance in Pennsylvania for public school students and to estimate the economic costs of the performance differences we identified. In this final chapter, we summarize our findings and draw out relevant policy implications.

Performance Gaps and Their Economic Consequences

Although average educational outcomes for public school students in Pennsylvania—namely, achievement test scores in fourth and eighth grade and the high school graduation rate—place the state in the top ranks relative to other U.S. states, the strong averages mask considerable variation across student subgroups defined by race-ethnicity and socioeconomic status, as well as wide differences across Pennsylvania's school districts. This study has documented the substantial gap in Pennsylvania student performance between white students and their African-American and Latino counterparts, between students with higher family economic status versus lower economic status, and between students differentiated by parent education. The magnitudes of the achievement gaps are similar whether measured using Pennsylvania's standardized student assessment, the PSSA, or using the comparable cross-state assessment, the NAEP. The gaps are equally large in terms of performance in reading as they are in math. Moreover, compared with other states, the achievement gaps in Pennsylvania are among the largest. Performance gaps are also manifested in differences in the on-time graduation rate across students defined by race-ethnicity and family economic status. We have also demonstrated that if the achievement gaps by race-ethnicity or socioeconomic status were eliminated by raising the scores of the lower-performing groups to their higher-performing peers, Pennsylvania would rank among the top U.S. states and would even reach the top tier of OECD countries assessed using the PISA.

We have further shown that the student performance gaps potentially equate to significant cost to the state's economy in terms of the lost productivity of the state's workforce and lost economic output. Race-ethnic gaps are estimated to result in lost earnings annually of $1.3 billion to $2.9 billion in 2013 for the current workforce of African-Americans and Latinos. If achievement gaps had been closed in 2003, our estimates show that, ten years later, Pennsylvania GDP would have been higher by 2 to 7 percent (or $12 billion to $44 billion) depending on whether race-ethnic gaps are closed (which has the smaller effect) or whether gaps by family economic status are eliminated (which has the larger effect). Our estimates are in line with those produced by McKinsey and Company (2009a, 2009b) for the United States as a whole, after accounting for the different size of the two economies and other differences, such as the lower wage structure in Pennsylvania.

We also considered two other methods for estimating the economic gains that would accrue to future cohorts that would enter the labor market without gaps in student achievement or attainment based on race-ethnicity or socioeconomic status. For each cohort, the present-value earnings gain alone amounts to $1 billion to $3 billion. Accounting for the total compensation and nonmarket benefits associated with higher human capital, the gains are estimated to extend from $3 billion to $5 billion in present-value benefits per cohort.

As we noted in Chapter Five, these economic estimates of the cost of existing student performance gaps or the gains from closing gaps for future cohorts should be viewed as estimates subject to some degrees of uncertainty, given the inability to employ economic parameters specific to the Pennsylvania economy. Nevertheless, the consistency in findings across alternative methods and the similarity in estimates for the county as a whole (adjusting for scale) provide greater confidence that the estimates serve as a valid gauge of the costs of achievement and attainment gaps in Pennsylvania.

Implications for Policy

The estimates provided in this study for Pennsylvania, like the earlier studies by McKinsey and Company and others for the United States, quantify the costs to individuals and the economy of the shortfalls in student performance and, conversely, place a value on the private and social economic benefits that would accrue from narrowing achievement differences across subgroups or across jurisdictions. Thus, such estimates provide the "shadow prices," or the economic values that can be attached to policies that would serve to reduce differences in education performance by race-ethnicity, by socioeconomic status, or by jurisdiction (e.g., school district). Using benefit-cost analysis methods, the estimates of economic benefits from reducing student performance gaps can then be compared to the costs of the policies required to achieve the improved student outcomes to determine whether there are favorable returns to specific policies, programs, or interventions.

While benefit-cost analysis is beyond the scope of this study, the substantial economic costs we have documented for existing student performance gaps and the potential gains to be realized from closing those gaps naturally invite consideration of what policies, programs, or interventions might serve to raise student achievement for low-performing groups and thereby narrow or eliminate the measured gaps. The current policy landscape includes a number of candidates that are currently being implemented, at least in some parts of Pennsylvania, and others that may be considered in the future. These include the following:

- *Investments in early childhood*. There is an extensive literature that delineates the impacts of high-quality early intervention programs, such as home visiting, as well as high-quality early education programs, in terms of improving school readiness and subsequent school performance, especially for children from low-income families and those who face other disadvantages (Karoly, Kilburn, and Cannon, 2005; Yoshikawa et al., 2013).

- *K–12 education investments and reforms*. There is a varied menu of potential policy options for K–12 education that seek to boost the academic success of low-performing groups of students, from whole-school reform models to targeted changes in school leadership, curricula, instructional practices, and specific structural features (e.g., class size). Past and ongoing research provides a foundation for informed decisions about how to deploy existing resources more effectively and how to strategically invest new resources (U.S. Department of Education, undated; Promising Practices Network, 2014).
- *After-school and summer learning programs*. Efforts to boost student performance extend to out-of-school-time learning, whether during the after-school hours or during the summer months. A growing evidence base is helping to define best practices in these areas and document effective models (Bodilly and Beckett, 2005; Beckett et al., 2009; McCombs et al., 2011; Augustine et al., 2013).
- *Youth development programs.* Older children and youth can potentially benefit from high-quality supports focused on educational attainment (e.g., dropout prevention), social emotional development and behavioral supports, and other community-based strategies to promote positive development, especially for those youth who are at risk of school failure and other negative outcomes (National Research Council, 2002; Redd et al., 2002).

Where these policy options and others can be demonstrated to improve academic achievement and educational attainment, there is the potential for narrowing the school performance gaps documented in this report. Our estimates of the economic benefits from closing gaps can then be used to determine whether the costs of implementing any given policy designed to close education performance gaps will be outweighed by the economic benefits, documented in this analysis, from closing those gaps. In this way, policymakers could take evidence of economic returns into account, along with other considerations, such as equity concerns, when making decisions regarding investments in children and youth.

Appendix A. Data Sources on Student Academic Performance

This appendix provides additional information about the sources of data used in the analyses reported in Chapters Two, Three, and Four and summarized in Tables 1.2 and 1.3.

Pennsylvania State- and District-Level Academic Performance Data

We obtained data from the Pennsylvania Department of Education (2015) website for state-level PSSA results by grade and subject from 2004 to 2013 (corresponding to academic years 2003–2004 to 2012–2013). Some information that was not available online was provided directly by the department. Achievement test results were available for all public-school students, as well as for subgroups based on race-ethnicity and economic status. PSSA records contained the number of test-taking students, the mean scale score, the standard deviation, and the percentage of students in each of four achievement levels: below basic, basic, proficient, and advanced. We obtained the same PSSA district-level results for 2013. We also accessed the four-year ACGR for 2011 to 2013 (corresponding to academic years 2010–2011 to 2012–2013) at the state and district levels, in total and by subgroup.

For analyses disaggregated by race-ethnicity, we focus on students classified as Hispanic (any race), non-Hispanic white, non-Hispanic Black or African-American, and Asian or Pacific Islanders. Residual groups include non-Hispanic American Indians or Alaskan Natives and non-Hispanic multiracial students.

In most cases, the subgroup records provided results for students classified as economically disadvantaged. We calculated the result for students not economically disadvantaged based on the total (mean score and total test-takers) and the results for the economically disadvantaged subgroup (mean score and total test-takers).

U.S. State Academic Performance Data

National and state-level results for the NAEP, which is based on a nationally representative sample of public-school students in all 50 states and the District of Columbia, were obtained from the National Center for Education Statistics (NCES) website (NCES, 2015). We used the main NAEP assessment data for fourth and eighth grades from 2003 (the first year all states participated) to 2013, analyzing the scale scores and percentage distribution of students across the four NAEP achievement levels: below basic, basic, proficient, and advanced. Although the NAEP reading and math frameworks, set by the National Assessment Governing Board, have changed over time, the content objectives for the core assessments in fourth- and eighth-grade reading and math have not changed, so that assessments from the early 1990s onward have been determined to be comparable.

We employed NAEP disaggregated results reported for student subgroups defined by race-ethnicity, FRPL eligibility, and parents' highest education. Results are reported for subgroups only when the criteria for the minimum sample size and school representation are met. As with PSSA data, we focused on the four major race-ethnic groups in Pennsylvania: Hispanic (any race), non-Hispanic white, non-Hispanic Black or African-American, and Asian or Pacific Islander. The residual groups include American Indians or Alaskan Natives and students recorded as "other or unclassified" (which includes those identifying with two or more race-ethnic groups). For the NAEP, student's FRPL-eligibility status is based on school records. Parent education is based on the parents' highest level of education, as reported by the test-taking student.

All states began reporting the four-year ACGR for public-school students using a rigorous, common method starting in 2010–2011 (NCES, 2014c). Because results for 2012–2013 had not yet been released by NCES, we relied on the cross-state results reported by DePaoli et al. (2015), which they compiled from state reports.

International Student Achievement Data

The OECD's 2012 PISA results are also available online (OECD, undated). We focused on the results for reading and math (mean scale scores) for the 34 OECD member countries, as well as the three U.S. states that participated in the assessment in 2012 as separate economies: Connecticut, Florida, and Massachusetts.

Appendix B. Supplemental Tables

This appendix provides additional tables to supplement those in the body of the report. In particular, Table B.1 provides results for all the states and the District of Columbia to supplement the subset of states presented in Table 1.1. Table B.2 displays results for all states and the District of Columbia to supplement the subset of states contained in Table 4.2.

Table B.1. Eighth-Grade NAEP Mean Scale Scores and Rank of Score Gaps by State: 2013

State	Mean Scale Score		Rank of Reading Score Gap			Rank of Math Score Gap		
	Reading	Math	White–African-American	White–Latino	High–Low Economic Status	White–African-American	White–Latino	High–Low Economic Status
Massachusetts	**277**	**301**	4	2	3	19	5	3
New Jersey	**276**	**296**	24	19	11	30	27	12
Connecticut	**274**	285	19	6	2	11	2	2
Vermont	**274**	**295**	41	–	33	6	–	20
New Hampshire	**274**	**296**	–	4	35	–	7	44
Maryland	**274**	287	27	23	20	28	29	22
Pennsylvania	272	290	6	3	17	8	3	10
Montana	272	289	–	29	42	–	44	45
Washington	272	290	36	8	15	40	22	33
Colorado	271	290	3	11	7	7	12	8
Minnesota	271	**295**	7	5	10	5	9	13
Wyoming	271	288	–	31	48	–	39	51
Idaho	270	286	–	15	45	–	14	49
Kentucky	270	281	17	43	24	42	38	28
Utah	270	284		22	46	–	4	43
Iowa	269	285	20	26	31	9	15	30
Maine	269	289	–	–	51	25	–	42
Nebraska	269	285	16	13	25	3	10	24
Ohio	269	290	21	46	12	33	31	15
North Dakota	268	**291**	40	–	32	41	–	38
Oregon	268	284	–	14	16	–	17	17
South Dakota	268	287	–	35	50	4	25	19
Virginia	268	288	18	41	9	22	35	11
Wisconsin	268	289	2	27	29	2	18	31
Illinois	267	285	5	20	4	12	19	6
Indiana	267	288	14	39	41	31	40	37
Kansas	267	290	8	21	18	29	26	23
Missouri	267	283	9	47	37	24	42	34
Rhode Island	267	284	23	7	6	21	6	4
Delaware	266	282	35	38	36	26	30	32
Florida	266	281	37	36	40	32	34	41
Michigan	266	280	15	32	23	10	13	14
New York	266	282	32	10	22	15	8	36
Georgia	265	279	33	34	27	27	37	9
North Carolina	265	286	34	28	13	34	33	29
Tennessee	265	278	38	45	39	37	41	16
Texas	264	288	12	9	26	18	24	39
Arkansas	262	278	25	40	30	13	43	21
California	262	276	10	12	8	17	11	18
Nevada	262	278	29	18	47	38	23	46
Oklahoma	262	276	31	25	43	39	36	48
Alaska	261	282	39	42	19	43	32	27
South Carolina	261	280	30	37	14	20	28	7
Arizona	260	280	26	16	28	36	16	26
Hawaii	260	281	42	30	44	–	45	50
Alabama	257	269	22	24	5	23	20	5
Louisiana	257	273	28	44	34	35	46	35
West Virginia	257	274	43	–	49	44	–	47
New Mexico	256	273	13	17	38	14	21	40
Mississippi	253	271	11	33	21	16	47	25
District of Columbia	248	265	1	1	1	1	1	1

SOURCE: Author's analysis of 2013 NAEP data.

NOTES: States are sorted from highest to lowest by the NAEP reading score. States with mean scale scores above Pennsylvania are shown in bold text. – = Not available because subgroup scale scores are not reported for one or both subgroups in the state when the subgroup size is too small.

Table B.2. Adjusted Mean Scale for Pennsylvania to Match Demographics of Other States: NAEP Eighth-Grade Reading and Math in 2013

	State Scale Score		Adjusted State Scale Score and Adjusted Gap: Adjusted for Race-Ethnicity		Adjusted for Economic Status		Adjusted for Parent Education	
	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA
a. Eighth-Grade Reading								
Massachusetts	277	5	278	6	276	4	278	6
New Jersey	276	4	276	4	275	3	277	5
Connecticut	274	2	274	2	273	0	276	4
Vermont	274	2	–	–	274	2	276	4
New Hampshire	274	2	–	–	271	–1	276	3
Maryland	274	2	278	6	273	1	275	3
Pennsylvania	272	0	272	0	272	0	274	2
Washington	272	0	274	2	273	1	277	5
Montana	272	0	–	–	271	–1	273	1
Minnesota	271	–1	267	–5	269	–3	271	–1
Colorado	271	–1	273	1	271	–1	274	2
Wyoming	271	–1	–	–	270	–2	273	1
Idaho	270	–2	–	–	271	–1	273	1
Utah	270	–2	–	–	269	–3	272	0
Kentucky	270	–2	–	–	271	–1	273	1
Nebraska	269	–3	–	–	270	–2	272	0
Maine	269	–3	–	–	269	–3	271	–1
Ohio	269	–3	269	–3	269	–3	272	–1
Iowa	269	–3	267	–5	268	–4	271	–1
Oregon	268	–4	–	–	272	–1	273	1
South Dakota	268	–4	–	–	267	–5	270	–2
North Dakota	268	–4	–	–	266	–6	268	–4
Virginia	268	–4	270	–2	266	–6	270	–2
Wisconsin	268	–5	264	–8	267	–5	270	–2
Indiana	267	–5	–	–	268	–4	270	–2
Missouri	267	–5	–	–	269	–4	270	–2
Illinois	267	–5	271	–1	268	–4	271	–1
Kansas	267	–5	267	–5	268	–4	269	–3
Rhode Island	267	–5	269	–3	267	–5	270	–2
New York	266	–6	268	–4	267	–5	269	–3
Delaware	266	–6	267	–5	267	–5	268	–4
Michigan	266	–6	264	–9	267	–5	268	–4
Florida	266	–6	270	–2	269	–3	269	–4
Tennessee	265	–7	–	–	268	–4	269	–3
Georgia	265	–7	270	–2	269	–4	267	–5

Table B.2—Continued

	State Scale Score		Adjusted State Scale Score and Adjusted Gap					
			Adjusted for Race-Ethnicity		Adjusted for Economic Status		Adjusted for Parent Education	
	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA
a. Eighth-Grade Reading								
North Carolina	265	–8	269	–3	268	–4	268	–4
Texas	264	–8	273	1	267	–5	269	–3
Arkansas	262	–10	–	–	266	–6	266	–6
Oklahoma	262	–10	–	–	264	–8	265	–7
Nevada	262	–10	267	–5	264	–8	268	–4
California	262	–11	269	–3	266	–6	268	–4
South Carolina	261	–11	264	–8	265	–7	264	–8
Alaska	261	–11	269	–3	262	–10	–	–
Arizona	260	–12	265	–7	264	–8	266	–6
Hawaii	260	–12	270	–2	262	–10	263	–9
Alabama	257	–15	–	–	261	–11	261	–11
West Virginia	257	–15	–	–	260	–12	262	–10
Louisiana	257	–15	–	–	262	–10	260	–12
New Mexico	256	–16	–	–	262	–11	261	–11
Mississippi	253	–19	–	–	260	–12	256	–16
District of Columbia	248	–24	–	–	259	–13	253	–19
b. Eighth-Grade Math								
Massachusetts	301	11	301	12	300	10	302	12
New Jersey	296	6	295	6	294	4	296	7
New Hampshire	296	6	–	–	292	2	296	7
Vermont	295	6	–	–	295	5	297	8
Minnesota	295	5	290	0	292	2	295	5
North Dakota	291	1	–	–	288	–1	290	1
Washington	290	0	291	1	291	1	294	4
Colorado	290	0	292	3	290	0	293	3
Pennsylvania	290	0	290	0	290	0	292	2
Ohio	290	0	289	0	290	0	292	3
Kansas	290	0	290	0	291	1	292	2
Montana	289	0	–	–	289	–1	291	1
Wisconsin	289	–1	285	–5	289	–1	290	1
Maine	289	–1	–	–	289	0	290	1
Texas	288	–1	295	6	292	2	292	3
Virginia	288	–1	291	1	287	–3	290	0
Wyoming	288	–2	–	–	288	–2	290	0
Indiana	288	–2	–	–	289	–1	291	1
South Dakota	287	–2	–	–	286	–4	289	–1

Table B.2—Continued

	State Scale Score		Adjusted State Scale Score and Adjusted Gap: Adjusted for Race-Ethnicity		Adjusted for Economic Status		Adjusted for Parent Education	
	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA	Level	Gap with PA
a. Eighth-Grade Reading								
Maryland	287	–3	294	4	287	–3	289	0
Idaho	286	–3	–	–	287	–3	288	–1
North Carolina	286	–4	291	1	289	0	289	0
Connecticut	285	–4	286	–4	283	–7	286	–4
Iowa	285	–5	282	–7	284	–5	287	–3
Nebraska	285	–5	285	–5	286	–4	287	–2
Illinois	285	–5	289	0	287	–3	288	–1
Utah	284	–5	–	–	284	–6	286	–3
Rhode Island	284	–6	284	–6	285	–5	287	–2
Oregon	284	–6	–	–	287	–2	289	–1
Missouri	283	–7	–	–	285	–5	286	–4
Delaware	282	–7	286	–4	284	–6	285	–5
New York	282	–8	284	–5	283	–7	284	–5
Alaska	282	–8	289	–1	283	–7	–	–
Hawaii	281	–8	–	–	284	–6	285	–5
Florida	281	–9	286	–3	284	–5	284	–5
Kentucky	281	–9	280	–10	283	–7	284	–6
Michigan	280	–9	278	–12	281	–8	282	–8
South Carolina	280	–10	–	–	284	–6	283	–7
Arizona	280	–10	285	–4	284	–6	286	–4
Georgia	279	–10	287	–3	284	–5	282	–7
Nevada	278	–11	284	–6	281	–8	284	–5
Arkansas	278	–12	–	–	282	–8	281	–8
Tennessee	278	–12	–	–	281	–9	281	–8
California	276	–14	285	–5	281	–8	283	–7
Oklahoma	276	–14	277	–13	278	–12	279	–11
West Virginia	274	–15	–	–	278	–12	278	–11
New Mexico	273	–17	–	–	279	–10	278	–11
Louisiana	273	–17	–	–	278	–12	276	–14
Mississippi	271	–18	–	–	278	–12	274	–16
Alabama	269	–20	–	–	274	–16	272	–18
District of Columbia	265	–24	–	–	279	–11	270	–19

SOURCE: Author's analysis of 2013 NAEP data.
NOTE: Adjusted gaps are calculated by applying Pennsylvania subgroup shares to the mean scale scores for a given state. – = Adjusted gap cannot be calculated because mean scale scores are not reported for one or more subgroups in the state when the subgroup size is too small. PA = Pennsylvania.

Appendix C. Methods for Economic Analysis

This appendix provides additional information on the data and methods used to derive the economic estimates in Chapter Five. We first note the sources of data and other parameters used in the estimates. We then detail the approach used to derive the results for the four estimation methods (Methods A to D).

Data Sources and Parameters

In addition to the estimates of the size of student performance gaps based on the results presented in Chapter Three (derived from data described in Appendix A), we drew on several other data sources for parameters specific to the Pennsylvania labor force and economy:

- *Pennsylvania employment and earnings.* Data on annual employment levels were obtained from the 2013 ACS (U.S. Census Bureau, undated) or the 2013 CPS (U.S. Bureau of Labor Statistics (BLS), undated-b). All data were reported in online tables.
- *Pennsylvania GDP.* The Bureau of Economic Analysis (BEA) provides annual figures at the state level for GDP and GDP per capita in both real and nominal terms (BEA, undated). The data were extracted using the online interactive data tool.

As discussed further below, the employment and earnings data were employed in Methods A and D, while the GDP data were required for Method B. Method D also required an estimate of the size of each annual cohort entering the labor market, which we approximated by the size of the 2013 cohort of entering ninth graders based on the PSSA data for that year.

As noted in Chapter Five, our economic estimates rely on three key parameters estimated in the literature (see Table 5.3). We discuss each parameter in turn.

Linking Student Academic Achievement and Earnings

An extensive literature in economics estimates the relationship between measures of academic achievement, such as reading and math scores, with labor market earnings over the course of life (see Duckworth et al., 2012, for a review). Table C.1 summarizes four such studies that illustrate the range of findings using various data sources and methods. All four studies employ one or more cohort longitudinal studies, with estimates that apply to men and women combined or men only. The academic achievement measures include subject-specific assessments in reading and math, as well as such general aptitude measures as the Armed Forces Qualifications Test (AFQT). The cognitive assessments are typically administered in the mid-teens to early 20s. Using multivariate regression, the measures of achievement are regressed on earnings (hourly wages or annual earnings) measured as young as age 25 and as old as age 48. The models include various controls for individual characteristics (age, race-ethnicity), initial endowments (e.g., birth weight), family background factors (e.g., parent education), and, in several cases, completed schooling. The robustness of the relationships to a wide array of control variables provides more confidence that the estimated relationships are causal. The range of estimates found in the four studies listed in Table C.1 is the one we employ in our estimates: a 9- to 15-percent gain in earnings for a one-standard-deviation increase in achievement.[19]

Table C.1. Methods for Estimating the Economic Value of Performance Gaps by Type of Gap

Study	Longitudinal Data Source/ Population	Achievement Measure/ Age(s) of Measurement	Earnings Measure / Age(s) of Measurement	Estimated Percentage Change in Earnings per SD Change in Achievement
Mulligan (1999)	NLSY79/ all	AFQT/ 15–23	Avg. hourly wage/ 25–33	11%
Murnane et al. (2001)	NLSY79/ males	AFQT/ 15–18	Avg. hourly wage/ 27–28	9%
Lazear (2003)	NELS88/ all	Reading, math/ 14–15	Annual earnings/ 25–27	15%
Duckworth et al. (2012)	Various[a]/ males	Reading, math/ 13–16	Annual earnings/ 27–48	9%–10%

[a] The study is based on results from longitudinal surveys from five data sets covering four countries: the United States, United Kingdom, Finland, and Sweden.
NOTES: NLSY79 = National Longitudinal Survey of Youth of 1979; NELS88 = National Education Longitudinal Study of 1988.

Linking Student Academic Achievement and GDP Growth

Like McKinsey and Company (2009a, 2009b), we rely on estimates from Hanushek and Woessmann (2008) for the relationship between academic achievement as a measure of human capital (or cognitive skills) and GDP growth (see also Hanushek and Woessmann, 2010). Specifically, based on their own empirical analyses and others in the endogenous growth literature, they conclude that a one-standard-deviation increase in average student achievement leads to a 1.2- to 2-percent increase in the growth of GDP per capita, all else being equal. This literature primarily derives from cross-national studies using estimates of cognitive skills from international assessments, such as the PISA, as predictors of the rate of annual economic growth, among other factors. While conclusive tests of causality are not possible, Hanushek and Woessmann (2009, 2010) and others demonstrate that the estimated relationship is robust to a range of alternative estimation strategies to seek to rule out other confounding factors. Although, to our knowledge, the types of models estimated at the county level by Hanushek and colleagues have not been replicated at the state level, there is an equivalent literature that shows a robust relationship between state economic growth and the level of education (measured by years of

[19] The McKinsey and Company study (2009a, 2009b) used a range of 11 to 15 percent.

school or the share of the population with a college degree) (Holtz-Eakin, 1993; Reed, 2009). Thus, it is reasonable to expect a similar relationship between the skill level of a state's population and its rate of economic growth.

Linking High School Graduation and Lifetime Private and Social Returns

We rely on the estimates by Cohen and Piquero (2009) of the present-value lifetime costs of a high school dropout or, alternatively, the benefits of graduating from high school. Their estimates, discounted to age 18 using a 2-percent discount rate, account for the effect of high school graduation (relative to being a dropout) on earnings, the value of fringe benefits, and the nonmarket returns in multiple private and public domains. Their estimated present-value lifetime earnings gain of $280,000 in 2007 dollars is consistent with estimates derived in other studies. For example, based on data from the CPS, Rouse (2007) estimates a lifetime present-value earnings gain in 2004 dollars (using a 3.5-percent discount rate) for a high school graduate over a dropout of $190,000 to nearly $300,000, depending on the assumption about annual real earnings growth. More recently, Belfield, Levin, and Rosen (2012) estimate that a high school dropout will earn about $400,000 less in present-value terms over his or her lifetime relative to a high school graduate (discounted at 3.5 percent). Rouse's (2007) review of the literature makes the case that such estimates represent a causal relationship, consistent with those found in studies linking earnings to educational attainment, while accounting for potential selectivity bias. In terms of spillover benefits, Levin et al. (2006) estimate that a high school graduate can be expected to generate about $200,000 in present-value public economic benefits over her or his lifetime from such factors as higher income and taxes paid, better health, reduced crime, and less welfare dependency. More generally, there is a well-established literature on the nonmarket returns to schooling, with evidence that the nonpecuniary benefits of increased educational attainment may at least equal the pecuniary ones (Haveman and Wolfe, 1984; Wolfe and Haveman, 2002; Oreopoulos and Salvanes, 2011).

Approach for Method A

Drawing on an approach used by McKinsey and Company (2009a, 2009b), Method A essentially estimates how much higher the earnings of African-Americans and Latinos in today's workforce would be if student achievement gaps between African-Americans and Latinos and their white counterparts were closed. This method takes a cross-sectional view, using the current workforce as the benchmark, and assumes that current earnings of African-Americans and Latinos are below the level they would otherwise be if the average skill level of African-Americans and Latinos were equal to the average skill level of whites. Differences in student achievement as of eighth grade are used as a proxy for the difference in average skill levels across race-ethnic groups. The method assumes that there is a causal relationship between academic skills and labor market earnings. Note that this method can be applied only to student performance differences based on race-ethnicity (see Table 5.2) because we do not have data on the current labor market outcomes for individuals based on their family economic status during the school-age years or based on their parents' education.

This approach involves the calculation of the following for each of the race-ethnic groups, i, affected by the closing of the score gaps (i.e., African-Americans and Latinos):

$$\underset{\text{(a)}}{T_i} \times \underset{\text{(b)}}{\Delta P} \times \underset{\text{(c)}}{E_i} \times \underset{\text{(d)}}{N_i} \tag{1}$$

where

T_i = the size of Pennsylvania test score gap in standard deviation units for subgroup i

ΔP = the percentage gain in earnings for a one-standard-deviation change in test scores (divided by 100)

E_i = average earnings of subgroup i in Pennsylvania

N_i = the size of subgroup i in the Pennsylvania workforce.

The magnitude of each of the parameters (a) to (d) and their sources are listed in Table C.2.

The results reported in Table 5.4 are based on summing the value in equation (1) for African-Americans and Latinos. The lower-bound estimate of $1.25 billion is based on using the lower bound for each group in the size of the achievement gap (parameter [a] in Table C.2) and the lower bound on the estimated percentage gain in earnings associated with gains in achievement (parameter [b] in Table C.2). The upper-bound estimate of $2.89 billion is based on using the upper-bound estimate for parameters (a) and (b).

Table C.2. Method A Parameters

Parameter	Parameter Value	Source
a. Size of race-ethnic achievement score gap	Range (minimum to maximum) of eighth-grade achievement score gap in standard deviation units in reading and math in the PSSA and NAEP • African-Americans .... 0.72–1.01 • Latinos 0.68–0.92	Table 3.2, panels (a) and (b)
b. Linkage between student academic achievement and adult earnings	A one-standard-deviation increase in student achievement leads to a 9- to 15-percent increase in earnings	Mulligan (1999) Murnane et al. (2001) Lazear (2003) Duckworth et al. (2012)
c. Annual earnings of Pennsylvania workforce in race-ethnic groups affected by closing of score gaps	Median earnings in past 12 months for persons age 16 and above in Pennsylvania in 2013 • African-Americans .... $24,685 • Latinos $21,157	2013 ACS (U.S. Census Bureau, undated)
d. Size of Pennsylvania workforce in race-ethnic groups affected by closing of score gaps	Annual average number of employed persons age 16 and above in Pennsylvania in 2013 • African-Americans .... 552,000 • Latinos 284,000	2013 CPS (BLS, undated-b)

SOURCE: Author's analysis of sources indicated.

This approach rests on a number of important assumptions:

- *The size of the achievement gaps for today's students are similar in magnitude to those that would have affected cohorts in the current workforce who were educated in earlier decades*. If anything, the evidence is that race-ethnic differences in student achievement were larger in earlier decades (Hedges and Nowell, 1998; Neal, 2006), so that we are likely underestimating the impact of achievement gaps on the labor market performance of cohorts in the current workforce.
- *The relationship between student achievement scores and earnings (parameter [b] in Table C.2) is causal*. As discussed above, the estimates we use are based on studies using methods designed to make inferences about causal relationships and are robust to alternative estimation methods.
- *The relationship between student achievement scores and earnings (parameter [b] in Table C.2) is the same for all subgroups—i.e., African-Americans and Latinos*. There is some evidence to suggest that the returns to higher skill in the labor market are actually higher for lower-performing groups. For example, Lazear (2003), in addition to estimating a 15-percent increase in earnings overall for a standard deviation increase in achievement scores (see Table C.1), reported returns of 21 percent for Latinos and 28 percent for African-Americans. Likewise, returns to schooling for African-Americans and Latinos are usually estimated to be larger than for whites (Henderson, Polachek, and Wang, 2011). Thus, the parameter range we use may understate the potential earnings gains for race-ethnic minorities from higher achievement.
- *The achievement gap is fully closed in the base year (2013) for all current workers.* In other words, we have not modeled a period of transition from the size of existing achievement gaps to a scenario in which achievement gaps are eliminated. This is the nature of the modeling exercise and is why we view it as an estimate of the cost of achievement gaps for the current workforce, rather than one that applies to future cohorts.
- *There are no general equilibrium effects on the wage structure from the improved skill levels of African-Americans and Latinos*. As noted in Chapter Five, this is a standard assumption in prior analyses (e.g., McKinsey and Company, 2009a, 2009b; Hanushek and Woessmann, 2010; Lynch and Oakford, 2014). If such effects were taken into account, they would likely attenuate the magnitude of our estimates.

Approach for Method B

Method B also draws on an approach employed by McKinsey and Company (2009a, 2009b) to estimate how much higher Pennsylvania's GDP would be if achievement gaps were closed. As noted in Chapter Five, the approach is based on the relationship between test scores and growth in GDP per capita, using a range of parameter values estimated by Hanushek and Woessmann (2008). Rather than projecting future economic growth, the method uses retrospective information on actual GDP growth. Using a ten-year horizon, the achievement gap is assumed to be eliminated in a base year, set to 2003 in our case. Then, for each successive year, GDP per capita in year *t* is derived from the actual growth rate in GDP per capita from year *t–1* to year *t* plus the added growth associated with the improved populationwide achievement score. Thus, as shown in equation (2), a sequence of adjusted GDP per capita values, G_t^*, are calculated:

$$G_t^* = \left[1 + \left\{ \frac{G_t - G_{t-1}}{G_{t-1}} \right\} + \left(\underset{(a)}{T} \times \underset{(b)}{\Delta E} \right) \right] \times G_{t-1} \tag{2}$$

where

G_t^* = Pennsylvania real GDP per capita in year t with augmented growth

G_t = Pennsylvania actual real GDP per capita in year t

T = gain in average test score in Pennsylvania from closing score gaps

ΔE = percentage gain in GDP growth per capita from a one-standard-deviation change in test scores (divided by 100).

The magnitudes of the two parameters labeled (a) and (b), which together determine the added GDP growth factor, are listed in Table C.3. Equation (2) pertains to real GDP per capita. Thus, as a final step, we calculate real GDP in each year using the population estimate implicit in the actual measure of real GDP versus real GDP per capita.

Following McKinsey and Company (2009a, 2009b), we calculate the adjusted GDP measure over a ten-year horizon (i.e., to 2013), accounting for compounded growth, and report the gain in GDP after one year and after ten years. We also plot the actual GDP trajectory and adjusted GDP trajectory with the added growth. We apply Method B to three types of achievement score gaps: based on race-ethnicity, economic status, and parent education. The results reported in Table 5.5 and Figures 5.1 and 5.2 show a lower-bound and upper-bound estimate for each gap-closing exercise. The lower bound comes from using the lower bound on the gain in average test score from gap closing, T, along with the lower bound on the percentage gain in GDP growth associated with that test score gain, ΔE (i.e., 1.2 percent). The upper-bound estimates come from using the upper limit on both parameters.

Table C.3. Method B Parameters

Parameter	Parameter Value	Source
a. Gain in student performance from gap closing in standard deviation units	Range (minimum to maximum) of overall eighth-grade achievement score gain in standard deviation units in reading and math in the PSSA and NAEP from closing score gaps • Race-ethnicity .... 0.16–0.21 • Economic status .... 0.28–0.33 • Parent education........................ 0.26–0.27	Table 3.5, panels (a) and (b)
b. Linkage between student academic achievement and GDP growth	A one-standard-deviation increase in student achievement leads to a 1.2- to 2.0-percent increase in the growth of GDP per capita	Hanushek and Woessmann (2008)
c. Real GDP and real GDP per capita for Pennsylvania	Real GDP and real GDP per capital for Pennsylvania from 2003 to 2013	2013 GDP (BEA, undated)

SOURCE: Author's analysis of sources indicated.

The most important assumption associated with Method B is that the GDP growth effect from increased student achievement estimated by Hanushek and Woessmann (2008), based on cross-national data, applies to a state economy like Pennsylvania. In theory, the same argument from endogenous growth theory of a link between the skills of the workforce and productivity, as well as innovation, applies. The key issues are whether the parameter would be as large for a state economy and whether the boost to economic growth would be short-lived or sustained. For this reason, we view this estimate as subject to greater uncertainty.

Approach for Method C

Method C is the first of two cohort-based approaches and asks what the gain in lifetime earnings (expressed in present-value dollars) from closing achievement gaps for each annual cohort is. Given the need to work from age-earnings profiles, this method can only be applied to race-ethnic gaps (see Table 5.2), because, as with Method A, we do not have access to the age-earnings profile when individuals are classified based on their family economic status when they were in school or based on their parents' education.

Method C parallels method A in applying similar parameters—the size of the race-ethnic achievement gap, G_i, and the relationship between test scores and earnings, ΔP—but the application is to a given age cohort that is followed over its work life, rather than looking at a current cross-section of the labor force spanning younger and older workers. In particular, we calculate the present discount value (PDV) from ages 20 to 64, using a 2-percent or 3-percent discount rate, of the following:

$$PDV[\underset{(a)}{T_i} \times \underset{(b)}{\Delta P} \times \underset{(c)}{E_i^a} \times \underset{(d)}{C_i}] \tag{3}$$

where

T_i = size of Pennsylvania test score gap in standard deviation units for subgroup *i*

ΔP = percentage gain in earnings for a one-standard-deviation change in test scores (divided by 100)

E_i^a = expected average earnings (average earnings of those employed times the share employed) of subgroup *i* at age *a* in Pennsylvania

C_i = size of the labor market entry cohort for subgroup *i* in Pennsylvania.

The product in the brackets in equation (3) is the expected gain in earnings, at each age, associated with closing achievement gaps for subgroup *i.* Table C.4 shows that we use the same values for parameters (a) and (b) as we did in Method A. To approximate the age-earnings profile for new entry cohorts, we use the current cross-section age-earnings profile. Because the age-earnings profile by race-ethnicity for Pennsylvania is not reported in the ACS or CPS, we use the U.S. profile and make an adjustment to account for the difference in the level of earnings among those employed and the share of the population employed for African-Americans and

Latinos in Pennsylvania compared with the United States.[20] This adjustment therefore assumes that the shape of the earnings profile with age in Pennsylvania matches the shape of the U.S. profile and that the only adjustment is in the earnings level.

Table C.4. Method C Parameters

Parameter	Parameter Value	Source
a. Size of race-ethnic achievement score gap	Range (minimum to maximum) of eighth-grade achievement score gap in standard deviation units in reading and math in the PSSA and NAEP • African-Americans .... 0.72–1.01 • Latinos 0.68–0.92	Table 3.2, panels (a) and (b)
b. Linkage between student academic achievement and adult earnings	A one-standard-deviation increase in student achievement leads to a 9- to 15-percent increase in earnings	Mulligan (1999) Murnane et al. (2001) Lazear (2003) Duckworth et al. (2012)
c. Expected annual earnings by age of Pennsylvania workforce in race-ethnic groups affected by closing of score gaps	Mean annual earnings and percentage with earnings from ages 20 to 64 by five-year age groups in 2013 for African-Americans and Latinos in the United States; earnings levels and percentage with earnings were adjusted based on the ratio of race-ethnic group values across all ages in Pennsylvania versus the United States	2013 ACS (U.S. Census Bureau, undated)
d. Size of Pennsylvania labor market entry cohort in race-ethnic groups affected by closing of score gaps	Number (rounded to nearest 100) in Pennsylvania 2013 graduation cohort based on ninth graders who entered high school four years earlier (adjusted for inflows and outflow) • African-Americans .... 22,300 • Latinos 11,000	2013 Pennsylvania ACGR (Pennsylvania Department of Education, 2015)

SOURCE: Author's analysis of sources indicated.

The results reported in Table 5.6 are based on summing the PDV of equation (3) for African-Americans and Latinos. As with other estimates, the lower bound comes from assuming the lower limit of parameters with ranges (in this case, [a] and [b]), while the upper-bound estimate comes from using the upper limit of the same parameters. Results in Table 5.6 are reported using both a 2-percent and a 3-percent discount rate.

Again, there are several key assumptions that should be kept in mind when interpreting the results. Several of the same assumptions delineated for Method A also apply, with the same justification:

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[20] In 2013, median annual earnings among employed African-Americans in Pennsylvania were 99 percent of the median earnings for employed African-Americans in the United States ($24,685 versus $24,864). The employment rate (percentage with earnings) for African-Americans in Pennsylvania was 95 percent of the equivalent rate for the United States (57.7 percent versus 60.4 percent). For Latinos, the Pennsylvania-U.S. median annual earnings ratio was 96 percent ($21,157 versus $21,936), and the ratio of the employment rate was 94 percent (63.2 percent versus 67.1 percent).

- The relationship between student achievement scores and earnings (parameter [b] in Table C.4) is causal and the same for African-Americans and Latinos.
- There are no general-equilibrium effects on the wage structure from the improved skill levels of African-Americans and Latinos.

One additional assumption is specific to this method:

- *The current cross-sectional age-earnings profile for each race-ethnic group applies to cohorts entering the labor market*. In the absence of a model to predict the lifetime wage profile of labor market entrants today, the current cross-section age-earnings profile is a reasonable approximation. This approach is conservative in that we do not assume any growth in real wages in the future relative to the current wage structure.

In Chapter Five, we also noted that our Method C cohort estimation approach did not account for outmigration or mortality of individuals in the labor market entry cohort through time. Our estimates accounting for those two factors were based on parameters for the Pennsylvania-specific outmigration rate and the U.S. mortality rate, as detailed in Chapter Five. Those rates were applied, starting at age 21 and at each successive age, to the surviving cohort. We did not account for eventual return migration of individuals educated in Pennsylvania, which means that our estimate of the migration effect is potentially overstated.

Approach for Method D

The second cohort approach, Method D, measures the gain in lifetime benefits to society (expressed in present-value dollars) from closing gaps in graduation rates for each annual cohort. Because we assume for this method that the economic gain from high school graduation is not dependent on the student's characteristics, we can apply this method to both the race-ethnic gap in the high school graduation rate and the economic status gap in this same indicator of educational attainment.

As discussed in Chapter Five, we rely on an estimate from Cohen and Piquero (2009) of the present-value lifetime economic gain from high school graduation compared with being a dropout. The economic gain is measured in terms of wages, fringe benefits, and other nonmarket benefits. Given that the parameter is already expressed as a present value, we simply apply this estimate to the number of additional high school graduates that would result if gaps in high school graduation rates were closed, either across race-ethnic groups or based on family economic status. Thus, we calculate the following product for the each group, i, affected by the gap closing (i.e., African-Americans and Latinos in the case of race-ethnic gaps and economically disadvantaged students in the case of the economic status gap):

$$\underset{(a)}{A_i} \times \underset{(b)}{C_i} \times \underset{(c)}{PDV[\Delta L]} \qquad (4)$$

where

A_i = size of Pennsylvania four-year ACGR gap in percentage points for subgroup i (divided by 100)

C_i = size of the labor market entry cohort for subgroup i in Pennsylvania

ΔL = [PDV at age 18 using a 2-percent discount rate] lifetime gain in wages, fringe benefits, and nonmarket value from completing high school.

The parameters for (a), (b), and (c) are listed in Table C.5. Parameter (b) is the same parameter used in Method C to measure the size of the labor market entry cohort. In this case, we also have an estimate for the size of the cohort that is economically disadvantaged, also based on the denominator of the four-year ACGR. Note that the size of the economically disadvantaged group is larger than the sum of the two race-ethnic groups (i.e., nearly 52,000 versus about 33,000). Thus, even though the percentage-point graduation gap is smaller for the economic status gap (14 percentage points versus 17 and 19 percentage points in the case of race-ethnic gaps), the estimated economic gain from closing economic status gaps based on equation (4) is larger compared with closing race-ethnic gaps (see Table 5.7).

Table C.5. Method D Parameters

Parameter	Parameter Value	Source
a. Size of four-year ACGR gap	Percentage-point gap in four-year ACGR compared with white students • African-Americans .... 17 • Latinos 19	Table 3.2, panel (c)
	Percentage-point gap in four-year ACGR compared with students who are not economically disadvantaged • Economically disadvantaged 14	Table 3.3, panel (c)
b. Size of Pennsylvania labor market entry cohort in subgroups affected by closing of score gaps	Number (rounded to nearest 100) in Pennsylvania 2013 graduation cohort based on ninth graders who entered high school four years earlier (adjusted for inflows and outflows) • African-Americans .... 22,300 • Latinos .... 11,000 • Economically disadvantaged 51,900	2013 Pennsylvania ACGR (Pennsylvania Department of Education, 2015)
c. Linkage between high school graduation and lifetime gain in wages, fringe benefits, and nonmarket benefits	PDV at age 18 using a 2-percent discount rate of lifetime gain for a high school graduate over a high school dropout (2007 dollars) • Wages .... $280,000 • Fringe benefits .... $70,000 • Nonmarket .... $70,000–$280,000 Converted to 2013 dollars using CPI-U • Wages .... $314,591 • Fringe benefits .... $76,648 • Nonmarket .... $76,648–$314,591	Cohen and Piquero (2009) [CPI-U from BLS (undated-a)]

SOURCE: Author's analysis of sources indicated.

Because Cohen and Piquero (2009) provide a range for the economic value associated with nonmarket benefits from high school graduation, the estimates in Table 5.7 that include that component provide a lower and upper limit.

The assumptions for Method D parallel those discussed for other methods. Once again, we have assumed that the estimates for the gains in market and nonmarket benefits from high school graduation are causal and that they would be the same for the subgroups whose gaps are closed (African-Americans, Latinos, and the economically disadvantaged). As noted earlier, there is some evidence to suggest potentially larger returns from higher education for disadvantaged youth. Another assumption in this case is that the national estimates for the returns to high school completion that Cohen and Piquero (2009) provide apply to Pennsylvania as well. Given the similarity in the level of wages, as indicated by the adjustment factors, required to go from national wage levels to Pennsylvania wage levels for Method C, this appears to be a reasonable assumption. Finally, the assumption that there are no general equilibrium effects on the wage structure applies in this case as well.

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