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High School Graduation Rates: Alternative Methods and Implications

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Abstract

The No Child Left Behind Act has brought great attention to the high school graduation rate as one of the mandatory accountability measures for public school systems. However, there is no consensus on how to calculate the high school graduation rate given the lack of longitudinal databases that track individual students. This study reviews literature on and practices in reporting high school graduation rates, compares graduation rate estimates yielded from alternative methods, and estimates discrepancies between alternative results at national, state, and state ethnic group levels. Despite the graduation rate method used, results indicate that high school graduation rates in the U.S. have been declining in recent years and that graduation rates for black and Hispanic students lag substantially behind those of white students. As to graduation rate method preferred, this study found no evidence that the conceptually more complex methods yield more accurate or valid graduation rate estimates than the simpler methods.

Introduction

The high school graduation rate has a history of being used as a measure of school effectiveness in the United States. The No Child Left Behind Act once again brought great attention to the high school graduation rate as one of the mandatory accountability measures for public school systems. However, calculating the high school graduation rate is no easy task due to the lack of longitudinal databases that track individual students.
This study reviews literature on and practices in reporting high school graduation rates, compares graduation rate estimates yielded from alternative methods, and estimates discrepancies between alternative results. The goal of this study is to evaluate the relative strengths and weaknesses of alternative reporting strategies and to contribute to a discussion of the policy implications, rather than to recommend a single best method.

Expansion of High School Education and the Value of A High School Diploma

Enrollment in United States high schools expanded rapidly in the first half of the twentieth century (Dorn, 1993, 1996, 2003; Goldin, 1998). According to the 2002 Digest of Education Statistics (Snyder & Hoffman, 2003), only 10% of 14- to 17-year-olds were enrolled in either public or private high schools in 1899-1900 school year. By the fall of 1963, high school enrollment had increased to 90% for the same age group, and the high school enrollment rate for fall 2000 was projected to be 93.4%. The expansion in high school enrollment has prompted an increase in the proportion of youths graduating from high school. At the turn of the twentieth century, 6.4% of 17-year-olds graduated from high school, including both public and private schools. By the 1962-63 school year, the percentage exceeded 70% and stabilized at this level until the present. As a result, it is fair to conclude that high school attendance and graduation have become normative expectations for teenagers in the United States (Dorn, 1996).

The value of the high school diploma experienced ups and downs during the period of high school expansion. Early on, the rarity of a high school diploma assured high school graduates better opportunities in the job market (Dorn, 1996). "Until about the 1970s, a high school diploma was generally viewed as a credential that would ensure a reasonably secure and well-paying job" (Swanson & Chaplin, 2003, p.1). With the expansion of higher education, the value of a high school diploma in the labor market diminished significantly. A recent survey by Public Agenda (Immerwahr, 2000) finds that 87% of Americans believe that "a college education has become as important as a high school diploma used to be" (p.1).

Despite its diminishing value in the job market, a high school diploma still serves as a gateway to post-secondary education as well as opportunities in the military. High school graduates fare better than dropouts in terms of employment opportunities and earnings. For the civilian noninstitutional[1] population ages 25 years and over, the average monthly unemployment rate was 5.35% for high school graduates for the period of September 2002 through September 2003. This compares to 8.78% for those without a high school diploma

[1] "Civilian noninstitutional population" refers to persons 16 years of age and older residing in the 50 states and the District of Columbia who are not inmates of institutions (for example, penal and mental facilities, homes for the aged), and who are not on active duty in the Armed Forces (Retrieved 10/16/2003 from http://www.bls.gov/bls/glossary.htm#C).

for the same period (Bureau of Labor Statistics, n.d.). There is also plenty of evidence that earnings of high school graduates are consistently higher than those without high school credentials (Day & Newburger, 2002; Sum & Harrington, 2003). For individuals 25 years old and over, the median income for high school graduates (including GED diploma holders) was $24,656 compared to $18,445 for non-graduates, as of March 2002. Such differences were observed across all races, as well as within each major racial group (Bureau of Labor Statistics, 2002a).

Distinguish between a Regular High School Diploma and GED Certificate

The labor statistics, as a convention, often group GED equivalency diploma holders together with persons who graduate with a regular high school diploma; however, the two credentials are not equivalent. Currently three types of high school credentials are often seen in literature and practice. A regular diploma is awarded to students who complete a standard number of years (12 for most) and meet the state or local requirements for graduation. An alternative (or other) diploma usually refers to the certificate given to students who complete state approved alternative programs (e.g. special education programs in some states). Students may also be awarded an equivalency certificate by passing a test.

The most common secondary certification test is the General Educational Development Test (the GED test), developed and distributed by The General Educational Development Testing Service of the American Council on Education (ACE). The GED tests were first developed for testing World War II veterans to determine their competence for higher education. After the war, the GED was also administered to civilians, and those who passed were granted high school credentials by the states. By 1959, civilian test takers outnumbered veterans and military members for the first time (Boesel, Alsalam, & Smith, 1998). Nowadays, ACE claims that "[a]bout one in seven high school diplomas issued in the United States each year is based on passing the GED Tests" (American Council on Education, 2003).

The increase in the number of GED certificate holders blurred the line between high school graduates and dropouts by creating a third category, namely the GED certificate holders. Studies show that the performance of GED holders in the job market and postsecondary institutions is not equivalent to that of regular diploma recipients although GED holders perform better than dropouts (Boesel, Alsalam, & Smith, 1998; Cameron & Heckman, 1993; Chaplin, 1999, 2002; National Research Council, 2001; Tyler, 2003). Although equivalency credentials, such as the General Educational Development (GED) equivalency diploma, are accepted for both college admission and military recruitment, a regular high school diploma is the preferred credential[2] (Boesel, Alasam, & Smith, 1998;

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[2] The military services distinguish between three tiers of educational attainment. Tier I includes traditional high school graduates, alternative/continuation high school graduates, or college/post-secondary students. Tier II includes holders of alternative credential such as GED, certificate of attendance, correspondence school diploma, and occupational program certificate. Tier III are non-high school graduates. The military services accept very few Tier III category personnel. When they do make a rare exception, the applicant must usually score significantly higher on the ASVAB than Tier I and Tier II candidates. The services also limit the number of Tier II candidates it will allow to enlist each year. In the Air Force, the

Military Enlistment Standards). Studies show that the completion rates in the postsecondary schooling and training programs are much higher for the regular high school graduates than for equivalency diploma recipients (Boesel, Alasam, & Smith, 1998; Cameron & Heckman, 1993).

Graduation Rate as a Measure for School Effectiveness

Because of the social and economic value associated with school credentials, the proportion of students graduating from a school system is often used as an indicator to evaluate the system. As early as 1907, Thorndike examined records of more than two-dozen cities, and found that only 10 percent of white students graduated from high school (Thorndike, 1907). Two years later, Leonard Ayres conducted another study, which included 55 city school systems. Ayres found that, on the average, one-sixth of the students were repeating grades, one third of all public school students were older than they should be for the grades they were in, and these students were more likely to drop out (Ayres, 1909). Both authors criticized the slow progression of students as inefficient and wasteful of resources.

Conducted in the early 1900's, the studies of Thorndike and Ayres were mostly concerned with school children at the elementary level. With the expansion of high school education in the first half of the twentieth century, the importance of the high school graduation rate has been repeatedly emphasized in federal legislation and practices. "The on-time graduation rate was routinely reported in the 1970s and 1980s by the U.S. department of Education and was a central part of Secretary Bell's 'Wall Chart'" (Kaufman, 2001, p.20). "The Hawkins-Stafford School Improvement Amendments of 1988… required the Commissioner [of Education Statistics] to report to Congress each year on the second Tuesday after Labor Day about the rate of school dropouts and completions in the nation (under current legislation, this report is no longer mandatory)" (Young & Hoffman, 2002, p.59). Six years later in 1994 the Clinton administration passed the *Goals 2000: Educate America Act*, which set out eight national goals for improving public education. The second national goal was that "by the year 2000 the high school graduation rate will increase to at least 90 percent"(Goals 2000, 1, Sec. 102, (1), (A)).

High School Graduation Rate in the No Child Left Behind Act

Although the lofty goal of a 90% graduation rate was not achieved by 2000, it did not stop the Bush administration from mandating states to report high school graduation rates. The most recent reauthorization of the Elementary and Secondary Education Act (ESEA), also known as the *No Child Left Behind Act* (NCLB), requires states to report graduation rates for public secondary schools as one of the indicators for measuring whether school systems are making Adequate Yearly Progress (AYP) towards state performance goals. This legislation mandates states to report graduation rates for the total state student population, as well as for subgroups of students, including economically disadvantaged students, students from major racial and ethnic groups, students with disabilities, and students with limited English proficiency.

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limit is less than one percent each year (http://usmilitary.about.com/library/weekly/aa082701c.htm accessed on 02/17/2004).

The No Child Left Behind Act requirement is different from previous federal requirements in a number of ways. First, NCLB is more specific in defining the high school graduation rate as

> The percentage of students, measured from the beginning of high school, who graduate from high school with a regular diploma (not including an alternative degree that is not fully aligned with the State's academic standards, such as a certificate or a GED) in the standard number of years (34C.F.R. §200).

This definition of high school graduates explicitly excludes GED recipients, who were counted as high school completers in connection with the *Goals 2000* legislation. The final regulation (34C.F.R. §200) further pointed out that states must avoid counting a dropout as a transfer in defining graduation rates, which is speculated to be one of the reasons for the underreporting of dropouts by local agencies (Haney, 2000; Kaufman, 2001; Swanson & Chaplin, 2003). In addition, the NCLB definition also requires youth to complete high school in "a standard number of years", which mandates a more specific time frame for school systems to achieve the objective of graduating students from high school. By shifting the focus from the 18-to 24-year old population (as in *Goals 2000*) to the population enrolled in high school and excluding alternative credentials, NCLB brings attention to regular day programs in the public school system where the majority of U.S. youths receive their secondary education and where most educational resources are devoted.

NCLB also differs from *Goals 2000* by allowing states to set their own goals instead of setting a single national goal for the graduation rate. Thus, the focus is on each state making progress over time rather than lining up all states for a horse race by requiring the same national goal for each. Despite the specific definition for graduation rate, states are also allowed flexibility in choosing alternative definitions as long as the Secretary of Education approves (34C.F.R. §200). Thus, the NCLB definition leaves room for states to determine specific data collection and calculation strategies.

One of the cornerstones of the NCLB is its strong emphasis on accountability for results. Failure to make Adequate Yearly Progress in the required time frame may lead to increasingly severe consequences ranging from public identification of low performing schools, withholding of federal funds, to loss of students to other schools and/or change in school personnel (Swanson & Chaplin, 2003). Issues have been raised about unintended consequences of attaching high stakes to results such as increased retention of low performing students at certain grade levels (Edley & Wald, 2002; Haney, 2000; National Research Council, 2001). Studies show that grade retention often does not help students make improvement academically as is intended; moreover, retained students are more likely to drop out of high school (Hauser, 2000; Jimerson, 2001; Jimerson, Anderson & Whipple, 2002; National Research Council, 2001; Shepard & Smith, 1989). When increased retention rates and dropout rates occur, improvement in test scores may be the result of testing a smaller number of relatively better achieving students rather than an accurate assessment of the whole student population.

Therefore, inclusion of the graduation rate as an accountability indicator is especially important in the current standards-based education reform and is likely to counter the potential pressure to "push out" low achieving students so as to inflate test results, and shift the attention to helping all students meet the standards (Swanson & Chaplin, 2003).

Challenge for Measurement

The high-stakes use of test results required by NCLB poses extraordinarily high demands on the validity and reliability of educational measurement. Experts in educational measurement have described the technical challenges for current standardized assessments to serve such high-stakes accountability purposes (Linn & Baker, 2002). The dramatic increase in the demand for large-scale assessment is pushing the limits of the testing industry, which is dominated by a small number of testing companies. The increased volume of testing mandated by NCLB is likely to trigger more testing errors as the industry is being pushed to its limit. Already researchers have identified almost as many testing errors in 2002 alone as the total number of errors reported between 1976 and 1996 (Rhoades & Madaus, 2003).

Compared to standardized testing, calculating high graduation rates may appear much more straightforward. The graduation rate is calculated simply by dividing one number into another. However, to calculate the high school graduation rate, at least three things need to be specified. First, at what point should the rate be calculated? Or, at what time points are the numbers counted for both the numerator and the denominator? Although the standard length of high school is four years in most school systems in the United States, it is likely that some students will take more than four years to graduate from high school for various reasons. The NCLB definition suggests following a high school cohort from the beginning of high school; however, it leaves it open for the states to interpret "the standard number of years" for completing high school.

Second, questions arise about who counts as a graduate in the numerator? The NCLB legislation limits high school graduates only to regular diploma recipients. However, students may have completed high school in different number of years, four or five in most cases, and NCLB is not clear on whether states need to distinguish between late graduates and on-time graduates when reporting the high school graduation rate.

Third, one might also ask who is included in the denominator as the base population? The NCLB definition requires counting the base population from the beginning of high school; however, it does not specify how the base population should be adjusted for fluctuations, such as cases of transfer, grade retention and dropout, over four years of high school.

The seemingly simple procedure of calculating high school graduation rates proves to be no easy task (Dorn, 1996; Kaufman, 2001; Swanson & Chaplin, 2003). Depending on the method and the source of data used, published U.S. national high school graduation or completion rates for the class of 2000 range from 66.6% to 86.0%; the variation between alternative graduation rates at state level is of comparable magnitude (Greene, 2002b; Haney, 2003; Kaufman, Alt, & Chapman, 2001; Swanson, 2003; Warren, 2003). Even when limiting high school graduates to the NCLB definition, no consensus has been reached among researchers on how to calculate high school graduation rates.

One major challenge in reporting graduation rates lies in the lack of comprehensive state data collection systems that track individual students through their schooling experiences (Swanson & Chaplin, 2003). Due to limited resources, it is very difficult for schools to account for students who have left the school before graduation. The status of many transfer students has never been verified by schools, and some of these unverified transfers are virtually dropouts (Archer, 2003; Haney, 2001; Kaufman, 2001).

Moreover, in a country like the United States where education decision-making is largely based at the local level, school districts around the nation do not follow a standardized data collection and reporting procedure. For example, the National Center for Educational Statistics (NCES) has a definition for high school completion—a concept close but not equivalent to high school graduation defined by NCLB—for the Common Core of Data survey; however, not all states conform to this approach (Kaufman, Alt & Chapman, 2001; Winglee, Marker, Henderson, Young & Hoffman, 2000; Young & Hoffman, 2002). *The No Child Left Behind Act* undoubtedly revives public attention to the high school graduation rate, but it may not bring the country much closer to a standardized reporting approach because of its substantial regulatory flexibility. In a recent study, Swanson (2003) reviewed the NCLB implementation plans that all 50 states and the District of Columbia submitted to the U.S. Department of Education. He found that 45 states and the District of Columbia proposed one of four general approaches, and the remaining six states proposed idiosyncratic approaches. Not surprisingly, such variation in the reporting strategies across states makes an accurate national evaluation of high school graduation rates very difficult.

As an effort to clarify the confusion surrounding the calculation of the high school graduation rate, this study reviews recent literature on and current practices in reporting high school graduation rates, compares results and trends in state-level graduation rates from alternative methods over 10 high school cohorts, and estimates discrepancies between results from different calculation methods. The goal of this study is to evaluate the relative strengths and weaknesses of alternative reporting strategies and to contribute to a discussion of the policy implications, rather than to recommend a single best method.

Review of Alternative Methods

Before we move on to discuss alternative procedures to compute the high school graduation rates, we will first introduce the two major data sources for the estimation: the Current Population Survey (CPS) sponsored jointly by the U.S. Census Bureau and the Bureau of Labor Statistics (BLS), and the Common Core of Data (CCD) collected by the National Center for Education Statistics (NCES) via annual surveys of public elementary and secondary schools.

The Current Population Survey (CPS)

The Current Population Survey (CPS) is a monthly survey conducted in a state-based probability sample of 50,000-60,000 households. One adult in each sample household (the reference person) responds to questions regarding all eligible household members. To be eligible to participate in the CPS, individuals must be 15 years of age or over and not in the Armed Forces, nor in institutions, such as prisons, long-term care hospitals, and nursing homes. Therefore the target population of CPS is often referred to as the civilian noninstitutional population.

The CPS instrument has a series of questions on school enrollment, college attendance, and high school graduation. Questions are asked about all people in the household 3-year-old or above regarding their school attendance in the year of the survey and the previous year. Questions are also asked on educational attainment for those who are not enrolled in schools at the time of the survey. From 1972 to 1991, the CPS survey identified high school graduates based on attendance and completion of grade 12. Starting in 1992, CPS distinguishes completion of 12th grade from high school graduation; however, this classification does not distinguish GED holders from regular high school diploma recipients (Hauser, 1997; Kaufman, Alt & Chapman, 2001).

The CPS collects information on both the age and school enrollment or educational attainment for the sample. A cross-tabulation of age and enrollment data allows the examination of age-grade progression and school completion rates among various age groups. This forms the basis for the multiple indicators of school progression and completion rate, such as the high school completion rate adopted by the National Goals Panel, the status dropout rate and the event dropout rate reported in NCES's *Condition of Education*.

The great advantage of CPS data is that it has been collected in a reasonably uniform manner every year for nearly four decades, and is considered by some researchers as the only source of long-term trends in dropout and completion rates (Kaufman, 2001). Meanwhile, researchers also noted a number of limitations of the CPS data for estimating high school graduation rates and dropout rates.

Kaufman (2001) identified two broad sources of error in the CPS data—sampling and non-sampling error. The sampling errors for national estimates in the CPS are generally within accepted range for large surveys; however, the CPS was not designed to provide estimates of small subpopulations and the sampling errors for subgroups can become rather large (Greene, 2002b; Kaufman, 2001). Hauser (1997) noted there was "substantial statistical unreliability from year to year in the CPS measure of attainment for minority populations" (p.160). Reliability can be improved by aggregating across years and reporting three-year average (Hauser, 1997; Kaufman, 2001; Kaufman, Alt & Chapman, 2001; Annie E. Casey Foundation, 2002); however, the standard errors on the state estimates are still too large to allow meaningful state-to-state comparisons.

Non-sampling errors come from a variety of sources and affect all types of surveys, universe as well as sample surveys. Non-sampling error can occur when members of the target population are excluded from the sampling frame or when sampled members of the population fail to respond. It is estimated that the CPS survey has a coverage ratio of 93 percent (Bureau of Labor Statistics, 2002b); however, for some subgroups this ratio is much lower. Historically, black and Hispanic males have had lower coverage ratios. In 1996 the coverage ratio for black males aged 20 to 29 was only about 66 percent (Kaufman, 2001). CPS used weights to adjust for the undercounting of various subpopulations; however, such weighting will introduce bias into the estimates of graduation rates if those persons missed by CPS drop out of high school at higher rates than those covered in the survey.

A couple of other issues with the use of CPS for calculating graduation rates are internal to the design of the survey. The target population for CPS interviews is the "civilian noninstitutional population", therefore the graduation rate estimates derived from such a population does not include the military personnel, and prison inmates in the base population. Two potential biases exist in such results as an estimate of a "true" national high school graduation rate. On the one hand, exclusion of the military personnel is likely to underestimate the graduation rate since the military services accept very few personnel without a traditional secondary school credential. However, such effect is barely noticeable due to the small number of military personnel compared to the national population (Kominski, 1987). On the other hand, the exclusion of prison inmates is likely to overestimate the graduation rate since school dropouts are found to have a larger risk of incarceration (Pettit & Western, 2002), and dropouts are disproportionately represented among people in prison (Greene, 2002; Harlow, 2003). However, the bias introduced by exclusion of prison inmates on the high school graduation rate is yet to be evaluated.

Other criticisms of CPS noted that change in the CPS instrument and data collection process over the years may threaten the trend lines derived from the data (Hauser, 1997; Kaufman, 2001; Sum & Harrington, 2003). For example, changes in the instrumentation in 1992, though intended for improvement in the measurement, make it difficult to disentangle actual change in the construct from changes related to alteration of the instrument or operation process, especially for the first few data collection cycles immediately after the change is made. It is possible, though, to assess the effect of change in instrumentation by examining long-term time series (Kaufman, Alt, & Chapman, 2001).

In light of the No Child Left Behind definition for high school graduation rate, the CPS data have three additional limitations. First, the CPS categorization of education attainment considers holders of any secondary credentials as high school completers, without distinguishing between GED certificates and regular high school diplomas. Therefore, the CPS indicators are the more generous measures of high school completion rate, and are overestimates for the high school graduation rate defined by NCLB. Second, the CPS completion rate indicators include high school completers from both public and private schools, while the NCLB requirement only concerns public secondary schools; hence, indicators based on CPS data are somewhat off the target for the NCLB purpose. Third, the CPS target population includes adult residents of a state, who may not have attended schools in that state. Education attainment information derived from such a sample may provide accurate information for the labor market in a state, for which the CPS was originally designed; however, such information may not be an accurate reflection of the K-12 school system in that state.

The Common Core of Data (CCD)

The Common Core of Data (CCD) has been a program of the US Department of Education's National Center for Education Statistics (NCES) since 1986. The CCD program conducts annual census surveys of all public elementary and secondary schools (approximately 95,000) and school districts (approximately 17,000) in the country. The CCD collects a wide range of information via a set of five surveys sent to state education departments. Most of the CCD data are obtained from administrative records maintained by the state education agencies (SEAs). The SEAs compile CCD requested data into prescribed formats and transmit the information to NCES.

The CCD data are different from CPS data in several ways. First, the two programs are designed to serve different purposes although they cover some common ground. The Current Population Survey was originally established to provide direct measurement of monthly unemployment, while the Common Core of Data was designed specifically to "provide basic information and descriptive statistics on public elementary and secondary schools and schooling" (Thurgood, Walter, Carter, Henn, Huang & Notter, et al, 2003, p. 19). This contrast in the orientation determines the different focuses and strategies of the two programs. The CPS data are collected from a state-based sample of households on a monthly basis, and standard errors are reported along with the statistics to indicate the magnitude of sampling error. In contrast, the CCD survey is a census of public elementary and secondary schools in the United States, and therefore by definition has no sampling error associated with the observations. While the CPS data collection relies on self-report, the CCD is based on administrative records collected for each school year by local education agencies. Although sampling error is not an issue in the CCD data, the accuracy of CCD data relies heavily on the quality of record keeping in local school districts nation-wide (Young & Hoffman, 2002).

Measures of the NCLB Graduation Rate Based on CCD Data

Researchers have devised multiple measures of high school graduation rates based on the Common Core of Data. This study focuses only on measures of the graduation rate as is suggested in the NCLB, in particular, the simple grade 9 to graduation rate, the simple grade 8 (or 10) to graduation rate, the Greene rate, the CPI rate and the Warren rate.

Simple on-time graduation rate

The simple on-time graduation rate is a reasonable, though simplistic, interpretation of the NCLB definition of graduation rate, which is computed by taking high school graduates at the end of senior year as a proportion of the ninth graders three school years earlier:

$$GR_{year(i+4)} = \frac{N^{Graduates}_{Year(i+4)}}{N^{G9}_{Year(i)}}$$

For example, the simple on-time graduation rate for the class of 2000 is computed by dividing the 9th grade enrollment in the fall of 1996 into the number of high school graduates in the spring of 2000.

This approach answers the three basic questions regarding the specification of the numerator, the denominator, and the time span for the high school graduation rate. Criticisms of this approach focus upon three major deficiencies. First, these comparisons ignore possible effects on the graduation rate caused by in- or out-migration of students between the ninth and twelfth grades (Ginsburg, Noell & Plisko, 1988; Greene, 2002; Warren, 2003). Second, special education students, reported in ungraded classes (and in some states vocational students), are not counted in the ninth grade enrollments, although they are counted when they graduate (Ginsburg, Noell & Plisko, 1988; Greene, 2002b; Warren, 2003). Third, since 9th grade is a common grade for students to be retained, the denominator may be artificially larger, leading to an underestimate of the graduation rate (Haney, 2000; Haney, Madaus, Abrams, Wheelock, Miao & Gruia, 2004; Greene, 2002b; Warren, 2003).

In practice, the observed grade 9 enrollment is likely to differ from the "true" cohort size because students move in and out of a cohort during the four years of high school for various reasons: transfer, grade retention, disease or death, etc. Because of grade retention, the denominator includes students who are repeating grade 9 in addition to first time 9th graders. A number of recent studies pointed to the 9th grade "bulge" in public school enrollment, suggesting relatively large numbers of students repeating grade 9 instead of being promoted to 10th grade on time (Carnoy, Loeb, & Smith, 2001; Greene, 2002b; Haney, 2003; Haney, et al., 2004). Analysis of enrollment data over the past three decades (Haney, et al., 2004) found that nationwide the grade 9 bulge tripled, and the bulging up trend is observed in many states as well.

Meanwhile, due to the practice of grade retention, the numerator of this simple rate includes not only on-time graduates but also late graduates, who have been retained at certain grade levels and hence graduate with a later cohort than the one they started 9th grade with. As a result, the simple graduation rate does not accurately identify graduates who complete high school on time in four years. It is also possible for students to graduate earlier than their peers; however, since the number is likely to be small, early graduates will not be further discussed in this study.

In sum, three possible biases exist in using the simple on-time graduation rate approach. First, the grade 9 bulge makes the denominator artificially large, which leads to an underestimate of graduation rates. Second, inclusion of retained students in the numerator tends to overestimate on-time graduation. Third, other changes in the denominator, such as transfers, bring uncertain effects into the estimate. Unaccounted net immigration makes the denominator artificially small, leading to overestimate of the graduation rate; whereas unaccounted net emigration makes the denominator artificially large, leading to underestimate of the graduation rate.

In the absence of an ideal data source, which tracks individual students through their school career, a number of alternative reporting strategies based on CCD data are suggested in recent studies to overcome the three issues affecting the simple on-time graduation rate. To facilitate the discussion, we will use the notation system shown in Table 1 when referring to a high school cohort.

Table 1
Notation System in Proceeding Sections

Grade	School year	Data Collected	Notation	Example
7th grade	Two years before high school (e.g. school year 1994-1995)	Grade 7 enrollment	$N^{G7}_{year(i-2)}$	N^{G7}_{1994}
8th grade	One year before high school (e.g. school year 1995-1996)	Grade 8 enrollment	$N^{G8}_{year(i-1)}$	N^{G8}_{1995}
9th grade	Freshman year of high school (e.g. school year 1996-1997)	Grade 9 enrollment	$N^{G9}_{year(i)}$	N^{G9}_{1996}
10th grade	Sophomore year of high school (e.g. school year 1997-1998)	Grade 10 enrollment	$N^{G10}_{year(i+1)}$	N^{G10}_{1997}
11th grade	Junior year of high school (e.g. school year 1998-1999)	Grade 11 enrollment	$N^{G11}_{year(i+2)}$	N^{G11}_{1998}
12th grade	Senior year of high school (e.g. school year 1999-2000)	Grade 12 enrollment	$N^{G12}_{year(i+3)}$	N^{G12}_{1999}
Graduation	Senior year of high school (e.g. school year 1999-2000)	Number of graduates	$N^{Grads}_{year(i+4)}$	N^{Grads}_{2000}

Typically students start high school at grade 9 in September, and graduate at the end of grade 12 in June. Accordingly, the CCD enrollment data are collected during the fall in October, and the number of graduates reported is based on the count of students who "received a diploma during the previous school year or subsequent summer school" (NCES, 2003, Appendix C) . We will refer to 9th grade year as year i of high school, 10th grade year (i+1), 11th grade year (i+2) and 12th grade year (i+3) of high school. For example, by year 1999, we mean the fall to spring school year (i.e. school year 1999-2000) rather than the January to December calendar year 1999. By class 2000, we mean the cohort that started high school in the fall of 1996 and graduated on time in the spring of 2000. However, the number of graduates reported for spring 2000 is likely to include a small number of students who started high school before or after 1996 (i.e. late graduates and early graduates in addition to on-time graduates).

Substitute grade 9 enrollment with grade 8 or grade 10 enrollment

As mentioned earlier, the widespread practice of grade 9 retention makes the 9th grade enrollment artificially large and therefore graduation rates based on grade 9 enrollment tend to be an underestimate of the "true" graduation rate. Figures 1 presents the U.S. total grade enrollment in public schools from Kindergarten through 12th grade for the 1999-2000 school year. The figure clearly illustrates the grade 9 bulge, with the grade 9 enrollment substantially larger than the two adjacent grades, whereas enrollment in grades 8 and 10 are much closer to each other.

Figure 1. National Public School Enrollment Trend (1999-2000 School Year)

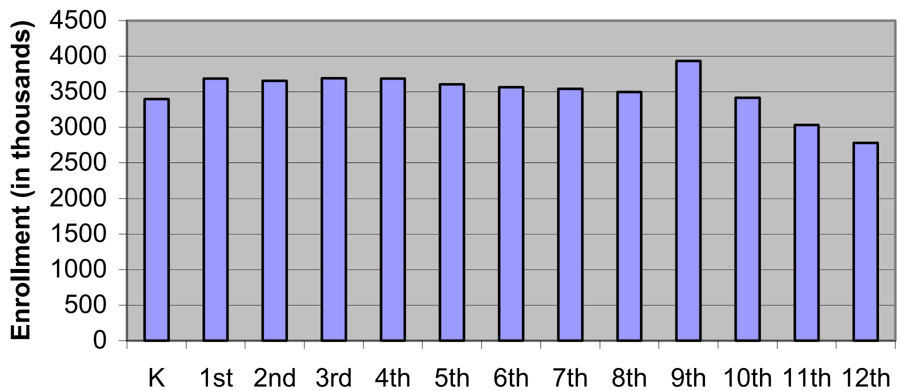
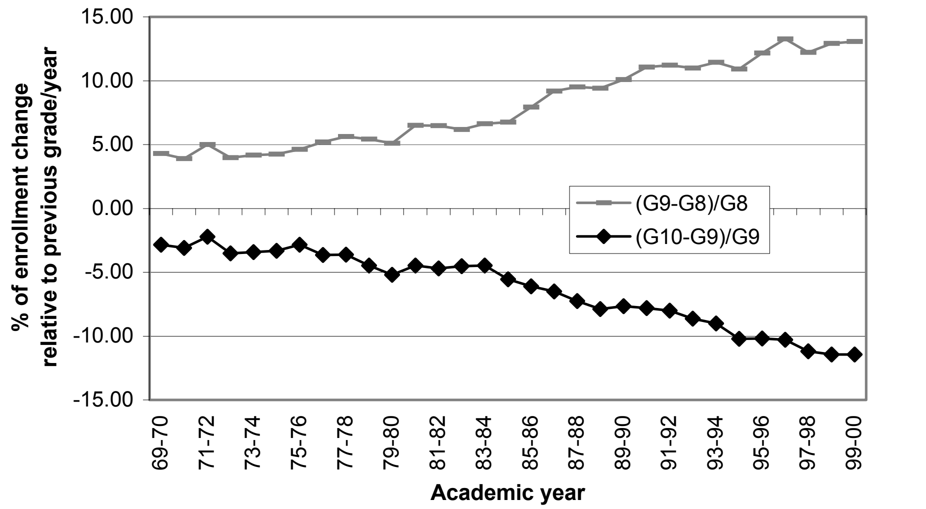


Figure 2 presents the national enrollment trend from the 1969-1970 school year to the 1999-2000 school year, which allows an examination of the enrollment change in grades 8, 9 and 10 over three decades. The vertical axis represents the percent change in enrollment between two adjacent grade levels from one year compared to the previous year. For example, the national 8th grade enrollment in fall 1997 was 3,415,000 and 9th grade enrollment in fall 1998 was 3,856,000. The percent change between grade 8 and 9 for this cohort equals the difference between 3,856,000 and 3,415,000 divided by 3,415,000, which yields 11.44%. A positive change rate indicates increase in grade enrollment compared to the previous grade/year, while a negative rate indicates decrease.

Figure 2. Percent Enrollment Change between Grades 8, 9 & 10 (Source: Digest of Education Statistics, 1970 through 2002)



The gray line on the top represents the percent enrollment change between grades 8 and 9, and the black line at the bottom represents the percent enrollment change between grades 9 and 10 over three decades. The pattern shown in Figure 2 warrants two observations. First, the position of the two lines in regard to the vertical axis indicates the national grade 9 enrollment is larger than the enrollment in grades 8 and 10 for each and every year during the three decades, thus evidencing a grade 9 bulge. Second, the divergence between the two lines indicates the increasing size of the grade 9 bulge since the early 1980's.

The above two figures illustrate enrollment trends at the national level. At the state level, the same pattern holds although with variation across states regarding the magnitude of the grade 9 bulge. As a result of the increasing grade 9 bulge, using grade 9 enrollment as the denominator in calculating graduation rate is likely to underestimate the graduation rate at national and state levels. One alternative is to substitute the grade 9 enrollment with either grade 8 or grade 10 enrollment as the denominator, which is likely to result in higher graduation rate estimates. It is noted that the grade 8 to graduation proxy is applicable at district and state level but not at the school level because 8th grade and 9th grade are often assigned to different schools, e.g. middle school and high school; however, this is not an issue with the grade 10 to graduation proxy.

The major advantage of the simple longitudinal approach lies in its straightforward calculation, which makes it easier to communicate to the public and the policy makers. Also, this indicator is less demanding on data collection since schools and local districts usually keep records of enrollment consistently.

Smoothing out the grade 9 bulge

Another strategy is to smooth out the grade 9 bulge by averaging enrollment in several grade levels. Haney (2001) calculated the cohort graduation rate for the nation's 100 largest school district in school year 1997-98, and the denominator he used is the average district enrollment for grades 7 to 9 in the freshman year (9th grade year) for a given cohort. The numerator is the number of high school diploma recipients (GED excluded) in senior year. For systems where grade 9 retention is common, cohort graduation rates thus calculated are likely to be larger, and supposedly more accurate, than the estimates using grade 9 enrollment as the base population.

Haney's cohort graduation rate is conceptually similar to the simple on-time graduation ratio (or the simple grade 9 rate), yet more accurate when 9th grade retention is a serious issue. Since the average is based on enrollment at three grade levels in the same school year (i.e. average of $N^{G7}_{year(i)}$, $N^{G8}_{year(i)}$ and $N^{G9}_{year(i)}$) rather than in three different school years (i.e. average of $N^{G7}_{year(i-2)}$, $N^{G8}_{year(i-1)}$ and $N^{G9}_{year(i)}$), the underlying assumption for this method is that grade enrollment is similar from cohort to cohort. The advantage of this method is that it only requires data from two school years, and therefore is not much more complicated than the simple grade 9 rate.

Alternatively, Greene (2002b) used the average enrollment of grades 8, 9 and 10 to get the "smoothed" estimate of the cohort's first time 9th grade enrollment, for a given cohort. Unlike Haney's method, Greene averaged grades 8, 9, and 10 enrollment from three different school years to come up with a smoothed estimate of grade 9 enrollment. That is, Haney smoothed out the bulge in a cross-sectional approach, while Greene uses a longitudinal approach. The latter is conceptually more appealing, yet the calculation is more complicated since the "smoothing" requires three years of data. In practice, the cross-sectional "smoothing" strategy can be a good choice for school systems with relatively stable enrollment from cohort to cohort.

Stabilizing the cohort enrollment

As is discussed earlier, enrollment for a single high school cohort may fluctuate due to various factors; therefore, it may be inaccurate to assume that the same number of students will move along from grade 9 to graduation. Adjustment is desirable to deal with the natural increase or decrease in cohort enrollment through high school years.

The Intercultural Development Research Association (IDRA), a non-profit minority advocacy organization, conducted the first comprehensive dropout analysis in the state of Texas (Cardenas, Robledo & Supik, 1986). The attrition rate developed and used by IDRA included a size change ratio to adjust for the enrollment change. The size change ratio was calculated by dividing the total district high school enrollment for the senior year by the total district high school enrollment for the freshman year for a cohort.
While a change ratio of 1 indicates zero net change in the cohort enrollment, a change ratio larger than 1 indicates net increase, and a change ratio smaller than 1 indicates net decrease in the cohort enrollment.

The graduation rate index devised by Greene (2002a, 2002b) incorporated the same idea as the IDRA change ratio to make adjustment to the smoothed estimate of the grade 9 enrollment. The numerator in the Greene formula is the number of *regular diploma* recipients in senior year. Therefore, the Greene graduation rate for a given cohort can be computed by dividing the adjusted grade 9 enrollment into the number of graduates as follows:

$$GR^{Greene}_{Year(i+4)} = \frac{N^{Grads}_{Year(i+4)}}{Adj.\hat{N}^{G9}_{Year(i)}}$$

The Greene estimate for cohort graduation rate has conceptual advantages for systems with large fluctuations in high school enrollment. Empirically, Warren (2003) found through simulation that Greene's estimates are biased under various conditions. Hence the complexity of Greene's method is not justified by its conceptual advantage and lack of empirical accuracy.

The cumulative promotion index (CPI)

Swanson and Chaplin (2003) developed the Cumulative Promotion Index (CPI) to estimate the high school graduation rate. It conceives of high school completion as "a stepwise process composed of three grade-to-grade promotion transitions in addition to the ultimate high school completion event" (p. 19), and estimates high school graduation rate as the probability that a student entering the 9th grade will complete high school on time with a regular diploma. For example, for the high school class of 1999-2000 (i.e. the class graduating in spring 2000), the CPI graduation rate for a given jurisdiction is calculated as follows:

$$CPI_{2000} = \left[\frac{N_{2000}^{G10}}{N_{1999}^{G9}}\right] * \left[\frac{N_{2000}^{G11}}{N_{1999}^{G10}}\right] * \left[\frac{N_{2000}^{G12}}{N_{1999}^{G11}}\right] * \left[\frac{N_{2000}^{Grad}}{N_{1999}^{G12}}\right]$$

The CPI uses a so-called "synthetic cohort" and focuses on two school years for the estimation. The formula would look as follows if a longitudinal cohort were used:

$$CPI_{2000}{*} = \left[\frac{N_{2000}^{G10}}{N_{1999}^{G9}}\right] * \left[\frac{N_{2001}^{G11}}{N_{2000}^{G10}}\right] * \left[\frac{N_{2002}^{G12}}{N_{2001}^{G11}}\right] * \left[\frac{N_{2003}^{Grad}}{N_{2002}^{G12}}\right]$$

$CPI_{2000}*$ is equivalent to the simple grade 9 rate (number of graduates divided by the freshman year enrollment) once enrollments in grades 10 to 12 cancel out each other.

The authors claimed that CPI's "shortened window of observation" (Swanson, 2004, p.8) has several potential advantages, which are not solidly grounded. First, Swanson claimed that large changes in student demographics and school practices are less likely to occur in a shorter time period. This may hold for slow and gradual changes; however, not all changes are in administrative control and can be phased in gradually.

Second, Swanson claimed that using a "synthetic" cohort requires data from only two school years, so the CPI indicator can be estimated "very quickly after two waves of data collection over a one-year period" (Swanson, 2004, p.8). This claim is completely misleading. The CPI method uses data from the junior and senior years of a focal cohort; however, data for the freshman and sophomore years are already collected by the time data are available for the senior year. Therefore, using CPI's "synthetic" cohort is not any faster than using a four-year longitudinal cohort. As a matter of fact, in operation the CPI method still needs four years of data to determine inclusion of districts. Districts have to be in operation for at least four years and have not experienced boundary changes in order to be included in the Swanson's analysis.

Third, Swanson and Chaplin claimed that the CPI weighs heavily the contemporary conditions (rather than the past conditions), and therefore provides "a more legitimate basis for estimating the current level of educational system performance and also for imposing sanctions that are experienced in the present" (Swanson & Chaplin, 2003, p. 21). However, the CPI rate is a significant departure from the NCLB definition of high school graduation rate. In essence, the CPI rate indicates how well a system (school, district, state or country) promotes students from one grade level to another in a given pair of school years. The CPI indicator can be a valuable measure for evaluating school systems, but not for the purpose of the No Child Left Behind legislation: it does not really tell how well a system graduates students from high school in a standard number of years; at least, it is not a good way of providing information NCLB requires and the advantages claimed by the authors do not hold under close examination.

Two additional issues are worth mentioning in the calculation of the CPI rate. First, the reported CPI rates are computed at school district level; the district rates are then weighted and aggregated to state and national level. Estimates based on aggregated district rates are likely to be inaccurate since the authors' operation rules excluded one-quarter of the districts from the analysis. Although such exclusion rules are justified for district level analysis, it brings unknown bias to the aggregated CPI rates at state and national level. Since CCD collects census data for all public schools and report at state level, it is obviously a better procedure, in terms of efficiency and accuracy, to estimate state rates directly from CCD state data, and to estimate the national rate based on national data aggregated from state level.

The CPI rate is a product of four progression rates (grades 9 to 10, 10 to 11, 11 to 12, and 12 to graduation), which have a theoretical range of 0 to 1. However, sometimes the progression rate can exceed 1 due to unique district context. Progression rates that are larger than 1 yet smaller than 1.1 are "trimmed" to 1; while even larger values are censored and assigned a missing value code. Such strategies are justified for obtaining meaningful district rates, however they also lead to exclusion of more districts, which increases the bias in aggregated state and national rates.

In addition, the CPI estimates are subject to the same issues affecting the simple on-time graduation rate, namely, grade retention, transfer students and ungraded special education students. All these may lead to biases in the graduation rate estimates.

Supplementing CCD with CPS Data

The reader may come to a reasonable observation that the CCD enrollment data have limitations for estimating high school graduation rate. Through simulation of various conditions, Warren (2003) was able to illustrate systematic biases in the graduation rate estimates using the simple on-time graduation rate method, the Greene method, and the Cumulative Promotion Index (CPI):

- In the case of positive net migration (i.e. increase in cohort enrollment due to transfer), all three methods overestimate the graduation rate.
- In the case of negative net migration (i.e. decrease in cohort enrollment due to transfer), all three methods underestimate the graduation rate.
- In the case of grade 9 retention, all three methods underestimate the graduation rate.
- When multiple factors are at work such as cohort size increase (i.e. increase in the size of entering class from year to year), negative net migration and grade 9 retention, the three methods underestimate the graduation rate with varying magnitude.

Warren (2003)[3] proposed a measure using CCD enrollment data supplemented with CPS data to adjust for grade retention and migration. This new measure conceptually

[3] Warren proposed a revised measure for the high school graduation rate in 2004. For detail, see http://www.soc.umn.edu/%7Ewarren/Warren%20---%20July%202004.pdf.

represents "the percentage of incoming public school 9th graders in a particular state and in a particular year who obtain a regular high school diploma within four or five years of first starting 9th grade" (p. 12). In essence, Warren's measure is computed by making adjustments to both the numerator and denominator of the simple on-time graduation rate. The denominator is adjusted by multiplying the observed CCD number of enrolled public school 9th graders in a particular state and a particular year by (1) the proportion of first time 9th graders in that state and year (denoted as P), and by (2) one plus the net migration rate (denoted as MR) for members of that particular cohort in that state.

As for the numerator, the observed CCD number of graduates for a given year includes both on-time graduates and late graduates who were retained from previous cohort(s). On the other hand, some students of the reference cohort are retained and will not graduate until a year later than their peers. For example, the number of graduates reported by CCD for school year 1999-2000 in a given state includes on-time graduates (those who started high school in fall 1996) and late graduates (those who started high school in the fall of 1995 or earlier). Meanwhile not all students started high school in the fall of 1996 graduate in 2000, some might have been retained or otherwise delayed, and graduate in 2001 or later. Therefore, in order to calculate the graduation rate for the class graduating in 2000, the adjusted numerator equals the observed CCD number of graduates minus the number of graduates who started high school in 1995 (denoted as N_1), and plus the number of retained students who started high school in 1996 and graduate in 2001 (denoted as N_2).

Therefore, Warren's measure for graduation rate can be expressed as follows:

$$GR_{Year(i+4)}^{warren} = \frac{N_{year(i+4)}^{Grad} - N_1 + N_2}{N_{Year(i)}^{G9} * P * (1 + MR)}$$

In this formula, the number of graduates ($N_{Year(i+4)}^{Grads}$) and grade 9 enrollment ($N_{Year(i)}^{G9}$) are available from CCD files, while the other parameters (N_1, N_2, P and MR) are estimated based on CPS data (Warren, 2003). Through simulation, Warren was able to illustrate that, theoretically, this new measure is not affected by migration, grade retention, and cohort size change. However, in practice, the measure is also subject to error because N_1, N_2, P and MR are estimated from CPS data, which are influenced by various sources of error. Therefore, the empirical accuracy of Warren's measure of graduation rate remains to be evaluated.

Using the measure thus defined, Warren (2003) estimated graduation rates for nine high school classes graduating from 1992 to 2000 at both state and national levels, and compared the results to the simple on-time graduation rate estimates. It appears that the two approaches yield very similar trends at national level, yet Warren's estimates are slightly higher (by 0.3% to 1.9%) than the simple on-time rate estimates. At state level, the two approaches yield similar state rankings for the class of 2000 except for the District of Columbia and Nevada, both of which have much higher migration rates (-15% and 30% respectively) than the other states (ranging from -5% to 10%).

In sum, Warren's adjusted graduation rate measure is conceptually more accurate after accounting for migration, retention and cohort size change. Operationally, the computation for this measure requires both CCD and CPS data and is much more complicated. The empirical accuracy of the measure is yet to be determined. For states with relatively low migration rates, Warren's estimates correlate highly with the simple on-time graduation rate.

High school graduates compared with population 17 years of age

Another indicator based on both the CCD and CPS data is "graduates as a percent of 17-year-old population" (Snyder & Hoffman, 2003, p.127). This indicator is reported by the National Center for Education Statistics in the *Digest of Education Statistics* back to 1869-1870 (DES, 2002). The denominator of this indicator is derived from Current Population Reports, which is based on the CPS survey and reflects the October 17-year-old civilian noninstitutional population in a given year (e.g. October 1999). The numerator includes graduates of regular day school programs from both public and private schools in the spring of the next year (e.g. spring of 2000). Although a potentially accurate indicator for the on-time school progression behavior of the 17-year-old population, the DES 17-year-old rate is a significant departure from the graduation rate defined in NCLB. In addition, this measure is not designed to report for subpopulations due to the limitations of the CPS sampling design.

In sum, this section introduced two major data sources for estimating the high school graduation rate and reviewed alternative measures based on the Common Core of Data (see Table 2 for a summary of these methods). A number of recent studies compared alternative graduation rate estimates for particular years, at state level and/or for major ethnic groups. However, little research effort has been devoted to a comprehensive examination of the alternative graduation rate estimates over a longer period of time.

The purpose of this study is to compare results and trends in national, state and state ethnic group level graduation rate estimates using alternative methods over time, and to evaluate the discrepancies between these results.

Table 2
Overview of Alternative Methods

Method	Formula	Class 2000 Grad. Rate	Source
Simple Grade 8 Rate	$GR^{G8}_{Year(i+4)} = N^{Grad}_{Year(i+4)} \big/ N^{G8}_{Year(i-1)}$	**75.9%**	Computed
Simple Grade 9 Rate	$GR^{G9}_{Year(i+4)} = N^{Grad}_{Year(i+4)} \big/ N^{G9}_{Year(i)}$	**67.0%**	Computed
Simple Grade 10 Rate	$GR^{G10}_{Year(i+4)} = N^{Graduates}_{Year(i+4)} \big/ N^{G10}_{Year(i+1)}$	**75.4%**	Computed
The Greene Rate	$GR^{Greene}_{Year(i+4)} = \dfrac{3 * N^{Grad}_{Year(i+4)} * (N^{G9}_{Year(i)} + N^{G10}_{Year(i)} + N^{G11}_{Year(i)} + N^{G12}_{Year(i)})}{(N^{G8}_{Year(i-1)} + N^{G9}_{Year(i)} + N^{G10}_{Year(i+1)}) * (N^{G9}_{Year(i+3)} + N^{G10}_{Year(i+3)} + N^{G11}_{Year(i+3)} + N^{G12}_{Year(i+3)})}$	**69.0%**	Greene, 2002
The CPI Rate	$CPI_{year(i+4)} = \left[\dfrac{N^{G10}_{year(i+4)}}{N^{G9}_{year(i+3)}}\right] * \left[\dfrac{N^{G11}_{year(i+4)}}{N^{G10}_{year(i+3)}}\right] * \left[\dfrac{N^{G12}_{year(i+4)}}{N^{G11}_{year(i+3)}}\right] * \left[\dfrac{N^{Grads}_{year(i+4)}}{N^{G12}_{year(i+3)}}\right]$	**66.6%**	Swanson & Chaplin, 2003
The Warren Rate (2003)	$GR^{Warren}_{year(i+4)} = Adj.N^{Grad}_{year(i+4)} \,/\, Adj.N^{G9}_{year(i)}$	**67.5%**	Warren, 2003

Methods and Results

This study uses the grade enrollment and numbers of graduates[4] at national and state levels to estimate U.S. high graduation rates. The data are from two primary sources: the *Common Core of Data* (CCD) and the *Digest of Education Statistics* (DES), both published by the National Center for Educational Statistics (NCES). The state data are available from the CCD state nonfiscal files since 1986-87 school year[5]. The U.S. national[6] enrollment and graduation data are obtained from the DES since the CCD program does not have the national aggregates in a readily available format. Moreover, the DES has national data available back to the 1968-1969 school year, which provides a much longer period for examining the national trends in high school graduation rates. Beginning in the 1992-1993 school year, enrollment and graduation data are broken down by the five major ethnic groups in most states, which allows for the comparison of the high school graduation rate across races. The race level analysis in this study will focus on three groups, white, black and Hispanic.

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[4] NCES changed the reporting categories for high school graduates since CCD 1997. See Appendix I for details.

[5] State enrollment and graduation data from both CCD and DES were compared at state level for the 1986-87 to 2001-02 school years. Three large discrepancies were identified from these comparisons (see Appendix II). Based on the data from adjacent years, the current study resolves the discrepancies by adopting the DES reported data for all three cases.

[6] The U.S. national data includes the 50 states and the District of Columbia.

The data allows for multiple levels of analyses to study the effect of alternative methods on the high school graduation rate estimates. This study reports results of the analyses at three levels, namely, graduation rates at the national level, graduation rates for individual states, and graduation rates for major ethnic groups within states.

National Level Analysis

Alternative methods are applied to the national enrollment and graduation data complied from the DES to estimate high school graduation rates. These methods include (1) the simple grade 8 to graduation rate, (2) the simple grade 9 to graduation rate, (3) the simple grade 10 to graduation rate, (4) the Greene rate, and (5) the CPI rate. It is noted that the state and national CPI rate is computed here in a slightly different way from the published CPI rates (Swanson and Chaplin, 2003; Swanson, 2004). Rather than first computing district level CPI rates and then aggregating to state and national level, the current study computes the national and state CPI rate directly from national and state level enrollment and graduation data. Despite this procedural difference, the national CPI rate computed in this study is conceptually the same as the measure proposed by Swanson and Chaplin. However, the results computed in the current study are likely to differ from Swanson and Chaplin's results. Such differences are probably attributed to the fact that Swanson and Chaplin excluded some districts in their analysis. The national CPI rate computed in this study is based on national data collected in a census approach, and therefore is likely to be more accurate.

High school graduation rate estimates are not computed using Warren's method, which requires the CPS data and more complex procedures. However, reported Warren rates (Warren, 2003) for classes 1992 to 2000 are compared to estimates yielded from other methods for respective years.

The alternative graduation rate estimates are tabulated and graphed to reveal the trend of the national high school graduation rate over the past three decades. The national level analysis addresses the following research questions:

- What are the national graduation rates in the past three decades based on different methods?
- What are the trends in the national high school graduation rates based on different methods? Do these methods yield similar or different patterns?
- Are the graduation rates yielded from different methods related? What are the directions of these relationships? How strong are these relationships?
- When different methods yield different high school graduation rate estimates, what are the magnitudes of the differences?

Alternative national rate estimates and trends

Table 3 lists the graduation rate estimates for the past three decades. For example, the following are the six graduate rate estimates for the class of 2000:

- The simple grade 8 rate is 75.9%, which is the number of high school graduates in the spring of 2000 divided by the grade 8 enrollment in the fall of 1995;
- The simple grade 9 rate is 67.0%, which is the number of high school graduates in the spring of 2000 divided by the grade 9 enrollment in the fall of 1996;
- The simple grade 10 rate is 75.4%, which is the number of high school graduates in the spring of 2000 divided by the grade 10 enrollment in the fall of 1997;

- The Greene rate is 69.6%, which is the number of high school graduates in the spring of 2000 divided by adjusted grade 9 enrollment in the fall of 1996;
- The CPI national rate[7] is 67.5%, which is the product of the progression rates from 1999-2000 to 2000-2001 between every two adjacent high school grades;
- The Warren rate is 67.5%, which is the adjusted number of high school graduates in the spring of 2000 divided by adjusted grade 9 enrollment in the fall of 1996.

Table 3
Alternative Estimates for National High School Graduation Rates

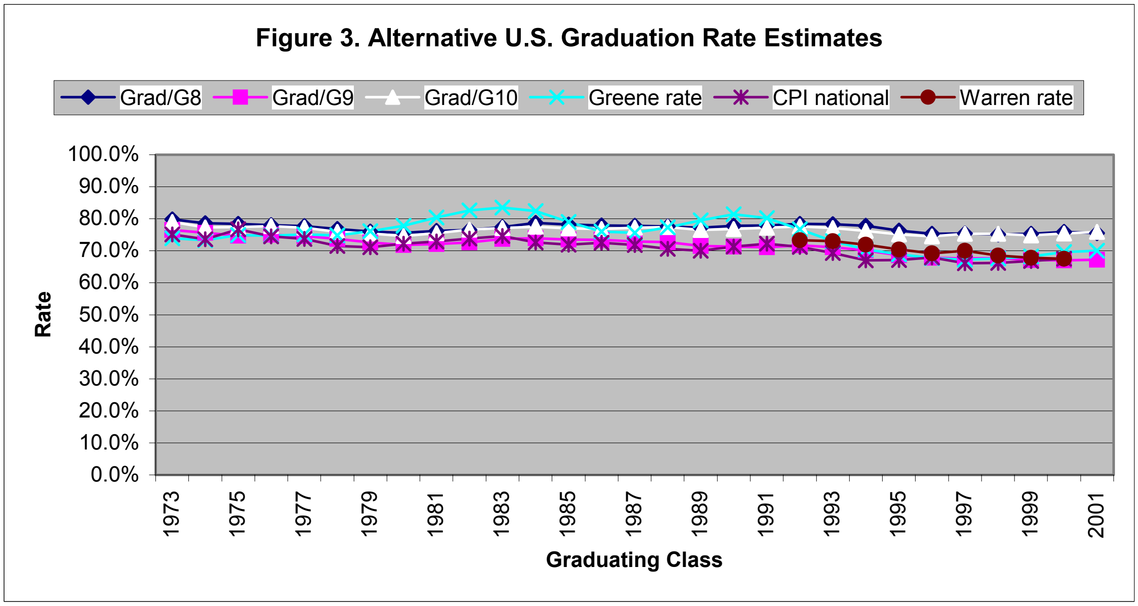
Year of Graduation	Grade 8 Rate[1]	Grade 9 Rate[1]	Grade 10 Rate[1]	Greene Rate[1]	CPI National Rate[1]	Warren Rate[2]
1973	79.8%	76.5%	79.0%	73.9%	75.1%	n/a
1974	78.6%	75.6%	77.3%	73.3%	73.6%	n/a
1975	78.4%	74.7%	77.4%	74.9%	76.7%	n/a
1976	78.0%	75.0%	77.7%	74.7%	74.5%	n/a
1977	77.7%	74.6%	77.2%	75.1%	73.7%	n/a
1978	76.8%	73.7%	75.9%	74.8%	71.5%	n/a
1979	76.0%	72.6%	75.4%	76.1%	71.1%	n/a
1980	75.6%	71.8%	74.6%	77.8%	72.2%	n/a
1981	76.2%	72.1%	75.5%	80.4%	72.9%	n/a
1982	76.5%	72.6%	76.6%	82.6%	73.8%	n/a
1983	77.4%	73.7%	77.1%	83.5%	74.6%	n/a
1984	78.7%	73.9%	77.5%	82.4%	72.6%	n/a
1985	78.2%	73.5%	77.0%	79.0%	71.9%	n/a
1986	77.9%	73.4%	76.8%	76.0%	72.5%	n/a
1987	77.8%	72.9%	77.2%	75.6%	71.8%	n/a
1988	77.6%	72.7%	77.4%	77.3%	70.6%	n/a
1989	77.2%	71.5%	76.5%	79.5%	70.0%	n/a
1990	77.8%	71.3%	76.8%	81.4%	71.3%	n/a
1991	77.9%	71.1%	77.2%	80.2%	72.2%	n/a
1992	78.4%	71.7%	77.6%	76.7%	71.2%	73.3%
1993	78.3%	71.1%	77.1%	73.0%	69.3%	73.0%
1994	77.8%	70.1%	76.2%	70.4%	67.0%	71.9%
1995	76.3%	68.6%	75.1%	68.9%	67.1%	70.4%
1996	75.3%	67.8%	74.5%	67.7%	67.9%	69.2%
1997	75.4%	67.6%	75.3%	67.2%	66.1%	70.0%
1998	75.1%	67.7%	75.3%	67.6%	66.2%	68.5%
1999	75.3%	67.1%	74.8%	68.2%	66.8%	67.8%
2000	75.9%	67.0%	75.4%	69.6%	67.5%	67.5%
2001	75.5%	67.2%	75.9%	70.0%	n/a	n/a

1. Graduation rate estimates computed using national data from the *Digest of Education.*
2. Graduation rate estimates reported in Warren, 2003, Table 7.

Figure 3 is a graphic presentation of the information in Table 3. The horizontal axis indicates the year in which students graduate. For example, the graduating class of 1973 refers to the cohort of students who started 9th grade in the fall of 1969 and graduated on

7 The computed CPI rate at national level is labeled as "CPI national rate" rather than "Swanson rate" in order to distinguish from the national rate reported by the Urban Institute. As mentioned earlier, this study computes the rate directly from national level data, while the Urban Institute researchers computed the national rate based on district aggregate.

time in the spring of 1973. The vertical axis indicates the graduation rate estimates. The lines with different markers represent graduate rate estimates yielded from the different estimation methods.



The national graduation rate estimates presented in Table 3 and Figure 3 suggest several observations. First, the national graduation rate slightly decreases from 1973 to 2001 regardless of the method used for the estimation. In 1973, the graduation rate estimates range between 73.9% (the Greene rate) and 79.8% (simple grade 8 rate), whereas the estimates for 2001 range between 67.2% (simple grade 9 rate) and 75.9% (simple grade 10 rate). One way to verify the observed decline in the six trend lines is by fitting an Ordinary Least Square (OLS) regression model on these observations and testing the significance of the slopes. Table 4 lists the OLS slopes and their significance level, which indicates that the decline in each of the six trend lines is statistically significant. This means the negative slopes of the OLS regression lines are significantly different from zero, hence indicating a declining trend in the national graduation rate. It is noted, however, that the OLS models are only a rough approximation to the data in this case since the national high school graduation rates are probably not independent from year to year. Also, in the case of the Greene rate, the relationship between the two variables is not a linear pattern, and therefore the OLS model is not a good fit.

Table 4
Ordinary Least Square (OLS) Slopes of the Trend Line

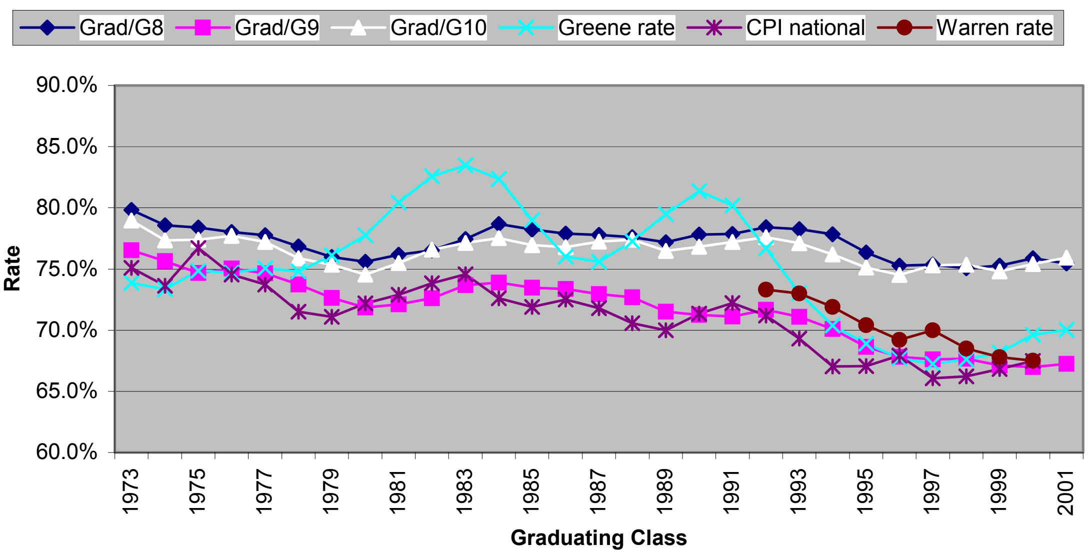
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Simple Grade 8 Rate[1]	-.001	.000	-.546	-3.389	.002
Simple Grade 9 Rate[1]	-.003	.000	-.932	-13.406	.000
Simple Grade 10 Rate[1]	-.001	.000	-.505	-3.038	.005
Greene Rate[1]	-.003	.001	-.515	-3.120	.004

National CPI Rate[1]	-.003	.000	-.886	-9.739	.000
Warren Rate[2]	-.008	.001	-.972	-10.871	.000

1. Based on 28 years of observations (1973 to 2001).
2. Based on nine years of observations (1992 to 2000).

Figure 4 is a re-scaled version of Figure 3, which allows a closer look at the trend lines of alternative graduation rate estimates. Five of the six trend lines appear to be quite stable from year to year, while the line representing the Greene estimates wildly fluctuates and departs from other methods during late 1970's through the 1980's. This raises questions about the reliability and validity of the Greene method. The line representing the CPI national rates appears less smooth than the three simple rates and the Warren rates, yet much more stable compared to the Greene rates.

Figure 4. Alternative U.S. Graduation Rate Estimates (Rescaled)



Third, if we put the Greene rate aside, the remaining five lines fall into two groups: (1) the simple grade 8 rates and simple grade 10 rates are close to each other, and (2) the simple grade 9 rates, the CPI national rates, and the Warren rates are close to each other. In addition, group 1 methods yield consistently higher estimates than group 2 methods, and the differences have been increasing over the years. Such differences between the two groups are supported by the standardized OSL estimates presented in Table 4, with the simple grade 8 rate and the simple grade 10 rate having standardized slopes of over -.50, while the other three lines having standardized slopes around -.90. This pattern is not surprising given the increasing size of the grade 9 bulge over time at the national level, which was shown earlier in Figure 2. Simple arithmetic operation[8] is sufficient to show that the larger the grade 9 bulge, the larger the difference between the simple grade 8 rates and the simple grade 9 rates. Similarly, the higher the grade 9 to 10 attrition rate, the larger the difference between the simple grade 9 rates and the simple grade 10 rates.

[8] See Appendix III for an illustration of the effect of grade enrollment change rate on the difference between alternative simple graduation rate estimates.

Correlation Analysis

The correlation coefficient is a useful tool for examining the relationship between the alternative sets of graduation rate estimates. Since the alternative methods are intended to estimate the same "true" graduation rate, the estimates should be highly correlated even though the observed values are somewhat different. We would expect the correlations to be fairly high; however, low correlations between alternative graduation rate estimates suggest the existence of other factors that add "disturbance" to the measurement. Table 5 lists the correlation coefficients between these alternative estimates for the national graduation rates.

Table 5
Correlations Between Alternative National Graduation Rates

	Grade 8 Rate	Grade 9 Rate	Grade 10 Rate	Greene Rate	National CPI
Grade 9 Rate	.780**(N=29)				
Grade 10 Rate	.925**(N=29)	.745**(N=29)			
Greene Rate	.454*(N=29)	.609**(N=29)	.463*(N=29)		
National CPI	.635**(N=28)	.907**(N=28)	.669**(N=28)	.684**(N=28)	
Warren	.905**(N=9)	.968**(N=9)	.850**(N=9)	.781*(N=9)	.688*(N=9)

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 6 summarizes these correlation coefficients in the order of their magnitude. The 15 correlation coefficients fall into three groups[9]: high correlations ($r > .8$), moderate correlations ($.6 < r < .8$), and low correlations ($r < .5$).

Table 6
Correlations between Alternative National Rates (Sorted by Value)

Group	Methods	Correlation Coefficients	Number of Years Compared
High	Grade 9 vs. Warren	**.968****	9
	Grade 8 vs. Grade 10	**.925****	29
	Grade 9 vs. CPI national	**.907****	28
	Grade 8 vs. Warren	**.905****	9
	Grade 10 vs. Warren	**.850****	9
Moderate	Greene vs. Warren	**.781***	9
	Grade 8 vs. Grade 9	**.780****	29
	Grade 9 vs. Grade 10	**.745****	30
	CPI national vs. Warren	**.688***	9
	CPI national vs. Greene	**.684****	28
	Grade 10 vs. CPI national	**.669***	28
	Grade 8 vs. CPI national	**.635****	28
	Grade 9 vs. Greene	**.609****	29

[9] The four groups are arbitrarily decided and are more stringent than the interpretation rule of thumb that correlation coefficients of larger than .9 are very high, .7 to .9 high, .5 to .7 moderate, .3 to .5 low, and coefficients lower than .3 are considered little or no relationship (Hinkle, Wiersma, & Jurs, 1998).

Low	Grade 10 vs. Greene	**.463***	29
	Grade 8 vs. Greene	**.454***	29

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

The correlation structure among the alternative estimates is in agreement with the previous observations of the trend lines in Figures 3 and 4.

- The simple grade 8 and grade 10 rates are highly correlated (r = .925).
- The Warren rate is highly correlated with the three simple graduation rates (r = .968 with the simple grade 9 rate, r = .905 with the simple grade 8 rate, and r = .850 with the simple grade 10 rate).
- The simple grade 9 rate is moderately correlated with the other two simple rates (r = .780 with the simple grade 8 rate, and r = .745 with the simple grade 10 rate).
- The correlation between the CPI national rate and the simple grade 9 rate is high (r = .907), and the correlations between the CPI national rate and the simple grade 8 rate (r = .635) and the simple grade 10 rate (r = .669) are moderate.
- The correlation between the Greene rate and the simple grade 9 rate is moderate (r = .609), and the correlations between the Greene rate and the other two simple rates are low (r = .454 with the simple grade 8 rate, and r = .463 with the simple grade 10 rate).

It is noted that since the graduation rate estimates are available for different numbers of years, the correlation coefficients are based on different numbers of cases. Correlation coefficients yielded from larger numbers of cases are likely to be more stable than those based on smaller numbers of observations.

Effect Sizes

Even though correlated, the estimates based on alternative methods are different in value. Effect sizes are computed in order to assess the magnitude of such differences. Mathematically, graduation rates are the same as proportions, ranging between 0 and 1. Therefore the effect size of the difference between two graduation rate estimates (r_1 and r_2) can be computed as follows:

$$ES = \frac{r_1 - r_2}{\sqrt{[r_1(1-r_1) + r_2(1-r_2)]/2}}$$

By using effect sizes, the difference between two groups is "represented as a proportion of the standard deviation of a reference group, and thus standardizes the difference" (Pedulla, Abrams, Madaus, Russell, Ramos, & Miao, 2003, p. 21). The interpretation of the magnitude of effect sizes depends on the discipline and situation. According to the criterion of Cohen (1965), an effect size of .25 is considered small, .50 medium, and 1.0 large (as cited in Hinkle, Wiersma, & Jurs, 1998, p.339). Alternatively, Feldt (1977) considers a standardized effect size of .20 as small, .50 medium, and .80 large (as cited in Hinkle, Wiersma, & Jurs 1998, p.339). In practice, an effect size of over half a standard deviation is rare (Mosteller, 1995, p.120).

The effect sizes in the current study should be interpreted differently from results of traditional experimental (or quasi-experimental) studies. In experimental studies, the objective is for a treatment to create a significant difference, and the research hypothesis usually predicts a significant effect size. In the current study, the focus is to examine the difference between two estimates of the same construct (the high school graduation rate for a given cohort). Since the alternative methods are expected to approximate the same "true" graduation rate, the effect sizes are expected to be small in the current study.

Table 7 lists the effect sizes of the differences between selected sets of estimates. For example, for the class of 2000, the standardized difference between simple grade 8 rate and simple grade 9 rate is .198, meaning that the simple grade 8 rate is higher than the simple grade 9 rate by almost one fifth of a standard deviation. For the class of 2001, the standardized difference between simple grade 8 rate and simple grade 10 rate is -.011, meaning that the simple grade 8 rate is lower than the simple grade 10 rate by slightly over one percent of a standard deviation. Just by examining the values in Table 7, we can see that the difference between the grade 8 rate and grade 9 rate (G8R vs. G9R) has more than doubled over the past three decades. In addition, the differences between grade 8 rates and grade 9 rates are much larger compared to those between grade 8 rate and grade 10 rate (G8R vs. G10R). The differences between the grade 10 rate and grade 9 rate (G10R vs. G9R) experienced even larger increases over the same time period.

Table 7
Standardized Difference between Alternative Rates

Class	G8R vs. G10R	G8R vs. G9R	G10R vs. G9R	Greene vs. G9R	CPI vs. G9R	Warren vs. G9R[1]
1973	0.021	0.080	0.059	-0.062	-0.034	n/a
1974	0.030	0.070	0.040	-0.052	-0.046	n/a
1975	0.024	0.088	0.064	0.004	0.048	n/a
1976	0.008	0.070	0.062	-0.008	-0.012	n/a
1977	0.013	0.073	0.060	0.010	-0.021	n/a
1978	0.023	0.073	0.050	0.025	-0.050	n/a
1979	0.014	0.077	0.062	0.080	-0.034	n/a
1980	0.024	0.085	0.061	0.137	0.007	n/a
1981	0.016	0.093	0.077	0.196	0.017	n/a
1982	-0.001	0.091	0.092	0.241	0.028	n/a
1983	0.007	0.087	0.080	0.240	0.020	n/a
1984	0.028	0.113	0.085	0.206	-0.029	n/a
1985	0.031	0.111	0.081	0.130	-0.035	n/a
1986	0.026	0.106	0.079	0.060	-0.019	n/a
1987	0.013	0.112	0.099	0.060	-0.026	n/a
1988	0.005	0.114	0.109	0.106	-0.047	n/a
1989	0.017	0.130	0.114	0.186	-0.033	n/a
1990	0.023	0.151	0.127	0.240	0.002	n/a
1991	0.016	0.156	0.139	0.213	0.025	n/a
1992	0.019	0.156	0.137	0.115	-0.010	0.037
1993	0.028	0.166	0.138	0.043	-0.039	0.043
1994	0.039	0.178	0.138	0.007	-0.066	0.040
1995	0.028	0.173	0.145	0.005	-0.034	0.038
1996	0.017	0.166	0.149	-0.002	0.002	0.030
1997	0.001	0.172	0.171	-0.008	-0.033	0.051
1998	-0.006	0.164	0.171	-0.001	-0.031	0.018
1999	0.011	0.181	0.170	0.022	-0.006	0.015
2000	0.010	0.198	0.187	0.057	0.011	0.011
2001	-0.011	0.183	0.194	0.060	n/a	n/a

1. n/a: rates not available for comparison.

The data in Table 7 are graphed to facilitate understanding of these effect sizes. Figure 5 shows the standardized differences between simple grade 8 rate and simple grade 9 rate (G8R vs. G9R), and the standardized differences between the simple grade 10 rate and simple grade 9 rate (G10R vs. G9R).

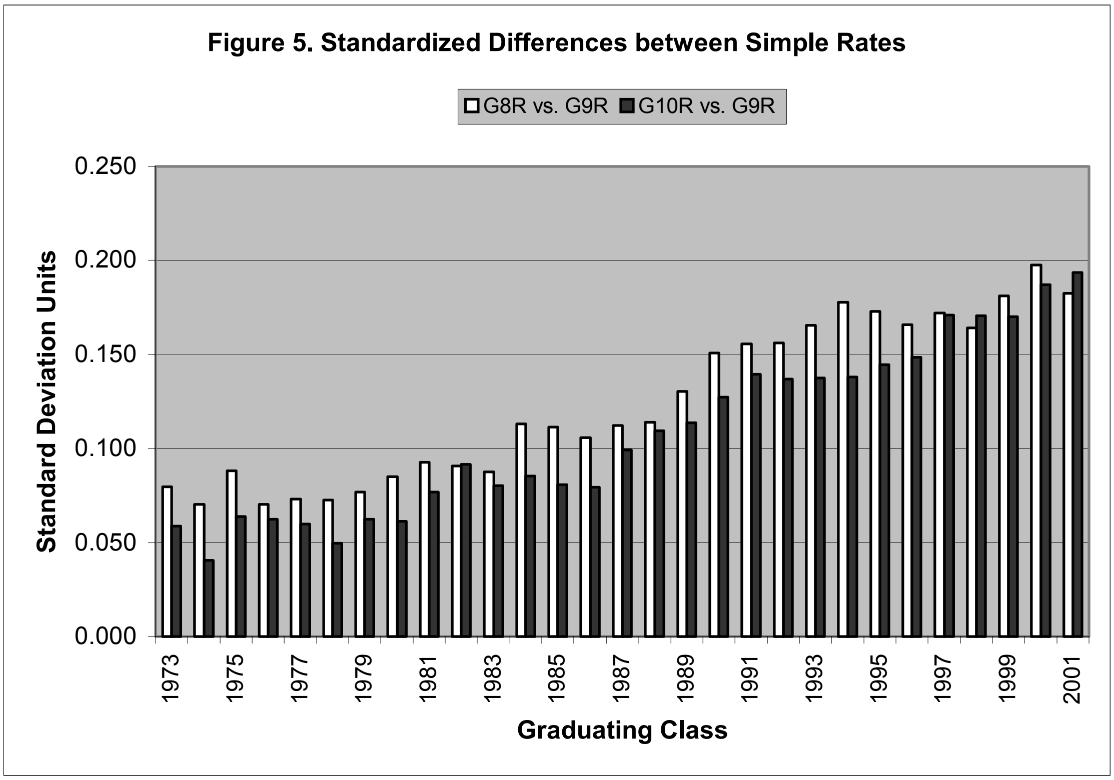
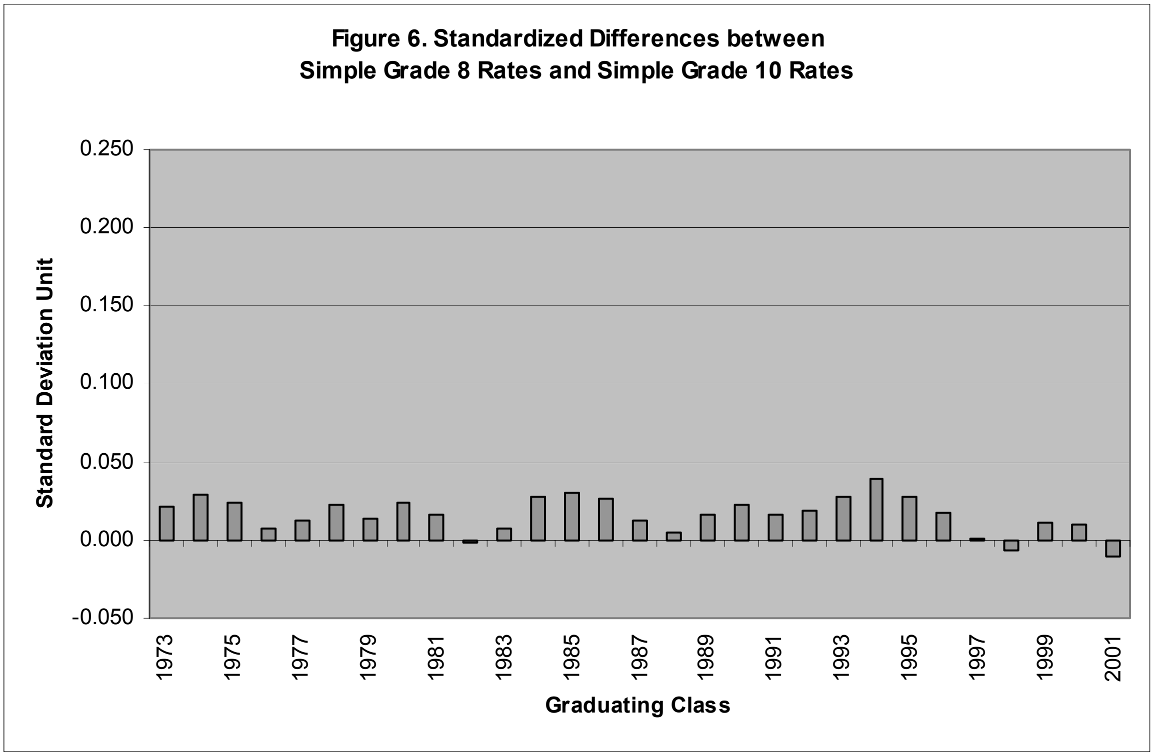


Figure 5 warrants two observations about the difference between the grade 8 rate and the grade 9 rate. First, all differences are positive, meaning that the simple grade 8 rate is consistently higher than the simple grade 9 rate. Second, despite fluctuations, the difference between the grade 8 and grade 9 rates has increased by about one tenth of a standard deviation during the past three decades. In 1973, the standardized difference was 0.080, as compared to 0.183 in 2001. The same pattern holds for the differences between the simple grade 10 rate and the simple grade 9 rate (G10R vs. G9R), and the increase in the effect size is even larger, from .059 in 1973 to 0.194 in 2001.

These observations are consistent with the earlier observations concerning national grade enrollment (see Figure 2). That is, the increasing difference between the grade 8 rate and the grade 9 rate corresponds with the increasing grade 9 bulge, and the increasing difference between the grade 10 rate and the grade 9 rate corresponds with the increasing grade 9 to 10 attrition rate.

Figure 6 shows the standardized differences between simple grade 8 rate and simple grade 10 rate.



For most years during the observed time period (25 out of 29 years), the standardized difference is positive; this means the simple grade 8 rate tends to be higher than the simple grade 10 rate. These positive values indicate that for most cohorts during the past three decades more students were enrolled in grade 10 nationwide than were enrolled in grade 8 two years earlier. However, the magnitude of the standardized differences between the grade 8 rate and the grade 10 is less than .04 of one standard deviation, much smaller than the effect sizes observed in Figure 5, meaning the enrollment difference between grades 8 and 10 is much smaller compared to the difference between grades 8 and 9 or the difference between grades 9 and 10. One compelling explanation of the enormous bulge in grade 9 enrollment is the common practice of holding students back at grade 9 (Greene, 2003; Haney, et al, 2004). An increasing number of students around the nation are repeating grade 9 instead of moving on to grade 10, which causes a "jam" in the flow of students at grade 9.

Figure 7 shows the standardized differences between the Greene rates and the simple grade 9 rates. For most years during the observed time period (23 out of 29 years), the positive values indicate that Greene rates are higher than the simple grade 9 rates. This is not surprising given that the Greene method smoothes out the grade 9 bulge through adjustment and hence has a smaller denominator than that of the simple grade 9 rate. However, the magnitude of the standardized differences vary substantially from year to year, with a low of close to zero and a high of nearly a quarter of one standard deviation, which is substantial given that these measures are intended to estimate the same graduation rate.

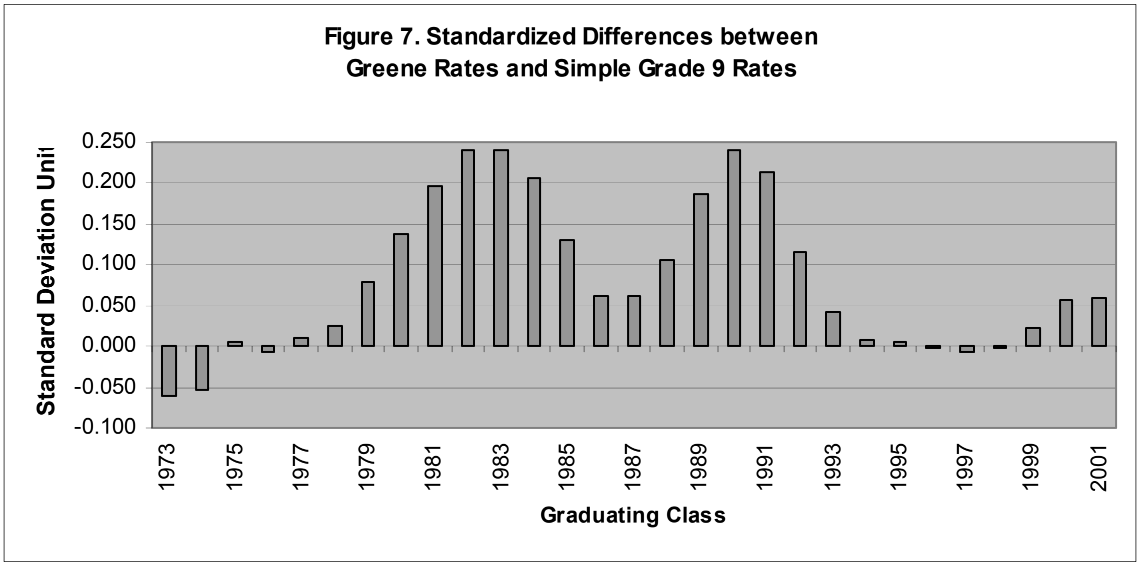


Figure 8 shows the standardized differences between the CPI national rates and the simple grade 9 rates. The relationship between the two rates has been inconsistent over the past three decades. However, the magnitudes of the standardized differences are less than one tenth of a standard deviation in both directions, much smaller than the large magnitudes observed in Figures 5 and 7.

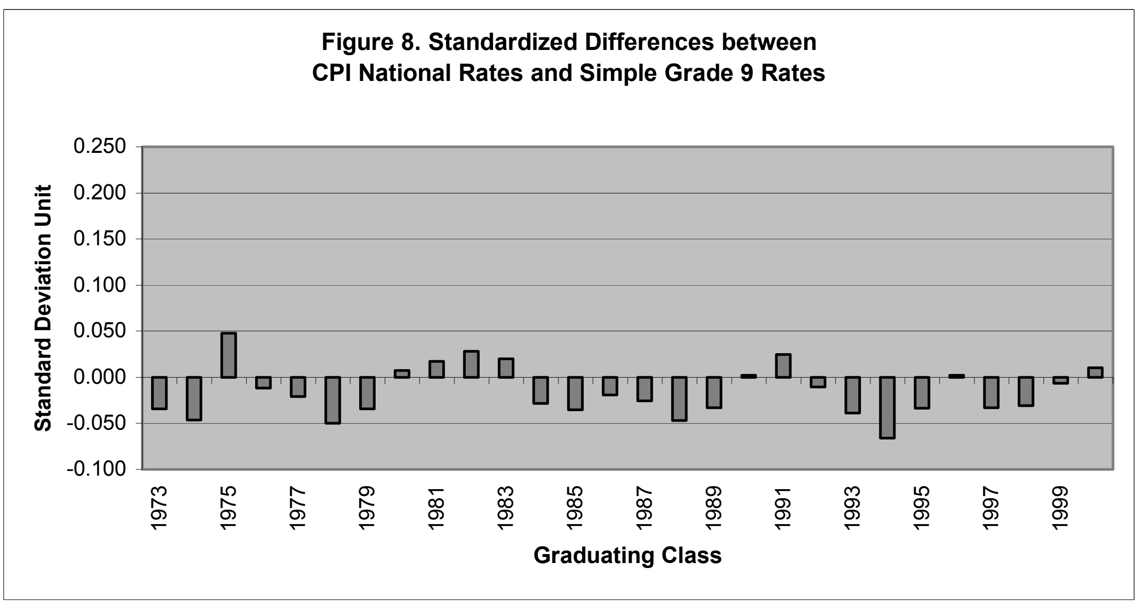
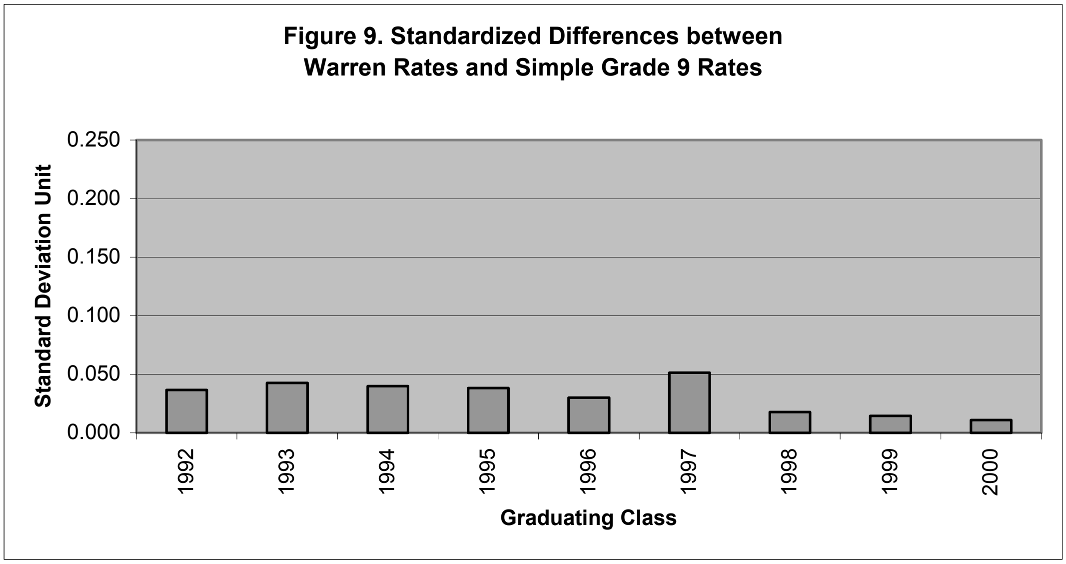


Figure 9 shows the standardized differences between the Warren rates and the simple grade 9 rates from 1992 to 2000. Consistent with the earlier observations from Figure 4, the Warren graduation rate estimates are slightly higher than the simple grade 9 rates, with standardized differences within one twentieth of a standard deviation, which are small relative to the large differences observed in Figures 5 and 7.



Summary of National Level Analyses and Results

Alternative national high school graduation rate estimates are computed for the past three decades using national enrollment and graduation data published in the *Digest of Education Statistics*. Regardless of the method used, the national graduation rate shows a slightly declining trend from the early 1970's to the end of the century, and the magnitude of the decrease depends on the estimation method used.

Analysis of the trends suggests that the three simple methods produce the most reliable estimates over the past three decades. While the simple grade 8 and grade 10 methods yield very close estimates, the simple grade 9 rates are consistently lower. Moreover, the differences between the simple grade 9 rate and the other two simple rates have been increasing over the past three decades and are substantial in magnitude by the class of 2001 (over 8% for a given cohort). Two of the three adjusted methods, the CPI national method and the Warren method, yield estimates and trends similar to those resulting from the simple grade 9 rate. Results from the Greene method appear to be unstable and depart from other methods during the late 1970's through the 1980's.

The correlation structure among the alternative estimates is consistent with the observations based on trend lines. Correlations among the three simple rates, the CPI national rates, and the Warren rates are either high or moderate, while the correlations between the Greene estimates and the other estimates are moderate or low.

Analysis of standardized differences yields findings consistent with the trend pattern and the correlation structure. The simple grade 9 rates are consistently lower than the other two simple rates, and the standardized differences have more than doubled, which corresponds with the increasing grade 9 bulge and grade 9 to 10 attrition rate. The differences between the simple grade 8 rates and simple grade 10 rates are small and consistent, and so are the differences between the Warren rates and the simple grade 9 rates. The Greene estimates tend to be larger than the simple grade 9 rates, yet the standardized differences vary substantially over the past three decades and are substantial at times. The differences between the CPI rate and the simple grade 9 rate indicate no clear pattern, and the magnitude of the differences between CPI rate and grade 9 rate are small compared to those between the Greene rate and the simple grade 9 rate, or the simple grade 8 rate and the simple grade 9 rate.

In summary, the above evidence leads to two conclusions at national level: (1) five of the six methods yield reliable results and similar trends, yet differences in the graduation rate due to estimation methods are substantial at times; and (2) the Greene method, despite its conceptual advantages, yields empirically unstable results at the national level.

State Level Analysis

The five alternative methods (the simple grade 8 rate, the simple grade 9 rate, the simple grade 10 rate, the Greene rates, and the CPI state rate[10]) are also applied to enrollment and graduation data for the 50 states to estimate high school graduation rates for each state. As CCD state level data are only available since the 1986-1987 school year, the state level analysis includes 10 high school cohorts graduating in the 1991-1992 through 2000-2001 school years; however, the reported Warren rates are only available for 9 classes graduating from 1992 to 2000.

Before getting into the details of analysis, let us first examine several issues encountered at state level. First, state results are only available for 10 years, whereas national results are available for 29 years. Therefore, the state level observations are based on a much smaller sample size and not as robust as national level results.

Second, state results are based on a much smaller student populations than the national results; therefore, state results are likely to be more volatile than national results. Also, enrollment size varies substantially from state to state; therefore state graduation rate estimates are likely to be more stable in large states than smaller ones (Kane & Staiger, 2002). Figure 10 illustrates the effect of enrollment size on the change in graduation rate estimate for all 50 states. In this scatterplot, the horizontal axis represents the state high school enrollments (i.e. total enrollment for grades 9 to 12) in fall 2000 and the vertical axis represents the change in the simple grade 9 graduation rates between 1992 and 2000.

[10] CPI state rates are computed based on state level enrollment and graduation data rather than aggregate from district level rates as the original Swanson CPI method.

Figure 10. State High School Enrollment Size vs. Change in Graduation Rate

Simple Grade 9 Rate

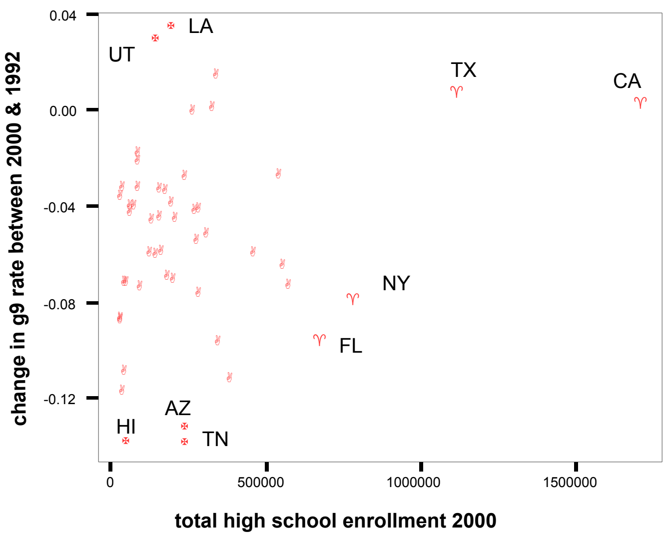


Figure 10 warrants two observations. First, more states experienced decreases in the simple grade 9 graduation rate than increases. This is consistent with the overall decrease observed in the national estimates. Second, states with smaller enrollments tend to have more variability in the change of simple grade 9 rates, while larger states are less likely to experience change in graduation rates. For example, California and Texas, the two states with largest public high school enrollments, had almost no change in the simple grade 9 rate between 2000 and 1992; while states showing larger changes during the same period tended to have small enrollments (e.g. Arizona, Hawaii, Louisiana, Tennessee, and Utah). Similar patterns are observed when other graduation rate estimation methods are used instead of the simple grade 9 rate, although the magnitudes of changes vary from method to method. In sum, the size of state enrollment plays a role in the observed change in the graduation rate, and hence interpretation should be made with caution and with the local context in mind.

We can now move on with the state analysis. The state analyses are intended to answer questions parallel to those posed at national level. Two additional questions are of interest at the state level:

- How do the state patterns compare to the national pattern? Are the national patterns also observed at state level? How are they similar or different?
- Is the relationship between alternative estimates consistent across different states?

Although addressing research questions similar to those examined in the national level analysis, we will proceed with the state analyses differently for two reasons. First, it is not feasible to examine closely the correlations and effect sizes in each state since there are 50 states. Also, with results only available for 10 cohorts, correlation coefficients based on a sample size of 10 in each state are not robust enough to warrant close attention.

State longitudinal trends

One feasible way to study the trend within and across the 50 states is to use graphic tools. Alternative state graduation rates are computed and graphed for each of the 50 states. Two raters examined the state graphs to classify the states using a simple rubric. The rater first determines if the six lines in each graph indicate a consistent trend for state high school graduation rate. If the answer is yes, the rater describes the state trend by choosing one category from six options: (1) rising; (2) falling; (3) first rising then falling; (4) first falling then rising; (5) fluctuating; or (6) stable. If the rater decides that the six lines in a graph indicate an inconsistent trend, the rater needs to describe the pattern.

The following two examples will illustrate this process. Figure 11 shows the alternative graduation rate estimates for Massachusetts from 1992 to 2001. The lines in Figure 11 show a consistent falling trend in high school graduation rates in the state of Massachusetts.

Figure 11. Alternative Graduation Rate Estimates (Massachusetts)

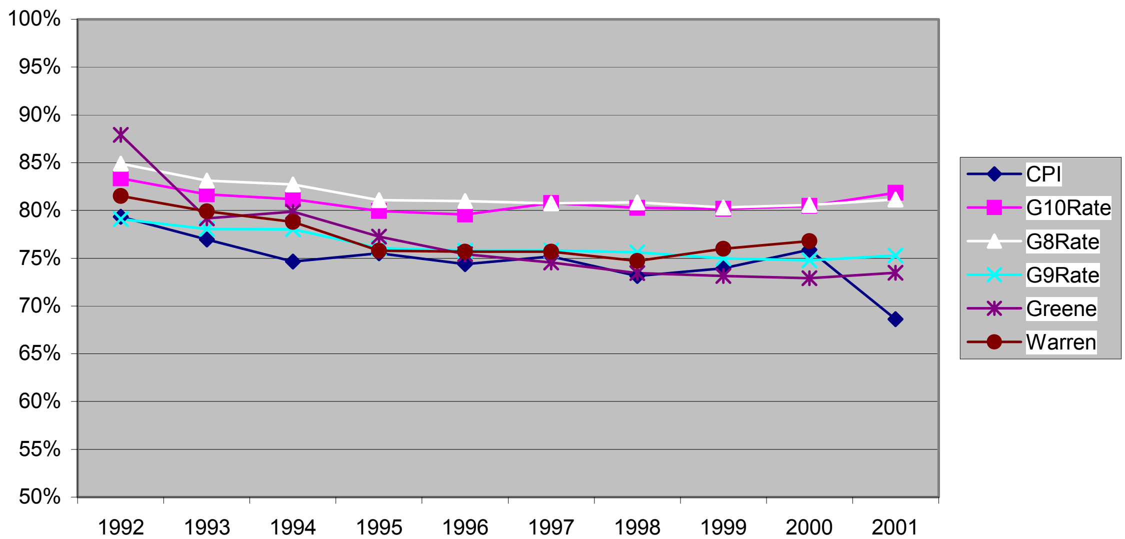
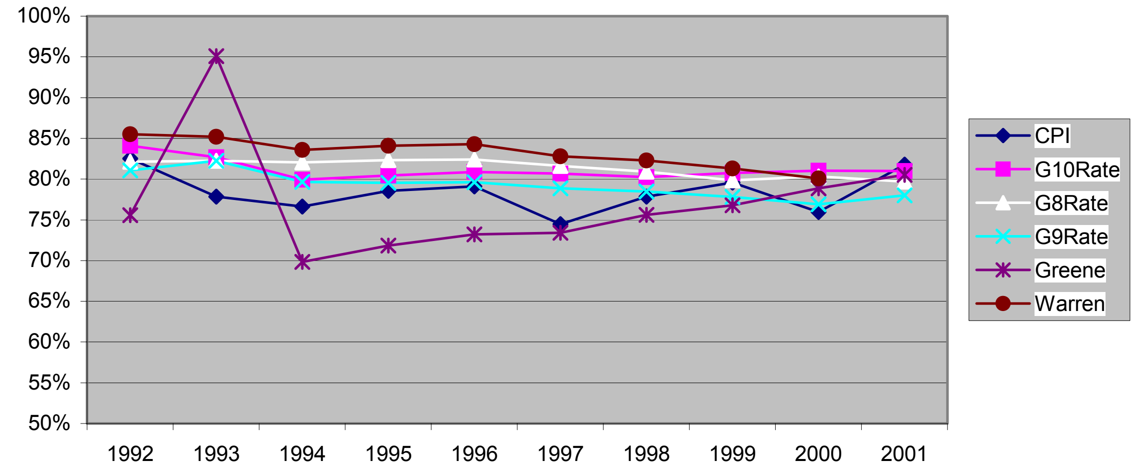


Figure 12 presents the alternative estimates for Idaho. In contrast to the results for Massachusetts, the Idaho pattern is considered inconsistent with a fluctuating CPI line, a rising Greene line and the other four falling lines.

Figure 12. Alternative Graduation Rate Estimates (Idaho)



In essence, each rater examined 50 individual state trends and put each state in an appropriate category in Table 8. Based on the above figures, Massachusetts is classified as showing a consistent falling trend. In contrast, although Idaho shows an overall falling trend, the CPI estimates and the Greene estimates are inconsistent with the overall pattern as noted in the parentheses.

Table 8
State Classification Table with Sample States

	Lines show consistent trend	Lines show inconsistent trend[1]
Rising		
Falling	MA	ID (CPI & Greene)
Rise/Fall		
Fall/Rise		
Stable		
Fluctuate		

1. The method noted in the parentheses is showing trend inconsistent with trends yielded from other methods.

The two raters examined the state trends independently and recorded the classifications. After the first rating, the two raters had complete agreement on 22 states and partial agreement on 15 states. Partial agreement means the two raters agreed on the overall state trend (e.g. falling or rising), but disagreed on the consistency of alternative rates. The two raters then reviewed the classification rubrics together, and rated for a second round, independently, the 28 states they did not completely agree upon. After the second round of rating, the two raters reached complete agreement on five more states, and partial agreement on 15 states. In the third round, the two raters discussed their ratings of the 23 states and reached a consensus. Based on this state classification, a descriptive of the trends in 50 states is arrived as is shown in Table 9.

Table 9
State Trend Classification

	Lines show consistent trend (32)	Lines show inconsistent trend[1] (18)
Rising (2)	LA, TX	--
Falling (34)	AK, AL, CO, CT, FL, GA, HI, IL, IN, MA, MN, NH, NV, NY, PA, SC, SD, WA, WI	DE (Greene), IA (Greene), ID (CPI & Greene), KS (CPI & Greene), MD (CPI), MS (Greene & CPI), MT (CPI & Greene), NC (CPI), ND (Greene), NE (Greene), OK (CPI & Greene), OR (CPI), RI (CPI & G10R), TN (CPI), WY (Greene)
Rise/Fall (2)	UT	KY (CPI)
Fall/Rise (6)	AR, AZ, CA, ME, NJ, NM	--
Stable (3)	VA	MO (Greene), WV (Greene)
Fluctuate (3)	MI, OH, VT	--

1. The method noted in the parentheses is showing trend inconsistent with trends yielded from other methods.

Consistent with the national pattern, the declining trend is also observed in over two thirds of the states. Of the 50 states, 34 show an overall pattern of declining graduation rates from 1992 to 2001. Only two states (Texas and Louisiana) show slight increases in graduation rates over the same period. The remaining states present a rise/fall pattern (two states), a fall/rise pattern (six states) pattern, a fluctuating pattern (three states), or a stable (three states) pattern in high school graduation rates.

At national level, the CPI method and the Greene method yield results less reliable than the other four methods. This lack of reliability is also observed in about one third of the states. In 10 states, the Greene method yielded trends inconsistent with others, and in 11 states the CPI method yielded inconsistent trends. Meanwhile, in 32 states, alternative methods yielded similar graduation rate trends from 1992 to 2001, although the actual rates may differ.

It is acknowledged that the classification of state trends based on graphic tools has its limitations. In order for this to work, the classification rubrics have to be simple enough. However, such simplification is at the cost of the discrimination of more complex patterns. For example, states with a declining trend differ from one another in the magnitude.

Another observation from national rates and state average rates is the increasing difference between the simple grade 8 rate and the simple grade 9 rate, indicating that more students are enrolled in grade 9 than in grade 8 the previous year. Such difference s are observed in almost all states; however, the magnitude of such differences varies from state to state. This consistent pattern across states suggests that more students are enrolled in grade 9 than in grade 8 the previous year, probably due to grade retention.

Correlations between alternative state rates and rankings

Since state graduation rate estimates are only available for 10 cohorts, it is cumbersome to compute the correlation coefficients between alternative rates over time based on a sample size of only 10 in each of the 50 states. A more meaningful approach is to correlate alternative state rates for a given cohort, with a sample size of 50 states.

The alternative methods intend to estimate the high school graduation rate for the same year in the same jurisdiction; therefore the results should be highly correlated if not exactly the same. Table 10 lists the correlation coefficients between state graduation rate estimates for the class of 2000 derived from the six alternative methods. Given the very nature of the graduation rate, the data we currently have are of a very restricted range: theoretically, graduation rates are within the range of 0 to 1, and the observed range of the estimates for the class of 2000 is between .500 and .938. Given such limited range, the correlation coefficients presented in Table 10 are high, ranging between .871 and .947, suggesting that these six alternative methods yield similar state graduation rate estimates for the class of 2000.

Table 10
Correlations (Pearson's r) between Alternative State Rates for Class of 2000 (N=50)

	Grade 8 rate	Grade 9 rate	Grade 10 rate	Greene rate	Warren rate
Grade 9 rate	.922**				
Grade 10 rate	.899**	.917**			
Greene rate	.871**	.899**	.910**		
Warren rate	.881**	.931**	.924**	.923**	
CPI state rate	.897**	.934**	.936**	.913**	.947**

** Correlation is significant at the 0.01 level (2-tailed).

Another means by which to study the relationship of alternative estimates is to examine the state rankings derived from alternative graduation rate estimates. Since rankings are an ordinal measure, Spearman's rho correlation coefficient is used instead of Pearson's r coefficient. By correlating the rankings, we examined the state graduation rate relative to each other in a norm-referenced approach, which provides a new perspective. The coefficients in Table 11 range between .873 and .948, which are comparable to those in Table 10. This suggests that these six alternative methods yield similar state rankings in terms of graduation rate for the class of 2000.

Table 11
Correlations (Spearman's rho) between Alternative State Rankings for Class 2000 (N=50)

	Grade 8 rank	Grade 9 rank	Grade 10 rank	Greene rank	Warren rank
Grade 9 rank	.902**				
Grade 10 rank	.909**	.926**			
Greene rank	.889**	.906**	.904**		
Warren rank	.873**	.945**	.935**	.915**	
CPI state rank	.905**	.948**	.935**	.918**	.941**

** Correlation is significant at the 0.01 level (2-tailed).

Magnitude of differences

At the national level, we standardized the differences between alternative rates in order to compare across methods; however, it would be a cumbersome task to carry out at the state level given the number of states and years included in the state level analysis. To get a sense of how big a difference the method makes, we can examine the descriptive statistics (e.g. range, median, and mean) of state rate estimates for a given year. Another approach is to examine the range of alternative estimates for individual states in a single year.

Distribution of alternative estimates for a given class

By examining the descriptive statistics of state rate estimates, we can get a sense of how big a difference the method can make for a given class. Table 12 lists the descriptive statistics of alternative state rates for the class of 2000. For example, the simple grade 9 rates for the class of 2000 range between 51.0% (South Carolina) and 85.5% (New Jersey), with a mean of 69.7% and a median of 71.0%.

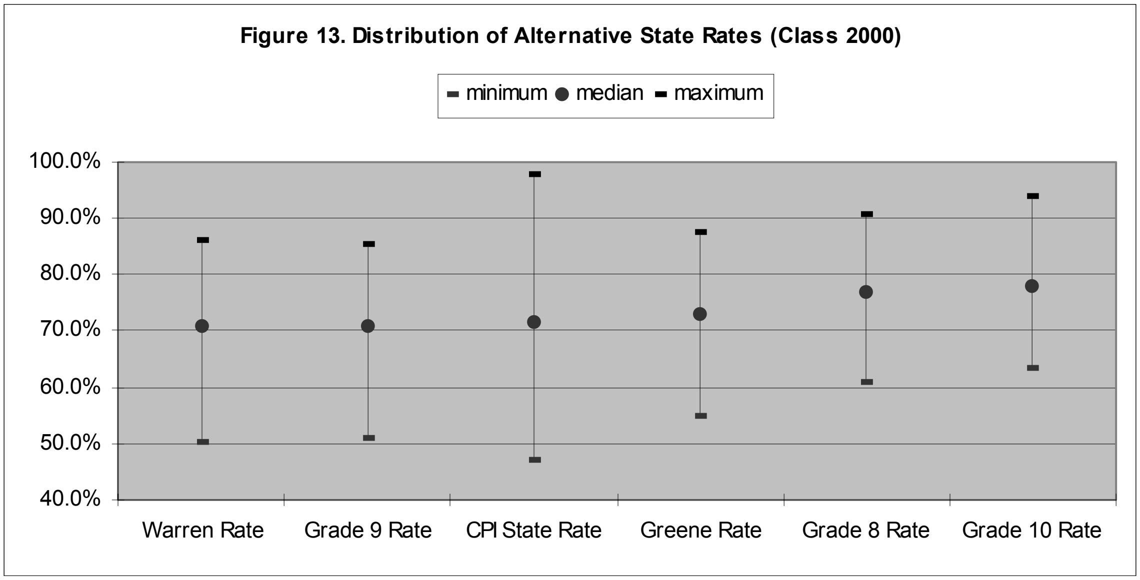
Table 12
Descriptive Statistics for Alternative State Rates (Class 2000)

	Grade 9 Rate	CPI State Rate	Warren Rate	Greene Rate	Grade 8 Rate	Grade 10 Rate
Minimum	51.0% (SC)	47.0% (TN)	50.4% (SC)	54.8% (FL)	60.9% (MS)	63.5% (FL)
Mean	69.7%	70.0%	70.1%	71.9%	76.3%	76.7%
Median	71.0%	71.6%	70.9%	73.0%	76.8%	77.9%
Maximum	85.5% (NJ)	98.0% (NJ)	86.2% (NJ)	87.5% (NJ)	90.8% (NJ)	93.8% (NJ)
# of states w/rates < 66.6%	17	15	14	15	7	6
# of states w/rates > 80.0%	6	7	9	10	16	17

The two rows in the bottom of Table 12 are very revealing. They indicate the number of states with graduation rate estimates in two arbitrary ranges – rates below 66.6% (two thirds) and rates over 80%. For the class of 2000, the simple grade 9 method yielded the most conservative estimates with 17 estimates (or one third of the states) falling below 66.6% and six estimates above 80%. In contrast, the simple grade 10 method yielded the most liberal state graduation rate estimates with only six estimates below 66.6% and 17 estimates above 80%. Based on earlier conceptual review and empirical results we have discussed so far, it is reasonable to speculate the "truth" to be somewhere in between, although hard to pinpoint exactly.

Figure 13 is a visual presentation of the information in Table 12. Each line segment in the figure represents the range of the results yielded from one method, with the dot in the middle representing the median estimates. The most striking observation from Figure 13 is the extraordinary length of the CPI line relative to others, indicating that the CPI state rates have more variability across states. For the class of 2000, New Jersey[11] has the maximum CPI state rate of 98.0%, which appears unrealistically high compared to results yielded from other methods. The remaining five methods have ranges comparable to each other.

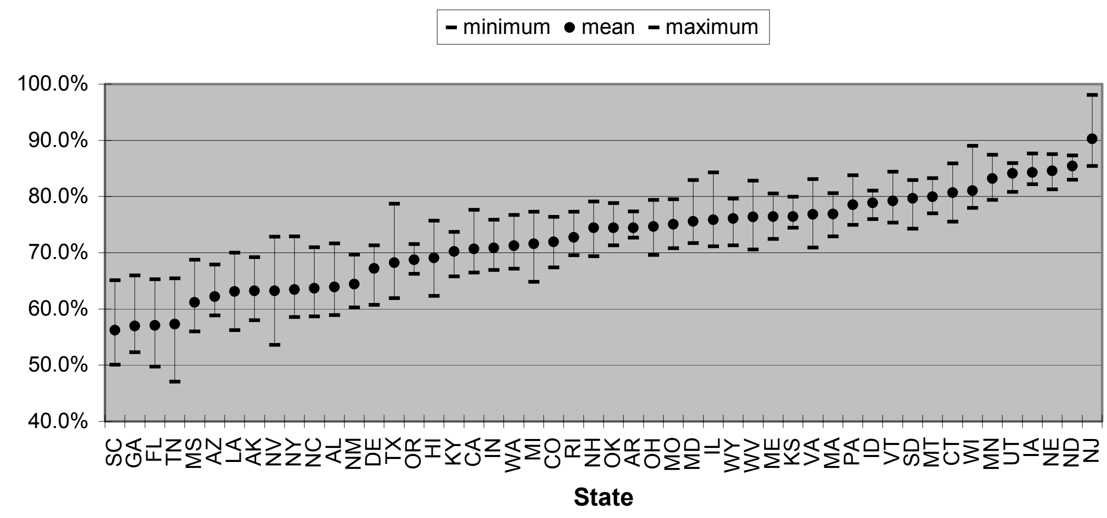
[11] New Jersey has an alternative review process for students who failed to pass the exam required for high school graduation. However, it is not clear as to how much this process affects the statewide high school graduation rate. For more information see http://www.nj.gov/njded/assessment/apa/.



Alternative estimates for individual states in a given year

Another approach is to examine the range of alternative estimates for individual states in a single year. Figure 14 presents the distribution of alternative state rates for the class of 2000. Each line segment in the figure represents the range of graduation rate estimates for the class of 2000 in one state, with the dot in the middle representing the mean of alternative estimates. The states are sorted by the mean estimates. We can make two observations based on Figure 14. First, states vary substantially in terms of the mean graduation rate estimate for the class of 2000, with South Carolina having the lowest mean graduation rate estimate of 56.3%, and New Jersey having the highest mean estimate of 90.3%. Second, the range of alternative estimates also differs considerably from state to state. In North Dakota, the difference between the highest estimate (the simple grade 8 rate, 87.3%) and the lowest estimate (the CPI state rate, 83.0%) is only 4.33%. In contrast, in Nevada, the simple grade 8 rate (72.9%) is 19.3% higher than the Warren rate (53.6%). Such a large discrepancy is probably attributable to the high net migration rate in the state of Nevada (Warren, 2003).

Figure 14. Distribution of Alternative State Rates (Class 2000)



Next, Figure 15 shows the ranges of graduation rate estimates across methods in each individual state for the class of 2000. Of the 50 states, 27 have a range of less than 10%, 19 have a range between 10~15%, and the remaining four states have a range of over 15%.

Figure 15. Range of State Graduation Rate Estimates across Methods (Class 2000)

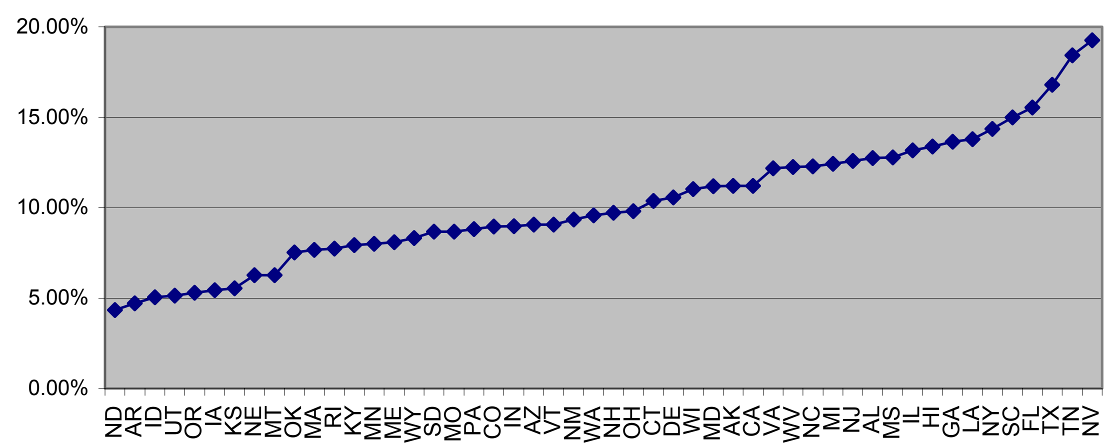
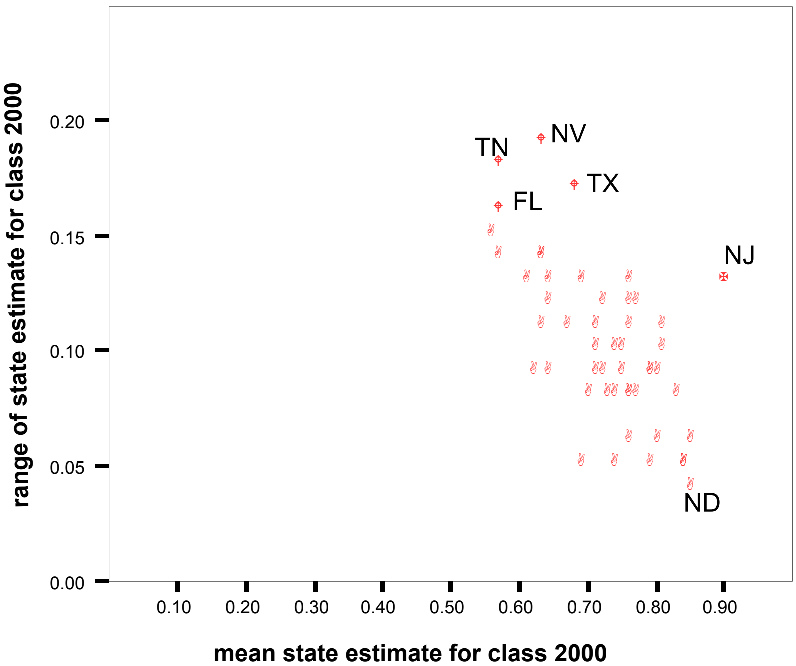


Figure 16 plots the range of state estimates against the mean state estimates for the class of 2000. An inverse relationship is apparent in this graph, with higher mean state estimates associated with smaller range of alternative state estimates. This suggests that alternative graduation rate methods make a larger difference on the estimates for states with relatively poor graduation rates; whereas, the method effects are smaller for states with higher graduation rates. Only one state (New Jersey) departs from the pattern, with a mean estimate of 90.3% and a range of .13. The CPI state rate (98.0%) is the highest estimate for New Jersey for the class of 2000. It is 7.7% higher than the mean estimate and 12.5% higher than the lowest estimate (85.5%, using the simple grade 9 method).

The correlation between the mean state estimates and the range of state estimates is -.636 (p<.01) for all 50 states, and -.709 (p<.01) when New Jersey is excluded. Such correlation coefficients are fairly high given the limited range of mean state estimates.

Figure 16. Range of State Estimate vs. Mean State Estimate

Class 2000

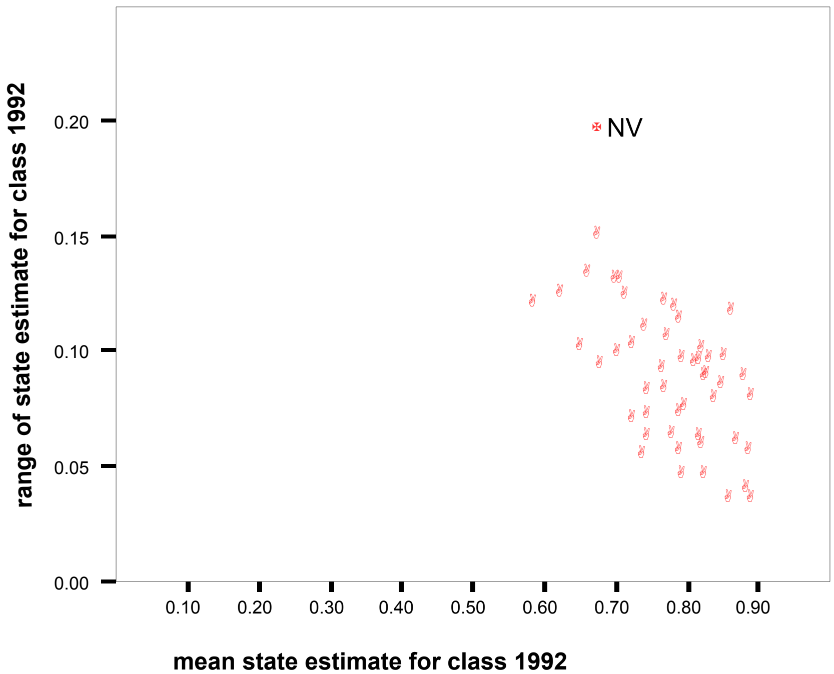


The same negative relationships between the range of state estimates and the mean state estimates is also observed for the class of 1992 as is shown in Figure 17. No state stands out from the general pattern, although Nevada is some distance away from the other states. For the class of 1992, the mean state graduation rate estimate for Nevada is 67.3%; however, the range between the lowest estimate (the reported Warren rate of 54.5%) and the highest estimate (the simple grade 8 rate of 74.0%) is almost 20%. A comparison of Figures 16 and 17 suggests that the difference between alternative state estimates have increased as more states are located in the range of .15 and .20 in 2000 than in 1992.

For the class of 1992, the correlation between the mean state estimates and the range of state estimates is -.590 (p < .01). This correlation coefficient is smaller than the coefficient for the class of 2000, which is probably attributable to the fact that for the class of 1992, there is less variability among states in terms of the range of state graduation rate estimates.

Figure 17. Range of State Estimate vs. Mean State Estimate

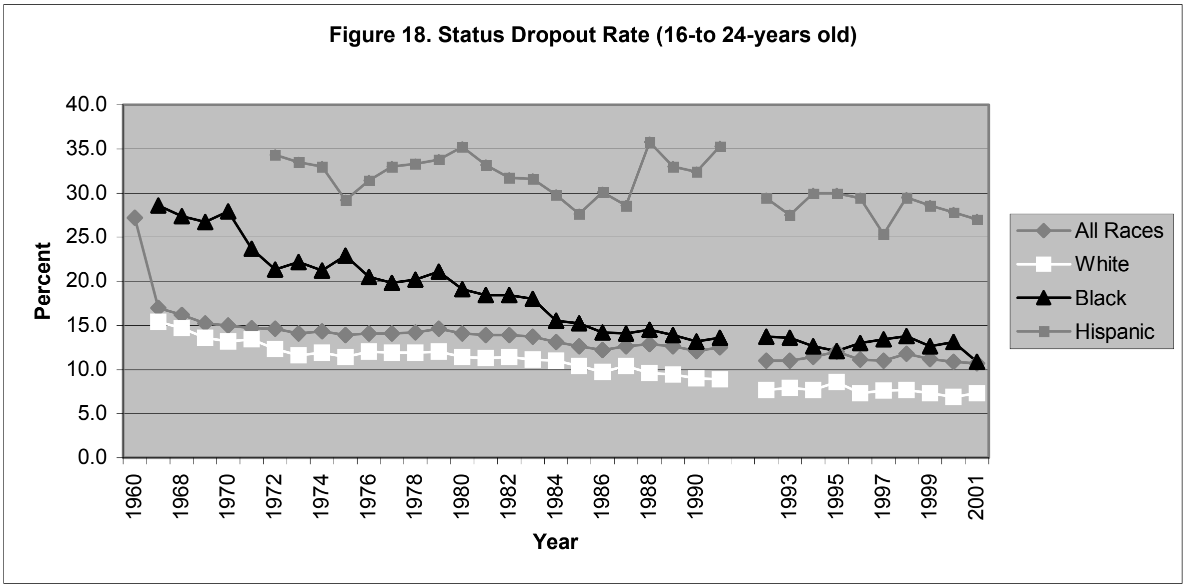
Class 1992



In summary, the alternative state graduation rate estimates present similar long-term trends and are highly or moderately correlated with each other. Meanwhile, alternative estimation methods do have substantial influences on the graduation rate estimates for individual states. For states with relatively low graduation rates, the difference between the alternative estimates can be substantial.

State Level Results by Major Ethnic Groups

In an ethnically diverse society like the United States, racial gaps in various indicators of academic achievement have long been documented (The Education Trust, 2004). In regard to high school graduation and dropout rates, the Current Population Survey (CPS) results have long shown that black and Hispanic students are less likely to graduate from high school and currently more likely to drop out of high school than their white peers (Dorn, 1996; Hauser, 1997; Hauser, Simmons & Pager, 2000; Sum & Harrington, 2003). For example, the status dropout rates for the 16-to 24-year-old age group are consistently higher for the black and Hispanic student population than for the white in the last few decades (see Figure 18). Although the black and white gap has decreased since the 1960's, based on this measure, the difference in the status dropout rate between Hispanics and whites remains large.



Source: Snyder, T. D., & Hoffman, C. M. (Eds.) (2003). Digest of Education Statistics 2002, Table 108.

Measures based on the CCD also revealed substantial racial gaps in high school graduation rate. Using the CPI method, Swanson (2004) found "tremendous racial gaps" for the class of 2001: only 50% of students from historically disadvantaged minority groups (American Indian, Hispanic and black) finish high school with a diploma, while the high school graduation rates for whites is 75% and for Asians is 77% nationwide. Even larger racial gaps are observed within individual states. For example, in Massachusetts, while 73.7% of white students graduated in 2001, only 36.1% of Hispanic students leave high school with a regular diploma.

Swanson's graduation rate estimates are close to what Greene (2003) reported at the national level. However, the two authors' results differ substantially for some minority groups within individual states (see Table 13). For example, Swanson reported a graduation rate of 65% for blacks in Massachusetts, while Greene's estimate is only 49.5%.

Table 13
Graduation Rate for Class 2001

	Source	All Races	American Indian	Asian	Hispanic	Black	White
National	Greene (2003)	68.0%	51.1%	76.8%	53.2%	50.2%	74.9%
	Swanson (2004)	70.0%	54.0%	79.0%	52.0%	51.0%	72.0%
Massachusetts	Greene (2003)	73.0%	n/a[1]	76.0%	49.0%	65.0%	78.0%
	Swanson (2004)	71.0%	25.4%	60.5%	36.1%	49.4%	73.7%

1. Insufficient data to calculate graduation rate.

In this section, we computed alternative graduation rates for major ethnic groups in selected states and compared the results to detect the effect of alternative methods on the magnitude of racial differences uncovered. As illustrated by the example in Table 13, the racial gap in graduation rates may differ substantially depending on the methods used. Not all 50 states are included in the race level analysis simply because some states (e.g. Idaho, New Hampshire, South Carolina, and Vermont) do not report enrollment and graduation information by student ethnicity, hence the information is not available in the CCD database. Other states are excluded for the concern of small sub-population sizes.

In the earlier discussion of state level analysis, we illustrated the potential influence of enrollment size on the change in the graduation rate. Graduation rate estimates for states with small enrollments are more likely to change than states with larger enrollments. This is a more salient issue when we break down state enrollment by student ethnicity. Due to historical and geographical reasons, student demographics differ tremendously from state to state in terms of ethnicity. While some states are overwhelmingly white (e.g. based on CCD data, Maine has only 3.8% non-white public school enrollment in 2001-2002), other states serve much more diverse student populations (e.g. over 60% of the public school enrollment in California, New Mexico, and Hawaii are non-white in 2001-2002). Therefore, sub-population sizes differ drastically among states. For example, in the 2001-2002 school year, Montana had a total enrollment of only 962 black students (including students from pre-kindergarten through 12th grade and ungraded students), which means an average of fewer than 80 students in each grade in the whole state. In contrast, for the same school year, Florida enrolled 621,569 black students (pre-kindergarten through 12th grade), which is 646 times the black enrollment in Montana. Results based on such drastically different sample sizes are hardly comparable since any measurement based on a small population size of less than 100 is likely to be unreliable and prone to fluctuation from year to year. In this section, we compute high school graduation rates for all three major racial groups in the states, for which the data are available. However, results based on an average cohort grade enrollment of fewer than 100 are excluded from the analysis.

For the students graduating in 1997 and 2001, we computed graduation rates for the three major ethnic groups (black, Hispanic and white) using five methods: the simple grade 8 rate, the simple grade 9 rate, the simple grade 10 rate, the Greene rate, and the CPI race rate[12]. The Warren method is not included in this analysis since Warren did not compute graduation rates by race. Results from the five alternative methods are tabulated and graphed, and the summary descriptive statistics are examined to illustrate the difference across methods. Also, correlations are calculated across methods in order to examine the similarity between alternative results. The objective for this analysis is, again, to detect the effect of alternative methods on the magnitude of racial differences uncovered.

Table 14 lists the alternative graduation rate estimates for the class of 2001 in three major ethnic groups within states. In Massachusetts, for example, the graduation rate for black students in 2001 ranges between 51.7% (CPI rate) and 80.9% (simple grade 8 rate), the graduation rate for Hispanic students ranges between a low of 34.2% (CPI rate) and a high of 65.9% (simple grade 10 rate), and the graduation rate for white students ranges between 76.3% (CPI rate) and 84.5% (simple grade 10 rate). Alternative methods yielded relatively reliable estimates for the white student population, yet drastically different results for the black and Hispanic student population.

Race results are not available for all states due to several reasons. First, there are insufficient data to compute the race rates for certain states since these states did not report enrollment and graduation data disaggregated by race. Second, race rates are suppressed, in some cases, when the cohort size is extremely small, i.e. with fewer than 100 graduates statewide in a given group. For example, in the state of Montana, only 33 black students graduated in the year of 2001, therefore graduation rate estimates for the black population are not reported for Montana. Third, in a couple of cases, the CPI rate is "censored" due to abnormally high grade promotion rates. That is, when the promotion rate in any grade exceeds 110%, the CPI rate is not reported (see earlier discussions of the CPI method).

[12] Again, this is based on race enrollment and graduation rates at the state level rather than aggregate rates from the district level as Swanson did in his report.

Table 14
Class of 2001 Graduation Rates for Major Ethnic Groups (Percent)

	Black					Hispanic					White				
STATE	G8R	G9R	G10R	GRN	CPI	G8R	G9R	G10R	GRN	CPI	G8R	G9R	G10R	GRN	CPI
AK	60.7	55.7	67.8	64.2	63.7	68.4	68.4	69.8	59.7	55.9	74.4	67.7	72.3	68.1	63.9
AL	59.4	50.1	64.1	59.3	53.5	65.2	55.2	70.4	44.3	63.0	68.0	62.8	73.5	70.3	65.3
AR	66.1	66.2	68.9	69.4	69.2	88.3	80.0	76.2	52.3	C	74.5	74.8	79.1	78.0	76.6
CA	67.7	56.7	62.9	58.1	57.8	68.5	57.4	63.2	55.7	57.8	82.5	77.5	79.9	76.7	77.2
CO	62.7	53.0	63.2	56.0	53.0	56.5	49.4	62.0	47.4	48.8	80.2	75.6	79.9	74.1	75.9
CT	68.0	54.2	66.5	55.6	56.1	59.7	45.6	65.0	47.4	50.9	84.7	81.4	85.1	76.8	80.4
DE	63.5	50.7	64.9	57.6	52.8	57.5	42.1	57.0	44.3	49.5	77.8	70.0	76.9	74.3	69.8
FL	56.7	44.2	55.3	47.2	40.9	66.8	52.8	63.5	47.8	52.3	67.8	59.1	68.7	61.3	58.7
GA	51.6	40.3	55.3	46.4	43.3	56.7	43.8	59.9	32.3	47.3	65.9	58.8	71.0	62.7	61.7
HI	37.2	44.1	57.1	50.5	60.7	63.3	51.7	65.3	64.5	59.9	59.9	57.8	70.3	63.9	64.7
IA	64.4	56.1	63.3	57.8	61.1	77.1	64.2	70.2	54.0	62.0	87.4	83.5	85.7	86.7	83.2
IL	54.4	45.1	57.8	52.7	44.5	63.4	54.1	67.8	53.4	61.7	87.0	82.0	85.7	83.5	83.6
IN	54.0	43.8	58.0	53.3	45.2	73.7	59.8	72.8	59.2	64.1	75.5	71.3	78.7	77.6	73.3
KS	62.2	I	64.1	I	61.2	60.6	I	59.4	I	58.7	81.6	I	82.0	I	82.6
KY	I	50.0	61.5	I	45.4	I	82.3	84.4	I	77.5	I	67.0	76.9	I	66.3
LA	60.0	50.3	65.0	62.1	60.2	80.7	64.9	76.4	74.4	86.5	71.7	65.2	77.1	75.7	68.1
MA	80.9	66.3	73.5	65.5	51.7	63.8	50.4	65.9	49.0	34.2	82.6	79.4	84.2	77.6	76.3
MD	78.6	64.7	76.8	66.3	64.0	92.6	73.7	77.2	61.9	76.5	83.6	79.5	85.4	78.2	79.5
ME	S	S	S	S	S	S	S	S	S	S	73.7	75.9	82.3	74.6	77.4
MI	61.7	46.7	64.0	55.6	48.9	64.1	50.2	68.8	52.9	56.4	82.3	75.8	81.6	77.7	78.0
MN	60.8	51.8	55.9	42.7	56.3	68.5	60.7	64.2	46.9	59.6	88.3	85.5	85.5	85.6	84.2
MO	66.9	54.0	65.0	58.0	53.9	92.8	79.4	83.4	65.6	76.6	79.8	75.9	80.7	77.4	76.1
MS	57.6	52.8	64.9	61.1	53.3	S	S	S	S	S	64.4	60.9	71.6	67.7	64.1
MT	S	S	S	S	S	100.0	96.6	98.3	84.3	91.1	83.5	80.2	84.0	84.7	81.6
NC	60.6	I	64.9	I	53.0	69.9	I	71.5	I	60.0	72.5	I	76.5	I	69.2
ND	S	S	S	S	S	S	S	S	S	S	89.1	88.4	90.3	93.2	86.0
NE	64.1	50.8	69.4	54.7	50.6	74.9	63.8	76.7	56.9	60.5	88.1	83.7	87.6	88.7	86.3
NJ	I	I	I	I		I	I	I	I	C	I	I	I	I	99.5
NM	88.8	63.1	70.9	72.7	62.0	72.1	54.8	64.9	62.1	57.0	81.6	69.5	75.4	79.4	69.2
NV	61.8	56.4	59.9	50.0	40.7	62.9	57.7	57.2	40.7	36.3	74.0	72.2	74.1	68.8	62.4
NY	56.9	36.8	47.1	46.7	39.7	52.5	33.1	43.5	42.4	36.4	79.7	75.5	81.2	77.1	77.2
OH	56.1	42.5	61.8	52.3	46.7	66.9	54.7	70.3	60.9	62.1	83.1	76.9	83.6	82.3	76.7
OK	68.7	60.0	70.7	66.1	60.6	80.3	70.8	77.9	59.8	67.7	76.1	74.0	79.7	80.0	73.7
OR	59.9	51.6	55.0	50.1	60.0	59.5	51.4	53.9	42.6	60.6	70.1	67.4	71.0	69.4	73.0
PA	69.7	49.9	66.9	57.6	54.4	64.8	46.2	61.3	48.8	53.2	86.2	81.9	85.5	82.9	84.5
RI	76.8	64.5	78.0	62.5	85.2	73.8	57.4	71.3	55.7	69.1	78.1	72.6	80.4	74.6	73.6
SD	S	S	S	S	S	S	S	S	S	S	85.7	83.1	86.3	88.2	87.0
TX	70.3	54.9	75.3	61.8	58.0	66.6	51.4	73.9	56.9	57.1	79.3	72.1	82.8	76.7	74.9
UT	74.2	71.9	70.5	56.5	67.7	73.9	70.6	68.7	53.8	69.9	85.1	84.5	84.3	90.4	84.5
VA	72.7	64.7	76.5	64.2	62.7	94.2	75.9	79.5	59.0	71.7	83.0	77.4	85.1	77.4	75.5
WA	61.1	52.8	58.9	52.5	53.9	61.9	54.7	58.7	48.2	53.4	73.2	67.2	70.7	68.6	67.8
WI	50.4	37.8	53.9	44.2	43.0	70.6	55.6	66.0	54.7	64.0	94.4	84.4	86.8	87.4	84.8
WV	66.5	65.6	67.0	70.0	63.3	S	S	S	S	S	76.5	73.5	79.0	84.7	71.1
WY	S	S	S	S	S	55.0	58.5	64.3	64.6	66.8	75.6	75.3	75.3	79.2	74.9

Note: Insufficient data to compute the rates for AZ, ID, NH, SC, TN, VT.
S: Rate suppressed because of small cohort size (less than 100 graduates) **C**: Value censored due to large progression rate.

Table 15 summarizes the race results for the class of 2001 by listing the maximum, median, and minimum estimates across states based on alternative methods. For example, the simple grade 8 method yielded valid graduation rate estimates for black students in 37 states, ranging from 37.2% to 88.8%, with a median of 62.2%.

Table 15
Descriptive Statistics for Alternative State Rates by Race (Class 2001)

Group	Method	G8R	G9R	G10R	GRN	CPI
Black	Count	37	36	38	35	38
	Maximum	88.80%	71.90%	78.00%	72.70%	85.20%
	Median	62.20%	52.80%	64.50%	57.60%	54.20%
	Minimum	37.20%	36.80%	47.10%	42.70%	39.70%
Hispanic	Count	37	36	38	35	37
	Maximum	100.00%	96.60%	98.30%	84.30%	91.10%
	Median	66.90%	56.50%	68.30%	54.00%	60.00%
	Minimum	52.50%	33.10%	43.50%	32.30%	34.20%
White	Count	42	41	43	40	44
	Maximum	94.40%	88.40%	90.30%	93.20%	99.50%
	Median	79.70%	75.50%	80.40%	77.50%	76.00%
	Minimum	59.90%	57.80%	68.70%	61.30%	58.70%

The information in Table 15 is graphed in Figures 19 to 21, which allows a comprehensive view of the distribution of the alternative graduation rates by race. Several observations are obvious from the three figures. First, regardless of the estimation method, the median estimates for the white student population (ranging from 75.5% to 80.4%) are much higher than the median estimates for both the black student population (ranging from 54.2% to 64.5%) and the Hispanic student population (ranging from 54.0% to 68.3%). Second, differences between alternative estimates are smaller for the white population than for the black and Hispanic student population. Third, the ranges of alternative rates are smaller for the white student population than for the black and Hispanic student population, indicating a larger disparity among states in terms of high school graduation rate for minority students.

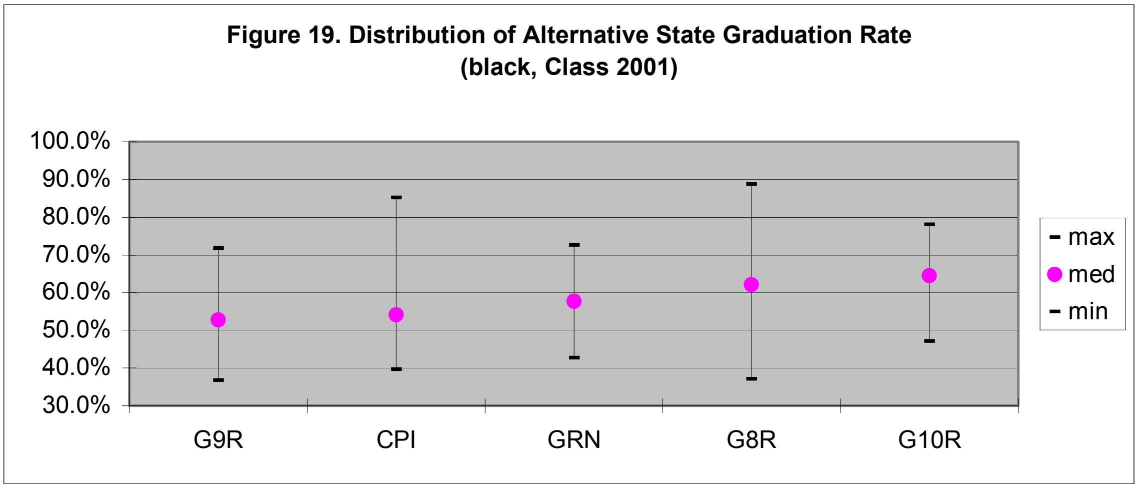


Figure 19. Distribution of Alternative State Graduation Rate
(black, Class 2001)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
G9R
CPI
GRN
G8R
G10R
max
med
min

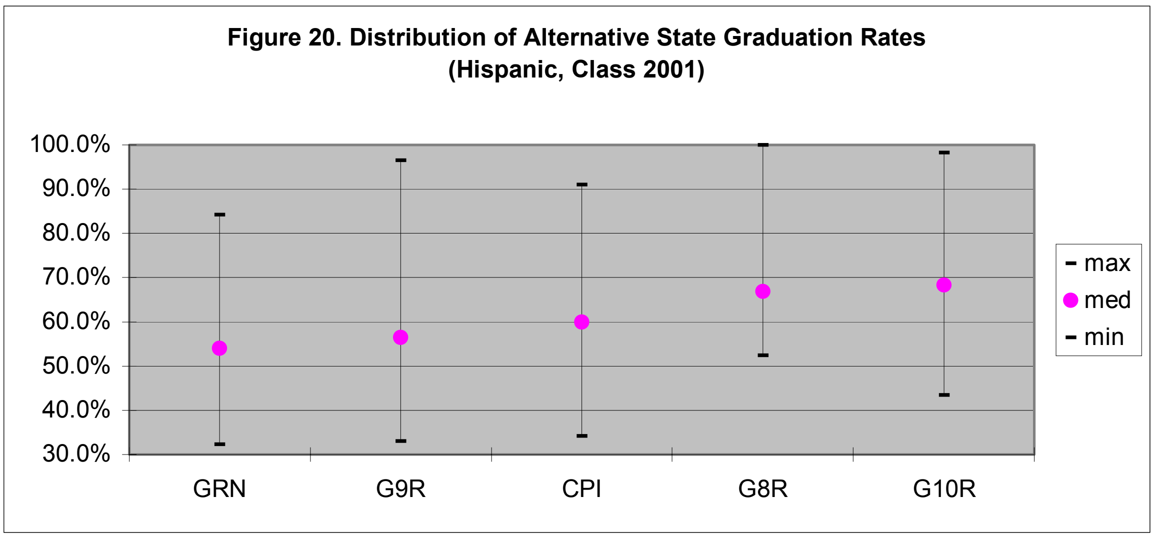


Figure 20. Distribution of Alternative State Graduation Rates
(Hispanic, Class 2001)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
GRN
G9R
CPI
G8R
G10R
max
med
min

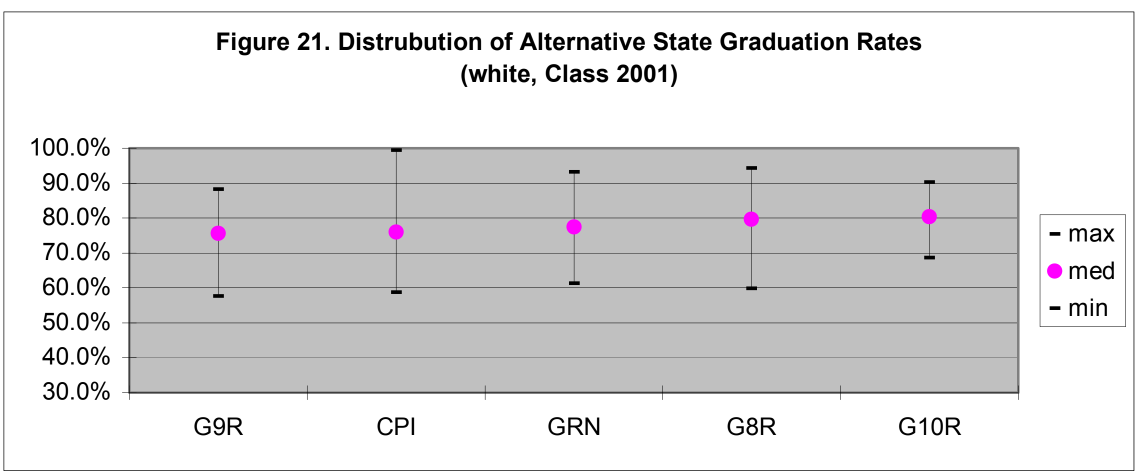
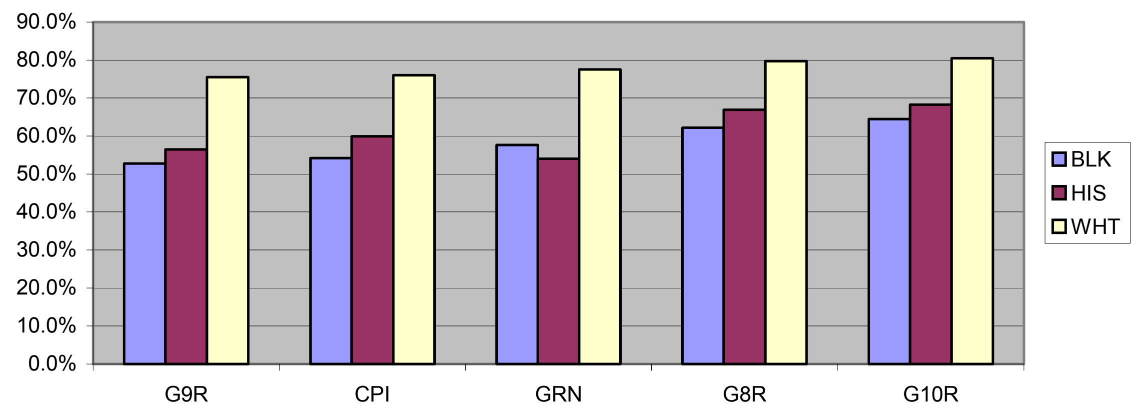


Figure 21. Distrubution of Alternative State Graduation Rates
(white, Class 2001)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
G9R
CPI
GRN
G8R
G10R
max
med
min

Figure 22 provides yet another angle to examine the alternative graduation rate estimates within state by race. Earlier observations based on Figures 19 to 21 are also salient in Figure 22: (1) White rates are consistently higher than the black or Hispanic rates and (2) the difference between alternative state median rates is smaller for the white subpopulation than for the black or Hispanic subpopulation. In addition, Figure 22 shows that, in terms of the state median estimates by race, the simple grade 9 method reveals larger gaps between the white and the black/Hispanic student population than the simple grade 8 method or the simple grade 10 method. This suggests that not only are race estimates affected by the method used, but also are the magnitudes of the racial gaps in high school graduation rates. The relatively larger racial gap revealed by the simple grade 9 rate is a reflection of larger grade 9 bulges for the black and Hispanic subpopulations than for the white. That is, black and Hispanic students are more likely to be retained in grade 9 than their white peers.

Figure 22. State Median Estimates by Race (Class 2001)



Next, Table 16 summarizes the race results for individual states for the class of 2001 by listing the maximum, mean, and minimum estimates. The states are sorted by the mean estimates from low to high. For example, New York state has the lowest mean estimates for black and Hispanic students (45.4% and 41.6%), while the mean estimate for the white population is much higher (77.2%).

Table 16
Descriptive Statistics for Individual State Rates by Race (Class 2001)

	Black				Hispanic				White		
	Min	Mean	Max		Min	Mean	Max		Min	Mean	Max
NY	36.8%	45.4%	56.9%	NY	33.1%	41.6%	52.5%	FL	58.7%	61.3%	68.7%
WI	37.8%	45.9%	53.9%	GA	32.3%	48.0%	59.9%	GA	58.8%	62.7%	71.0%
GA	40.3%	47.4%	55.3%	DE	42.1%	50.1%	57.5%	HI	57.8%	63.9%	70.3%
FL	40.9%	48.9%	56.7%	NV	36.3%	51.0%	62.9%	MS	60.9%	64.4%	71.6%
HI	37.2%	49.9%	60.7%	MA	34.2%	52.7%	65.9%	KY	66.3%	67.0%	76.9%
IN	43.8%	50.9%	58.0%	CO	47.4%	52.8%	62.0%	AL	62.8%	68.0%	73.5%
IL	44.5%	50.9%	57.8%	OR	42.6%	53.6%	60.6%	AK	63.9%	68.1%	74.4%
OH	42.5%	51.9%	61.8%	CT	45.6%	53.7%	65.0%	WA	67.2%	68.6%	73.2%
KY	45.4%	52.3%	61.5%	PA	46.2%	54.9%	64.8%	OR	67.4%	70.1%	73.0%
MN	42.7%	53.5%	60.8%	WA	48.2%	55.4%	61.9%	LA	65.2%	71.7%	77.1%
NV	40.7%	53.8%	61.8%	FL	47.8%	56.6%	66.8%	NV	62.4%	72.2%	74.1%
OR	50.1%	55.3%	60.0%	MI	50.2%	58.5%	68.8%	NC	69.2%	72.5%	76.5%
MI	46.7%	55.4%	64.0%	KS	58.7%	59.6%	60.6%	DE	69.8%	74.3%	77.8%
WA	52.5%	55.8%	61.1%	AL	44.3%	59.6%	70.4%	RI	72.6%	74.6%	80.4%
AL	50.1%	57.3%	64.1%	MN	46.9%	60.0%	68.5%	WY	74.9%	75.3%	79.2%
CO	53.0%	57.6%	63.2%	IL	53.4%	60.1%	67.8%	NM	69.2%	75.4%	81.6%
NE	50.6%	57.9%	69.4%	CA	55.7%	60.5%	68.5%	IN	71.3%	75.5%	78.7%
DE	50.7%	57.9%	64.9%	HI	51.7%	60.9%	65.3%	ME	73.7%	75.9%	82.3%
MS	52.8%	57.9%	64.9%	TX	51.4%	61.2%	73.9%	CO	74.1%	75.9%	80.2%
NC	53.0%	59.5%	64.9%	WY	55.0%	61.8%	66.8%	OK	73.7%	76.1%	80.0%
LA	50.3%	59.5%	65.0%	NM	54.8%	62.2%	72.1%	WV	71.1%	76.5%	84.7%
MO	53.9%	59.6%	66.9%	WI	54.7%	62.2%	70.6%	AR	74.5%	76.6%	79.1%
PA	49.9%	59.7%	69.7%	OH	54.7%	63.0%	70.3%	TX	72.1%	76.7%	82.8%
CT	54.2%	60.1%	68.0%	AK	55.9%	64.4%	69.8%	NY	75.5%	77.2%	81.2%
IA	56.1%	60.6%	64.4%	RI	55.7%	65.5%	73.8%	MO	75.9%	77.4%	80.7%
CA	56.7%	60.6%	67.7%	IA	54.0%	65.5%	77.1%	VA	75.5%	77.4%	85.1%
AK	55.7%	62.4%	67.8%	IN	59.2%	65.9%	73.7%	CA	76.7%	77.5%	82.5%
KS	61.2%	62.5%	64.1%	NE	56.9%	66.5%	76.7%	MI	75.8%	78.0%	82.3%
TX	54.9%	64.1%	75.3%	NC	60.0%	67.1%	71.5%	MA	76.3%	79.4%	84.2%
OK	60.0%	65.2%	70.7%	UT	53.8%	67.4%	73.9%	MD	78.2%	79.5%	85.4%
WV	63.3%	66.5%	70.0%	OK	59.8%	71.3%	80.3%	CT	76.8%	81.4%	85.1%
MA	51.7%	67.6%	80.9%	AR	52.3%	74.2%	88.3%	KS	81.6%	82.0%	82.6%
AR	66.1%	67.9%	69.4%	VA	59.0%	76.0%	94.2%	OH	76.7%	82.3%	83.6%
UT	56.5%	68.1%	74.2%	MD	61.9%	76.4%	92.6%	MT	80.2%	83.5%	84.7%
VA	62.7%	68.2%	76.5%	LA	64.9%	76.6%	86.5%	IL	82.0%	83.6%	87.0%
MD	64.0%	70.1%	78.6%	MO	65.6%	79.5%	92.8%	UT	84.3%	84.5%	90.4%
NM	62.0%	71.5%	88.8%	KY	77.5%	81.4%	84.4%	PA	81.9%	84.5%	86.2%
RI	62.5%	73.4%	85.2%	MT	84.3%	94.0%	100.0%	MN	84.2%	85.5%	88.3%
AZ	n/a	n/a	n/a	AZ	n/a	n/a	n/a	IA	83.2%	85.7%	87.4%
ID	n/a	n/a	n/a	ID	n/a	n/a	n/a	SD	83.1%	86.3%	88.2%
NH	n/a	n/a	n/a	ME	n/a	n/a	n/a	WI	84.4%	86.8%	94.4%
NJ	n/a	n/a	n/a	MS	n/a	n/a	n/a	NE	83.7%	87.6%	88.7%
SC	n/a	n/a	n/a	ND	n/a	n/a	n/a	ND	86.0%	89.1%	93.2%
TN	n/a	n/a	n/a	NH	n/a	n/a	n/a	NJ	99.5%	99.5%	99.5%

Figures 23 to 25 are graphic presentations of the information in Table 16. Each line segment in the figure represents the range of graduation rate estimates for class 2001 for a designated group in a given state, with the dot in the middle representing the mean estimates. The states are sorted by the mean estimates from low to high. Again, two observations are salient from these figures. First, the average estimates for the white student population within states (ranging from 61.3% in Florida to 95.5% in New Jersey) are much higher than the mean estimates for both the black student population (ranging from 45.4% in New York to 73.4% in Rhode Island) and the Hispanic student population (ranging from 41.6% in New York to 94.0% in Montana). Second, the ranges of alternative race rates, indicated by the length of the bars, are relatively small for the white student population compared to the ranges for the black and Hispanic student population. This suggests a larger method effect on the graduation rate estimates for the black and Hispanic student population than for the white within individual states.

Figure 23. Distribution of Individual State Rates (black: Class 2001)

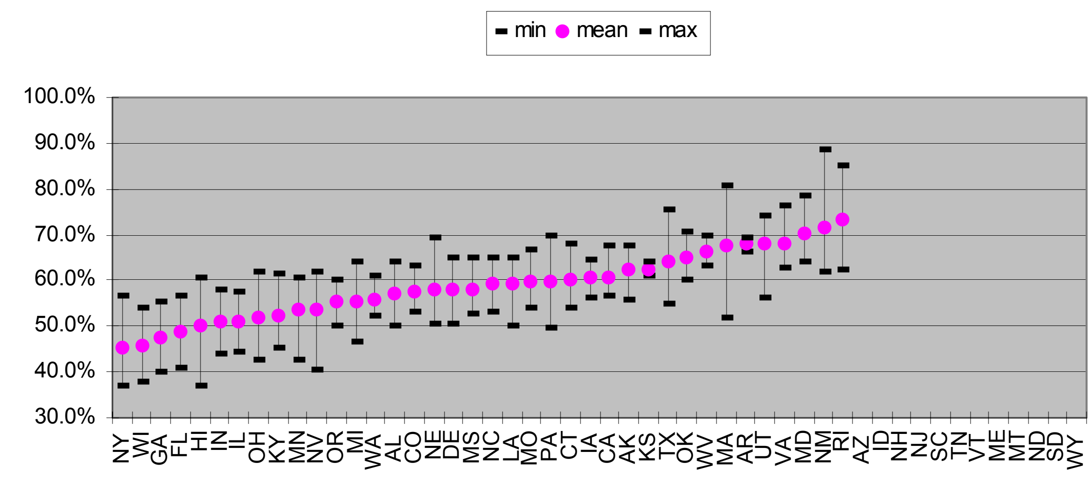
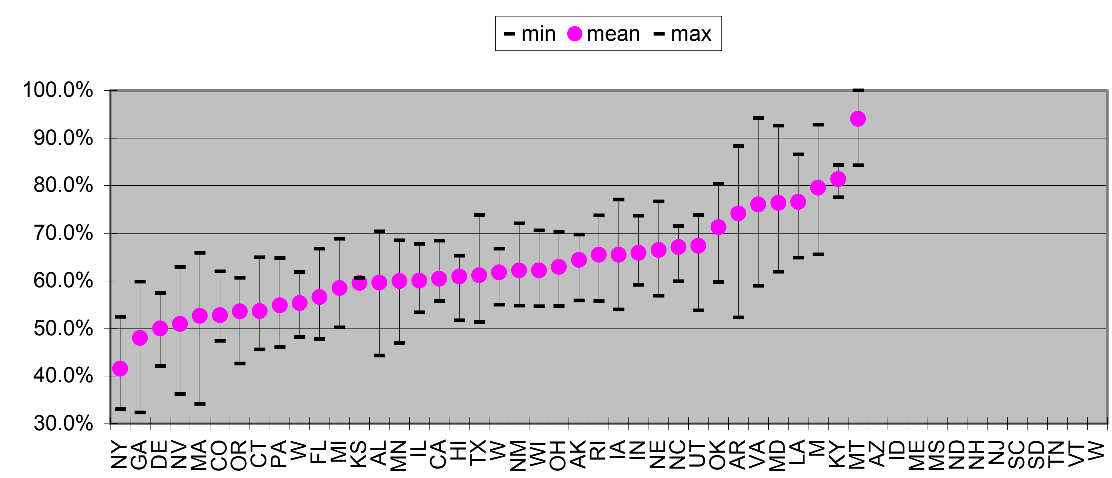
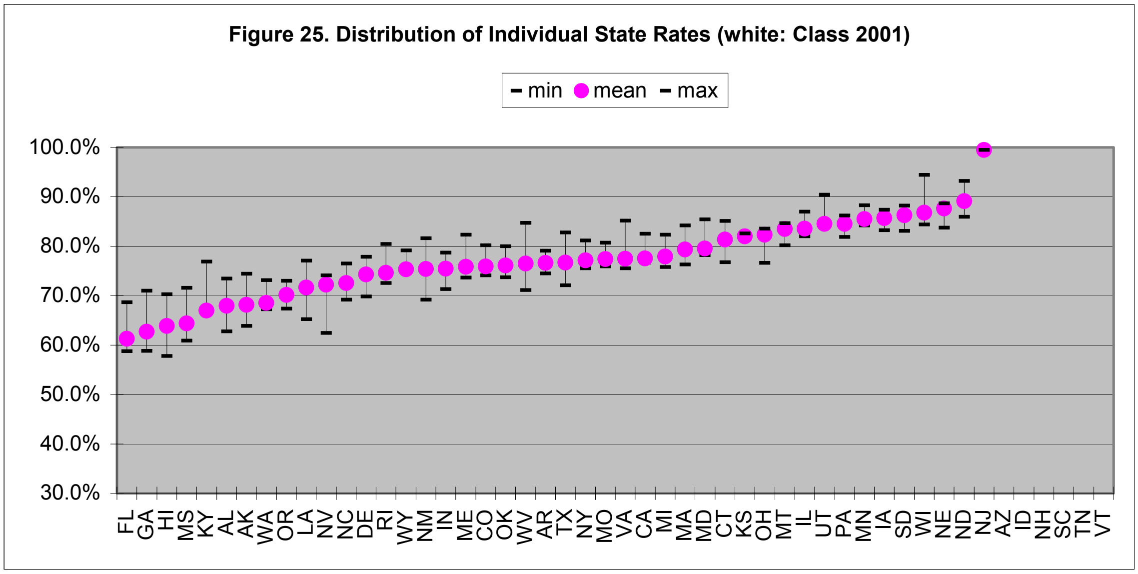


Figure 24. Distribution of Individual State Rates (Hispanic: Class 2001)





Correlations

Up to this point, the race level results have focused on the differences between alternative estimates. Next, correlation coefficients are examined to determine the similarity of race results from alternative methods. Table 17 lists the correlation coefficients between state graduation rate estimates (all races) for the class of 2001 derived from the five alternative methods. All correlation coefficients are high, except the correlation between CPI and G8R is moderate (.794). This suggests that the five alternative methods yield similar state graduation rate estimates for the class of 2001.

Table 17
Correlations between Alternative State Rates (All Races: Class 2001)

	ALL_G8R	ALL_G9R	ALL_G10R	ALL_GRN
ALL_G9R	.925** (N=50)			
ALL_G10R	.910** (N=50)	.915** (N=50)		
ALL_GRN	.830** (N=50)	.883** (N=50)	.872** (N=50)	
ALL_CPI	.794** (N=50)	.864** (N=50)	.850** (N=50)	.841** (N=50)

** Correlation is significant at the 0.01 level (2-tailed).

The next three tables list the correlation coefficients between graduation rate estimates for the three major ethnic groups within state. The correlation coefficients between alternative estimates for the white population are high, ranging from .854 to .938. This suggests the five alternative methods yield fairly consistent graduation rate estimates for the white sub-population within states for the class of 2001.

Table 18
Correlations between Alternative State Rates (white: Class 2001)

	WHT_G8R	WHT_G9R	WHT_G10R	WHT_GRN
WHT_G9R	.936** (N=40)			
WHT_G10R	.896** (N=42)	.927** (N=41)		
WHT_GRN	.854** (N=40)	.893** (N=40)	.867** (N=40)	
WHT_CPI	.869** (N=42)	.938** (N=41)	.911** (N=43)	.886** (N=40)

** Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficients between alternative estimates for the Hispanic population range from .664 to .904 (moderate to high). The correlation coefficients between alternative estimates for the black population are moderate (.60 to .80) except for the one low coefficient (.501 between the CPI rate and simple grade 8 rate) and one high coefficient (.814 between the Greene rate and the simple grade 10 rate). This means that, for the class of 2001, the alternative graduation rate estimates for the black and Hispanic sub-population are much less consistent than the alternative estimates for white sub-population.

Table 19
Correlations between Alternative State Rates (Hispanic: Class 2001)

	HIS_G8R	HIS_G9R	HIS_G10R	HIS_GRN
HIS_G9R	.904** (N=35)			
HIS_G10R	.864** (N=37)	.869** (N=36)		
HIS_GRN	.664** (N=35)	.683** (N=35)	.767** (N=35)	
HIS_CPI	.771** (N=36)	.796** (N=35)	.797** (N=37)	.791** (N=34)

** Correlation is significant at the 0.01 level (2-tailed).

Table 20
Correlations between Alternative State Rates (black: Class 2001)

	BLK_G8R	BLK_G9R	BLK_G10R	BLK_GRN
BLK_G9R	.791** (N=35)			
BLK_G10R	.766** (N=37)	.797** (N=36)		
BLK_GRN	.690** (N=35)	.755** (N=35)	.814** (N=35)	
BLK_CPI	.501** (N=37)	.739** (N=36)	.680** (N=38)	.636** (N=35)

** Correlation is significant at the 0.01 level (2-tailed).

To verify the observations at the race level, the same procedures are applied to race results for the Class of 1997. The resulting pattern is consistent with the pattern for the Class of 2001. In summary, although alternative estimates are moderately to highly correlated at the state level both for the total student population and for the white subpopulation, the correlations are lower for alternative estimates for the black and the Hispanic subpopulation. Racial gaps are obvious in the graduation rate between the white and black/Hispanic subpopulation regardless of the method used for estimation. However, the graduation rate estimates by race are definitely affected by the method used, as well as the magnitudes of the racial gaps in high school graduation rates. For the class of 1997 and 2001, the simple grade 9 rate is the most conservative and reveals relatively larger racial gaps than the other methods.

Summary and Discussion

The high school graduation rate is an important indicator of school effectiveness, and has appeared repeatedly in the federal legislations since the 1960's. The *No Child Left Behind Act* of 2001 brought increased attention to the high school gradation rate by mandating that states report public school graduation rates for the states' general student population, as well as for subpopulations disaggregated by major demographic characteristics.

Currently, two major data sources are available for estimating the high school graduation rate. The Current Population Survey (CPS) targets the "civilian noninstitutional population" who are 15 years of age or older and collects information from a state-based probability sample of 50,000-60,000 households. Various measures of high school completion and dropout have been reported based on CPS data. However, there are a number of problems with these CPS based measures, and CPS based measures are not good options to report the public high school graduation rate as required by the *No Child Left Behind Act*.

The Common Core of Data (CCD) has been a program of the U.S. Department of Education's National Center for Education Statistics (NCES) since 1986. The CCD program conducts annual census surveys of all public elementary and secondary schools and school districts in the country. The CCD data are based on administrative records collected for each academic year by local education agencies. The accuracy of CCD data depends heavily on the quality of record keeping in local districts nationwide. NCES reports a four-year high school completion rate, which is the number of graduates divided by the sum of graduates and reported dropouts over four academic years. However, evidence has been gathering that graduation rates based on dropout statistics are often times inflated because of under reporting of dropouts.

Alternative measures of the high school graduation rate based on the CCD grade enrollment and graduate counts have been devised and reported. These measures fall into two categories--simple graduation rates and adjusted graduation rates. The simple graduation rates are computed by dividing the number of graduates in a certain year by the cohort enrollment in an earlier grade. Conceptually straightforward and easy to compute, the simple graduation rates are often criticized for not accounting for various changes as a cohort progresses through high school, such as student migration and grade retention. A number of adjusted graduation rate measures have been devised, such as the Greene method, the CPI method and the Warren method, to address these issues in various ways.

In this study, these methods are applied to the CCD enrollment and graduation data at the national level, the state level and to major ethnic groups within states to compute alternative graduation rates. Statistical analyses have been conducted to examine the relationship between results based on these alternative methods in order to examine these methods empirically with a focus on the association and differences between alternative estimates.

Summary of findings

The national graduation rate has been decreasing slightly from 1973 to 2001, regardless of the estimation method. Despite its conceptual advantages, the Greene method is empirically unstable, especially during the late 70's and early 90's. In contrast, national results from the other five methods are much more stable over the past three decades. The correlation coefficients between the alternative national estimates are all statistically significant and positive. The correlation structure matches the observation of the national graduation rate trend. While the correlation coefficients between the Greene estimates and the other estimates are only moderate to low, the correlations between other alternative estimates are high to moderate. Despite the positive correlation between alternative estimates, differences between these estimates are substantial at times. The simple grade 8 to graduation rates and the simple grade 10 to graduation rates are close to each other, yet consistently higher than the simple grade 9 to graduation rates, the CPI rates and the Warren rates. The difference between the simple grade 8 (or grade 10) rate and the simple grade 9 rate has been increasing since the 1970's, and reaches almost one fifth of one standard deviation for the class of 2000, which is substantial.

The state level analysis examined alternative graduation rate estimates for the 50 states for high school classes graduating during 1992 to 2001. Consistent with the national pattern, a decline in the graduation rate is observed in over two thirds of the states. Of the 50 states, 34 show an overall pattern of declining graduation rates from 1992 to 2001, while only two states (Texas and Louisiana) show slight increases in graduation rates over the same period. In 32 states, alternative methods yield similar graduation rate trends from 1992 to 2001, although the actual estimates may differ. Meanwhile, in 10 states, the Greene method yielded trends inconsistent with the trends from the other methods, and in 11 states the CPI method yielded inconsistent trends. There is a consistent pattern across states which shows that more students are enrolled in Grade 9 than in Grade 8 the previous year. Accordingly, the differences between simple grade 8 (and grade 10) to graduation rate and simple grade 9 rate are observed in almost all states; however, such differences vary in magnitude from state to state.

Overall the six alternative methods yield consistent state level estimates for the class of 2000. For the class of 2000, the correlation coefficients (Pearson's r) between alternative state estimates are high, and so are the correlation coefficients (Spearman's rho) between alternative state rankings. Despite the high correlations, the actual values of the alternative estimates differ substantially. For the class of 2000, the simple grade 9 method yielded the most conservative estimates with 17 estimates (or one third of the states) falling below 66.6% and 6 estimates above 80%. In contrast, the simple grade 10 method yielded the most liberal state graduation rate estimates with only six estimates below 66.6% and 17 estimates above 80%.

Alternative graduation rate methods make a larger difference for states with relatively poor graduation rates; whereas, the method effects are smaller for states with higher graduation rates. For individual states, the range of alternative state estimates varies. For the class of 2000, 27 out of the 50 states have a range of less than 10%, 19 have a range between 10 and 15%, and the remaining four states have a range of over 15%. An inverse relationship is apparent between mean state estimates and the range of alternative state estimates. Such an inverse relationship is confirmed by the state estimates for the class of 1992.

Graduation rates were also computed for major ethnic groups within state for the class of 1997 and the class of 2001. Racial gaps between the white and black/Hispanic subpopulation are obvious in the graduation rate regardless of the method used for estimation. The effect of method is inconsistent across ethnic groups, and the choice of method makes a larger difference in the graduation rate estimates for minority groups. Alternative estimates are moderately to highly correlated for the state total population and for the white subpopulation; however, the correlations are lower between alternative estimates for the black and the Hispanic subpopulation. The graduation rate estimates by race are definitely affected by the method used, as well as the magnitudes of the racial gaps in high school graduation rates. The simple grade 9 rate is the most conservative and reveals relatively larger racial gaps than other methods. These above findings of the current study suggest two major implications.

Counting Graduates is No Easy Task

It is obvious to the reader that counting the graduates is no easy task. The major obstacle is the lack of databases which track individual students throughout their entire school careers. Without such databases, it is not possible to conduct true cohort analyses by following the same students from school entry to graduation and to compute the *true* high school graduation rate. The alternative methods applied in the current study are quasi-cohort approaches, which are based on group counts on an annual basis. With such data, it is probable that the group we counted in year one is not the exact same group we count again in year two, despite the fact that the vast majority of the students included in both counts are the same.

The National Center for Educational Accountability (NCEA) conducted a survey of statewide data-collection systems, by focusing on a list of essential elements (Dougherty, 2003; National Center for Educational Accountability, 2003). It found only 23 states use a statewide student identifier that assigns each student a unique statewide student number. The survey results, however, did not mention the history of state data-collection systems; hence it is unclear how far back these data systems are capable of tracking students in their school careers. For other states that plan to establish longitudinal student tracking systems, it will undoubtedly be years before they can fully benefit from their new statewide data collection systems.

It is important to acknowledge that a well-designed data system does not guarantee accurate data collection. A recent Houston case on the undercount of dropouts exemplifies this perfectly. According to the NCEA survey, Texas has the best comprehensive data system to date, which comprises all the key elements identified by the organization (National Center for Educational Accountability, 2003). However, a recent investigation by the Texas Education Agency reviewed 5,458 student files at 16 Houston schools and found nearly 3,000 students left school in the 2000-01 school year with incomplete files. These students should have been counted as dropouts but were not. For one thing, Texas uses the "leaver codes" to explain why a student was no longer enrolled by identifying 30 different categories, 20 of which exempt students from being counted as dropouts. Such a large number of categories is cumbersome and confusing and requires a lot more school resources (i.e. personnel and time) to keep records straight than if a simpler system was used. Of the 16 schools, the investigator found all but one school had either assigned students the wrong leaver codes or had failed to back up their choices of codes with proper documents (Archer, 2003a; Galley, 2003a, 2003b).

As the Houston case exemplifies, there is a trade-off between comprehensive coverage and feasibility, which is common to all social policies. If a policy is not comprehensive enough, certain individuals will fall through the cracks without being identified. On the other hand, when a policy exhausts all possible scenarios, it becomes restrictive and extremely difficult to implement. This certainly applies to the design of state data-collection systems. No data system is perfect and guarantees error-free results. Therefore the complexity in computing the high school graduation rate is likely to remain, and we have to live with the less than perfect data.

Complexity Does Not Guarantee Validity

Researchers have devised different approaches trying to reach a close estimation of the high school graduation rate based on different assumptions. In the current study, we reviewed the conceptual advantages and disadvantages of six methods and also compared the empirical results from the six methods. Although we have no "true" values against which to compare the alternative estimates, we can examine the alternative estimates and compare them against each other to determine the relative strengths.

Of the six methods, three simply compare the number of graduates in a given year to enrollment at an earlier grade level, two methods (Greene and Warren) incorporate adjustments to either the numerator or the denominator, while the CPI method conceptualizes the graduation rate as the product of promotion rates between every two adjacent high school grade levels and final graduation. A critical review of the CPI method identified several conceptual and procedural flaws, and the advantages of the method claimed by its author do not hold up under scrutiny. Empirically, the state trends based on CPI state rates are less consistent compared with the simple rates.

The Greene method incorporates adjustments to the grade 9 enrollment as the denominator so as to address the issue of grade 9 retention and student population change over the four years of high school. Despite its conceptual advantage, the empirical results from this study indicate that the Greene estimates are not reliable from year to year. Analysis of national graduation rate estimates from 1972 to 2001 indicates that the Greene estimates deviate substantially from estimates based on other methods during the 1980's. In 12 states (see Table 9), the Greene rates present trends inconsistent with results from the other methods. In the state of Oregon, for example, the Greene estimates for the class of 1992 is 71.6%, and shoots up by over 10% to 82.8% for the class of 1993, and then plummets even more to 65.2% for the class of 1994. Such dramatic changes in the state graduation rate in three adjacent years are hard to make sense of, and raise questions about the validity of the Greene method for producing accurate high school graduation rate estimates.

Warren's measure for the graduation rate incorporates adjustment to the CCD reported numbers of graduates and grade 9 enrollment based on CPS estimates. The national and state Warren rates for classes of 1992 to 2001 are found reliable and consistent, and very close to the simple grade 9 estimates. However, the Warren method is operationally much more complicated than the simple grade 9 to graduation rate.

Given the empirical findings from this study, there is no evidence that the conceptually more complex methods yield more accurate or valid graduation rate estimates than the simpler methods. Hence the recommendation is to use the simple graduation rate to measure the high school graduation rate required by the *No Child Left Behind Act* until better measures are devised. This study shows that the simple graduation rates are both conceptually and procedurally straightforward. These features are important for a measure used for accountability purposes, which needs to be simple enough for the various stakeholders to understand and for authorities and the general public to monitor. Moreover, the simple graduation method yields reliable trends over time, and the simple grade 9 rate yields similar results to the much more complicated Warren method, suggesting that the additional complexity is unnecessary.

Of the simple graduation rates, the simple grade 8 (or grade 10) to graduation rate is consistently higher than the grade 9 to graduation rate. In addition, the difference between them has been increasing, indicating an increasing grade 9 bulge across the nation. In this sense, the simple grade 8 (or grade 10) to graduation rate is likely to be more accurate than the simple grade 9 rate. In addition, the grade 8 rate is preferable to the grade 10 rate because the grade 10 enrollment is confounded by retention at grade 9 as well as attrition between grade 9 and 10. However, the simple grade 8 to graduation rate is not applicable at school level since high schools usually accept 9^{th} graders from different middle schools.

Although a more conservative measure, the simple grade 9 to graduation rate is conceptually the most straightforward and can be used at any administrative level. Moreover, the method also discloses larger gaps between the white and the black/Hispanic subpopulations. Given that one goal of the *No Child Left Behind Act* is to identify low-performing schools and move every child forward to meet the standards, it is justifiable to err on the conservative side by magnifying problem areas than going the other direction. The conservative estimates of simple grade 9 to graduation rate bring to light the widespread practice of grade 9 retention, which is of questionable educational value, yet costly to society and to individual students. By retaining low-performing students at grade 9, schools may delay these students from taking state mandated tests and artificially inflate school test results. However, research shows that retention does not help low-achieving students to catch up with their peers (Jimerson, 2001; Nagaoka & Roderick, 2004). Moreover, retained students are at higher risk of dropping out of high school (Shepard & Smith, 1989; Jimerson, Anderson, & Whipple, 2002). The adoption of the simple grade 9 to graduation method is likely to counterbalance such practice. Requiring schools to report simple grade 9 to graduation rate in addition to test scores will encourage schools to promote as many students to graduation as possible instead of leaving low-achieving students behind.

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Appendix I

Reporting Categories for High School Graduates/Completers

One clarification is necessary on the change of reporting categories for high school graduates/completers. CCD surveys are conducted annually with reference to school years instead of the calendar year. In this study, the CCD survey for a school year (e.g., 1998-99) is often referred to as CCD followed by the survey year, which is the beginning of the school year (e.g., CCD for the 1998-99 school year is referred to as CCD 1998). In each CCD file, while the grade enrollment data are reported for the current school year being surveyed, the number of high school graduates and completers are reported for the previous school year. For example, in CCD 1998 (i.e., CCD for the 1998-1999 school year), the grade enrollments are reported for 1998-1999 as of fall 1998, while the graduate/completer counts are for the 1997-98 school year as of spring 1998.

High school graduate/completer counts at state level are available in CCD files for the 1986-2001 survey years. There has been one change in the reporting strategy since CCD 1997. Up to CCD 1996, four categories of high school completers were reported in the CCD state non-fiscal data files:[13] regular high school diploma completers (REGDIP), other diploma recipients (OTHDIP)[14], high school equivalency recipients (EQUIV) and other high school completers (OTHCOM). According to the documentation for the State Nonfiscal Data Survey for the 1996-97 school year (NCES, n.d.), the definitions for the four categories are as follows:

- Regular Diploma Recipient: A graduate of regular day school who received a high school diploma during the previous school year or subsequent summer school. The diploma is based upon completion of high school requirements through traditional means.
- Other Diploma Recipient: A student who received a diploma by completing a program other than one in a regular school program during the previous school year or subsequent summer.
- Other High School Completer: A student who has received a certificate of attendance or other certificate of completion in lieu of a diploma during the previous school year and subsequent summer school.
- High School Equivalency Recipient: An individual, age 19 years or younger, who received a high school equivalency certificate during the previous school year or subsequent summer.

Since CCD 1997, other diploma recipients are no longer reported separately but are combined with regular diploma recipients as one category[15] (NCES, n.d.). Therefore, state non-fiscal files reported three categories of high school completers for the 1997-2001 survey years.

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[13] This is based on state Excel files downloaded from http://www.nces.ed.gov/ccd/stnfis.asp. The layout of the text files is slightly different.

[14] For the 1986 survey year, the second category is OTHPRG, which refers to completers of other programs such as GED adult evening school, etc. (layout file for 1986-87 st861b.dat retrieved from http://www.nces.ed.gov/ccd/data/txt/stNfis86lay.txt)

[15] The state nonfiscal files continue to label this new category as REGDIP although TOTDPL (used in district files) seems to be more appropriate.

High school graduate/completer counts are not reported by CCD at the national level (namely, the 50 states plus the District of Columbia) but are available from the DES back to the 1968-69 school year. The DES counts include "graduates of regular day school programs, but exclude graduates of other programs and persons receiving high school equivalency certificates" (Snyder & Hoffman, 2003, p. 128). Since the comparison of DES and CCD data at state level identified very few discrepancies from 1986-87 to 2001-02, it is reasonable to speculate that the DES reporting on numbers of graduates experienced the same change as in the CCD State Nonfiscal Data Survey. That is to say, only regular diploma recipients are reported as graduates in DES before the class of 1997, while both regular diploma and other diploma recipients are counted as graduates in DES since the class of 1997.

In order to compute alternative graduation rates, the current study uses the DES reported high school graduates at the national level. For state graduation rates, the REGDIP counts are used from CCD survey years 1986 to 2001.

Table A1
CCD Reporting Categories for High School Graduates/Completers

	Year	CCD Reported	Current Study Uses
National	None	None	DES data
State	1986-1996	4 categories: REGDIP, OTHDIP, EQUIV, OTHCOM	REGDIP
	1997-2001	3 categories: REGDIP[1], EQUIV, OTHCOM	REGDIP[1]

1. Sum of REGDIP and OTHDIP from previous years.

Appendix II
State Level Data: DES vs. CCD

Enrollment and graduation data from both CCD and DES were compared at state level for the 1986-87 to 2001-02 school years. Only nine discrepancies (less than .01% of the data entries) were found out of over 10,000 data entries, and the magnitudes of most discrepancies were within 5% of the observed value reported in CCD files. Three large discrepancies (either with percent difference larger than 5% or with absolute differences over 1000) were identified from these comparisons (see Table 3-2). Based on the data from adjacent years, the current study resolves the discrepancies by adopting the DES reported data for all three cases.

Table A2
Discrepancies between CCD & DES Data

State	Academic Year	Variable	Reported in CCD	Reported in DES	Used in Current Study
CA	1996-97	Graduates	311,818[1]	269,071[2]	269,071
TX	1992-93	Graduates	162,270[1]	160,546[3]	160,546
VT	1992-93	Graduates	5,697[1]	5,215[3]	5,215

1. CCD state non-fiscal data files retrieved from http://www.nces.ed.gov/ccd/stnfis.asp
2. Digest of Education Statistics 2000, Table 102.
3. Digest of Education Statistics 1997, Table 99.

Appendix III

The Effect of Enrollment Change on the Simple Graduation Rate

The following example of a single cohort[16] will help to illustrate the effect of grade enrollment change rate on graduation rate estimates.

In general, students who were in grade 8 during 1996-1997 should graduate in the spring of 2001. Table A-1 shows that in the fall of 1996, a total of 3,403 thousand students enrolled students in grade 8 nationwide; one year later the enrollment in grade 9 is 3,819 thousand, 12.2% more than in grade 8 in 1996. In 1998, U.S. public schools enrolled 3,382 thousand students in grade 10, which is 11.4% less than in grade 9 the previous year. Therefore, for the class of 2001 in the U.S., the simple grade 8 graduation rate is 75.5%, the simple grade 9 graduation rate is 67.2% and the simple grade 10 graduation rate is 75.9%. Although the grade enrollment change rates (i.e. the grade 9 bulge rate and the grade 10 attrition rate) are over 10%, the difference between the simple grade 9 graduation rate and simple grade 8 graduation rate (or simple grade 10 graduation rate) is substantial in this case, yet almost one third smaller than the grade enrollment change rate.

Table A3
The Effect of Grade Enrollment Change on National Graduation Rate
(Number in thousands)

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
G8	3,403				
G9		3,819			
G10			3,382		
Grads					2,568
(G9-G8)/G8					12.2%
(G10-G9)/G9					-11.4%
Grads/G8					75.5%
Grads/G9					67.2%
Grads/G10					75.9%
G8R-G9R					8.3%
G10R-G9R					8.7%
G10R-G8R					0.4%

The following section illustrates the effect of grade 9 bulge and grade 10 attrition on the difference between three simple graduation rate estimates in more generalized terms. Suppose the grade 8 enrollment for a hypothetical cohort of students is N in year 1. Assume there are ($100xR_b$)% more students in grade 9 in year 2 than in grade 8 the previous year, then the grade 9 enrollment for the reference cohort is $(1+R_b)N$. Moreover, assume there are ($100xR_a$)% less students in grade 10 in year 3 than in grade 9 the previous year, then the grade 10 enrollment for the reference cohort equals

[16] This is not a cohort analysis in the strictest sense since students may join or leave a cohort as time goes on, and it is not possible to track individual students due to the nature of aggregate data.

$(1-R_a)(1+R_b)N$. Suppose the number of students graduate in year 5 is G, therefore the three simple graduation rates and the difference between these rates can be expressed as in the lower part of Table A-2.

Table A4
The Effect of Grade Enrollment Change on Graduation Rate—General Case

	Year 1	Year 2	Year 3	Year 4	Year 5
G8	N				
G9		$(1+R_b)N$			
G10			$(1-R_a)(1+R_b)N$		
Grads					G
(G9-G8)/G8					$(100xR_b)\%$
(G10-G9)/G9					$(100xR_a)\%$
Grads/G8					G/N
Grads/G9					$G/[(1+R_b)N]$
Grads/G10					$G/[(1-R_a)(1+R_b)N]$
Grads/G8-Grads/G9					$(G/N)[R_b/(1+R_b)]$
Grads/G10-Grads/G9					$(G/N)[R_a/(1-R_a)(1+R_b)]$
Grads/G10- Grads/G8					$(G/N)[(R_a-R_b+R_aR_b)/ (1-R_a)(1+R_b)]$

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