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2021 Multi-State Analysis of Trends in CTE

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A Multi-State Analysis of Trends in Career and Technical Education

Massachusetts, Michigan, Tennessee, and Washington

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Context

Career and Technical Education (CTE) is the most rapidly-evolving and in-demand facet of education in the United States today, and it is championed by policymakers and politicians of all stripes. It is also one of the most understudied. In America's secondary schools, the academic landscape has shifted from a model where high schools focus on academic preparation—ostensibly for college—to a model preparing students to be college and career ready. As a result, CTE enrollment is near an all-time high, accompanied by a dramatic rise in the number and diversity of programs, new and varied delivery models, innovations in credentialing, dual enrollment programs, and work-based learning experiences.

This Report

This is the second annual report from researchers at the Career & Technical Education Policy Exchange (CTEx)[1] to study how state contexts affect participation in high school CTE programs. We provide the latest-available CTE participation data for Massachusetts (MA), Michigan (MI), and Tennessee (TN),[2] and we add trends in Washington (WA), which is a new CTEx partner state. We utilize these data to learn how state contexts inform our understanding of what drives participation in CTE programs and how it might impact subsequent educational outcomes for high school students.

Key Findings

- All states are required to report relevant CTE statistics under the federal Perkins Act. Yet, guidelines are sufficiently broad such that key definitions (e.g., program concentrators and completers) are not uniform across states. Because of this variation, any multi-state CTE analysis has limitations. We recommend considering unified definitions across states in future federal policy.
- According to definitions used in this report, almost 50% of TN students, 40% of MI students, over 25% of WA students, and roughly 20% of MA students concentrate in or complete a CTE program of study in high school.

- We find that while White students are more likely to concentrate in a CTE program of study, these differences are largely driven by differences across schools. When we compare students within schools, much, and in some cases, all of the race and ethnicity differences in concentration rates are eliminated.
- In two states (MI and TN), we find students with identified disabilities are less likely to concentrate in a CTE program, while in MA and WA they can be more likely—depending on the type of disability.
- We also show students reaching (at least) concentrator status are more likely to graduate high school and to enroll in two-year colleges, while they are less likely to enroll in four-year schools. This high school graduation advantage is particularly pronounced for students with identified disabilities.
- We find wide variation both across and within states in concentrator rates and outcomes for concentrators and non-concentrators. This finding suggests that state-specific contexts play an important role in studying CTE, which is uncovered by access to statewide longitudinal databases.

Overview and Purpose

This is the second report by researchers at the Career & Technical Education Policy Exchange (CTEx) that studies how state contexts affect participation in high school career and technical education (CTE) programs. CTE remains a salient education issue in the United States, largely due to a reinvigorated focus on preparing high school students for college and careers. This report updates the findings in our initial report[3] to provide an overview of CTE engagement, measured by the share of students who concentrate in or complete a CTE program before graduating from high school.

We make two new contributions relative to last year's report. First, we add data from the most recent available school year (SY)—SY 2018-19—for two of the three states in the previous report: Massachusetts and Michigan. Unfortunately, updated data are unavailable for Tennessee, but we report our previous findings for Tennessee to allow for comparison among the states. Second, we add findings from Washington, a new CTEx partner state. The inclusion of Washington broadens the focus of our report to a state on the west coast and begins what we hope is an ongoing expansion in the number of CTEx partner states that we can include in future reports.

The analytic focus of this report continues to be differences in CTE concentration rates over time and across student groups. We also analyze high school graduation rates and college enrollment across concentrators and non-concentrators, focusing on students with identified disabilities. Our updated analysis provides a novel examination of trends in CTE concentration using detailed administrative records from four states. We continue to harmonize samples as much as possible across states, although definitional differences—particularly concerning the measurement of CTE participation and programmatic progress—mean that limitations to the analysis remain.

Analysis Sample and Creation of Common Terms

We define the same analysis sample as in our prior report. We encourage interested readers to refer to that report[4] for a detailed description of the samples across states and the creation of common definitions. In what follows, we summarize the information needed to interpret the findings in this report.

CTE Concentrators

We focus on measuring whether a student “concentrated” in a CTE program of study. States have historically had a fair amount of discretion in defining a concentrator for federal reporting purposes, particularly under Perkins IV, and CTE courses and programs (including mode of delivery and how credits are assigned) also vary.[5] Our first key finding is that any multi-state analysis of CTE should be interpreted with caution, even when care is taken to reconcile definitions.

During the time period in this study, states took differing approaches to define a CTE participant, concentrator, or completer. In general, these can loosely be translated to taking a CTE course, completing multiple courses in an aligned sequence but not completing a program of study, and completing an aligned program of study (typically at least three courses in a sequence and often including a capstone experience such as work-based learning or an end of pathway exam), respectively. These definitions are not standardized. Under Perkins IV, states could establish their own performance requirements and define populations for which they would report data. The U.S. Department of Education had flexible guidelines for these and other definitions under Perkins IV and defined a concentrator as

Table 1. State-Specific Definitions of CTE Concentrator Status

State	Concentrator definition in this report
Massachusetts	Student was identified by the school or district as being a participant in a CTE program for two or more academic years.
Michigan	Student completed at least seven out of 12 segments in a program of study.
Tennessee	Student completed at least three credits in a program of study.
Washington	Student completed at least three credits in a program of study.

> [a] secondary student who has earned three (3) or more credits in a single CTE program area (e.g., health care or business services), or two (2) credits in a single CTE program area, but only in those program areas where 2 credit sequences at the secondary level are recognized by the State and/or its local eligible recipients.[6]

To reconcile CTE concentration measures across states, we focus on students who concentrate in a program of study (including those who also complete a program). Our data do not allow us to define students as participants or completers across all four states easily or consistently. Additionally, course length is not uniform across states, and whether any specific course might count for one or more "programs" also differs. Hence, differences in concentration rates across states reflect, in part, differences in the share of students who take CTE courses in addition to differences in how states define two or three courses in a sequence. Table 1 provides the definitions of CTE concentrator used by each state in this report, which align with Perkins IV.[7]

Analysis Sample

The analysis sample in each of the four states—Massachusetts, Michigan, Tennessee, and Washington—is defined by first-time ninth-graders whom we observe for at least four years in the administrative data. We retain students with irregular grade progression, such as students retained in a grade. The advantages of this definition are threefold:

- It includes most students who concentrate in a CTE program in Grade 11 or Grade 12.
- It limits bias from attrition (e.g., moving out-of-state).

Table 2. Ninth-Grade Cohorts by State

State	Earliest ninth-grade cohort	Latest ninth-grade cohort	Latest year of administrative data
Massachusetts	SY 2007-08	SY 2015-16	SY 2019-20
Michigan	SY 2007-08	SY 2015-16	SY 2019-20
Tennessee	SY 2009-10	SY 2013-14	SY 2017-18
Washington	SY 2010-11	SY 2015-16	SY 2019-20

- It reduces the mechanical relationship between the time a student spends in high school, their probability of concentrating in a CTE program, and our main outcomes of interest (e.g., college enrollment).

The main disadvantage is that our findings do not include students who move into or out of public school after Grade 9. If CTE participation is more common among students who would likely graduate (even in its absence) than among students who are more likely to drop out (before attending school for four years), we will *underestimate* any positive relationship between CTE and high school graduation, and consequently, we will *overestimate* any negative relationship. The earliest and latest ninth-grade cohorts are shown in Table 2, along with the last available year of administrative data.

Other Definitions

Race & Ethnicity

We use four mutually-exclusive categories: non-Hispanic Black students, non-Hispanic White students, Hispanic students, and non-Hispanic students of another race. We do not observe whether students identify with more than one race or ethnicity in all states.

Students With Identified Disabilities

There are several categories of students with identified disabilities, differing in the type and intensity of disability. Each state has specific definitions that mirror the 13 federally-recognized categories. We arrange the 13 categories into four groups: high-incidence, low-incidence, intellectual, and behavioral. Although state-specific definitions are not identical, there is considerable overlap. Appendix Table 1 shows each of the specific disability categories that fall under the broader classifications.

Table 3. Source of Standardized Test Scores, by State

State	Test name	Grade(s)	Cohorts
Massachusetts	Massachusetts Comprehensive Assessment System (MCAS)	8	2008-16
Michigan	Michigan Educational Assessment Program (MEAP)	8	2008-16
Tennessee	English I and Algebra I	9, 10	2010-14
Washington	Measurement of Student Progress	8	2011-15
	Smarter Balanced Assessment (SBA)	8	2016

Standardized Test Scores

Table 3 shows each state's source for standardized test scores in reading and math. We do not consider alternative assessments in each state so that scores are on a comparable scale.

High School Graduation

We define high school graduation as graduating with any high school diploma within four years after first entering Grade 9. Students who do not graduate "on time" (i.e., within four years of first entering Grade 9) are defined as non-graduators in the analyses.

College Enrollment

We measure college enrollment five years after entering Grade 9.[8] In Massachusetts, Michigan, and Tennessee, we observe whether a student enrolled in college (two-year or four-year) during the summer, fall, or spring semester the year after their expected high school graduation date. In future versions of this report, we will analyze college enrollment for two years or longer after the student's expected graduation date.

At this time, we are not considering employment outcomes because we do not have access to the necessary data in all four states.

State-Specific Contexts

Massachusetts

Students have multiple avenues to participate in CTE in high school. Nearly all students live in towns that have access to a Regional Vocational Technical School (RVTS). More than two dozen such schools exist across Massachusetts and all serve students who intend to study CTE in high school. In these RVTS settings, students can explore multiple CTE programs of study in Grade 9 and then make an informed choice about their preferred program. They spend their remaining three years in high school with a largely stable set of peers and instructors in their core academic and technical courses. Students apply to attend these schools (many of which are oversubscribed) using middle school grades, attendance, and disciplinary records. In schools that are oversubscribed, they are scored on these elements, given a total application score, and then admitted in descending order until all seats are filled. The RVTSs educate about half of the CTE concentrators in the state. The other half take CTE courses as electives in their residentially-assigned comprehensive high school.

Tennessee

In Tennessee, dedicated CTE high schools are less common than they are in Massachusetts. Most CTE students in Tennessee are enrolled in comprehensive high schools where CTE courses are available as electives. Each CTE course is associated with at least one program of study; there are 58 distinct programs of study. The number of CTE programs throughout Tennessee has fallen from over 200 in SY 2012-13 as programs were reorganized or retired. Amidst this reorganization, the percentage of students classified as CTE concentrators rose from 31% of regular graduates in SY 2011-12 to 47% in SY 2016-17. Programs of study are grouped into 16 career clusters that cover almost any industry or occupation where a student might eventually work. Career clusters include between one and six different programs of study. Currently, each program of study is associated with just one career cluster.[9]

Michigan

Similar to Tennessee, students in Michigan usually take CTE courses as electives within their comprehensive high school. If the school does not offer a specific program of study, the student can take CTE courses at career centers that are operated by Intermediate School Districts or, in some cases, local school districts (e.g., Detroit). The Michigan Department of Education (MDE) created Career Education Planning Districts, composed of one or more neighboring districts, to coordinate CTE program offerings across high schools and career centers that reflect regional priorities. As of SY 2018-19, there are 52 state-recognized programs of study within 16 career clusters. Schools intending to offer new programs of study require approval from the Office of Career and Technical Education, which verifies that the program covers some pre-defined standards that outline the basic contents and objectives a program should cover. For monitoring purposes, MDE grouped these standards into 12 "segments." Students' progress in the program is measured by the successful completion of each of these segments.

Washington

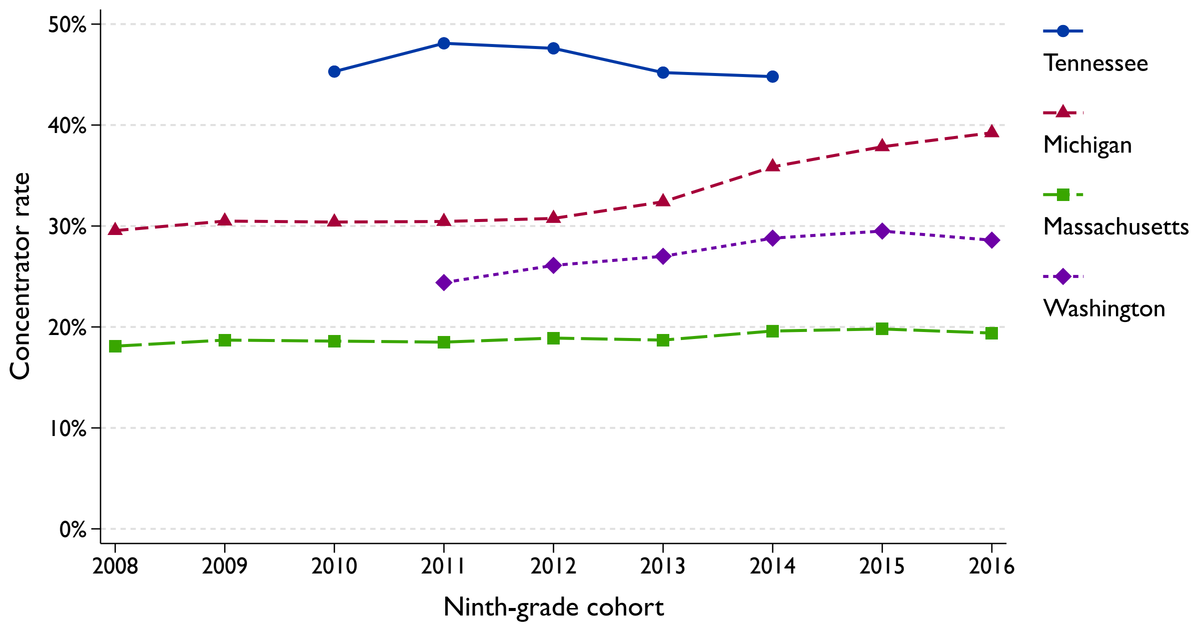
Like Michigan and Tennessee, most CTE courses in Washington are offered as electives within comprehensive high schools; however, CTE courses that are too specialized or expensive to be offered by individual school districts can be taken through a system of 14 Skills Centers across the state. The state has a graduation requirement that all students must complete at least one CTE credit, but the state also uses the definition of CTE concentrator under Perkins V as a student who completes at least two courses in a single program or program of study.[10] As a result, a high percentage of students in the state (more than half) are CTE concentrators under this definition. We therefore follow prior research in Washington[11] and define a CTE concentrator in Washington as a student who takes at least three credits in a single program of study. It is also important to note that in 2019, the Washington legislature passed House Bill 1599. This bill provided Washington high school students with multiple pathways to graduation—including new CTE Graduation Pathways in 16 state-approved "career clusters"—but the data we use for this report (SY 2010-11 to SY 2018-19) precedes this policy change.

Results

Overall Trends in the Share of CTE Concentrators

We begin by tracking the share of students in each ninth-grade cohort who reach CTE concentrator status or higher (program concentrators or completers). Figure 1 shows that definitional differences may contribute to differences in the levels of CTE concentrators across states. Concentrator trends, however, have been relatively stable over time, with two exceptions: Beginning in 2013, Michigan saw an increase in the share of all students who concentrate or complete a program of study, while concentrator rates in Washington increased by five percentage points from the 2011 to the 2015 ninth-grade cohorts. While we cannot rule out a material increase, at least some of the rise in Michigan is plausibly attributable to a funding change that incentivized districts to increase concentrator or completer status for students. The increase in Washington precedes a policy change incentivizing CTE

Figure 1. CTE Concentrator Rate in Four States, by Ninth-Grade Cohort



Notes. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a CTE program. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for additional definitions.

participation through the state's new CTE graduation pathways and is therefore less clearly tied to any specific policy change.

According to state-level definitions, almost 50% of Tennessee students, 40% of Michigan students, over 25% of Washington students, and roughly 20% of Massachusetts students concentrate in or complete a CTE program in high school. Figure 1 shows concentrator rates by state over time. Differences in concentration rates are likely due to many factors, including (a) different structures of CTE delivery (such as whole-school models in Massachusetts versus integrated models in Tennessee, Michigan, and Washington), (b) different definitions of concentration, (c) different courses counted toward CTE concentration or completion, (d) different accountability benchmarks that may directly or indirectly include CTE courses, or (e) regional differences in the types of CTE program offerings. That concentrator rates are relatively stable over time suggests that shifting supply and demand for programs is not driving cross-state differences. Michigan's increase in concentration rates following a state-specific funding change adds support to the notion that state requirements and/or definitions impact concentration rates.

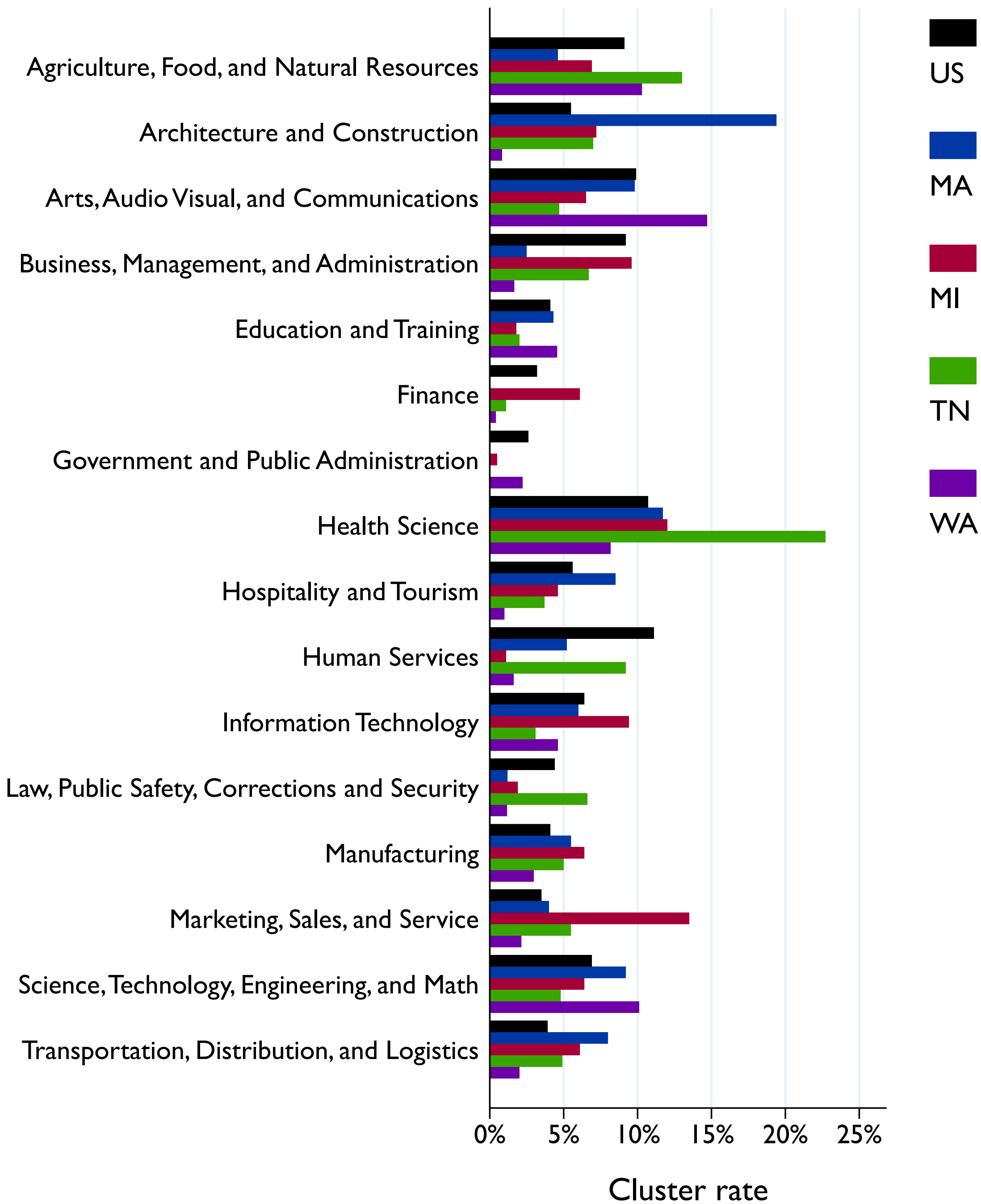
Popular Career Clusters by State

It is helpful to understand what CTE students are studying in each state and how that differs from the rest of the nation. Figure 2 shows the nationwide share of CTE concentrators in SY 2018-19 in each of the 16 major career clusters and, for comparison, the share of concentrators by state.[12] Nationwide, the five most-popular CTE clusters are Human Services; Health Science; Arts, Audio-Visual, and Communications; Business, Management, and Administration; and Agriculture, Food, and Natural Resources. The same career clusters are relatively popular in one or more of the states in this study, but there are important differences in the distribution of clusters across states.

In Massachusetts, Architecture and Construction; Science, Technology, Engineering, and Math (STEM); and Hospitality and Tourism are among the top five most-popular clusters, whereas Human Services and Agriculture, Food, and Natural Resources are less common than they are nationally. Concentrators in Human Services are also relatively uncommon in Michigan, whereas Marketing, Information Technology, and Architecture and Construction students collectively account for three in 10 Michigan concentrators. In Tennessee, 23% of CTE concentrators took a program of study in the Health Science cluster—almost twice the rate seen in Massachusetts, Michigan, Washington, or the United States more broadly. Tennessee's Agriculture, Food, and Natural Resources cluster and Law and Public Safety cluster are also more prominent than in other states. In Washington, 15% of concentrators took a program in Arts, Audio Visual, and Communications, which is five percentage points higher than in Massachusetts. Students in Washington were also more likely to concentrate in the STEM cluster relative to Michigan and Tennessee.

Considering Figures 1 and 2 together, it does not appear that regional variation in cluster intensities alone can explain widely varying rates in CTE concentration. Massachusetts has the lowest rate of CTE concentration among the four states, and it is relatively more invested in Architecture and Construction, a field that can entail more facility costs and capacity constraints than clusters such as Information Technology, Business, or Marketing. The same is true, however, of Health Science and Agriculture, Food, and Natural Resources. These clusters account for one in three CTE concentrators in Tennessee (a state with a very high rate of CTE concentration).

Figure 2. Career Cluster Rate Among CTE Concentrators, for Students Nationwide and by State



Concentration and Completion Rates by Gender

Figure 3 breaks out trends in CTE concentration by gender across states. In Tennessee, male and female students concentrate in CTE at about the same rate. Conversely, Michigan, Massachusetts, and Washington have higher concentration rates for male students than female students. For our most recent cohort (those starting Grade 9 in 2016), 43% of male students in Michigan are concentrators, as compared to 36% of female students. The seven-point difference is replicated in Washington, where 32% of male students are concentrators as compared to 25% of female students.

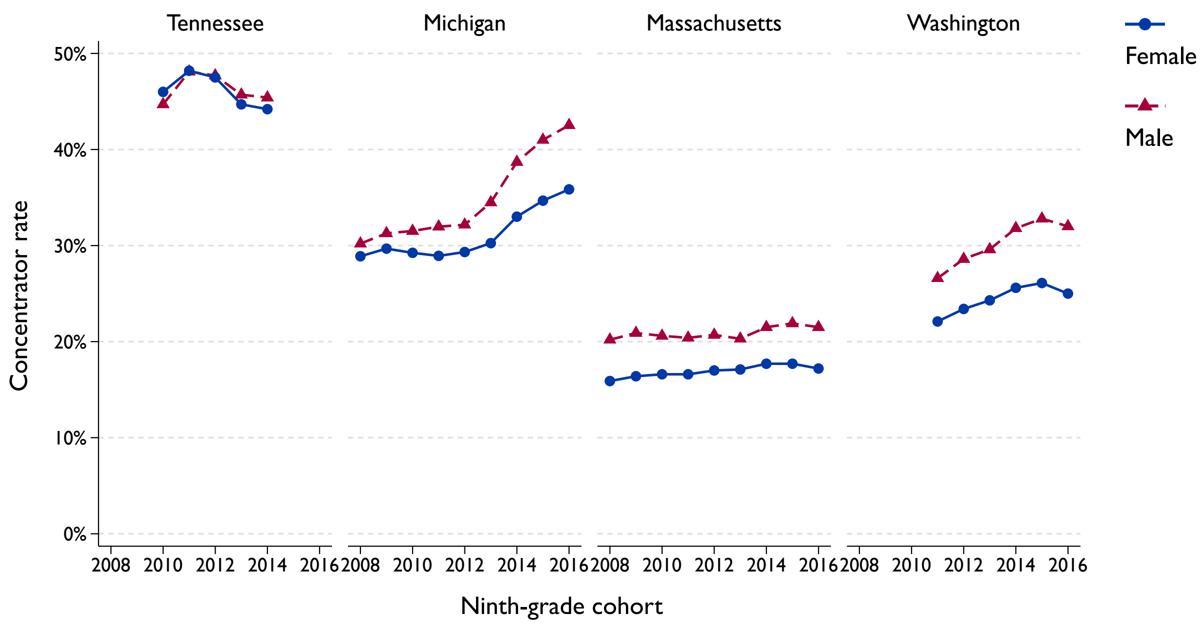
Figure 4 illustrates the gender breakdown from Figure 3 in a different way by plotting the gender differences in CTE concentration in each state over time. Specifically, for each state and cohort, Figure 4 plots the percentage by which the number of male CTE concentrators exceeds the number of female CTE concentrators. Since the 2013 cohort, the concentrator difference between male and female students has risen in all four states. The gap is highest in Massachusetts and Washington, which have similar levels of and trends in gender differences since 2013. The gender differences in concentration have almost doubled in Michigan since 2012.

We cannot point to a particular explanation for the level of differences (or lack thereof) across states or the widening of the differences over time. As one example, though, it is possible from the distribution of career clusters in Figure 2 that popular and male-dominated industries are driving some of the gap in Massachusetts (e.g., Architecture and Construction). We believe unpacking gender differences in CTE concentration rates is an important area for future research.

Concentration and Completion Rates by Race and Ethnicity

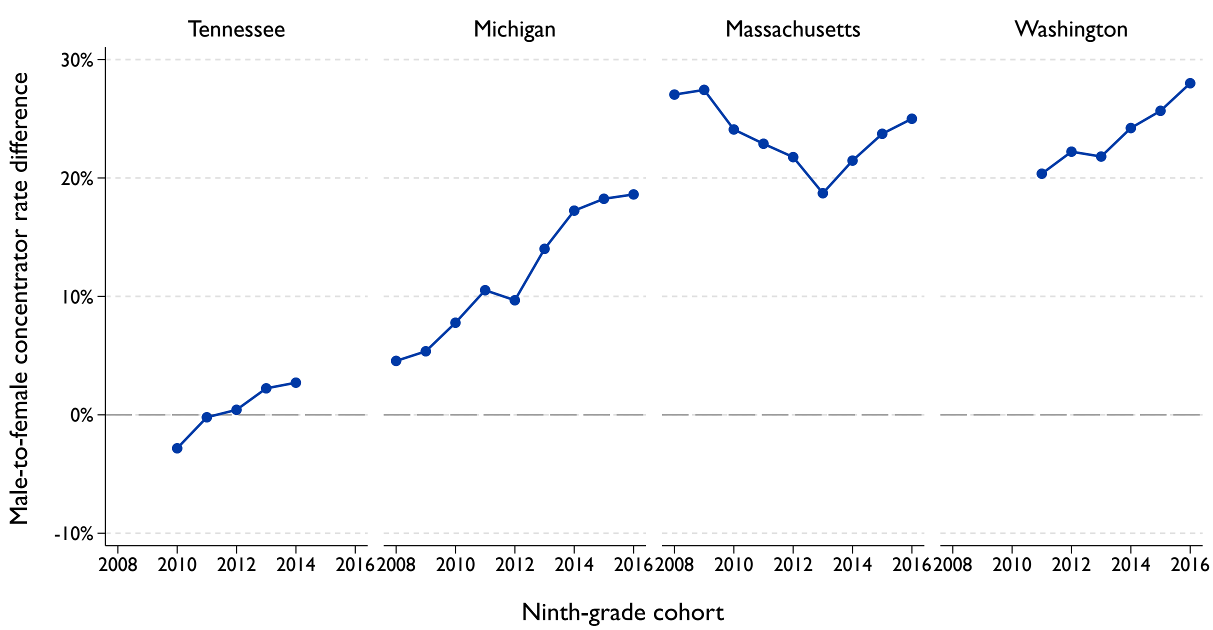
A similar breakout by race and ethnicity highlights unconditional average differences in concentrator status across groups. These differences, however, do not account for differences in course availability or for other factors correlated with race that might affect CTE participation or concentrator status. We explore how these factors interact with race in the regression analysis that follows, showing that raw differences across race are largely, and in some cases entirely, explained by differences across schools. When we calculate within-school differences, we find far smaller disparities and in some cases none at all.

Figure 3. CTE Concentrator Rate by State, Ninth-Grade Cohort, and Gender



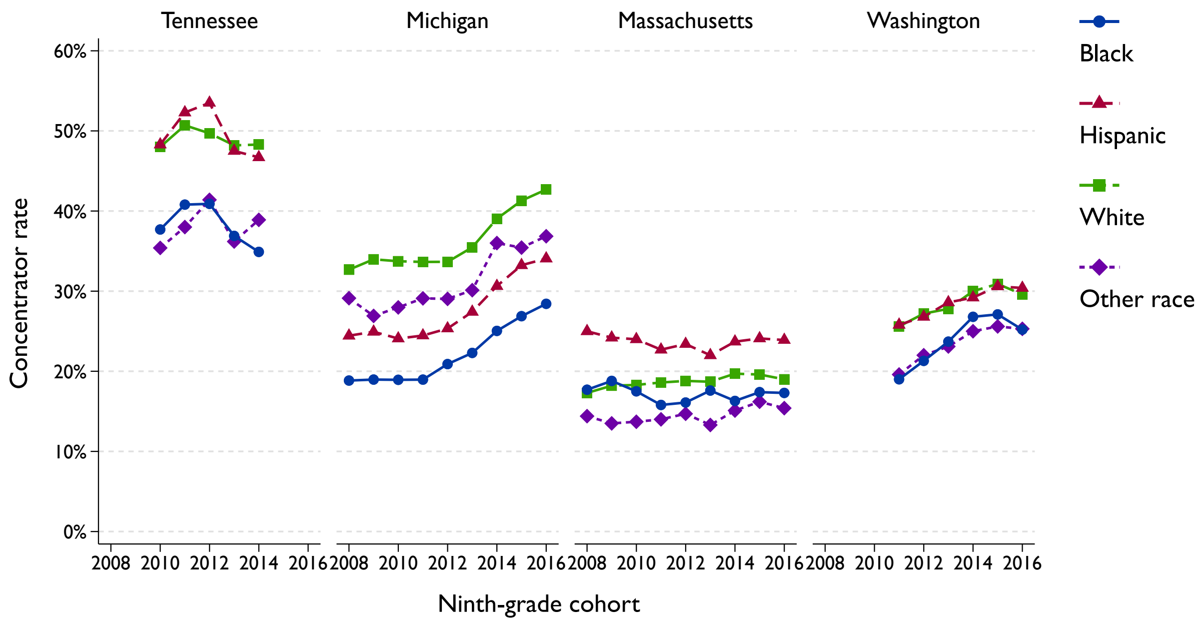
Notes. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for additional definitions.

Figure 4. Male-to-Female Difference in CTE Concentrator Rate, by Student and Ninth-Grade Cohort



Notes. This figure plots the percentage difference in concentrator rates for male students compared with female students. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for additional definitions.

Figure 5. CTE Concentrator Rate by State, Ninth-Grade Cohort, and Race and Ethnicity



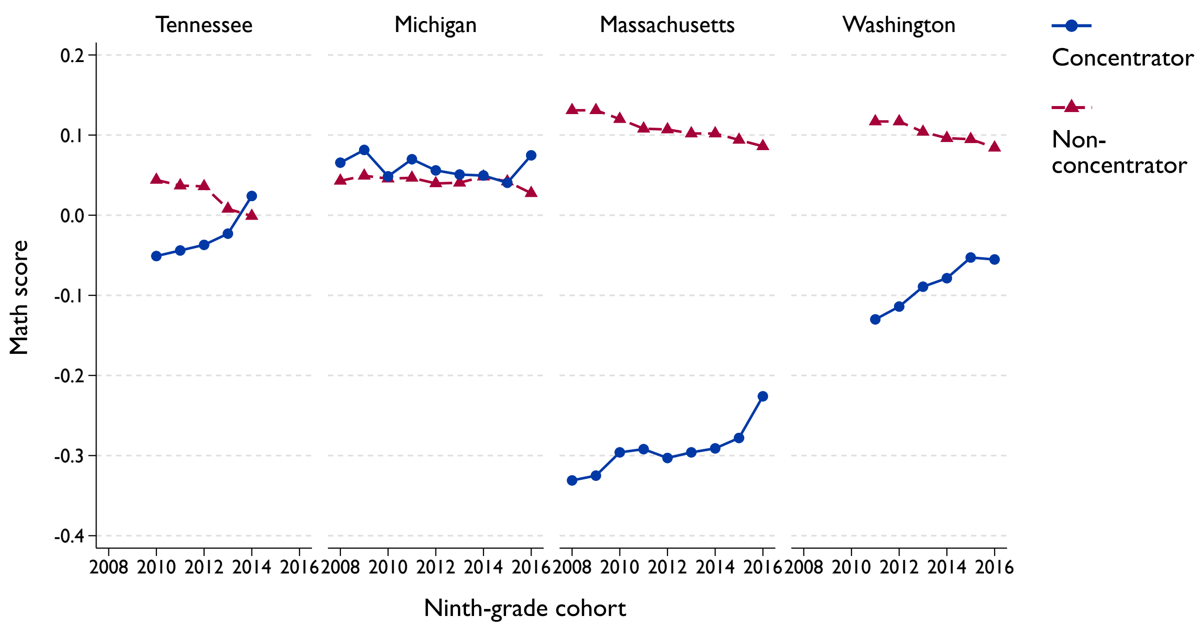
Notes. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for additional definitions.

When focusing on raw mean differences by race and ethnicity in Figure 5, we find wide variation both within and across states. In Tennessee and Washington, White and Hispanic students are more likely to concentrate in a CTE program of study than Black or other non-White students. Concentration rates, however, are around 20 percentage points higher in Tennessee than in Washington. In Michigan, students who are not White are significantly less likely to concentrate or complete a CTE program than White students. In Massachusetts, Hispanic students are most likely to concentrate in a CTE program, while Black and White students are roughly equal in concentration rates by the end of our time frame—closing differences by race and ethnicity among earlier cohorts.

Early Test Scores for Concentrators

In this section, we analyze whether pre-CTE academic performance (as measured by state-specific standardized math test scores) is predictive of CTE enrollment. We analyze whether students with higher math test scores are more or less likely to enroll in CTE later in their high school careers.

Figure 6. Standardized Math Assessment Scores, by State, Ninth-Grade Cohort, and CTE Concentrator Status



Notes. Scores are Grade 8 MEAP (MI), Grade 8 MACS (MA), Algebra I (TN), and Grade 8 Measures of Student Progression (2011-2015) and SBA (2016) (WA), normalized within state-cohort to z-scores. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for additional definitions.

Within each state cohort, we normalize raw scores to z-scores (with mean 0 and standard deviation 1 across all test takers in a given year) and plot mean differences over time for concentrators and non-concentrators in Figure 6.

In Tennessee, although non-concentrators in earlier cohorts had higher entering math scores, by approximately one-tenth of a standard deviation, test score differences between eventual concentrators and non-concentrators are marginal by the most recent entering cohorts (advantaging concentrators, if anything). In Michigan, concentrators and non-concentrators have nearly identical scores on average, although concentrators from the 2016 cohort have slightly higher math scores. In Massachusetts, differences are large. On average, concentrators score approximately 0.4 standard deviations lower in Grade 8 math than non-concentrators through the 2015 cohort. There was a slight narrowing of the gap for the 2016 cohort, however, as concentrators scored about 0.05 standard deviations higher than earlier cohorts. As noted above, about half of CTE concentrators are enrolled in CTE-dedicated high schools (RVTS) of choice to which they apply in Grade 8. In Washington (as in Massachusetts), concentrators score lower on Grade 8 math than non-concentrators, although the gap decreased between the 2011 and 2015 cohorts. By the 2016 cohort, the math-score gap was roughly 0.15 standard deviations in favor of non-concentrators.

The Role of Schools in Concentration Rates

While the previous figures show meaningful across-group differences in the likelihood students concentrate in a CTE program, they do not allow us to observe how these factors interact or what role geography (i.e., schools) plays. To address this, we estimate student-level regressions separately by state where the outcome is whether a student concentrated in a program of study. In Tables 4A and 4B, we first observe differences across race and ethnicity, gender, English learner status, and disability status within each state and student cohort. We then add measures of student test scores in Grade 8 or Grade 9 in the second column of each state regression. Finally, in the third column, we add a school-by-cohort fixed effect. The addition of this school-by-cohort fixed effect removes the school-cohort mean concentration rate for each student. Thus, the third column shows average differences in concentration rates across race, gender, English learner status, disability status, and math/reading scores *within* schools. Comparing the results with the first and second columns gives a sense of the degree to which differences in concentration rates across student types result from differences in program offerings and completion rates across schools or whether these disparities exist within school as well. Appendix Table 2 shows summary statistics for measures in the regression models.

The first column of each state-specific regression reflects descriptive details shown in the previous figures. In Michigan, Tennessee, Massachusetts, and Washington, Black students are less likely to concentrate than White students by 14, 11, two, and five percentage points, respectively. Hispanic students are seven percentage points less likely to concentrate in Michigan, five percentage points more likely to concentrate in Massachusetts, and not more or less likely in Tennessee and Washington. We also find that students in Michigan and Tennessee who were ever classified as having an identified disability are less likely to concentrate than their peers. In Massachusetts, students with an identified high-incidence disability are seven percentage points more likely to concentrate in a CTE program; students with an identified behavioral disability are six percentage points less likely to concentrate; and students with an identified low-incidence or intellectual disability are not more or less likely to concentrate in a CTE program. Washington follows a somewhat similar pattern

Table 4A. Regression Estimates for the Probability of Concentrating in a CTE Program, MI and TN

	Michigan			Tennessee		
	(1)	(2)	(3)	(1)	(2)	(3)
Female	-0.039^{+}	-0.038^{+}	-0.037^{+}	-0.002	-0.004	-0.003
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Black	-0.138^{+}	-0.151^{+}	-0.050^{+}	-0.107^{+}	-0.159^{+}	-0.035^{+}
	(0.010)	(0.010)	(0.004)	(0.015)	(0.015)	(0.006)
Hispanic	-0.070^{+}	-0.077^{+}	-0.025^{+}	0.0016	-0.024$^{\wedge}$	-0.008
	(0.012)	(0.012)	(0.004)	(0.011)	(0.011)	(0.005)
Other non-White	-0.046$^{\wedge}$	-0.036*	-0.026^{+}	-0.101^{+}	-0.082^{+}	-0.038^{+}
	(0.016)	(0.015)	(0.006)	(0.015)	(0.013)	(0.007)
English learner	-0.063$^{\wedge}$	-0.071^{+}	0.001	-0.035	-0.050$^{\wedge}$	-0.065^{+}
	(0.021)	(0.021)	(0.005)	(0.021)	(0.020)	(0.015)
Gifted				-0.252^{+}	-0.127^{+}	-0.079^{+}
				(0.014)	(0.014)	(0.012)
High incidence	-0.019^{+}	-0.035^{+}	-0.037^{+}	-0.012$^{\wedge}$	-0.0485^{+}	-0.034^{+}
	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)	(0.004)
Low incidence	-0.052^{+}	-0.055^{+}	-0.049^{+}	-0.085^{+}	-0.067^{+}	-0.038^{+}
	(0.011)	(0.010)	(0.013)	(0.019)	(0.021)	(0.013)
Intellectual	-0.177^{+}	-0.165^{+}	-0.165^{+}	-0.244^{+}	-0.0545^{+}	-0.040^{+}
	(0.008)	(0.008)	(0.008)	(0.015)	(0.015)	(0.013)
Behavioral	-0.131^{+}	-0.144^{+}	-0.144^{+}	-0.211^{+}	-0.190^{+}	-0.161^{+}
	(0.007)	(0.007)	(0.007)	(0.013)	(0.013)	(0.012)
Math 8th/9th		-0.011^{+}	-0.008^{+}		0.017^{+}	0.017^{+}
		(0.003)	(0.002)		(0.003)	(0.002)
Reading 8th/9th		-0.013^{+}	-0.014^{+}		0.003	0.001
		(0.002)	(0.001)		(0.003)	(0.002)
ACT score					-0.018^{+}	-0.013^{+}
					(0.001)	(0.001)
Cohort FE	Yes	Yes	No	Yes	Yes	No
Sch.-x-Cohort FE	No	No	Yes	No	No	Yes
Outcome mean	0.33	0.33	0.33	0.46	0.46	0.46
Observations	972,739	972,739	972,739	304,900	304,900	304,900

Notes. Dependent variable is an indicator = 1 if a student concentrated or completed a CTE program. Sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is year entering ninth grade. Sch.-x-cohort FE are school-cohort fixed effects. High/Low/Intellectual/Behavioral are disability types. Math and reading are z-scores for Grade 8 (MI and MA) and Grade 9 (TN) standardized scores. Results are interpreted as percentage-point differences in concentrator/completer rates. Regressions are separate by state. Robust standard errors are in parentheses. Table A2 in the Appendix shows summary statistics for the regression models. Significance levels: * 0.1, ^ 0.05, + 0.01.

Table 4B. Regression Estimates for the Probability of Concentrating in a CTE Program, MA and WA

	Massachusetts			Washington		
	(1)	(2)	(3)	(1)	(2)	(3)
Female	-0.036^{+}	-0.029^{+}	-0.020^{+}	-0.057^{+}	-0.053^{+}	-0.054^{+}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Black	-0.015^{+}	-0.061^{+}	-0.011^{+}	-0.049^{+}	-0.069^{+}	-0.051^{+}
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Hispanic	0.048^{+}	0.009^{+}	-0.011^{+}	0.001	-0.016^{+}	-0.024^{+}
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Other non-White	-0.039^{+}	-0.024^{+}	-0.014^{+}	-0.048^{+}	-0.043^{+}	-0.037^{+}
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
English learner	-0.002	-0.013^{+}	-0.008^{+}	-0.025^{+}	-0.051^{+}	-0.052^{+}
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Gifted				-0.073^{+}	-0.041^{+}	-0.046^{+}
				(0.003)	(0.003)	(0.004)
High incidence	0.069^{+}	-0.015^{+}	-0.005^{+}	0.034^{+}	-0.013^{+}	-0.004
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Low incidence	0.001	-0.070^{+}	-0.032^{+}	-0.050^{+}	-0.073^{+}	-0.065^{+}
	(0.004)	(0.004)	(0.003)	(0.009)	(0.009)	(0.009)
Intellectual	0.006	-0.061^{+}	-0.055^{+}	-0.024^{+}	-0.048^{+}	-0.052^{+}
	(0.005)	(0.005)	(0.003)	(0.009)	(0.009)	(0.009)
Behavioral	-0.062^{+}	-0.141^{+}	-0.055^{+}	-0.086^{+}	-0.129^{+}	-0.103^{+}
	(0.004)	(0.004)	(0.003)	(0.009)	(0.009)	(0.009)
Math 8th/9th		-0.044^{+}	-0.005^{+}		-0.027^{+}	-0.020^{+}
		(0.001)	(0.001)		(0.001)	(0.001)
Reading 8th/9th		-0.044^{+}	-0.008^{+}		-0.022^{+}	-0.021^{+}
		(0.001)	(0.001)		(0.001)	(0.001)
ACT score						
Cohort FE	Yes	Yes	No	Yes	Yes	No
Sch.-x-Cohort FE	No	No	Yes	No	No	Yes
Outcome mean	0.189	0.189	0.189	0.274	0.274	0.274
Observations	503,563	503,563	503,563	440,589	440,589	440,589

Notes. Dependent variable is an indicator = 1 if a student concentrated or completed a CTE program. Sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is year entering ninth grade. Sch.-x-cohort FE are school-cohort fixed effects. High/Low/Intellectual/Behavioral are disability types. Math and reading are z-scores for Grade 8 (MI and MA) and Grade 9 (TN) standardized scores. Results are interpreted as percentage-point differences in concentrator/completer rates. Regressions are separate by state. Robust standard errors are in parentheses. Table A2 in the Appendix shows summary statistics for the regression models. Significance levels: * 0.1, ^ 0.05, + 0.01.

to Massachusetts: Students with an identified low-incidence, intellectual, or behavioral disability are less likely to concentrate than their peers, but students with an identified high-incidence disability are more likely to concentrate. English learner students are less likely to concentrate in all states except Massachusetts, noting that part of this effect is captured by the inclusion of indicators for Hispanic and Other race—many of whom are English learners.

In the second column of each state panel, we add controls for Grade 8 or Grade 9 math and reading scores (normalized to have mean 0 and standard deviation 1) within each state cohort (as well as ACT scores in Tennessee, if observed). First, we document that in Michigan, Massachusetts, and Washington, students with higher test scores in early grades are less likely to concentrate in a CTE program. In Tennessee, students with higher Grade 9 math scores are more likely to concentrate, but higher ACT-scoring students are less likely to concentrate, which suggests a weaker relationship between CTE and prior or concurrent test scores in Tennessee compared to the other states. The second column also shows that in Michigan, Tennessee, and Washington, differences between Black students and White students and between Hispanic students and White students widen once accounting for achievement. If Black students and Hispanic students score, on average, lower than White students, and if students who score higher on math and reading tests also are less likely to concentrate, the second column implies that the relationship between math and reading ability and race moves in different directions for non-White and White students (at least in models without school fixed effects). We believe this is another important area for future research.

Finally, in the third column of each panel, we include a school-cohort fixed effect, meaning we are comparing students within (as opposed to across) schools. We begin by noting that, while female students are less likely to concentrate than male students in Michigan, Massachusetts, and Washington and equally likely in Tennessee, this relationship is largely unchanged by adding a school fixed effect. This makes sense as, in most cases, the gender balance is constant across schools (i.e., few if any schools are disproportionately male or female), except in Massachusetts where some schools are RVTSs and enroll more male students because they receive more male than female applicants. The same is largely true for students with identified disabilities and for the relationship between test scores and concentration rates, which are modestly affected by the school fixed effect in Tennessee, Michigan, and Washington. In Massachusetts, the test score relationship is reduced to nearly zero, likely due to the admissions nature of the RVTSs.

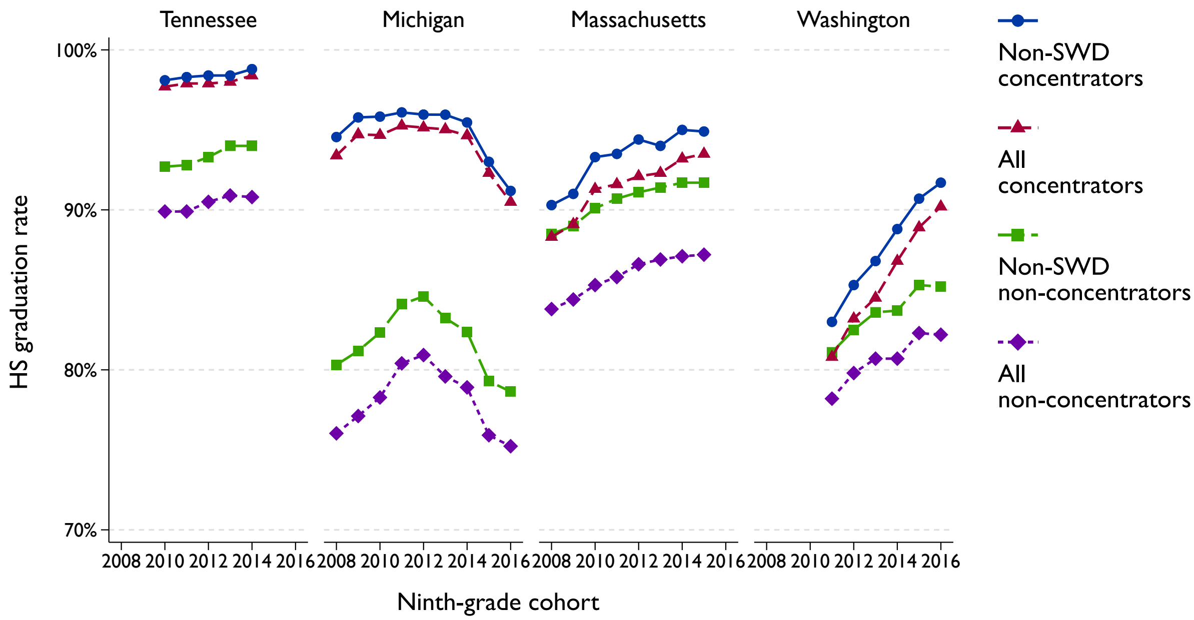
Yet, the addition of school fixed effects narrows racial differences in concentrator rates. In Michigan, we find that two-thirds of the Black-White and Hispanic-White gap is due to Black and Hispanic students attending different schools. Within schools, these differences reduce to a five- and two-percentage-point gap, respectively. In Tennessee, we see a similar result: The initial 10-percentage-point Black-White gap reduces to three percentage points. In Massachusetts, within school gaps across race are no larger than one percentage point. Racial differences in Washington, however, are slightly smaller for Black students and larger for Hispanic students with the inclusion of school fixed effects. Overall, these results suggest that differences across race are largely driven by differences in CTE concentration rates across schools with more or less non-White student populations, and participation rates across race are significantly smaller within schools (and non-existent in some cases).

CTE and High School Graduation

In this section, we focus on CTE and high school graduation rates. Our sample is limited to students who enrolled in high school for four consecutive years, so we do not observe students who dropped out before their fourth year of high school. For these analyses, we show graduation rates for all students and separately for students who were never classified as having an identified disability. Later in this report, we analyze students with identified disabilities. Figure 7 plots high school graduation rates by concentrator and special education participation over time. Red lines plot high school graduation rates for concentrators and blue lines for non-concentrators. Solid lines are for students not enrolled in special education, and dashed lines are for all students, including those ever classified as having an identified disability.

Even after conditioning on students who persist in high school for four years, concentrators graduate at higher rates than non-concentrators in all states and all years. In Tennessee, graduation rates for concentrators are near 100% regardless of disability status. Figure 7 plots percentage-point differences between concentrators and non-concentrators. Non-concentrators in Tennessee and Massachusetts are roughly three to seven percentage points less likely to graduate high school than concentrators. In Michigan, concentrators (again, regardless of special education enrollment) graduate high school at higher rates. Among all students, concentrators are between 12 and 15 percentage points more likely to graduate. In Washington, the graduation gap between concentrators and non-concentrators has grown from around four percentage points in the 2011 cohort to seven percentage points in the 2016 cohort.

Figure 7. High School Graduation Rate by State, Ninth-Grade Cohort, CTE Concentrator Status, and Students With Identified Disabilities (SWD) Status



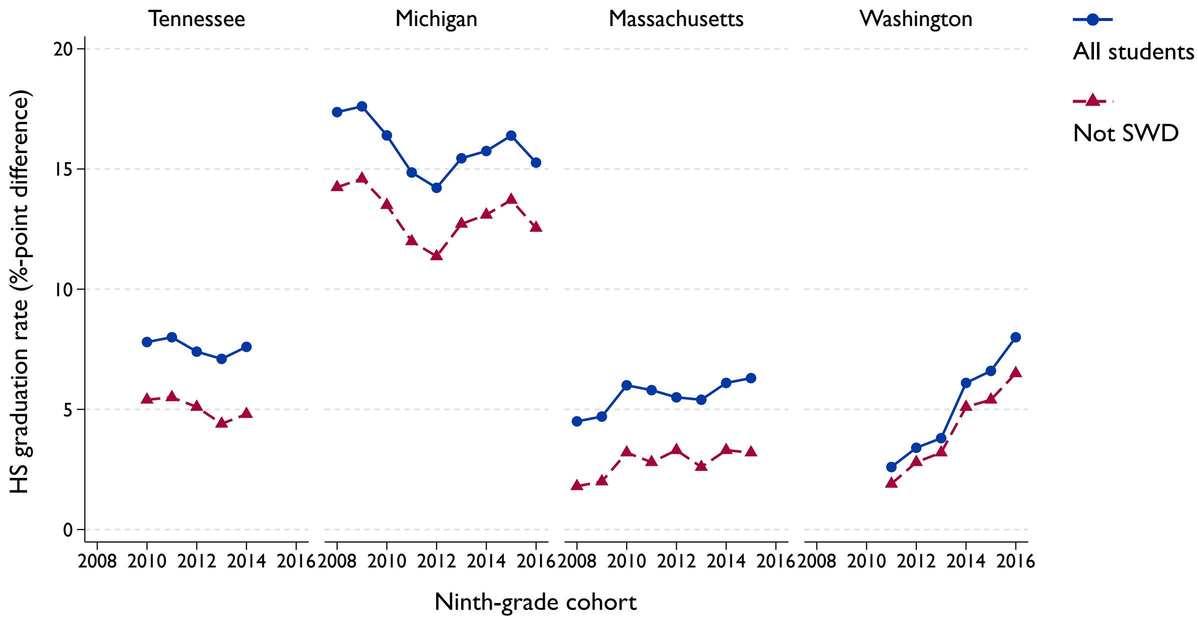
Notes. Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for definitions. Students with identfied disabilties (SWD) status is determined by whether students were ever classified as taking special education.

Figures 7 and 8 demonstrate that the high school graduation rate advantage for CTE concentrators is higher for students receiving special education services, evidenced by larger graduation advantages for all students than for their peers. We explore this finding in greater detail later in this report.

College Enrollment

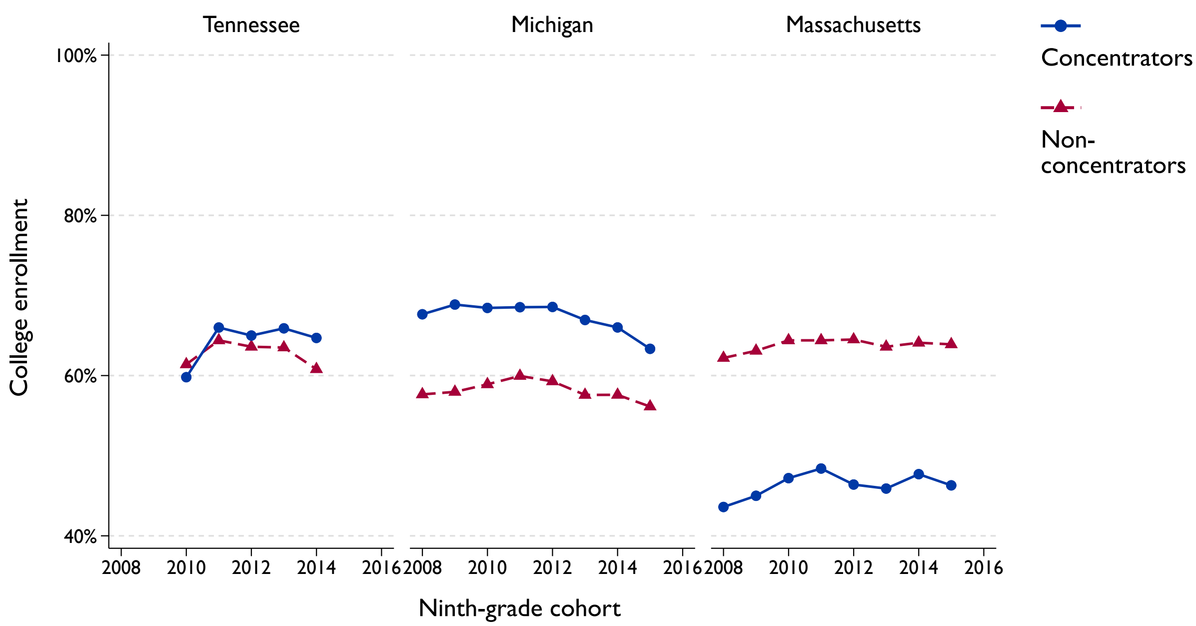
Building on high school graduation rates from the previous section, we turn next to college enrollment. To maximize our sample window, we define college enrollment as enrolling in college within five years of entering high school (i.e., within one year of the expected high school graduation date, although we do not condition the sample on completing high school on time). Figure 9 shows enrollment in any college by concentrator status over time in three of the four states.[13] In Tennessee, concentrators have become marginally more likely to enroll in college than non-concentrators over time by two to four percentage points. In Michigan, concentrators are about nine to 10 percentage

Figure 8. Difference in High School Graduation Rate by State, Ninth-Grade Cohort, and Students With Identified Disabilities (SWD) Status



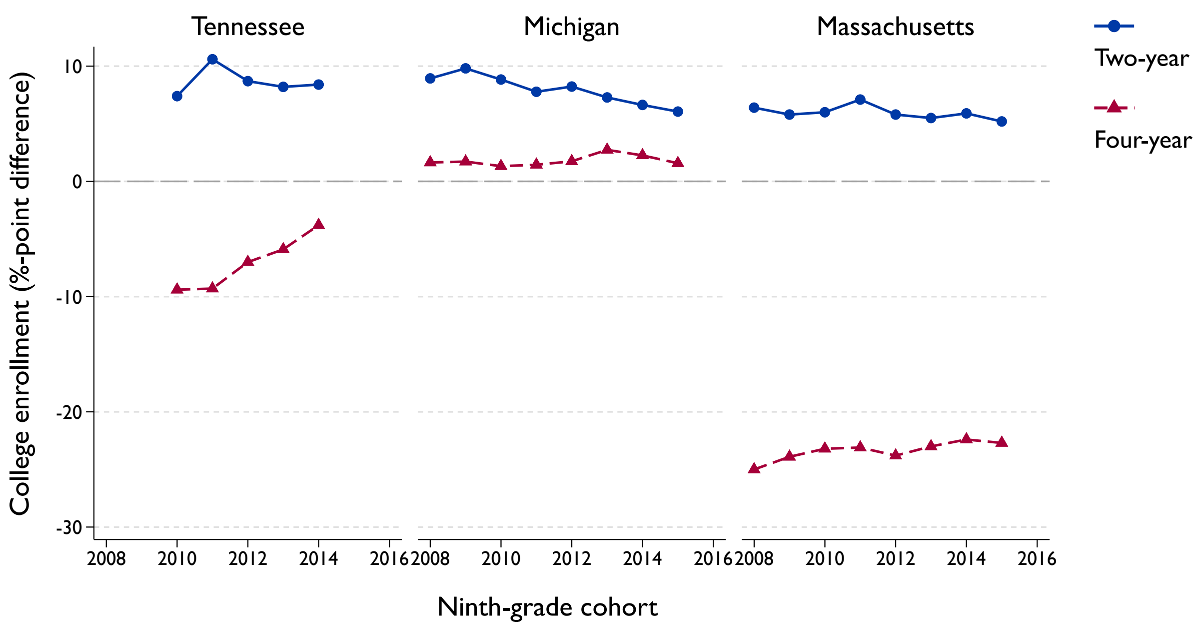
Notes. Sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for definitions. Students with identified disabilities (SWD) status is determined by whether students ever classified as taking special education.

Figure 9. College Enrollment by State, Ninth-Grade Cohort, and CTE Concentrator Status



Notes. College enrollment is measured within five years of entering high school (or one year after the expected on-time graduation year based on ninth-grade cohort). Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for definitions.

Figure 10. Difference in College Enrollment by State, Ninth-Grade Cohort, and College Type



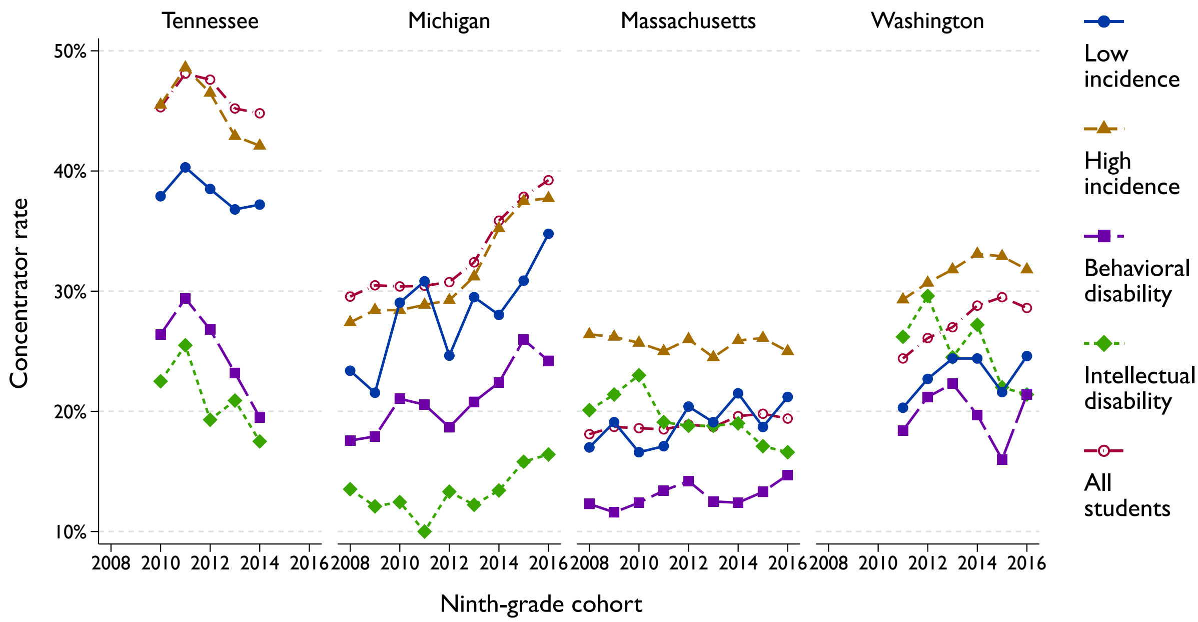
Notes. The figure shows the percentage-point difference between concentrators and non-concentrators in college enrollment by college type. College enrollment is within five years of entering high school (or one year after expected graduation). Each state's sample is students who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for definitions.

points (roughly 17%) more likely to enroll in college than non-concentrators, although the gap narrowed to seven percentage points for the 2015 cohort. In Massachusetts, the pattern is reversed: Non-concentrators are 11 to 12 percentage points more likely to enroll in college than non-concentrators.

Figure 10 shows percentage-point differences in college enrollment between completers and non-completers in two-year (red lines) and four-year (blue lines) colleges. This graph unmasks differences in college enrollment choices not apparent for overall enrollment. For example, while concentrators and non-concentrators in Tennessee attend any college at similar rates, concentrators are nearly 10 percentage points more likely than non-concentrators to attend a two-year school, and concentrators are between four and nine percentage points less likely to attend a four-year institution—a gap that has narrowed steadily over time.

A similar pattern emerges in Massachusetts: Concentrators are between six and nine percentage points more likely to attend a two-year school but are roughly

Figure 11. CTE Concentrator Rate by State, Ninth-Grade Cohort, and Disability Type



Notes. Each state's sample is students who were ever identified as having a disability and who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for concentrator definitions. Appendix Table 1 provides definitions of disability types.

20 percentage points less likely to attend a four-year institution.[14] In Michigan, concentrators are more likely to attend any college, but their advantage is larger for two-year institutions. Appendix Figure 1 plots average college-going rates by college level and concentrator status for all states. Two-year colleges in each of these states also receive Perkins funds and offer CTE programming. Thus, these patterns may align with students continuing in existing CTE programs.

CTE and Students With Identified Disabilities

In this section, we focus on CTE and students with identified disabilities. Students with identified disabilities attend college at lower rates and have lower labor market participation rates—with important variation by type of disability.[15] In Figure 11, we plot concentrator rates for all students with identified disabilities (red dashed line) and by disability type (non-red lines). Students with identified disabilities in Tennessee, particularly those with identified high-incidence disabilities, are much more likely to concentrate in a CTE program than students with identified behavioral or intellectual disabilities.

In Michigan and Washington, a similar pattern emerges, although students with an identified intellectual disability were more likely to concentrate than their peers before 2013. In Massachusetts, students with identified disabilities are more likely to concentrate in a CTE program than their peers.

In Figure 12, we plot high school graduation rates by disability status, including students without identified disabilities for comparison. While students without identified disabilities graduate at higher rates than students with identified disabilities, these gaps are narrower among CTE concentrators. Across all disability categories, concentrators graduate at significantly higher rates than non-concentrators and, in some cases, are on par with students without identified disabilities in their cohorts. In most cases, these differences are cut in half or more.

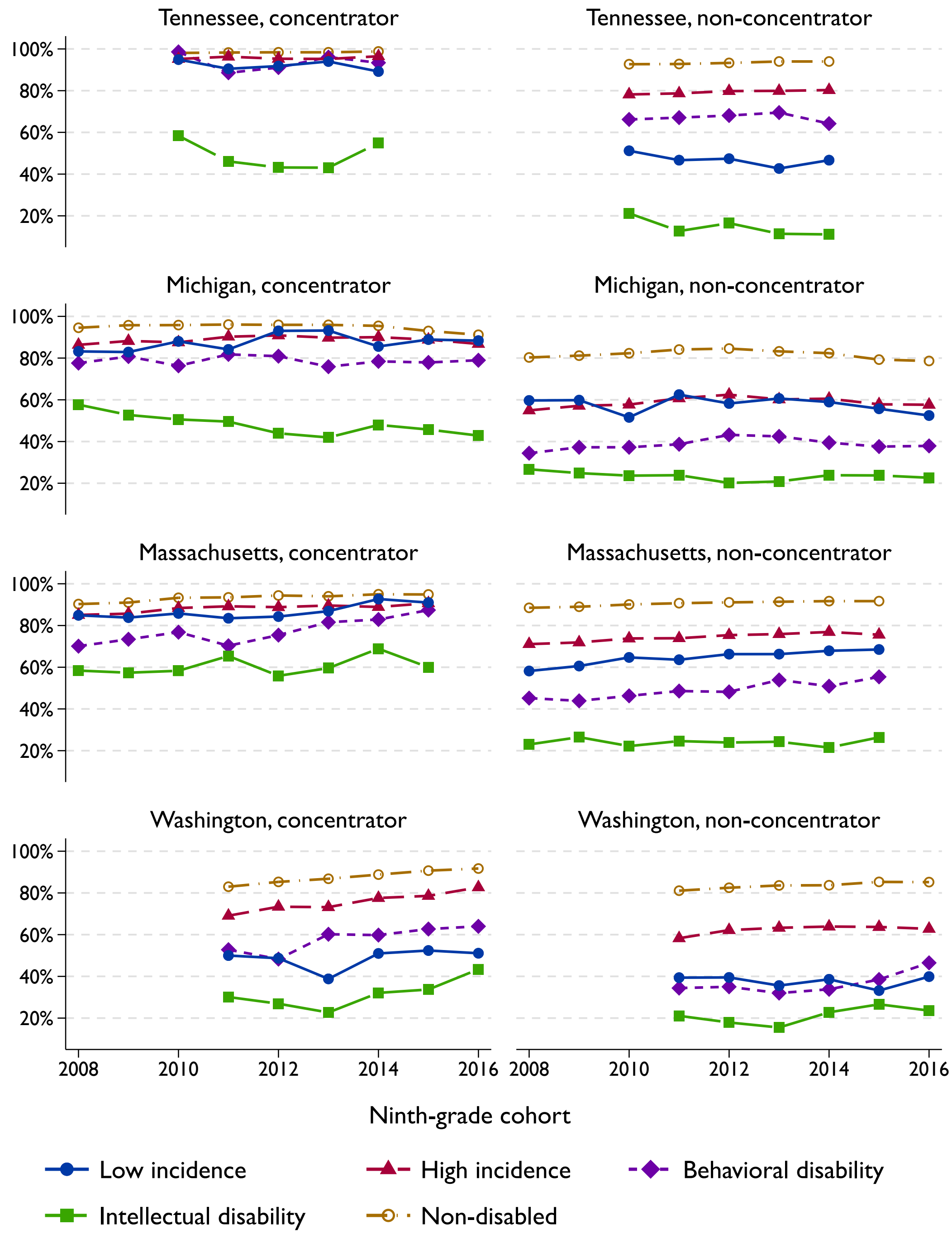
One potential inference from Figure 12 is that students with identified disabilities should be encouraged to concentrate in CTE to improve their chances of successfully completing high school, and research from a variety of settings has found that CTE can positively affect high school graduation rates. Yet, caution is warranted because much of that research has not focused specifically on students with identified disabilities, and it is possible that non-CTE students with identified disabilities graduate at lower rates for factors unrelated to their participation in or access to CTE. This is an area where more research is urgently needed.

Conclusions

In this report, we undertake a descriptive analysis of CTE trends across four states (Michigan, Massachusetts, Tennessee, and Washington) as part of the Career & Technical Education Policy Exchange—a multi-state CTE research consortium.[16] We take, as our primary participation measure, whether students reach concentrator status. This aligns to federal reporting requirements and allows us to create some semblance of homogeneity across states that have quite different measures of CTE participation. This first annual update to the report includes trends for a new state—Washington—as well as the latest-available ninth-grade cohort (2016) for Massachusetts and Tennessee.

We note caution in interpreting these results. None of our estimates should be interpreted as causal effects of CTE but rather a careful accounting of outcomes for CTE concentrators compared with high school students who did not concentrate in a CTE program.

Figure 12. High School Graduation Rate by State, Ninth-Grade Cohort, CTE Concentrator Status, and Disability Type



Notes. Each state's sample is students who were ever classified as having an identified disability and who attended high school for four consecutive years. Concentrators are defined using state-specific definitions for students who concentrate in or complete a program of study. Ninth-grade cohort is the school year for first-time ninth graders (e.g., 2016 means first-time ninth graders in SY 2015-16). See Table 1 for concentrator definitions. Disability classifications are low and high incidence, behavioral and intellectual. See Appendix Table 1 for disability classification definitions.

Our key takeaways are as follows:

- Multi-state CTE analyses are limited by definitional differences in CTE participation and completion across states.
- Concentrator rates differ in levels across states due to state-based definitions.
- Differences in concentrator rates by student groups (e.g., gender, race, ethnicity, disability status) vary across states and time. State-specific contexts matter, and national statistics mask significant and meaningful differences across states.
- While Black, Hispanic, or other non-White students are typically less likely than White students to concentrate in CTE (with some state-specific exceptions), most or all of these gaps are explained by unobserved differences in school-level factors. School-level factors likely play a meaningful role in CTE availability or take-up by non-White students. More specifically, schools with more non-White students likely have lower CTE concentration rates overall.
- Students who concentrate in a CTE program of study are more likely to graduate high school and to enroll in a two-year college but less likely to enroll in a four-year college.
- The high school graduation advantage from CTE is particularly pronounced for students with identified disabilities.

We hope this report encourages other researchers to use state longitudinal data systems to study CTE across state lines. In future updates, we will aim to refine consistent measures of CTE participation and access and follow students further into college (and, ideally, into the labor market). Promising areas for more in-depth research include efforts to understand better the differences in access to or take-up of CTE by race and the effect of CTE on secondary and post-secondary success for students with identified disabilities.

Acknowledgments

This research could not have been conducted without enthusiastic and generous participation from state partners in Massachusetts, Michigan, Tennessee, and Washington. This unique partnership through CTEx has allowed us to generate what we think is a first step in a line of research we hope will include new states, more outcomes, and greater detail as we move forward. Walt Ecton, Alfredo Martin, and Sydney Payne provided outstanding research assistance. The authors also wish to thank Maggie Reeves and Tyler Rogers for their contributions to all CTEx products.

Endnotes

1. For more information, see gpl.gsu.edu/ctex.

2. Tennessee cohorts and statistics are very similar to those reported in last year's report (Carruthers et al., 2020), the only difference being that in the current analysis we focus on on-time high school graduation (within four years of ninth grade) rather than any high school graduation.

3. Carruthers, C., Dougherty, S., Kreisman, D. & Martin, A. (2020). A multi-state analysis of trends in career and technical education: Massachusetts, Michigan, and Tennessee. Career & Technical Education Policy Exchange. Georgia Policy Labs. gpl.gsu.edu/publications/cross-state-analysis/

4. Carruthers, C., Dougherty, S., Kreisman, D. & Martin, A. (2020). A multi-state analysis of trends in career and technical education: Massachusetts, Michigan, and Tennessee. Career & Technical Education Policy Exchange. Georgia Policy Labs. gpl.gsu.edu/publications/cross-state-analysis/

5. It is not possible to consistently define CTE participants across states because in some states almost every high school student takes at least one CTE course.

6. See Program Memorandum: "Student Definitions and Measurement Approaches for the Core Indicators of Performance Under the Carl D. Perkins Career and Technical Education Act of 2006 (Perkins IV)." Troy R. Justesen. Office of Vocational and Adult Education State Administration and Accountability Group. March 3, 2007. Accessed at s3.amazonaws.com/PCRN/docs/nonregulatory/studentdef.pdf on April 27, 2021.

7. For each Program of Study, the Michigan Department of Education defines a set of standards that outline the basic contents and objectives a program should cover. To simplify monitoring and track student progress, the Michigan Department of Education defines 12 groupings of standards called segments, which are specific to each Program of Study. There are no requirements as to how many segments should be covered in one course or how many hours of instruction should be allocated to cover one segment. (Move footnote to table)

8. College enrollment comes from the National Student Clearinghouse, which covers the majority of post-secondary schools in the United States. College enrollment data are not currently available in Washington.

9. A complete crosswalk of programs of study to career clusters is available at tn.gov/content/dam/tn/education/ccte/cte/cte_pos_2018-19.pdf.

10. Strengthening Career and Technical Education for the 21st Century Act, Pub. L. No. 115-224, § 7, 132 Stat. 1563 (2018). congress.gov/115/plaws/publ224/PLAW-115publ224.pdf

11. Theobald, R., Goldhaber, D., Gratz, T., & Holden, K. (2019). Career and technical education, inclusion, and postsecondary outcomes for students with learning disabilities. Journal of Learning Disabilities, 52(2), 109-119.

12. Data for Figure 2 is drawn from the U.S. Department of Education Perkins Collaborative Research Network: cte.ed.gov/profiles/national-summary.

13. We do not yet have access to college enrollment data in Washington but expect to be able to include those data in the next annual report.

14. Massachusetts has one of the highest rates of four-year college attendance of any state.

15. Newman, L., Wagner, M., Cameto, R., & Knokey, A.-M. (2009). "The Post-High School Outcomes of Youth with Disabilities up to 4 Year After High School. National Longitudinal Transition Study-2 (NLTS2)." SRI International.

Newman, L., Wagner, M., Cameto, R., Knokey, A.-M., & Shaver, D. (2010). "Comparisons Across Time of the Outcomes of Youth with Disabilities up to 4 Years after High School. A Report of Findings from the National Longitudinal Transition Study (NLTS) and the National Longitudinal Transition Study-2 (NLTS2). NCSER 2010-3008." National Center for Special Education Research.

Sanford, C., Newman, L., Wagner, M., Cameto, R., Knokey, A.-M., & Shaver, D. (2011). "The Post-High School Outcomes of Young Adults with Disabilities up to 6 Years After High School. Key Findings from the National Longitudinal Transition Study-2 (NLTS2). NCSER 2011-3004." National Center for Special Education Research.

16. For more information, see gpl.gsu.edu/ctex

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Thomas Goldring is the director of research at the Georgia Policy Labs. He supports the faculty directors in managing research projects and providing analytical and technical support across GPL's three components. His research focuses on K-12 education, including educational accountability, school finance, and graduation rates; early childhood education; career and technical education; post-secondary education; and education and mortality. He received his doctorate in public policy and management from Carnegie Mellon University and completed a post-doctoral fellowship at the University of Michigan.

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About the Georgia Policy Labs

The Georgia Policy Labs is an interdisciplinary research center that drives policy and programmatic decisions that lift children, students, and families—especially those experiencing vulnerabilities. We produce evidence and actionable insights to realize the safety, capability, and economic security of *every* child, young adult, and family in Georgia by leveraging the power of data. We work alongside our school district and state agency partners to magnify their research capabilities and focus on their greatest areas of need. Our work reveals how policies and programs can be modified so that every child, student, and family can thrive.

Housed in the Andrew Young School of Policy Studies at Georgia State University, we have three components: the Metro Atlanta Policy Lab for Education (metro-Atlanta K-12 public education), the Child & Family Policy Lab (supporting children, families, and students through a cross-agency approach), and the Career & Technical Education Policy Exchange (a multi-state consortium exploring high-school based career and technical education).

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