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A Multi-State Study of Equity in Career and Technical Education

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Key Findings

- We find that student demographic characteristics strongly predict CTE participation and intensity but show that these differences are primarily driven by schools. Within schools, differences in CTE course-taking are much smaller and, in some cases, zero.
- Further, we show that, with the exception of gender, few clear demographic patterns emerge across states. Black and Hispanic students take more CTE courses in some locations and fewer courses in other locations. The same is true for other characteristics (e.g., free/reduced-price lunch status). We show that is in part a function of varying urbanicity across the sample states.
- We show student characteristics are predictive of which CTE clusters student engage in, particularly for gender.
- Our key headline is that disparities in CTE course-taking across demographic groups—in particular race and ethnicity—are largely a function of which schools students attend. Hence, future work on equity in CTE should focus on across-school disparities in offerings and participation.

Introduction

Career and Technical Education (CTE) is a vital component of secondary schooling in the United States. Once considered a "vocational track" for students who were not bound for college, CTE is now interwoven into the fabric of the secondary curriculum with hundreds of courses in aligned CTE pathways across 17 nationally-recognized career clusters. These courses and pathways are designed to prepare students for both college and careers, acknowledging the importance of work-based skills in post-secondary schooling and the labor market.

CTE can raise high school graduation rates, increase college enrollment, and boost earnings after school.[1] However, it is less clear if students have equitable access to CTE regardless of their gender, race, ethnicity, family income, or disability identification (factors related to other educational opportunity measures). To date, an equity focus is largely absent from the CTE research literature,[2] despite the fact that it adds necessary depth to the ongoing question of whether and how students benefit from modern CTE.

This report describes differences in CTE participation by students' demographic characteristics, economic disadvantage, and disability identification in four states with very different populations and secondary CTE structures. We rely on administrative course-taking records from Massachusetts, Tennessee, the state of Washington, and metro Atlanta. Our multi-state analysis provides a wealth of insights that cannot be gleaned from national surveys or a single location's data, but this approach does have challenges. The scope of CTE course designations and definitions of concentration vary widely across locations.[3]

Our analysis builds on an initial study of the Atlanta metro region[4] where we analyze CTE participation and sorting among CTE clusters across and within schools—focusing on differences by student demographics. We follow this pattern of analysis here. In particular, we ask whether a student's CTE participation, concentration, and cluster are significantly related to their demographics, economic circumstances, or disability identification.

Our analysis is organized around three questions:

1. Does CTE participation differ by student gender, race, ethnicity, family income, or disability identification?
2. Are differences in CTE participation due to differences in availability across schools, or are they a product of different take-ups across groups within the same school?
3. Do student characteristics differ across CTE career clusters?

To preview results, we find meaningful differences in CTE participation across schools, especially by race, but these differences are much smaller when we compare students within the same school. We also find that racial differences in CTE participation vary across locations. In particular, Black students take *fewer* CTE courses than White students in non-urban areas but take *more* CTE courses in urban centers on average. We also show that students sort into particular CTE clusters in ways that resemble gender segregation across occupations in the labor market. Policymakers and school leaders should be aware that schools and broader inequities may play a decisive role in determining equity in CTE participation.

Sample and Context

This study is made possible through the Career & Technical Education Policy Exchange (CTEx), which is a multi-state research-practice partnership in the Andrew Young School of Policy Studies at Georgia State University.[5] CTEx is a consortium of academic researchers and state partners working together to provide actionable, evidence-based responses to pressing questions on CTE policy and practice. Through these partnerships, CTEx researchers have access to administrative databases containing student- and school-level information spanning many years. This study utilizes four of these researcher-state partnerships from metro Atlanta (four large school districts), Massachusetts, Tennessee, and Washington.

Using these administrative records, we first analyze CTE participation. We match course enrollment records to student characteristics and CTE pathways, focusing on cohorts with four complete years of matched data. The years of data vary across locations. In Atlanta, these data cover cohorts who entered Grade 9 between 2010-14; the Tennessee analysis is limited to the 2013 cohort;[6] the Massachusetts sample includes cohorts who entered Grade 9 between 2010-14; and the Washington sample includes cohorts who entered Grade 9 between 2011-16. For each state, we observe all courses students take, and we link specific CTE courses to their program of study and career cluster.[7]

Student characteristics include race and ethnicity,[8] gender, whether the student was ever identified as economically-disadvantaged or eligible for free or reduced-price meals, and whether the student was ever classified as having an identified disability. In Tennessee, we do not directly observe if individual students are economically-disadvantaged and use a school-level average where noted.

We make one meaningful limitation to our sample by focusing on students observed in all grades 9-12, including those who repeat a grade and those who do not graduate. This allows us to compare CTE credit accumulation over students' entire high school careers. Mechanically, we do not see as many courses for students enrolled three or fewer years. This limitation comes at the cost of omitting students who leave high school before Grade 12, transfer out of state, transfer out of public schools, or transfer into the system after Grade 9.

Table 1. Sample Means by State

	Metro Atlanta		Massachusetts	
	Share of sample	Avg. CTE credits/ courses	Share of sample	Avg. CTE credits/ courses
Female	0.53	3.33	0.49	1.84
Male	0.47	3.49	0.51	2.69
Black	0.61	4.02	0.09	1.74
White	0.21	1.98	0.65	2.49
Hispanic	0.08	3.56	0.17	1.93
Other race/ethnicity	0.10	2.47	0.09	1.95
Economically disadvantaged	0.62	4.02	0.35	2.19
Not econ disadvantaged	0.38	2.41	0.65	2.32
Any disability	0.08	3.86	0.20	2.10
No disability	0.92	3.36	0.80	2.32
Observations	68,330		283,248	
	Tennessee		**Washington**	
	Share of sample	Avg. CTE credits/ courses	Share of sample	Avg. CTE credits/ courses
Female	0.49	7.76	0.49	3.81
Male	0.51	7.80	0.51	4.36
Black	0.23	7.10	0.04	4.04
White	0.68	8.08	0.59	4.07
Hispanic	0.06	7.36	0.18	4.49
Other race/ethnicity	0.03	7.07	0.19	3.78
Economically disadvantaged			0.44	4.41
Not econ disadvantaged			0.56	3.84
Any disability	0.11	7.85	0.11	4.32
No disability	0.89	7.19	0.89	4.06
Observations	65,065		440,338	

Notes. Sample is comprised of students observed in all grades 9-12. Race is categorized mutually exclusively. Economic disadvantage is determined as ever-eligible for free/reduced-price meals. Disability status is defined as ever classified as having an identified disability.

Table 1 shows summary statistics for each location along with the average number of CTE credits accumulated by students of different gender, race, ethnicity, economic status, and disability identification.[9]

These four locations have widely different student populations as shown in Table 1. Notably, the majority (59-68%) of students in the Tennessee, Massachusetts, and Washington data are White, whereas the data from the

Atlanta-area schools have a majority of Black students (61%). The share of Hispanic students is two to three times as large in Massachusetts (17%) and Washington (18%) as in Atlanta (8%) or Tennessee (6%). These racial and ethnic categories are admittedly coarse. For example, in Washington, almost one in five students are not Black, Hispanic, or White.

Additionally, differences in the sample appear in other categories. The Atlanta metro region has the highest share of students identified as economically-disadvantaged at 62%, followed by Washington at 44% and Massachusetts at 35%. The share of students with an identified disability varies across states from 8% in Tennessee to 20% in Massachusetts.

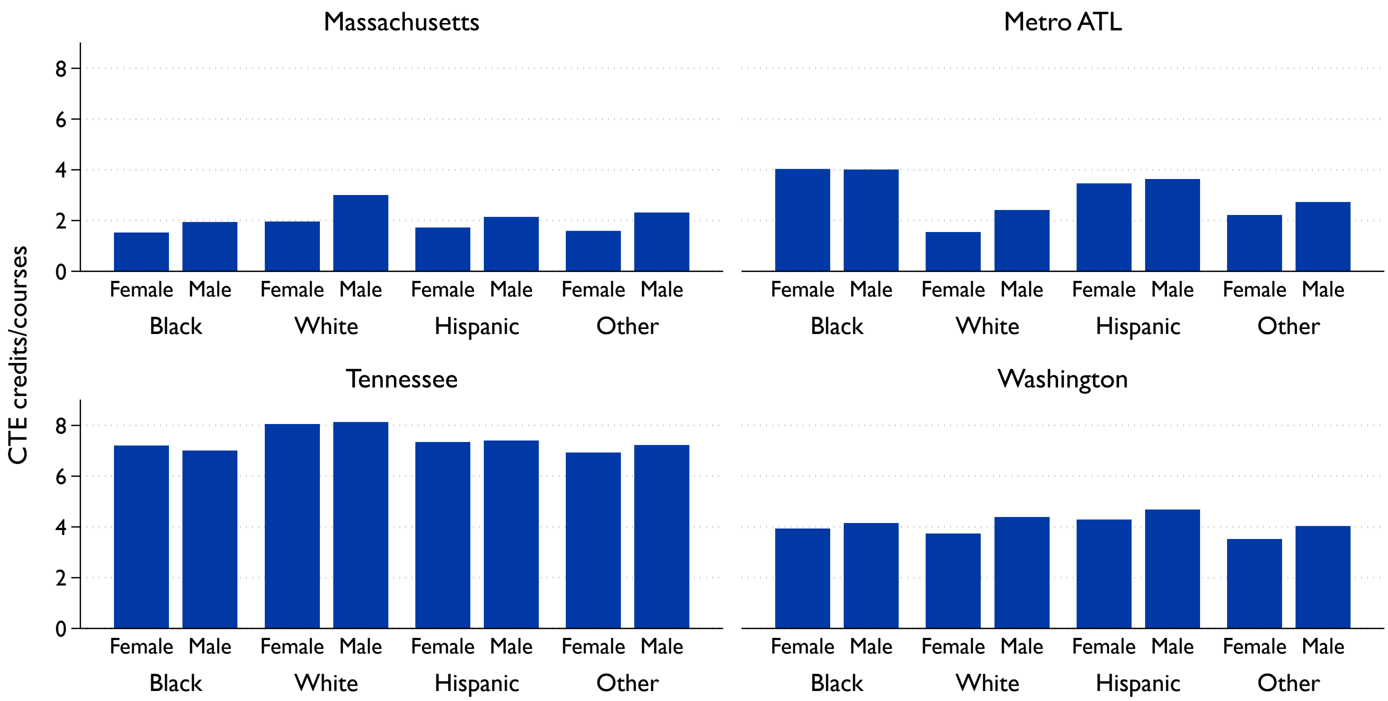
Concerning the number of CTE credits students take, we also observe wide variation in the total number of credits and in differences across groups. In Tennessee, students take almost eight CTE credits on average. We note that many of Tennessee's CTE-designated courses overlap with popular courses,[10] and 45% of graduates have a CTE concentration.[11] In Washington and metro Atlanta, the typical student takes just over three CTE credits. Massachusetts students take the fewest credit (just over two on average), reflecting that state's focus on stand-alone technical schools rather than CTE pathways within comprehensive high schools.

Descriptive Results

CTE Participation, Credit Accumulation, and Concentration by Race and Ethnicity and Gender

Figure 1 plots the average number of credits earned in CTE courses by race and ethnicity and gender in each location. We observe meaningful differences in CTE credit accumulation across these categories, which vary across states. In metro Atlanta, Black and Hispanic students accumulate about twice as many CTE credits over four years as White students (particularly White female students). In Tennessee and Massachusetts, by contrast, White students accumulate more CTE credits than non-White students but by a smaller proportion compared to the higher numbers of credits for Black students in Atlanta. In Washington, CTE credit accumulation varies little by race and ethnicity. Hence, racial and ethnic differences in CTE course-taking vary both in magnitude *and* direction across locations. This highlights the importance of state and local contexts while pushing back against broad, sweeping narratives concerning CTE participation by race and ethnicity.

Figure 1. CTE Credits by Race, Gender, and Location

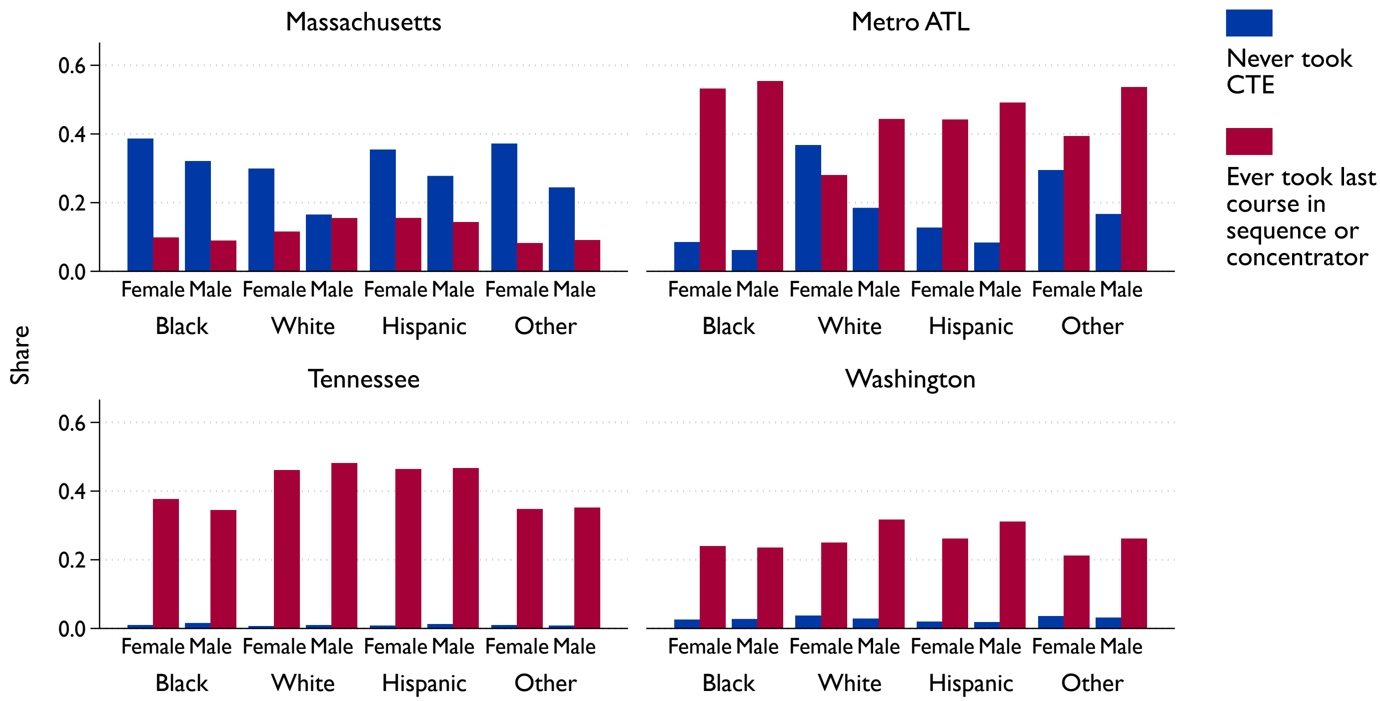


Notes. Figure plots CTE credits earned. Sample is comprised of students observed in all grades 9-12. Race is categorized mutually exclusively.

In Figure 2, we ask if there are differences in (a) never taking a CTE course or (b) reaching concentrator status across the same demographic categories. Concentrator definitions vary across states.[12] In Tennessee and Washington, concentrators have taken three or more credits in a program area. In contrast, Massachusetts concentrators are defined as students who took coursework in the same program of study for three or more years. In metro Atlanta, we do not observe a direct measure of credits and instead use a proxy measure of whether students reached a final course in a three-course sequence—an easily identifiable indicator for completing a program of study.[13]

There are almost no students in Tennessee or Washington who have never taken a CTE course. The same is not true in metro Atlanta or Massachusetts. In metro Atlanta, we observe wide variation at the intersection of race, ethnicity, and gender. Nearly all Black students in metro Atlanta take at least one CTE course, whereas 40% of the region's White female students and 20% of White male students never take a CTE course in high school. Moreover, far more Black and Hispanic students in Atlanta make it to the third course in a

Figure 2. Share of Students Never Taking CTE and Share Reaching Concentrator Status



Notes. Figure plots CTE credits earned. Sample is comprised of students observed in all grades 9-12. Race is categorized mutually exclusively. In metro Atlanta, concentrators are defined by having ever-taken the final course in a pathway.

sequence, whereas White female students are more likely to take zero CTE courses than complete a sequence.

In Massachusetts, a large share of students never take a CTE course, and concentration rates are relatively low. This is primarily due to the state's use of Regional Vocational Technical Schools (RVTS), which are application-based stand-alone schools with an explicit CTE focus. In this bifurcated system, the share of students concentrating in CTE is relatively similar across race and ethnicity and gender. However, Black students have both the lowest concentration rate and lowest participation rates overall, and White male students are most likely to have taken at least one CTE course.

In Tennessee, we find that White and Hispanic students are most likely to concentrate in CTE. Gender gaps in concentration rates flip between Black students (where females are more likely to concentrate in CTE) and White students (where males are more likely), but both differences are small. In Washington, differences are more muted across race and ethnicity and gender with White and Hispanic males being the most likely to become CTE concentrators.

CTE Credit Accumulation Across and Within Schools

Racial and ethnic differences in CTE course-taking and concentration lead to our second question of whether these gaps are an across-school phenomenon, a within-school phenomenon, or some mix of both. That is, do students take fewer CTE courses because they attend schools with lower CTE participation in general (whether because of availability or take-up), or do these differences exist within schools as well? To answer these questions, we compare CTE credit accumulation both across and within schools using the following regression model:

$$CTE_{itj} = \alpha + \beta_1 Race_i + \beta_2 Econ_i + \beta_3 Disabil_i + \beta_4 Scores_i + \phi Cohort_t \, [+ \theta School_j] + \epsilon_{ijt}$$

The outcome is the number of CTE credits student *i* in ninth-grade cohort *t* who attended school *j* took in grades 9-12.[14] The interpretation of each of the β coefficients tells us how many more or few CTE credits students in that group take compared to a reference group or omitted category.[15] The inclusion of a cohort fixed effect ($\phi Cohort_t$) means we are comparing students in the same ninth-grade cohort and controlling for temporal changes in CTE course-taking.[16] We first estimate the model without school fixed effects ($\theta School_j$), meaning we first compare CTE credit accumulation across all students regardless of which school they attend.

We then re-estimate the same equation adding school fixed effects. With school fixed effects in the regression, we are comparing differences in CTE credit accumulation across student subgroups *within* schools. If coefficients on the βs are similar across the two regression models, we might conclude that schools play a small role in different levels of CTE take-up by race, gender, disability identification, and income. If they are different, we can assess whether the variation is larger across or within schools. Table 2 shows results from both models. For each state, the first column shows across-school results, and the second column shows within-school results.

In column 1 (the metro-Atlanta "Across" model without school fixed effects), we find that female students take 0.193 fewer CTE credits than male students on average. In the column 2 "Within" school model for metro Atlanta, we find approximately the same relationship (-0.195). Because schools have roughly an equal proportion of male and female students, this result is not surprising. We find similar results for gender in the other states. The bottom row of the table lists average CTE credits for each location to help give a sense of the magnitude

Table 2. Across and Within School Differences in CTE Credit Accumulation Across States

	Metro Atlanta		Tennessee		Massachusetts		Washington State	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Across	Within	Across	Within	Across	Within	Across	Within
Female	-0.193**	-0.195**	-0.0237	-0.0291	-0.289***	-0.292***	-0.518**	-0.517**
	(0.0712)	(0.0695)	(0.0378)	(0.0340)	(0.00245)	(0.00202)	(0.008)	(0.007)
Black	1.281***	0.444**	-1.138***	-0.112	-0.296***	-0.0555***	-0.408**	-0.190**
	(0.155)	(0.141)	(0.159)	(0.0667)	(0.00442)	(0.00424)	(0.019)	(0.018)
Hispanic	0.795***	0.406**	-0.801***	-0.0929	-0.208***	-0.0479***	0.010	-0.066**
	(0.231)	(0.131)	(0.122)	(0.0538)	(0.00357)	(0.00345)	(0.011)	(0.011)
Other race/ethnicity	0.223	0.00564	-0.984***	-0.144*	-0.155***	-0.0264***	-0.342**	-0.245**
	(0.168)	(0.1000)	(0.121)	(0.0712)	(0.00428)	(0.00371)	(0.010)	(0.009)
Econ. disadvantage	0.762***	0.204***	0.00501		-0.0110***	-0.0249***	0.326**	0.083**
	(0.110)	(0.0504)	(0.00601)		(0.00292)	(0.00249)	(0.008)	(0.008)
Any disability	0.0507	0.0897	-0.245**	-0.0970	-0.252***	-0.152***	-0.443**	-0.333**
	(0.0883)	(0.0819)	(0.0913)	(0.0695)	(0.00333)	(0.00290)	(0.013)	(0.012)
Grade 9-12 ELA (Z)	-0.196***	-0.100***	-0.232***	-0.0663*	-0.0623***	-0.0312***	-0.189**	-0.175**
	(0.0280)	(0.0243)	(0.0474)	(0.0265)	(0.00191)	(0.00162)	(0.006)	(0.005)
Grade 9-12 math (Z)	-0.0838*	-0.00663	0.00264	0.0119	-0.0555***	-0.0157***	-0.345**	-0.303**
	(0.0325)	(0.0230)	(0.0445)	(0.0278)	(0.00183)	(0.00155)	(0.006)	(0.005)
School FE		X		X		X		X
Cohort FE	X	X	X	X	X	X	X	X
Observations	68,330	68,318	61,978	61,978	734,594	734,594	440,338	440,338
Mean CTE credits	3.4	7.8	2.3	4.1				

Notes. Dependent variable is CTE credits earned. Sample is comprised of students observed in all grades 9-12. Race is categorized mutually exclusively. Economic disadvantage is determined as ever-eligible for free/reduced-price meals. Disability status is defined as ever classified as having an identified disability. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

of each regression estimate. In column 1, the -0.193 female deficit in CTE credits is about 6% of the 3.4 credit average.

We next turn to results for race and ethnicity. In metro Atlanta, looking across schools (column 1), we find that Black students take 1.2 more CTE credits than White students. Yet, in the other three states, Black students take *fewer* CTE credits on average (columns 3, 5, and 7). When comparing regression estimates across locations, keep in mind that Tennessee has the highest average number of CTE credits (almost eight), Massachusetts has the fewest (almost two), the Atlanta average is 3.4, and the Washington average is four. Relative to these averages, Atlanta's Black-White difference across schools is quite large: Black students take 38% more CTE credits than White students. In Tennessee and

Massachusetts, Black students take 15% fewer CTE credits on average and 10% fewer on average in Washington.

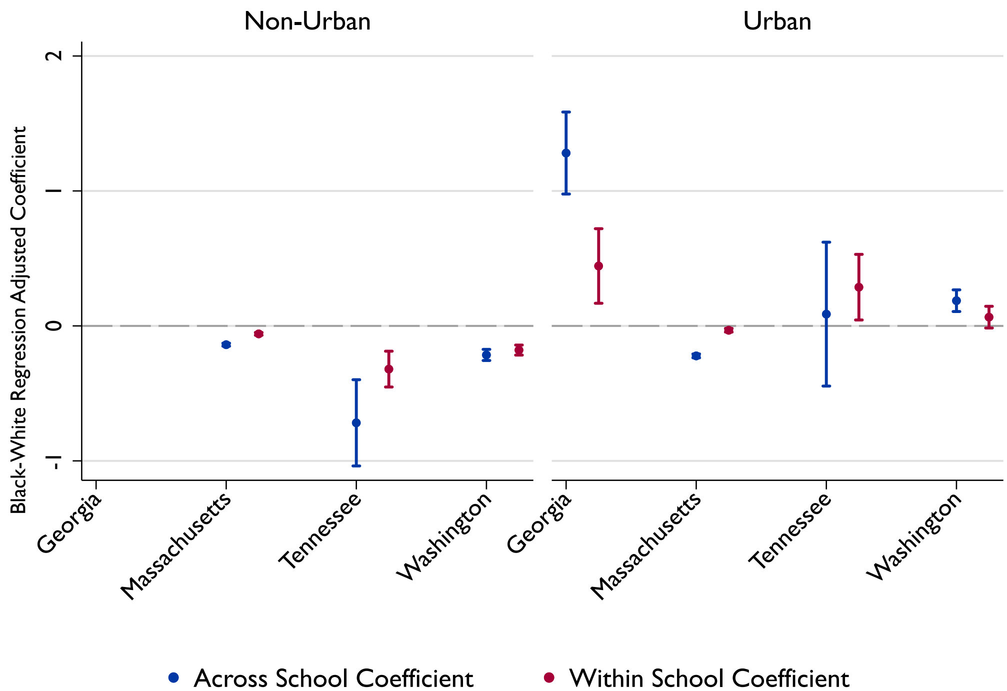
Yet, when we compare *within* schools (columns 2, 4, 6, and 8 drawn from regression estimates with school fixed effects), Black-White differences dramatically shrink. The difference drops to only 0.4 credits in Atlanta; the difference is effectively zero in Tennessee and Massachusetts; and the difference is less than 0.2 credits in Washington. *These results imply that Black-White variation in course-taking is largely driven by across-school differences in CTE availability or take-up, and that within schools, differences in CTE credit accumulation are small.*

The same analysis can be applied to any other covariate in Table 2. First, we note a similar pattern emerges with respect to economic disadvantage.[17] In metro Atlanta and Washington, economically-disadvantaged students take more CTE credits, while they take less in Massachusetts. In each case, these differences are much smaller when we compare students in the same school. In the three statewide samples, students with an identified disability tend to take fewer CTE courses than students without an identified disability, but again, the gap is narrower within the same school. In metro Atlanta, however, there is no significant difference in CTE course-taking related to disability identification either across or within schools. There are several other inconsistencies in the magnitude, direction, and relative size of regression estimates from different locations (a conclusion in and of itself that we return to later in this report).

While we show that the relationship between race and CTE credit accumulation differs across states, we acknowledge that these states have different racial compositions in part along urban/non-urban lines. To investigate what role this plays, we re-estimate our regression model separately for urban and non-urban districts (with the exception of metro Atlanta). We focus on differences between Black and White students in CTE credit accumulation. Figure 3 shows the results.

In non-urban districts, we find that White students take fewer CTE courses on average in both our across- and within-school regressions. In urban districts in Tennessee and Washington, Black students take *more* CTE credits than their White peers. In Massachusetts, differences across urban and non-urban districts are small, again reflecting that students can travel to CTE-specific schools. These results suggest that racial patterns of CTE participation are in part a function of urbanicity. We believe this is an important avenue for future research to explore in more depth.

Figure 3. Regression-Adjusted Black and White Student Differences in CTE Credits, by Urban/Non-Urban Districts



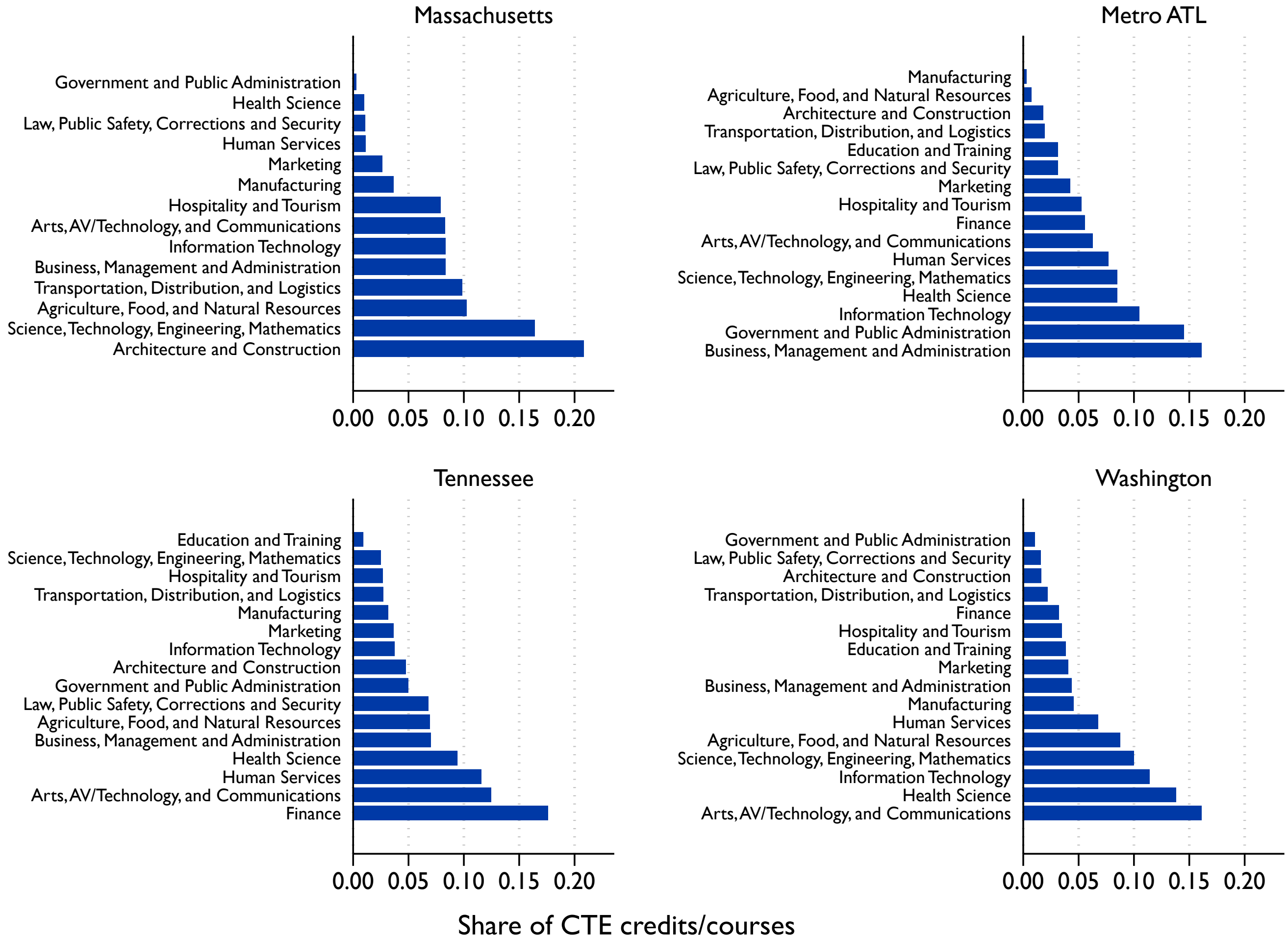
Notes. Figure plots coefficient on Black from regression model in Table 2 separately for urban and non-urban districts. Dependent variable is CTE credits accumulated in high school. Sample is comprised of students observed in all grades 9-12.

(Dis-)Proportionality Across CTE Clusters?

We now turn our attention to *which* CTE courses students take and in which career clusters they specifically engage.

Figure 4 plots the percent of all CTE credits taken in each cluster by location. It is immediately apparent that there is wide variation across states in which clusters are most popular (or at least which clusters account for the majority of CTE credits taken among all students). No single cluster is in every location's top five. Government and Public Administration accounts for almost 15% of all CTE credits in the Atlanta metro region,[18] while it accounts for only 1% of credits in Massachusetts, and it is last in Washington as well. In Massachusetts, Architecture and Construction and Science, Technology, Engineering, and Math (STEM) are the two most-popular clusters, accounting for nearly 40% of all credits. In Tennessee, Finance accounts for roughly 17% of all CTE credits, by far that state's most popular cluster.[19] In Washington, Arts/AV/Technology & Communications, Health Science, and Information Technology collectively

Figure 4. Share of Credits Taken in Each Cluster Across States

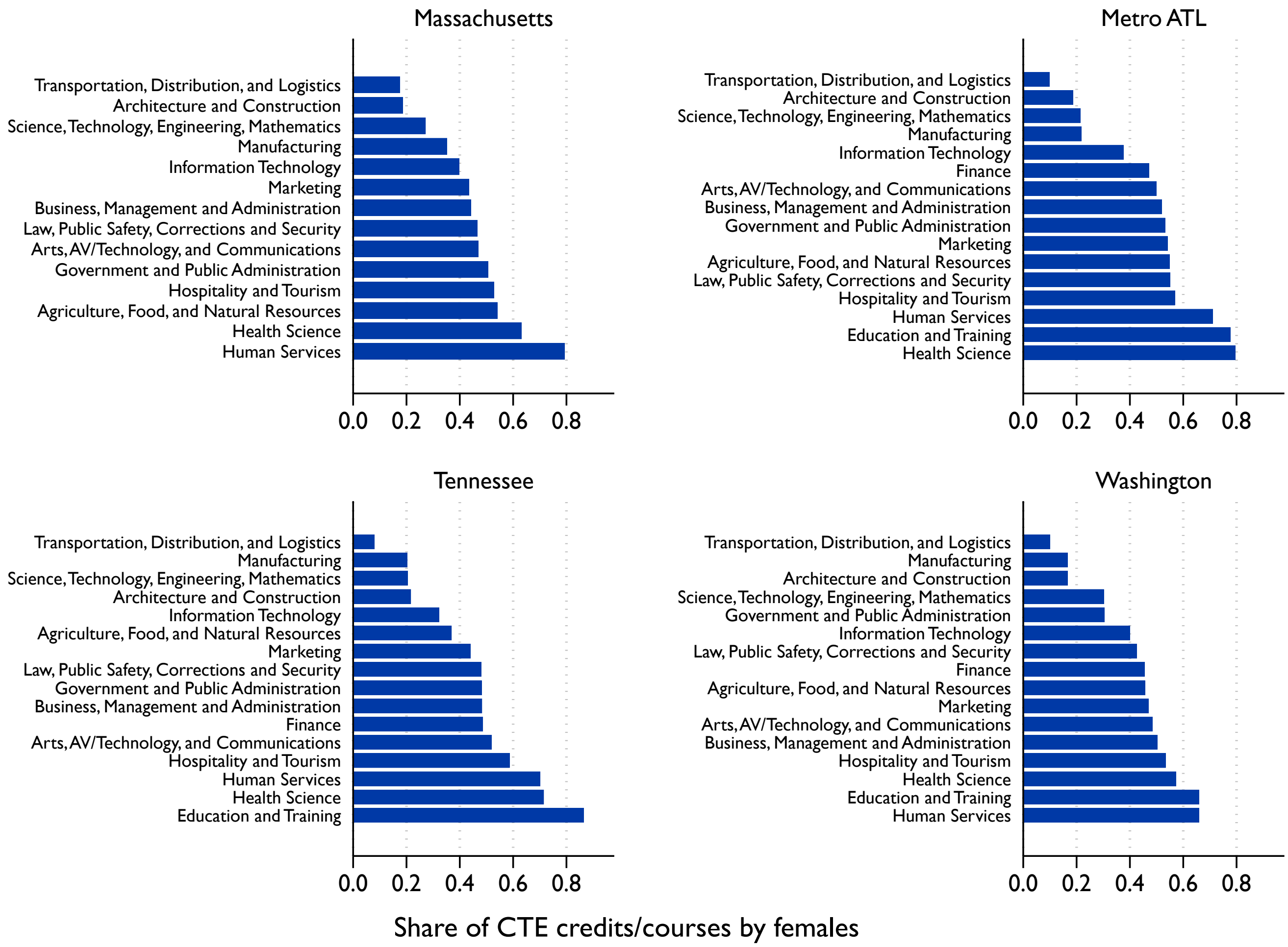


Notes. Figure plots share of all CTE credits earned in each cluster. Sample is comprised of students observed in all grades 9-12.

account for over 40% of all CTE credits. With these plots as a baseline for comparison, we next assess gender differences in cluster participation across and within states.

Figure 5 plots the share of credits *within* each cluster attributed to female students. Metro Atlanta and Tennessee have more clusters approaching or exceeding 50% female, which is consistent with Table 1 (where we show that male and female students take a similar number of CTE credits in those locations). In Washington, female students typically take 0.5 fewer credits than male students (13%), and in Massachusetts, female students take 0.85 fewer credits (32%). Similarly, those locations have fewer clusters at or above 50% female in Figure 5.

Figure 5. Share of Credits Taken by Female Students in Each Cluster

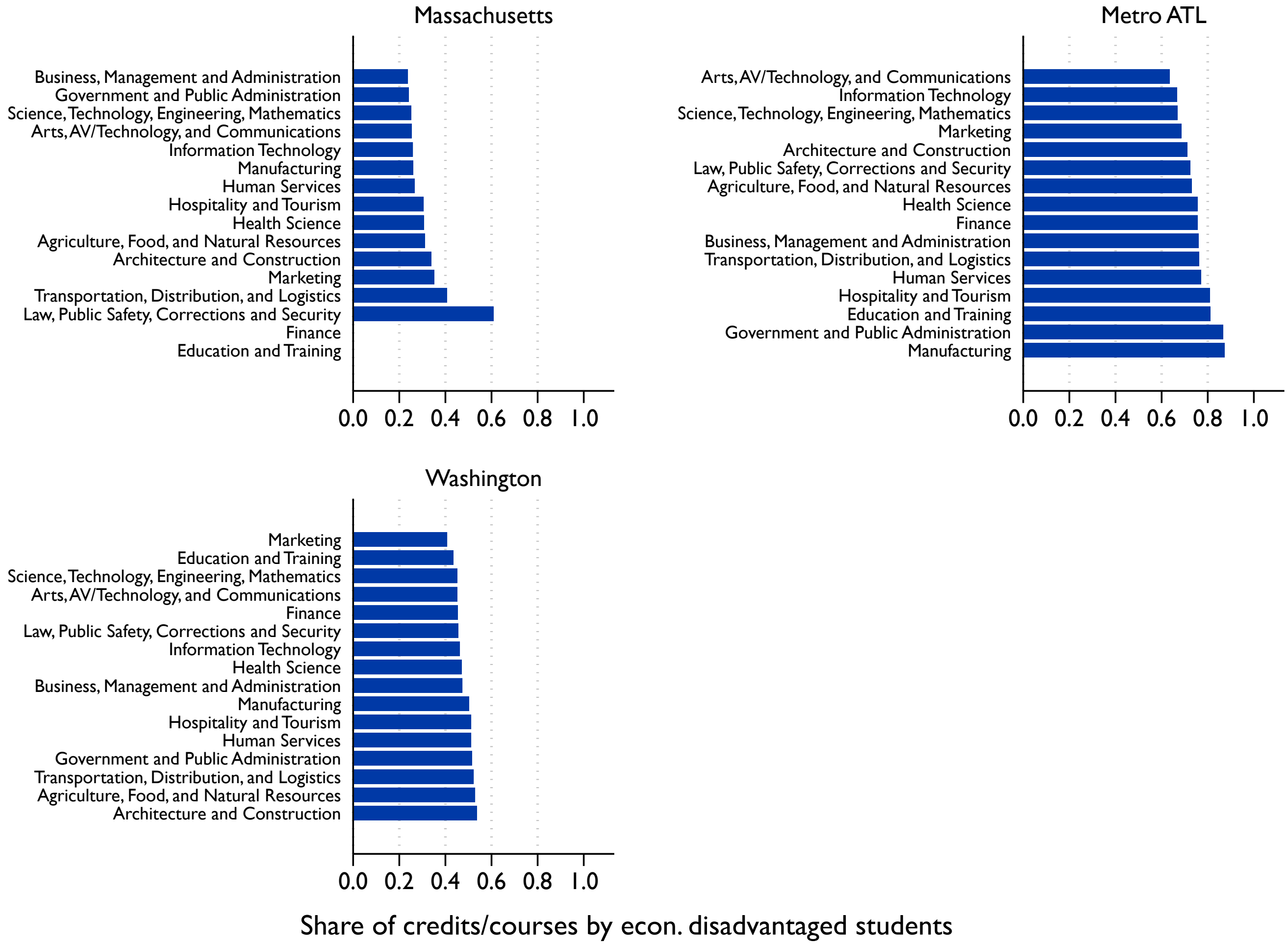


Notes. Figure plots share of all CTE credits earned in each cluster by female students. Sample is comprised of students observed in all grades 9-12.

Figure 5 reveals several heavily-gendered CTE clusters, with many in common across states. Education and Training, Health Sciences, and Human Services are the most female-dominated clusters in all states.[20] Across all four locations, female students take more than 60% of credits in these fields. These are also heavily populated clusters in general, accounting for a large share of all CTE credits accumulated in these states. *There is a higher degree of gender bifurcation within CTE than would be suggested by differences in overall credits and concentration.*

In addition, several clusters are heavily male dominated. For example, fewer than 20% of credits in Transportation, Distribution and Logistics are taken by female students in any location. Manufacturing, Architecture and Construction

Figure 6. Share of Credits Taken by Students Ever Identified as Economically Disadvantaged



Notes. Figure plots share of all CTE credits earned in each cluster by students ever identified as economically disadvantaged. Sample is comprised of students observed in all grades 9-12.

and STEM are also disproportionately male. Yet, coursework in Business, Management and Administration; Finance; and Marketing are more in balance. Taken together, a relatively clear result emerges within and across states. Non-financial service clusters (e.g., Education and Training, Health Science, and Human Services) are disproportionately female, while clusters leading to what are often manual trades and STEM are disproportionately male. These differences foreshadow gender segregation in the labor market and also in college majors.

In Figure 6, we repeat the same exercise for students ever identified as economically-disadvantaged in their respective states (except for Tennessee where we do not observe individual economic indicators). Each bar illustrates the percent of credits in a particular location and career cluster earned by economically-disadvantaged students. Except for the Law, Public Safety, Corrections and Security cluster in Massachusetts, which accounts for less than 2% of all CTE credits in that state, differences in the economic profile of clusters are smaller than those by gender. These relatively smaller differences suggest that economic disadvantage does not play as large of a role in cluster offerings or take-up as does gender.

Discussion and Conclusions

A growing body of research shows that CTE benefits short-term educational and career outcomes. This leads to the question of whether all students have equitable access to CTE across and within diverse state and local settings. We take on three pieces of this broader question: (a) Does CTE participation differ by student gender, race, ethnicity, family income, or disability identification?; (b) Are differences in CTE participation due to differences in availability across schools, or are they a product of different take-up across groups within the same school?; and (c) Do student characteristics differ across CTE career clusters? We ask these questions with the advantage of administrative data describing three states and one large metro region. This is the first study we know of to bring all of these factors together. We highlight three findings.

First, while student characteristics like race and ethnicity, gender, economic disadvantage, or disability identification predict CTE course-taking, there are wide differences across states in these relationships. For example, racial and ethnic differences emerge in all states, though not always in the same direction. White students take the fewest CTE credits in the metro Atlanta region, while in Massachusetts and Tennessee, they take the most. Broad generalizations about the relationship between CTE and race and ethnicity may not be warranted without careful consideration of state and local factors.

Second, differences in CTE credit accumulation across race and ethnicity, economic status, and disability identification are generally larger across schools than within them. This implies that the differences we observe in CTE credit accumulation (e.g., between Black and White students) might be due to differences in school-level access to these courses or typical CTE enrollment rates across schools with higher or lower proportions of non-White students. In other words, schools with more non-White students in Massachusetts, Tennessee, and Washington have less CTE course-taking, leading to statewide CTE enrollment differences with higher rates for White students. Looking within schools, however, the CTE participation gap is much smaller in those states.

Third, we find that male and female students concentrate in a very different mix of CTE career clusters, mirroring gender differences across occupations in the labor market. Service-focused clusters such as Health Science, Education and Training, and Human Services are disproportionately female, while trade-focused clusters like Manufacturing and Architecture and Construction are disproportionately male. School-level differences in available clusters are probably not a factor here as there is little variation in the proportion of male and female students across schools.

Next Steps for Research and Policy

Our descriptive findings begin to address the question of equitable access to high-school-based CTE and highlight a few avenues for further research as well as policy implications for promoting equity in CTE.

First and foremost, we find that different rates of CTE participation by student race and ethnicity are largely explained by participation gaps across schools rather than within schools. A next step in this line of analysis is to understand better which schools have disproportionately low CTE participation rates and why that might be the case. Another natural follow-on question is whether students have equitable access to *high-quality* CTE, which will require careful, evidence-based assessments of program effectiveness and labor market alignment.

Second, results point to gender differences in the CTE courses students take across and within schools. This suggests that the gender dichotomies we observe in the labor market may begin early in students' academic careers. Why male and female students enroll in different courses is beyond the scope of our analysis and likely requires complementary qualitative research to uncover the mechanisms at play. Yet, acknowledging these differences might encourage districts and states to pay close attention to the lack of gender parity in enrollment across CTE clusters.

Finally and possibly most interesting, we document wide variation in CTE course-taking patterns across states. State and local contexts likely play a strong role in these inconsistencies, which we may overlook in national survey data that pool students across many states. Decentralized state and local autonomy is part of that context and part of the variation in CTE take-up that we document here. Yet, this decentralization also offers a promising set of grounded and locally relevant levers to address differences in equitable access to CTE.

Endnotes

1. Kemple, J. J., & Willner, C. J. (2008). *Career academies: Long-term impacts on labor market outcomes, educational attainment, and transitions to adulthood* (pp. 4-5). New York, NY: MDRC

Mane, F. (1999). Trends in the payoff to academic and occupation-specific skills: the short and medium run returns to academic and vocational high school courses for non-college-bound students. *Economics of Education Review*, *18*(4), 417-437

Dougherty, S. M., Gottfried, M. A., & Sublett, C. (2019). Does Increasing Career and Technical Education Coursework in High School Boost Educational Attainment and Labor Market Outcomes? *Journal of Education Finance*, *44*(4), 423-447

Hemelt, S. W., Lenard, M. A., & Paeplow, C. G. (2019). Building bridges to life after high school: Contemporary career academies and student outcomes. *Economics of Education Review*, *68*, 161-178

Kreisman, D., & Stange, K. (2020). Vocational and career tech education in American high schools: The value of depth over breadth. *Education Finance and Policy*, *15*(1), 11-44.

2. Kim, E. H., Flack, C. B., Parham, K., & Wohlstetter, P. (2021). Equity in Secondary Career and Technical Education in the United States: A Theoretical Framework and Systematic Literature Review. *Review of Educational Research*, 0034654321995243.

3. See 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/ for a cross-state analysis of CTE, including a discussion of measurement and definitions.

4. Kreisman, D., & Villero, J. (2021). High school CTE in the Atlanta metro region: An overview focused on access and equity. Career & Technical Education Policy Exchange. Georgia Policy Labs. gpl.gsu.edu/publications/ctae-equity-in-access.

5. Read more about our model at gpl.gsu.edu/ctex.

6. Tennessee re-grouped and re-organized over 200 CTE pathways into fewer than 60 around the time that the 2013 ninth-grade cohort entered high school. Matched course-to-pathway data are not available for earlier cohorts.

7. For courses that align with multiple clusters or pathways, we designate a primary pathway/cluster (i.e., the one with the most students from that course). This choice has minimal impact on results.

8. Some of the administrative data systems in this study record Hispanic ethnicity as distinct and mutually exclusive from Black, White, and other races. We do so as well for consistency, but we acknowledge that this oversimplifies racial and ethnic identity.

9. We focus on CTE courses rather than sequential credits within a pathway to harmonize the analysis across very different CTE reporting structures. See 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 for an in-depth discussion of differences in reporting and definitions across states.

10. Tennessee's high school graduation requirements include 0.5 credits in Personal Finance, which is an elective in the Finance career cluster. Table 1 totals for Tennessee CTE courses are smaller if we exclude Personal Finance (by about 0.5 courses overall), but regression results and course-taking differences by gender, race, and ethnicity are very similar to what we report here.

11. 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/

12. Some states changed their definitions of CTE concentration following implementation of Perkins V, which is the updated federal funding and accountability program for CTE. Cohorts described in this report were largely unaffected by Perkins V, so we have adhered to earlier concentrator definitions.

13. We cannot measure whether someone takes two courses in a sequence as many courses apply to multiple sequences.

14. We define school j as a student's school in Grade 12 since many CTE courses are taken in the last two years of high school. This does risk misassignment of students to schools if they transferred between Grade 9 and Grade 12.

15. As specified, the reference group is White students without an identified disability or economic disadvantage.

16. Cohort fixed effects are omitted in the Tennessee model, which includes just one cohort.

17. In column 3 of the Tennessee model, we control for schools' average rate of economic disadvantage, as reported here: tn.gov/education/data/data-downloads.html

18. The Government and Public Administration cluster includes courses in the Junior Reserve Officers Training Corps (JROTC) program, which drive its popularity in Atlanta.

19. Finance is the most popular Tennessee CTE cluster regardless of whether we include Personal Finance courses. Without Personal Finance, the Finance cluster accounts for 14% rather than 17% of CTE course-taking.

20. Massachusetts does not have an Education and Training cluster.

About the Authors

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Celeste K. Carruthers is an associate professor in the Haslam College of Business at the University of Tennessee with a joint appointment in the Department of Economics and the Boyd Center for Business and Economic Research. Her research centers on education policy with crossovers into public economics, labor economics, and economic history. Carruthers is editor-in-chief of *Economics of Education Review*. Before arriving at UT in 2009, Carruthers earned a Ph.D. in economics from the University of Florida, an M.A. in economics from the University of New Hampshire, and a B.A. in economics and accounting from Appalachian State University.

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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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