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You Can't Get There From Here: Uncovering Differences in Access to CTE Programs in New York and Connecticut

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Abstract

As career and technical education (CTE) programming continues to expand to provide college and career preparation to a large number of secondary school students, concerns about equity arise as well. For example, current evidence suggests differences may exist regarding historically disenfranchised students and their participation in CTE. One explanation may be that some students lack access to the variety of programming CTE has to offer. This paper explores two CTE implementation contexts for differences in access between potential high school students of differing racial backgrounds by examining distance from home census tract to programs, organized by career cluster. The author finds significant differences in access for students from areas with proportionally more Black/Latinx students in some career clusters.

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Introduction

Practitioners, policymakers, and researchers continue to debate how best to prepare K–12 students for their lives beyond high school graduation. Shifting away from the college-for-all stance of the late 1990s and early 2000s, college and career readiness recently has gained traction in policy circles and across states and districts as an overarching goal for high school graduates (Rosenbaum et al., 2010); 36 states and the District of Columbia all define college and career readiness as an educational goal (Mishkind, 2014). Career and technical education (CTE) is one educational model intended to achieve academic preparation and work-related skills. As such, CTE has been the source of increased attention and funding in recent decades. For example, roughly 7.5 million students participated in CTE in the United States in 2015 (Pasarella, 2018). Relatedly, CTE remains a focus of federal funding; in 2018, the reauthorization of the Carl D. Perkins Career and Technical Education Act provided $1.2 billion in funding for states to implement CTE programming. Finally, a significant body of work suggests that CTE is in fact effective in achieving its stated goals of college and career readiness (Bishop & Mane, 2004; Brunner et al., 2021; Dougherty, 2018; Neumark & Rothstein, 2006). However, this research is limited in that it generally examines students participating in CTE and (in some cases) compares them to counterfactual students with similar CTE access. A salient question, then, is whether differences in access, and thus opportunity, exist for some students.

Concerns about equitable access in CTE have reemerged in recent years. These concerns echo issues surfaced in the 1980s and 1990s, when differences in vocational offerings created inequitable access for Black students in contrast to peers in predominantly White schools (Oakes, 1983). CTE programs are certainly different than the vocational programs of the past, some of which reinforced racial and socioeconomic segregation by tracking Black students toward work preparation over academics (Anderson, 1982). Still, there are some echoes of the past regarding differences in who selects into CTE. For example, some evidence suggests students with disabilities, low-income students, and some students of color are overrepresented in modern CTE programs (Dougherty & Lombardi, 2016). Additionally, although recent work has suggested Black students may not be overrepresented (Dougherty & Macdonald, 2020), troubling trends regarding representation across all these groups exist among programs of certain career clusters. That is, although CTE writ large may overrepresent students with disabilities and low-income students, these same groups may in fact be underrepresented in science, technology, engineering, and mathematics (STEM) CTE programs (Dougherty & Macdonald, 2020). Although one explanation of these differences among clusters could be differences in student preference, another explanation may be that students do not have similar access to the same variety of career clusters based on where they live and/or the school they attend. Even though CTE has expanded to include a broad spectrum of programs addressing a variety of careers (Association for Career and Technical Education [ACTE], 2019), CTE researchers must ask equity-focused questions regarding access to programs, particularly considering the problematic past of vocational education.

This paper expands the field's understanding of the extent to which differences in access to CTE programs might contribute to differences in participation on the basis of family income and race/ethnicity. Although considerations of equity are part of a complex landscape that requires thorough qualitative and quantitative work, this project analyzed equity of access to programs as one potential source of racial/ethnic and/or socioeconomic inequity with actionable policy implications. If students are limited in their access to CTE along racial/ethnic and/or socioeconomic lines, it is crucial to deliver that information to stakeholders and continue to develop this line of research to support shifting that reality in light of the present policy focus on CTE. This project does not comprehensively address all elements of equity, nor every element crucial to fully understanding differences in access. It does, however, provide a novel lens for examining the distribution of CTE programs in two particular contexts.

Currently, a wide variety of CTE programs are available to high school students. However, CTE is not a "one size fits all" program; rather, differences exist across the spectrum of CTE clusters and programs of study. Specifically, career clusters include such diverse offerings as Finance, Health Science, Manufacturing, and others (ACTE, 2020). As CTE continues to hold a prominent place in the secondary educational landscape, it is important to guard against the reproduction of the racialized and socioeconomic tracking that occurred in vocational programs as recently as a few decades ago. As such, this paper addresses the following research question: Are there differences in the number and type of CTE programs of study to which students have access based on their race/ethnicity or socioeconomic background?

Background

A Brief History of Career and Technical Education

The history of CTE can be traced to vocational education in the early 20th century. Implemented as schooling directly linked to workforce development, vocational education has been part of the U.S. education system for more than a century. Although more than 50 laws supporting vocational education have been passed since its beginnings (Cuban, 1982), the Smith-Hughes Act of 1917 set the stage for how we understand it today. Specifically, the Smith-Hughes Act created new federal funding for vocational education and was implemented as a state-matching program designed to help "nonacademic" students secure employment after they completed their compulsory education (Hyslop-Margison, 2000).

Charles Prosser authored the majority of the law and was an advocate of social efficiency in education and a student of David Snedden (Hyslop-Margison, 2000). Snedden's orientation toward education painted a dichotomy between "liberal" education and vocational education; the former he labeled as broadening intellectual/emotional horizons, and the latter as preparing students for the workforce (Wonacott, 2003). Although John Dewey famously argued for democratic and liberatory education that was accessible to all, Snedden advocated that education systems use a more targeted approach. For instance, he advocated for early counseling in which knowledgeable counselors would direct junior high school students into vocational training, and eventually occupations, that were appropriate for their counselor-perceived intellectual skill set. These vocations would often be precisely defined and determined by "working back from society" (Drost, 1977, p. 25), studying the needs of the communities in which students were eventually going to reside and (perhaps more importantly) have gainful employment. In this great debate between Snedden's desire for social efficiency and Dewey's more democratic view of education, historians largely see Snedden as the winner, despite Dewey's place in the canon of U.S. education philosophy (Labaree, 2010). U.S. high schools were largely dominated by social efficiency, including but not limited to vocational education, as evidenced by the generation-defining document *Cardinal Principles of Secondary Education* (National Education Association, 1928).

Perhaps unsurprisingly, the prevailing view of social efficiency in schools further established social inequities, and this did not go unnoticed by future scholars. As the U.S. high school continued to evolve, advocates for more democratic and accessible versions of education described the then-current system as facilitating the reproduction of social classes, as opposed to "spark[ing] upward mobility" (Dougherty & Lombardi, 2016, p. 332). Grubb and Lazerson (1982) argued that "vocationalization of the schools . . . exacerbated the contradictory pressures on the schools that relate to the allocation of social positions over generations" (p. 132). More specifically, if schooling is the predominant source of entry to occupations with high economic return, then entry to those schools is the predominant mechanism of upward mobility, and those with political power (namely White middle-class parents) enjoyed advantages over historically marginalized populations in gaining access to that entry (Grubb & Lazerson, 1982).

Some scholars further scrutinized vocational education as limiting choices for Black students in even more explicit ways. In various communities across the country in the years following the passage of Smith-Hughes, Black students were tacitly and explicitly limited in their vocational options by the guidance they received from teachers and counselors. Anderson (1982) noted that Black students of the 1930s in vocational education were generally enrolled in a limited swath of courses and excluded from higher paying trades such as mechanics, boat and shipbuilding, and the energy industry (p. 209).

Decades later, research did not demonstrate a dramatically different story. Oakes (1983), for example, explored differences in curricular options for "non-White" and White students and found notable differences between and within the vocational experiences of these two groups of students. When comparing students at predominantly White schools with students attending more racially mixed schools or schools serving predominantly students of color, students had similar access in terms of number of vocational courses offered. However, a closer examination of the courses offered tells a different story: Students at predominantly White schools had access to considerably more business and industrial arts programs, whereas students attending more racially mixed schools or those serving predominantly students of color had greater access to programs focusing on military training and home economics (pp. 343–344). Further, within the schools with greater diversity, White students were more likely to be enrolled in any business classes that were offered; 62% of business courses in such schools had disproportionately high White enrollment, whereas only 23% of such courses had disproportionately high enrollment of students of color.

Shifts in Modern Career and Technical Education

Although the history of vocational education is fraught with problems considering the goals of equitable schooling, its successor is different in both focus and execution. The Carl D. Perkins Vocational Education Act, passed in its first iteration in 1984, is the main source of funding for states' vocational education. As a result, Perkins and its subsequent reauthorizations have played an important role in dictating vocational education policy, including shifts toward accountability, postsecondary alignment, business partnerships, and work-based learning as well as a shift in nomenclature away from *vocational* to *career and technical education, or CTE* (ACTE, 2020). Perkins has been reauthorized four times, including most recently as the Strengthening Career and Technical Education for the 21st Century Act (U.S. Department of Education, 2018). As early as Perkins's first reauthorization in 1990, the use of vocational programming in secondary education had begun to move away from the "vocational alternative" paradigm to a mechanism for supporting college and career readiness in which students in CTE are not necessarily enrolling as an alternative to college but rather to develop skills that would be beneficial for postsecondary education and employment. In fact, a number of mechanisms in modern CTE support this end, including partnerships with postsecondary institutions and a "pathways" approach that supports further education beyond high school (Bonilla, 2019).

A growing body of research suggests CTE is having a positive impact on its desired student outcomes, namely high school graduation, postsecondary attainment, and labor market outcomes. For example, Dougherty et al. (2019) examined administrative data from Arkansas and found that after a policy shift led to more students taking CTE coursework, additional CTE course-taking is associated with increased likelihood of graduation, enrolling in a 2- or 4-year college, and being employed as well as an earnings premium. Numerous other studies have found similar benefits of CTE (Bishop & Mane, 2004; Brunner et al., 2021; Dougherty, 2018; Neumark & Rothstein, 2006).

The main delivery mechanism of CTE has not changed as dramatically as its stated goals and associated outcomes, however. CTE is largely delivered on an opt-in basis, at either the school or within-school program level, leaving inevitable questions about selection into programs. Although prior work leveraged quasi-experimental designs to develop causal estimates of CTE participation (e.g., Brunner et al., 2021), such studies have been limited by examining those students who choose to apply for a spot in a school and/or program. This implies that regardless of potential outcome, students are inherently limited by the choices to which they have access.

As CTE-dedicated options continue to expand in the United States, so too do the students taking advantage of said options. Thematically different alternatives to traditional schooling options, like CTE-dedicated high schools, have increased in popularity as well (Kemple et al., 2023). However, simply providing students and families with the de jure, or legal, policy-codified right to attend a given school does not ensure students truly have access. There are many de facto barriers that may prevent students from taking advantage of those choices, including physical access based on transportation time.

School Choice, Access, and Transportation

Broadly, the number of students taking advantage of non-neighborhood school choices has risen dramatically in recent years. From 1993 to 2007, the number of students attending their assigned public school dropped from 80% to 73%, and in 2019, more than 40% of families with children in Grades 1–12 reported having choices for their child's public schooling (de Brey et al., 2021). Many of these shifts were ushered in by the No Child Left Behind Act (2001), which gave parents the option to leave "failing" schools for other local schools, increasing the demand for choices outside of traditional neighborhood schools. Still, there are inherent barriers that may prevent a student from taking full advantage of all options to which they have access.

Two such barriers are transportation and travel time. Although students in systems of broad choice are given a wide array of schools from which to choose, those same students may be required to transport themselves a significant distance to reach the school they choose to attend. This may be problematic based on either cost or travel time. In Connecticut, for example, students may enroll in any of the CTE schools in the state, which may mean some choices are in fact hours of driving time away. Similarly, New York City gives students access to the entire city school system for high school. However, despite being a single municipal school system, driving time can exceed an hour between boroughs and twice that for the more likely scenario of public transportation.

Prior work confirms that transportation and distance to a given school can be a strong predictor of whether students take advantage of the de jure choices provided to them. Cullen et al. (2005) examined the impacts of attending choice-based schools in Chicago, where more than 50% of students opt out of their assigned neighborhood school. As an element of their analysis, Cullen et al. found a strong relationship between distance to a given type of school and likelihood of attendance. Similarly, Glazerman and Dotter (2017) determined that the likelihood of choosing a school is strongly related to its distance from students' residence; they found that for students in Washington, DC, each additional mile between home and a potential school lowered the odds of ranking it higher than a closer alternative by 6% (p. 606).

There is similar evidence on the impact of travel time on school choice in other major U.S. cities. A study by the Urban Institute (Blagg et al., 2018) examined travel time to school in cities with numerous school choice options: Denver, Detroit, New Orleans, New York City, and Washington, DC. The study found that most students live within a 20-minute drive from their schools; in New York City, only 10% of Grade 9 students travel more than 36 minutes to their schools, suggesting travel time is a limiting factor when determining whether to attend a school.

Because differences in likelihood of attending a given school are strongly related to proximity to that school, a salient question is: How do differences based on proximity have implications for equity? Indeed, given the racial/ethnic and socioeconomic segregation of U.S. cities, and the country's history of creating segregated schools (Rothstein, 2017), differences based on location are truly complex. Moreover, when differences in likelihood of attendance are drawn along geographic lines, it may lead to differences along racial/ethnic and socioeconomic lines as well.

In this paper, I examine two unique CTE delivery systems: Connecticut's Technical Education and Career System and the New York City Department of Education's dedicated CTE schools. Specifically, I examine whether the implied difference in travel time based on student home census tract creates an inherent difference in access for students of different socioeconomic and racial/ethnic backgrounds.

Methods

To answer my research question, I describe the variety of CTE opportunities available in two distinct and different systems: the New York City Department of Education and the Connecticut Technical Education and Career System. These systems provide open access to a substantial number of students in New York City and Connecticut and include a wide variety of programs of study across career clusters (Advance CTE, 2023). Students in these systems may apply to any of the dedicated CTE programs available, which have different admissions mechanisms, including lottery, competitive academic criteria, or more complex systems (Brunner et al., 2021; Nathanson et al., 2013).

Because students may end up choosing to attend any given CTE program for a variety of reasons and using a variety of mechanisms, I examined access as separate from actual enrollment, choosing to take a more supply-side approach and examine the supply in the context of physical proximity of potential students. In New York City and Connecticut, policies state that students may have access to all programs. However, there are de facto limitations to that access, such as the distance a student would have to travel to attend the school. For example, differences in distance could increase travel costs (fiscal and time) for a given student in comparison to a student who resides closer. Even though transportation may be provided in some cases, prior research demonstrates that proximity to nearby programs is a strong predictor of students opting out of their traditional schooling options (Cullen et al., 2005). As programs of study (i.e., career cluster offerings) may differ based on location, students in any given location within the systems' bounds have meaningful access only to particular programs in certain career clusters, and prior work suggests between-school differences have an impact on who participates in CTE (Carruthers et al., 2021). Moreover, as these programs may have limited capacity (i.e., not all applicants are accepted), students' access may be limited by number of available seats as well. As was shown in the past, the characteristics of students in the local area may predict which clusters and programs of study are offered.

Sample

To quantify these differences, I used census tracts as the primary unit of analysis. Census tracts are subdivisions of counties, generally between 2,500 and 6,000 residents (U.S. Census Bureau, 2018), and a variety of metrics measured by the U.S. Census and the American Community Survey allow for comparisons between tracts. For this study, I used 833 census tracts located in Connecticut and 2,167 in New York City.

I chose to rely on tract data for four reasons. First, per-student data, including addresses, can be difficult to access. Second, tracts are designed to capture actual neighborhoods of the communities in which they are drawn; as a result, according to the U.S. Census Bureau (2018), tracts "are homogeneous with respect to population characteristics, economic status, and living conditions" (p. 3). Third, tracts are small enough to capture hyperlocal differences among tracts in both samples (New York City and Connecticut) yet broad enough to provide data on race/ethnicity, socioeconomic status, industry and employment characteristics, and a variety of other covariates via the 5-year American Community Survey estimates. Additionally, these data can be linked directly to existing education databases, such as school locations by the National Center for Education Statistics (NCES) via the Education Demographic and Geographic Estimates program (EDGE).

Measures/Variables

Independent Variables

For this study, I used census tracts to determine the key predictors of interest, the number of students, and the students' tract-average characteristics. I used the number of potential high school students (ages 14–18) to weight my models (described later). Other census characteristics are included as key predictors, namely tract-average racial/ethnic characteristics, including proportions of population in a given racial/ethnic category, and socioeconomic characteristics, including poverty status and average income. Finally, I also used educational attainment, average age, and total population as additional covariates.

It is important to note that a variety of other characteristics could be associated with differences in access to CTE programming; for example, local labor markets could potentially lead policymakers to focus CTE programming on one or many career clusters within a certain geographic area. It is also important to note that I elected to exclude these potential differences from my modeling with reason. This analysis is not intended to be explanatory; therefore, those differences are not crucial to the conclusions I plan to draw. Indeed, this analysis is intended to describe the landscape of offerings for students from a given census tract and the differences in that landscape based on racial/ethnic and socioeconomic characteristics. That is to say, although differences may exist in local labor markets, I do not wish to "control" for those differences in my modeling as, from an equity perspective, those differences in local labor market conditions may or may not be relevant to a student's desired participation in a given CTE program. Although there may be a sound labor market–related rationale for programs being placed in particular areas, which may or may not be associated with race/ethnicity or socioeconomic status, this analysis sets aside that rationale in favor of understanding differences in access based on race/ethnicity and/or socioeconomic status.

Outcome Variables

The outcomes in this study are binary indicators of the existence of a given program, within a certain travel time, broken down by career cluster (Advance CTE, 2023). For example, in any given census tract, there resides a set of potential CTE students with tract-average demographic characteristics; those students have "near" access (< 15 minutes of travel time) to some predetermined number of existing CTE programs with a certain program focus at nearby schools. In a different census tract, there resides a different set of potential CTE students, with different tract-average demographic characteristics, that have "near" access to different CTE programs with the same or different program focus. The second group of students may have the right to apply to the same schools as the first hypothetical tract (i.e., have de facto access), but attendance would require them to drive much farther (e.g., > 60 minutes) to school each day.

To systematically measure the accessible programs for each census tract, I mapped each CTE program to which students have de facto access and categorized the career cluster(s) with which the programs were associated. I used a Here.com software package in conjunction with Stata to measure raw travel time to these programs among students residing in the same census tract. For New York City, I measured travel time in minutes on public transportation; for Connecticut, I measured travel time as time spent driving on a typical school day, as these are the modal transportation mechanisms in these systems. Combining travel time measurements with career cluster information about each program yielded a binary indicator for the existence of a program of each career cluster at a specified distance (I chose < 30 minutes for Connecticut and < 15 minutes for New York City); these binary indicators will be the outcome measures for Model 1. It is important to note that I chose to use binary indicators rather than a continuous outcome measure, as I do not believe a continuous metric is easily interpretable; for example, the implied differences in travel cost between 5 and 15 minutes of travel time do not translate similarly to the differences between 50 and 60 minutes. Thus, creating a binary indicator that measures the presence (or lack of presence) of a program is a more interpretable mechanic. The choice of 30 and 15 minutes for Connecticut and New York City, respectively, is somewhat arbitrary, although the shorter distance in New York City reflects the geographically smaller nature of that site. Still, this analysis is designed to measure differences in access between groups of students in census tracts; although the literature noted previously suggests that "closer" means more accessible, there isn't a clear threshold to define what "close" means. Thus, I selected what I believed to be rational choices for "close" in each of the two studied areas and built comparisons from those thresholds.

School data were collected from a few sources. For school program and career cluster information, I scraped the relevant websites for the Connecticut Technical Educational and Career System (2020) and the New York City Career and Technical Education (NYCCTE; 2020) system. I then linked these schools by school name to NCES data, using the EDGE database for location information and the Common Core of Data for enrollment.

I used enrollment data to measure the number of students in a given school and then used that number to approximate a proxy for the number of potential seats at a given program. Using the same raw travel distance measure described earlier, I categorized each program's distance to each census tract. Then, I summed the number of available seats, by career cluster and travel time, to develop a total number of seats available to students in each census tract for each combination of career cluster and travel time. This yielded the outcome measure for Model 2.

Descriptive Statistics

Despite my inclusion of two locations to assess the associated impact of race/ethnicity and socioeconomic status on access to CTE, this is not intended to be a comparative study. Each location has distinct features, as noted previously, that create unique circumstances for CTE delivery and unique opportunities to learn about the distribution of CTE across contexts. For example, Connecticut's Technical Education and Career System schools operate as a stand-alone district in the state, whereas New York City's CTE-dedicated high schools operate as a component of a much larger district in the city. Similarities and differences in outcomes certainly exist, but neither should be attributed directly to similarities or differences in pretreatment difference.

The landscape of CTE in New York City and Connecticut offers a variety of programs, distributed across their respective areas, with a few notable similarities and differences (Table 1). Both locales offer CTE-dedicated schools with multiple programs, although there are generally more programs per site in Connecticut. There are some particularly common programs, such as Architecture and Construction; Manufacturing; and Transportation, Distribution, and Logistics. Many Information Technology programs also exist in both contexts, but it is important to note that these programs are categorized separately from the STEM programs, which are comparatively infrequent, including just one in Connecticut and only three in New York City.

Table 1. Program Counts by Cluster

	Connecticut		New York City	
	Programs	Sites	Programs	Sites
Agriculture, Food, and Natural Resources	2	2	3	2
Architecture and Construction	64	17	14	10
Arts, A/V Technology, and Communication	4	4	18	11
Business, Management, and Administration	11	10	3	2
Health Science	20	17	14	8
Hospitality and Tourism	14	14	3	3
Information Technology	26	17	25	14
Law and Public Safety	2	2	1	1
Manufacturing Production	30	15	12	7
Marketing, Sales, and Service	2	2	5	3
Science, Technology, Engineering, and Mathematics (STEM)	1	1	3	3
Transportation, Distribution, and Logistics	28	17	13	9

Note. Slight variations exist in how each locale describes each cluster; for simplicity, they've been grouped together here.
Source. Connecticut Technical Educational and Career System (2020); New York City Career and Technical Education (2020).

There are some notable differences between the two locations, as shown in Table 2, which describes average census tracts across Connecticut and New York City. On average, Connecticut's census tracts are more White, less Hispanic/Latinx,[1] more affluent, and slightly older by average age than census tracts in New York City. Still, both locations have relatively widespread average proportions of White, Black, and Hispanic/Latinx residents as well as proportions of residents at or below the poverty line, evidenced by the relatively large standard deviations for each of those measures. Further, the minimums and maximums suggest some tracts are either completely or almost completely White and some are completely non-White, suggesting notable variation in the tracts in both locations.

[1] I use the term *Hispanic* here for fidelity to the U.S. Census measurements. However, this is an inaccurate term; for the analysis, I refer to this population with the more accurate term *Latinx*.

Table 2. Descriptive Statistics by Census Tract

	Connecticut				New York City			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Race/ethnicity								
Non-Hispanic White	0.655	0.275	0.000	0.989	0.322	0.291	0.000	1.000
Non-Hispanic Black	0.106	0.146	0.000	0.955	0.232	0.283	0.000	1.000
Non-Hispanic American Indian	0.002	0.005	0.000	0.049	0.002	0.010	0.000	0.251
Non-Hispanic Asian	0.043	0.046	0.000	0.408	0.143	0.169	0.000	0.916
Non-Hispanic Native Hawaiian/Pacific Islander	<0.001	0.002	0.000	0.032	<0.001	0.003	0.000	0.072
Non-Hispanic other	0.003	0.008	0.000	0.073	0.010	0.0269	0.000	0.311
Non-Hispanic two or more races	0.022	0.018	0.000	0.133	0.020	0.0208	0.000	0.203
Hispanic	0.170	0.175	0.000	0.843	0.271	0.224	0.000	0.924
Other characteristics								
At/below poverty line	0.110	0.113	0.000	1.000	0.173	0.124	0.000	1.000
Average age	41.57	7.45	19.90	71.40	37.81	6.78	13.20	82.10
High school or higher	0.897	0.091	0.411	1.000	0.820	0.114	0.200	1.000
College or higher	0.383	0.201	0.000	0.916	0.359	0.210	0.000	1.000
High school enrollment	235.5	136.4	0.0	937.0	174.9	131.6	0.0	876.0

Model Specification

Using census tract data weighted by potential student counts, and the travel times of those potential students, I developed a metric of program access using current CTE programs and their available seats grouped by program focus and pathway. To quantify the associations of differences among census tracts to career cluster access, I developed a pair of multivariate regression models. The models are specified as follows:

$$Pr(Program_{cdt} = 1) = \beta_0 + \boldsymbol{\gamma Predict_{it}} + \boldsymbol{\kappa_t} + \varepsilon_t \quad (1)$$

$$Seats_{cdt} = \beta_0 + \boldsymbol{\gamma Predict_{it}} + \boldsymbol{\kappa_t} + \varepsilon_t \quad (2)$$

Model 1 estimates the probability of the existence of a CTE program in career cluster *c*, at a travel distance threshold *d*, with distance grouped by the tiers described earlier, for each census tract *t*. Model 2 estimates a continuous number of available seats in career cluster *c*, at a travel distance threshold *d*, for each census tract *t*.

I used both probit and linear probability models for Model 1 and an ordinary least squares (OLS) model for Model 2. Each model is estimated twice: once for $\boldsymbol{Predict_{1t}}$, a measure of the percentage of Black/Latinx residents for each census tract t, and once for $\boldsymbol{Predict_{2t}}$, the percentage of tract residents at or below the poverty line of each census tract t. $\boldsymbol{\kappa}_t$ represents a vector of covariates and their respective coefficients, including educational attainment, average age, and total population within the tract t.

Estimates from these models capture the observed associations between race/ethnicity, socioeconomic status, and CTE program availability, measured separately by career cluster and travel distance. The results provide a compelling descriptive picture of the options available to students across and between broad systems in Connecticut and New York City.

Findings

In this section, I present estimates generated by implementing the models described previously to describe the landscape of CTE delivery as it relates to differences across census tracts in both localities. In combination, these multiple analytic strategies build support for my findings. In summary, findings vary widely across predictors and context, but there are a few particular results of interest. Namely, I found that although many programs are in fact more accessible to students of Black/Latinx backgrounds and from lower socioeconomic backgrounds than to White and Asian students or students from higher socioeconomic backgrounds, this is not universally true for all CTE career clusters. In particular, STEM and STEM-related programming may be more distant for Black/Latinx students in Connecticut, but these results do not hold for New York City.

Results in Connecticut: Similar Results With a Key Exception

Differences on Race/Ethnicity

Key 1. Tables 3–6 (Connecticut)	
(1)	Agriculture, Food, and Natural Resources
(2)	Architecture and Construction
(3)	Arts, Audiovisual Technology, and Communications
(4)	Health Science
(5)	Hospitality and Tourism
(6)	Human Services
(7)	Information Technology
(8)	Law, Public Safety, Corrections, and Security
(9)	Manufacturing
(10)	Marketing, Sales, and Service
(11)	Science, Technology, Engineering, and Mathematics (STEM)
(12)	Transportation, Distribution, and Logistics

I found that for almost all career clusters, students residing in census tracts with a higher proportion of Black/Latinx students are more likely to have a program within 30 minutes of travel time than students in census tracts with more White/Asian students. This result is demonstrated in Table 3, which presents a linear probability model, controlling for age and education level and weighted by number of potential high school students in each tract. The coefficient of interest in this table represents the additional likelihood of the existence of a program in a given career cluster, scaled by a factor of 100, of each additional percentage point of Black/Latinx residents in a census tract. For example, column 3 suggests that a 10% increase in Black/Latinx residents in a given census tract is associated with a 6.8% increased likelihood of an Arts, A/V Technology, and Communications CTE program within 30 minutes of travel time at a Connecticut Technical High School.

Table 3. Differences in Program Existence Within 30 Minutes by Black/Latinx Proportion: Connecticut

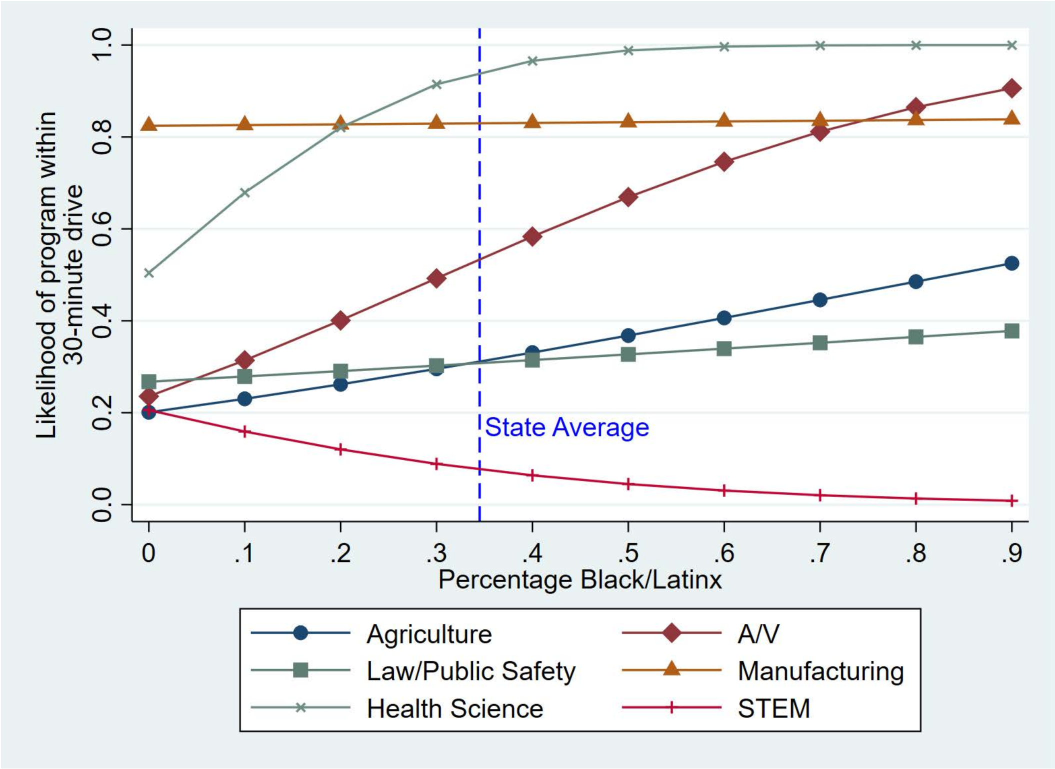
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Race/ethnicity	0.081***	0.102***	0.678***	0.289***	0.102***	0.017***	0.102***	0.170***	–0.036***	0.043***	–0.272***	0.102***
	(0.00583)	(0.00212)	(0.00554)	(0.00330)	(0.00212)	(0.00464)	(0.00212)	(0.00598)	(0.00421)	(0.00567)	(0.00381)	(0.00212)
Observations	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195
R^2	0.045	0.063	0.093	0.099	0.063	0.039	0.063	0.037	0.035	0.018	0.039	0.063

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 1 for corresponding programs.

I did find, however, that two career clusters are less likely to be close by to students from tracts with higher proportions of Black/Latinx students: STEM and Manufacturing. Although both are statistically significant (see columns 9 and 11 in Table 3), only STEM is practically significant (i.e., the magnitude is large enough to warrant discussion). The coefficient in column 11 suggests that a 10% increase in Black/Latinx residents correlates to a 2.7% decrease in likelihood of a STEM CTE program within 30 minutes of travel time.

These differences in access are more easily understood in the context of their overall availability. Although STEM and Manufacturing are less accessible to students from tracts with more Black/Latinx students, there is notably more overall availability of Manufacturing programs, especially relative to STEM. Figure 1 supports this finding. Although Table 3 presents results from a linear probability model, Figure 1 presents results from a similar probit model that includes the same set of controls. Figure 1 shows a select group of six of the career clusters for ease of interpretation, and each line represents the marginal effect of moving along a continuum of percentage of Black/Latinx residents in a census tract, with the left-most points representing a mostly White/Asian census tract and the right-most points representing an entirely Black/Latinx census tract. The state average is included as a vertical line for reference. Similar to Table 3, I found mostly positive trends, with the notable negative trend on the lowest line, representing STEM. The fact that STEM's points are overall lowest in comparison to other lines indicates that, regardless of racial/ethnic makeup of a census tract, STEM is the least accessible career cluster in Connecticut, supported by the fact that there is only one program in that cluster (see Table 1).

Figure 1. Probit Model Marginal Effects by Proportion of Black/Latinx Residents in Census Tract



I also found that students from tracts with a higher proportion of Black/Latinx students had fewer available seats in STEM and Marketing programs, although the latter is a very small difference in magnitude. Table 4 presents these results. These point estimates represent the associated increase/decrease in student seats available in a given career cluster, within a 30-minute drive, compared to the shifts in proportion of Black/Latinx residents in a career cluster. There are similarities and differences to the models presented prior. For example, it is still notable that the negative coefficient remains for STEM programs, suggesting that increases in Black/Latinx population are associated with greater access to most CTE programs in Connecticut, with the notable exception of STEM (and Manufacturing, although this is of comparatively small magnitude). The scale of positive results provides additional interpretable information. For example, noting the difference between columns 7 and 8 in Table 4—although both are positive and statistically significant—the associated number of seats in Information Technology CTE programs is far greater than in Law and Public Safety CTE programs. Again, this aligns with the relative frequency of the programs in general, as all sites have Information Technology programs, whereas only two have Law and Public Safety programs (see Table 1).

Table 4. Differences in Program Seats Within 30 Minutes by Black/Latinx Proportion: Connecticut

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Race/ethnicity	7.838***	88.238***	72.875***	9.572***	88.238***	58.074***	88.238***	21.385***	92.175***	–3.312***	–22.628***	88.238***
	(0.479)	(1.638)	(0.909)	(1.011)	(1.638)	(1.747)	(1.638)	(0.582)	(1.824)	(0.405)	(0.317)	(1.638)
Observations	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195	196,195
R^2	0.047	0.142	0.082	0.039	0.142	0.107	0.142	0.036	0.127	0.017	0.039	0.142

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 1 for corresponding programs.

In summation, when examining based on racial/ethnic breakdown of census tracts, the results for Connecticut's CTE programs seem to suggest that most program categories are more accessible to census tracts with higher proportions of Black/Latinx residents, meaning students in those tracts are more likely to live close to a given CTE program (that is, within 30 minutes of drive time). The clear and persistent exception is STEM programs, which are rare overall; these programs are located such that students in higher proportion Black/Latinx census tracts are statistically significantly less likely to be within 30 minutes of those programs than students in census tracts with more White/Asian students.

Results on Measures of Poverty

The next set of results, starting with Table 5, examines a similar question to those presented earlier, but instead measure differences based on poverty level of a census tract rather than differences in race/ethnicity.

Table 5. Differences in Program Existence Within 30 Minutes by Percentage Below Poverty Line: Connecticut

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
% at or below poverty line	0.137***	–0.045***	0.130***	–0.299***	–0.045***	0.327***	–0.045***	–0.462***	0.461***	0.857***	–0.004	–0.045***
	(0.0186)	(0.0075)	(0.0194)	(0.0092)	(0.0075)	(0.0125)	(0.0075)	(0.0189)	(0.0122)	(0.0172)	(0.0101)	(0.0075)
Observations	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178
R^2	0.045	0.059	0.039	0.082	0.059	0.041	0.059	0.037	0.039	0.032	0.004	0.059

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 1 for corresponding programs.

In contrast to the results from the prior section, I found fewer clear trends when examining differences between students in census tracts with a higher proportion of the population at or below the federal poverty line. In particular, there was a variety of positive and negative coefficients in Table 5, which presents these results. In this table, the dependent variable represents the percentage of a census tract at or below the federal poverty line, and the coefficients represent differences in likelihood of being within a 30-minute drive to each career cluster. For example, column 6 suggests that a 10% increase in the proportion of residents at or below the poverty line in a given census tract is associated with a 3.2% increase in likelihood of a Human Services CTE program existing within a 30-minute drive time radius. It should first be noted that although virtually all columns in Table 5 are statistically significant, practical significance is relevant as well. Columns 2, 5, and 12 are each statistically significant, but a 10% increase being associated with a .004% decrease in likelihood is hardly practically significant. Still, there are other compelling columns. For example, columns 4 and 8 suggest that increases in poverty level of a census tract are associated with a lower likelihood of Health Science and Law and Public Safety programs. Conversely, increases in poverty level are associated with an increased likelihood of access to programs in the Human Services, Manufacturing, and Marketing, Sales, and Service career clusters.

Figure 2. Probit Model Marginal Effects by Proportion of Residents at or Below Poverty Line in Census Tract

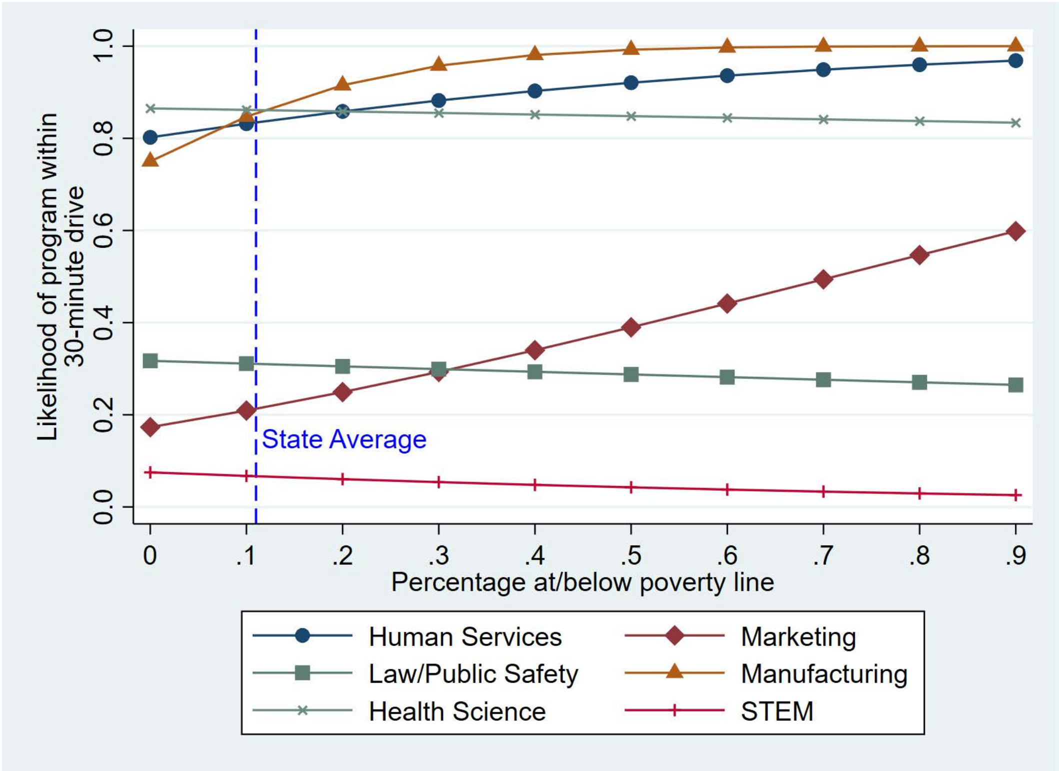


Figure 2 is similar to Figure 1 in that it shifts from a linear probability model to similar probit results, although it should be noted that these are different color-coded results to represent the variety of results uncovered in Table 5. Here, we see the most notable and substantial associated impact of increased poverty on accessibility to Marketing, Sales, and Service programs, supported by the large magnitude of the coefficient in column 10 of Table 5.

I found that when examining the variation in number of seats available in a given program by the proportion of residents at or below the poverty line, increases in residents at or below the poverty line generally correspond with increases in number of nearby seats in most programs. The sole exception is Law and Public Safety; Table 6, column 8 indicates a 10% increase in residents at or below the poverty line in a census tract is associated with 4.5 fewer seats in Law and Public Safety programs within a 30-minute radius. Conversely, that same 10% increase is associated with an increase of 7.7 seats in a Manufacturing program and 5.2 seats in a Marketing program.

Table 6. Differences in Program Seats Within 30 Minutes by Percentage Below Poverty Line: Connecticut

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
% at or below poverty line	8.047***	23.838***	11.182***	1.521	23.838***	47.316***	23.838***	–45.074***	76.953***	52.373***	–0.317	23.838***
	(1.528)	(5.256)	(2.873)	(3.558)	(5.256)	(5.354)	(5.256)	(1.833)	(5.685)	(1.175)	(0.836)	(5.256)
Observations	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178	196,178
R^2	0.046	0.130	0.051	0.038	0.130	0.103	0.130	0.033	0.117	0.028	0.004	0.130

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 1 for corresponding programs.

In sum, the results measuring access to programs in Connecticut based on residence in census tracts at or below the poverty line are similar in some ways to those based on race/ethnicity in that some programs have positive associations (namely Manufacturing and Marketing, which are the largest in magnitude), whereas others are negative (namely Law and Public Safety and Health Science). This suggests that students in census tracts experiencing higher incidence of poverty have notably different access than those who reside in tracts with lower incidence of poverty, although it is not clear if there is a systematic pattern to those differences.

Results in New York City: A Variety of Differences

Differences on Race/Ethnicity

New York City provides a slightly different implementation context than Connecticut, and so differences in results are likely. Still, there are some similarities that exist across both contexts. However, because New York City's size and density are notably different than Connecticut's, here I examine programs within a 15-minute travel time.[2] The first set of results presented for New York City mirror the first set of results presented for Connecticut; they examine the relationship between race/ethnicity and location of programs in a variety of career clusters.

Key 2. Tables 7–10 (New York City)	
(1)	Agriculture, Food, and Natural Resources
(2)	Architecture and Construction
(3)	Arts, Audiovisual Technology, and Communication
(4)	Business, Management, and Administration
(5)	Health Science
(6)	Hospitality and Tourism
(7)	Information Technology
(8)	Law and Public Safety
(9)	Manufacturing Production
(10)	Marketing, Sales, and Service
(11)	Scientific Research and Engineering
(12)	Transportation, Distribution, and Logistics

In New York City, I found a mix of positive and negative coefficients; that is, some career clusters are more likely to exist depending on increased numbers of Black/Latinx residents in a census tract, whereas others are less likely. These results are presented in Table 7, which shows the likelihood of the existence of a given program at an CTE-dedicated high school in New York City, in a given career cluster, within a 15-minute travel time, depending on the racial/ethnic breakdown of a given census tract. Similar to Table 3, these are results from a linear probability model and control for age and education level and are weighted by number of high school–age residents in each tract. The coefficient of interest again represents the additional likelihood of the existence of a given program, scaled by a factor of 100, of each additional percentage point of Black/Latinx residents in a census tract. For example, column 5 suggests that a 10% increase in Black/Latinx residents in a given census tract decreases the likelihood of a Health Science CTE program within 15 minutes of travel time by approximately 2.5%. Agriculture, Architecture, Health Science, Hospitality and Tourism, Law and Public Safety, and Transportation, Distribution, and Logistics all have statistically significant negative coefficients, meaning they are less likely to exist within 15 minutes of census tracts with higher Black/Latinx populations. Conversely, Arts and A/V Technology, Business Management, Information Technology, Manufacturing, Marketing, and Scientific Research and Engineering (the closest category to STEM) are all statistically significant positive coefficients, suggesting a positive relationship between likelihood of existence of one of these programs and the proportion of Black/Latinx residents in a census tract.

[2] Although not identical, results are generally comparable for a 30-minute specification in New York City.

Table 7. Differences in Program Existence Within 15 Minutes by Black/Latinx Proportion: New York City

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Race/ethnicity	–0.098***	–0.097***	0.476***	0.018***	–0.246***	–0.581***	0.014***	–0.167***	0.152***	0.109***	0.118***	–0.178***
	(0.00122)	(0.00251)	(0.00237)	(0.00144)	(0.00235)	(0.00203)	(0.00219)	(0.00141)	(0.00253)	(0.00229)	(0.00199)	(0.00257)
Observations	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957
R^2	0.124	0.025	0.145	0.114	0.146	0.219	0.073	0.110	0.041	0.044	0.126	0.033

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 2 for corresponding programs.

The variety of magnitudes suggest that these relationships are not all identical, however. For example, the large negative coefficient in column 6 suggests that a 10% increase in Black/Latinx residents is associated with a 5.8% decrease in likelihood of existence of a Hospitality and Tourism program within 15 minutes, whereas that same increase is associated with a roughly 1.7% decrease in likelihood of existence of a Law and Public Safety program; very small magnitudes of decreased likelihood exist for Agriculture and Architecture programs. Differences are similarly stark for the positive relationships, as a 10% increase in Black/Latinx residents is associated with a 4.7% increase in likelihood of an Arts and A/V Technology program, whereas there are much smaller positive associations for Business Management, Information Technology, Manufacturing, and Marketing programs.

Figure 3 presents a subset of the columns from Table 7, selected based on novelty of result (results of similar magnitude in Table 7 have similar paths in Figure 3). Thus, I show six of the 12 career clusters present in New York City and use a probit model to measure marginal impacts along a continuum of the same dependent variable, proportion of Black/Latinx residents in a given census tract. Again, the city average is included as a vertical line.

Figure 3 presents positive, negative, and null results, depending on the career cluster. The clearest result corresponds with the clearest result from Table 7. For the Hospitality and Tourism cluster, there is a notable decrease in likelihood as the percentage of Black/Latinx residents in the census tracts increases. There are programs with positive relationships as well, including A/V.

Figure 3. **Probit Model Marginal Effects by Proportion of Black/Latinx Residents in Census Tract**

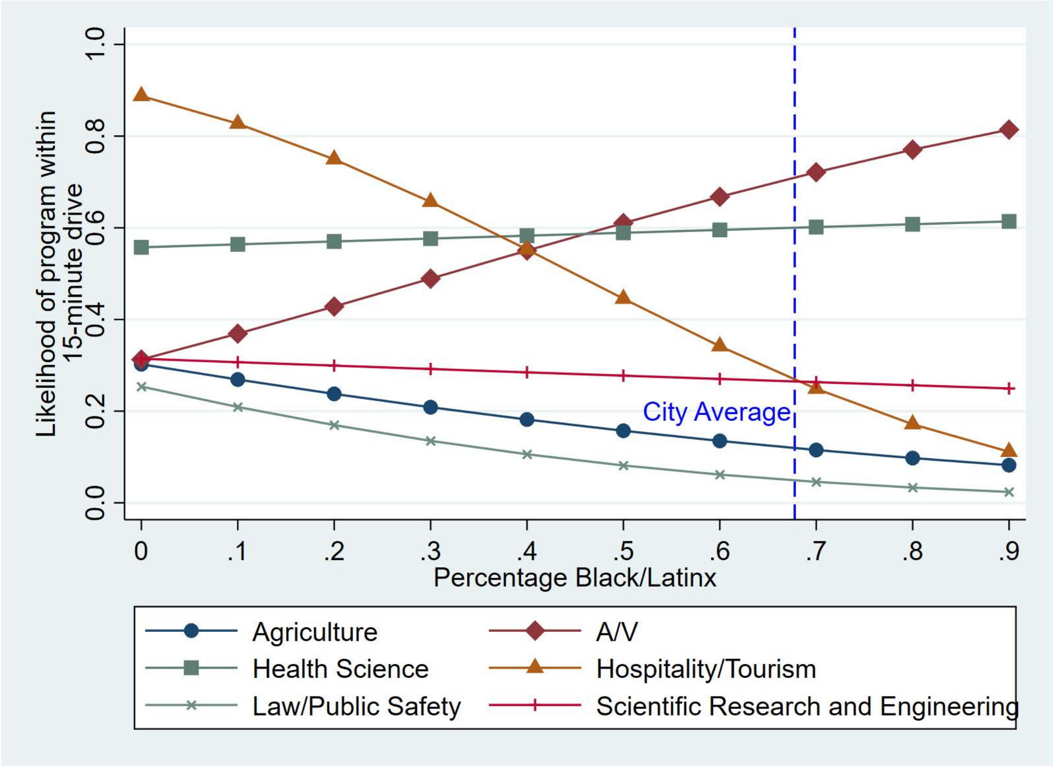


Table 8 presents the shifts in the number of seats in a given program associated with variations in racial/ethnic breakdown of New York City census tracts, similar to Table 4 for Connecticut. Again, these results present the associated increase or decrease in seats in a program in a given career cluster within 15 minutes of travel time. For example, column 6 indicates that a 10% increase in Black/Latinx residents in a given census tract is associated with slightly more than 86 fewer seats in a Hospitality and Tourism program within 15 minutes from the census tract.

Table 8. Differences in Program Seats Within 15 Minutes by Black/Latinx Proportion: New York City

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Race/ethnicity	–11.62***	85.50***	123.00***	2.98***	47.15***	–86.47***	107.90***	–37.26***	–26.97***	–29.61***	2.64***	–243.44***
	(0.161)	(0.853)	(0.962)	(0.296)	(1.096)	(0.379)	(1.196)	(0.314)	(1.201)	(0.498)	(0.331)	(3.099)
Observations	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957	378,957
R^2	0.146	0.097	0.093	0.117	0.116	0.151	0.025	0.110	0.011	0.071	0.068	0.036

Note. Standard errors in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Please see Key 2 for corresponding programs.

There are some similarities and some differences to results presented prior, although the direction of the coefficients is generally the same. These differences in magnitude between the results are due to the differences in school size and are more dramatic than differences in Connecticut. For example, column 12 suggests a 243-seat decrease within 15 minutes associated with a 10% increase in Black/Latinx population for Transportation programs, the largest magnitude of any column, despite only a modest magnitude in the "existence" results presented in Table 7.

In summation, when examining the relationship between racial/ethnic breakdown of census tracts and accessibility to the variety of career clusters available in New York City's CTE-dedicated schools, some programs of study appear to be more accessible to students from census tracts with more Black/Latinx residents, whereas other programs appear to be less so. Further, when examining the counts of seats, the results reveal stark differences in magnitude.

Results on Measures of Poverty

The next set of results mirrors the Connecticut numbers in Tables 5 and 6 and Figure 2. These results examine the same questions presented previously, but substitute differences in poverty level rather than racial/ethnic breakdown, and the dependent variable specifically measures the percentage of a census tract at or below the federal poverty line. Tables 9 and 10, as well as figure 4, control for the same covariates as previous results.

Table 9 presents the first set of these results, and there are some similarities and some differences compared with previous results. There are a few notable columns to highlight. First, column 6 presents the change in likelihood of a Hospitality and Tourism program within 15 minutes of a given census tract based on the difference in percentage of the census tract at or below the poverty line. The result suggests that a 10% increase in population at or below the poverty line is associated with a 4.9% increase in likelihood of the existence of such a program. Conversely, column 5 suggests that a 10% increase in population at or below the poverty level is associated with an 3.8% decrease in likelihood of a Health Science program.

Table 9. Differences in Program Existence Within 15 Minutes by Percentage Below Poverty Line: New York City

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
% at or below poverty line	0.371***	0.197***	0.731***	–0.228***	–0.380***	0.489***	–0.178***	0.181***	0.504***	0.034***	0.635***	0.524***
	(0.00578)	(0.00871)	(0.00815)	(0.00463)	(0.00935)	(0.00810)	(0.00806)	(0.00389)	(0.00888)	(0.00892)	(0.00869)	(0.00795)
Observations	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895
R^2	0.125	0.022	0.056	0.118	0.126	0.047	0.075	0.058	0.039	0.038	0.133	0.028

Note. Standard errors in parentheses; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Please see Key 2 for corresponding programs.

Figure 4 is similar to Figure 3 in that it shifts from a linear probability model to probit results, and again (similar to Connecticut's Figure 2) it should be noted that the color coding shifts to a slightly different set of results . Figure 4 presents a mix of positive and negative results to demonstrate differences across the spectrum of career clusters. Slopes generally correspond to the positive/negative coefficients presented in Table 9 and generally correspond in magnitude as well. Notably, these results present a slightly different picture of baselines; however, given that vertical differences represent overall differences in likelihood between clusters. One key result, then, is that the Business Management cluster not only is less accessible as the proportion of residents at or below the poverty line increases but is overall less accessible than many other career clusters.

Figure 4. Probit Model Marginal Effects by Proportion of Residents at or Below the Poverty Line in Census Tract

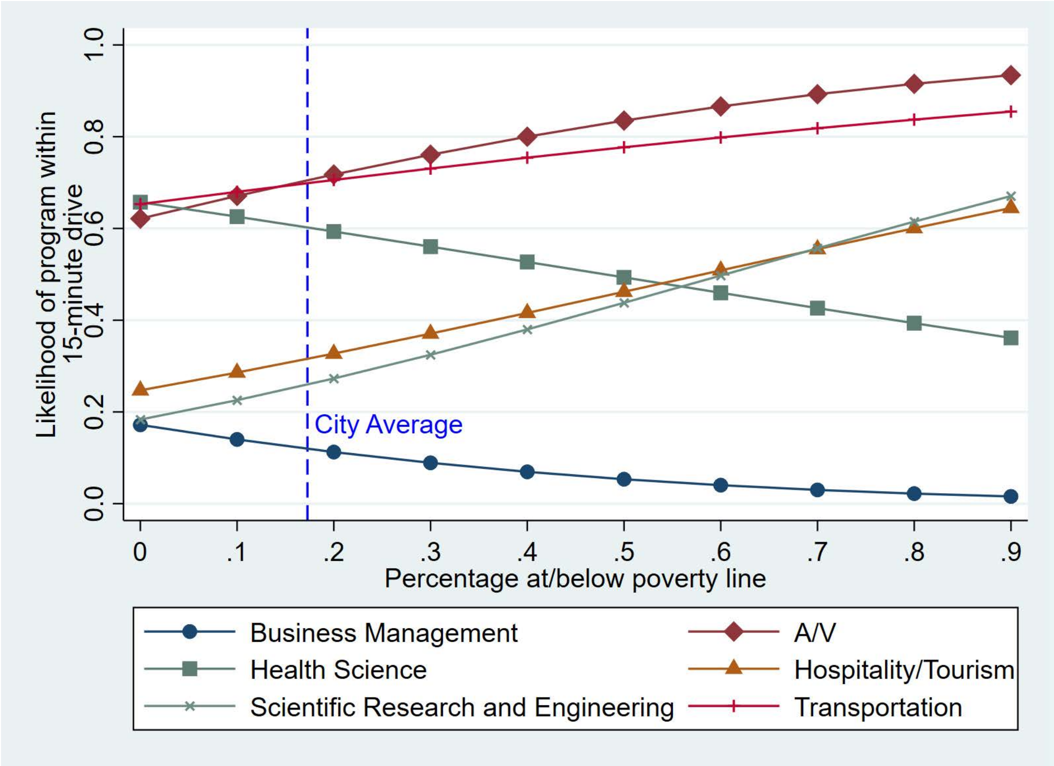


Table 10 represents differences in the number of seats, similar to Table 8. Positive coefficients suggest an associated increase in nearby seats with an increase in the number of residents at or below the poverty line, whereas negative coefficients suggest a similarly associated decrease. There are several particularly notable results in this table, emphasizing the need for robust sets of models that include both existence of the program and number of seats. For example, compare column 12 in Tables 9 and 10. Whereas Table 9 presents a positive result, suggesting a 10% increase in residents at or below the poverty line is associated with a roughly 5.0% increase in the likelihood of a Transportation program existing within 15 minutes, Table 10 indicates that the same 10% increase in residents at or below the poverty line is in fact associated with a decrease of slightly more than 27 seats in nearby programs, indicating the difference in program size is large enough to flip the coefficient. This is the only career cluster to see this shift, however, as most coefficients align to those in Table 9.

Table 10. Differences in Program Seats Within 10 Minutes by Percent Below Poverty Line: New York City

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
% at or below poverty line	50.98***	23.96***	284.69***	–45.20***	139.87***	117.54***	120.27***	40.36***	–24.26***	–4.57**	50.62***	–272.76***
	(0.813)	(3.708)	(3.566)	(0.961)	(4.775)	(1.807)	(4.365)	(0.865)	(4.401)	(1.656)	(1.323)	(11.780)
Observations	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895	378,895
R^2	0.148	0.076	0.071	0.120	0.114	0.088	0.006	0.058	0.009	0.063	0.071	0.023

Note. Standard errors in parentheses; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Please see Key 1 for corresponding programs.

In conclusion, the results highlight the wide variety of accessibility to career clusters in New York City and Connecticut when measuring based on localized differences in race/ethnicity and poverty level. Although these results are not intended to be comparative and are entirely descriptive, they demonstrate that students residing in differently oriented census tracts (based on race/ethnicity and poverty level) have differences in access to career and technical education career clusters in ways that are not entirely consistent across contexts, predictors, or models. Further consideration of how to interpret these results is addressed in the Discussion section.

Discussion

When framing the findings, there are two key points to keep in mind. First, these results are not intended to be evaluative, nor should they be used in such a manner. There are various reasons why these programs exist where they do; this study merely describes the landscape of available options and how opportunities differ for students of different backgrounds. That is not to say there are not policy implications to be drawn from the results, which are explored in later sections, but I intentionally chose not to frame these results as any system doing a "good" or "bad" job.

Relatedly, despite this study exploring two different contexts, it is important to reiterate that this is not a comparative study; rather, this paper suggests that two different contexts may have two different landscapes of program availability. These differences are implicit in the fact that the programs may have different designs, goals, and implementation structures, which are not explicitly discussed here.

I have outlined three key discussion points. First, I explore the implications of the sole negative coefficient of the race/ethnicity predictor in Connecticut. Second, I examine the variety of differences present in New York City and their association with job preparation. Finally, I note the differences in both contexts when using poverty as a predicting variable.

Connecticut: A Story of STEM

The landscape of CTE offerings in STEM is dynamic; there is significant recent research exploring the implications and offerings of STEM in CTE (Dougherty & MacDonald, 2020; Gottfried et al., 2021; Plasman & Gottfried, 2018). These recent papers have explored differences in not only who takes STEM-oriented CTE programming, but also the potential for positive implications of those programs above and beyond traditional high school curricula.

Perhaps the most compelling findings in this work, then, are the results for STEM programs when examining differences based on race/ethnicity in Connecticut. Indeed, it is the sole negative coefficient in Table 4, suggesting that students residing in areas with more Black/Latinx peers are less likely to have close access to a STEM CTE program. This is noteworthy because, in combination with the understanding that students generally are more likely to choose programs that are nearby, the findings suggest that Black/Latinx students are effectively limited in their access to STEM-based CTE programs in Connecticut.

This is not the case for other programs of study; in fact, Black/Latinx students in Connecticut have greater access to a wide variety of CTE programming in comparison to students residing in areas with more White students. There are two different yet related ways to consider this finding, each requiring future research to attend to the results more closely. First, does the increased access to CTE programs come at the cost of access to other programs? Is there a substitution for other programming to which students in more Black/Latinx areas have more limited access? If so, it is possible the increased access is in fact reinforcing the problematic past of vocational education.

This is not necessarily the only way to view these results, however. Another way to frame the increased access is simply that programs of study in 10 of the 12 CTE clusters are in fact more accessible to Black/Latinx students in Connecticut, and given the generally positive results seen in recent work on CTE (Bishop & Mane, 2004; Brunner et al., 2021; Dougherty, 2018; Dougherty et al., 2019; Neumark & Rothstein, 2006), this increased access is a boon for these students. This is reinforced by the increased number of seats available (Table 4) in the majority of CTE clusters.

New York City: Differences in Job Preparation

Although the results in Connecticut paint a specific picture, the results in New York City are a bit more complicated. Indeed, there are a variety of clusters with positive coefficients when comparing tracts of different racial/ethnic concentrations and a variety of clusters with negative coefficients as well.

Although there is no obvious difference between the clusters with positive and negative coefficients, recent emergent work may suggest a pattern. Kemple et al. (2023) examined the landscape of CTE in New York City and described (among other things) differences in programs based on their correlated "job zone" (O*Net OnLine, 2022): Some programs are associated with jobs that are more likely to require additional postsecondary education (i.e., a higher job zone), whereas other programs are more likely to be connected to jobs requiring less postsecondary education (i.e., a lower job zone). Programs that are more likely to be in the higher category are more likely to be in the Information Technology and Business Management clusters, whereas programs in the lower category are more likely to be in the Architecture/Construction, Hospitality, and Transportation clusters.

Examining the results through this lens reveals an interesting pattern. Based on the results in Table 7, clusters with higher job zone ratings are generally found to have positive coefficients, whereas clusters with lower job zone ratings are generally found to have negative coefficients. This suggests that although students from areas with more Black/Latinx residents may have increased access to a variety of clusters of programs, these programs are more likely to be associated with increased postsecondary requirements for job placement. Conversely, these same students have less access to programs that allow for direct placement into the workforce after high school. This should not be construed as any indication of overt bias in program placement, but it does highlight the fact that students in New York City have differences in the nearby core types of programs they can access when grouping by potential entry into the workforce.

Differences in Poverty: A Complicated Picture

Although the coefficients and implied differences in access noted are based on differences in racial/ethnic makeup in census tracts, a significant portion of the analysis focuses on differences in poverty rate within those same tracts. Although some coefficients in Connecticut and New York are similar for both analyses, there does not appear to be a general trend linking the two; rather, they appear to be relatively different in their results. Further, even within a single location, the differences are noticeable; although many statistically significant results exist in Connecticut and New York City, there appears to be little alignment to the results presented for race/ethnicity. Race/ethnicity and poverty status are related, but these analyses make it clear that they need to be treated as separate.

The salient question, then, is what to make of the results presented for differences in poverty rate by census tract. It's clear that students from lower socioeconomic backgrounds have less access to some clusters in each of the studied locales, and increased access to others, but it's not clear if there's any sort of systematic pattern to the results; that is, despite plenty of significance stars, it's not clear whether any practical pattern emerges from these results.

Still, it is important to recall the core purpose and context of these analyses, a point that is salient throughout the consideration of these results. This is not a subsample of any larger system; rather, these data describe the status of two distinct CTE delivery mechanisms. Rather than being indicative (or predictive) of any larger issue, these results are descriptive summaries of a snapshot in time. This is not to say they are irrelevant to a larger conversation, however. These results demonstrate that for students in each of these locales, access is not necessarily equal based on where students reside. This fact, in and of itself, could inform policymakers in planning decisions about expansion and/or the addition of programs and suggests these factors are worth considering throughout those processes.

Limitations

A number of important considerations accompany this type of analysis. The first is that this analysis is designed to be descriptive; it does not explain behaviors or phenomena, but rather demonstrates their existence. Further, these results are a (relatively current) snapshot; they do not reflect changes over time. To that point, if my analysis uncovers systematic racial/ethnic or socioeconomic differences in the placement of CTE programs, the specifications and design described will not contribute a rationale for those differences, nor does it explore how those differences have shifted over time. However, future analysis could address these questions.

A second limitation is based on data availability, specifically when considering questions of equity. Although race/ethnicity and socioeconomic status are captured by the U.S. Census in the American Community Survey, my analyses are limited to the measurements dictated by the data, which are inherently limited (O'Hare, 2019).

Last, my design is specifically intended to exclude student choice from the model; it is based on the notion that differences in access may yield differences in choices. Although literature exists that supports that notion, cited in the literature review noted earlier, it is important to clarify that this analysis does not attempt to measure, explain, or describe the mechanisms of that choice. Rather, it highlights the eventualities of policy decisions that may impact that choice. With additional, student-level data, these analyses could be bolstered in the future.

Significance

The arc of career and technical education has been fraught with elements of inequity. Indeed, at its inception as a vocational alternative to more traditional academic studies, participation was not distributed equally across different racial/ethnic or socioeconomic groups, often due to inequitable and discriminatory practices (described fully in the literature review). Even more modern CTE, and its research, has been described as "languishing as a place for someone else's child" (Stringfield & Stone, 2017, p. 166). That may not be the case anymore, however. Perhaps the starkest example of CTE no longer being simply for "someone else's child" is Seaton's (2019) personal essay in which he described his daughter's pathway through a CTE program in health technologies as a far cry from the former "dumping ground" once associated with vocational education. He cited numerous examples of CTE's benefits, particularly in reference to historically disadvantaged populations, including males of color and low-income students. Still, those benefits are limited to those who have the opportunity to take advantage of them. Seaton also noted that many communities are not taking advantage of the CTE opportunities presented to them. This paper provides the opportunity to reframe that as not an issue of choice but perhaps an issue of access.

This paper specifically addresses this question: Are those opportunities in fact present, or are they limited by distance? A small but growing body of causal literature has begun to address the efficacy of CTE, often relying on either regression discontinuity (Dougherty, 2018) or natural experiments as a function of lottery-based admissions

(Brunner et al., 2021) to examine the impact of attending a CTE school as opposed to a local alternative. These studies, however, are by design limited to the local average treatment effect, meaning they exclude students who are not able to take advantage of the choices due to restrictions of distance. If, in fact, students are not applying because their access is so limited, this reframes our understanding of how and why CTE is impactful and, perhaps more important, for whom. Although CTE programs may offer benefits, it is in the interest of policymakers and researchers to know whether these programs are in fact equally—and equitably—available to the full spectrum of students.

Conclusion

In conclusion, I want to clarify again the nature of these results. Rather than a sample of a larger population, these findings and the corresponding discussions are tied to two unique full populations of students with access to two distinct CTE delivery systems. These results are not intended to be predictive of CTE nationally or even statewide; rather, they provide a framework for understanding the ways in which CTE may or may not be equitably distributed and accessible to students of different racial/ethnic and socioeconomic backgrounds. In these two contexts, we see differences for STEM programs, differences based on job preparation, and differences based on poverty. Each of these differences may or may not be similar in other, unstudied contexts, but the results reinforce that the possibility of inequitable access deserves attention from both researchers and policymakers.

I encourage readers to keep an eye on such differences when considering the landscape of school choice offerings writ large, keeping in mind that location alone can be a barrier to entry and a de facto limit on program accessibility. Although a substantive and crucial set of research examines students who choose programs (for a variety of reasons), it is also crucial to continue a line of work that attends to differences in access, separate from preference.

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