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Heterogeneity in High School Career and Technical Education Outcomes

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High school Career and Technical Education (CTE) has received an increase in attention from both policymakers and researchers in recent years. This study fills a needed gap in the growing research base by examining heterogeneity within the wide range of programs falling under the broader CTE umbrella, and highlights the need for greater nuance in research and policy conversations that often consider CTE as monolithic. Examining multiple possible outcomes, including earnings, postsecondary education, and poverty avoidance, we find substantial differences in outcomes for students in fields as diverse as healthcare, IT, and construction. We also highlight heterogeneity for student populations historically overrepresented in CTE, and find large differences in outcomes for CTE students, particularly by gender.

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Heterogeneity in High School Career and Technical Education Outcomes

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Abstract: High school Career and Technical Education (CTE) has received an increase in attention from both policymakers and researchers in recent years. This study fills a needed gap in the growing research base by examining heterogeneity *within* the wide range of programs falling under the broader CTE umbrella, and highlights the need for greater nuance in research and policy conversations that often consider CTE as monolithic. Examining multiple possible outcomes, including earnings, postsecondary education, and poverty avoidance, we find substantial differences in outcomes for students in fields as diverse as healthcare, IT, and construction. We also highlight heterogeneity for student populations historically overrepresented in CTE, and find large differences in outcomes for CTE students, particularly by gender.

Keywords: Career and technical education, Vocational education, High school, Labor market outcomes, Educational policy, Heterogeneity

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Introduction

Throughout the second half of the 20th century, research on vocational education generally found negative effects for participating students. In particular, vocational education was shown to perpetuate curricular tracking, which prevented certain student groups – particularly students with disabilities and racially minoritized students – from accessing the academically rigorous instruction that would prepare them for college and high-earning careers (Tyack, 1974; Bowles & Gintis, 1976; Anderson, 1982; Oakes, 1983). In the early 21st century, vocational education underwent a significant reinvention, highlighted in part by the shift in terminology from vocational education to Career and Technical Education (CTE), as well as increased investments by the federal government along with positioning CTE as part of a "College and Career Readiness" agenda (Dougherty et al., 2020; Dougherty, 2016). While many traditional vocational programs remain in place, new CTE programs tend to emphasize pathways that were explicitly designed to prepare students for postsecondary education as well careers in high-demand, high-wage areas (see Bozick & Dalton 2013; Gottfried & Plasman 2018).

Alongside the renewed policy interest and shifts in curricular foci of CTE at the secondary level, an emerging body of experimental and quasi-experimental research using more recent data (Bonilla, 2020; Hemelt et al., 2019; Brunner, et al., 2021; Dougherty, 2018; Kemple & Willner, 2008) has enhanced our understanding of the causal effects of high school CTE programs, offering evidence of positive impacts that contrast with the earlier non-experimental research. However, given the increasingly broad range of contexts and programs that fall within

CTE, these studies are limited in that they largely treat CTE as a monolithic experience, potentially masking the extensive diversity of experiences students experience.1

Prior research has left several opportunities to further improve our understanding of whether CTE works, for whom, and under what conditions. First, recent research has tended to focus on CTE programming within oversubscribed, specialized CTE schools, where opportunities to estimate causal impacts have arisen. However, most CTE students across the nation engage with CTE within traditional comprehensive schools or part-time centers, which may not offer the same set of experiences as whole-school models of CTE, and therefore may not produce similar effects.

Furthermore, prior research has done little to disentangle potential differences in impact among the different programs *within* CTE, or how students with different personal characteristics may differently experience returns to CTE. With the push to expand CTE beyond traditional vocational programs and new federal guidelines that encourage CTE to emphasize college and career readiness, any analysis of CTE today must grapple with heterogeneity across career clusters as diverse as STEM, Cosmetology, Healthcare, and Manufacturing. Given the push for STEM-focused CTE programs, an emphasis on how these CTE programs may lead to different outcomes than more traditional vocational programs seems especially pertinent. We also pay close attention to differences in outcomes different student populations of interest, which is particularly relevant given the federal Perkins legislation's explicit focus on equity in access and outcomes for different student groups.

1 While this study focuses on high school CTE, several studies at the postsecondary level have more closely examined differences across fields of study; see Bockerman et. al, 2019; Stevens et. al, 2019; Belfield et. al, 2017; Jepsen et. al, 2014, among others).

This paper begins to fill a gap in the existing research base by estimating differences in the associations between high school CTE participation and various post-high school outcomes across different career clusters and for different student populations. Using administrative data from Massachusetts, we leverage factors known to be associated with selecting into CTE to observe how high school CTE program participation relates to college going, college completion, employment, and earnings for the nine cohorts of high school students expected to graduate high school from springs 2009 to 2017. We observe these students for between 1 and 7 years after anticipated high school graduation and find that advantages for CTE concentrators are highly heterogeneous for both college and workforce outcomes. We find that students concentrating in certain CTE fields see strong advantages in workforce, while students in other fields see stronger postsecondary outcomes. We also document that these advantages vary widely across the student characteristics, with students in populations that have historically been marginalized (including students with disabilities, students from lower-income families, Black and Latino students, students not attending college, and those with low tests scores) experiencing the largest benefits, along with those attending CTE-dedicated schools where the intensity of their CTE exposure may be more intensive. In particular, we find strong evidence that CTE may be a useful lever to help students avoid especially negative outcomes like poverty and disengagement from both education and the workforce. Though not explicitly causal in nature, our estimates hold up to a series of robustness checks which suggest that even under fairly conservative assumptions these returns cannot be explained by bias alone.

In this paper, we proceed as follows: We first review a brief history of the research base that motivates our work and the need to study heterogeneity within high school CTE. We then discuss the context, data and measures we use to explore heterogeneity within CTE. We follow

with a descriptive analysis, in which we focus on differences within who opts in to CTE and into different fields of study. After introducing our analytic approach, we present results in which we explore expected differences in outcomes associated with CTE by both career clusters and populations of interest. We then test limitations to our analytic approach through a number of robustness analyses. Finally, we conclude with remarks about the significance of our findings and implications for both policymakers and researchers who study CTE.

Literature Review

Given shifts in the CTE policy landscape in recent years towards CTE as a part of a college and career readiness curriculum, an emerging body of experimental and quasi-experimental research has sought to revisit potential returns to CTE, providing some reasons for optimism for proponents. Kemple & Willner (2008) implemented a random assignment study, in which students were assigned for admission to nine oversubscribed Career Academies, finding that Career Academy participants saw no meaningful difference in postsecondary education, but did earn 11% more per year than non-participants over the first 8 years after high school graduation, with returns concentrated among male students (who saw a 17% increase in earnings). Hemelt et al. (2019), using more recent data from a similar admissions lottery process in one career academy in North Carolina, find an 8% increase in high school graduation rates for Career Academy participants. Similar to Kemple & Willner, Hemelt et al. find more positive effects for male students, particularly when considering college enrollment. Dougherty (2018) and Brunner et al. (2021) both employ a regression discontinuity design using admissions score cut-offs for CTE-dedicated high school, with Dougherty finding a 7-10% increase in the likelihood of high school graduation, and Brunner et al. finding a 31% increase in quarterly

earnings (again, with returns accruing primarily to male students), though evidence of null effects on college enrollment by age 23. Bonilla (2020) uses a school district level regression discontinuity on receipt of additional funding for CTE and found a reduction in high school dropout among districts that received additional funds to spend on CTE. Importantly, these impacts were stronger for girls, but schools invested principally in health services CTE programs, which are disproportionately enrolled in by females.

Overall, the emerging causal literature paints a picture of positive earnings returns, particularly for male students, with more mixed evidence of effects on postsecondary education. One limitation of all of these studies, however, is that they rely on the experiences of CTE students in oversubscribed, whole-school CTE models, which are not representative of the wide range of settings in which CTE is offered throughout different local contexts.

In addition to the recent experimental and quasi-experimental work, further quantitative research has enhanced our understanding of CTE in the more modern policy context and raises questions about the nuanced impact CTE may hold for participants. Kreisman and Stange (2020), for example, find evidence that participation in CTE is more widespread across academic achievement levels than in previous eras, raising doubts of whether longstanding assumptions about CTE as a "dumping ground" for low-achieving students still hold true (Kelly & Price, 2009). Kreisman and Stange also find that earnings returns largely accrue to students who take upper-level CTE course, arguing that in-depth concentration in a particular career cluster may be important for meaningful returns. Cellini (2006) finds some evidence that CTE participation increases high school graduation as well as two-year college enrollment, though the two-year college enrollment increase may be partially due to some diversion of CTE students from four-year colleges. Other studies including Bishop and Mane (2004) and Meer (2007) also find

evidence of positive returns that may vary across career cluster, though these results rely on older data from students attending school in an era before the shift from vocational education towards the modern era of CTE that aims to be more focused on academic rigor and college and career readiness.

While an emerging base of research points to some positive benefits to CTE, there are a few general limitations we seek to address. First, most research either uses relatively outdated data from a time when CTE plausibly operates much differently than today given recent policy initiatives; by using more recent data, we can speak more closely to the current policy context. Second, many of the more recent studies only consider students in oversubscribed, CTE-dedicated school settings, limiting generalization to the other settings including undersubscribed CTE schools and comprehensive high schools; by incorporating statewide administrative data, we can generalize more broadly to a wide range of settings in which students engage with CTE. Finally, studies generally consider CTE as a single curricular intervention, rather than exploring differences across CTE programs (potentially in part because many studies of CTE have focused on outcomes such as attendance, high school graduation, and college-going - outcomes that may be more dependent on CTE participation overall rather than participation in a specific field of study). However, given policy interest in workforce outcomes and the rise of new STEM-focused CTE programs that were designed to be part of a college and career readiness agenda, this paper seeks to explore differences in outcomes experienced by CTE concentrators across the range of career clusters within CTE.

Context

Massachusetts provides a compelling setting to study CTE participation in that it has a prominent, well-established system, a diverse range of program offerings, and a participation rate well-suited for meaningful analysis. With approximately 21.5% of students across the state concentrating in CTE, there is a large sample of CTE concentrators within which we can examine several dimensions of heterogeneity. Moreover, the diversity of contexts in which CTE is offered in Massachusetts mirrors the diversity of contexts nationwide; slightly under half of CTE concentrators (46%) attend CTE-dedicated schools, while just over half (54%) take CTE courses within comprehensive schools. Some programs are heavily funded by the state through a Chapter 74 program2, while others receive less funding and support. Finally, Massachusetts has one of the nation's longest-standing longitudinal databases to track student participation in high school CTE, enabling analysis of medium-term outcomes. Furthermore, by merging K-12 data with National Student Clearinghouse and unemployment Insurance (UI) records through the Department of Labor, we can examine outcomes for students several years after high school.

In Massachusetts, students can concentrate in ten career clusters by taking two or more years of courses in that cluster. While these career cluster are somewhat different than the 16 national career clusters promoted by AdvanceCTE, there are broad enough similarities that findings in Massachusetts can help inform our thinking heterogeneity across different career clusters nationwide (AdvanceCTE, 2018). Three of the five most common clusters, Construction,

2 Chapter 74 programs are defined by Massachusetts General Law Chapter 74, and are required to successfully undergo go an application and approval process by the Massachusetts Department of Elementary and Secondary Education (DESE) and are required to build partnerships with local employers and postsecondary institutions, offer work-based learning experiences, meet certain teacher licensure requirements, have certain seat-time requirements for students, and are considered to High Quality College and Career Pathways by DESE.

Manufacturing, and Transportation, include courses that may be thought of as more "traditional vocational" courses (in so far as they include traditional skilled trades like electrical, plumbing, construction, and auto mechanics).3 Still, a substantial portion of CTE students concentrate in clusters like Business & Consumer Science, Communications, Healthcare, and Information Technology that may break the mold of the common conception of old vocational programs, and may be more aligned with what some have called "new CTE" (Duncan, 2011) and STEM-aligned pathways (Dougherty & Harbaugh, 2020; Plasman et al., 2017).

Data

We use data from the Massachusetts state longitudinal data system (SLDS) covering cohorts of first-time 9th graders whose on-time (i.e., four years after entering 9th grade) graduations from high school were expected in the springs of 2009 through 2017 (for most of our analyses, we focus on students from the 2009-2011 cohorts, for which we can observe 7 years of post-high school data). The dataset includes enrollment data, demographics, attendance, town of residence, Massachusetts state standardized test scores, immigrant status, disability status, and English learner status. We add college enrollment and completion data from the National Student Clearinghouse, as well as quarterly earnings data reported to the Massachusetts Department of Labor through the unemployment insurance (UI) system. We observe individual student outcomes for up to seven years after their on-time graduation year. UI records include only taxable reported earnings for non-federal employment within the state that are eligible for unemployment benefits. While we consider those individuals with zero reported earnings within a year as non-earners in that year, this may exclude some earnings such as federal work, some

3 We display the percent of CTE concentrators in each career cluster in Appendix Figure A1.

seasonal work (for example, in agriculture) that may go unreported to unemployment insurance, along with self-contract employment, including some work in the "gig economy." 45 The analytic sample used for most of the analyses includes 251,437 students, approximately 19.8% of whom are CTE concentrators under the state definition used for federal reporting purposes.6

Measures

Our primary measure of interest is whether a student completed a CTE concentration when in high school. For our purposes, this means a school identifies a student as a CTE concentrator if they are enrolled in CTE courses for two or more school years at any time during high school. This "concentrator" definition is used for federal reporting purposes, making it a meaningful designation with implications for how much Perkins funding the state receives. It also represents a substantive commitment to CTE, above and beyond any more minor exposure students would receive from taking a single CTE course as an elective credit. Moreover, many CTE clusters are explicitly designed to be completed in two-year course sequences, with students often prepared to take licensure/certification exams, or to receive industry or state-recognized credentials after two years of CTE courses. In the analyses in which we consider the advantages

4 See Collins et al. (2019) for more detail about the implications of this limitation in the UI data.

5 Following Foote and Stange (2019), we also show analyses in which we exclude those with 0 earnings from our analyses.

6 While we use this sample for our primary analyses throughout, we also present outcomes in the appendix that take full advantage of additional cohorts for which we have access to some, but not all outcomes (for example, cohorts that have not yet been out of high school for seven years). In these analyses, our complete dataset includes 636,766 students in the graduating samples from 2009 to 2017 (with exact samples varying depending on the outcome). These analyses show similar results and provide additional confidence that our results generalize across a longer timeframe, and across cohorts graduating into very different economic realities.

for CTE concentrators in specific career clusters, we count only those students taking two or more years of courses *in that cluster* to be cluster concentrators (eg, Healthcare concentrators, Construction concentrators). For those students who completed two or more years of CTE, but not within a single cluster (sometimes referred to as CTE "dabblers"), we include them as CTE concentrators, but not as concentrators in any one cluster for the cluster-specific analyses. These "dabblers" receive substantial exposure to CTE courses, but are mostly enrolled in comprehensive high schools where some CTE programs can be less defined (as opposed to CTE-dedicated schools), and some simply become dabblers by taking multiple CTE courses as electives without necessarily making conscious decisions about their CTE concentrator status.

Our key outcomes of interest are college enrollment, college completion, earnings, employment, and economic outcomes that are associated with economic dependence on the state (poverty, and being neither enrolled in college nor employed). We define these outcomes as follows. First, we define enrolling in any college as a binary indicator equal to 1 if individuals are ever observed enrolling in a two- or four-year college after completing high school. We also create separate indicators to capture whether students graduate from a two-year college, a four-year college, or complete a certificate or degree at either type of institution. For labor market outcomes, we examine total annual earnings in each of the first seven years after expected completion of high school, as well as binary indicators of whether individuals earned at or above the inflation-adjusted federal poverty level at each of these time periods. Our final outcomes of interest are whether students are neither employed nor enrolled in college (NEET) during the first seven years after expected completion of high school, and whether an individual earned enough money to clear the federally-defined threshold for poverty for a household size of one.

These latter sets of outcomes help us understand whether students are able to avoid outcomes known to be associated with larger negative personal and social costs.

Descriptive Analyses

Heterogeneity within CTE occurs on two clear dimensions that we explore here – the characteristics of students who become CTE concentrators relative to non-CTE students, and the characteristics of students *across* career clusters.7 Table 1 and Figure 1 highlight the starkness of these differences. Echoing work from other settings (Plasman et al., 2020; Dougherty, 2018; Dougherty et al., 2018, among others), Table 1 shows that CTE concentrators are less likely to be female, more likely to be lower-income, and more likely to be English language learners than non-concentrators. In terms of racial and ethnic identity, Latino students are especially overrepresented and Asian students underrepresented among CTE concentrators. CTE concentrators score well below the state average on 8th grade standardized tests and are nearly 13 percentage points less likely to attend and graduate from college (especially 4-year colleges) than their non-CTE peers.8

We present in Figure 1 the over- or under-representation of select student characteristics, relative to the statewide average (represented by the horizontal red line in each panel) by cluster and show clear variation. Perhaps the most striking differences relate to gender. Construction concentrators are 36 percentage points more male than the statewide average, with male students

7 For a breakdown of the share of CTE concentrators in each career cluster, see Appendix figure A1.

8 Appendix Table A1 displays descriptive statistics for the full sample (cohorts 2009-2017).

also widely over-represented in the Transportation, Manufacturing & Technology, and IT clusters. In contrast, male students are 43 percentage points less likely to concentrate in Education than the state average, and also highly underrepresented in Healthcare and Business & Consumer Sciences.

Figure 1 (see also Table A2) also highlights that prior academic performance differs across clusters. Students scoring in the lowest quintile of 8th grade test scores are overrepresented in every cluster, though low-scoring students are particularly present in Transportation, Hospitality & Tourism, and Construction. Substantial differences in selection into CTE also exists across clusters for lower-income students, students with disabilities, and Black and Latino students. Also clear in Figure 1 is that while CTE concentrators as a whole are less likely to attend college than the statewide average, this varies by career cluster. In some clusters (Healthcare, Education), students are descriptively somewhat *more* likely to lead to college than the statewide average, while in others (Construction, Transportation) students are far less likely to enroll in college than the statewide average.

These underlying differences in the characteristics of students who become concentrators in the different career clusters present a compelling case that we might consider each cluster as a distinct intervention, rather than one single program, broadly labelled as CTE. Since students who have access to and/or choose to opt into CTE vary so widely across cluster, it appears that students themselves may view the clusters quite differently. Thus, the construction of potential counterfactuals should account for those differences in models and estimate different impacts by cluster.

Figure 2 displays descriptive trends and differences in earnings across the career clusters, separated by whether students concentrated in CTE and also whether they attended college. As

expected, students who attend college earn more than students not attending college, especially as more time passes after high school. In certain fields tightly connected with college-going (for example, Healthcare; see Figure 1), CTE students who attend college earn more than non-CTE college students, suggesting that in pathways tied explicitly to postsecondary education (e.g., nursing) CTE may be especially advantageous. Among students *not* attending college, CTE concentrators in *every* cluster attain higher earnings on average throughout the first seven years after their expected high school graduation, with this descriptive advantage for concentrators in some clusters (particularly in the traditional trades such as Engineering & Manufacturing, Construction and Transportation) increasing over time. On the whole, college-goers' earnings increase rapidly in years 5 through 7, as many college-going students enter the workforce. However, in these same trade fields, CTE concentrators not attending college continue seeing competitive earnings to those attending college, even 7 years after high school. In Appendix Figure A2, we also present descriptive differences in the rates of college-going and degree attainment, compared to the statewide averages (represented by the long red-dashed lines) demonstrating substantial differences across cluster in how likely students are to attend college; across every cluster, however, CTE concentrators are less likely to *complete* a college degree than the statewide average, though, again, this varies widely.

Analytic Approach

Because student self-selection is endemic to high school curricular choice, descriptive analyses - while informative - almost certainly obscure the role of CTE in helping students achieve certain outcomes. While a regression-based approach is prone to bias from unobserved variables that may predict selection into CTE, our approach allows us to take advantage of a

statewide database in which students engage with CTE in vastly different contexts. This approach also allows for stronger generalizability, as we are able to consider CTE in both CTE-dedicated settings and comprehensive school settings, *and* across a wide-ranging of career clusters, mirroring the many different ways CTE is offered across American public schools.

While the primary aim of this analysis is to explore *heterogeneity* within CTE, we first establish the credibility of our analytic approach by fitting a model to compare student outcomes for students who are observably similar and had access to a similar set of school and curricular options. We specify our main model as follows:

$$Y_{ict} = \beta_1 CTE_i + \boldsymbol{X_i'\gamma} + \pi_c + \tau_t + \epsilon_{ict} \qquad (1)$$

Here, Y_{ict} is a generic outcome for student *i,* in cohort *c,* and town *t*. The key predictor CTE is equal to 1 if student *i* is a CTE concentrator (zero otherwise), $\boldsymbol{X_i'}$ is a vector of student-level covariates including demographic characteristics and 8th grade test scores and attendance, π_c represents fixed effects for entering cohort and τ_t represents fixed effects for town of residence. Errors are heteroscedasticity robust and clustered by the town of residence. In all models, β_1 is the coefficient of interest and represents the average population difference in a given outcome associated with CTE concentration, relative to otherwise similar non-concentrators. We also consider an alternate counterfactual group, students who take a single year of CTE but do not concentrate, which we discuss below under Limitations and Tests for Robustness.

While we cannot rule out the presence of unobserved factors predicting selection in CTE, and accordingly use non-causal language when interpreting our estimates, our models include a rich set of controls for student-level demographic information, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts), which accounts for unobservable characteristics that would influence *both* 8th grade academic

performance *and* selection into high school CTE. Cohort and town of residence fixed effects account for differential labor market trends and access to CTE offerings.

To demonstrate the merits of our approach, we fit initial models that show the stability of our estimates once we include an increasing number of controls. Following the argument in Altonji, Elder, and Taber (2005), the stability of these estimates across the more saturated models provides evidence that we have accounted for the most egregious sources of potential bias. We also apply Oster's (2019) approach by estimating how large remaining unobserved selection bias would have to be to nullify our estimates (discussed below under Limitations), and find that unobserved bias would have to substantially outweigh observed explained variation for true impacts to be zero.

Before examining the different dimensions of heterogeneity for our different outcomes, in Table 2 we present our estimates of the relationship between CTE concentration and one outcome (cumulative earnings over the first seven post-high school years) using five specifications of model for students concentrating in each of the 10 career clusters (1).9 Each specification sequentially adds controls to better isolate any difference in outcomes that might be associated with CTE concentration. By adding year and town of residence fixed effects, in Model 2 we highlight that a portion of these differences can be explained by the contexts in which students live, the years in which they enter high school, and the schools they can attend. This also highlights that access to CTE offerings (as dictated by what school someone attends) plays an important role in driving unconditional differences in outcomes, but does not fully account for differences.

9 In Appendix Table A3 we also present a similar table in which we lay out results using these 5 models for the full sample, but across the full range of outcomes.

Adding student demographic characteristics (Model 3) reduces the magnitude of the CTE concentration estimate across all clusters, suggesting that observable student characteristics do not differentially explain differences in outcomes across clusters. Model 4 adds controls for 8th grade assessments and 8th grade attendance rates, which allow us to consider students within the context of demonstrated academic performance prior to any engagement with CTE in high school. As with demographics, adding test scores as controls changes the relationship between CTE concentration and total earnings in similar ways across clusters. Finally, Model 5 includes all controls from earlier models, as well as town and cohort fixed effects. Across all career clusters, the direction and significance of the estimates remain consistent across model specifications, lending confidence to the inference that there is some persistent contribution of CTE concentration to earnings. While there are some differences in how the various specifications change the estimates across the different clusters, these differences are relatively minor, with estimates in Model V generally no more than 10% larger or smaller than the unconditional estimates in Model I. The largest increase in returns from Model I to Model V are in Education and Hospitality, suggesting that there may be more negative selection into these clusters. While these clusters may have some negative selection, they also see some of the weakest returns, alleviating concerns that we are overstating their earnings advantage. Conversely, after conditioning on these factors, returns are somewhat more modest for the Arts and IT, suggesting that there may be positive selection into these clusters (and that we may be somewhat overstating our findings). While there are some differences in how selection driven by observables may not be identical across clusters, the relatively minor sensitivity to changes in the model are small enough that they do not change the overall take-aways of our analysis. Thus,

throughout the rest of the paper, we present results using the specification from column 5 (our fully specified model in equation (1) above).

Results

Postsecondary Outcomes

In Figure 3 we present estimates of the relationship between CTE concentration and postsecondary outcomes (also presented in Tables A4 & A5). Each panel of Figure 3 presents β_1 for the overall population of students, male and female students, and for several populations of interests; in particular, we focus on student populations for whom there have historically been concerns about inequitable tracking into CTE. For reasons of sample size and statistical power, we present results for Black & Latino students together, though findings are similar for both populations. Moreover, we focus on populations that have been historically underrepresented in higher education and have faced lower earnings outcomes, and thus are of particular interest to policymakers and researchers focus on CTE. Throughout the paper, overall results are presented first, with results then presented from left to right in order of most to least likely (based on the descriptive evidence above) to attend college. Vertical bars on each coefficient result represent 95% confidence intervals. Intervals not crossing 0 indicate statistical significance at α=0.05 level. Throughout the paper, differences and advantages or disadvantages for CTE students that we discuss can be interpreted as statistically significant at the 95% level or better, unless otherwise noted. Looking first at the top-left panel of Figure 3, CTE concentration predicts essentially no difference on the extensive margin of attending any college; however, this estimate varies by population. Female students see a moderate (3.8 percentage point) increase in their overall rate of college-going, while male students see a minor, but statistically insignificant

decrease. Conversely, Black & Latino students see a large increase in their likelihood of attending college (8.9 percentage points), as do students eligible for Free or Reduced-price Lunch. CTE concentration is also associated with a decrease in overall degree attainment (see Appendix Figure A3), though, notably, this relationship is not significant in population groups that are currently underrepresented in college-going, particularly Black & Latino, students with low test scores, and those eligible for Free & Reduced-price Lunch.10

Figure 3 also presents results specifically for 2- and 4-year college enrollment. Here, CTE is associated with an *increase* in attending a 2-year college and smaller or insignificant decreases in 2-year college-going degree attainment across all subpopulations. However, CTE is associated with lower rates of attendance at 4-year colleges (although, again, the negative associations are not significant for Black and Latino students and students with disabilities). Overall, Figure 3 highlights a picture in which CTE is associated with a modest overall decrease in college-going and, in particular, attainment. While our approach cannot definitively speak to whether CTE leads some students to substitute away from 4-year colleges and into 2-year colleges, that pattern of substitution at the intensive margins of college enrollment would be consistent with our estimates.

The righthand panels of Figure 3 (also in Table A5) explore the same education outcomes as above, but rather than comparing outcomes for CTE concentration more generally across different student populations, we now present differences of outcomes accruing to CTE

10 As seen in Appendix Table A3, our postsecondary outcomes are relatively sensitive to the inclusion of additional covariates and fixed effects in our model specifications. This suggests that our education estimates may overstated in magnitude, as additional unobserved covariates would be likely to continue to reduce the magnitude of the disadvantages seen by CTE concentrators, especially in the clusters with especially high (e.g., Healthcare, Education) and low (e.g., Construction, Transportation) point estimates related to college-going.

concentrators in each specific career cluster. For example, in order to estimate anticipated advantages from concentration in the Healthcare cluster, we compare Healthcare concentrators to non-CTE students who were otherwise similar on observable characteristics. For cluster-specific analyses here (and throughout the paper), concentrators in clusters other than the one under study are excluded, which allows us to examine the expected difference for students who become CTE students in a particular career cluster, compared to students who do not concentrate in CTE. Again, we arrange results from the clusters where students are descriptively most likely to attend college (Healthcare, Education) to least likely (Transportation, Construction). Interestingly, even after accounting for student and local characteristics, the clusters with the highest college-going rates also see the strongest increases in the probability of college attendance. The differences between the advantages for Healthcare and Education concentrators (15.1 and 13.0 percentage points) and the disadvantages for Transportation and Construction (-14.9. and -12.7) is striking. For Transportation and Construction, this is driven almost entirely by large decreases in the likelihood of attending 4-year colleges (-17.7 and -16.6). Additionally, there are several clusters in the center where students experience little to no change in their likelihood of attending college. In terms of degree attainment, decreases in college-going are especially notable for the less college-going clusters (see Appendix Table A5). Most of the clusters are associated with an increase in 2-year college-going, and in some cases, modest increases in 2-year college completion. Finally, some clusters (most notably Healthcare, IT, and Education) see large increases in overall and 2-year college attendance without an equivalent decrease in 4-year college attendance, suggesting that these clusters (which often require additional education to be completed at least at the 2-year college level) may be inducing some students to attend 2-yr colleges who otherwise might not otherwise have pursued postsecondary education. Given that

some career clusters (for example, healthcare) have clearly aligned paths to the community college level (i.e., nursing programs), the strong relationship with 2-year college attendance is notable and likely speaks to the design of the pathways.

Earnings

While policymakers have increasingly pointed to postsecondary education as an important intended outcome of Career and Technical Education, another longstanding goal for students is to position themselves for higher earnings. We turn now to the question of how students may expect to benefit financially from their engagement with CTE.

Figure 4 (also Appendix Table A6) displays the predicted impact of CTE concentration for the first 7 years after high school graduation.11 Overall, CTE concentration is associated with a large increase in initial earnings ($1792 in the first year after high school), that persist even 7 years after high school ($3359 in annual earnings). Figure 4 also presents clear differences in who sees positive earnings advantages from CTE. Advantages are especially strong and persistent for students who never attend college within the first 7 years after high school (whom we refer to as "No College"), with CTE No College students earning $6053 more in the 7th post-high school year than otherwise similar "No College" peers who are not CTE concentrators. Echoing results from prior studies (Brunner et al., 2021), male students see larger differences attributed to CTE concentration, while female students see more modest advantages that quickly diminish over time. Moreover, CTE is associated with an increase in earnings for several of the student populations who have been historically marginalized, especially students with

11 We also present results from the full sample with cohort 2009-2017 in Appendix Table A7 and Figure A4, and present outcomes in log earnings in Figure A6.

disabilities, as well as lower-income students, Black and Latino students, and students with the lowest prior achievement scores.12

Figure 5 (also Table A8) presents the relationship between earnings and CTE concentration, here disaggregated by career cluster.13 The heterogeneity in these results across cluster are even greater than the differences across student populations presented in Figure 4, lending support to the hypothesis that cluster selection is crucial in determining whether and how they might expect to benefit from CTE. Looking across cluster, the strongest predicted increase in earnings is associated with the Construction, Transportation, Manufacturing & Technology, and Healthcare clusters, while students in Hospitality, Agriculture, and Communications see little-to-no predicted benefit in their earnings, especially as students are further removed from high school graduation. In most clusters, the positive association with earnings begins to subside in years 5 through 7 (likely as college-goers who may serve as the counterfactual reenter the workforce); still it is noteworthy that in the career clusters with the highest predicted advantages (especially Healthcare and Construction), the earnings advantages remain large (though in Transportation, the advantage noticeably declines by 7 years after high school).

Poverty and Disengagement

While CTE may be thought of as way to *increase* earnings and education, it has also often been thought of as a tool to *reduce* the most adverse outcomes. This is of particular importance for students who face social and economic disadvantages and inequitable access to

12 We also present estimates of the relationship between CTE concentration and earnings 7 years after high school using propensity score matching in Appendix Table A23, with similar results.

13 We also present results from the full sample with cohort 2009-2017 in Appendix Table A9 and Figure A5 and present log outcomes in Figure A7.

services that may make them vulnerable to negative outcomes after high school. CTE may therefore also be evaluated by the extent to which it reduces students' likelihood of living in poverty, or of being Neither Employed nor in Education or Training (NEET, or disengaged).

We first turn to a measure of disengagement that combines both education and earnings to assess the extent to which a young adult is Neither Employed nor in Education or Training (NEET). We consider someone to be NEET if they fail to *either* earn above the single-person poverty threshold14, *or* to be enrolled in any postsecondary institution in that year. In Figure 6 (and Table A10), we present some evidence to suggest CTE may be a tool to reduce overall disengagement, particularly among students who do not go to college. Figure 6 highlights that students CTE concentrators are 7.8 percentage points less likely to be disengaged from both education and the workforce seven years after high school. Among students not attending college, we find evidence that CTE may be especially useful in mitigating the risk of being NEET in the earliest years after high school, though a sizeable advantage (14.1 percentage points) remains even 7 years after high school. Advantages are also notable among many of the specific populations examined. In Appendix Figure A8, we illustrate differences by career cluster, finding that while differences in the magnitude of the advantage, CTE concentrators in every cluster are less likely to be NEET than otherwise similar non-CTE students.

In Appendix Figures A9 & A10, we also present evidence of CTE concentration's relationship with poverty avoidance, with CTE students 8.4 percentage points more likely to avoid poverty seven years after high school than we might expect (and a nearly 14.1 percentage point advantage among students not attending college). Again, male CTE concentrators see

14 Given that the individuals in our sample are almost entirely ages 18-25, we use the single person threshold for poverty as specified by the U.S. Department of Health & Human Services, which ranges from $10,830 to $12,060 during the years under study.

stronger advantages than female concentrators, and CTE concentrators across all the populations examined here see a lower likelihood of poverty, lending strength to the argument that CTE may help students avoid poverty, at least in the early years of their adulthood. Moreover, as seen in Appendix Figure A8, the positive relationship between CTE and poverty avoidance holds across all career clusters, with CTE concentrators substantially more likely to *at least* earn above the poverty threshold than other observable factors would suggest, even 7 years after high school when most college-going students would have reentered the workforce.

School Setting

An important feature of CTE in Massachusetts is that it is offered in both comprehensive high school settings and in CTE-dedicated schools of choice. These CTE-dedicated schools differ substantially in their perceived quality and student/family demand, but in CTE-dedicated schools, all students concentrate in CTE, and all students opted-in to attending that school. These schools might then represent a more intensive exposure to CTE than concentrators are likely to receive at comprehensive schools, where many students become CTE concentrators through focused elective coursetaking. While these two settings mirror two common ways CTE is offered nationwide, we might worry that results are driven primarily by a particular type of school – especially a CTE-dedicated school that has been the focus of most recent quasi-experimental CTE research. In Figure 7, we disaggregate results for students attending CTE-dedicated school and those attending comprehensive high schools. Here, it is clear that CTE concentrators in CTE-dedicated schools, at levels differing by career cluster, see a substantially larger advantage compared to non-concentrators. However, by definition, these concentrators are compared to otherwise similar students at comprehensive high schools (see the Limitations section for a

discussion of why these school type-specific analyses introduce the potential for additional selection bias and how we address this).15 Yet, while the earnings advantages are greater for students at CTE-dedicated schools (echoing results seen in Connecticut from Brunner et al, 2021), it remains relevant that earnings advantages persist for CTE students at comprehensive schools, especially in the career clusters with the highest returns, albeit at more modest magnitudes.

Limitations and Tests for Robustness

A key limitation of these findings involves the possibility of omitted variable bias, particularly selection bias associated with student sorting into CTE (or into specific career clusters). While the inclusion of pre-high school assessment scores and fixed effects work to alleviate these concerns, we follow the example of Oster (2019) by examining the extent of selection on unobservable characteristics that would be needed to invalidate our results. We present the results of this test in Appendix Table A14, using both $\boldsymbol{R_{max}}$ proposed by Oster of $\boldsymbol{R_{max}}=1.3R$, and a more conservative $\boldsymbol{R_{max}}=2R$. The coefficient bound on each outcome of interest tells us the range of possible coefficients on β_1 (CTE Concentration) from a model with no unobserved bias to potential models with unobserved characteristics explaining 30% as much selection as our observed characteristics. If 0 does not fall within this range, it tells us that unobserved bias would need to explain more than 30% as much as observed characteristics. The bias parameter **δ** represents how many times larger unobserved factors would need to be than observed characteristics to nullify the results. We next take a similar approach but with $\boldsymbol{R_{max}}=2R$.

15 Given the likelihood of selection bias for students entering CTE-dedicated schools, we find it likely that this specific analyses may overstate the earnings returns for students at CTE-dedicated schools.

Given that no coefficient bounds include 0 and all bias **δ**s are greater than 116, we can conclude that selection on unobservables would need to be larger than on observables to invalidate results (and in many cases, far larger).

Concerns that students who never take CTE courses are not appropriate counterfactual group for these analyses may also arise; in particular, if our observed characteristics do not account for differential selection into the various career clusters. In Tables A15 & A16, we compare students to a new counterfactual group, students who took 1 year (but no more than 1 year) in the same cluster, relying on the assumption that students taking 1 year of Agriculture classes, for example, showed some interest in Agriculture and might be a more suitable comparison. These results show a mix of similar and different findings, however we posit that this is actually *not* an appropriate counterfactual. Students taking only a single year in a career cluster are relatively rare, and exceedingly rare at the CTE-dedicated schools, in which CTE Concentration is required. As such, this counterfactual primarily consists of students at comprehensive high schools mainly taking a CTE course as an elective, rather than indicating a more substantial interest in CTE.

While Figure 7 demonstrated differences in earnings advantages by school setting, there may be unobserved selection bias in these results due to the opt-in nature and selective application processes at many CTE-dedicated schools. To reduce concerns of bias driven by who attends CTE-dedicated schools, we must consider the returns to CTE *outside of* any decisions about high school attendance. To do this, we estimate models among only those students residing in towns that were *not* eligible for a CTE-dedicated school. Though estimates from this

16 The one exception in which the coefficient bound does cross 0 and the delta is less than 1 is the "Any College Attend" outcome, which has a statistically insignificant coefficient of 0.004. Given the small and non-significant coefficient, this is in line with what we would expect for this outcome.

specification are not identical to the full sample, the sign and significance of these results mirror the full sample, emphasizing that our main results are not solely driven by CTE-dedicated schools. In fact, in Table A17, we present results of only those students residing in towns eligible for a vocational/technical school and find very similar results, while in Table A18, we show outcomes for students in towns *not* eligible for CTE-dedicated schools; echoing the findings from Figure 7, the direction and significance of the outcomes is similar, with somewhat smaller magnitudes for students not eligible to attend CTE-dedicated schools. In Table A19 and A20, we approach this idea in a different way, looking only at those students who attend comprehensive schools (i.e., did not attend a CTE-dedicated school). While this removes one key mechanism through which CTE may matter in the Massachusetts (selection of high school), Tables A19 and A20 make clear that the associations between CTE and later outcomes largely hold (albeit diminished) even at comprehensive schools.

Finally, our analyses are subject to limitations of UI data. First, not all earnings are reported through UI data, including "gig economy" work and self-contract employment (Collins et al, 2019). Another limitation of our UI data is that we are unable to observe earnings that occur outside the state of Massachusetts, a concern potentially exacerbated by the relatively small geographic size of the state and borders with six others. This may be especially important for higher-income earners and college-goers (Foote & Stange, 2019). Given that some of those individuals reporting $0 earnings are likely earning, just not in a way captured by our UI data, we also fit models in which we exclude all those not reporting earnings in a given year. After removing these zeros from analyses, the point estimates are moderately lower across the clusters, suggesting that while some combination of actual unemployment and employment not eligible/reported for unemployment may partially drive the advantage we see for CTE

concentrators, the comparison with non-reported earnings does not fully account for the CTE advantage. To examine the extent to which our estimates are biased by students crossing into other states for work, we also re-ran our earnings-related models without students from towns bordering another state, who, due to proximity may be most likely to work across a state border (and be missing from UI records). After excluding these students, our results across all career clusters and student populations are nearly identical (see Appendix Tables A21 and A22), suggesting that students working out of state are not a major source of bias. Moreover, we see especially large advantages for CTE students among two populations less likely to move out of state for work, lower-income students and students with disabilities, which provides additional confidence that our results would hold even after accounting for unobserved out-of-state work.

Conclusions and Discussion

One challenge for evaluating the success of CTE programs is that it can be difficult to identify optimal outcomes. Some may view academic and college preparation as a primary goal, particularly given the economy's increasing reliance on jobs that require postsecondary education (Carnevale et al, 2015; Holzer and Baum, 2017). Others may argue that CTE should prepare students for high-wage, high-growth jobs that they're qualified for immediately after their high school CTE experience. Ideally, CTE programs might prepare students for both college and career, as both federal and Massachusetts policy has worked to emphasize in recent years. One key finding from these analyses is that different CTE programs appear to help students attain different positive outcomes to varying degrees.

Figure 8 demonstrates that the relationship between CTE and different student outcomes vary across student populations. Black & Latino, Lower-Income concentrators, and those scoring poorly in 8th grade tests all see positive anticipated advantages in both dimensions – income and postsecondary enrollment. Overall, we find evidence that CTE is associated with a higher students' predicted cumulative earnings over the first seven years after high school, as well as almost no change in postsecondary enrollment (at least in the aggregate). For male students, the change in predicted outcomes are especially stark, with both the largest predicted increase in earnings and the largest decrease in the likelihood of college attendance, likely in part because of the different career clusters they select. With many studies now finding evidence of stronger economic returns to CTE for men than women across a number of contexts (Brunner et al, 2021; Hemelt et al, 2019; Kemple & Willner, 2008; see also Dougherty & Ecton, 2021 for a discussion of this trend across an international context), these results could offer one explanation as to why – with women disproportionately sorting into CTE fields (e.g. Heathcare, Education) that lead students into postsecondary education, as opposed to men, who disproportionately opt into fields (e.g. Construction, Transportation) that are far more likely to set students up for direct entry into the workforce. These findings suggest that selection of field of study within CTE are a key driver of the differences in outcomes by gender, though more work should be done to unpack these gender gaps – particularly the extent to which gender gaps persist even after entry into the workforce.

As Figure 9 highlights, some career clusters are more positively associated with higher earnings, while others are more associated with higher rates of postsecondary success. Some clusters, like Healthcare, Education, and IT perform especially well on both dimensions. Other clusters, like Construction and Transportation, might represent a trade-off for students, in which

students can expect higher earnings, but a lower likelihood of college attendance. These differences may be by design. Some programs, like Healthcare and Education neatly tie into a postsecondary pathway, and may receive explicit preparation and encouragement to continue in those programs. Other career clusters, like Construction and Transportation may be more explicit about encouraging direct entry into the workforce through apprenticeship and school-to-work programs. Encouragingly, no clusters fall in or even near the bottom left quadrant of Figure 16; all clusters point to positive outcomes on at least one dimension.

By considering a wide range of outcomes, different relationships across the career clusters, and different anticipated advantages and disadvantages to CTE across student populations, we present a nuanced picture of the wide range of heterogeneity within CTE. For advocates of CTE, these results offer evidence that CTE is associated with positive labor market outcomes, particularly for male students and students from historically marginalized backgrounds. Some of the labor market advantages may be partially driven by some students foregoing college, particularly at the 4-year college level, at least in the first years after high school. However, earnings advantages persist for CTE concentrators even 7 years after high school, at which point most college attenders will have re-entered the workforce. Given the nature of many CTE programs, it might make intuitive sense that some CTE concentrators may be more likely to develop the skills and professional network that allows them to enter the workforce immediately after high school. For some, postsecondary education may come later, as they are better able to afford college and as they need additional education and training to advance in their careers.

While advantages persist through 7 years for CTE concentrators as a whole, it is important to note that this also varies by cluster, with clear evidence of diminishing returns over

time for students in clusters including Arts & Communication, Hospitality, Agriculture, & Transportation. Strong early career earnings can help young adults build a foundation of financial stability, however, many CTE students will eventually need to return to postsecondary education or training to maintain strong earnings levels (Holzer & Baum, 2017). Following similar evidence of diminishing returns to CTE from Europe (Brunello & Rocco, 2017; Hanushek et. al, 2017), policymakers should pay special attention to the extent to which CTE students are able to adapt to new work over time by ensuring CTE coursework balances the skills needed for specific jobs *and* a focus on developing students' general skills (critical thinking, problem-solving, reading, etc.) that are especially important in a rapidly changing economy (see Autor, 2019; Lazear, 2009). If CTE coursework does *not* incorporate general skill development, these courses may be ripe for re-examination.

Finally, we find suggestive evidence that CTE may be especially beneficial as a stopgap to prevent some of the worst possible outcomes for students – poverty and disengagement, as CTE is associated with a decreased likelihood of earning below the poverty line and a decreased likelihood of being completely disengaged from both education and employment. Given that individuals earning below the federal poverty threshold and not engaged in education are far more likely to rely on government assistance programs, this outcome may be of particular policy relevance given the financial implications. These advantages to CTE are especially strong for students who do not enter college in the first 7 years after high school. As policymakers consider ways to help their most vulnerable students avoid these negative post-high school outcomes, CTE may be an especially attractive option. Moreover, while some of the traditional vocational career clusters like Construction, Transportation, and Manufacturing & Technology are

associated with negative college outcomes, these clusters are also associated with the strongest pay-offs in terms of expected earnings.

As states and districts consider their menu of CTE offerings, these findings have important implications for researchers and policymakers. Importantly, CTE outcomes are different for different types of CTE career clusters and across different student populations. Some career clusters may offer stronger benefits than others, while some students might be more poised to realize those benefits than others. In many cases, CTE may represent a set of trade-offs between early career earnings and postsecondary education, though these trade-offs manifest themselves in heterogeneous ways. Ultimately, our findings encourage a re-framing of conversations around CTE that moves beyond the standard consideration of CTE as a single, monolithic curricular policy, to one that embraces the substantial heterogeneity across the many different student populations and programs under the broader CTE umbrella.

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Table 1
Descriptive Statistics for CTE Concentrators and Non-Concentrators

	CTE Concentrators	Non-Concentrators
Female	0.43	0.50
	(0.50)	(0.50)
Free/Reduced Lunch	0.56	0.37
	(0.50)	(0.48)
Students w/Disabilities	0.24	0.18
	(0.43)	(0.38)
Immigrant	0.04	0.05
	(0.20)	(0.22)
English Language Learners	0.07	0.07
	(0.26)	(0.26)
Latino	0.20	0.15
	(0.40)	(0.35)
Asian	0.04	0.06
	(0.19)	(0.23)
Black	0.11	0.10
	(0.31)	(0.30)
White	0.70	0.72
	(0.46)	(0.45)
8th Grade Math Score (Std.)	-0.32	0.08
	(0.79)	(0.93)
8th Grade ELA Score (Std.)	-0.58	-0.31
	(0.80)	(0.93)
8th Grade Attendance Rate	0.96	0.95
	(0.05)	(0.06)
Attend Regional Vocational School	0.44	0.00
	(0.50)	(0.06)
On-Time HS Graduation Rate	0.81	0.71
	(0.39)	(0.45)
Attend 2-Yr College	0.40	0.29
	(0.49)	(0.46)
Attend 4-Yr College	0.36	0.54
	(0.48)	(0.50)
College Graduate	0.28	0.44
	(0.45)	(0.50)
Observations	49691	201746

Notes: Analytic sample includes first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years.

Table 2

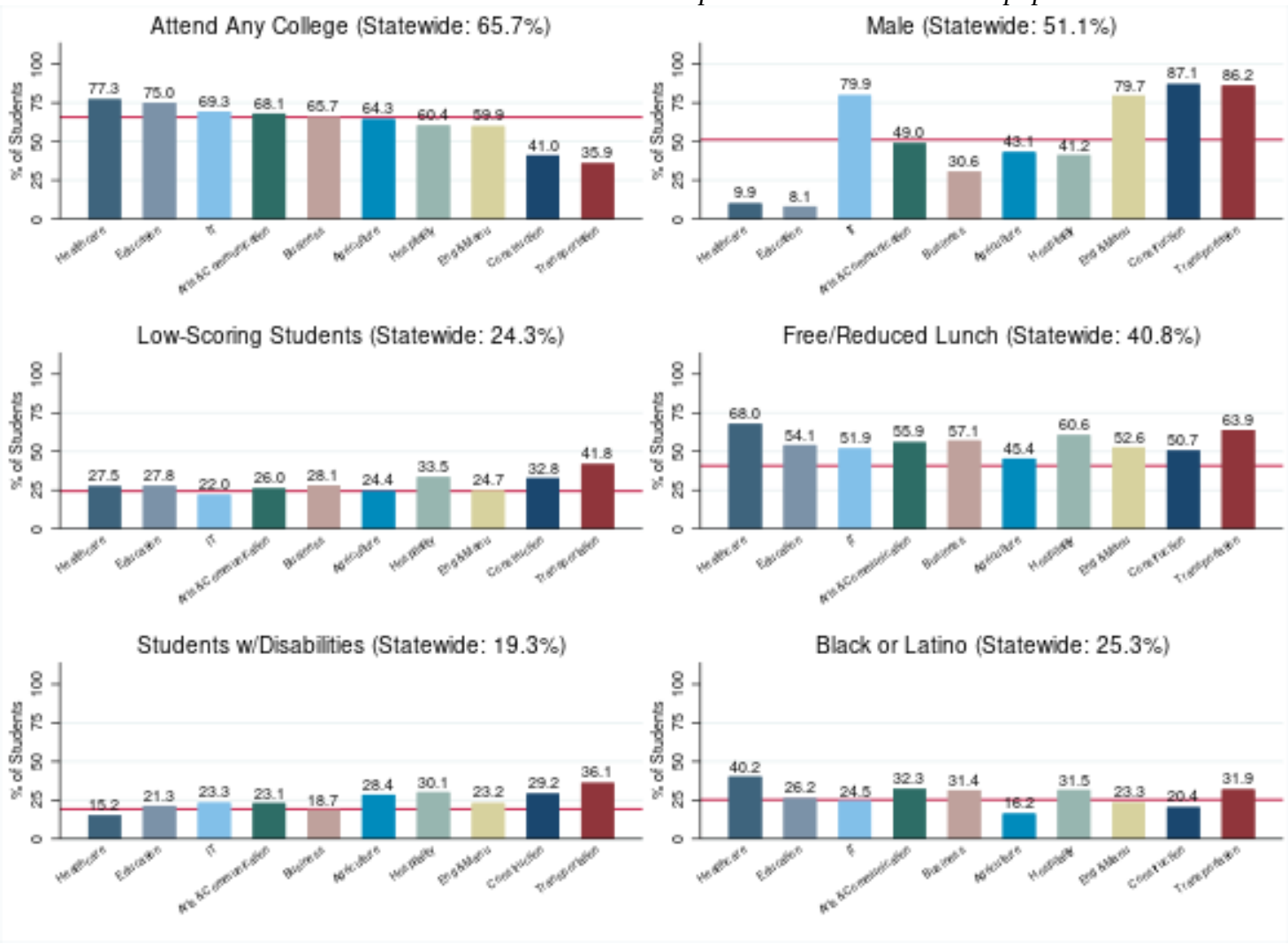
Regression-adjusted estimates for each CTE career cluster concentration on select cumulative earnings over the first 7 years post-high school

	I	II	III	IV	V
Healthcare	31220.65	35973.3	31693.38	35324.68	32570.59
Standard Error	*2160.071*	*2483.01*	*2176.249*	*2475.084*	*2079.79*
Observations	205316	205316	205316	205316	205316
Education	14604.71	17571.52	14532.6	20527.64	17996.69
Standard Error	*1666.653*	*1744.966*	*1654.109*	*2219.148*	*1854.856*
Observations	204051	204051	204051	204051	204051
IT	16570.46	16889.72	12835.86	18510.43	13098.68
Standard Error	*2301.413*	*2155.278*	*2056.111*	*2331.869*	*2150.374*
Observations	204059	204059	204059	204059	204059
Arts & Communication	7233.973	9519.232	6024.094	9635.332	6126.694
Standard Error	*1448.891*	*1369.872*	*1458.307*	*1633.192*	*1418.954*
Observations	206117	206117	206117	206117	206117
Business	21899.78	24056.06	20526.65	23014.96	20407.06
Standard Error	*1942.044*	*1647.925*	*1488.458*	*1761.041*	*1365.647*
Observations	207911	207911	207911	207911	207911
Agriculture	14735.02	16066.52	13574.41	15587.56	13869.62
Standard Error	*2681.871*	*2471.453*	*1972.986*	*2842.125*	*2330.243*
Observations	203734	203734	203734	203734	203734
Hospitality	12725.73	16521.58	13167.3	15818.11	14753.18
Standard Error	*1652.558*	*1602.283*	*1555.519*	*1682.908*	*1530.081*
Observations	205503	205503	205503	205503	205503
Engineering & Manufacturing	29075.82	28611.39	25195.43	31577.66	26108.08
Standard Error	*1963.436*	*1936.152*	*1744.748*	*1907.752*	*1502.024*
Observations	207377	207377	207377	207377	207377
Construction	49386.04	48550	45119.36	49721.55	44761.62
Standard Error	*1788.445*	*1791.622*	*1668.635*	*1847.146*	*1611.037*
Observations	209749	209749	209749	209749	209749
Transportation	37615.57	40216.34	36539.9	39603.03	37016.74
Standard Error	*1759.247*	*1657.522*	*1580.524*	*1884.191*	*1632.641*
Observations	205982	205982	205982	205982	205982
Controls for Demographic Characteristics	No	No	**Yes**	**Yes**	**Yes**
Controls for 8th Gr. Assessments & Attendance	No	No	No	**Yes**	**Yes**
Fixed Effects for Cohort & Town of Residence	No	**Yes**	No	No	**Yes**

Notes: Estimates are the coefficient associated with CTE concentration in each cluster, specified by row, on students' cumulative earnings over the first 7 years after expected high school graduation. Model I includes only an indicator of CTE concentration and the outcome of interest. Model II adds cohort and town of residence fixed effects, with errors clustered by town of residence. Model III includes controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, and disability status. Model IV adds 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts) to demographic controls. Model V includes both fixed effects and all controls. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009-2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure 1

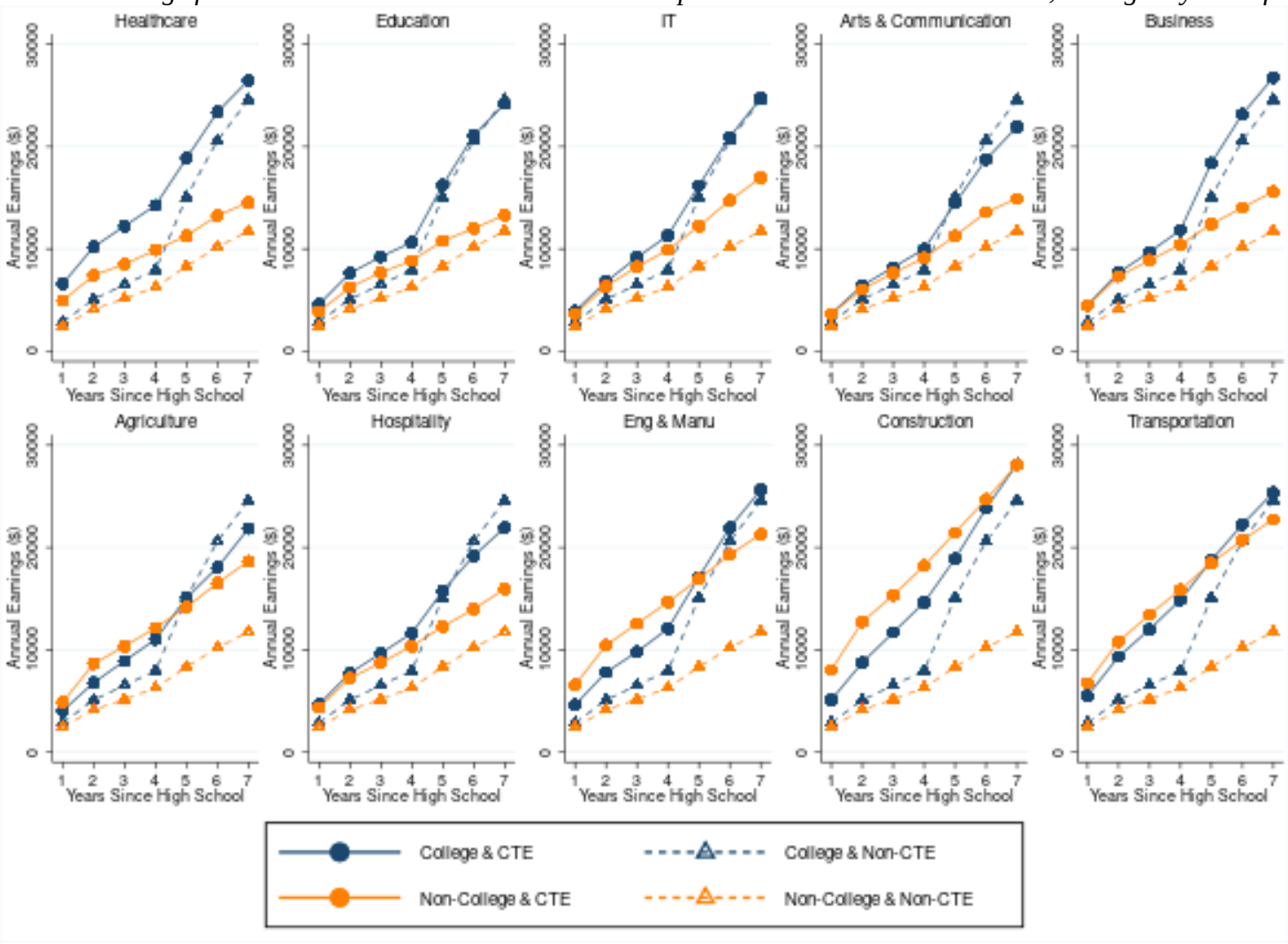
CTE concentrators characteristics in each career cluster compared to statewide student population



Notes: Each bar represents the percent of students in a given career cluster meeting the respective characteristics, compared to the statewide average (represented by the red line). Career clusters in which a student demographic group is overrepresented are indicated by bars above the red line, and clusters in which student demographic groups are underrepresented are marked by bars below the red line. Sample includes all 9th grade public school students in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a CTE concentrator in a given career cluster if they are enrolled in CTE in that career cluster for at least two academic years.

Figure 2

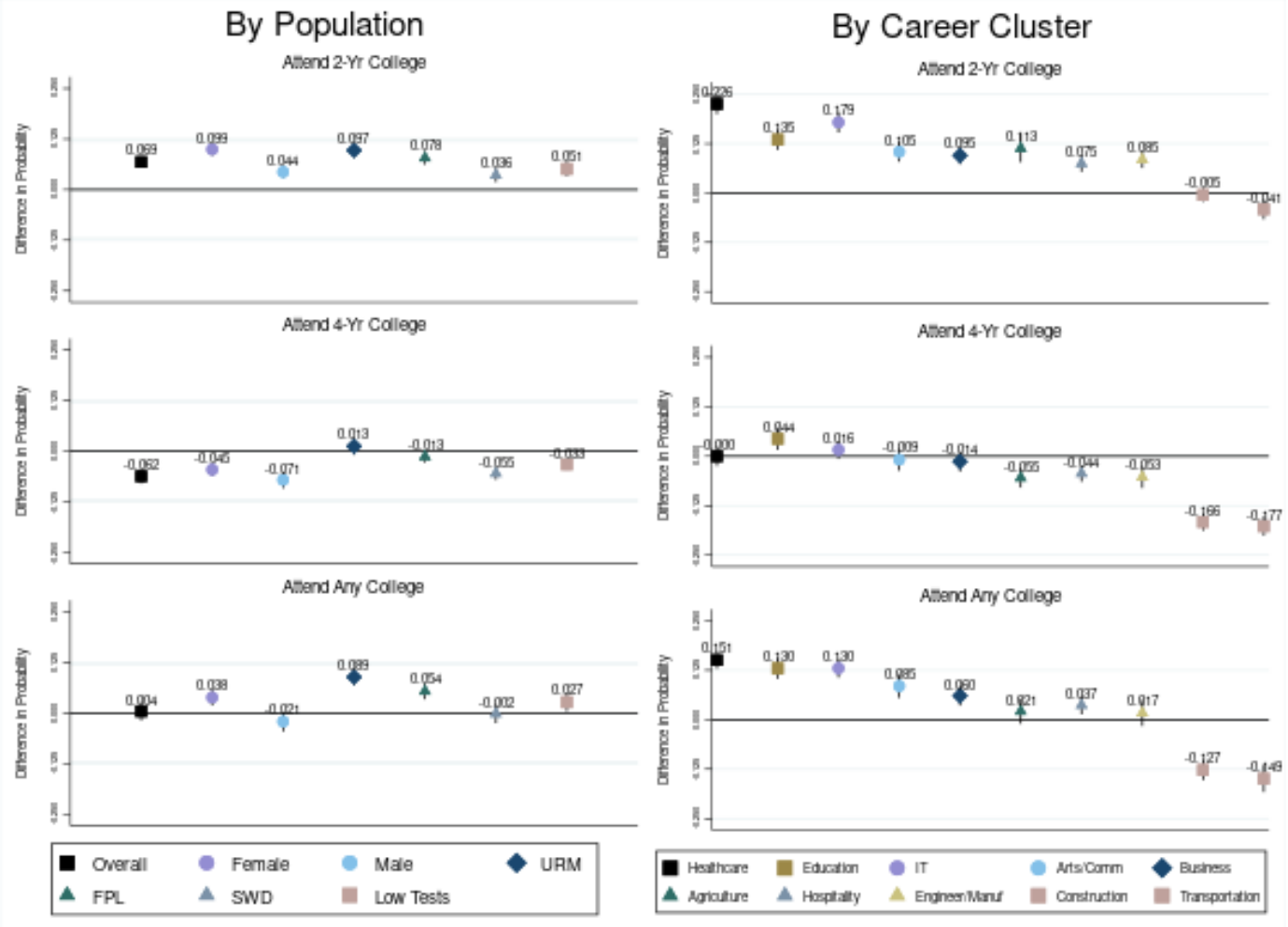
Annual earnings for CTE concentrators in each cluster compared to non-CTE concentrators, through 7 years after high school



Notes: Sample all 9th grade public school students in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a CTE concentrator in a given career cluster if they are enrolled in CTE in that career cluster for at least two academic years. Non-CTE concentrators (constant across all panels) are those students not ever enrolled in CTE. Non-College students are those students who never enroll in college during the time period available in our data.

Figure 3

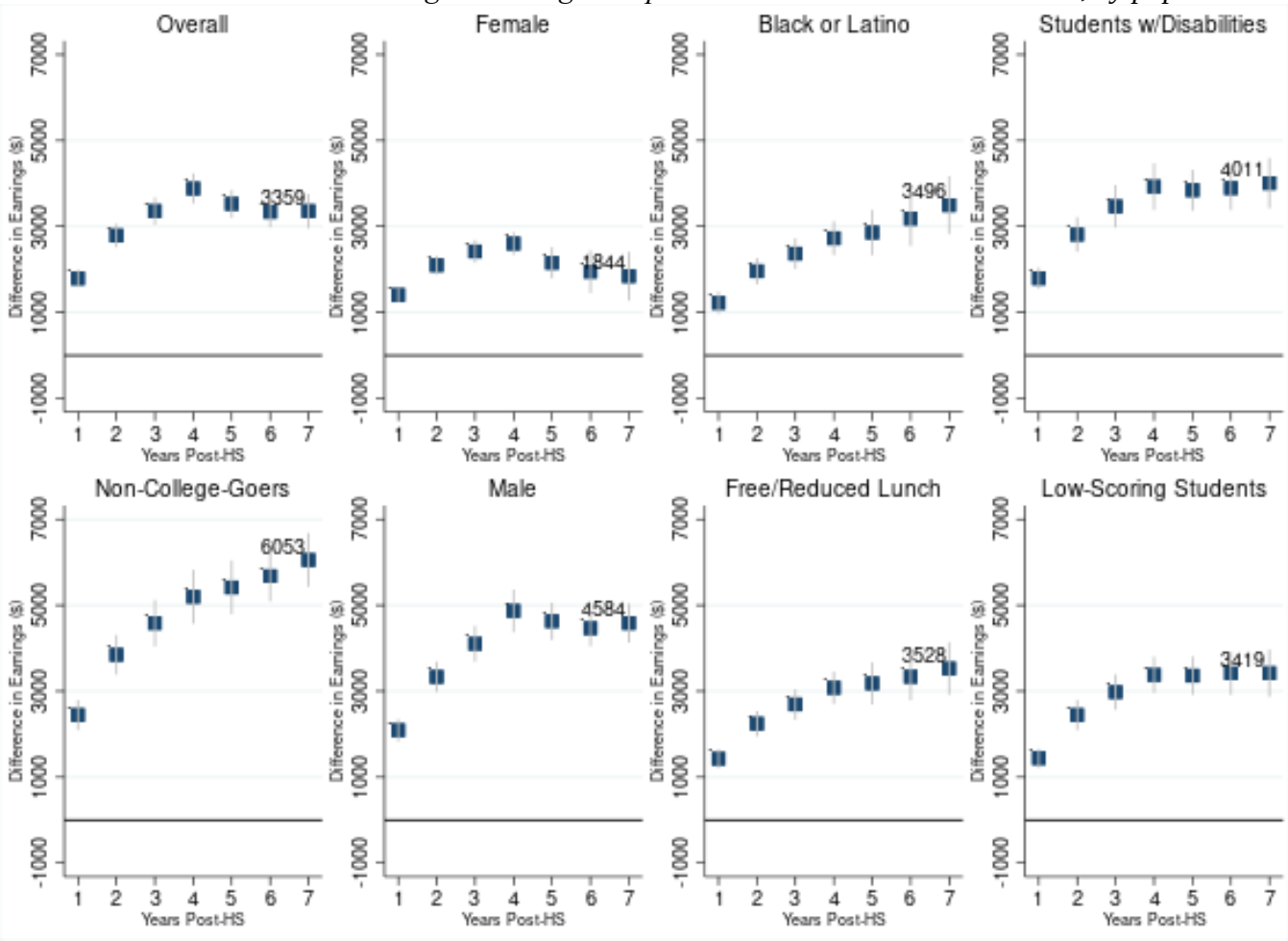
CTE concentrators' college attendance outcomes compared to similar non-concentrators, by populations of interest & career cluster



Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (separated by panel) with estimates for each population of interest. Righthand panels are the estimates for students concentrating in each CTE career cluster. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students in all models are those who were never enrolled as a CTE student.

Figure 4

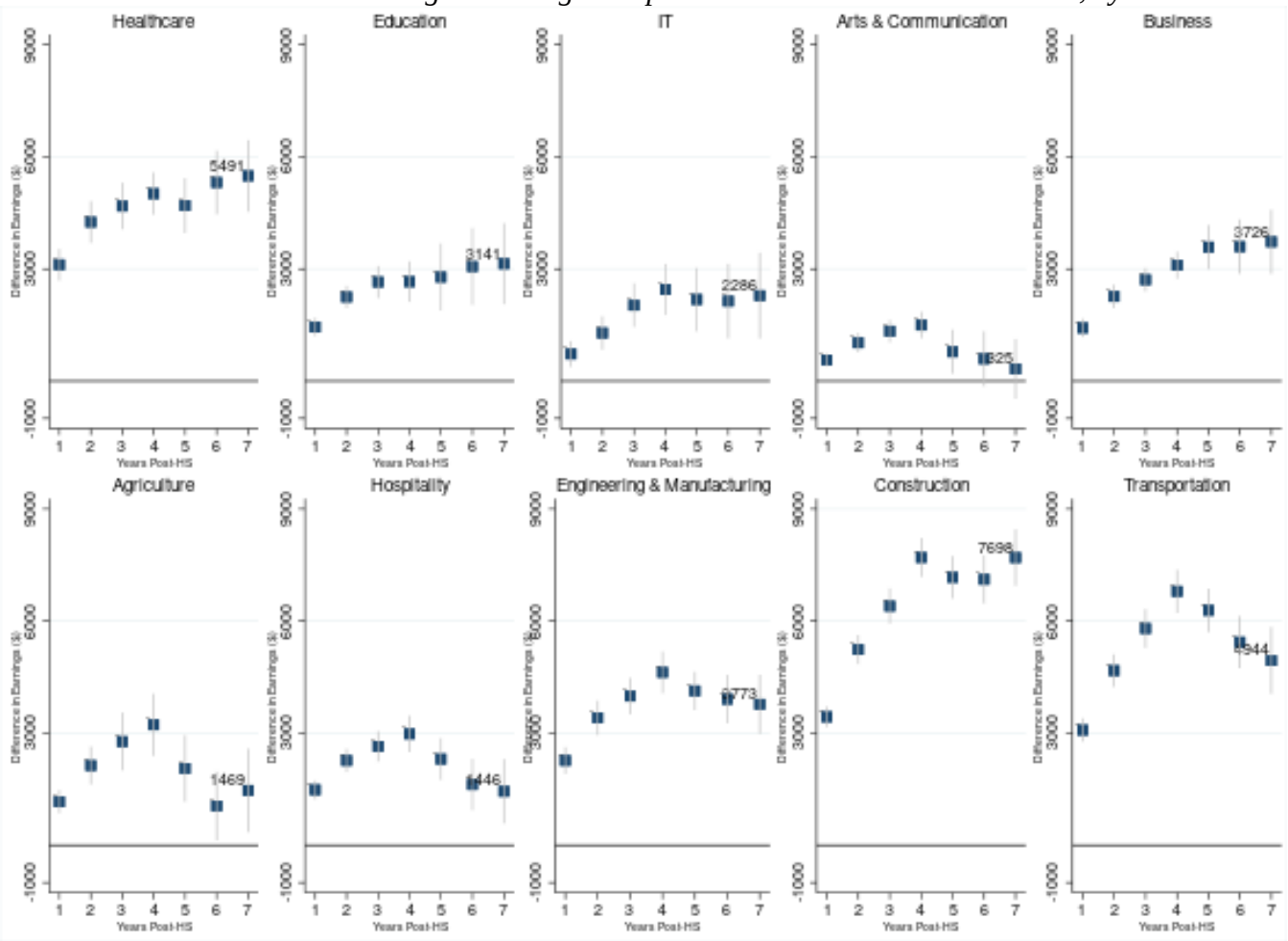
CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest



Notes: Estimates are the coefficient associated with CTE concentration on students' earnings in the first 7 years after high school, compared to similar non-CTE students meeting the same student characteristic (by panel). All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are students meeting the same characteristics who were never enrolled as a CTE student.

Figure 5

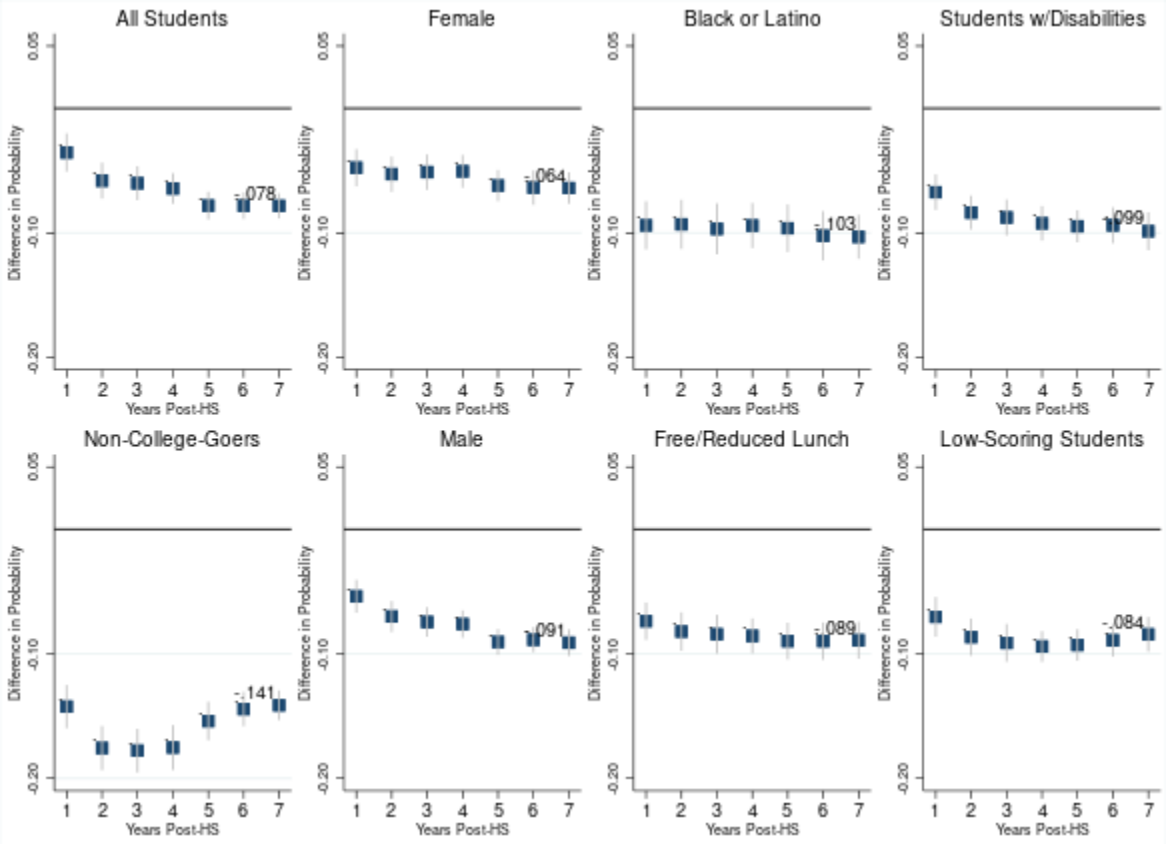
CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster



Notes: Estimates are the coefficient associated with CTE concentration in each career cluster (by panel) on students' earnings in the first 7 years after high school, compared to similar non-CTE students meeting. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are students who were never enrolled as a CTE student.

Figure 6

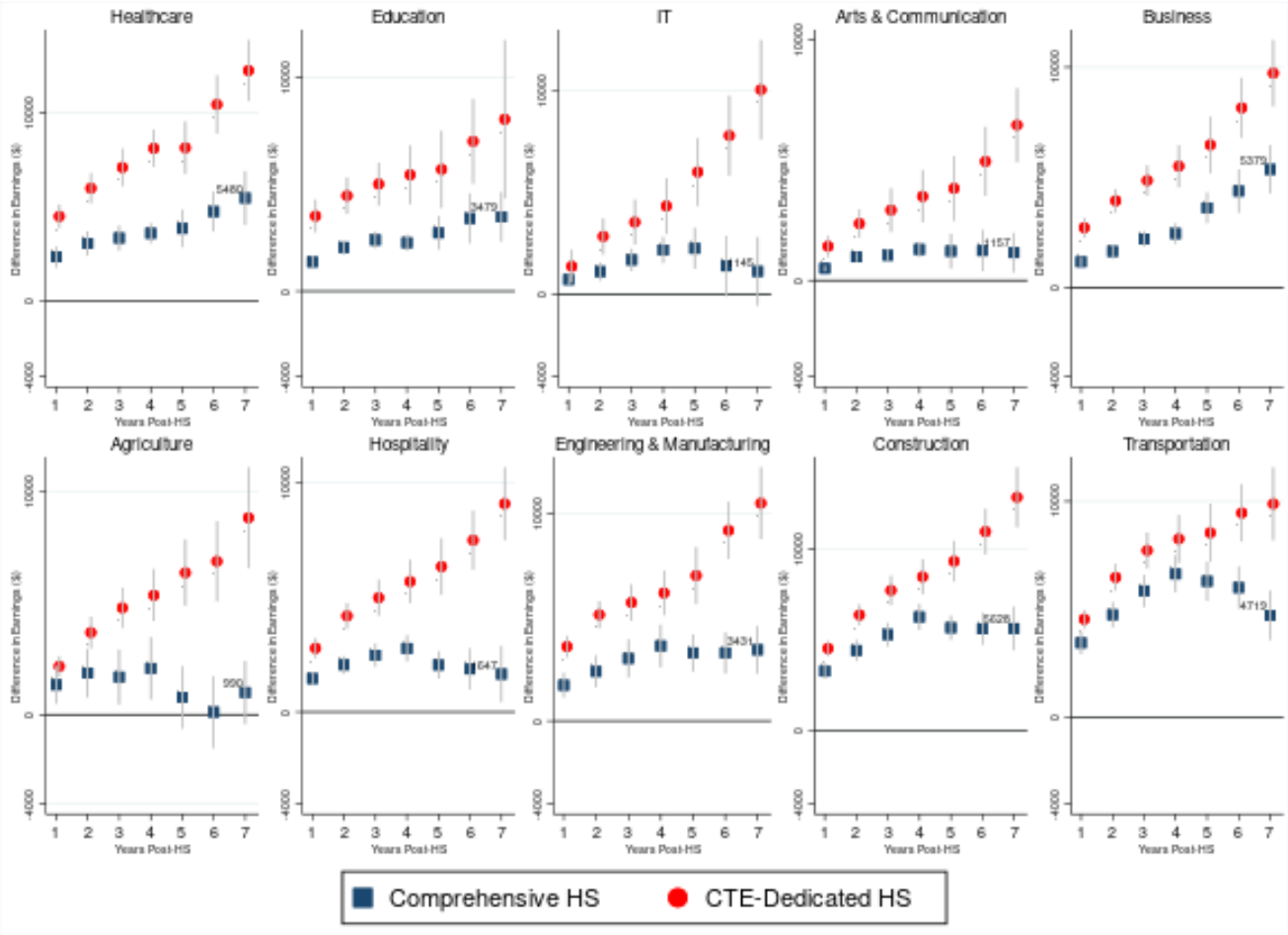
CTE concentrators' difference in likelihood of being neither employed nor in education or training (NEET) compared to similar non-concentrators, by populations of interest



Notes: Estimates are the coefficient associated with CTE concentration on students' likelihood of being NEET in the first 7 years after high school, compared to similar non-CTE students meeting the same student characteristic (by panel). Student are considered to be NEET if they are neither enrolled in education nor earning at or above the federal individual poverty line at the specified time period. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those students meeting the same characteristic who were never enrolled as a CTE student.

Figure 7

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster & school setting



Notes: Estimates are the coefficient associated with CTE concentration in each career cluster (by panel) on students' earnings in the first 7 years after high school, compared to similar non-CTE students meeting. Blue point estimates are for students at comprehensive schools, and red point estimates are for students at CTE-dedicated schools. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are students at the same high school type who were never enrolled as a CTE student.

Figure 8
CTE concentrator differences in education and earnings outcomes, by populations of interest

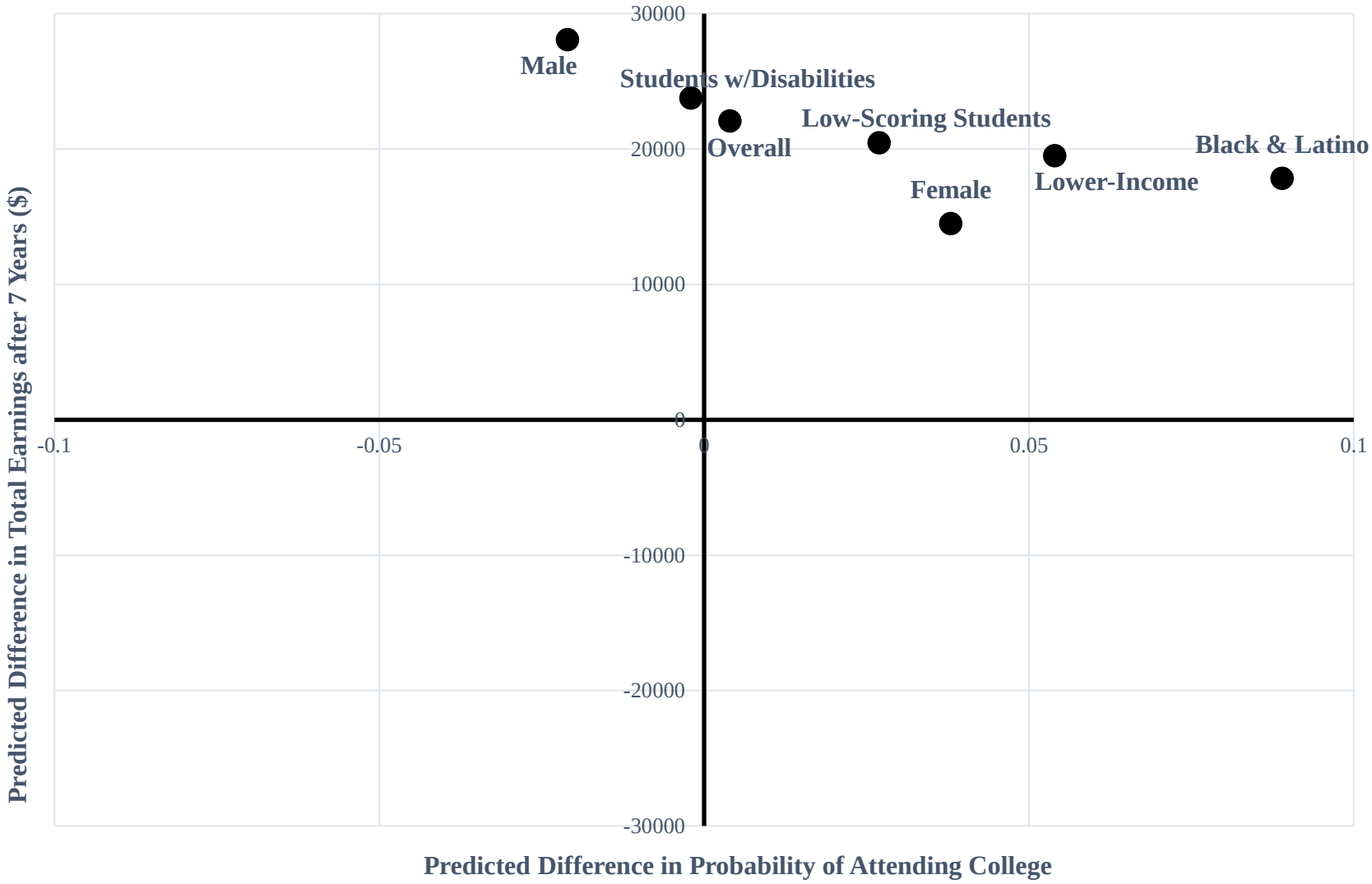


Figure 9
CTE concentrator differences in education and earnings outcomes, by career cluster

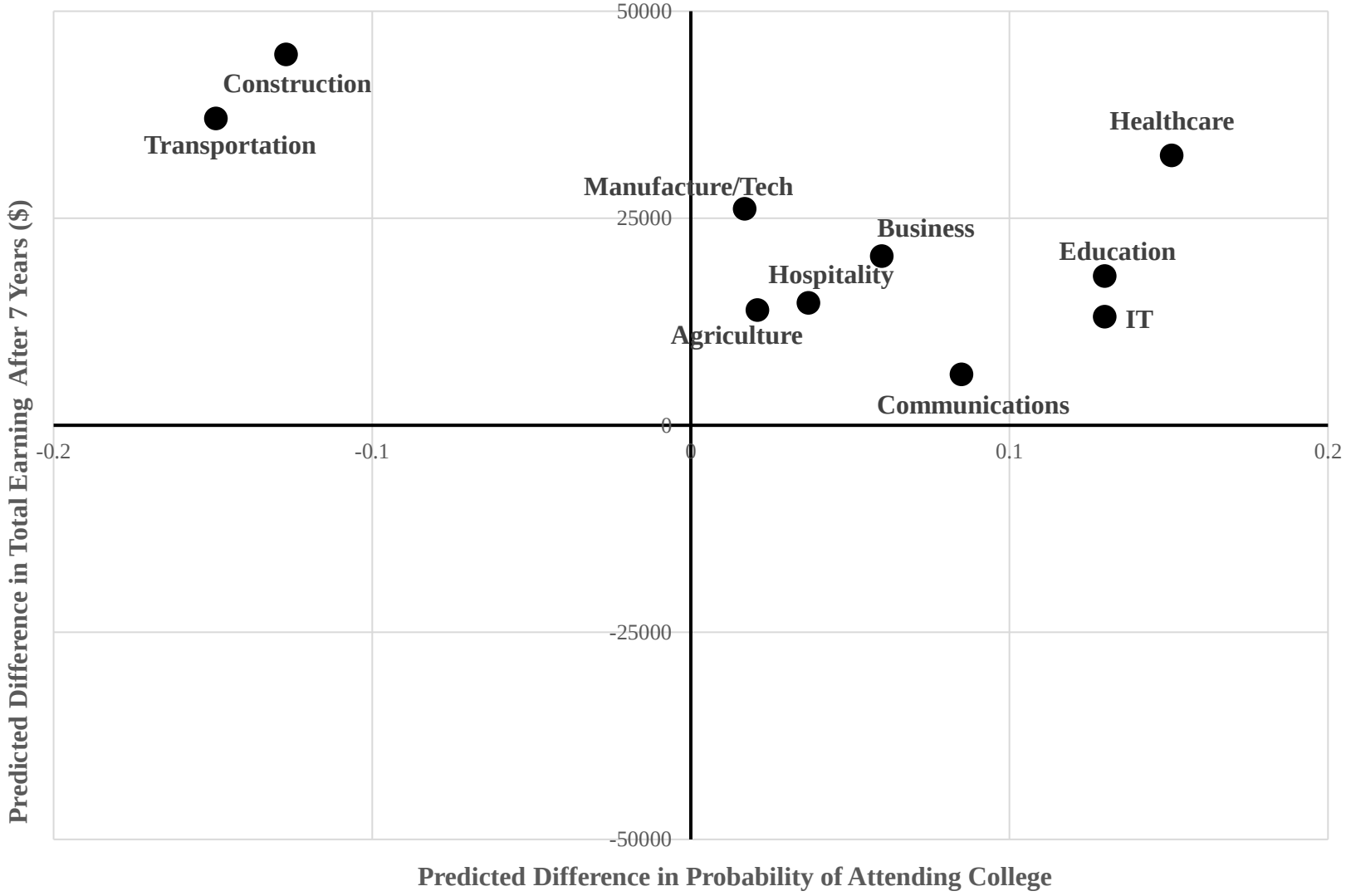


Table A1
Descriptive Statistics for CTE Concentrators and Non-Concentrators
Rolling Sample

	CTE Concentrators	Non-Concentrators
Female	0.44	0.50
	(0.50)	(0.50)
Free/Reduced Lunch	0.57	0.40
	(0.49)	(0.49)
Students w/Disabilities	0.25	0.19
	(0.43)	(0.39)
Immigrant	0.04	0.06
	(0.19)	(0.23)
English Language Learners	0.07	0.08
	(0.26)	(0.28)
Latino	0.20	0.16
	(0.40)	(0.37)
Asian	0.04	0.06
	(0.19)	(0.24)
Black	0.10	0.10
	(0.30)	(0.30)
White	0.69	0.69
	(0.46)	(0.46)
8th Grade Math Score (Std.)	-0.30	0.08
	(0.83)	(0.92)
8th Grade ELA Score (Std.)	-0.39	-0.05
	(0.87)	(0.93)
8th Grade Attendance Rate	0.96	0.95
	(0.05)	(0.06)
Attend Regional Vocational School	0.45	0.00
	(0.50)	(0.06)
On-Time HS Graduation Rate	0.85	0.73
	(0.36)	(0.44)
Attend 2-Yr College	0.35	0.25
	(0.48)	(0.43)
Attend 4-Yr College	0.36	0.53
	(0.48)	(0.50)
College Graduate	0.16	0.25
	(0.37)	(0.43)
Observations	146464	590920

Notes: Analytic sample includes first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years.

Table A2

Descriptive Statistics for Concentrators in Each Career Cluster

	Health	Educ	IT	Comms	Bus	Ag	Hosp	Manu	Cons	Tran
Female	0.92	0.93	0.22	0.50	0.70	0.56	0.58	0.18	0.11	0.13
Free/Reduced Lunch	0.68	0.52	0.52	0.56	0.55	0.48	0.57	0.51	0.48	0.60
Students w/Disabilities	0.15	0.21	0.21	0.22	0.18	0.29	0.31	0.23	0.29	0.34
Immigrant	0.06	0.03	0.06	0.05	0.04	0.01	0.02	0.04	0.02	0.04
English Language Learners	0.10	0.05	0.08	0.08	0.07	0.02	0.05	0.06	0.05	0.08
Latino	0.26	0.18	0.19	0.20	0.23	0.11	0.20	0.16	0.13	0.24
Asian	0.06	0.03	0.04	0.03	0.03	0.02	0.02	0.04	0.02	0.03
Black	0.17	0.11	0.12	0.14	0.11	0.09	0.11	0.07	0.06	0.07
White	0.56	0.72	0.68	0.65	0.67	0.81	0.71	0.77	0.82	0.69
8th Grade Math Score (Std.)	-0.44	-0.30	-0.16	-0.28	-0.28	-0.32	-0.45	-0.16	-0.36	-0.51
8th Grade ELA Score (Std.)	-0.54	-0.46	-0.44	-0.45	-0.48	-0.44	-0.63	-0.52	-0.65	-0.75
8th Grade Attendance Rate	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.96
Attend Regional Vocational School	0.52	0.21	0.41	0.35	0.42	0.71	0.50	0.55	0.68	0.59
On-Time HS Graduation Rate	0.89	0.87	0.86	0.84	0.86	0.85	0.83	0.85	0.86	0.79
Attend 2-Yr College	0.60	0.46	0.50	0.43	0.44	0.46	0.42	0.40	0.32	0.28
Attend 4-Yr College	0.42	0.50	0.45	0.42	0.44	0.39	0.35	0.38	0.24	0.16
College Graduate	0.35	0.41	0.33	0.32	0.34	0.29	0.27	0.28	0.18	0.12
Observations	3204	1939	1947	4005	5799	1622	3391	5265	7637	3870

Notes: Includes first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years.

Table A3

Regression-adjusted estimates for CTE concentration on select outcomes (Rolling Sample)

	I	II	III	IV	V
Difference in 2-Yr College Attendance	0.089	0.068	0.082	0.055	0.049
Standard Error	*0.008*	*0.007*	*0.008*	*0.008*	*0.007*
Observations	636776	636776	636776	636776	636776
Difference in 4-Yr College Attendance	-0.217	-0.139	-0.129	-0.103	-0.090
Standard Error	*0.018*	*0.015*	*0.012*	*0.010*	*0.008*
Observations	636776	636776	636776	636776	636776
Difference in Overall College Attendance	-0.122	-0.066	-0.052	-0.047	-0.037
Standard Error	*0.015*	*0.016*	*0.011*	*0.010*	*0.011*
Observations	636776	636776	636776	636776	636776
Difference in 2-Yr College Degree Attainment	0.006	0.006	0.016	0.009	0.007
Standard Error	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*
Observations	496856	496855	496856	496856	496855
Difference in 4-Yr College Degree Attainment	-0.215	-0.139	-0.126	-0.097	-0.085
Standard Error	*0.016*	*0.012*	*0.010*	*0.009*	*0.007*
Observations	358485	358484	358485	358485	358484
Difference in Any College Degree Attainment	-0.198	-0.124	-0.110	-0.084	-0.072
Standard Error	*0.016*	*0.013*	*0.010*	*0.008*	*0.008*
Observations	358485	358484	358485	358485	358484
1 Year Post-HS Difference in Earnings ($)	2921	2714	2740	2423	2403
Standard Error	*159*	*143*	*150*	*135*	*132*
Observations	636776	636776	636776	636776	636776
3 Year Post-HS Difference in Earnings ($)	4604	4245	4282	3692	3660
Standard Error	*242*	*204*	*222*	*199*	*185*
Observations	496856	496855	496856	496856	496855
5 Year Post-HS Difference in Earnings ($)	2995	3559	3665	3286	3456
Standard Error	*223*	*284*	*237*	*195*	*182*
Observations	358485	358484	358485	358485	358484
7 Year Post-HS Difference in Earnings ($)	1311	2716	2829	2568	2867
Standard Error	*337*	*376*	*311*	*250*	*205*
Observations	217636	217635	217636	217636	217635
Controls for Demographic Characteristics	No	No	**Yes**	**Yes**	**Yes**
Controls for 8th Gr. Assessments & Attendance	No	No	No	**Yes**	**Yes**
Fixed Effects for Cohort & Town of Residence	No	**Yes**	No	No	**Yes**

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest, specified by row. Model I includes only an indicator of CTE concentration and the outcome of interest. Model II adds cohort and town of residence fixed effects, with errors clustered by town of residence. Model III includes controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, and disability status. Model IV adds 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts) to demographic controls. Model V includes both fixed effects and all controls. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student. For degree attainment outcomes, only those cohorts who would have enough time for "on-time" degree attainment are included in the analytic samples. For earnings outcomes, only those cohorts for whom earnings could be observed 1, 3, 5, and 7 years after on-time high school graduation are included in the analytic samples for those respective outcomes

Table A4

CTE concentrators' college outcomes compared to similar non-concentrators, by populations of interest

	Overall	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
Difference in 2-Yr College Attendance	0.069	0.044	0.099	0.097	0.036	0.078	0.051
Standard Error	*0.007*	*0.007*	*0.008*	*0.009*	*0.009*	*0.008*	*0.009*
Observations	251435	128476	122958	63484	48448	102664	61091
Difference in 4-Yr College Attendance	-0.062	-0.071	-0.045	0.013	-0.055	-0.013	-0.033
Standard Error	*0.009*	*0.011*	*0.008*	*0.011*	*0.008*	*0.008*	*0.007*
Observations	251435	128476	122958	63484	48448	102664	61091
Difference in Overall College Attendance	0.004	-0.021	0.038	0.089	-0.002	0.054	0.027
Standard Error	*0.011*	*0.013*	*0.010*	*0.011*	*0.012*	*0.010*	*0.012*
Observations	251435	128476	122958	63484	48448	102664	61091
Difference in 2-Yr College Degree Attainment	0.014	0.009	0.023	0.026	0.002	0.020	0.007
Standard Error	*0.004*	*0.003*	*0.005*	*0.004*	*0.004*	*0.004*	*0.004*
Observations	251435	128476	122958	63484	48448	102664	61091
Difference in 4-Yr College Degree Attainment	-0.070	-0.073	-0.061	-0.002	-0.048	-0.021	-0.034
Standard Error	*0.009*	*0.009*	*0.008*	*0.006*	*0.007*	*0.006*	*0.006*
Observations	251435	128476	122958	63484	48448	102664	61091
Difference in Overall College Degree Attainment	-0.055	-0.060	-0.044	0.012	-0.037	-0.008	-0.021
Standard Error	*0.009*	*0.009*	*0.009*	*0.007*	*0.007*	*0.006*	*0.006*
Observations	251435	128476	122958	63484	48448	102664	61091

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A5

CTE concentrators' college outcomes compared to similar non-concentrators, by career cluster

	Health	Educ	IT	Comms	Bus	Ag	Hosp	Manu	Cons	Tran
Difference in 2-Yr College Attendance	0.226	0.135	0.179	0.105	0.095	0.113	0.075	0.085	-0.005	-0.041
Standard Error	*0.013*	*0.013*	*0.013*	*0.013*	*0.011*	*0.018*	*0.011*	*0.011*	*0.009*	*0.013*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in 4-Yr College Attendance	0.000	0.044	0.016	-0.009	-0.014	-0.055	-0.044	-0.053	-0.166	-0.177
Standard Error	*0.013*	*0.014*	*0.012*	*0.014*	*0.013*	*0.013*	*0.011*	*0.014*	*0.011*	*0.012*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in Overall College Attendance	0.151	0.130	0.130	0.085	0.060	0.021	0.037	0.017	-0.127	-0.149
Standard Error	*0.011*	*0.014*	*0.012*	*0.015*	*0.013*	*0.016*	*0.012*	*0.017*	*0.013*	*0.017*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in 2-Yr College Degree Attainment	0.08	0.05	0.07	0.02	0.02	0.03	0.01	0.02	-0.01	-0.03
Standard Error	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in 4-Yr College Degree Attainment	-0.032	0.019	-0.030	-0.031	-0.035	-0.085	-0.058	-0.068	-0.143	-0.142
Standard Error	*0.012*	*0.016*	*0.012*	*0.011*	*0.014*	*0.012*	*0.011*	*0.012*	*0.009*	*0.011*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in Overall College Degree Attainment	0.005	0.033	-0.004	-0.015	-0.022	-0.068	-0.038	-0.052	-0.130	-0.125
Standard Error	*0.012*	*0.015*	*0.012*	*0.012*	*0.013*	*0.013*	*0.011*	*0.012*	*0.010*	*0.011*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A6

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest

	Overall	No College	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
1 Year Post-HS Difference in Earnings ($)	1792	2445	1225	1289	2092	1407	1428	1796
Standard Error	*104*	*178*	*132*	*151*	*132*	*85*	*117*	*127*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
2 Year Post-HS Difference in Earnings ($)	2789	3848	1961	2093	3332	2100	2242	2812
Standard Error	*139*	*233*	*155*	*183*	*179*	*110*	*150*	*204*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
3 Year Post-HS Difference in Earnings ($)	3359	4585	2367	2967	4104	2421	2692	3469
Standard Error	*162*	*275*	*181*	*216*	*212*	*135*	*181*	*251*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
4 Year Post-HS Difference in Earnings ($)	3882	5197	2727	3304	4869	2605	3079	3930
Standard Error	*178*	*318*	*200*	*256*	*252*	*135*	*190*	*277*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
5 Year Post-HS Difference in Earnings ($)	3527	5414	2859	3709	4628	2154	3182	3845
Standard Error	*165*	*319*	*269*	*340*	*222*	*184*	*249*	*242*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
6 Year Post-HS Difference in Earnings ($)	3341	5677	3183	3933	4465	1951	3336	3893
Standard Error	*184*	*299*	*322*	*377*	*212*	*253*	*279*	*259*
Observations	251435	86192	63484	18272	128476	122958	102664	48448
7 Year Post-HS Difference in Earnings ($)	3359	6053	3496	4150	4584	1844	3528	4011
Standard Error	*203*	*318*	*344*	*459*	*232*	*288*	*311*	*298*
Observations	251435	86192	63484	18272	128476	122958	102664	48448

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A7

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest (Rolling Sample)

	Overall	No College	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
1 Year Post-HS Difference in Earnings ($)	2431	3492	2933	1797	1608	2417	1954	2049
Standard Error	*134*	*215*	*172*	*98*	*156*	*151*	*136*	*157*
Observations	737384	258387	375966	361415	192123	146250	322355	147752
2 Year Post-HS Difference in Earnings ($)	3216	4668	3937	2306	2208	3313	2601	2892
Standard Error	*162*	*263*	*202*	*126*	*185*	*212*	*169*	*216*
Observations	656829	226106	335076	321750	169391	129963	284522	133366
3 Year Post-HS Difference in Earnings ($)	3769	5406	4678	2623	2610	3878	3013	3393
Standard Error	*187*	*305*	*238*	*149*	*226*	*267*	*197*	*242*
Observations	575489	196276	293739	281748	147357	113373	246617	118522
4 Year Post-HS Difference in Earnings ($)	4240	5874	5359	2802	2895	4306	3340	3764
Standard Error	*209*	*349*	*276*	*152*	*266*	*306*	*220*	*265*
Observations	495650	168797	253126	242521	126478	97283	210046	104473
5 Year Post-HS Difference in Earnings ($)	3728	5890	4971	2174	2960	4177	3258	3700
Standard Error	*190*	*355*	*252*	*188*	*343*	*271*	*275*	*271*
Observations	414959	141278	211932	203023	105481	80968	173714	89661
6 Year Post-HS Difference in Earnings ($)	3406	5919	4624	1899	3243	3977	3338	3604
Standard Error	*199*	*325*	*233*	*247*	*396*	*268*	*302*	*279*
Observations	333138	114006	170300	162834	84237	64503	137647	75500
7 Year Post-HS Difference in Earnings ($)	3359	6053	4584	1844	3496	4011	3528	3419
Standard Error	*203*	*318*	*232*	*288*	*344*	*298*	*311*	*279*
Observations	251435	86192	128476	122958	63484	48448	102664	61091

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student. Only those cohorts for whom earnings could be observed at each number of years after on-time high school graduation are included in the analytic samples for those respective outcomes

Table A8

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster

	Health	**Educ**	**IT**	**Comms**	**Bus**	**Ag**	**Hosp**	**Manu**	**Cons**	**Tran**
1 Year Post-HS Difference in Earnings ($)	3111	1447	725	563	1422	1165	1482	2267	3437	3083
Standard Error	*216*	*125*	*175*	*85*	*125*	*156*	*128*	*181*	*140*	*158*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
2 Year Post-HS Difference in Earnings ($)	4255	2250	1286	1026	2266	2133	2268	3408	5237	4674
Standard Error	*285*	*152*	*228*	*133*	*160*	*259*	*159*	*235*	*198*	*221*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
3 Year Post-HS Difference in Earnings ($)	4686	2650	2031	1333	2711	2777	2646	3993	6402	5800
Standard Error	*317*	*219*	*297*	*153*	*160*	*394*	*207*	*248*	*241*	*264*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
4 Year Post-HS Difference in Earnings ($)	5017	2660	2450	1499	3101	3224	2980	4626	7702	6794
Standard Error	*287*	*275*	*350*	*181*	*184*	*425*	*248*	*284*	*266*	*294*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
5 Year Post-HS Difference in Earnings ($)	4696	2782	2181	786	3584	2055	2306	4130	7170	6285
Standard Error	*374*	*456*	*432*	*299*	*300*	*453*	*284*	*261*	*289*	*296*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
6 Year Post-HS Difference in Earnings ($)	5316	3066	2139	596	3598	1048	1625	3911	7117	5436
Standard Error	*433*	*524*	*508*	*374*	*371*	*469*	*351*	*330*	*329*	*355*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
7 Year Post-HS Difference in Earnings ($)	5491	3141	2286	325	3726	1469	1446	3773	7698	4944
Standard Error	*488*	*552*	*585*	*407*	*438*	*570*	*438*	*403*	*385*	*456*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A9

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster (Rolling Sample)

	Health	Educ	IT	Comms	Bus	Ag	Hosp	Manu	Cons	Tran
1 Year Post-HS Difference in Earnings ($)	3275	1766	956	668	1792	1568	1843	2959	5049	4231
Standard Error	*256*	*154*	*117*	*68*	*117*	*149*	*104*	*206*	*180*	*157*
Observations	602640	598215	598062	604879	608242	597104	602660	608699	614492	603197
2 Year Post-HS Difference in Earnings ($)	4062	2463	1500	1092	2376	2324	2512	3847	6487	5639
Standard Error	*302*	*160*	*184*	*100*	*154*	*198*	*130*	*272*	*213*	*200*
Observations	537492	533694	533473	539521	542520	532707	537652	542740	548156	538186
3 Year Post-HS Difference in Earnings ($)	4515	2752	2119	1251	2862	2838	2951	4391	7575	6880
Standard Error	*315*	*178*	*227*	*123*	*155*	*285*	*164*	*290*	*254*	*261*
Observations	470940	467699	467448	472804	475407	466798	471173	475500	480297	471646
4 Year Post-HS Difference in Earnings ($)	4842	2645	2726	1483	3108	3231	3272	4953	8723	7627
Standard Error	*290*	*186*	*287*	*145*	*186*	*346*	*188*	*316*	*285*	*295*
Observations	405535	402784	402614	407247	409495	402118	405681	409430	413716	406300
5 Year Post-HS Difference in Earnings ($)	4495	2653	2512	820	3221	1918	2261	4315	8013	6705
Standard Error	*373*	*354*	*378*	*295*	*257*	*413*	*222*	*260*	*281*	*283*
Observations	339233	336953	336883	340726	342730	336456	339429	342511	346186	339999
6 Year Post-HS Difference in Earnings ($)	5002	3136	1749	496	3390	713	1648	4068	7618	5904
Standard Error	*382*	*516*	*509*	*354*	*356*	*473*	*324*	*291*	*319*	*339*
Observations	272116	270307	270354	273237	275240	269957	272301	274810	277841	272844
7 Year Post-HS Difference in Earnings ($)	5491	3141	2286	325	3726	1469	1446	3773	7698	4944
Standard Error	*488*	*552*	*585*	*407*	*438*	*570*	*438*	*403*	*385*	*456*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student. Only those cohorts for whom earnings could be observed at each number of years after on-time high school graduation are included in the analytic samples for those respective outcomes

Table A10

CTE concentrators' difference in likelihood of being neither employed nor in education or training (NEET) compared to similar non-concentrators, by populations of interest

	Overall	No College	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
Difference in NEET rate 1 Year Post-HS	-.036	-.142	-.054	-.048	-.094	-.067	-.074	-0.070
Standard Error	*.008*	*.009*	*.007*	*.008*	*.01*	*.007*	*.008*	*0.008*
Observations	251435	258387	375966	361415	192123	146250	322355	147752
Difference in NEET rate 2 Year Post-HS	-.058	-.176	-.07	-.053	-.093	-.084	-.082	-0.087
Standard Error	*.007*	*.009*	*.006*	*.007*	*.01*	*.007*	*.008*	*0.008*
Observations	251435	226106	335076	321750	169391	129963	284522	133366
Difference in NEET rate 3 Year Post-HS	-.06	-.178	-.074	-.051	-.097	-.088	-.084	-0.091
Standard Error	*.007*	*.009*	*.006*	*.007*	*.01*	*.007*	*.008*	*0.008*
Observations	251435	196276	293739	281748	147357	113373	246617	118522
Difference in NEET rate 4 Year Post-HS	-.064	-.175	-.076	-.051	-.094	-.092	-.086	-0.094
Standard Error	*.006*	*.009*	*.006*	*.007*	*.009*	*.007*	*.007*	*0.006*
Observations	251435	168797	253126	242521	126478	97283	210046	104473
Difference in NEET rate 5 Year Post-HS	-0.078	-0.154	-0.090	-0.062	-0.096	-0.095	-0.090	-0.093
Standard Error	*0.006*	*0.008*	*0.005*	*0.006*	*0.010*	*0.007*	*0.008*	*0.006*
Observations	251435	141278	211932	203023	105481	80968	173714	89661
Difference in NEET rate 6 Year Post-HS	-0.078	-0.144	-0.089	-0.064	-0.102	-0.094	-0.090	-0.089
Standard Error	*0.005*	*0.007*	*0.005*	*0.007*	*0.010*	*0.007*	*0.008*	*0.007*
Observations	251435	114006	170300	162834	84237	64503	137647	75500
Difference in NEET rate 7 Year Post-HS	-0.078	-0.141	-0.091	-0.064	-0.103	-0.099	-0.089	-0.084
Standard Error	*0.005*	*0.006*	*0.005*	*0.006*	*0.009*	*0.008*	*0.008*	*0.007*
Observations	251435	86192	128476	122958	63484	48448	102664	61091

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. Student are considered to be NEET if they are neither enrolled in education nor earning at or above the federal individual poverty line at the specified time period. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A11

CTE concentrators' difference in likelihood of being neither employed nor in education or training (NEET) compared to similar non-concentrators, by career cluster

	Health	Educ	IT	Comms	Bus	Ag	Hosp	Manu	Cons	Tran
Difference in NEET rate 1 Year Post-HS	-.149	-.13	-.113	-.06	-.063	-.043	-.04	-.056	-.002	.035
Standard Error	*.011*	*.012*	*.012*	*.015*	*.013*	*.017*	*.012*	*.011*	*.01*	*.012*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 2 Year Post-HS	-.164	-.122	-.088	-.063	-.08	-.06	-.074	-.079	-.052	-.03
Standard Error	*.014*	*.012*	*.012*	*.014*	*.012*	*.015*	*.012*	*.01*	*.009*	*.011*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 3 Year Post-HS	-.146	-.116	-.091	-.052	-.083	-.051	-.076	-.08	-.057	-.064
Standard Error	*.012*	*.014*	*.012*	*.013*	*.012*	*.017*	*.012*	*.01*	*.009*	*.011*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 4 Year Post-HS	-.159	-.121	-.077	-.061	-.085	-.062	-.058	-.079	-.074	-.072
Standard Error	*.012*	*.014*	*.011*	*.012*	*.011*	*.013*	*.012*	*.01*	*.008*	*.011*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 5 Year Post-HS	-0.151	-0.149	-0.083	-0.063	-0.091	-0.066	-0.070	-0.095	-0.094	-0.091
Standard Error	*0.012*	*0.016*	*0.011*	*0.010*	*0.009*	*0.016*	*0.009*	*0.009*	*0.008*	*0.010*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 6 Year Post-HS	-0.150	-0.140	-0.079	-0.072	-0.084	-0.055	-0.073	-0.090	-0.104	-0.098
Standard Error	*0.011*	*0.014*	*0.009*	*0.009*	*0.010*	*0.014*	*0.010*	*0.008*	*0.007*	*0.010*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Difference in NEET rate 7 Year Post-HS	-0.144	-0.126	-0.076	-0.072	-0.080	-0.066	-0.075	-0.090	-0.107	-0.093
Standard Error	*0.009*	*0.014*	*0.011*	*0.009*	*0.009*	*0.014*	*0.011*	*0.008*	*0.008*	*0.009*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster indicated by column. Student are considered to be NEET if they are neither enrolled in education nor earning at or above the federal individual poverty line at the specified time period. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A12

CTE concentrators' difference in likelihood of employment above poverty line compared to similar non-concentrators, by populations of interest

	Overall	**No College**	**Male**	**Female**	**Black & Latino**	**Students w/ Disabilities**	**Lower Income**	**Low-Scoring Students**
Diff. in Rate of Employment above Poverty 1 Year Post-HS	.076	.102	.088	.06	.047	.075	.06	.059
Standard Error	*.005*	*.008*	*.007*	*.004*	*.006*	*.006*	*.005*	*.006*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 2 Year Post-HS	.126	.156	.141	.108	.086	.122	.1	.108
Standard Error	*.006*	*.009*	*.008*	*.006*	*.007*	*.009*	*.007*	*.008*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 3 Year Post-HS	.134	.162	.15	.115	.101	.136	.107	.118
Standard Error	*.006*	*.009*	*.007*	*.006*	*.007*	*.01*	*.007*	*.008*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 4 Year Post-HS	.139	.169	.156	.117	.104	.142	.114	.122
Standard Error	*.006*	*.009*	*.007*	*.006*	*.007*	*.009*	*.006*	*.006*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 5 Year Post-HS	0.103	0.152	0.118	0.086	0.095	0.113	0.100	.101
Standard Error	*0.005*	*0.008*	*0.005*	*0.007*	*0.010*	*0.008*	*0.008*	*.007*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 6 Year Post-HS	0.091	0.146	0.103	0.077	0.100	0.104	0.097	.094
Standard Error	*0.005*	*0.007*	*0.005*	*0.006*	*0.010*	*0.008*	*0.007*	*.008*
Observations	251435	86192	128476	122958	63484	48448	102664	61091
Diff. in Rate of Employment above Poverty 7 Year Post-HS	0.084	0.141	0.098	0.069	0.098	0.103	0.090	.086
Standard Error	*0.004*	*0.006*	*0.005*	*0.006*	*0.008*	*0.007*	*0.007*	*.007*
Observations	251435	86192	128476	122958	63484	48448	102664	61091

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring

years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A13

CTE concentrators' difference in likelihood of employment above poverty line compared to similar non-concentrators, by career cluster

	Health	**Educ**	**IT**	**Comms**	**Bus**	**Ag**	**Hosp**	**Manu**	**Cons**	**Tran**
Diff. in Rate of Employment above Poverty 1 Year Post-HS	.138	.053	.03	.017	.054	.05	.058	.094	.155	.141
Standard Error	*.013*	*.008*	*.01*	*.005*	*.007*	*.009*	*.007*	*.008*	*.007*	*.008*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 3 Year Post-HS	.208	.1	.068	.053	.113	.111	.125	.134	.219	.21
Standard Error	*.017*	*.01*	*.013*	*.006*	*.008*	*.013*	*.008*	*.009*	*.009*	*.009*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 5 Year Post-HS	.212	.129	.094	.064	.127	.115	.138	.147	.218	.228
Standard Error	*.016*	*.012*	*.012*	*.007*	*.009*	*.02*	*.01*	*.009*	*.009*	*.01*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 7 Year Post-HS	.209	.131	.093	.078	.134	.129	.144	.149	.224	.224
Standard Error	*.012*	*.014*	*.012*	*.007*	*.009*	*.017*	*.01*	*.012*	*.007*	*.009*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 3 Year Post-HS	0.151	0.129	0.057	0.063	0.118	0.080	0.102	0.109	0.162	0.169
Standard Error	*0.012*	*0.015*	*0.010*	*0.009*	*0.009*	*0.016*	*0.010*	*0.007*	*0.007*	*0.008*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 5 Year Post-HS	0.149	0.124	0.056	0.072	0.105	0.066	0.091	0.094	0.134	0.135
Standard Error	*0.011*	*0.013*	*0.010*	*0.009*	*0.009*	*0.014*	*0.010*	*0.007*	*0.007*	*0.010*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982
Diff. in Rate of Employment above Poverty 7 Year Post-HS	0.135	0.112	0.061	0.071	0.093	0.070	0.086	0.088	0.124	0.114
Standard Error	*0.010*	*0.011*	*0.012*	*0.009*	*0.008*	*0.014*	*0.011*	*0.009*	*0.008*	*0.009*
Observations	205316	204051	204059	206117	207911	203734	205503	207377	209749	205982

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A14

Estimates of coefficient bounds and bias needed to find null results

	2-Yr College Attend	4-Yr College Attend	Any College Attend	2-Yr College Degree	4-Yr College Degree	Any College Degree	1 Year Post-HS Earnings	3 Yr Post-HS Earnings	5 Yr Post-HS Earnings	7 Yr Post-HS Earnings
CTE Concentrator Difference	0.069	-0.062	0.004	0.014	-0.070	-0.055	1791	3358.689	3526.521	3358.757
Standard Error	0.007	0.009	0.011	0.004	0.009	0.009	104.215	162.064	164.736	203.409
Coefficient Bound (R_{max} =1.3R)	(.069, .062)	(-.062, -.049)	(.004, .01)	(.014, .015)	(-.07, -.057)	(-.055, -.042)	(1791, 1684)	(3358, 2977)	(3526, 3395)	(3358, 3239)
Bias δ (R_{max} =1.3R)	7.325	4.685	-0.744	-33.955	4.716	4.038	7.954	4.020	12.713	17.412
Coefficient Bound (R_{max} =2R)	(.069, .045)	(-.062, -.02)	(.004, .023)	(.014, .017)	(-.07, -.023)	(-.055, -.011)	(1791, 1417)	(3358, 2047)	(3526, 3071)	(3358, 2948)
Bias δ (R_{max} =2R)	2.584	1.435	-0.223	-10.445	1.459	1.236	3.427	2.010	5.053	5.846
R-Squared	0.035	0.218	0.160	0.022	0.199	0.188	0.069	0.044	0.039	0.047

Notes: CTE Concentrator Difference, Standard Errors, and R-Squared are from Model 1 and include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Coefficient bounds refer to the range of estimates associated with CTE Concentration on each outcome (by column) as the degree of selection on unobservables increases from none to 30% (row 3) or to 100% (row 5) of selection on observables. Bias **δ** represents the amount of selection on unobservables that would be needed to move estimates of the CTE Concentrator Difference to 0. Calculations of coefficient bourns and Bias **δ**s were conducting using the "psalcalc" STATA package (Oster, 2019).

Table A15

CTE concentrators' college outcomes compared to similar non-concentrators, by populations of interest
Alternate comparison group: Students taking course(s) in each given CTE cluster for only one year

	Health	Educ	IT	Comms	Bus	Ag	Hosp	Manu	Cons	Tran
Difference in 2-Yr College Attendance	.091	.041	.063	.029	.02	.081	.018	.031	.001	.021
Standard Error	*.022*	*.013*	*.013*	*.009*	*.013*	*.019*	*.009*	*.01*	*.011*	*.01*
Observations	15123	12772	10317	23334	29996	6378	16850	24221	26696	14125
Difference in 4-Yr College Attendance	.039	.054	.024	.015	.006	.037	.002	-.005	-.017	-.001
Standard Error	*.016*	*.01*	*.014*	*.008*	*.011*	*.019*	*.009*	*.017*	*.006*	*.009*
Observations	15123	12772	10317	23334	29996	6378	16850	24221	26696	14125
Difference in Overall College Attendance	.091	.072	.065	.049	.025	.086	.017	.022	-.012	.021
Standard Error	*.02*	*.012*	*.015*	*.009*	*.012*	*.025*	*.01*	*.015*	*.011*	*.012*
Observations	15123	12772	10317	23334	29996	6378	16850	24221	26696	14125
Difference in 2-Yr College Degree Attainment	.036	.024	.025	.006	.009	.034	.011	.014	.003	.013
Standard Error	*.009*	*.007*	*.007*	*.005*	*.007*	*.011*	*.005*	*.005*	*.005*	*.005*
Observations	11669	10210	8152	18443	23584	5043	13369	18503	20779	11222
Difference in 4-Yr College Degree Attainment	.023	.037	.024	-.002	-.001	.015	-.01	-.015	-.006	.001
Standard Error	*.011*	*.01*	*.014*	*.009*	*.01*	*.02*	*.011*	*.014*	*.007*	*.008*
Observations	8352	7496	6109	13581	17211	3761	9535	13166	15008	8171
Difference in Overall College Degree Attainment	.039	.037	.027	.005	.006	.033	.000	-.004	-.008	.014
Standard Error	*.013*	*.01*	*.015*	*.009*	*.01*	*.021*	*.011*	*.014*	*.009*	*.009*
Observations	8352	7496	6109	13581	17211	3761	9535	13166	15008	8171

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who enrolled in 1 (but no more than 1) year in the specified career cluster.

Table A16

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest
Alternate comparison group: Students taking course(s) in each given CTE cluster for only one year

	Health	**Educ**	**IT**	**Comms**	**Bus**	**Ag**	**Hosp**	**Manu**	**Cons**	**Tran**
1 Year Post-HS Difference in Earnings ($)	1559	613	249	112	680	261	719	1489	2645	2369
Standard Errors	*250*	*148*	*143*	*79*	*96*	*202*	*119*	*215*	*157*	*192*
Observations	15123	12772	10317	23334	29996	6378	16850	24221	26696	14125
3 Year Post-HS Difference in Earnings ($)	2096	841	935	-52	1240	1547	1241	2065	4292	4363
Standard Errors	*328*	*180*	*266*	*183*	*156*	*419*	*234*	*301*	*237*	*320*
Observations	11669	10210	8152	18443	23584	5043	13369	18503	20779	11222
5 Year Post-HS Difference in Earnings ($)	2607	926	1560	113	2004	2430	1091	2289	5518	4958
Standard Errors	*428*	*317*	*436*	*315*	*327*	*700*	*383*	*327*	*378*	*508*
Observations	8352	7496	6109	13581	17211	3761	9535	13166	15008	8171
7 Year Post-HS Difference in Earnings ($)	3127	1083	1131	-31	3024	5076	924	2426	7102	5066
Standard Errors	*601*	*653*	*848*	*525*	*442*	*1099*	*481*	*618*	*663*	*795*
Observations	4810	4528	3841	7901	10984	2120	5495	7835	8997	4832

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who enrolled in 1 (but no more than 1) year in the specified career cluster.

Table A17

Regression-adjusted estimates for CTE concentration on select outcomes
Among only students residentially eligible for a vocational/technical school

	I	II	III	IV	V
Difference in 2-Yr College Attendance	0.114	0.095	0.109	0.081	0.076
Standard Error	*0.009*	*0.007*	*0.009*	*0.009*	*0.008*
Observations	206557	206556	206557	206557	206556
Difference in 4-Yr College Attendance	-0.173	-0.090	-0.095	-0.075	-0.058
Standard Error	*0.021*	*0.016*	*0.014*	*0.012*	*0.010*
Observations	206557	206556	206557	206557	206556
Difference in Overall College Attendance	-0.064	-0.002	-0.004	-0.004	0.010
Standard Error	*0.017*	*0.017*	*0.012*	*0.012*	*0.013*
Observations	206557	206556	206557	206557	206556
Difference in 2-Yr College Degree Attainment	0.016	0.017	0.028	0.019	0.018
Standard Error	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
Observations	206557	206556	206557	206557	206556
Difference in 4-Yr College Degree Attainment	-0.183	-0.105	-0.108	-0.084	-0.070
Standard Error	*0.020*	*0.014*	*0.013*	*0.011*	*0.010*
Observations	206557	206556	206557	206557	206556
Difference in Overall College Degree Attainment	-0.164	-0.088	-0.089	-0.069	-0.054
Standard Error	*0.020*	*0.015*	*0.012*	*0.011*	*0.010*
Observations	206557	206556	206557	206557	206556
1 Year Post-HS Difference in Earnings ($)	2213	2063	2124	1894	1839
Standard Error	*151*	*148*	*144*	*127*	*129*
Observations	206557	206556	206557	206557	206556
3 Year Post-HS Difference in Earnings ($)	4127.278	3908.361	3957.556	3451.77	3402.608
Standard Error	*248.785*	*228.9*	*239.75*	*209.45*	*197.25*
Observations	206557	206556	206557	206557	206556
5 Year Post-HS Difference in Earnings ($)	3314	3908	3850	3443	3558
Standard Error	*240*	*325*	*262*	*197*	*193*
Observations	206557	206556	206557	206557	206556
7 Year Post-HS Difference in Earnings ($)	2281	3767	3525	3068	3359
Standard Error	*363*	*445*	*337*	*242*	*223*
Observations	206557	206556	206557	206557	206556
Controls for Demographic Characteristics	No	No	**Yes**	**Yes**	**Yes**
Controls for 8th Gr. Assessments & Attendance	No	No	No	**Yes**	**Yes**
Fixed Effects for Cohort & Town of Residence	No	**Yes**	No	No	**Yes**

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest, specified by row. Model I includes only an indicator of CTE concentration and the outcome of interest. Model II adds cohort and town of residence fixed effects, with errors clustered by town of residence. Model III includes controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, and disability status. Model IV adds 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts) to demographic controls. Model V includes both fixed effects and all controls. Analytic samples include first-time 9th graders from towns of residence in which students are eligible to attend a CTE-dedicated school, and in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student. For degree attainment outcomes, only those cohorts who would have enough time for "on-time" degree attainment are included in the analytic samples.

Table A18

Regression-adjusted estimates for CTE concentration on select outcomes
Among only students NOT residentially eligible for a vocational/technical school

	I	II	III	IV	V
Difference in 2-Yr College Attendance	0.051	0.048	0.049	0.022	0.030
Standard Error	*0.014*	*0.011*	*0.013*	*0.012*	*0.010*
Observations	44880	44879	44880	44880	44879
Difference in 4-Yr College Attendance	-0.193	-0.146	-0.108	-0.088	-0.076
Standard Error	*0.031*	*0.028*	*0.023*	*0.019*	*0.018*
Observations	44880	44879	44880	44880	44879
Difference in Overall College Attendance	-0.109	-0.069	-0.043	-0.042	-0.026
Standard Error	*0.024*	*0.024*	*0.019*	*0.016*	*0.017*
Observations	44880	44879	44880	44880	44879
Difference in 2-Yr College Degree Attainment	-0.015	-0.008	0.002	-0.007	0.000
Standard Error	*0.009*	*0.009*	*0.008*	*0.008*	*0.007*
Observations	44880	44879	44880	44880	44879
Difference in 4-Yr College Degree Attainment	-0.192	-0.144	-0.108	-0.085	-0.070
Standard Error	*0.026*	*0.023*	*0.019*	*0.015*	*0.014*
Observations	44880	44879	44880	44880	44879
Difference in Overall College Degree Attainment	-0.178	-0.129	-0.094	-0.075	-0.058
Standard Error	0.025	0.022	0.018	0.015	0.014
Observations	44880	44879	44880	44880	44879
1 Year Post-HS Difference in Earnings ($)	1827	1848	1715	1533	1567
Standard Error	*155*	*115*	*143*	*143*	*112*
Observations	44880	44879	44880	44880	44879
3 Year Post-HS Difference in Earnings ($)	3732	3731	3481	3024	3141
Standard Error	*301*	*208*	*277*	*264*	*194*
Observations	44880	44879	44880	44880	44879
5 Year Post-HS Difference in Earnings ($)	3026	3556	3464	3080	3374
Standard Error	*445*	*335*	*418*	*394*	*296*
Observations	44880	44879	44880	44880	44879
7 Year Post-HS Difference in Earnings ($)	2335	3386	3351	2909	3382
Standard Error	*790*	*621*	*739*	*686*	*513*
Observations	44880	44879	44880	44880	44879
Controls for Demographic Characteristics	No	No	**Yes**	**Yes**	**Yes**
Controls for 8th Gr. Assessments & Attendance	No	No	No	**Yes**	**Yes**
Fixed Effects for Cohort & Town of Residence	No	**Yes**	No	No	**Yes**

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest, specified by row. Model I includes only an indicator of CTE concentration and the outcome of interest. Model II adds cohort and town of residence fixed effects, with errors clustered by town of residence. Model III includes controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, and disability status. Model IV adds 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts) to demographic controls. Model V includes both fixed effects and all controls. Analytic samples include first-time 9th graders from towns of residence in which students are *not* eligible to attend a CTE-dedicated school, and in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student. For degree attainment outcomes, only those cohorts who would have enough time for "on-time" degree attainment are included in the analytic samples.

Table A19

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest
Sample only includes students at comprehensive schools

	Overall	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
Difference in 2-Yr College Attendance	.051	.037	.071	.076	.043	.067	.059
Stand Error	*.008*	*.008*	*.008*	*.009*	*.007*	*.009*	*.008*
Observations	572314	288785	283528	137832	116806	239706	125436
Difference in 4-Yr College Attendance	-.039	-.045	-.028	-.006	-.028	-.015	-.007
Stand Error	*.008*	*.009*	*.009*	*.012*	*.006*	*.008*	*.006*
Observations	572314	288785	283528	137832	116806	239706	125436
Difference in Overall College Attendance	.011	-.005	.035	.061	.023	.043	.05
Stand Error	*.01*	*.012*	*.008*	*.011*	*.01*	*.009*	*.01*
Observations	572314	288785	283528	137832	116806	239706	125436
Difference in 2-Yr College Degree Attainment	.006	.004	.009	.011	.003	.011	.008
Stand Error	*.003*	*.003*	*.004*	*.003*	*.003*	*.003*	*.003*
Observations	447059	225676	221383	105829	90538	182568	100708
Difference in 4-Yr College Degree Attainment	-.038	-.042	-.031	-.011	-.023	-.017	-.012
Stand Error	*.007*	*.007*	*.008*	*.009*	*.005*	*.007*	*.004*
Observations	323099	163084	160015	75960	64743	128494	76331
Difference in Overall College Degree Attainment	-.03	-.034	-.022	-.002	-.014	-.008	-.003
Stand Error	*.006*	*.007*	*.007*	*.008*	*.006*	*.007*	*.005*
Observations	323099	163084	160015	75960	64743	128494	76331

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders at *comprehensive* public schools in cohorts that would have graduated on-time in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A20

CTE concentrators' college outcomes compared to similar non-concentrators, by populations of interest
Sample only includes students at comprehensive schools

	Overall	No College	Male	Female	Black & Latino	Students w/Disabilities	Lower Income	Low-Scoring Students
1 Year Post-HS Difference in Earnings ($)	1403	2009	1594	1174	1182	1461	1288	1297
Standard Errors	*118*	*181*	*150*	*98*	*155*	*144*	*117*	*140*
Observations	572314	172461	288785	283528	137832	116806	239706	125436
3 Year Post-HS Difference in Earnings ($)	2355	3419	2861	1765	1967	2511	2065	2366
Standard Errors	*170*	*285*	*213*	*164*	*209*	*297*	*168*	*230*
Observations	447059	131281	225676	221383	105829	90538	182568	100708
5 Year Post-HS Difference in Earnings ($)	2645	3982	3313	1846	2241	2868	2328	2684
Standard Errors	*240*	*390*	*264*	*292*	*366*	*315*	*281*	*281*
Observations	323099	95041	163084	160015	75960	64743	128494	76331
7 Year Post-HS Difference in Earnings ($)	2710	4343	3193	2287	2962	2808	2671	2632
Standard Errors	*284*	*401*	*275*	*425*	*468*	*365*	*344*	*304*
Observations	196492	58414	99172	97318	45966	38811	76152	52115

Notes: Estimates are the coefficient associated with CTE concentration on the outcomes of interest (specified by row) with estimates for each population of interest, indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders at *comprehensive* public schools in cohorts that would have graduated on-time in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A21

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest
Using only those cohorts that can be observed 7 years after High School
Excluding students who live in towns bordering other states

	Overall	**No College**	**Male**	**Female**	**Black & Latino**	**Students w/Disabilities**	**Lower Income**	**Low-Scoring Students**
1 Year Post-HS Difference in Earnings ($)	1737	2399	2065	1315	1201	1755	1386	1374
Standard Error	*111*	*198*	*146*	*82*	*135*	*137*	*125*	*121*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
2 Year Post-HS Difference in Earnings ($)	2729	3775	3281	2024	1914	2739	2204	2357
Standard Error	*150*	*259*	*198*	*111*	*156*	*220*	*161*	*190*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
3 Year Post-HS Difference in Earnings ($)	3289	4531	4041	2340	2310	3360	2625	2857
Standard Error	*177*	*308*	*235*	*141*	*182*	*270*	*194*	*220*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
4 Year Post-HS Difference in Earnings ($)	3808	5156	4781	2544	2685	3838	2999	3278
Standard Error	*195*	*359*	*278*	*145*	*205*	*300*	*203*	*228*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
5 Year Post-HS Difference in Earnings ($)	3515	5373	4583	2188	2819	3721	3112	3297
Standard Error	*185*	*360*	*246*	*203*	*279*	*258*	*270*	*249*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
6 Year Post-HS Difference in Earnings ($)	3351	5637	4443	2002	3099	3768	3269	3398
Standard Error	*200*	*333*	*232*	*273*	*325*	*277*	*302*	*284*
Observations	223982	76505	114481	109501	60066	43625	93202	54196
7 Year Post-HS Difference in Earnings ($)	3386	6046	4567	1922	3465	3903	3511	3428
Standard Error	*219*	*354*	*246*	*315*	*357*	*317*	*340*	*308*
Observations	223982	76505	114481	109501	60066	43625	93202	54196

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each population of interest (by column). All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011, excluding those students residing in towns bordering other states. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A22

CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster
Excluding students who live in towns bordering other states

	Health	**Educ**	**IT**	**Comms**	**Bus**	**Ag**	**Hosp**	**Manu**	**Cons**	**Tran**
1 Year Post-HS Difference in Earnings ($)	2885	1486	756	525	1344	1059	1425	2239	3481	3051
Standard Error	*214*	*124*	*192*	*93*	*123*	*158*	*140*	*206*	*161*	*166*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
2 Year Post-HS Difference in Earnings ($)	4003	2355	1299	997	2164	2030	2193	3355	5273	4737
Standard Error	*267*	*159*	*247*	*147*	*161*	*276*	*174*	*266*	*227*	*228*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
3 Year Post-HS Difference in Earnings ($)	4500	2780	2040	1297	2578	2661	2613	3999	6406	5826
Standard Error	*308*	*224*	*327*	*167*	*161*	*430*	*233*	*281*	*277*	*277*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
4 Year Post-HS Difference in Earnings ($)	4846	2852	2291	1542	2960	3193	2918	4623	7731	6785
Standard Error	*280*	*273*	*374*	*195*	*194*	*483*	*274*	*326*	*302*	*314*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
5 Year Post-HS Difference in Earnings ($)	4600	3070	2059	904	3592	2029	2305	4189	7202	6242
Standard Error	*377*	*456*	*471*	*316*	*324*	*508*	*318*	*293*	*322*	*314*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
6 Year Post-HS Difference in Earnings ($)	5141	3441	1876	673	3750	1067	1727	4016	7083	5527
Standard Error	*439*	*505*	*546*	*401*	*400*	*519*	*386*	*360*	*359*	*377*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339
7 Year Post-HS Difference in Earnings ($)	5297	3517	1894	418	3940	1510	1694	3820	7783	4972
Standard Error	*528*	*551*	*616*	*436*	*469*	*619*	*482*	*454*	*420*	*441*
Observations	183697	182715	182670	184481	185990	182279	183791	185372	187316	184339

Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by row) with estimates for each CTE cluster indicated by column. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011, excluding those students residing in towns bordering other states. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Table A23

CTE concentrators' earnings advantage 7 years after High School compared to non-concentrators with similar propensity of being a CTE concentrator, by population of interest

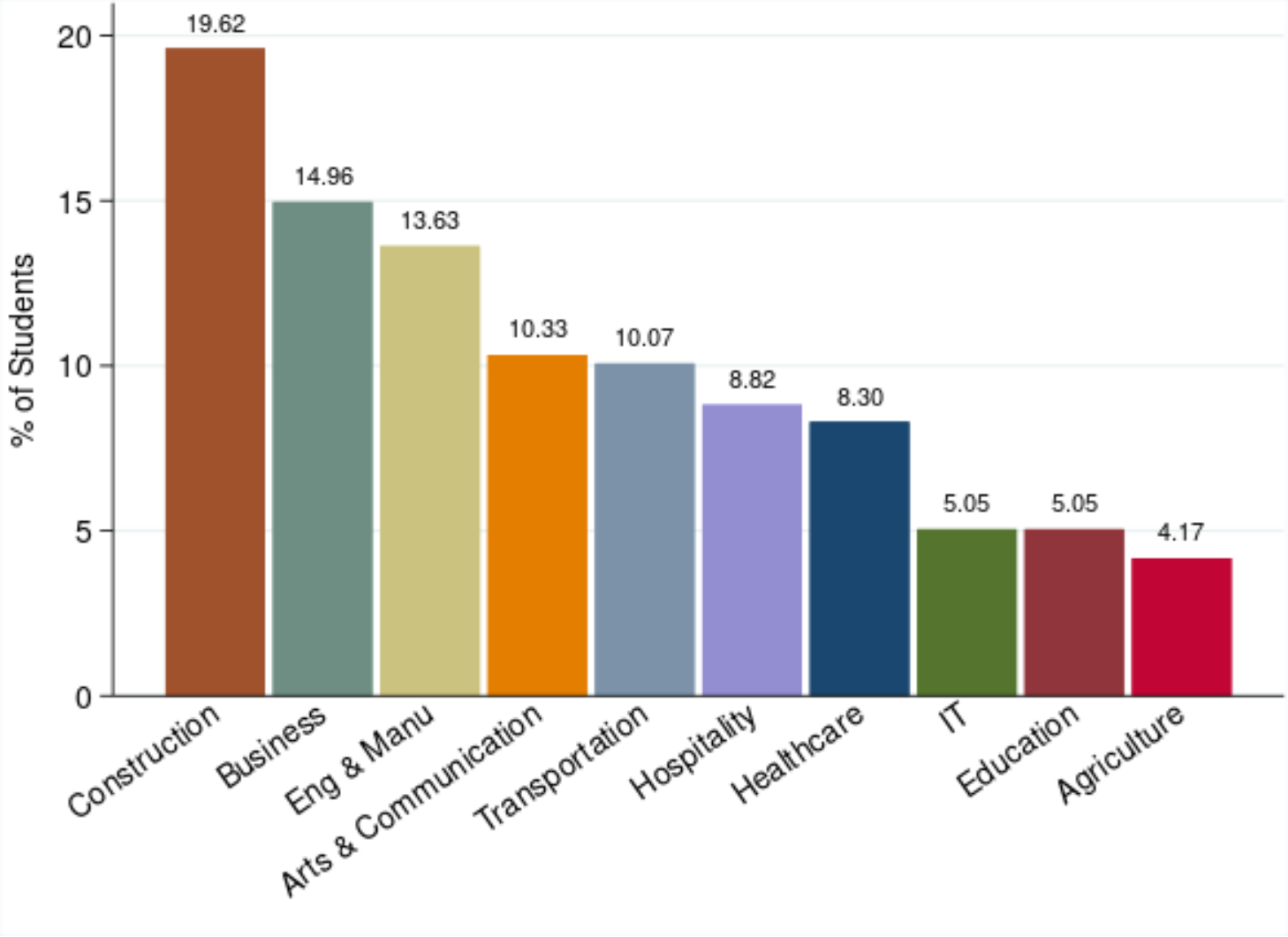
Using Propensity Score Matching

Overall	3082
Standard Error	*170*
Observations	251,437
Non-College	4954
Standard Error	*219*
Observations	86,194
Male	3683
Standard Error	*234*
Observations	128,479
Female	2249
Standard Error	*257*
Observations	122,958
Black or Latino	3049
Standard Error	*228*
Observations	63,506
Free or Reduced-Price Lunch	2894
Standard Error	*173*
Observations	102667
Students with Disabilities	3148
Standard Error	*255*
Observations	48450
Low-Scoring Students	2953
Standard Error	*202*
Observations	61,092

Notes: Estimates are the coefficient associated with CTE concentration on earnings 7 years after on-time high school graduation for each student population. Estimates compare students who were CTE concentrators with those who were not CTE concentrators, but had a similar propensity to be a CTE concentrator, according to observed characteristics including gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts) and cohort. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Propensity scores were estimated using Stata's "teffects psmatch" package.

Figure A1

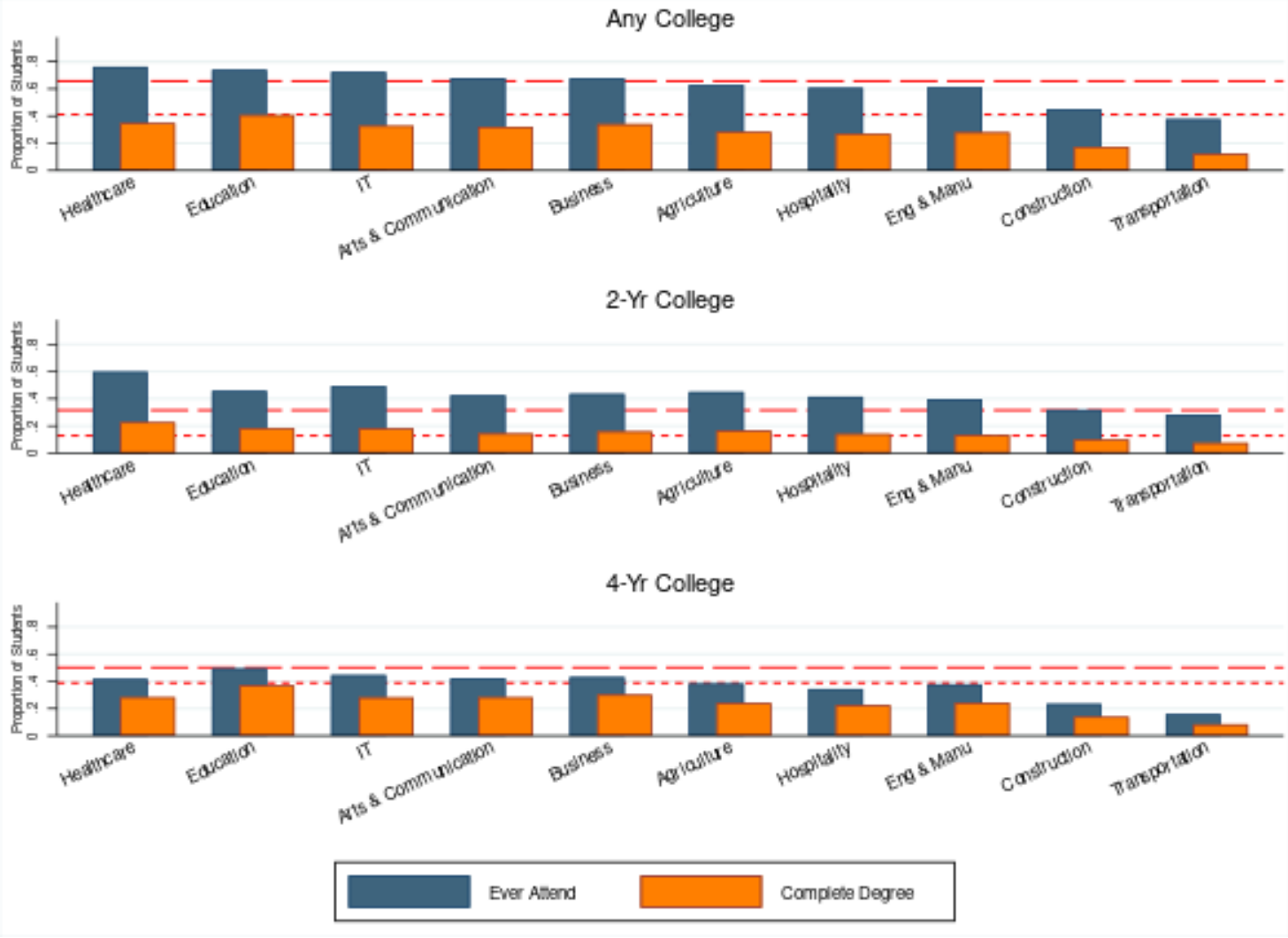
CTE concentrators by career cluster



Notes: Sample includes CTE concentrators in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a CTE concentrator in a given career cluster if they are enrolled in CTE in that career cluster for at least two academic years.

Figure A2

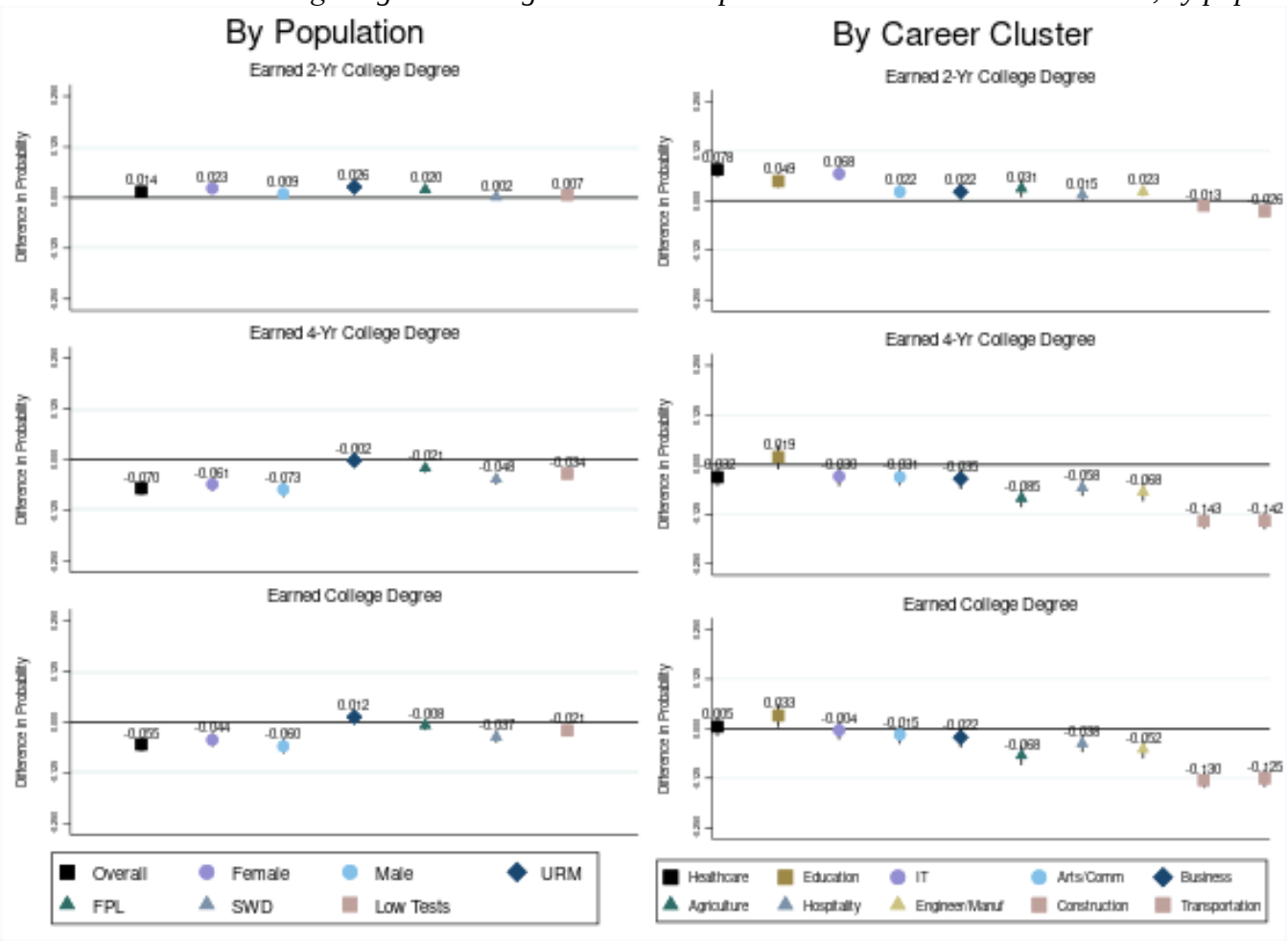
CTE concentrators rates of college attendance and completion in each career cluster compared to statewide averages



Notes: Each bar represents the proportion of students in the specified career cluster who attend and complete at a given level, compared to the statewide averages indicated by the red dashed lines. Sample all 9th grade public school students in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a CTE concentrator in a given career cluster if they are enrolled in CTE in that career cluster for at least two academic years.

Figure A3

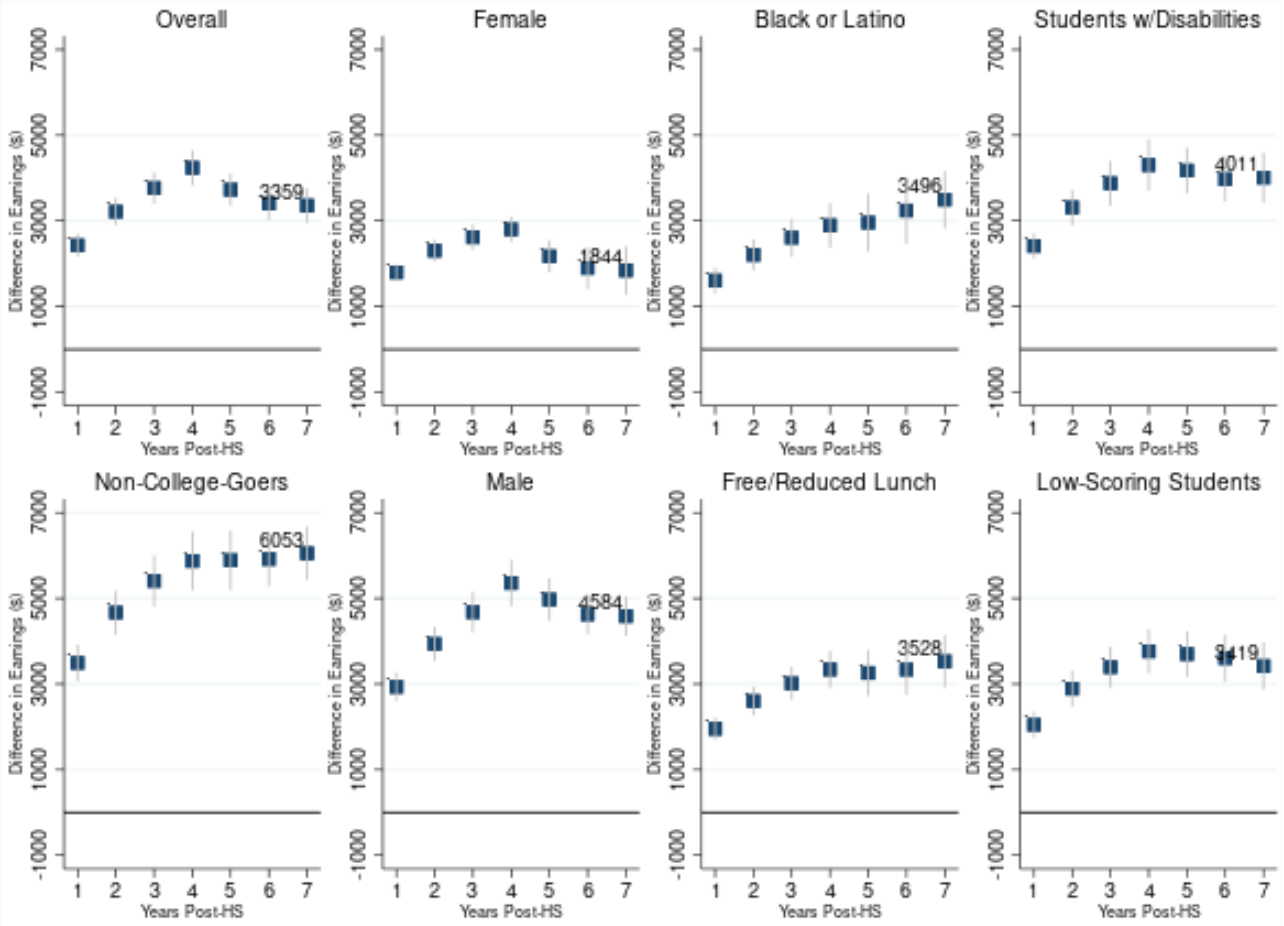
CTE concentrators' college degree-earning outcomes compared to similar non-concentrators, by population & career cluster



Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the outcomes of interest (specified by panel) with estimates for each CTE cluster or population of interest. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A4

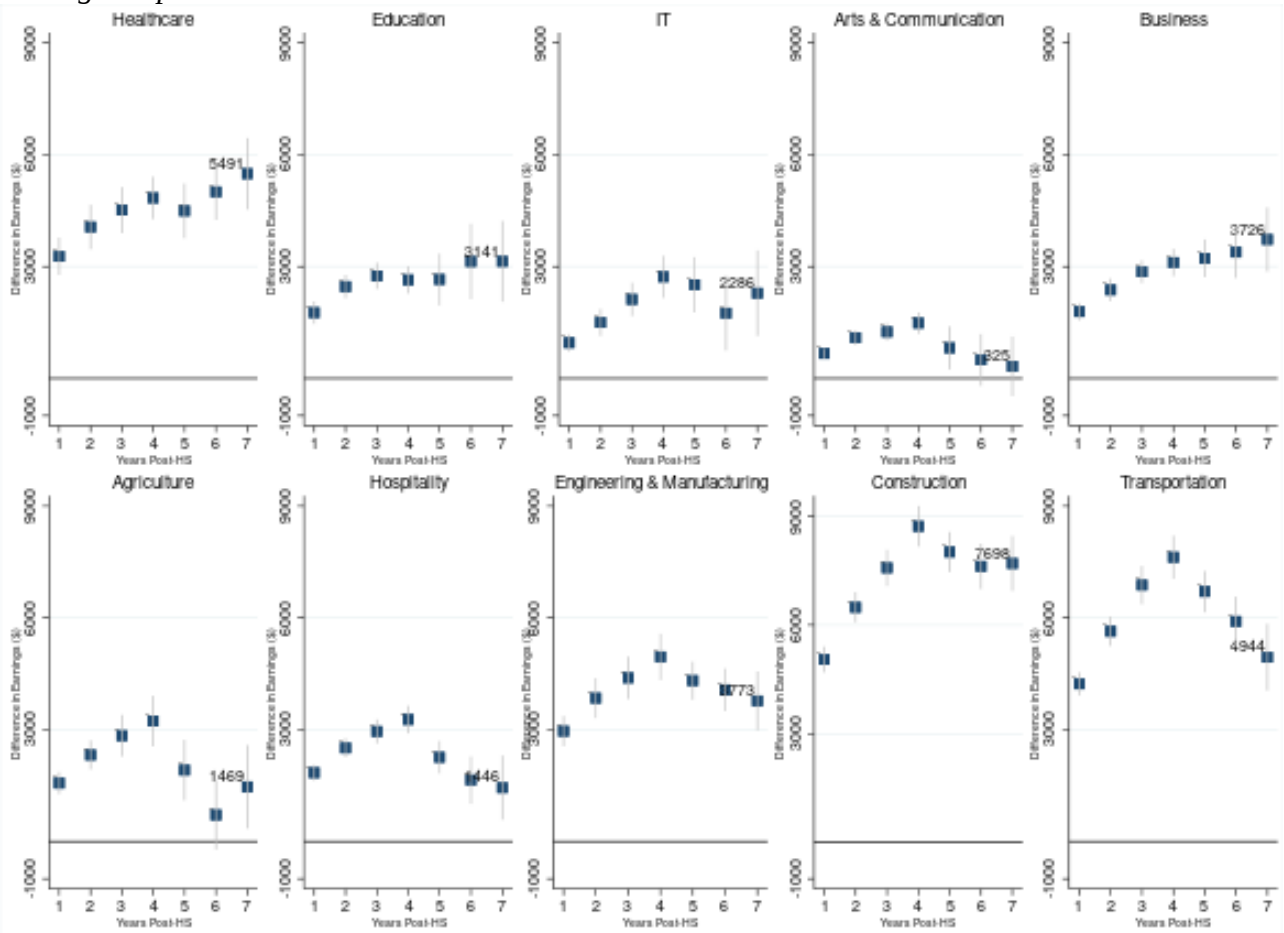
CTE concentrators' annual earnings advantage compared to similar non-concentrators, by populations of interest
Rolling Sample



Notes: Estimates are the coefficient associated with CTE concentration for earnings in each of the first 7 years after high school for each population of interest (by panel). All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student. Only those cohorts for whom earnings could be observed at each number of years after on-time high school graduation are included in the analytic samples for those respective outcomes

Figure A5

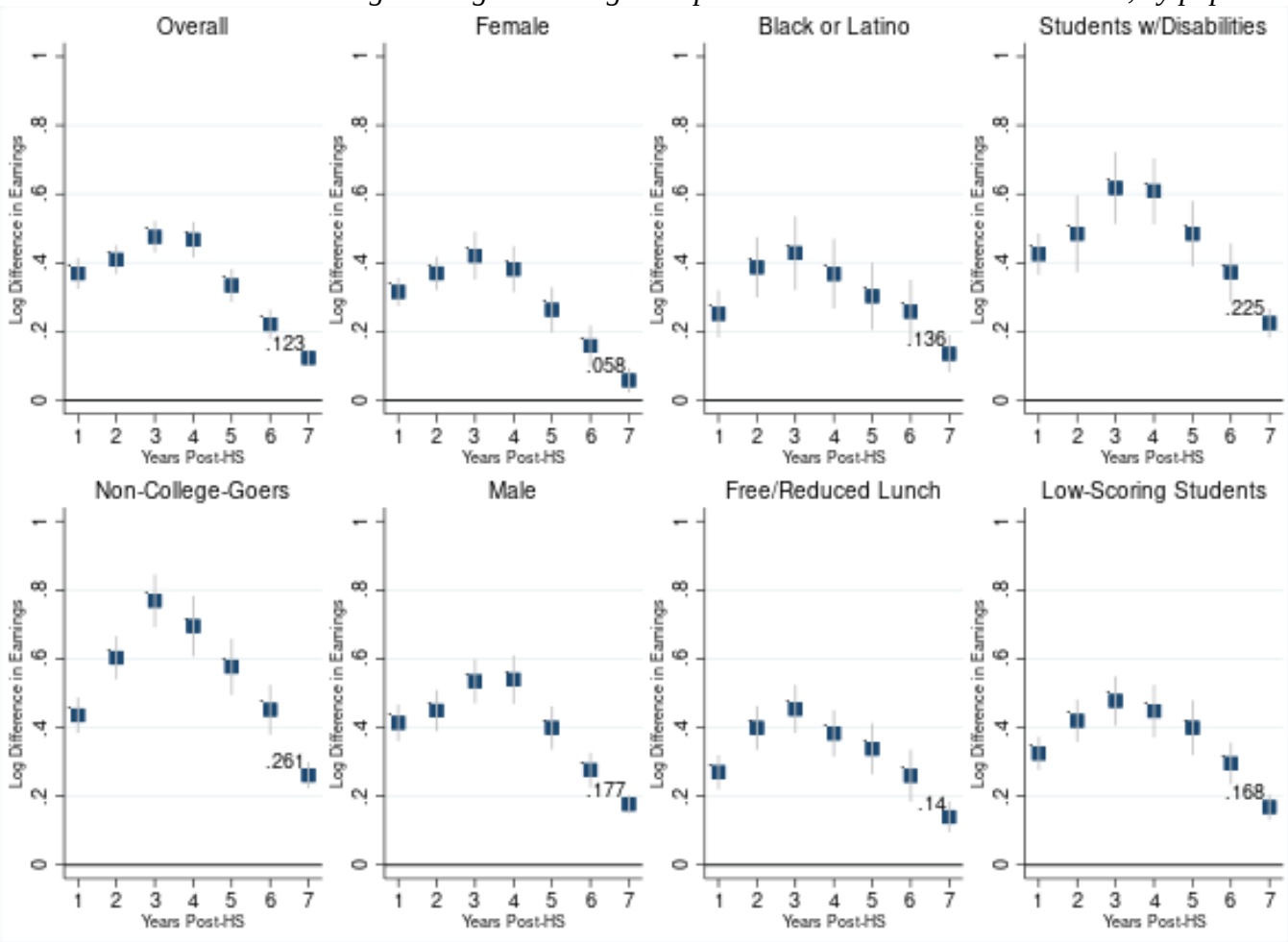
CTE concentrators' annual earnings advantage compared to similar non-concentrators, by career cluster
Rolling Sample



Notes: Estimates are the coefficient associated with CTE concentration in each given cluster for earnings in each of the first 7 years after high school. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2017. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student. Only those cohorts for whom earnings could be observed at each number of years after on-time high school graduation are included in the analytic samples for those respective outcomes

Figure A6

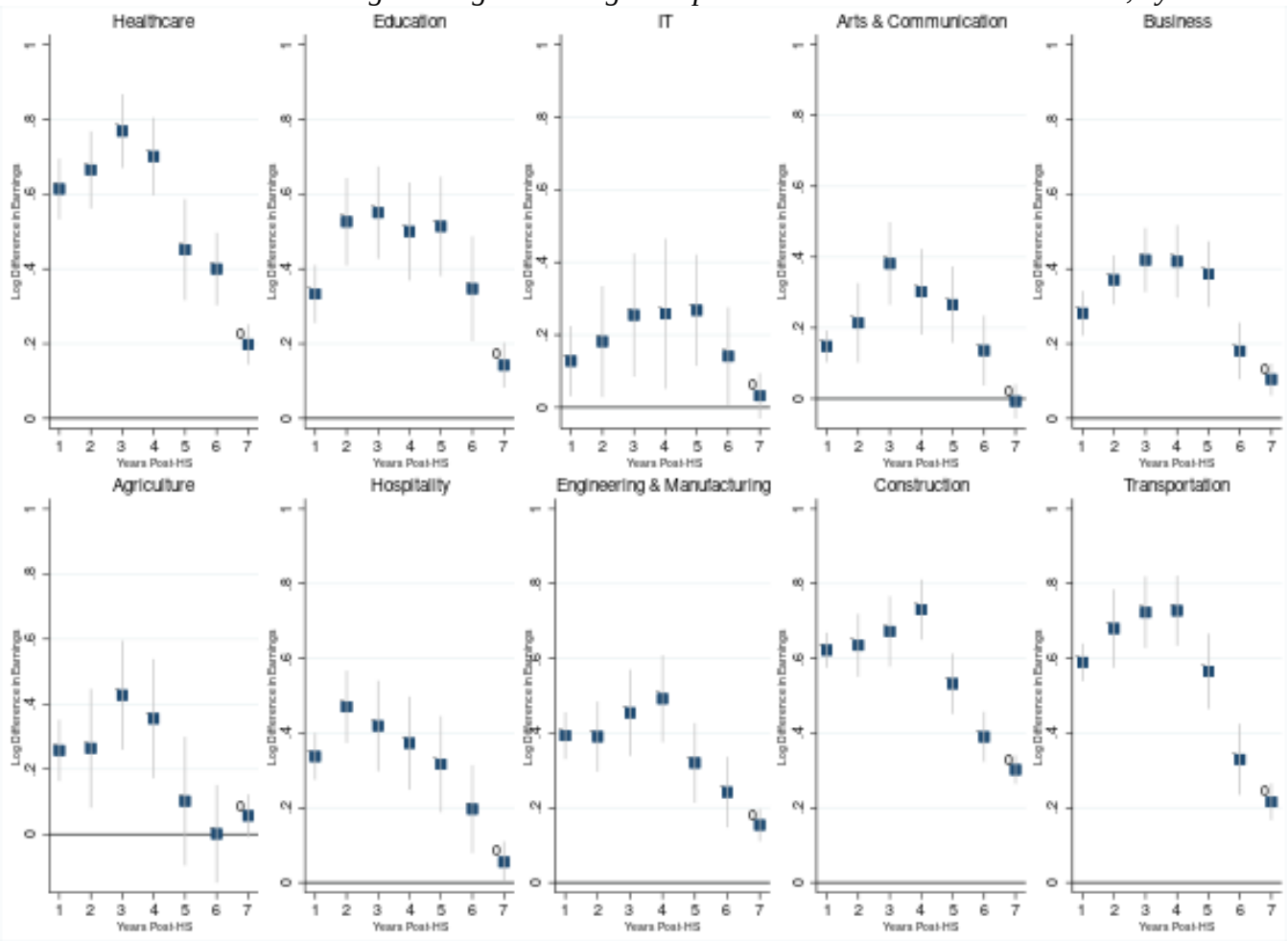
CTE concentrators' annual log earnings advantage compared to similar non-concentrators, by populations of interest



Notes: Estimates are the coefficient associated with CTE concentration for log earnings in each of the first 7 years after high school for each population of interest. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A7

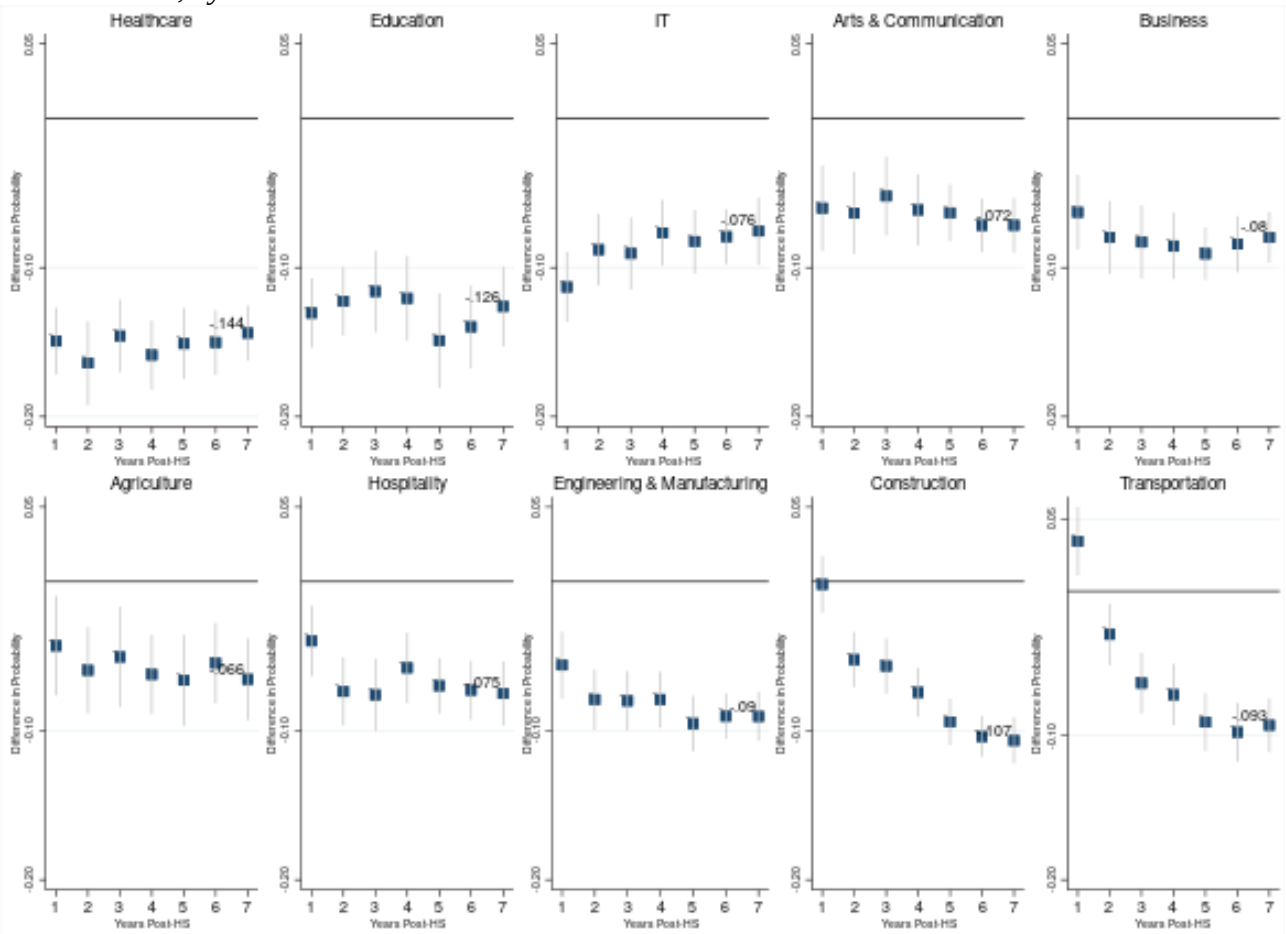
CTE concentrators' annual log earnings advantage compared to similar non-concentrators, by career cluster



Notes: Estimates are the coefficient associated with CTE concentration in each given cluster for log earnings in each of the first 7 years after high school. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A8

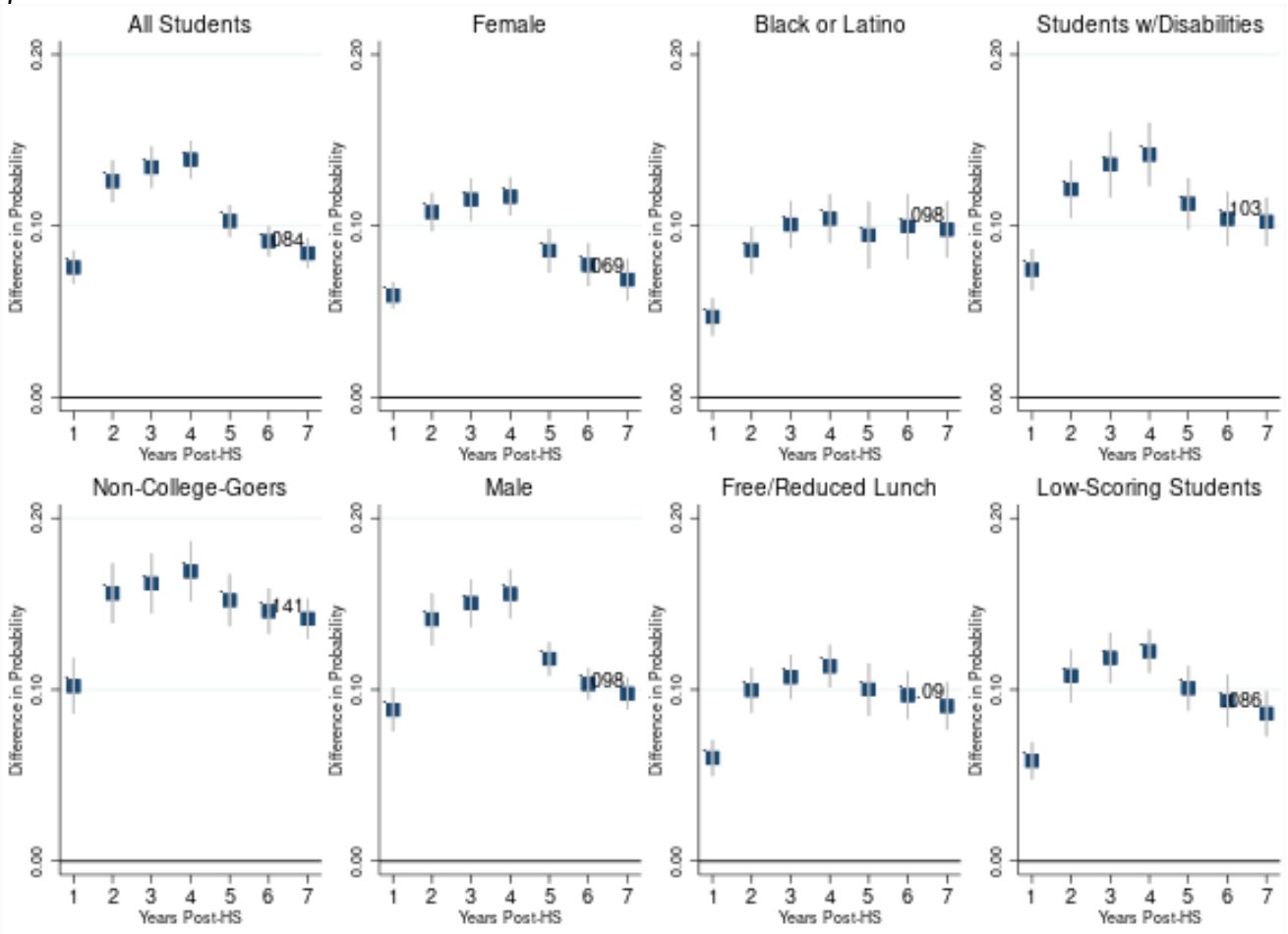
CTE concentrators' difference in likelihood of being neither employed nor in education or training (NEET) compared to similar non-concentrators, by career cluster



Notes: Estimates are the coefficient associated with CTE concentration on the likelihood of being NEET in each of the first 7 years after high school, by career cluster. All Student are considered to be NEET if they are neither enrolled in education nor earning at or above the federal individual poverty line at the specified time period. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A9

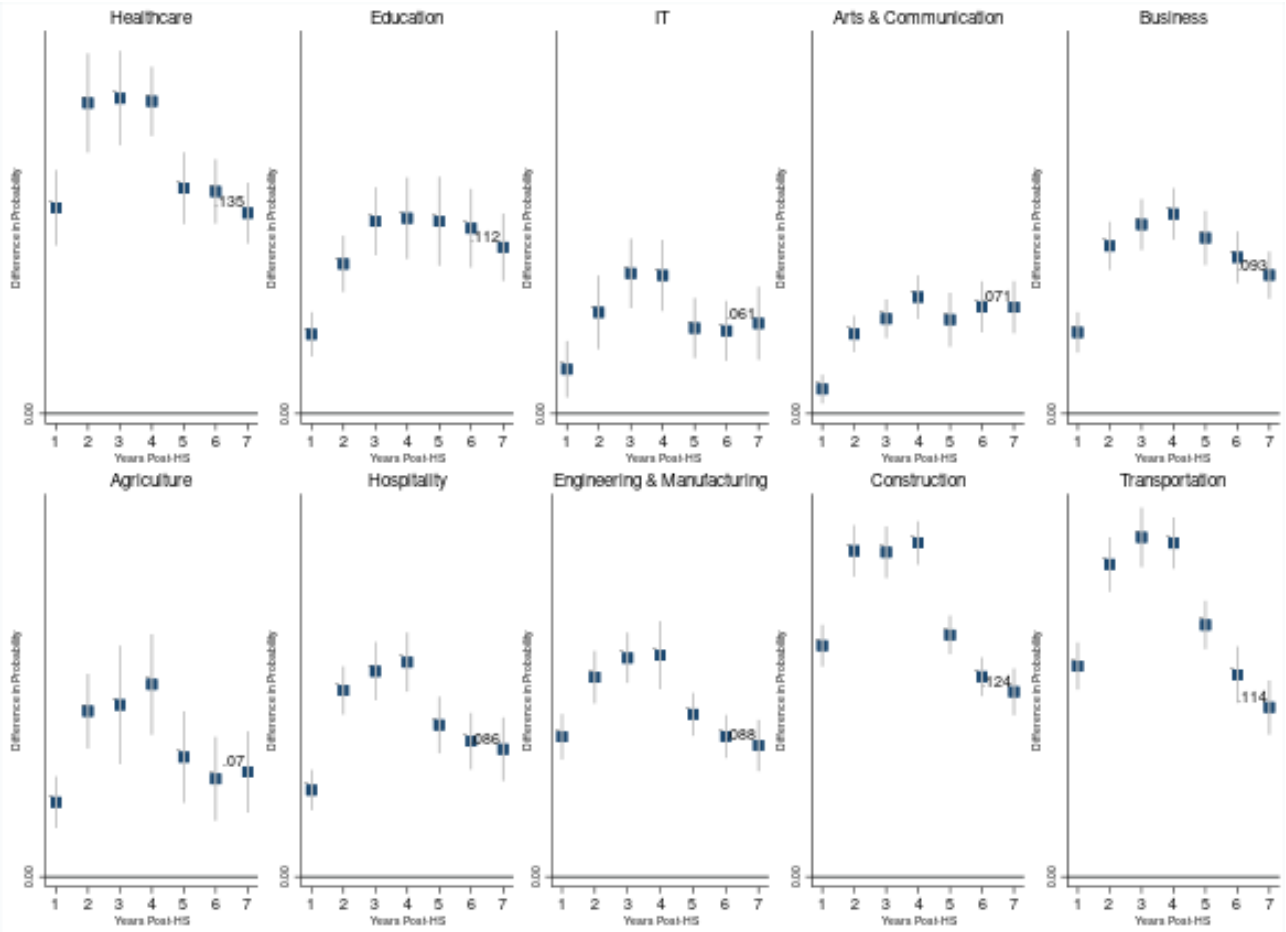
CTE concentrators' difference in likelihood of employment above poverty line compared to similar non-concentrators, by populations of interest



Notes: Estimates are the coefficient associated with CTE concentration on the probability of earning above the federal individual poverty threshold 1-7 years after on-time high school graduation, by population of interest. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "CTE concentrator" if they are enrolled in CTE for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A10

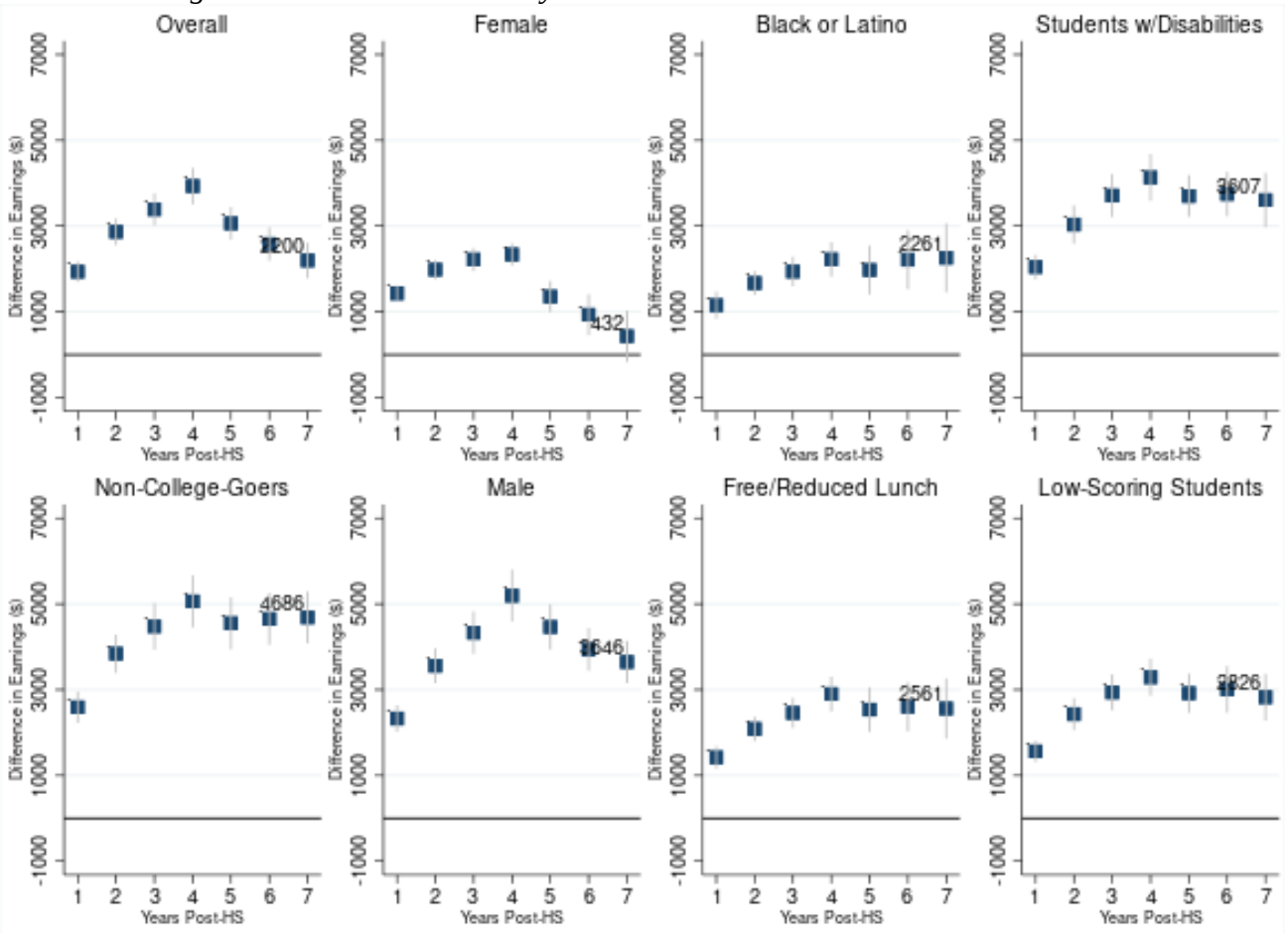
CTE concentrators' difference in likelihood of employment above poverty line compared to similar non-concentrators, by career cluster



Notes: Estimates are the coefficient associated with CTE concentration in each given cluster on the probability of earning above the federal individual poverty threshold 1-7 years after on-time high school graduation. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A11

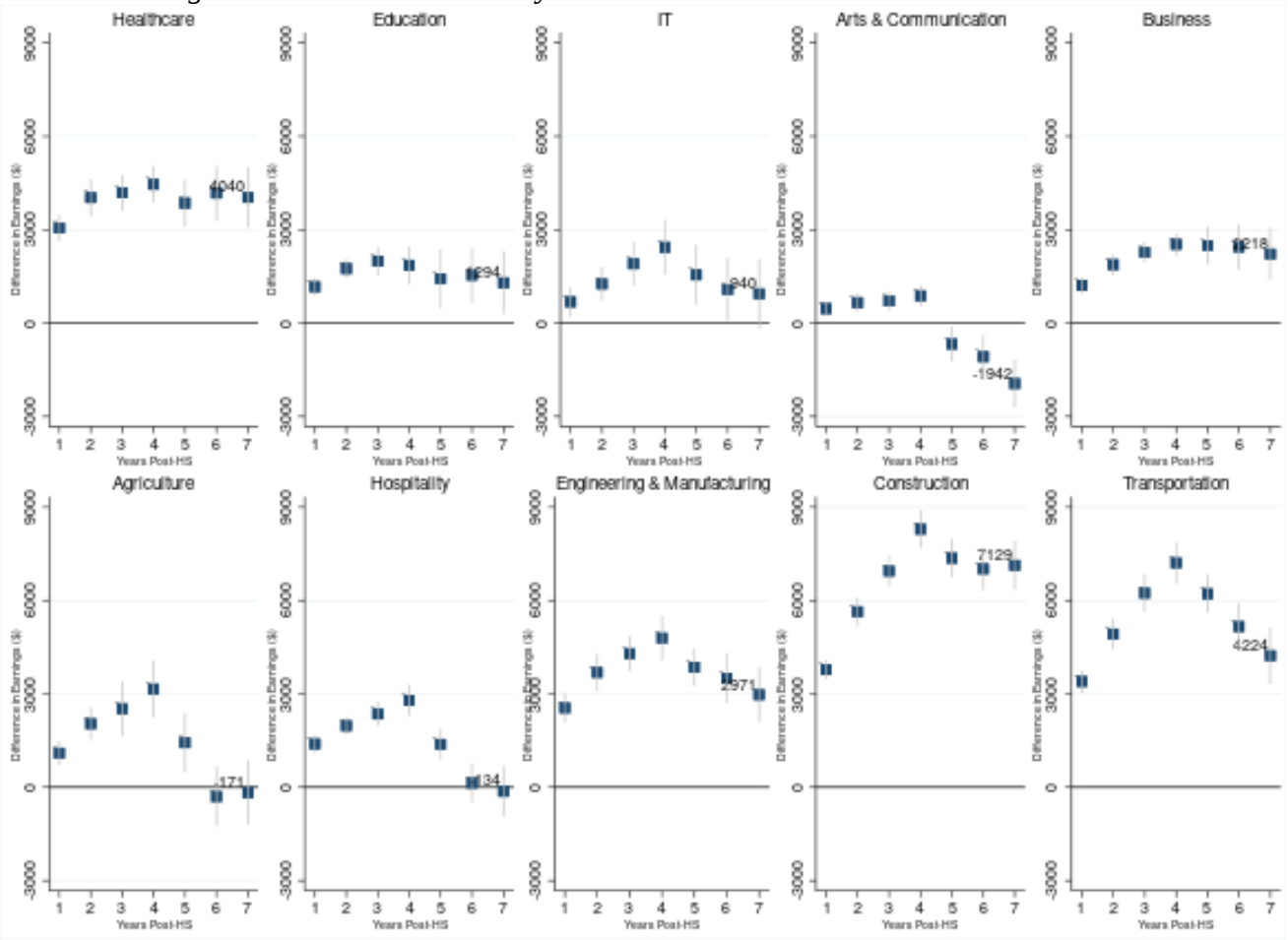
CTE concentrators' annual earnings advantage compared to similar non-concentrators by population of interest
With $0 earnings records excluded in analysis



Notes: Estimates are the coefficient associated with CTE concentration on earnings over the first 7 years after on-time high school graduation, with estimates for each population of interest. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Individuals with no reported income in each year are excluded from the analysis for that year. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.

Figure A12

CTE concentrators' annual earnings advantage compared to similar non-concentrators by career cluster
With $0 earnings records excluded in analysis



Notes: Estimates are the coefficient associated with CTE concentration in each given cluster for earnings in each of the first 7 years after high school. All models include controls for gender, race & ethnicity, lower-income status, English language learner status, immigrant status, disability status, 8th grade school attendance rates, and 8th grade performance on state assessments (both Mathematics and English Language Arts). Models also include cohort and town of residence fixed effects, with errors clustered by town of residence. Analytic samples include first-time 9th graders in cohorts that would have graduated on-time from public high schools in the spring years of 2009 through 2011. Individuals with no reported income in each year are excluded from the analysis for that year. Students are considered to be a "concentrator" in a specific career cluster if they are enrolled in the given cluster for at least two academic years. Comparison students are those who were never enrolled as a CTE student.