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Does Expanding Access to High Quality Technical Education Induce Participation and Improve Outcomes?*

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ABSTRACT

Over the last 15 years, Career and Technical Education (CTE) has been changing as schools have aimed to better meet workforce needs and diversify pathways into higher education and the workforce. This study provides the first known causal evidence on the impact of CTE program expansion in U.S. comprehensive high schools on student participation and postsecondary outcomes. Using administrative data from Massachusetts, we leverage variation from the staggered rollout of state-approved CTE program offerings across high schools and examine overall effects as well as heterogeneity by student and program characteristics. Our findings show that access to a new CTE program induces 11.5 percent of prior non-participants to take-up the program. CTE exposure increases the number of quarters with earnings by 2 percent, with larger effects for students with disabilities and Black or Hispanic students. Conditional on employment, exposure increases earnings by 9 percent one year after high school graduation, particularly among male students. We also find suggestive evidence that exposure to Education programs for female students and IT programs for Black or Hispanic students increase four-year college enrollment and completion by 5 percent.

Keywords: Career and Technical Education, Postsecondary Outcomes, College, Earnings

JEL Classification: I24, J24, H52

INTRODUCTION

Over the past 15 years, the growing policy emphasis on college and career readiness (as a change from College for All) has elevated the position of Career and Technical Education (CTE) as a crucial policy lever for developing students' human capital. During this same period, the reauthorization of the federal Perkins Act has pushed CTE programs to more closely align with workforce demands. Since 2000, high-demand fields such as Information Technology, Health Services, Engineering, and Early Childhood Education have been added or expanded within CTE, with many of these programs designed to include pathways into both 2-year and 4-year colleges. This broadening of scope and increased focus on CTE have raised important questions about their effectiveness not just in boosting workforce outcomes, but in shaping longer-term educational trajectories as part of a broader human capital development strategy.

Among the many states expanding their CTE offerings, Massachusetts has undertaken similar modifications over the past 20 years to meet evolving local labor market needs. A primary area of expansion within Massachusetts is the state-approved Chapter 74 programs, which are recognized as high-quality programs that meet additional state standards that exceed federal requirements. By the 2020-2021 school year, over 20 percent of their comprehensive high schools offered at least one Chapter 74 program, and more than 80 percent of CTE participants in Massachusetts were enrolled in these state-approved programs (DESE, 2022). Growth in these programs is evident not only in wall-to-wall CTE schools (i.e. dedicated technical high schools) but also within comprehensive high schools (typical high schools with residential assignments). More than half of students taking aligned multi-course sequences in CTE (called concentrators in Federal Perkins legislation) in the state are now in comprehensive high schools, underscoring the need to understand how CTE expansion affects students in these more common settings (Ecton & Dougherty, 2023).

While a growing body of quasi-experimental studies has shown that high school CTE programs can improve high school graduation and early labor market outcomes, much of the evidence comes from specialized CTE programs or schools, which often have selective admissions and unique resources (Bonilla, 2020; Brunner et al., 2023; Dougherty, 2018; Hemelt et al., 2019; Kemple et al., 2023). These findings, while insightful, may not fully capture the dynamics of CTE programs within comprehensive or traditional public high schools, where access and resources tend to be more limited. Moreover, the evidence on CTE's impact on postsecondary pathways remains limited and mixed. Earlier studies found traditional CTE programs—typically not aligned with college pathways—boost workforce outcomes (Bishop & Mane, 2004) and, to a lesser extent, 2-year college enrollment (Cellini, 2006). More recent research suggests that college-related impacts depend on whether programs are aligned with careers requiring postsecondary education or offer dual enrollment or credentialing opportunities (Ecton & Dougherty, 2023; Edmunds et al., 2024; Hemelt et al., 2019; Kemple et al., 2023). However, the extent to which observed benefits are driven by selection bias remains an open question, reinforcing the need for causal evidence from more typical educational settings.

This study addresses this gap by providing the first known causal evidence of the impact of state-approved CTE program expansion in comprehensive high schools on both students' program take-up and their postsecondary educational and workforce outcomes. Using longitudinal administrative data from the Massachusetts Department of Elementary and Secondary Education (DESE), we leverage the staggered rollout of Chapter 74 programs across comprehensive high schools in Massachusetts. Our design compares the changes in outcomes between exposed and unexposed cohorts who attend schools newly offering a program and those in schools not-yet offering it. Our approach builds on empirical approaches from recent research on the effects of expanded program choices in non-CTE settings (De Philippis, 2021; Liu et al., 2024; Owen, 2024). Because treatment occurs at the school level, we focus on Intent-to-Treat (ITT) effects—capturing the average impact of exposure to a CTE-enhanced school environment on all students, regardless of whether they enroll in a program.[4] We also examine heterogeneity by student demographics and program career clusters, building on recent calls to explore variation in CTE impacts across subgroups (Brunner et al., 2023; Dougherty, 2018; Ecton & Dougherty, 2023; Stevens et al., 2019).

Our findings show that gaining access to a new Chapter 74 program increases participation by 11.5 percent, on average, among prior non-participants, with a larger effect of 16.9 percent for students whose first exposure to the new program began in 9th grade. While average impacts on postsecondary education are null or modestly negative—including a suggestive decline in 4-year college enrollment—exposure to these programs improves early labor market engagement, increasing the number of quarters with earnings by 0.45 (about 2 percent relative to the baseline) and initial post-high school earnings by 9 percent. These early gains, however, do not persist into longer-term wage increases by age 23.

Heterogeneity analyses reveal meaningful patterns masked by average effects. First, employment benefits are concentrated among students with disabilities (SWD) and

[4] Though treatment on the treated estimates could be produced, we are doubtful that such estimates would meet the exclusion restriction when using program adoption as an instrument for participation. Thus, we focus on the policy-relevant ITT.

underrepresented minority (URM: Black or Hispanic) students, with gains of 2.2 and 0.8 additional quarters worked, respectively. These groups, along with male students, also experience notable increases in initial earnings (up to 13.9 percent) while female students see no comparable effect. Second, student demographics do shape which career cluster programs students participate in. Male students are 2 to 20 times more likely to take-up IT, Transportation, Construction, and Manufacturing, Engineering, and Technology (MET) programs than female students, who are more likely to enroll in Education and Health Services programs. URM students disproportionately enroll in Health Services, and SWD more often take-up Transportation programs. Third, we find suggestive evidence that access to Education programs for female students and IT programs for URM students increases both 4-year college enrollment and any college completion by about 2 percentage points (roughly a 5 percent gain relative to the baseline). Finally, and consistent with other recent findings in specialized settings, early workforce benefits for SWD, URM students, and male students are concentrated in male-dominated, technical and skilled trades clusters, such as Construction, Transportation, and MET.

Taken together, our findings suggest that expanding state-approved CTE programs in comprehensive high schools can enhance early workforce outcomes overall, with especially strong benefits for male and minority students. Moreover, alignment between program cluster and student demographics appears crucial for maximizing both labor market and postsecondary education benefits. This study also provides evidence that diversifying CTE programs beyond traditional trades (e.g., Construction, Transportation) to include fields such as IT, Education, and Health Services may better support some students' transitions into college pathways. Our findings highlight areas for future research: the mechanisms underlying the lack of long-term earnings impacts, and how students sort into different career clusters in ways that contribute to gendered patterns in participation and outcomes.

This paper contributes to three literatures in education and economics. First, we contribute to a growing body of research on the impact of CTE expansion by providing causal evidence on school-level exposure effects in a generalizable setting. As cited above, prior studies have largely examined outcomes in CTE-dedicated schools, where participation is nearly universal and the effects of program exposure on non-participants cannot be meaningfully identified. In contrast, our study leverages a major state investment in CTE pathways within comprehensive high schools to estimate intent-to-treat effects—capturing how the availability of new programs affects the full student body, including those who may not directly participate. This design allows us to evaluate the broader impact of CTE expansion as a large-scale education policy, rather than as a selective intervention.

Second, we contribute to the literature on gender disparities in STEM pathways and labor market outcomes. Our findings are consistent with prior work documenting how gendered occupational choices are shaped by implicit stereotypes and structural constraints across K–12 and postsecondary settings (Buser et al., 2014; Cheryan et al., 2017; Kugler et al., 2021; Owen, 2023). We further show that this sorting contributes to differential returns from CTE, echoing earlier research that finds stronger labor market benefits for male students, particularly in male-dominated technical fields (Brunner et al., 2023; Dougherty & Ecton, 2021; Ecton & Dougherty, 2023; Hemelt et al., 2019; Kemple & Willner, 2008; Plasman et al., 2017).

Third, we contribute to human capital literature by examining the tradeoffs students may face between entering the workforce and pursuing longer-term postsecondary education. Consistent with previous studies highlighting tradeoffs not only between employment and continued schooling (Brunner et al., 2023; Hanushek et al., 2017; Krueger & Kumar, 2004) but also between two- and four-year college pathways (Bonilla & Sparks, 2025; Gurantz, 2020; House & Dell, 2020; Nguyen, 2020; Stevens et al., 2019), our findings suggest that CTE pathways can lead to short-term labor market gains while potentially reducing four-year college enrollment. These patterns underscore how program design and student sorting shape not only immediate outcomes, but also the sequencing and scope of human capital accumulation over time.

The rest of this paper is organized as follows. In the next section, we delve deeper into the context of CTE in Massachusetts. Section three outlines our data and explains how we restrict our sample. In section four, we describe how we define our measures, including the treatment variable and outcome variables of interest, and provide descriptive statistics. We then present our empirical strategies in section five, followed by the results of our main analysis, heterogeneity analysis, and robustness checks. In the last section, we conclude with a discussion of the results and their implications for future CTE research and policy.

CAREER AND TECHNICAL EDUCATION IN MASSACHUETTS

In Massachusetts, Career and Technical Education (CTE) is offered through two main types of programs: Chapter 74-approved programs (i.e., state-approved CTE programs, C74) and Perkins-only programs (i.e., Career Connections programs, N74). These programs differ notably in terms of their requirements, with Chapter 74 programs meeting state's higher standards and offering more rigorous learning opportunities. Chapter 74 programs include features such as 900 hours of immersive learning, co-operative education with local employers, and opportunities for students to earn industry-recognized credentials (DESE, 2024). While CTE was once primarily focused on preparing students for careers in skilled trades, Chapter 74 programs have diversified over the past few decades to include a broad range of sectors, such as Health Services, Information Technology (IT), Biotechnology, and Advanced Manufacturing.

Under federal policy, CTE programs are organized into 16 career clusters, which align educational offerings with national industry needs and include nearly 80 programs of study. In Massachusetts, Chapter 74 framework offers a subset of these national programs, with 44 programs organized into 11 industry clusters as of the 2024-2025 school year. These clusters not only reflect federal categories but are also tailored to meet specific local workforce needs, including fields like Biotechnology and Environmental Science.

In wall-to-wall CTE schools (historically known as regional vocational technical high schools), nearly all programs are Chapter 74-approved, ensuring students receive high-quality, industry-aligned training. These schools are often highly competitive, with limited spots available for students. In contrast, comprehensive high schools offer a mix of Chapter 74-approved and Perkins-only programs. However, recent expansions in CTE programs in these schools also have focused primarily on Chapter 74 offerings, reflecting the state's emphasis on improving CTE quality across all school settings.

Figure 1 shows that the proportion of comprehensive high schools offering at least one Chapter 74 program steadily increased over the decade, serving as the source of variation leveraged in this study. By the 2022–2023 school year, over 20 percent of comprehensive high schools in Massachusetts offered at least one Chapter 74 program. The number of Chapter 74 programs per school also grew during this period. Among schools offering at least one CTE program (either

Chapter 74 or Perkins), the average number of Chapter 74 programs per school increased from fewer than two in 2007–2008 to three in 2022–2023. The number of Perkins-only programs exhibited an opposite pattern, suggesting that schools not only open a brand-new Chapter 74 program but, in some cases, reauthorized existing Perkins-only programs as Chapter 74.

Launching a Chapter 74 program is far more than simply adding a new course. Schools must apply to the Massachusetts Department of Elementary and Secondary Education (DESE) for approval, submitting evidence of alignment with workforce needs, instructional capacity, and infrastructure readiness. Once approved, schools receive state funding to hire licensed teachers, purchase specialized equipment, and renovate or expand instructional space. These investments introduce structural changes to the school—new course sequences, adjusted scheduling, and the integration of technical instruction into the general academic framework. Given that program implementation reshapes the broader school environment, not just the experience of direct participants, we focus on intent-to-treat (ITT) effects: the average impact of program availability on all students, regardless of individual take-up.

DATA AND SAMPLE

Data

Our study uses administrative data from the Massachusetts Department of Elementary and Secondary Education. The primary dataset is the Student Information Management System (SIMS), which provides detailed information on each student by school year, including enrollment status, career and technical education participation, gender, race or ethnicity, and disability status. We merge this with Student Course Schedule (SCS) data to capture each student's Chapter 74 coursetaking records and the credits earned for completing specific courses. We also integrate the National Student Clearinghouse (NSC) data, which includes students' college enrollment and completion details, as well as earnings data reported by the Massachusetts Department of Labor through the Unemployment Insurance (UI) system. This combined dataset allows us to track individual student outcomes for up to 14 years after their expected high school graduation year as shown in Table A1.

Sample Restriction

We focus on high school students who began their 9th-grade in a public comprehensive high school between the 2005–2006 and 2019–2020 school years. We first exclude students without school identifiers in grade 9, as well as those who initially enrolled in regional vocational-technical high schools, private schools, special education programs, or other types of schools.[5] We next drop students from the 2005–2006 and 2006–2007 9th-grade cohorts who attended high schools lacking enrollment data in the first year we are able to track CTE course offerings at the school level. To further ensure the sample includes only comprehensive high schools, we also exclude students from schools where the maximum total enrollment across high school grades (within all cohorts) is fewer than 10 students.[6] Note that we use different ranges of cohorts across outcomes to ensure sufficient follow-up time for all students. For example, while we use the full range of cohorts for our CTE participation outcome, we restrict the sample to the 2005–2006 through 2014–2015 9th-grade cohorts for outcomes requiring at least five years of post-graduation follow-up (see Table

[5] We drop students enrolled in alternative (development center, learning center), adult school, K–8 only, hospital, and collaborative programs. Students who are out of state, in homeschooling or foreign exchange program are excluded as well. Our sequence of sample restrictions is presented in Appendix Table A2.

[6] Based on the results of a manual search for the schools dropped due to this restriction, most were K–8 schools that reported only a few high school-grade students.

A1).If a school already offered a Chapter 74 program in the first year of our data (the 2007–2008 school year), we cannot determine whether the program was newly launched that year or had been in place prior to it. Even if the program was indeed introduced in 2007–2008, it would appear in the data as being present from the outset, making it impossible to observe any pre-treatment period (i.e., these schools are considered "always treated"). To avoid this ambiguity, we exclude students enrolled in the 52 schools that already offered a Chapter 74 program in 2007–2008. After applying this restriction, our analytic sample consists of 740,097 students from 330 comprehensive high schools, as shown in Table A2.[7]

A potential threat to validity is the endogeneity driving from student self-selection—students can choose their high schools based on the availability of Chapter 74 programs. This creates the possibility that the observed effects of program exposure are confounded by the effects of school choice and sorting. To address this concern and test the robustness of our findings, we also report average treatment effects using only students who were unexpectedly exposed to the program—those who already chose their high school before the program was introduced.

Our main analytic sample, therefore, includes both unexpectedly and expectedly exposed (i.e., students who enrolled in a high school after the program was already available) cohorts in the treatment group, to preserve statistical power and capture potential long-term effects. In our robustness checks, however, we restrict the treatment group to only the unexpectedly exposed cohorts. Further details on the definition of our treatment variable are provided in the next section.

[7] Table A3 presents a comparison of summary statistics between the population, initial sample, and analytic sample for this main model.

MEASURES

Treatment: Exposure to Chapter 74 Program Offering

School-level Treatment

We first define a school-level treatment defined as the introduction of a new Chapter 74 program in a comprehensive high school. We construct this measure by identifying program opening years at the career cluster level which is indicated by the introduction of new course offerings based on the CIP (Classification of Instructional Programs) codes within each career cluster.[8] We can then aggregate across indicators of specific programs opening to define a treatment indicator for the opening of any Chapter 74 program.

The opening year for each new CIP code level program is defined as the earliest year a school reports enrollment of at least one high school student (grades 9 to 12) in the corresponding program. We then aggregate these CIP-level opening years at the career cluster level, using the earliest opening year among all CIP codes within a cluster. Based on this, we classify schools into three categories: never treated, eventually treated, and always treated.

For example, in the Health Services career cluster, there are three distinct CIP-level programs, each identified by a unique CIP code. If none of these programs were offered between the 2007–2008 and 2022–2023 school years of our data range, the school's health cluster is classified as never treated. If at least one program was available from the start (2007–2008), the school is

[8] We present a list of Chapter 74 programs for each career cluster along with their corresponding CIP codes in Table A4.

classified as always treated. Schools that introduced at least one program between the 2008–2009 and 2022–2023 school years are classified as eventually treated. For these schools, the opening year of the health career cluster Chapter 74 program is determined by the earliest opening year of any of the three programs.

Note that the opening year for any Chapter 74 program at a school is defined as the earliest opening year among any of the eleven career clusters.[9] Among the 382 unique comprehensive high schools in our initial sample, 52 schools always offered a Chapter 74 program, 278 schools never offered one during our data range, and 52 schools eventually introduced a program (i.e., treated schools). Figure 2 maps the geographic distribution of these 52 treated schools across Massachusetts. They are spread across 30 public school districts and are relatively well distributed geographically. As shown in Table 1, these treated schools serve a disproportionately high share of students with disabilities and underrepresented minority (URM) students—specifically Black and Hispanic students. These student populations tend to have lower on-time high school graduation rates, are more likely to enroll in 2-year colleges and are less likely to enroll in 4-year colleges or complete any postsecondary degree. This group of students also exhibits higher earnings one year after high school graduation, although this advantage does not persist through age 23, which is likely explained by the entry into the workforce by students previously enrolled in college.

[9] In Table A5, we present details of the career cluster openings captured through this measure and the number of programs offered simultaneously. Among the 52 schools treated by any Chapter 74 program opening, an average of 1.44 career clusters were initially introduced at the same time, ranging from 1 to 5. The distribution of career clusters shows some focus on specific clusters, but no single cluster exceeds 18%. This suggests that the openings were fairly balanced, with no cluster being overly dominant in this measure.

Two Types of Offering: Brand-new and Conversion from Perkins-only

To test whether the estimated treatment effects are sensitive to how the program was introduced, we also divide the eventually treated group into two categories—brand-new openings and conversions from Perkins-only programs (i.e., previously existing programs reauthorized by the state as Chapter 74 programs)—and compare their effects as part of our robustness check. If a Perkins-only program with the matched CIP code existed prior to the introduction of Chapter 74 program, it is classified as a conversion; otherwise, it is considered a brand-new opening.[10]

For example, if School A introduced a Dental Assisting program in the Health Services cluster during the 2012–2013 school year and other programs in the cluster were introduced subsequently, School A is considered to have had a Chapter 74 health cluster program since 2012–2013 school year. If a Perkins-only program with the matched CIP-code existed before 2012–2013, the program's introduction is classified as a conversion.

School-cohort-level Treatment: Unexposed and Exposed cohorts

We construct a school-cohort-level treatment variable by merging school-level treatment defined above with individual student based on each student's first enrolled high school and 9th-grade entry cohort.[11] Our primary definition of treatment is the number of years a cohort was exposed to a Chapter 74 program during high school.

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[10] The matches between Chapter 74 and Perkins-only CIP codes, which are used to define the type of program openings, are also presented in Table A4.

[11] Among our analytic sample of 740,097 students, 71,472 (9.66 percent) transferred to another comprehensive high school during their high school years. Of these, 63,696 (8.61 percent) transferred once, 7,303 (0.99 percent) changed schools two times, and 473 (0.06 percent) switched schools every year throughout their four years of high school.

Continuing the example of School A, students in grade 9 (2012–2013 9th-grade cohort) to grade 12 (2009–2010 9th-grade cohort) when the Chapter 74 Health Services cluster program was first introduced in the 2012–2013 school year are considered unexpectedly exposed cohorts. The 2009–2010 cohort, being in 12th-grade at the time, had only one year of exposure and is assigned a value of 1. The 2012–2013 cohort, in 9th-grade at the time, is assigned a value of 4. Earlier cohorts are marked with 0 or a negative value, such as the 2008-2009 cohort and 2007–2008 cohort are marked with 0 and -1, respectively, indicating pre-exposure. This exposure timeline for School A is shown in Appendix Table A6. As outlined in the sample restriction section, cohorts that enrolled after the program was launched (expectedly exposed) are included in our main model (with values of 5 and higher), but excluded in our robustness check, following the approach of Liu et al. (2024), to mitigate potential bias from program-driven school selection.

Chapter 74 Participation

In the Student Information Management System (SIMS) dataset, participation in a Chapter 74 program is documented annually through CIP codes, which we aggregate to both career cluster and overall levels. We measure students' Chapter 74 participation by the number of years they completed a Chapter 74 program by high school graduation. For example, if a student participates in a Chapter 74 program within the Health Services cluster from grades 10 through 12, their health cluster Chapter 74 participation is recorded as 3 years.

Table 1 provides summary statistics of Chapter 74 participation, both overall and by groups of schools (categorized as never, eventually, and always offering Chapter 74 programs) and cohorts (unexposed, unexpectedly exposed, and expected), reflecting our treatment of program expansion. On average, students in our initial sample completed 0.177 years in any Chapter 74 program, equivalent to approximately 32 days out of a 180-day school year. Students in comprehensive high schools that always offered a Chapter 74 program had the highest average participation, at 0.606 years. Among students from schools that eventually introduced Chapter 74 programs (our primary group of interest), the unexpectedly exposed cohorts participated for an average of 0.095 years. Expected cohorts, who enrolled after these programs were established, had a longer average participation of 0.225 years, similar to the overall sample average.

To ensure the robustness of our main Chapter 74 participation measure and the first-stage estimates based on it, we also create an alternative credit-based measure using the Student Course Schedule (SCS) data. This dataset provides each student's course-taking records and credits earned for individual courses. As with the construction of our year-based measure, we aggregate students' earned credits for each Chapter 74 course at both the career cluster and overall levels. This credit-based measure offers a more nuanced view of Chapter 74 participation by capturing greater variation in credits, but it is limited by the data range from the 2010–2011 9th-grade cohort. In Table A7, we report how our analytic sample aligns with this credit-based measure and compare the descriptive statistics of the two participation measures.[12]

Postsecondary Outcomes

To estimate the impact of Chapter 74 program expansion on students' postsecondary outcomes, we examine both educational and workforce measures. Educational outcomes include on-time high

[12] As shown in Table A7, across the 2010–2011 to 2019–2020 9th-grade cohorts, approximately 77 percent of students matched with at least three years of SCS course records. SIMS data indicates that about 8 percent of students ever participated in a Chapter 74 program, while SCS data shows a slightly lower participation rate of 5 percent. Our robustness check using this credit-based measure focuses on the 2010–2011 to 2019–2020 9th-grade cohorts with at least three years of SCS records and summary statistics for this sample are presented in Table A3.

school graduation, which is defined as graduating within four years of initial enrollment, enrollment in 2-year and 4-year colleges, and completion of any college. All educational measures are binary.

Workforce outcomes are measured through the number of quarters with earnings, initial earnings (observed one year after high school graduation), and earnings at age 23 (five years post-graduation). Earnings at age 23 are used as this point typically aligns with students entering the job market if they attend a 4-year college. Earnings data are aggregated from quarterly to annual figures, adjusted to 2010-dollar values for consistency, and log transformed.

Earnings data from Unemployment Insurance (UI) records include only taxable wages from non-federal employment in Massachusetts eligible for unemployment benefits. This means that earnings are not captured for individuals who move out of state, are self-employed, or work in seasonal or contract positions, which could induce bias as suggested by Foote and Stange (2022).[13] Following their recommendations to mitigate migration-related bias, we first classify individuals with no reported earnings in a given year as non-earners (zero-earnings) and apply a log transformation to condition our sample on individuals with positive observed earnings. This approach not only reduces the bias but also improves the normality of the earnings variable and facilitates interpretation in terms of percent increase. Additionally, we compare differential rates

[13] We also observe a lower matching rate between the UI and SIMS datasets from the 2016 9th-grade cohort. To ensure the robustness of our main findings using the full set of cohorts from 2006 through 2019, we conduct a sensitivity analysis restricting the sample to cohorts from 2006 to 2015. As shown in Figure A5, our estimates for log earnings 1-year after high school graduation remain robust to this restriction.

of matching with earning records between students in eventually-offered schools and never-offered schools.[14]

To address another potential bias arising from the exclusion of unemployed individuals and to further isolate the impact on students' employment apart from earnings, we also focus on the number of quarters with earnings—calculated by counting quarters with non-zero earnings within our data range. Further, we validate our log earning models by using the alternative measure of untransformed real dollar earnings.

Table 2 shows the representation of postsecondary pathways by CTE participation status. Compared to the full sample, Chapter 74 participants are less likely to enroll in a four-year college and more likely to enroll in a two-year college or enter the labor market directly after high school. Among Chapter 74 participants, 37 percent enroll in a four-year college, 19 percent in a two-year college, and 17 percent enter the labor force directly. Notably, 27 percent have no record of either postsecondary enrollment or in-state formal earnings one-year after graduation. This rate of non-coverage is higher than that observed among both non-Chapter 74 CTE participants (21 percent) and non-CTE students (20 percent). The elevated rate of non-coverage among Chapter 74 participants likely reflects their higher rates of workforce entry, particularly into employment types not fully captured by administrative data—such as self-employment, out-of-state work, or informal

[14] For earnings measured one year after high school graduation, 39.20 percent of students in never-offered schools lack matching earnings records, 62 percent of whom have a college enrollment record. The unmatched rate is 45.96 percent in eventually-offered schools (34.7 percent enrolled in college) and 41.77 percent in always-offered schools (44.8 percent enrolled). These differences likely reflect variation in short-term postsecondary enrollment and limitations of administrative earnings data. By contrast, five years after graduation (age 23), when enrollment is less likely to affect earnings data, unmatched rates are more similar across groups: 33.42 percent for never-offered, 36.43 percent for eventually-offered, and 33.89 percent for always-offered schools.

sectors. Accordingly, the 17 percent estimate for direct labor market entry might understate the true figure.

Pathway selection varies across career clusters. Students in Chapter 74 programs focused on Education, Health Services, IT, Manufacturing, Engineering and Technology (MET), Arts and Communication Services (ACS), Business and Consumer Services (BCS), and Legal and Protective Services are notably more likely to pursue a four-year college pathway, with over 40 percent enrolling in such institutions—more than twice the rate observed in Construction and Transportation clusters, where only about 20 percent enroll in four-year colleges. Conversely, over 25 percent of students in the Construction and Transportation clusters enter the workforce directly after high school. These clusters also exhibit relatively high rates of students classified as pursuing neither postsecondary education nor formal earnings. In these cases, the prevalence of self-employment—especially in construction trades—may contribute to underreporting in administrative data. However, in other career clusters where self-employment is less common, higher rates of neither pathway are more likely to reflect actual postsecondary disengagement.

EMPIRICAL STRATEGY

Staggered Difference-in-Differences and Event Study

To estimate the impact of new program offerings on student take-up and postsecondary outcomes, we employ a staggered difference-in-differences (DID) approach. This method leverages the staggered roll-out of new programs in comprehensive high schools as a source of exogenous variation for cohorts already enrolled in high school before these programs were introduced. To capture both the immediate and dynamic impacts based on the length of exposure, we use event study models, focusing on outcomes such as the number of years a student completed in a Chapter 74 program (as a measure of participation) as well as the set of educational and workforce outcomes described above.[15]

Our models compare the changes in outcomes between exposed and unexposed cohorts of students between schools newly offering a Chapter 74 program (treatment group) and schools not-yet offering it (comparison group), while controlling for potential selection bias and endogeneity due to time-invariant school characteristics and time-varying cohort characteristics. First, high school fixed effects control characteristics such as overall school quality, teacher quality, and neighborhood factors, which might vary between schools across time and correlate with students' CTE participation and their postsecondary outcomes. The 9th-grade cohort fixed effects control for factors common to all students or schools in a given cohort, such as economic conditions, job market prospects, and state or federal policy changes.

Within this framework, we ensure the validity of our models by relying on the staggered parallel trends assumption. This assumption posits that treated and comparison cohorts had similar trends in outcomes during the pre-treatment period and would have continued along the same trajectory in the absence of exposure to the new programs (Roth et al., 2023).

First-stage: Impact of Program Exposure on Take-up

The staggered nature of the treatment, across years and schools, explain our decision to use the Callaway & Sant' Anna (2021) estimator as our main approach to specifying our difference-in-

[15] Figure A1 presents descriptive trends in program participation and postsecondary outcomes by years of exposure among eventually treated schools. This figure is intended to illustrate how outcomes change with levels of exposure, prior to introducing comparisons with not-yet-treated schools in our causal estimation framework.

differences model.[16] We generate estimates by employing the *csdid* command with the *not-yet treated* option in Stata, which allows us to set our comparison group as schools that have not yet offered the program. Our event study model for estimating the first-stage impacts of program openings on student take-up is specified as follows:

$$C74\_Years_{isc} = Sch_s + Cohort_c + \emptyset_n \sum_{n=-5}^{7} (EventTime_{sc} = n) + \rho_{isc} \quad (1)$$

where $C74\_Years_{isc}$ is the first-stage outcome for student *i* in high school *s* and cohort *c*, representing the total number of years a student completed in each career cluster and overall Chapter 74 programs before high school graduation. Sch_s is the fixed effect for the high school where the student first enrolled, and $Cohort_c$ is the fixed effect for the 9th-grade cohort. ρ_{isc} is the error term, which is clustered at the first enrolled high school level. $EventTime_{sc}$ is a continuous variable indicating the duration of exposure to a new Chapter 74 program. Positive values represent post-offering cohorts, while negative and zero values represent pre-offering cohorts. A student in grade 12 during the first year of the offering would be coded as 1 (least exposed), while a student in grade 9 would be coded as 4 (fully exposed). Our coefficients of interest in this model are $\emptyset_n$, which represent the first-stage average treatment effects of program exposure on Chapter 74 take-up, for each cohort being exposed to *n* years to the program.

Intent-to-Treat (ITT): Impact of Program Exposure on Postsecondary Outcomes

[16] To ensure the robustness of our event-study findings, we also employ two alternative staggered DID estimators: the Sun & Abraham (2021) method and the traditional nonparametric two-way fixed effects (TWFE) approach.

Our event study model for estimating the intent-to-treat impacts of program openings on students' subsequent outcomes is specified as follows:

$$Y_{isc} = Sch_s + Cohort_c + \partial_n \sum_{n=-5}^{7} (EventTime_{sc} = n) + \tau_{isc} \quad (2)$$

where Y_{isc} is a set of outcome variables for student *i* in high school *s* and cohort *c*, covering a student's educational and workforce outcomes such as on-time high school graduation, college enrollment and completion, employment, and earnings. In this model, ∂_n estimates the intent-to-treat average treatment effects of program exposure on students' postsecondary outcomes, for each cohort being exposed to *n* years to the program.

Heterogeneity

Our analysis extends to exploring heterogeneities in the impact of Chapter 74 program exposure across different student demographics and program career clusters. Our intent is to understand potential differences in the effect of CTE participation by student demographics and program characteristics on subsequent outcomes, thus highlighting variation that contributes to aggregate impacts.

Student Demographics

We investigate how exposure to new Chapter 74 programs impacts differently by student's demographics, including gender (categorized as female and male), race/ethnicity (categorized as URM[17] and non-URM), and disability status. Figure A2 illustrates variations in the proportion of

[17] In this study, underrepresented minority (URM) includes Black/Hispanic students.

students who ever participated in a Chapter 74 program, highlighting differences based on these demographic characteristics. Overall, male students and those from historically marginalized groups, including URM students and students with disabilities (SWD), are more likely to participate in Chapter 74 programs compared to the overall average.

Notably, these patterns differ further by the career cluster of the program, emphasizing the importance of understanding the intersection between demographic characteristics and program career cluster. As shown in Panel (b), female students are more likely to participate in Health Services and Education programs, while male students are more represented in Information Technology (IT), Transportation, Construction, and Manufacturing, Engineering, and Technology (MET) programs. URM students most frequently enroll in Health Services, Hospitality & Tourism, and Business and Consumer Services (BCS) programs, while Construction and Transportation are the most common clusters among SWD students.

Program Career Clusters

We also examine heterogeneities in the impact of Chapter 74 program expansion across program career clusters. Both Massachusetts Chapter 74 and Federal Perkins V emphasize the alignment of CTE programs with workforce demands, leading to notable differences between newer and traditional technical education programs. Figure A3 and Table A8 illustrate the divergent trends in school participation across career clusters over the past decade. Specifically, clusters such as Education, Health Services, and Information Technology Services (IT) have seen significant growth, with over 5.4 percentage point increases in the share of schools offering these programs. This translates to about 20 additional comprehensive high schools introducing these clusters.

Conversely, Construction and Hospitality & Tourism have shown modest increases during the same period.

To ensure sufficient variation for robust analysis at both the school and cohort levels, we focus on career clusters that exhibited at least 3 percentage points increase in program availability between Spring 2008 and 2023. This threshold, representing an expansion in roughly 12 schools out of our initial sample of 382, allows us to capture meaningful variation in program uptake. Our final heterogeneity analysis, therefore, focuses on eight career clusters: 1) Education, 2) Health Services, 3) Information Technology (IT), 4) Transportation, 5) Manufacturing, Engineering, and Technology (MET), 6) Construction, 7) Art and Communication Services (ACS), and 8) Business and Consumer Services (BCS).

RESULTS

Average Effects

Panel (a) of Figure 3 shows that, on average, exposure to a new Chapter 74 program increases student participation by an additional 0.115 school years, equivalent to approximately 20 school days.[18] In other words, gaining access to the program induces 11.5 percent of prior non-participants (roughly 1 in 8 students) to take-up the program. Among students with full exposure (i.e., those in their 9th-grade year at the time of the program opening, or $t + 4$), take-up is even greater, increasing by 0.169 school years (approximately 30.4 days), or about 1 in 6 students.

[18] We calculate this based on an average of 180 days per school year.

However, program exposure does not appear to improve educational outcomes and may even reduce the likelihood of 4-year college enrollment. As shown in Panels (b) through (e), we find no statistically significant effects on 4-year high school graduation rates, 2-year college enrollment, and completion of any postsecondary certificate or degree. There is also suggestive evidence of a negative impact on 4-year college enrollment, with results indicating a reduction of approximately 4 percentage points (about 11 percent decline relative to the baseline rate of 35.8 percent).

In contrast to education outcomes, exposure to Chapter 74 programs does modestly increase early workforce outcomes. Panel (a) of Figure 4 shows that access to the program increases the number of quarters with earnings by 0.452 (about 2 percent increase relative to the baseline rate of 20.39 quarters), with gains concentrated among students who were fully exposed (i.e., from t+4 onward).[19] As shown in Panel (b), conditional on being employed, initial earnings (measured one year after high school graduation) increase by approximately 9 percent. However, these gains do not persist, as we find no statistically significant effect on earnings at age 23. Table A10 indicates that these results are robust to alternative earnings specification of real dollar values.

Our main results remain robust when the treatment group is restricted to only cohorts that could not have anticipated the change in offerings. While some effect sizes are slightly smaller and estimates less precise—particularly for the number of quarters with earnings—the overall pattern

[19] In the last two rows of Table 1, we compare the number of quarters with earnings during high school and after high school graduation through age 23 across our treatment groups to assess whether the modest increase in employment originates during high school or in the postsecondary period. Among students in eventually treated schools, unexposed cohorts worked an average of 1.16 quarters during high school, while unexpectedly exposed cohorts worked 1.65 quarters—an increase of about 42 percent. From high school graduation through age 23, unexposed cohorts worked an average of 11.33 quarters, compared to 13.54 quarters for unexpectedly exposed cohorts—about a 20 percent increase. While these are simple descriptive statistics rather than precise causal estimates, they suggest that employment gains occurred in both periods, with the increase more pronounced during high school.

of findings is consistent, as shown in Table A9. In Figure A4, we also show that estimates using two alternative staggered DID approaches, traditional two-way fixed effects and Sun & Abraham (2021), are statistically indistinguishable from our main results, further supporting the robustness of our findings.[20]

Heterogeneity

Student Demographics

In Table A11, we present event study estimates by student demographic group to explore whether average effects mask important heterogeneity. We do not observe significant differences in the impacts on program take-up, on-time high school graduation, or 2-year college enrollment across groups. While male students experience larger declines in 4-year college enrollment and college completion relative to the average and to female students, these differences are also not statistically significant.

However, in postsecondary workforce outcomes—particularly early employment outcomes, where we identified positive average effects—we observe meaningful heterogeneity by gender, race/ethnicity, and disability status. As shown in Figure 5, Chapter 74 program exposure increases the number of quarters with earnings by about 0.8 quarters for URM (Black or Hispanic) students and by approximately 2 quarters for students with disabilities (SWD). These gains are two to five times larger than the average effect. Conditional on employment, initial earnings increase by 13.9 percent for male students and by 17.5 percent for students with disabilities. However, even for

[20] Our preferred Callaway & Sant' Anna (2021) approach presents comparable estimates to these alternative approaches, especially the estimates from Sun & Abraham (2021), which also apply adjustments to improve the estimation of treatment effects in staggered treatment settings.

these subgroups, the earnings gains fade out by age 23, with no significant longer-term observed differences in earnings .

Program Career Clusters

In Table A12, we present average treatment effects representing the impact of exposure to each career cluster program opening on program take-up and postsecondary outcomes. For example, the cells under the row labeled "Education" and the column labeled "Female" reflects the impact of exposure to an Education Chapter 74 program on female students' take-up of the program and their postsecondary outcomes. This career cluster-level treatment reveals meaningful patterns: students' demographics do shape both which career cluster programs students participate in and the extent of their participation.

This variation is most pronounced by gender, as shown in Figure 6. Female students are more likely to enroll in Education and Health Services programs (Panels a and b), while male students are more likely to participate in IT, Manufacturing, Engineering and Technology (MET), Transportation, and Construction programs (Panels c through f).[21] In these clusters, gender gaps in program take-up are consistently large: male participation exceeds female participation by a factor of 2 to 20 in male-dominant fields, and vice versa for female-dominant fields. These gender differences are much less pronounced in Art and Communication Services (ACS) and Business and Consumer Services (BCS) clusters, which encompass a broader range of programs and may therefore contribute to more balanced gender participation patterns.

[21] As explained in the empirical strategy section, our models include school fixed effects and cohort fixed effects; therefore, this variation in program take-up across genders implies within-school sorting.

Heterogeneity across other demographic groups is more muted but still notable in some clusters. For example, exposure to a Transportation induces 2.2 percent of students with disabilities (SWD) to take-up the program—more than double the overall average of 1.1 percent. Similarly, 8.5 percent of URM students newly participate in Health Services programs following program exposure, compared to 4.4 percent of non-URM students.

This heterogeneity analysis also illustrates some positive impacts in postsecondary outcomes, particularly for female and URM students. As shown in Figure 7, female students exposed to Education programs and URM students exposed to IT programs experienced an increase in 4-year college enrollment of approximately 2 percentage points (5 percent increase relative to the baseline rate of 35.8 percent), as well as an increase in any college completion of about 2 percentage points (7 percent increase relative to the baseline of 29.06 percent).

These gains in college participation appear to come with expected short-term trade-offs in the labor market. One year after high school graduation, these groups experience a 7 percent decline in initial earnings, likely reflecting increased college enrollment. However, most of this earnings loss is recovered by age 23, at which point we observe a 4 percent increase in earnings, though this estimate is less precise. As reported in Table A2, although not statistically significant, these groups also experience a suggestive decline in 2-year college enrollment of approximately 1 to 2 percentage points—further implying the potential substitution effects between 2-year and 4-year college pathways. A similar but reversed pattern is observed among non-URM (mostly White) students exposed to MET programs: they experience a 1.3 percentage point increase in 2-year college enrollment, alongside a 4.4 percentage point decrease in 4-year college enrollment.

Early workforce benefits for students with disabilities, URM students, and male students are concentrated in technical and skilled trades training programs such as Construction, Transportation, and MET. Panel (a) in Figure 8 shows that students with disabilities experience a 1.2-quarter increase in the number of quarters with earnings after exposure to a new Construction program (a 5 percent increase relative to the baseline of 20.39 quarters). They show little to no gain following exposure to other cluster programs. As shown in Table A12, these students also experience a 9 percent increase in initial earnings following exposure to a Transportation program—a cluster in which they showed relatively higher take-up—although this estimate is not statistically significant. URM students also exhibit employment benefits after gaining access to a Transportation program, with an additional 0.8 quarters with earnings (Panel b).

Male students see pronounced gains in initial earnings (measured one year after high school graduation) following exposure to Transportation and MET programs, with increases of 6.9 and 5.8 percent, respectively (Panels c and d). They also experience an increase of about 9.1 percent after exposure to a Construction program, though this estimate is less statistically precise. These three clusters—Construction, Transportation, and MET—are all male-dominated in our take-up patterns (see Figure 6).

Some of these early workforce gains translate into longer-term earnings benefits by age 23, though we still observe trade-offs between early labor market benefits and college enrollment. As shown in Panels (e) and (f), students with disabilities (SWD) and URM students see about an 8 percent increase in earnings at age 23 following exposure to Construction programs. However, as reported in Table A12, they also experience declines in college enrollment, approximately a 2.5

percentage point decrease in 2-year college enrollment for URM students in 4-year college enrollment for SWD.

One additional notable pattern is that nearly all demographic groups, except URM students, experience significant long-term gains following exposure to Business and Consumer Services (BCS) programs, with approximately a 10 percent increase in earnings by age 23.

Robustness

First-stage: Credit-based Chapter 74 participation measure

In Table A13, we present the results based on an alternative measure of Chapter 74 program participation from the Student Course Schedule (SCS) data: the number of Chapter 74 credits completed before high school graduation. These results closely align with our main findings, which use our preferred measure of Chapter 74 participation—the total number of years completed in the program.

In this alternative specification, we find that gaining access to any Chapter 74 program leads students to complete an additional 0.7 credits in the program. Given that Massachusetts high school graduation requires a minimum of 24 credits over 4 years (roughly 6 credits per year), the 0.115 school years (or 20 school days) estimated in our main analysis translate to about 0.7 credits. This close alignment reinforces the validity of our main results, which we prefer to this course-taking measure because they cover a broader range of cohorts.

Two types of offering: Brand-new and conversion from Perkins-only

In Figure A6 and Table A14, we compare the effects of brand-new program openings with those that were conversions from Perkins-only programs, in which existing non-state approved programs were reauthorized as Chapter 74. As shown in Table A5, among our 52 comprehensive high schools that eventually introduced a Chapter 74 program across the eleven career clusters, 42 schools (80 percent) launched brand-new programs, while 10 schools (20 percent) converted existing Perkins-only programs into Chapter 74 offerings.

Figure A6 shows that the overall impact of Chapter 74 program exposure is largely consistent regardless of how the program was introduced. In Panels (f) through (h), we observe similar positive impacts on the number of quarters with earnings and on initial earnings, aligning closely with our main results.

However, we do find notable differences in program participation and educational outcomes between the two types of offerings. In cases where the program was converted from Perkins-only, meaning the school already offered a non-state-approved CTE program before upgrading it to Chapter 74, student take-up is substantially higher. In these cases, prior engagement with Perkins-only programs appears to translate smoothly into participation in the newly approved program. Specifically, conversions induce program take-up among approximately 27 percent of students who had not previously participated in Chapter 74 programs—substantially higher than the 6.7 percent induced by brand-new offerings, which is consistent with the main estimates.

Converted programs also lead to an increase in on-time high school graduation rates by 5 percentage points and show a less negative (almost null) impact on 4-year college enrollment, suggesting that students in these programs may benefit from greater continuity or familiarity with existing program structures.

Early adopters and late adopters

A limitation of our event study design—relying on an unbalanced panel with staggered treatment timing—is that later-year point estimates, particularly for longer-term outcomes, are based on different subsets of sample. Specifically, for schools that implemented Chapter 74 programs in the 2022 school year, we cannot observe outcomes for the expectedly exposed cohorts who entered high school in 2023 or later. As a result, later-year estimates increasingly reflect outcomes from early-adopting schools, which may differ systematically from late adopters.

To assess the sensitivity of our findings to this fact, we divide the treatment sample into two groups based on the program's implementation year. Schools that launched Chapter 74 programs between 2009 and 2015 are classified as early adopters (N = 22), while those that did so between 2016 and 2022 are classified as late adopters (N = 30).

As shown in Table A7, both groups exhibit broadly similar patterns, and our main findings on average effects remain consistent across key outcomes—including Chapter 74 participation, educational attainment, and workforce outcomes—with one notable exception: the number of quarters with earnings. We observe gains in employment duration among students in early-adopting schools, but not among those in late-adopting schools. This discrepancy may reflect differences in school or student characteristics, but is also likely driven by variation in data availability—specifically, the increase in the unmatched rate beginning with the 2016 9th-grade cohort (as noted in the Measures section) and the shorter follow-up periods for later cohorts. In other words, students in early-adopting schools can be tracked for a longer period post-graduation, allowing for more accurate identification of cumulative employment gains.

Finally, we note that estimates from early-adopter schools tend to be more precise, as reflected in narrower confidence intervals. For outcomes such as any college completion and log earnings at age 23, later-period estimates for late adopters are omitted from the analysis, as we restrict these outcomes to the 2006–2016 and 2015 9th-grade cohorts, respectively, to ensure sufficient follow-up time—at least five years post-graduation—for all students.

DISCUSSION & CONCLUSION

This paper provides the first causal evidence on the effects of state-approved CTE program expansion in the more generalizable context of comprehensive high schools. Leveraging the staggered rollout of Chapter 74 programs across Massachusetts, we estimate both the first-stage effects on student participation and the intent-to-treat (ITT) effects on a range of postsecondary and labor market outcomes. In doing so, we not only identify average impacts but also uncover substantial heterogeneity by student demographics and program content focus.

While the decision to adopt Chapter 74 programs is not random at the school level, our empirical design leverages cohort-level variation: students are often unexpectedly exposed to newly launched programs after enrolling in a school. This feature allows for internally valid causal estimates of program exposure. At the same time, our descriptive analyses show that program expansions are more likely to occur in schools serving higher proportions of Black and Hispanic students and located in lower-income districts. These contextual factors may partly explain why workforce gains are most pronounced among historically underserved students. Although this limits external validity to all U.S. schools, our findings provide relevant evidence for more typical, under-resourced school settings—where new CTE investments may have the greatest need and potential impact.

Our findings contribute to several ongoing academic and policy debates. First, we shed light on whether CTE offers a viable alternative to traditional four-year college pathways as a form of human capital development. On average, we find that access to Chapter 74 programs reduces four-year college enrollment but improves short-term labor market participation and early earnings. However, these earning gains begin to fade around five years after high school graduation, coinciding with the typical timing of 4-year college completion and the point at which returns to higher education begin to compound. As shown in Figure A8, the estimated effects are positive during the first four years but decline thereafter and become slightly negative by year ten—approximately age 27. This trajectory is consistent with previous studies on the tradeoffs of vocational education, which often finds that while specific job training or vocational programs boost short-term earnings, these benefits tend to diminish within five years (Oswald-Egg & Renold, 2021; Stenberg & Westerlund, 2015). Some studies even suggest that long-term effects may turn negative due to lower levels of educational attainment and weaker general skills (Forster & Bol, 2018; Hanushek et al., 2017; Ruhm, 1997).

Nonetheless, given that the earnings gains during the first four years after high school are nearly 10 percent—and the subsequent declines from years five to ten are smaller in magnitude—our results suggest that cumulative earnings through age 27 may still be higher for students exposed to Chapter 74 programs, even if these advantages may reverse in the longer term. In our accounting, we have not fully considered the college costs for students in the counterfactual, which are relevant to any net-benefit calculation, but that require a range of assumptions that we place outside the scope of this paper. The pattern we observe implies that for students who prioritize early entry into the workforce or face barriers to completing a four-year degree, high-quality CTE programs may provide a meaningful alternative pathway with short- to medium-run economic benefits. Taken together, our results suggest that while CTE may not substitute for the long-run returns of postsecondary education, it can provide substantial early-career value within a more diversified set of human capital pathways.

Second, our heterogeneity analysis underscores the importance of program alignment with student demographics and postsecondary pathways. Workforce benefits are particularly pronounced for male students and students with disabilities in Construction, Transportation, and MET (Manufacturing, Engineering, and Technology) clusters. In contrast, female and URM students experience postsecondary education gains through exposure to Education and IT programs. These findings highlight how student demographics interact with program design and labor market segmentation, reflecting broader dynamics of occupational sorting. They also raise key policy questions: How do students sort into programs in ways that reinforce or challenge existing disparities? And how can schools ensure that all students benefit equitably from CTE opportunities—regardless of the pathways they hope to pursue, whether college or workforce? Given the gendered and racialized patterns of take-up and the differentiated benefits across pathways, more proactive advising and inclusive program design may be necessary to avoid reproducing labor market inequalities.

Third, our null findings on on-time high school graduation and 2-year college enrollment diverge from results in more selective, CTE-dedicated school settings (Bonilla, 2020; Brunner et al., 2023; Cellini, 2006; Hemelt et al., 2019). Several features of our setting and research design may help explain these differences. First, prior studies often rely on regression discontinuity designs, which estimate local average treatment effects for students near admission cutoffs, whereas our models estimate average intent-to-treat effects for a broader and more heterogeneous population. Second, dedicated CTE schools often offer more intensive and specialized programming, stronger institutional linkages—that can include dual enrollment and credentialing pathways—and different peer environments than comprehensive high schools. Although the debate continues over whether increasing 2-year rather than 4-year college enrollment best serves students and the broader economy, recent studies of tuition-free community college initiatives (e.g., Bonilla & Sparks, 2025; Gurantz, 2020; Nguyen, 2020) point to the value of access and institutional coordination in shaping outcomes. Our findings extend this literature by offering new causal evidence from a more typical school context, emphasizing that pathway clarity may be a critical mechanism through which CTE expansion can maximize its postsecondary impact.

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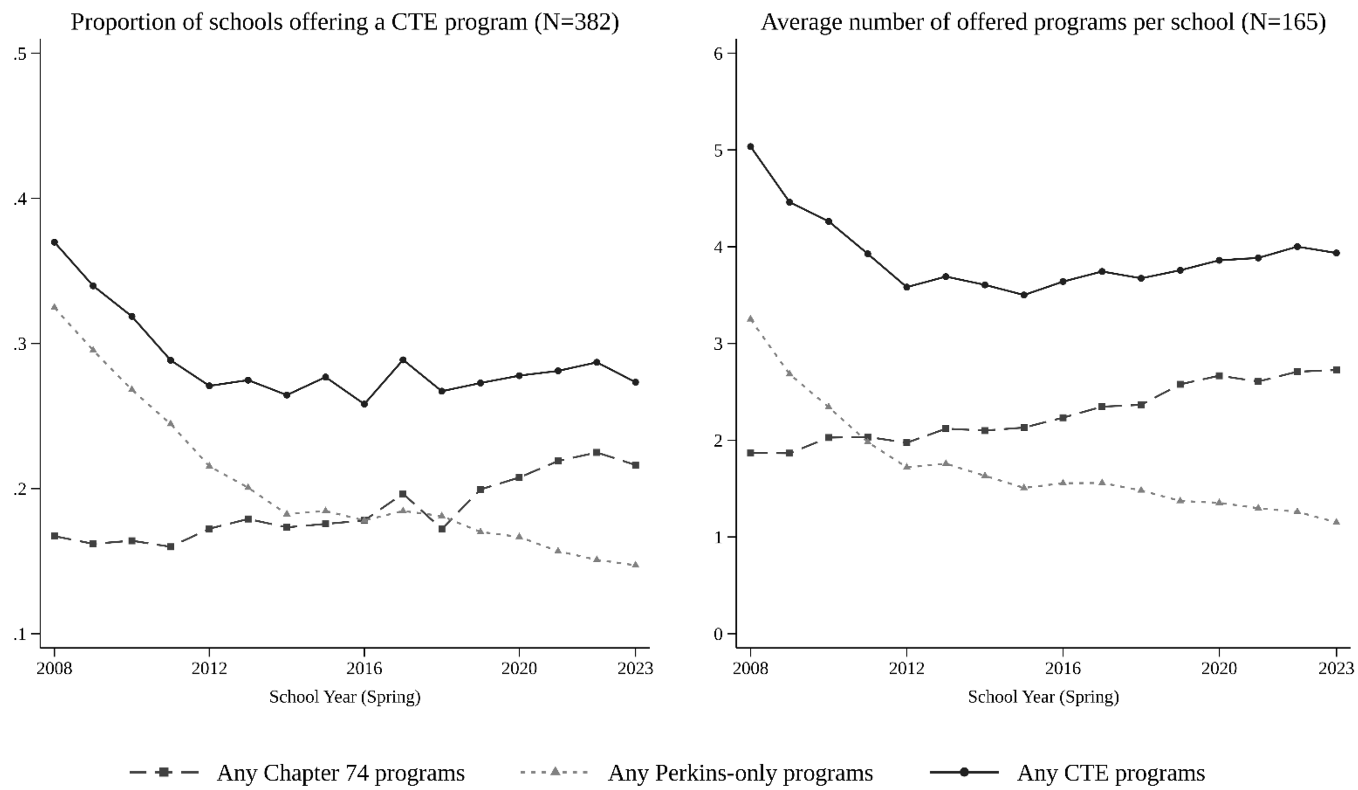
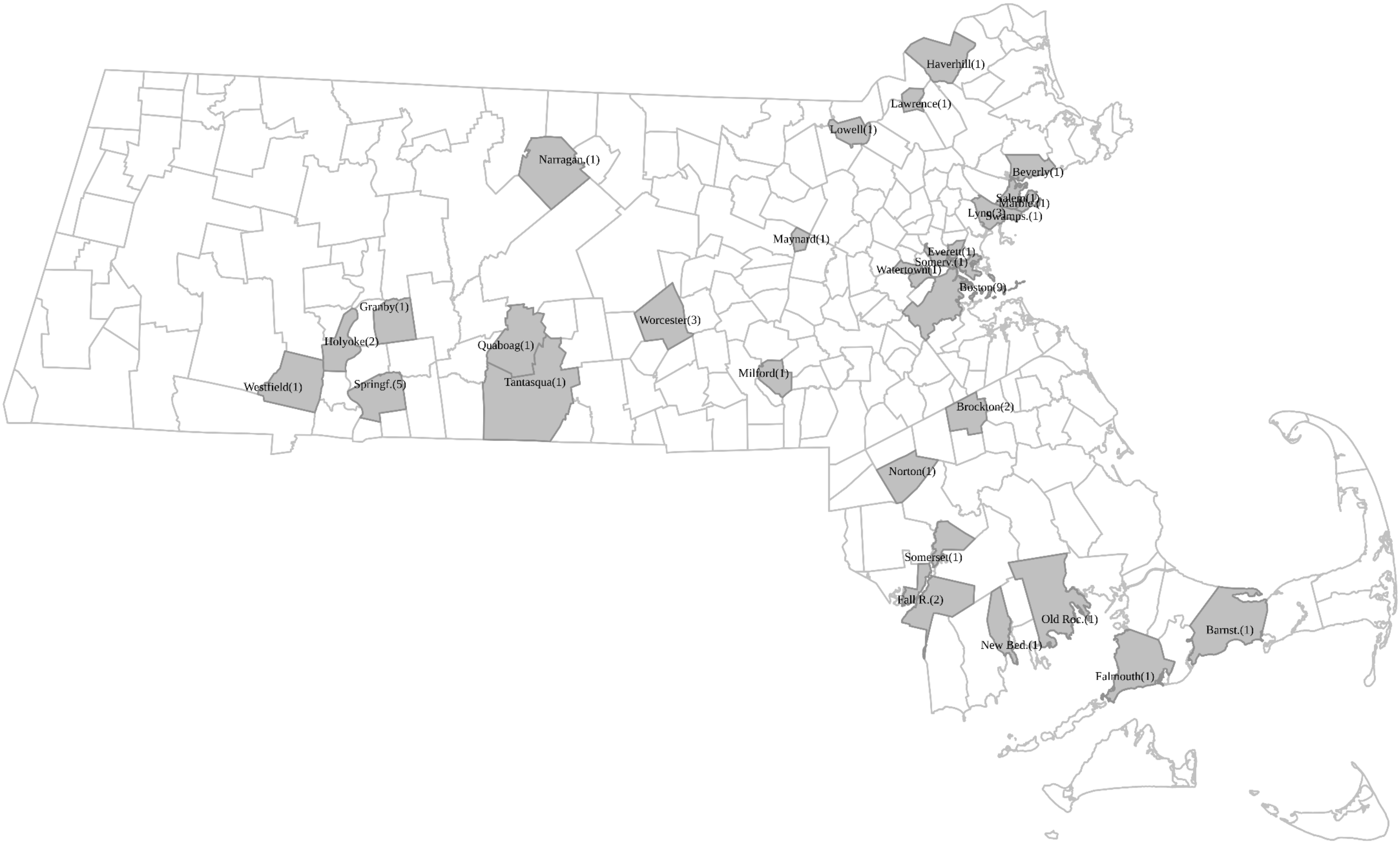
FIGURES & TABLES

Figure 1. Trends in CTE program offerings: Chapter 74 or Perkins-only.



Notes: This figure presents trends in CTE program offerings in Massachusetts comprehensive high schools in our dataset. The left panel shows the proportion of schools offering a CTE program from Spring 2008 through 2023. Each line represents the proportion of schools offering any Chapter 74 program, Perkins-only programs, and either type of CTE program among 382 comprehensive schools. The right panel shows the average number of CTE programs offered per school over the same period. The sample for this panel is restricted to schools that offered at least one CTE program at any point during the study period, resulting in a subset of 165 schools.

Figure 2. Public school districts with a comprehensive high school that eventually offered a Chapter 74 program.



Notes: This figure presents the geographic locations of public-school districts with at least one comprehensive high school that eventually offered a Chapter 74 program. A total of 52 eventually treated schools are located in 30 unique districts in Massachusetts. The number in parentheses next to each district name indicates the number of unique eventually treated schools in that district.

Table 1. Summary statistics by treatment groups.

	Never offered	Always offered	Eventually offered	Eventually offered: Unexposed	Unexpectedly	Expected	Total
N of schools (Cohort 2006–2020)	278	52	52		52		382
N of students (Cohort 2006–2020)	588,750	248,048	151,347	80,675	38,656	32,016	988,145
Female	0.501	0.485	0.486	0.493	0.485	0.479	0.495
Student with disabilities	0.151	0.179	0.186	0.169	0.184	0.206	0.163
Black	0.074	0.112	0.150	0.137	0.148	0.164	0.094
Hispanic	0.109	0.175	0.365	0.291	0.408	0.396	0.161
White	0.728	0.619	0.414	0.498	0.374	0.371	0.656
Asian	0.063	0.065	0.044	0.046	0.045	0.042	0.061
Average number of years completed Chapter 74 (SIMS)							
Any (11 career clusters)	0.019	0.606	0.116	0.027	0.095	0.225	0.177
Education	0.001	0.034	0.008	0.001	0.006	0.017	0.010
Health Services	0.001	0.055	0.030	0.002	0.021	0.067	0.018
IT	0.001	0.027	0.008	0.002	0.007	0.015	0.008
Transportation	0.002	0.06	0.006	0.004	0.004	0.011	0.017
MET	0.003	0.09	0.005	0.003	0.007	0.004	0.025
Construction	0.004	0.097	0.009	0.006	0.009	0.013	0.028
ACS	0.001	0.049	0.017	0.002	0.011	0.038	0.015
BCS	0.002	0.086	0.017	0.004	0.011	0.035	0.025
HS grad in 4 years	0.820	0.763	0.669	0.663	0.672	0.672	0.782
Cohort 2006–2019							
Enrolled in 2-year college	0.110	0.173	0.169	0.179	0.172	0.157	0.135
Enrolled in 4-year college	0.646	0.454	0.358	0.408	0.345	0.321	0.557
Cohort 2006–2016							
Completed in any college	0.549	0.389	0.291	0.337	0.271	0.264	0.473
Cohort 2006–2019							
N of quarters with earnings	22.507	24.272	20.392	26.487	19.392	15.296	23.093
Log: Initial earnings	7.852	8.115	8.217	8.036	8.264	8.352	7.956
Initial earnings ($)	2757.485	3380.521	3102.813	3270.06	3202.027	2836.351	2977.941
Cohort 2006–2015							
Log: Earnings at 23	9.380	9.335	9.281	9.277	9.253	9.312	9.354
Earnings at 23 ($)	13165.09	12112.67	10577.873	11362.81	10495.38	9875.43	12587.49
N of quarters with earnings : after graduation through age 23	11.484	12.132	11.894	11.326	13.541	14.115	11.706
N of quarters with earnings: during HS	1.483	1.350	1.294	1.160	1.648	1.922	1.422

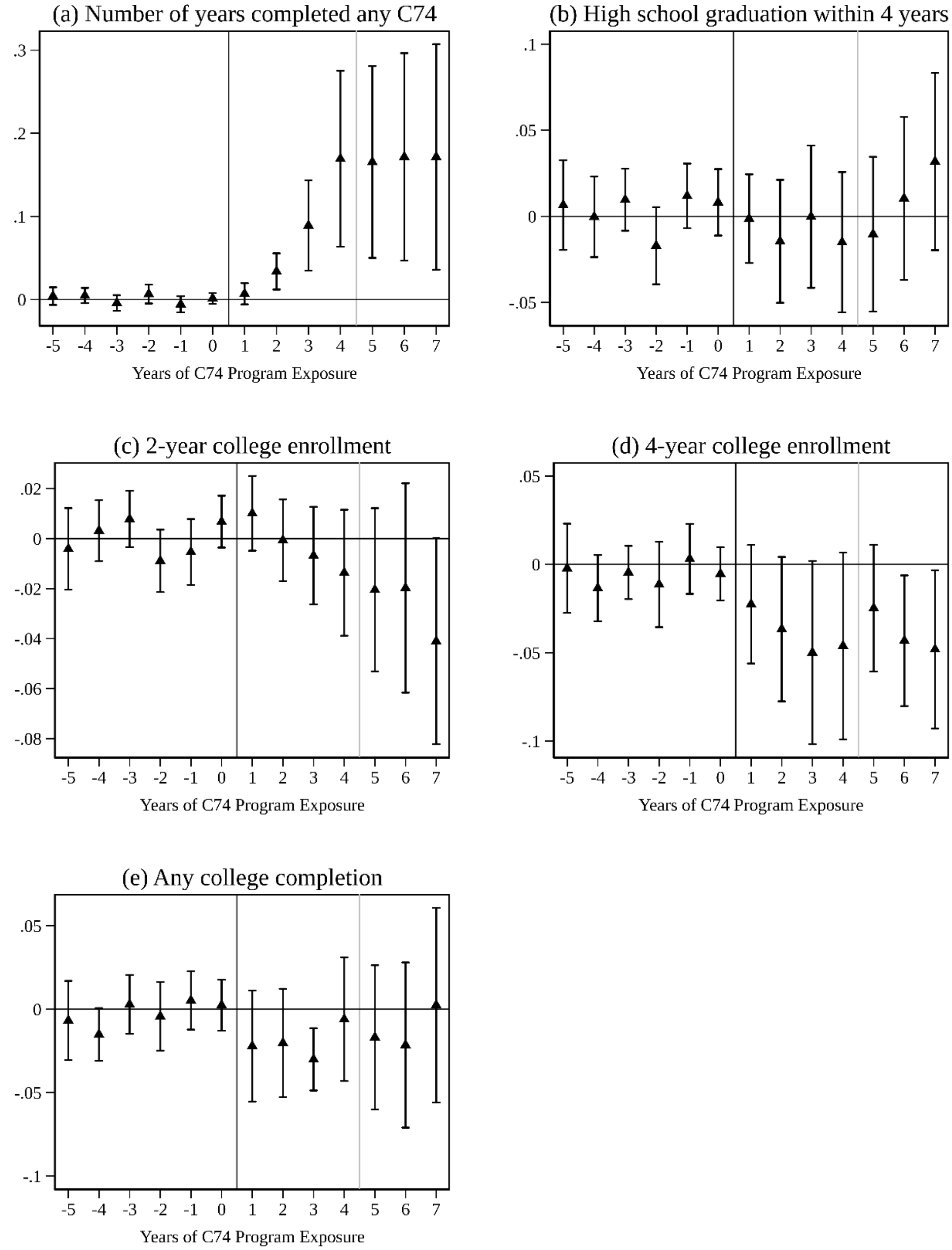
Notes: This table presents summary statistics for demographic characteristics and outcome variables overall and by groups of schools (never, eventually, or always offering a Chapter 74 program) and cohorts (unexposed, unexpectedly exposed, and expected), reflecting our treatment of program expansion. The initial sample includes 988,145 students from 382 unique comprehensive high schools. Note that students from "never offered" schools have a value above 0, as school grouping by treatment is based on each student's first enrolled high school and does not account for subsequent transfers. Appendix Table A2 details our sample restrictions to arrive at the initial and analytic samples, and Table A3 compares summary statistics across the population, initial sample, and analytic sample for our main model. Demographic characteristics are measured in 9th-grade.

Table 2. Postsecondary pathways of Chapter 74 participants.

	College		Work	Neither	N
	4-year	2-year			
Full Initial Sample	0.55	0.13	0.11	0.21	988,145
Not participated in any CTE program	0.48	0.19	0.13	0.20	78,355
Ever participated in a Perkins-only program (non-C74)	0.57	0.12	0.10	0.21	834,541
Ever participated in a Chapter 74 program					
Any (11 career clusters)	0.37	0.19	0.17	0.27	75,249
Education	0.48	0.22	0.10	0.19	4,728
Health Services	0.47	0.24	0.10	0.19	8,013
Information Technology Services (IT)	0.40	0.22	0.11	0.27	3,941
Transportation	0.19	0.17	0.27	0.37	7,365
Manufacturing, Engineering and Technology (MET)	0.41	0.18	0.16	0.25	10,758
Construction	0.21	0.15	0.25	0.38	11,158
Arts and Communication Services (ACS)	0.46	0.19	0.12	0.24	7,133
Business and Consumer Services (BCS)	0.44	0.19	0.14	0.23	12,845
Agriculture and Natural Resources (ANR)	0.33	0.20	0.19	0.27	3,637
Hospitality and Tourism	0.37	0.21	0.16	0.27	9,498
Legal and Protective Services	0.44	0.16	0.07	0.32	625

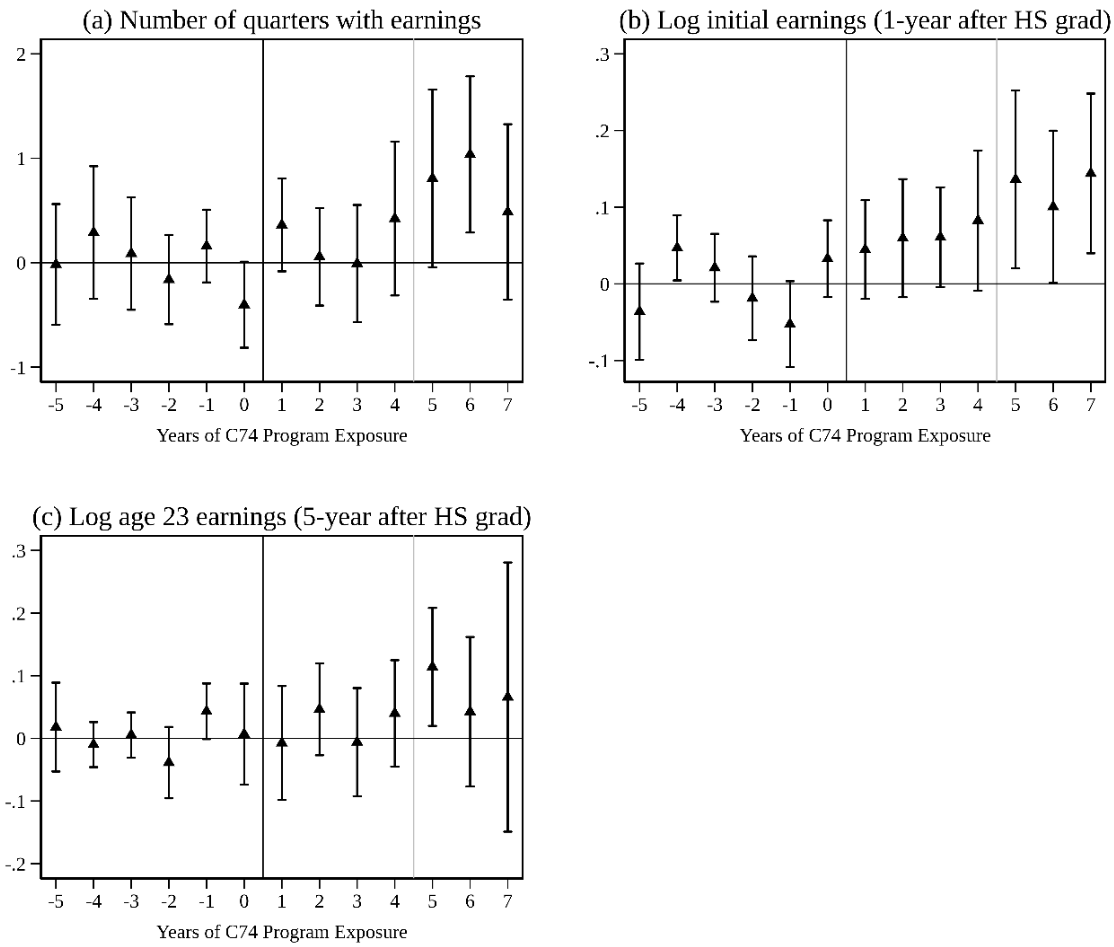
Notes: This table presents the distribution of postsecondary pathways selected by Chapter 74 program participants following high school graduation. The first two columns report the proportion of students enrolled in 4-year and 2-year colleges, respectively. The third column shows the share of students with earnings one year after graduation but without any college enrollment records. Note that our earnings data capture only non-federal employment within Massachusetts that is eligible for unemployment insurance benefits (see Measures section for details). The fourth column reports the proportion of students with neither college enrollment nor in-state employment records. This category includes not only students who pursue neither pathway but also those working out of state, self-employed individuals, and those in seasonal or contract-based positions—implying that our measure of workforce participation may underestimate true labor market activity.

Figure 3. Main results: Impact on Chapter 74 participation and educational outcomes.



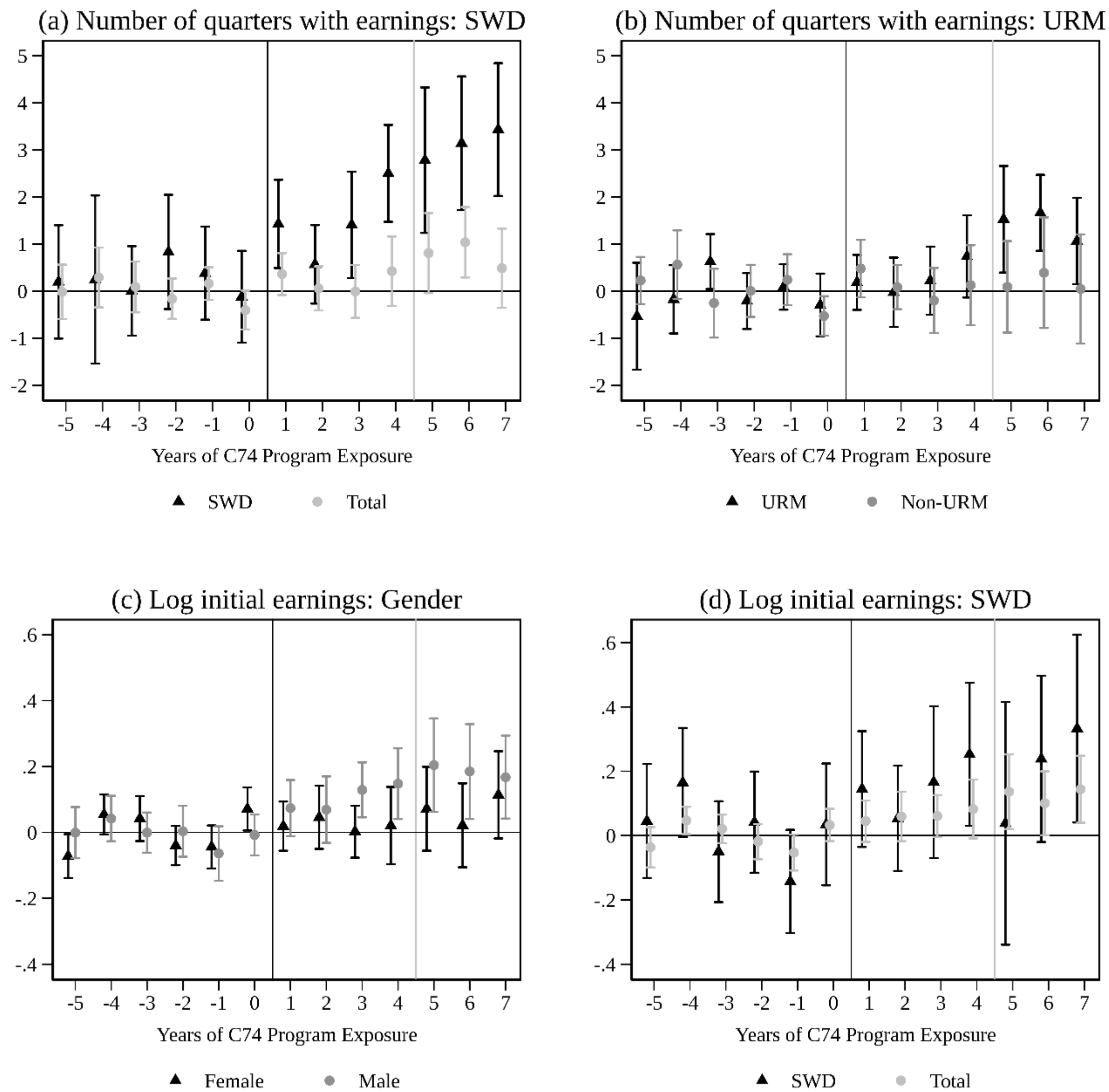
Notes: This set of figures presents event study estimates for each main model estimating the impact of exposure to any Chapter 74 program offering on students' take-up and postsecondary educational outcomes: Chapter 74 participation (a), on-time high school graduation (b), college enrollment (c and d), and any college degree completion (e). In each panel, estimates for 0 and negative exposure values represent unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly; 5 to 7: expectedly). Standard errors for the 95% confidence intervals are clustered at the first enrolled high school level. In Table A9, we report point estimates along with pre-average and post-average treatment effect estimates.

Figure 4. Main results: Impact on workforce outcomes.



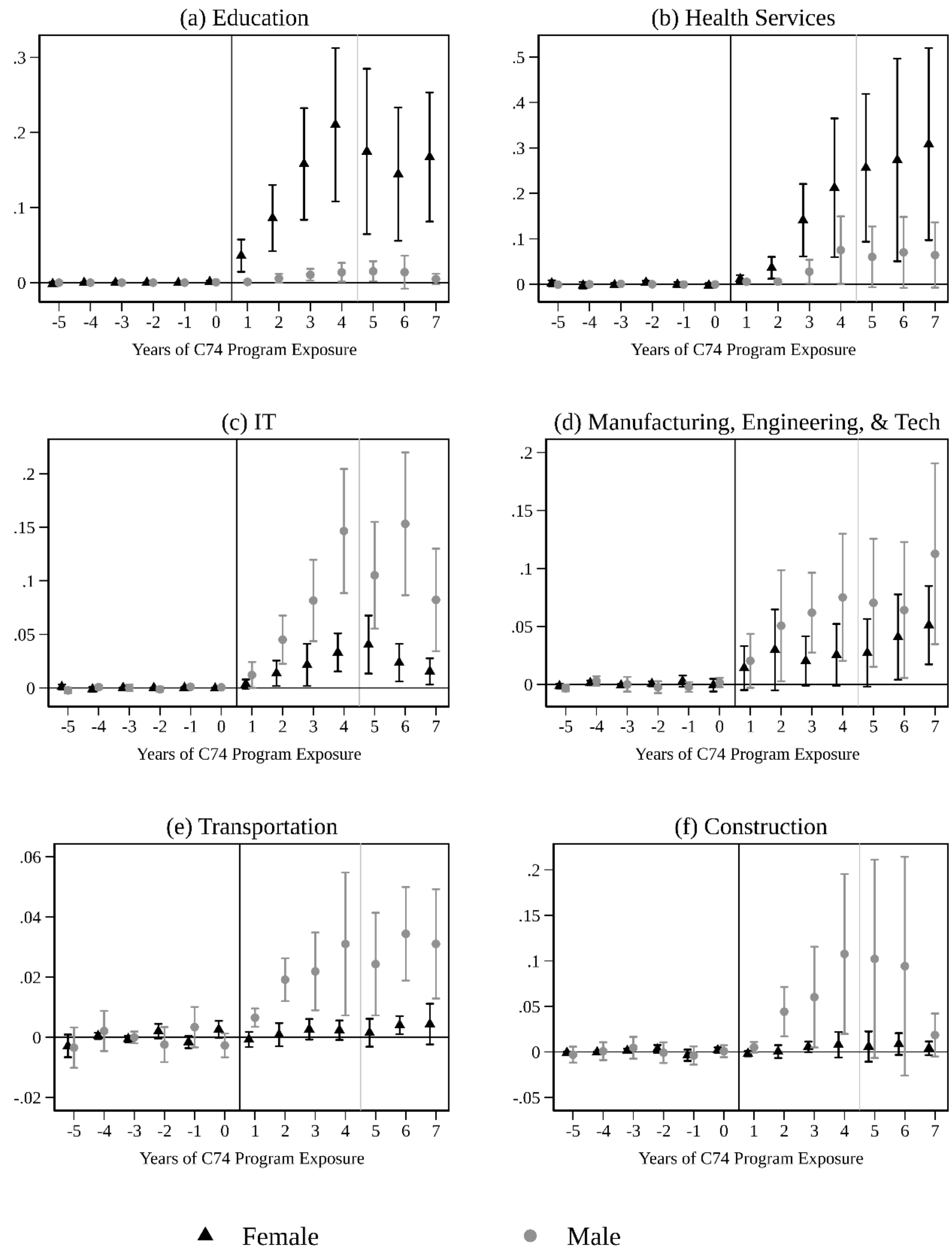
Notes: This set of figures presents event study estimates for each main model estimating the impact of exposure to any Chapter 74 program offering on students' postsecondary workforce outcomes: the number of quarters with earnings (a) and log earnings immediately after high school graduation (b) and at age 23 (c). In each panel, estimates for 0 and negative exposure values represent unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly; 5 to 7: expectedly). Standard errors for the 95% confidence intervals are clustered at the first enrolled high school level. In Table A9, we report point estimates along with pre-average and post-average treatment effect estimates.

Figure 5. Heterogeneity by student demographics: Impact on workforce outcomes.



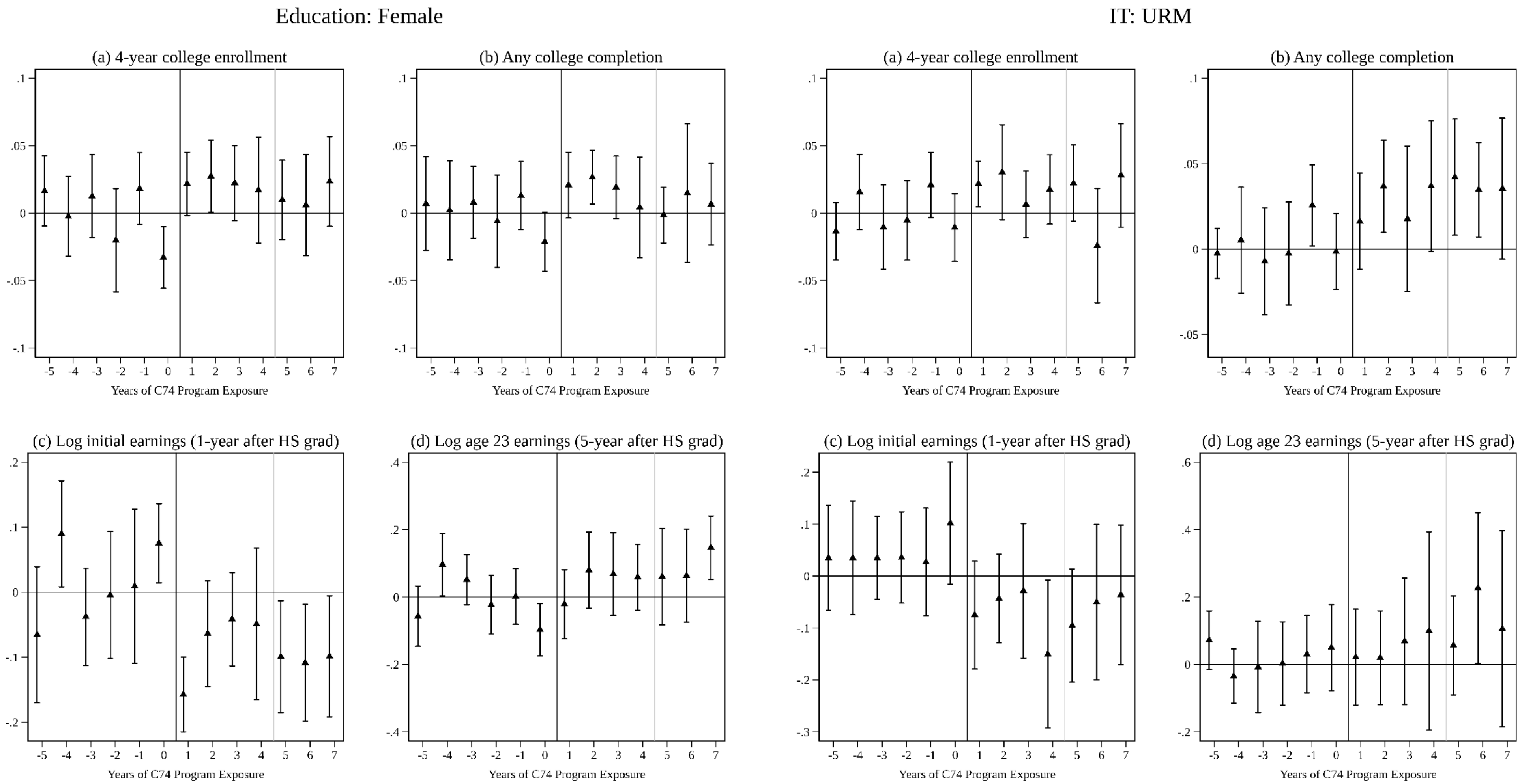
Notes: This set of figures presents heterogeneity in event study estimates capturing the impact of exposure to any Chapter 74 program offering on students' postsecondary workforce outcomes across student demographics. "SWD" refers to students with disabilities, "URM" refers to underrepresented minorities including Black and Hispanic students. "Non-URM" includes White, Asian, and other race/ethnicities. In each panel, estimates for 0 and negative exposure values represent unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly; 5 to 7: expectedly). Standard errors for the 95% confidence intervals are clustered at the first enrolled high school level. In Table A10, we report point estimates along with pre-average and post-average treatment effect estimates.

Figure 6. Heterogeneity by program career clusters and gender: Impact on program take-up.



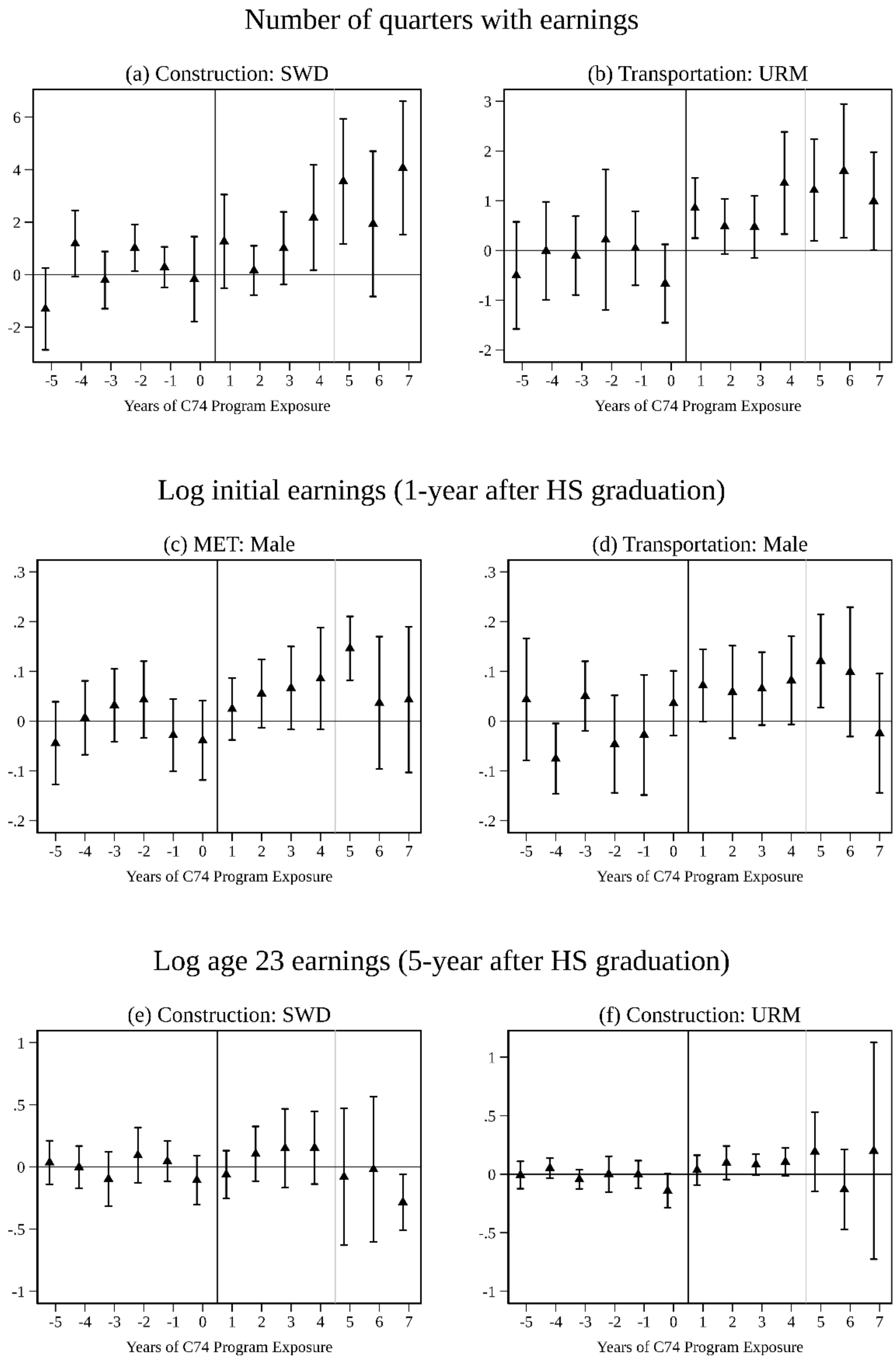
Notes: This set of figures presents event study estimates capturing the impact of exposure to each career cluster program on program take-up by gender. For example, in panel (a), gray markers and confidence intervals represent the impact of gaining access to an Education Chapter 74 program on male students' participation, while black markers represent female students. In each panel, estimates for zero and negative exposure values correspond to unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Standard errors for the 95% confidence intervals are clustered at the level of students' first enrolled high school. Corresponding pre-treatment and post-treatment average treatment effect estimates for each model are reported in Table A12.

Figure 7. Heterogeneity by program career clusters: Impacts on postsecondary college pathway.



Notes: This set of figures presents event study estimates capturing the impact of exposure to Education program for female students' postsecondary outcomes (left panel) and the impact of exposure to IT program for URM (Black or Hispanic) students' postsecondary outcomes (right panel). In each panel, estimates for zero and negative exposure values correspond to unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Standard errors for the 95% confidence intervals are clustered at the level of students' first enrolled high school. Corresponding pre-treatment and post-treatment average treatment effect estimates for each model are reported in Table A12.

Figure 8. Heterogeneity by program career clusters: Impacts on early workforce outcomes.



Notes: This set of figures presents event study estimates capturing the impact of exposure to Construction, Transportation, and Manufacturing, Engineering, and Technology (MET) programs on early workforce outcomes: the number of quarters with earnings (top panel) and log initial earnings (bottom panel). “SWD” refers to students with disabilities and “URM” refers to Black or Hispanic students. In each panel, estimates for zero and negative exposure values correspond to unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Standard errors for the 95% confidence intervals are clustered at the level of students’ first enrolled high school. Corresponding pre-treatment and post-treatment average treatment effect estimates for each model are reported in Table A12.

APPENDIX

Table A1. Data cohorts and observed outcomes.

		Included	9th-grade cohort (Fall-Spring)														
Outcomes	Source	Cohorts (Spring)	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
C74 completed years	SIMS	2006-2020	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
C74 credits	SCS	2011-2020	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●
HS graduation within 4yrs	SIMS	2006-2020	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2-year college enrollment	NCS	2006-2019	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
4-year college enrollment	NCS	2006-2019	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
Any college graduation	NCS	2006-2016	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○
Quarters of Earnings	UI	2006-2019	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
Initial Earnings (1 year after)	UI	2006-2019	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
Age 23 Earnings (5 years after)	UI	2006-2015	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
School Year																	
2005-06			HS1														
2006-07			HS2	HS1													
2007-08 (C74 Tracking)			HS3	HS2	HS1												
2008-09			HS4	HS3	HS2	HS1											
2009-10			PS1	HS4	HS3	HS2	HS1										
2010-11 (SCS Available)			PS2	PS1	HS4	HS3	HS2	HS1									
2011-12			PS3	PS2	PS1	HS4	HS3	HS2	HS1								
2012-13			PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1							
2013-14			Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1						
2014-15				Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1					
2015-16					Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1				
2016-17						Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1			
2017-18							Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1		
2018-19								Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1	
2019-20									Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2	HS1
2020-21										Age23	PS4	PS3	PS2	PS1	HS4	HS3	HS2
2021-22											Age23	PS4	PS3	PS2	PS1	HS4	HS3
2022-23												Age23	PS4	PS3	PS2	PS1	HS4

Notes: The top section of this table specifies the data sources, and the range of 9th-grade cohorts included for each outcome. A filled circle indicates inclusion, while a blank circle indicates exclusion. The bottom section reports the expected high school grades and postsecondary trajectories for each 9th-grade cohort across the school years captured in our dataset. "HS" refers to high school years, and "PS" refers to postsecondary years. Our key treatment measure for Chapter 74 program offerings is available starting from the 2007–08 school year, while SCS data for Chapter 74 credits (used in a robustness test) is available from the 2010–11 school year.

Table A2. Sample restriction.

	Number of students	Number of schools
Total HS population : 9th-grade cohorts who enrolled high school from 2005–2006 through 2019–2020	**1,162,394**	**1,435**
Drop students who initially enrolled in private, collaborative programs, out-of-state programs, or foreign exchange programs	1,145,656	898
Drop students who initially enrolled in Regional Vocational Technical high schools (i.e. wall-to-wall CTE schools)	1,018,553	862
Drop students who initially enrolled in special education-only, alternative, adult school, K8 only, hospital, or homeschooling programs—using school name	990,865	557
Drop 2005–2006 and 2006–2007 9th-grade cohort students whose first HS lacks enrollment data from the SY 2007–2008	988,968	548
Drop students from schools where the maximum total number of high school grade students across all cohorts is fewer than 10—most of those schools are K–8 (didn't identified in previous steps) **[Initial Sample]**	**988,145**	**382**
By each career cluster model: example of any Chapter 74 program model		
Drop students who enrolled in HSs that already offered any Chapter 74 program in the 2007–2008 school year (i.e. always treated group) **[Analytic Sample: Main]**	**740,097**	**330**
Drop expected cohort students who enrolled in a HS after the school first began offering a Chapter 74 program **[Analytic Sample: Robust]**	708,081	330

Notes: This table shows the number of observations and schools that remain after applying additional sample restrictions. The first row (in bold) reports the full population of 9th-grade cohorts from the 2006 to 2020 spring school years in the SIMS dataset. The sixth row (also in bold) shows the initial analytic sample, restricted to students whose first enrolled school in 9th grade was a public comprehensive high school. For each model, we exclude students from schools that always offered a Chapter 74 program of interest throughout the period covered in our dataset. To further address potential selection bias—where students may choose their high schools based on the availability of Chapter 74 programs—we apply additional restrictions for our robustness checks.

Table A3. Summary statistics: HS population, initial sample, and analytic samples.

	(1) HS Population	(2) Initial Sample	(3) Analytic : Main	(4) Analytic : Robust	(5) Analytic : Credit
N (Cohort 2006~2020)	1,162,394	988,145	740,097	708,081	381,529
N of unique schools	1,435	382	330	330	320
Female	0.487	0.495	0.498	0.499	0.509
Student with disabilities	0.183	0.163	0.157	0.155	0.150
Black	0.089	0.094	0.089	0.085	0.085
Hispanic/Latino	0.168	0.161	0.157	0.146	0.149
White	0.660	0.656	0.669	0.682	0.666
Asian	0.055	0.061	0.059	0.060	0.070
Ever participated in Chapter 74					
Any (11 career clusters)	0.170	0.076	0.015	0.011	0.019
Education	0.007	0.005	0.001	0.001	0.001
Health Services	0.019	0.008	0.002	0.001	0.004
IT	0.009	0.004	0.001	0.001	0.001
Transportation	0.018	0.008	0.001	0.001	0.002
MET	0.026	0.011	0.001	0.001	0.002
Construction	0.036	0.011	0.002	0.002	0.002
ACS	0.015	0.007	0.002	0.001	0.003
BCS	0.023	0.013	0.002	0.002	0.003
HS grad in 4 years	0.779	0.783	0.789	0.794	0.926
N (Cohort 2006~2019)	1,085,905	923,405	690,935	665,803	339,397
Enrolled in 2-year college	0.145	0.135	0.123	0.122	0.119
Enrolled in 4-year college	0.520	0.557	0.591	0.602	0.658
N (Cohort 2006~2016)	853,494	725,593	540,348	528,836	224,454
Completed in any college	0.441	0.473	0.502	0.507	0.569
N (Cohort 2006~2019)	1,085,905	923,405	690,935	665,803	339,397
N of quarters with earnings	23.486	23.093	22.707	22.881	18.010
Log: Initial earnings	8.027	7.956	7.903	7.892	8.010
Initial earnings ($)	3218.1	2977.9	2842.5	2842.7	3144.4
N (Cohort 2006~2015)	776,322	659,832	490,541	482,647	191,753
Log: Earnings at 23	9.369	9.354	9.360	9.361	9.480
Earnings at 23 ($)	12735.9	12587.5	12751.3	12798.4	14355.2

Notes: This table compares summary statistics for demographic characteristics and key outcome variables across different sets of samples based on the sample restrictions outlined in Table A2: HS population (Column 1), initial sample (Column 2), analytic sample for our main analysis (Column 3), analytic sample for the robustness check excluding expectedly exposed cohorts (Column 4), and analytic sample using the SCS Chapter 74 credits measure (Column 5). The rows under "Ever participated in Chapter 74" display the proportion of students who ever participated in each career cluster's Chapter 74 program during high school. For the analytic sample using the credit measure (Column 5), as noted in the main text, we focus on the 2010–11 to 2019–20 9th-grade cohorts with at least three years of SCS records. This restriction excluded many cases, including schools that had adopted Chapter 74 programs in earlier years, resulting in differing sample characteristics compared to the other samples. Baseline demographic characteristics are measured in 9th grade and all the earnings measures are adjusted to 2010-dollar values.

Table A4. Chapter 74 Career and Technical Education programs in Massachusetts.

Career Clusters	Program Names		CIP codes	
	Chapter 74: 2023–2024 school year	Captured in this study	C74	Perkins
Agriculture and Natural Resources (ANR)	Agricultural Mechanics	Agricultural Mechanics	010201	0121
	Animal Science	Animal Science	010599	0159
	Environmental Science & Technology	Environmental Science & Technology	150507	1557
	Horticulture	Horticulture	010601	0161
	Veterinary Science			
Arts and Communication Services (ACS)	Design & Visual Communications	Design & Visual Communications	500401	5041
	Graphic Communications	Graphic Communications	100301	1031
	Radio & Television Broadcasting	Radio & Television Broadcasting	090701	0971
Business and Consumer Services (BCS)	Cosmetology	Cosmetology	120401	1241
	Fashion Technology	Fashion Technology	500407	5047
	Marketing	Marketing	190203	1923
	Business Technology	Business Technology	520407	5247
Construction	Cabinetmaking	Cabinetmaking	480703	4873
	Carpentry	Carpentry	460201	4621
	Construction Craft Laborer	Construction Craft Laborer	469999	4699
	Building/Property Maintenance	Building/Property Maintenance	460401	4641
	Heating/Ventilation/Air Conditioning/Refrigeration	Heating/Ventilation/Air Conditioning/Refrigeration	470201	4721
	Masonry & Tile Setting	Masonry & Tile Setting	460101	4611
	Painting & Design Technologies	Painting & Design Technologies	460408	4648
	Sheet Metalworking	Sheet Metalworking	480506	4856
	Electricity	Electricity	460302	
	Plumbing	Plumbing	460503	
Education	Early Education and Care	Early Education and Care	131210	1320
Health Services	Dental Assisting	Dental Assisting	510601	5161
	Health Assisting	Health Assisting	510000	5100
	Medical Assisting	Medical Assisting	510801	5181
Hospitality and Tourism	Culinary Arts	Culinary Arts	120500	1250
	Hospitality Management	Hospitality Management	520901	5291
Information Technology Services (IT)	Information Support Services & Networking	Information Support Services & Networking	110401	1141
	Programming & Web Development	Programming & Web Development	110201	1121
Legal and Protective Services	Criminal Justice	Criminal Justice	430107	4300

Table A4 (Continued). Chapter 74 Career and Technical Education programs in Massachusetts.

Career Clusters	Program Names		CIP codes	
	Chapter 74: 2023–2024 school year	Captured in this study	C74	Perkins
Manufacturing, Engineering and Technology (MET)	Biotechnology	Biotechnology	150401	1541
	Drafting	Drafting	151301	1531
	Electronics	Electronics	150303	1533
	Engineering Technology	Engineering Technology	150000	1500
	Advanced Manufacturing (C74=480510)	Machine Tool Technology	480501	4851
	Metal Fabrication & Joining Technologies	Metal Fabrication & Joining Technologies	480599	4859
	Robotics and Automation Technology	Robotics and Automation Technology	150403	1543
	Stationary Engineering	Stationary Engineering	479999	4799
	Telecommunications—Fiber Optics	Telecommunications—Fiber Optics	150305	1535
		Appliance Installation	470106	4716
Transportation	Automotive Collision Repair & Refinishing	Automotive Collision Repair & Refinishing	470603	4763
	Automotive Technology	Automotive Technology	470604	4764
	Diesel Technology	Diesel Technology	470605	4765
	Marine Service Technology	Marine Service Technology	470616	4761
	Power Equipment Technology	Power Equipment Technology	470606	4766
	Aviation Maintenance Technology		470607	

Notes: This table lists Chapter 74 programs for each career cluster, along with their corresponding Chapter 74 and Perkins-only CIP codes (right two columns), based on the SIMS Dataset Handbook Version 9.2 (DESE, 2018) and Version 31.1 (DESE, 2024). To compare the programs captured in our dataset with the most recent list of Chapter 74 programs in Massachusetts, the second column reports the program titles for the 2023–2024 school year (DESE, 2024).

Table A5. Summary statistics of “Any Chapter 74 program opening” treatment measure.

	N of schools	N of program career clusters launched in opening year		
		Mean	Min	Max
Never treated	278	0	0	0
Always treated	52	1.44	1	9
Eventually treated	52	4.02	1	5
Total	382	0.74	0	9

Among Eventually treated schools

By opening school year

School Year (Spring)	N of schools	Percent (%)	Brand-new	Converted
2009	2	3.85	2	0
2010	3	5.77	2	0
2011	1	1.92	1	0
2012	5	9.62	4	1
2013	4	7.69	3	1
2014	1	1.92	1	0
2015	6	11.54	4	2
2016	2	3.85	2	0
2017	5	9.62	5	0
2018	1	1.92	1	0
2019	7	13.46	4	3
2020	2	3.85	1	1
2021	6	11.54	4	2
2022	7	13.46	7	0
Total	52	100.00	42	10

By opening career clusters

	All eventually treated schools (N=52)		Schools treated by one career cluster program opening (N=40)	
Career clusters	N of openings	Percent (%)	N of openings	Percent (%)
ANR	4	5.33	4	10.00
ACS	10	13.33	5	12.50
BCS	9	12.00	6	15.00
Construction	11	14.67	2	5.00
Education	5	6.67	3	7.50
Health	12	16.00	7	17.50
Law	0	0.00	0	0.00
Hospitality	8	10.67	3	7.50
IT	2	2.67	1	2.50
MET	5	6.67	3	7.50
Transportation	9	12.00	6	15.00
Total	75	100.00	40	100.00

Notes: This table provides details on our main treatment measure, "Any Chapter 74 program opening," which captures the earliest opening year among 11 career cluster programs. On average, the 52 always-treated schools already had 4.02 career cluster programs as of Spring 2008, ranging from 1 to 9. Among the 52 schools eventually treated by any Chapter 74 program opening, an average of 1.44 career clusters were initially introduced in the treatment year, ranging from 1 to 5. 40 of these 52 schools offered only one career cluster program at the time of treatment. The distribution of career clusters included in this measure shows some focus on specific clusters; however, no single cluster accounts for more than 18% of the openings. This indicates that the openings were relatively balanced, with no cluster being overly dominant in this measure.

Table A6. Exposure timeline for school A: First offering Health cluster program in SY 2012–13.

9th-grade cohort (Spring)	2006	2007	2008	2009	2010	2011	2012	**2013**	2014	2015	2016	2017
Treatment status	Unexposed				Exposed							
					Unexpectedly Exposed				Expectedly exposed			
$EventTime_{sc}$	-3	-2	-1	0	1	2	3	4	5	6	7	8
Main Model	Included				Included				Included			
Robustness Check	Included				Included				Excluded			

Notes: This table outlines the 9th-grade cohort exposure timeline for High School A, which first offered a Health Services cluster Chapter 74 program in the 2012–13 school year. The 2006–2009 9th-grade cohorts are classified as unexposed, as they likely graduated before the program was introduced. The 2010–2013 cohorts were unexpectedly exposed to the program, as it was first introduced while these students were already enrolled in the high school. These cohorts might not have anticipated the program's availability when selecting their school. For example, the 2010 cohort was in their senior year when the program began, giving them only one year of exposure (coded as 1), while the 2013 cohort, in grade 9 at the time of introduction, experienced the full four years of program exposure (coded as 4). The 2014–2017 cohorts were expectedly exposed to the program, as they enrolled in the school after the program's offering. For these cohorts, the program's availability may have influenced their decision to attend the school. To minimize potential selection bias arising from this issue, the expectedly exposed cohorts are excluded in our robustness check.

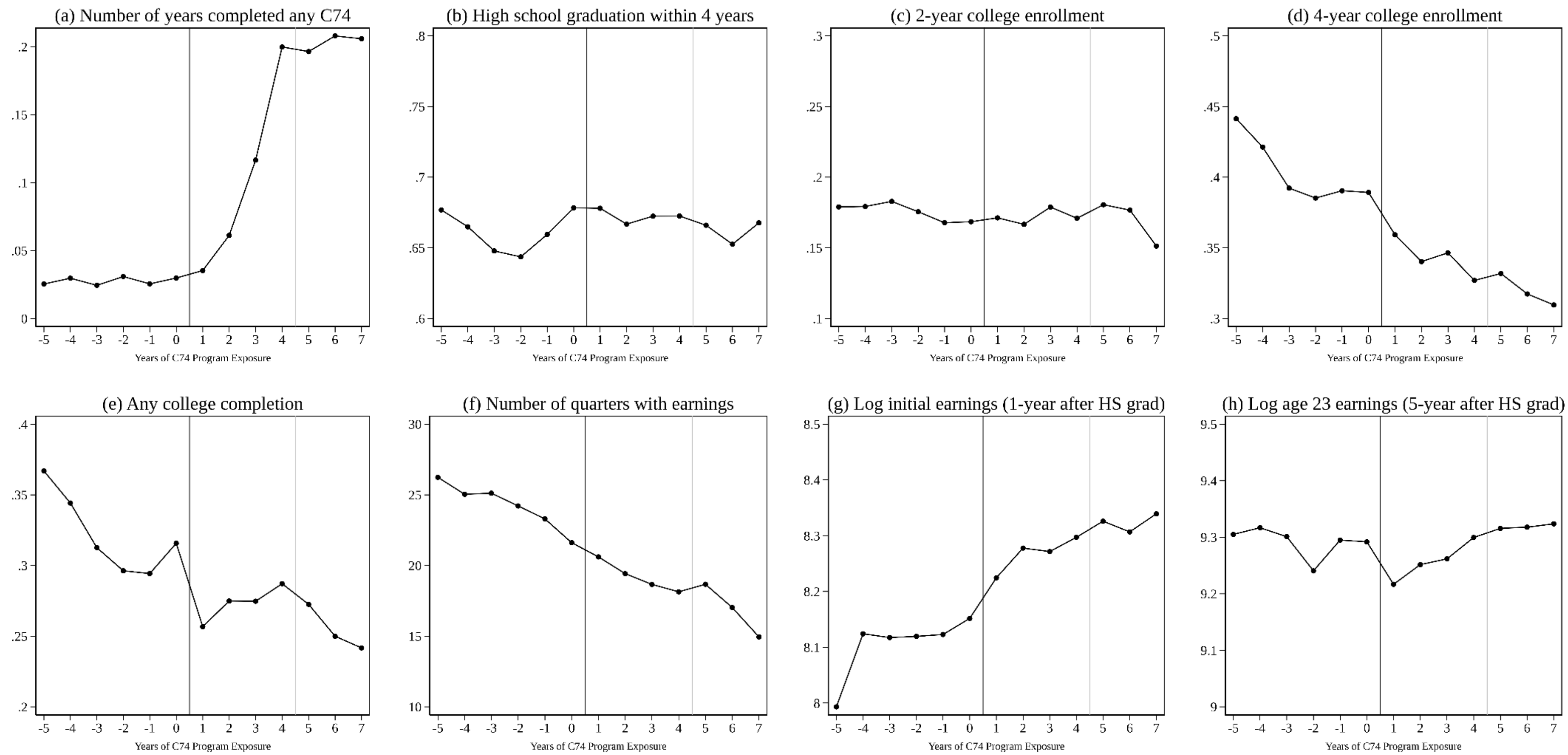
Table A7. Comparison between two Chapter 74 participation indicators from SIMS and SCS.

9th-grade cohort	Proportion of students by the number of years with SCS records					SIMS	SCS
(Spring)	0	1	2	3	4	Ever participated in C74	Ever reported C74 credit
2011	0.07	0.06	0.06	0.10	0.71	0.07	0.04
2012	0.06	0.05	0.06	0.12	0.71	0.07	0.04
2013	0.06	0.05	0.08	0.11	0.71	0.08	0.05
2014	0.06	0.08	0.09	0.19	0.59	0.08	0.05
2015	0.08	0.09	0.17	0.12	0.54	0.08	0.05
2016	0.07	0.14	0.13	0.11	0.54	0.08	0.05
2017	0.07	0.11	0.16	0.11	0.54	0.09	0.05
2018	0.06	0.04	0.11	0.22	0.57	0.09	0.06
2019	0.05	0.04	0.05	0.14	0.72	0.09	0.07
2020	0.04	0.05	0.05	0.07	0.79	0.09	0.07
Total	0.06	0.07	0.10	0.13	0.64	0.08	0.05

(Mean)	SIMS: Number of years completing Chapter 74		SCS: Chapter 74 credits	
	Including zero	Excluding zero	Including zero	Excluding zero
2011	0.17	2.35	0.65	15.13
2012	0.17	2.38	0.65	14.62
2013	0.17	2.27	0.63	13.79
2014	0.18	2.38	0.59	12.97
2015	0.19	2.34	0.48	10.06
2016	0.19	2.33	0.53	11.40
2017	0.20	2.33	0.68	13.21
2018	0.21	2.36	0.82	13.88
2019	0.23	2.46	1.00	15.15
2020	0.23	2.43	1.06	16.00
Total (SD)	0.19 (0.72)	2.36 (1.06)	0.71 (4.25)	13.75 (13.01)

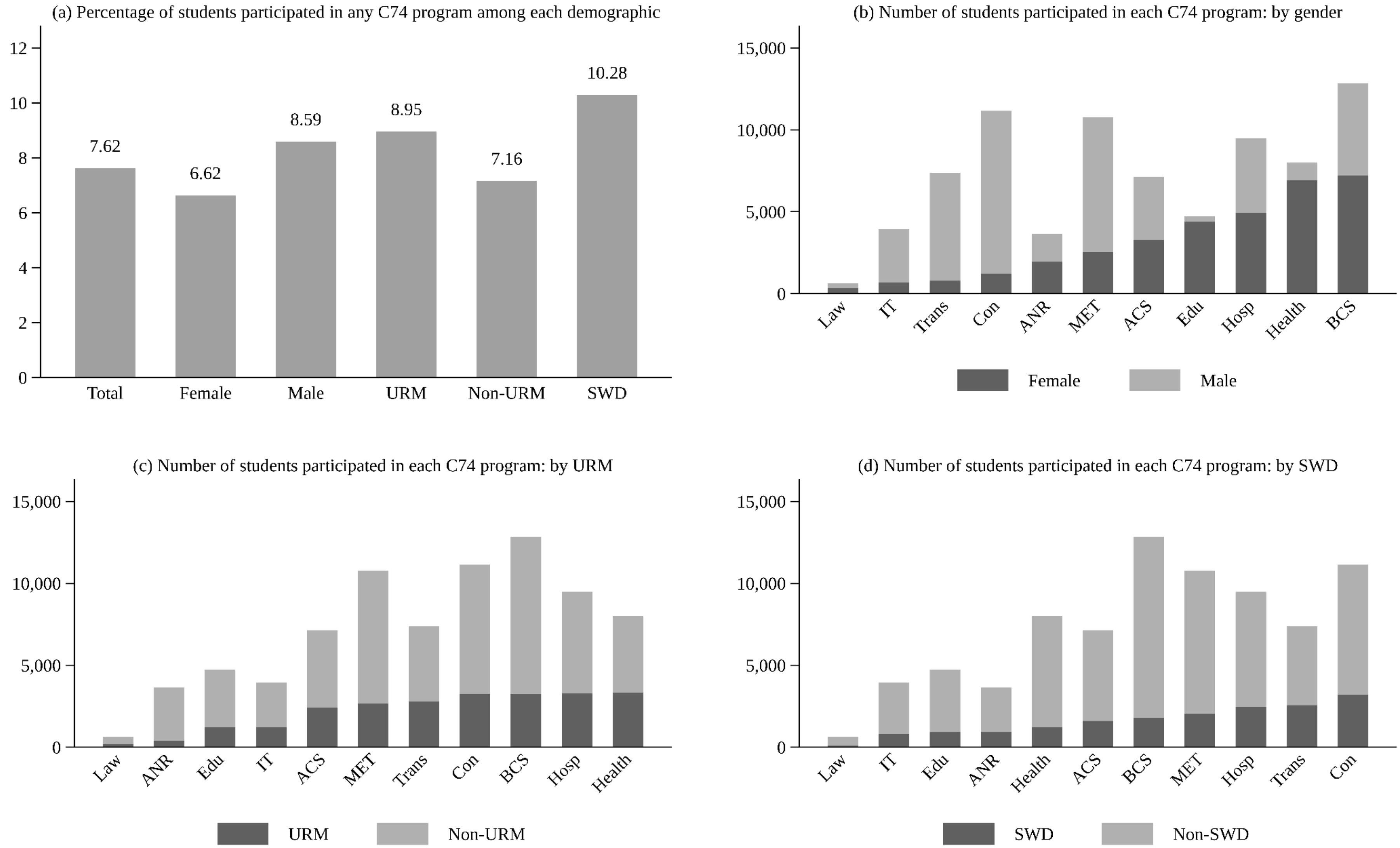
Notes: This table compares two measures of Chapter 74 participation: (a) the number of years completing a Chapter 74 program from the SIMS dataset and (b) completed Chapter 74 credits from the SCS dataset. The top left section of the table shows the proportion of students by the number of years with SCS records, matched to SIMS 9th-grade cohorts. For example, the first row (2011 cohort) in the column labeled "4" indicates that 71% of the 2011 9th-grade cohort in the SIMS dataset is matched with a full four years of SCS records. We observe that approximately 77% of SIMS students have at least three years of SCS records. While this indicates a less-than-perfect match between the two datasets, it is still reasonably robust. The top right section of the table compares how each measure captures Chapter 74 participation and their level of similarity. SIMS data indicates that about 8 percent of students ever participated in a Chapter 74 program, while SCS data shows a slightly lower participation rate of 5 percent, a difference of 3 percentage points. The bottom section of the table presents summary statistics (mean) for each measure. As the units differ, we observe greater variation in the credit-based measure. On average, Massachusetts high school students take about six credits per year. Given this, the average years of completing a Chapter 74 program (2.36 years) translates to approximately 14 credits, aligning closely with the mean number of credits for students who ever participated in a Chapter 74 program (13.75 credits in the column labeled “Excluding zero”). This alignment supports the use of credits as an alternative measure for robustness checks, despite the more limited sample size.

Figure A1. Descriptive trends in program participation and postsecondary outcomes by number of years of exposure to a new Chapter 74 program.



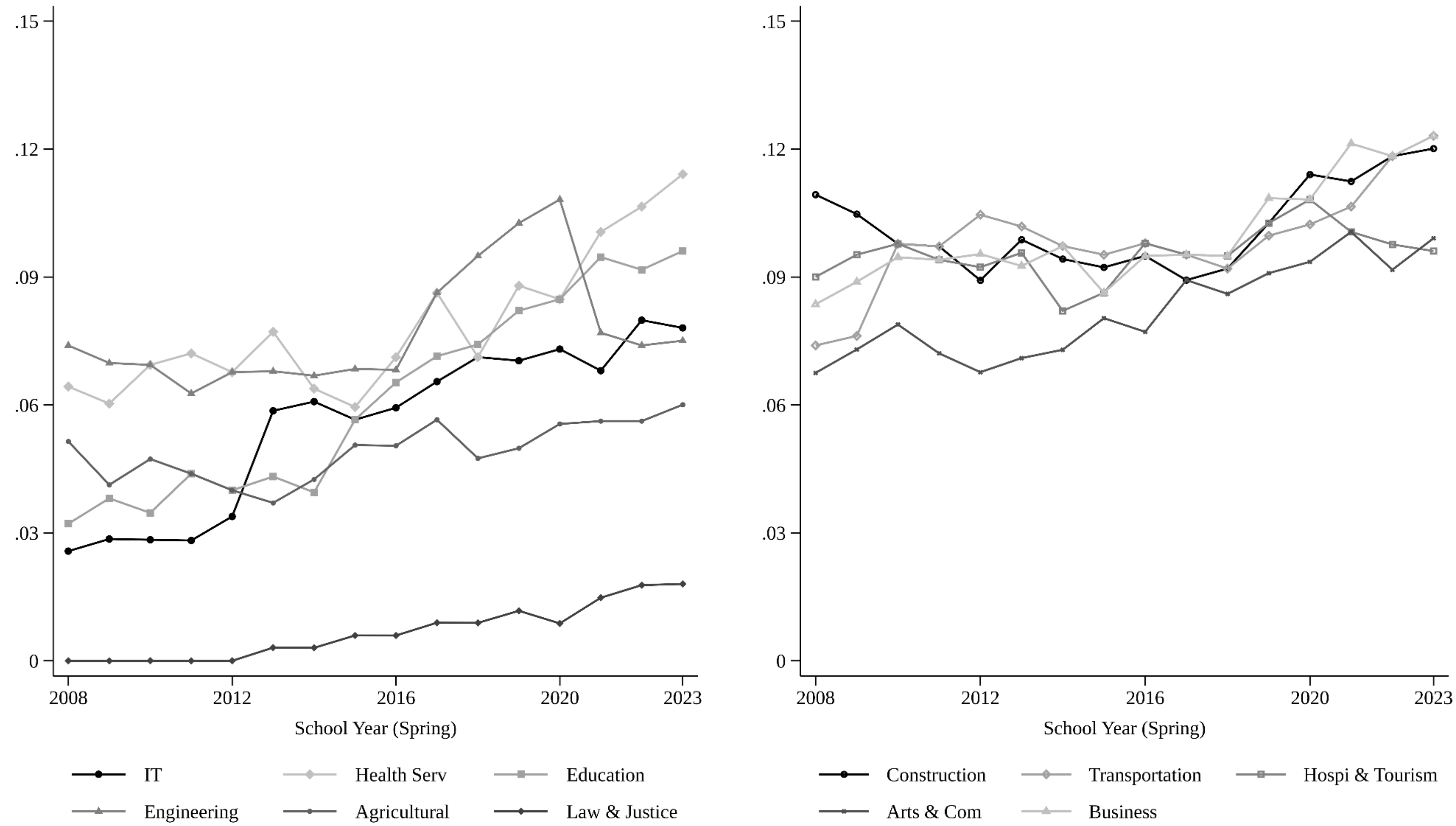
Notes: This set of figures presents descriptive trends in program participation and postsecondary outcomes by the number of years of exposure to a new Chapter 74 program. We use data from 151,347 students who enrolled in eventually treated schools (N=52), centering their 9th-grade cohorts relative to the year their school first introduced a Chapter 74 program. In each panel, estimates for zero or negative values represent unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Each dot represents the average outcome at each exposure level. In panel (f), the number of quarters with earnings declines consistently across higher exposure values. This pattern arises because more highly exposed cohorts tend to belong to more recent 9th-grade cohorts, limiting the length of their post-graduation follow-up period. In our main event study models, we account for this by including cohort fixed effects.

Figure A2. Share of students who participated in a Chapter 74 program: by student demographic groups and program career clusters.



Notes: This figure presents the share of students who participated in a Chapter 74 program, disaggregated by demographic groups and program career clusters. Panel (a) displays the percentage of students who participated in any Chapter 74 program within each demographic group. For example, 6.62% of female students and 8.59% of male students participated in a Chapter 74 program. Panels (b) through (d) show the number of students participating in each career cluster program, broken down by gender, race/ethnicity (URM: Black or Hispanic students), and disability status (SWD: students with disabilities). Overall, the three most commonly chosen clusters are Business and Consumer Services (BCS), Construction, and Manufacturing, Engineering, and Technology (MET). Among female students, the most selected clusters are BCS, Health Services, and Hospitality. For male students, the top clusters are Construction, MET, and Transportation. Among URM students, the most common programs are Health Services, Hospitality, and BCS, while for SWD students, they are Construction, Transportation, and Hospitality.

Figure A3. Proportion of schools offering Chapter 74 program: by career cluster.



Notes: This figure shows trends in the proportion of Massachusetts comprehensive high schools offering at least one Chapter 74 program by career cluster. For example, in the left panel, the line for IT indicates an increase in the share of schools offering at least one IT cluster Chapter 74 program, from 2.6 percent in Spring 2008 to 7.6 percent in Spring 2020. Detailed values for each career cluster, including the approximate number of schools expanding their Chapter 74 offerings, are provided in Appendix Table A8.

Table A8. The percentage of schools offering at least one Chapter 74 program in each career cluster.

School Year (Spring)	**Edu**	**Hea**	**IT**	**Trans**	**MET**	**BCS**	**ACS**	**Con**	Hosp	ANR	Law
2008	3.2	6.4	2.6	7.4	7.4	8.4	6.8	10.9	9	5.1	0
2009	3.8	6	2.9	7.6	7	8.9	7.3	10.5	9.5	4.1	0
2010	3.5	6.9	2.8	9.8	6.9	9.5	7.9	9.8	9.8	4.7	0
2011	4.4	7.2	2.8	9.7	6.3	9.4	7.2	9.7	9.4	4.4	0
2012	4	6.8	3.4	10.5	6.8	9.5	6.8	8.9	9.2	4	0
2013	4.3	7.7	5.9	10.2	6.8	9.3	7.1	9.9	9.6	3.7	0.3
2014	4	6.4	6.1	9.7	6.7	9.7	7.3	9.4	8.2	4.3	0.3
2015	5.7	6	5.7	9.5	6.8	8.6	8	9.2	8.6	5.1	0.6
2016	6.5	7.1	5.9	9.8	6.8	9.5	7.7	9.5	9.8	5	0.6
2017	7.1	8.6	6.5	9.5	8.6	9.5	8.9	8.9	9.5	5.7	0.9
2018	7.4	7.1	7.1	9.2	9.5	9.5	8.6	9.2	9.5	4.7	0.9
2019	8.2	8.8	7	10	10.3	10.9	9.1	10.3	10.3	5	1.2
2020	8.5	8.5	7.3	10.2	10.8	10.8	9.4	11.4	10.8	5.6	0.9
2021	9.5	10.1	6.8	10.7	7.7	12.1	10.1	11.2	10.1	5.6	1.5
2022	9.2	10.7	8	11.8	7.4	11.8	9.2	11.8	9.8	5.6	1.8
2023	9.6	11.4	7.8	12.3	7.5	12.3	9.9	12	9.6	6	1.8
Max-Min	6.4	5.4	5.4	4.9	4.5	3.9	3.3	3.1	2.6	2.3	1.8
Approx. N of Schools (Expanded Chapter 74)	24	21	21	19	17	15	13	12	10	9	7

Notes: This table shows the percentage of schools offering at least one Chapter 74 program in each career cluster among the initial sample of 382 comprehensive high schools. The second row from the bottom present the percentage point changes from 2008 to 2020. Career clusters with increases exceeding 3 percentage points are highlighted in bold, indicating the addition of approximately 12 schools newly offering Chapter 74 programs in those clusters.

Table A9. Main results: Impact on program participation and postsecondary outcomes.

	(1) Take-up	(2) HS grad	(3) 2-year	(4) 4-year	(5) Col grad	(6) Qtrs. Emp	(7) Log: Initial	(8) Log: Age23
Pre–treat ATT	0.001	0.003	-0.000	-0.006*	-0.003	-0.007	-0.001	0.004
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.089)	(0.008)	(0.009)
Post–treat ATT: Main	0.115**	0.000	-0.013	-0.039*	-0.016	0.452+	0.090*	0.042
	(0.037)	(0.017)	(0.011)	(0.016)	(0.015)	(0.263)	(0.035)	(0.042)
Post–treat ATT: Robust	0.075***	-0.008	-0.003	-0.039+	-0.020+	0.208	0.062+	0.018
	(0.022)	(0.016)	(0.008)	(0.022)	(0.011)	(0.249)	(0.034)	(0.035)
Unexposed cohorts								
$t-5$	0.004	0.007	-0.004	-0.002	-0.007	-0.016	-0.036	0.018
	(0.005)	(0.013)	(0.008)	(0.013)	(0.012)	(0.295)	(0.032)	(0.036)
$t-4$	0.005	-0.000	0.003	-0.013	-0.015+	0.289	0.047*	-0.010
	(0.005)	(0.012)	(0.006)	(0.010)	(0.008)	(0.324)	(0.022)	(0.018)
$t-3$	-0.004	0.010	0.008	-0.005	0.003	0.088	0.021	0.005
	(0.005)	(0.009)	(0.006)	(0.008)	(0.009)	(0.275)	(0.023)	(0.018)
$t-2$	0.007	-0.017	-0.009	-0.011	-0.004	-0.161	-0.019	-0.039
	(0.006)	(0.011)	(0.006)	(0.012)	(0.010)	(0.218)	(0.028)	(0.029)
$t-1$	-0.006	0.012	-0.005	0.003	0.005	0.159	-0.053+	0.043+
	(0.005)	(0.010)	(0.007)	(0.010)	(0.009)	(0.177)	(0.029)	(0.023)
$t+0$	0.001	0.008	0.007	-0.005	0.002	-0.403+	0.033	0.007
	(0.003)	(0.010)	(0.005)	(0.008)	(0.008)	(0.210)	(0.026)	(0.041)
Exposed cohorts								
[Unexpectedly exposed]								
$t+1$	0.007	-0.001	0.010	-0.023	-0.022	0.362	0.045	-0.007
	(0.007)	(0.013)	(0.008)	(0.017)	(0.017)	(0.227)	(0.033)	(0.046)
$t+2$	0.034**	-0.015	-0.001	-0.037+	-0.020	0.057	0.060	0.046
	(0.011)	(0.018)	(0.008)	(0.021)	(0.017)	(0.239)	(0.039)	(0.037)
$t+3$	0.089**	-0.000	-0.007	-0.050+	-0.030**	-0.008	0.061+	-0.006
	(0.028)	(0.021)	(0.010)	(0.026)	(0.010)	(0.286)	(0.033)	(0.044)
$t+4$	0.169**	-0.015	-0.014	-0.046+	-0.006	0.423	0.083+	0.040
	(0.054)	(0.021)	(0.013)	(0.027)	(0.019)	(0.376)	(0.047)	(0.043)
[Expectedly exposed]								
$t+5$	0.165**	-0.010	-0.020	-0.025	-0.017	0.807+	0.136*	0.114*
	(0.059)	(0.023)	(0.017)	(0.018)	(0.022)	(0.434)	(0.059)	(0.048)
$t+6$	0.172**	0.010	-0.020	-0.043*	-0.021	1.037**	0.101*	0.042
	(0.064)	(0.024)	(0.021)	(0.019)	(0.025)	(0.382)	(0.051)	(0.061)
$t+7$	0.172*	0.032	-0.041+	-0.048*	0.002	0.486	0.144**	0.066
	(0.069)	(0.026)	(0.021)	(0.023)	(0.030)	(0.428)	(0.053)	(0.110)
N	737,036	736,846	688,005	688,005	537,882	521,725	409,339	322,379

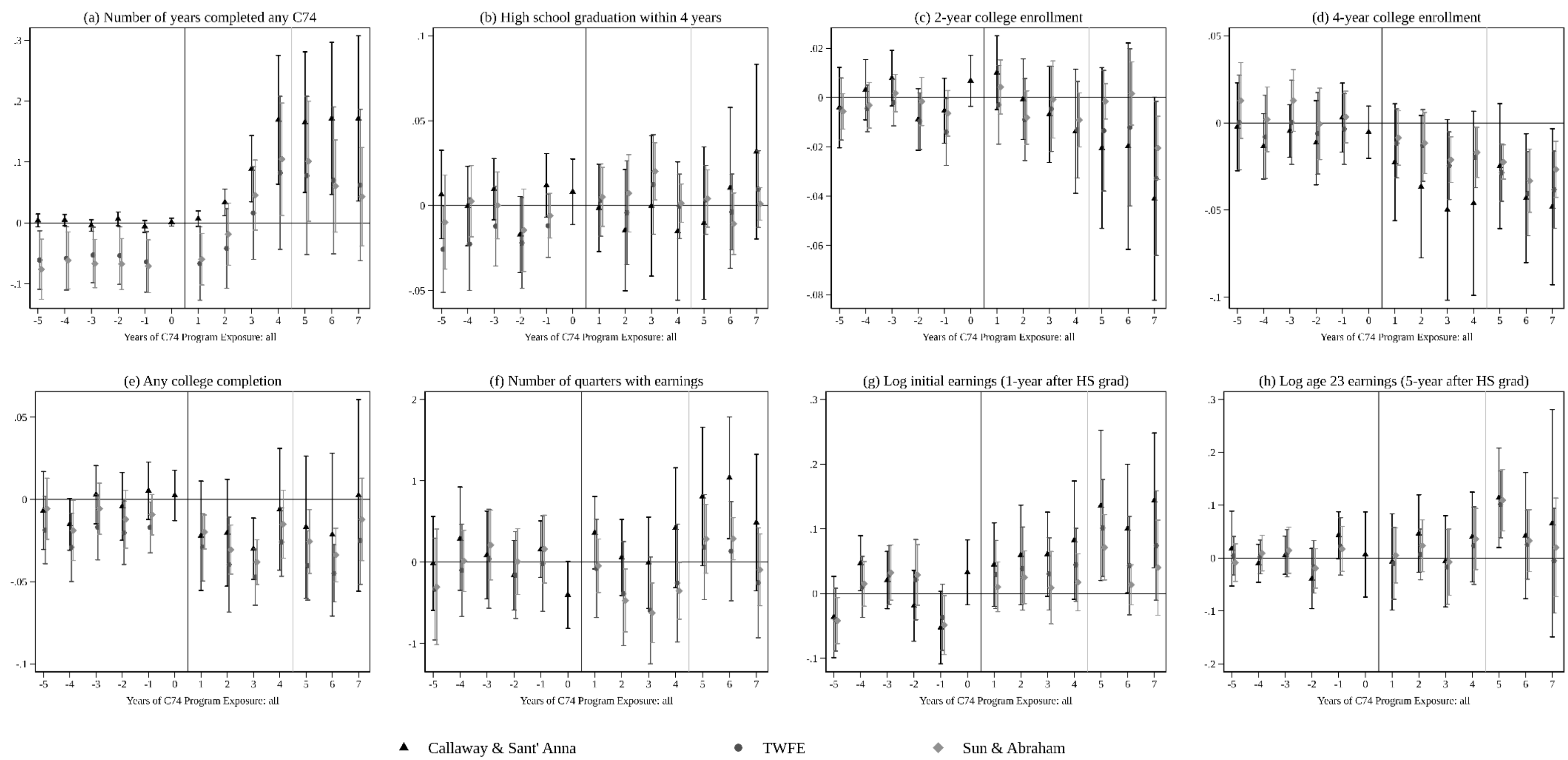
Notes: This table presents the main event study estimates, capturing the impact of exposure to any Chapter 74 program offering on students' program take-up and postsecondary outcomes. "Pre–treat ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post–treat ATT: Main" reports post-treatment ATT estimates from our main specification, which includes both unexpectedly and expectedly exposed cohorts in the treated group (t+1 to t+7). "Post–treat ATT: Robust" presents post-treatment ATT estimates from an alternative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors (in parentheses) are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table A10. Alternative earning measure: Untransformed real-dollar values.

	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM
	(a) Real-dollar: Initial earnings (1-year after HS graduation)					
Pre ATT	-32.716	-34.309	-3.415	-58.119+	-95.659*	0.541
	(29.906)	(36.516)	(31.641)	(33.017)	(37.985)	(27.925)
Post ATT: Main	28.019	207.104	-66.839	128.032	-180.559	189.576*
	(97.145)	(199.904)	(135.313)	(109.489)	(147.155)	(95.174)
Post ATT: Robust	119.284	300.343*	-55.863	281.555*	-127.380	276.882**
	(98.217)	(146.525)	(131.192)	(113.355)	(177.058)	(85.101)
N	688,005	107,509	343,200	344,794	164,011	523,987
	(b) Real-dollar: Age 23 earnings (5-year after HS graduation)					
Pre ATT	-167.101*	49.793	-170.955*	-153.575	-148.874+	-122.005
	(67.353)	(114.954)	(74.530)	(96.281)	(89.518)	(85.493)
Post ATT: Main	-75.420	-226.844	403.299	-508.533	-458.816	383.898
	(367.305)	(408.545)	(423.907)	(399.703)	(497.634)	(461.004)
Post ATT: Robust	-116.401	18.545	168.745	-395.364	-310.238	372.459
	(302.976)	(331.808)	(380.167)	(343.424)	(316.332)	(443.654)
N	488,240	74,722	243,678	244,551	108,133	380,100

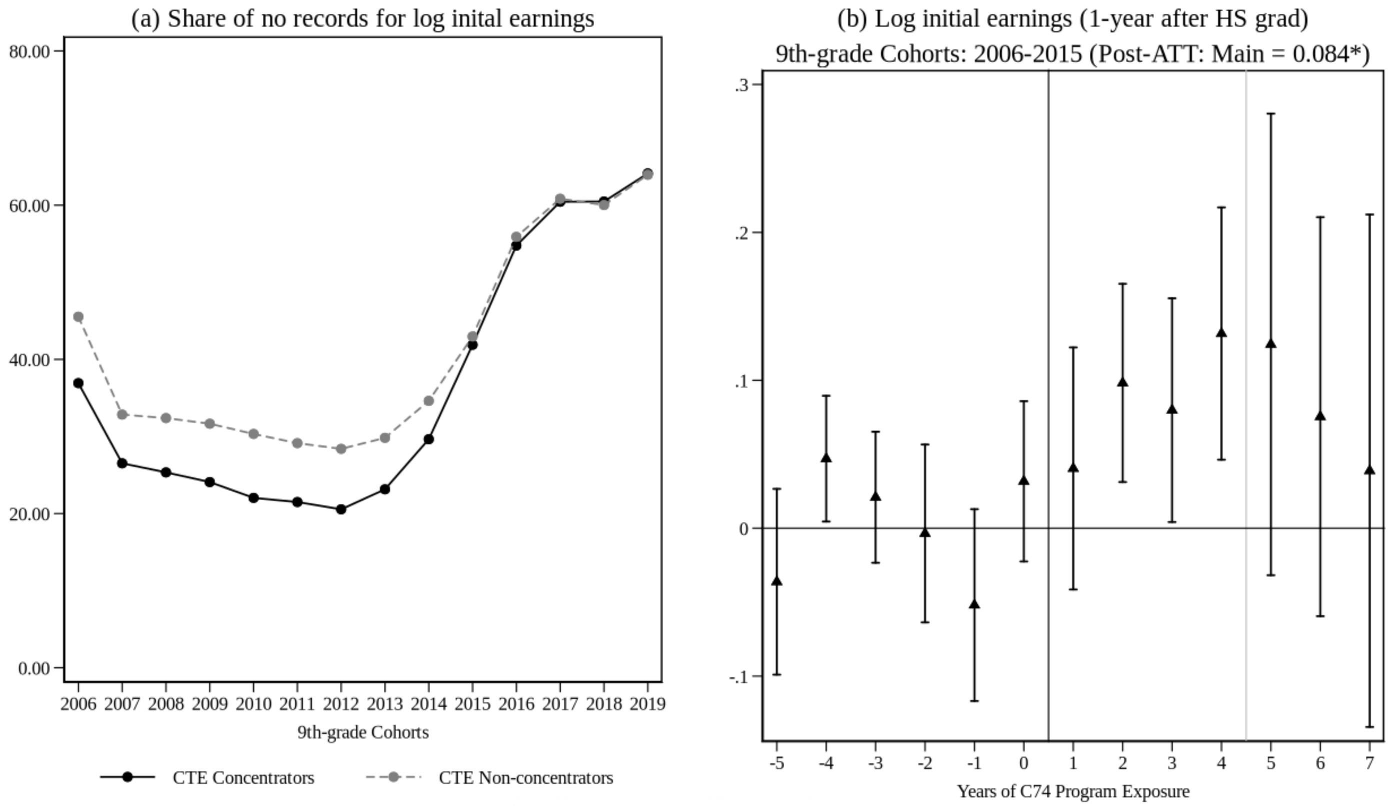
Notes: This table presents the main event study estimates using the alternative earnings measures of untransformed real dollar earnings. "Pre–treat ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post–treat ATT: Main" reports post-treatment ATT estimates from our main specification, which includes both unexpectedly and expectedly exposed cohorts in the treated group (t+1 to t+7). "Post–treat ATT: Robust" presents post-treatment ATT estimates from an alternative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors (in parentheses) are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Figure A4. Main results with alternative staggered DID approaches.



Notes: This figure compares event study estimates across three different staggered DID estimators: Callaway & Sant' Anna (2020), traditional nonparametric two-way fixed effects (TWFE), and Sun & Abraham (2021). Standard errors are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Figure A5. Impact on log initial earnings (1-year after HS grad) with limited cohorts.



Notes: The panel (a) displays the share of missing log initial earnings records across 9th-grade cohorts from 2006 through 2019. The unmatched rate between the UI and SIMS datasets remains around 30–40 percent through the 2015 cohort, but increases sharply to approximately 60 percent beginning with the 2016 cohort. While there is no significant difference in matching rates by students' CTE concentration status for the 2016–2019 cohorts, we conduct a sensitivity analysis to address concerns about potential bias due to differential matching. We replicate our main estimates of log initial earnings using only cohorts from 2006 to 2015 and report in the panel (b). The resulting post-treatment ATT estimate (Main: t+1 to t+7) is 0.084 and statistically significant, closely aligning with our main estimate of 0.090 using the full 2006–2019 sample, as shown in Table A9, column (7).

Table A11. Heterogeneity by student demographics: Impact on program participation and postsecondary outcomes.

	(a) Number of years completed any Chapter 74 program						(b) On-time high school graduation					
	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM
Pre ATT	0.001	0.001	0.002*	-0.000	0.001	0.000	0.003	0.008*	0.004	0.003	-0.002	0.008**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.003)	(0.004)	(0.003)
Post ATT: Main	0.115**	0.105**	0.131**	0.102***	0.109*	0.122**	0.000	0.004	0.005	-0.004	-0.004	-0.006
	(0.037)	(0.036)	(0.049)	(0.030)	(0.050)	(0.040)	(0.017)	(0.021)	(0.016)	(0.021)	(0.022)	(0.013)
Post ATT: Robust	0.075***	0.066***	0.077**	0.074***	0.065*	0.086***	-0.008	-0.004	-0.005	-0.011	-0.014	-0.008
	(0.022)	(0.020)	(0.026)	(0.020)	(0.029)	(0.023)	(0.016)	(0.018)	(0.016)	(0.019)	(0.026)	(0.009)
Unexposed cohorts												
$t-5$	0.004	0.011	0.005	0.003	0.012	-0.002	0.007	0.033	0.009	0.006	-0.012	0.016
	(0.005)	(0.012)	(0.005)	(0.007)	(0.008)	(0.005)	(0.013)	(0.035)	(0.013)	(0.017)	(0.020)	(0.011)
$t-4$	0.005	-0.004	0.008+	0.002	-0.001	0.008	-0.000	-0.012	-0.002	0.001	0.001	-0.001
	(0.005)	(0.010)	(0.004)	(0.008)	(0.008)	(0.005)	(0.012)	(0.029)	(0.015)	(0.015)	(0.022)	(0.012)
$t-3$	-0.004	0.002	-0.007	-0.002	-0.001	-0.007	0.010	-0.003	0.014	0.007	0.015	0.017
	(0.005)	(0.012)	(0.005)	(0.007)	(0.004)	(0.009)	(0.009)	(0.017)	(0.015)	(0.011)	(0.016)	(0.011)
$t-2$	0.007	-0.008	0.009	0.004	0.011	0.001	-0.017	0.003	-0.018+	-0.015	-0.031	-0.008
	(0.006)	(0.010)	(0.006)	(0.007)	(0.008)	(0.007)	(0.011)	(0.020)	(0.010)	(0.016)	(0.019)	(0.009)
$t-1$	-0.006	0.006	-0.004	-0.007	-0.013	0.001	0.012	0.006	0.010	0.013	0.012	0.012
	(0.005)	(0.007)	(0.006)	(0.006)	(0.008)	(0.004)	(0.010)	(0.018)	(0.009)	(0.015)	(0.018)	(0.009)
$t+0$	0.001	-0.002	0.003	-0.000	-0.000	0.002	0.008	0.023	0.010	0.007	-0.000	0.008
	(0.003)	(0.010)	(0.005)	(0.005)	(0.005)	(0.005)	(0.010)	(0.019)	(0.011)	(0.017)	(0.016)	(0.010)
Exposed cohorts												
[Unexpectedly exposed]												
$t+1$	0.007	0.000	0.001	0.013	0.004	0.009	-0.001	-0.001	-0.001	-0.005	-0.001	-0.001
	(0.007)	(0.009)	(0.007)	(0.008)	(0.006)	(0.011)	(0.013)	(0.020)	(0.013)	(0.015)	(0.021)	(0.009)
$t+2$	0.034**	0.042*	0.034**	0.034**	0.019*	0.051**	-0.015	-0.006	-0.012	-0.017	-0.024	-0.004
	(0.011)	(0.018)	(0.013)	(0.012)	(0.010)	(0.017)	(0.018)	(0.020)	(0.018)	(0.020)	(0.028)	(0.011)
$t+3$	0.089**	0.070*	0.102**	0.078**	0.082*	0.096***	-0.000	-0.018	0.003	-0.004	-0.003	-0.011
	(0.028)	(0.027)	(0.036)	(0.024)	(0.038)	(0.028)	(0.021)	(0.026)	(0.021)	(0.025)	(0.032)	(0.012)
$t+4$	0.169**	0.152**	0.172**	0.170***	0.155*	0.186***	-0.015	0.008	-0.012	-0.018	-0.029	-0.015
	(0.054)	(0.049)	(0.064)	(0.051)	(0.078)	(0.048)	(0.021)	(0.024)	(0.020)	(0.025)	(0.030)	(0.016)
[Expectedly exposed]												
$t+5$	0.165**	0.127**	0.190*	0.146**	0.165*	0.172**	-0.010	-0.011	-0.006	-0.013	-0.022	-0.014
	(0.059)	(0.049)	(0.076)	(0.050)	(0.078)	(0.055)	(0.023)	(0.031)	(0.021)	(0.029)	(0.034)	(0.021)
$t+6$	0.172**	0.194**	0.205*	0.142**	0.165+	0.172*	0.010	0.016	0.018	0.004	0.012	-0.004
	(0.064)	(0.071)	(0.089)	(0.051)	(0.088)	(0.070)	(0.024)	(0.034)	(0.022)	(0.031)	(0.028)	(0.020)
$t+7$	0.172*	0.152*	0.214*	0.131*	0.169+	0.165*	0.032	0.037	0.042	0.024	0.037	0.005
	(0.069)	(0.070)	(0.091)	(0.052)	(0.094)	(0.078)	(0.026)	(0.041)	(0.026)	(0.032)	(0.027)	(0.027)
N	737,036	115,626	367,507	369,518	178,997	558,032	736,846	115,579	367,413	369,422	178,844	557,995

Table A11 (Continued). Heterogeneity by student demographics: Impact on program participation and postsecondary outcomes.

	(c) 2-year college enrollment						(d) 4-year college enrollment					
	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM
Pre ATT	-0.000	-0.003	-0.001	0.001	-0.001	-0.000	-0.006*	-0.001	-0.003	-0.007*	-0.006**	0.002
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Post ATT: Main	-0.013	0.008	-0.009	-0.016	-0.011	-0.003	-0.039*	-0.029*	-0.034+	-0.042*	-0.025	-0.030*
	(0.011)	(0.017)	(0.013)	(0.013)	(0.013)	(0.009)	(0.016)	(0.013)	(0.018)	(0.017)	(0.021)	(0.015)
Post ATT: Robust	-0.003	0.008	0.004	-0.009	-0.001	0.002	-0.039+	-0.025	-0.039	-0.039+	-0.037	-0.021+
	(0.008)	(0.013)	(0.012)	(0.009)	(0.010)	(0.008)	(0.022)	(0.018)	(0.024)	(0.020)	(0.030)	(0.012)
Unexposed cohorts												
$t-5$	-0.004	-0.024	-0.010	0.001	-0.013	-0.001	-0.002	0.041*	0.009	-0.011	-0.012	0.010
	(0.008)	(0.018)	(0.008)	(0.011)	(0.013)	(0.012)	(0.013)	(0.021)	(0.012)	(0.017)	(0.016)	(0.013)
$t-4$	0.003	0.001	-0.003	0.010	-0.002	0.008	-0.013	-0.038*	-0.011	-0.016	-0.002	-0.018
	(0.006)	(0.014)	(0.009)	(0.007)	(0.010)	(0.009)	(0.010)	(0.017)	(0.010)	(0.014)	(0.015)	(0.013)
$t-3$	0.008	0.003	0.014+	0.002	0.012	0.000	-0.005	0.004	-0.006	-0.000	0.015	-0.000
	(0.006)	(0.014)	(0.008)	(0.008)	(0.009)	(0.006)	(0.008)	(0.014)	(0.010)	(0.011)	(0.011)	(0.010)
$t-2$	-0.009	0.002	-0.011	-0.006	-0.009	-0.011+	-0.011	-0.002	-0.004	-0.017	-0.024*	0.003
	(0.006)	(0.014)	(0.010)	(0.008)	(0.010)	(0.007)	(0.012)	(0.011)	(0.014)	(0.013)	(0.011)	(0.014)
$t-1$	-0.005	-0.013	-0.001	-0.009	-0.006	-0.002	0.003	0.004	-0.003	0.008	-0.007	0.020+
	(0.007)	(0.010)	(0.010)	(0.008)	(0.012)	(0.007)	(0.010)	(0.014)	(0.014)	(0.010)	(0.010)	(0.011)
$t+0$	0.007	0.011	0.005	0.009	0.011	0.004	-0.005	-0.014	-0.004	-0.005	-0.007	-0.005
	(0.005)	(0.012)	(0.009)	(0.007)	(0.007)	(0.007)	(0.008)	(0.012)	(0.009)	(0.011)	(0.009)	(0.009)
Exposed cohorts												
[Unexpectedly exposed]												
$t+1$	0.010	0.025	0.013	0.007	0.020*	-0.002	-0.023	-0.014	-0.031	-0.018	-0.024	-0.005
	(0.008)	(0.016)	(0.012)	(0.007)	(0.010)	(0.006)	(0.017)	(0.015)	(0.019)	(0.016)	(0.024)	(0.011)
$t+2$	-0.001	0.001	0.008	-0.009	0.000	0.003	-0.037+	-0.010	-0.042*	-0.029	-0.029	-0.026**
	(0.008)	(0.014)	(0.012)	(0.011)	(0.012)	(0.008)	(0.021)	(0.020)	(0.020)	(0.021)	(0.030)	(0.010)
$t+3$	-0.007	-0.006	0.001	-0.014	-0.009	0.002	-0.050+	-0.037	-0.033	-0.065**	-0.046	-0.030*
	(0.010)	(0.016)	(0.016)	(0.011)	(0.013)	(0.011)	(0.026)	(0.024)	(0.031)	(0.025)	(0.036)	(0.014)
$t+4$	-0.014	0.012	-0.006	-0.020	-0.015	0.003	-0.046+	-0.038+	-0.048	-0.043+	-0.048	-0.022
	(0.013)	(0.022)	(0.015)	(0.016)	(0.015)	(0.012)	(0.027)	(0.021)	(0.033)	(0.024)	(0.036)	(0.021)
[Expectedly exposed]												
$t+5$	-0.020	0.019	-0.024	-0.016	-0.025	0.001	-0.025	-0.018	-0.010	-0.036	0.005	-0.036
	(0.017)	(0.025)	(0.015)	(0.022)	(0.018)	(0.013)	(0.018)	(0.019)	(0.017)	(0.024)	(0.019)	(0.026)
$t+6$	-0.020	0.025	-0.012	-0.025	-0.008	-0.011	-0.043*	-0.040*	-0.042+	-0.043+	-0.021	-0.040+
	(0.021)	(0.027)	(0.021)	(0.025)	(0.027)	(0.015)	(0.019)	(0.017)	(0.022)	(0.024)	(0.021)	(0.022)
$t+7$	-0.041+	-0.018	-0.044+	-0.037+	-0.041+	-0.017	-0.048*	-0.047**	-0.034	-0.059*	-0.013	-0.053*
	(0.021)	(0.026)	(0.024)	(0.021)	(0.024)	(0.015)	(0.023)	(0.017)	(0.023)	(0.024)	(0.023)	(0.026)
N	688,005	107,509	343,200	344,794	164,011	523,987	688,005	107,509	343,200	344,794	164,011	523,987

Table A11 (Continued). Heterogeneity by student demographics: Impact on program participation and postsecondary outcomes.

	(e) Any college completion						(f) Number of quarters with earnings					
	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM
Pre ATT	-0.003	0.000	-0.004	-0.000	-0.003	0.002	-0.007	0.256+	-0.075	0.062	-0.084	0.041
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.089)	(0.139)	(0.101)	(0.101)	(0.118)	(0.096)
Post ATT: Main	-0.016	0.003	-0.008	-0.021	-0.005	-0.019	0.452+	2.179***	0.351	0.517	0.767*	0.145
	(0.015)	(0.010)	(0.018)	(0.014)	(0.015)	(0.017)	(0.263)	(0.462)	(0.360)	(0.327)	(0.312)	(0.362)
Post ATT: Robust	-0.020+	0.003	-0.015	-0.022*	-0.015	-0.012	0.208	1.475***	0.146	0.251	0.280	0.122
	(0.011)	(0.009)	(0.014)	(0.009)	(0.013)	(0.013)	(0.249)	(0.389)	(0.364)	(0.275)	(0.323)	(0.294)
Unexposed cohorts												
$t-5$	-0.007	0.010	-0.001	-0.009	-0.013	0.002	-0.016	0.196	-0.475	0.507+	-0.535	0.224
	(0.012)	(0.017)	(0.016)	(0.013)	(0.010)	(0.012)	(0.295)	(0.614)	(0.418)	(0.298)	(0.580)	(0.255)
$t-4$	-0.015+	-0.019	-0.019*	-0.012	-0.015	-0.010	0.289	0.246	0.438	0.098	-0.174	0.562
	(0.008)	(0.012)	(0.009)	(0.013)	(0.011)	(0.012)	(0.324)	(0.911)	(0.304)	(0.424)	(0.370)	(0.371)
$t-3$	0.003	-0.004	-0.002	0.011	0.027*	-0.000	0.088	0.004	0.080	0.124	0.626*	-0.256
	(0.009)	(0.010)	(0.011)	(0.013)	(0.011)	(0.011)	(0.275)	(0.485)	(0.326)	(0.325)	(0.298)	(0.373)
$t-2$	-0.004	-0.003	0.004	-0.010	-0.018*	0.007	-0.161	0.831	-0.598*	0.300	-0.210	0.003
	(0.010)	(0.011)	(0.013)	(0.011)	(0.009)	(0.014)	(0.218)	(0.619)	(0.280)	(0.265)	(0.303)	(0.282)
$t-1$	0.005	0.027**	-0.009	0.019*	0.000	0.008	0.159	0.381	0.568*	-0.268	0.088	0.241
	(0.009)	(0.009)	(0.012)	(0.009)	(0.010)	(0.008)	(0.177)	(0.505)	(0.241)	(0.210)	(0.246)	(0.276)
$t+0$	0.002	-0.010	0.004	0.000	-0.002	0.004	-0.403+	-0.121	-0.464	-0.392+	-0.295	-0.528*
	(0.008)	(0.013)	(0.010)	(0.008)	(0.011)	(0.008)	(0.210)	(0.497)	(0.290)	(0.231)	(0.340)	(0.214)
Exposed cohorts												
[Unexpectedly exposed]												
$t+1$	-0.022	0.006	-0.036+	-0.010	-0.030	0.001	0.362	1.427**	0.364	0.304	0.186	0.479
	(0.017)	(0.013)	(0.020)	(0.015)	(0.020)	(0.018)	(0.227)	(0.478)	(0.337)	(0.251)	(0.298)	(0.311)
$t+2$	-0.020	0.007	-0.016	-0.022	-0.016	-0.005	0.057	0.568	-0.237	0.363	-0.026	0.084
	(0.017)	(0.018)	(0.017)	(0.016)	(0.011)	(0.024)	(0.239)	(0.425)	(0.316)	(0.308)	(0.376)	(0.240)
$t+3$	-0.030**	-0.009	-0.006	-0.050***	-0.016	-0.034***	-0.008	1.407*	0.100	-0.167	0.221	-0.200
	(0.010)	(0.015)	(0.015)	(0.013)	(0.015)	(0.010)	(0.286)	(0.577)	(0.469)	(0.359)	(0.369)	(0.353)
$t+4$	-0.006	0.009	-0.003	-0.005	0.002	-0.008	0.423	2.499***	0.356	0.504	0.736+	0.124
	(0.019)	(0.015)	(0.027)	(0.015)	(0.018)	(0.021)	(0.376)	(0.525)	(0.492)	(0.391)	(0.445)	(0.434)
[Expectedly exposed]												
$t+5$	-0.017	0.006	-0.006	-0.020	0.015	-0.032	0.807+	2.780***	0.892+	0.698	1.525**	0.090
	(0.022)	(0.019)	(0.024)	(0.025)	(0.021)	(0.027)	(0.434)	(0.788)	(0.540)	(0.550)	(0.578)	(0.496)
$t+6$	-0.021	0.000	-0.007	-0.033	-0.004	-0.039	1.037**	3.141***	0.529	1.506***	1.662***	0.391
	(0.025)	(0.015)	(0.033)	(0.025)	(0.025)	(0.028)	(0.382)	(0.724)	(0.518)	(0.441)	(0.411)	(0.599)
$t+7$	0.002	0.001	0.015	-0.009	0.013	-0.014	0.486	3.431***	0.452	0.412	1.064*	0.045
	(0.030)	(0.024)	(0.036)	(0.029)	(0.021)	(0.032)	(0.428)	(0.719)	(0.525)	(0.558)	(0.468)	(0.592)
N	537,882	82,878	268,491	269,380	121,264	416,611	521,725	71,476	267,693	254,022	106,501	415,220

Table A11 (Continued). Heterogeneity by student demographics: Impact on program participation and postsecondary outcomes.

	(g) Log initial earnings: 1-year after HS graduation						(h) Log age 23 earnings: 5-year after HS graduation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Overall	SWD	Female	Male	URM	N-URM	Overall	SWD	Female	Male	URM	N-URM
Pre ATT	-0.001	0.016	0.002	-0.005	0.007	-0.007	0.004	0.013	-0.000	0.010	0.007	-0.002
	(0.008)	(0.019)	(0.009)	(0.010)	(0.013)	(0.008)	(0.009)	(0.019)	(0.011)	(0.011)	(0.011)	(0.009)
Post ATT: Main	0.090*	0.175	0.042	0.139**	0.081+	0.051+	0.042	0.075	0.071	0.013	-0.023	0.068
	(0.035)	(0.108)	(0.041)	(0.046)	(0.049)	(0.026)	(0.042)	(0.070)	(0.062)	(0.040)	(0.045)	(0.056)
Post ATT: Robust	0.062+	0.154+	0.022	0.105**	0.037	0.045+	0.018	0.071	0.041	-0.009	-0.030	0.060
	(0.034)	(0.091)	(0.040)	(0.040)	(0.043)	(0.027)	(0.035)	(0.067)	(0.048)	(0.040)	(0.047)	(0.047)
Unexposed cohorts												
$t-5$	-0.036	0.045	-0.072*	-0.001	-0.021	-0.049	0.018	0.081	0.009	0.031	0.048	-0.002
	(0.032)	(0.090)	(0.034)	(0.040)	(0.054)	(0.031)	(0.036)	(0.086)	(0.049)	(0.047)	(0.060)	(0.038)
$t-4$	0.047*	0.165+	0.054+	0.042	0.076**	0.037	-0.010	-0.010	0.011	-0.032	0.017	-0.027
	(0.022)	(0.087)	(0.031)	(0.035)	(0.029)	(0.029)	(0.018)	(0.061)	(0.028)	(0.043)	(0.032)	(0.025)
$t-3$	0.021	-0.050	0.042	-0.001	0.015	0.006	0.005	-0.065	-0.023	0.036	-0.012	0.012
	(0.023)	(0.080)	(0.035)	(0.031)	(0.031)	(0.025)	(0.018)	(0.057)	(0.026)	(0.037)	(0.029)	(0.032)
$t-2$	-0.019	0.042	-0.040	0.003	-0.059+	0.027	-0.039	-0.003	-0.047	-0.028	-0.071*	-0.010
	(0.028)	(0.080)	(0.030)	(0.040)	(0.035)	(0.033)	(0.029)	(0.074)	(0.042)	(0.031)	(0.034)	(0.034)
$t-1$	-0.053+	-0.143+	-0.044	-0.064	-0.041	-0.062+	0.043+	0.017	0.061*	0.027	0.046	0.037
	(0.029)	(0.082)	(0.033)	(0.042)	(0.040)	(0.034)	(0.023)	(0.075)	(0.026)	(0.031)	(0.038)	(0.028)
$t+0$	0.033	0.035	0.071*	-0.008	0.071+	-0.003	0.007	0.055	-0.010	0.024	0.012	-0.021
	(0.026)	(0.097)	(0.033)	(0.032)	(0.036)	(0.029)	(0.041)	(0.107)	(0.050)	(0.049)	(0.044)	(0.048)
Exposed cohorts												
[Unexpectedly exposed]												
$t+1$	0.045	0.145	0.019	0.074+	0.021	0.035	-0.007	0.050	0.015	-0.027	-0.040	0.034
	(0.033)	(0.092)	(0.038)	(0.043)	(0.042)	(0.032)	(0.046)	(0.090)	(0.063)	(0.046)	(0.052)	(0.059)
$t+2$	0.060	0.054	0.046	0.069	0.056	0.036	0.046	0.059	0.042	0.047	0.010	0.078+
	(0.039)	(0.084)	(0.049)	(0.051)	(0.042)	(0.041)	(0.037)	(0.079)	(0.049)	(0.048)	(0.057)	(0.045)
$t+3$	0.061+	0.166	0.002	0.129**	0.035	0.037	-0.006	0.049	0.014	-0.032	-0.093+	0.066
	(0.033)	(0.120)	(0.040)	(0.042)	(0.045)	(0.036)	(0.044)	(0.104)	(0.056)	(0.051)	(0.055)	(0.056)
$t+4$	0.083+	0.253*	0.021	0.148**	0.036	0.075*	0.040	0.124	0.094	-0.024	0.002	0.061
	(0.047)	(0.114)	(0.060)	(0.055)	(0.065)	(0.032)	(0.043)	(0.085)	(0.074)	(0.052)	(0.060)	(0.066)
[Expectedly exposed]												
$t+5$	0.136*	0.038	0.072	0.204**	0.115	0.098+	0.114*	0.203	0.161*	0.074	0.133*	0.094
	(0.059)	(0.193)	(0.065)	(0.072)	(0.088)	(0.053)	(0.048)	(0.151)	(0.081)	(0.060)	(0.063)	(0.077)
$t+6$	0.101*	0.239+	0.021	0.185*	0.123+	0.013	0.042	0.060	0.092	-0.004	-0.054	0.067
	(0.051)	(0.132)	(0.065)	(0.073)	(0.068)	(0.043)	(0.061)	(0.114)	(0.082)	(0.070)	(0.077)	(0.079)
$t+7$	0.144**	0.333*	0.114+	0.168**	0.183**	0.064	0.066	-0.021	0.079	0.055	-0.121	0.076
	(0.053)	(0.149)	(0.068)	(0.064)	(0.070)	(0.041)	(0.110)	(0.152)	(0.160)	(0.075)	(0.108)	(0.107)
N	409,339	51,815	214,887	194,447	82,986	326,350	322,379	45,250	166,154	156,221	66,385	255,992

Notes: This table presents event study estimates for each student demographic group. "Pre–treat ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post–treat ATT: Main" reports post-treatment ATT estimates from our main specification, which includes both unexpectedly and expectedly exposed cohorts in the treated group (t+1 to t+7). "Post–treat ATT: Robust" presents post-treatment ATT estimates from an alternative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors (in parentheses) are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table A12. Heterogeneity by program career clusters: Impact on program participation and postsecondary outcomes.

	(a) Number of years completed any Chapter 74 program						(b) On-time high school graduation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Overall	SWD	Female	Male	URM	N-URM	Overall	SWD	Female	Male	URM	N-URM
[Education]												
Pre ATT	0.000	0.000	-0.000	0.000	0.000	-0.000	0.004	0.007	0.004	0.005	0.010+	0.002
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.007)	(0.004)	(0.004)	(0.006)	(0.003)
Post ATT: Robust	0.064***	0.061***	0.123***	0.008**	0.067***	0.063***	0.018*	0.023	0.021+	0.016+	-0.010	0.023*
	(0.016)	(0.015)	(0.029)	(0.003)	(0.020)	(0.016)	(0.008)	(0.019)	(0.011)	(0.010)	(0.014)	(0.011)
[Health Services]												
Pre ATT	-0.000	0.000	-0.000	-0.000	-0.001	0.000	-0.001	0.001	-0.001	-0.002	-0.009*	0.002
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.003)	(0.005)	(0.003)	(0.004)	(0.005)	(0.003)
Post ATT: Robust	0.063**	0.040*	0.100**	0.028*	0.085*	0.044***	0.000	-0.016	-0.002	0.004	-0.002	-0.005
	(0.021)	(0.017)	(0.031)	(0.013)	(0.038)	(0.013)	(0.011)	(0.023)	(0.013)	(0.012)	(0.019)	(0.009)
[IT]												
Pre ATT	-0.000	0.001+	-0.000	-0.000	-0.000	0.000	0.007	0.004	0.007	0.007	0.006	0.005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.007)	(0.005)	(0.005)	(0.008)	(0.003)
Post ATT: Robust	0.045***	0.048***	0.018**	0.071***	0.040***	0.048***	-0.004	0.008	0.001	-0.010	-0.002	-0.007
	(0.010)	(0.012)	(0.006)	(0.014)	(0.010)	(0.013)	(0.007)	(0.018)	(0.008)	(0.010)	(0.017)	(0.007)
[Transportation]												
Pre ATT	-0.000	-0.000	0.000	-0.001	-0.001	0.000	-0.000	-0.002	0.000	0.000	0.000	0.004
	(0.000)	(0.002)	(0.000)	(0.001)	(0.001)	(0.000)	(0.005)	(0.008)	(0.006)	(0.006)	(0.008)	(0.004)
Post ATT: Robust	0.011***	0.022***	0.001	0.020***	0.012***	0.010**	0.008	0.014	0.001	0.014	0.014	-0.004
	(0.002)	(0.004)	(0.001)	(0.004)	(0.003)	(0.003)	(0.009)	(0.018)	(0.007)	(0.014)	(0.014)	(0.011)
[MET]												
Pre ATT	-0.000	-0.001	0.000	-0.001	0.000	-0.000	0.007**	0.007	0.008**	0.007*	0.010	0.005+
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.003)	(0.006)	(0.003)	(0.004)	(0.007)	(0.002)
Post ATT: Robust	0.037*	0.033***	0.022+	0.052**	0.029**	0.042*	-0.012	0.006	-0.012	-0.014	-0.015	-0.015**
	(0.015)	(0.009)	(0.013)	(0.019)	(0.010)	(0.019)	(0.011)	(0.017)	(0.014)	(0.010)	(0.024)	(0.006)
[Construction]												
Pre ATT	0.000	-0.000	0.000	-0.000	-0.000	0.000	-0.000	0.002	0.003	-0.004	-0.000	0.001
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.003)	(0.006)	(0.003)	(0.003)	(0.005)	(0.003)
Post ATT: Robust	0.030**	0.048**	0.003	0.054**	0.025**	0.040**	-0.000	0.019	-0.000	-0.001	-0.016	0.000
	(0.010)	(0.015)	(0.002)	(0.018)	(0.008)	(0.014)	(0.010)	(0.030)	(0.012)	(0.014)	(0.017)	(0.008)
[ACS]												
Pre ATT	-0.000	-0.000	-0.001	0.000	0.000	-0.001	0.003	0.009	0.004	0.001	-0.005	0.008*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.004)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)
Post ATT: Robust	0.066***	0.050***	0.058**	0.073***	0.057*	0.070***	0.035*	0.002	0.028	0.043*	0.072**	0.001
	(0.018)	(0.013)	(0.018)	(0.020)	(0.023)	(0.021)	(0.017)	(0.020)	(0.017)	(0.020)	(0.025)	(0.009)
[BCS]												
Pre ATT	-0.000	0.001	-0.000	0.000	-0.000	-0.000	0.006**	0.008	0.007**	0.006*	0.001	0.008*
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.005)	(0.002)	(0.003)	(0.003)	(0.003)
Post ATT: Robust	0.043***	0.025**	0.056***	0.032***	0.038***	0.049**	0.007	0.016	0.012	0.000	-0.002	-0.001
	(0.010)	(0.008)	(0.015)	(0.008)	(0.008)	(0.017)	(0.012)	(0.012)	(0.013)	(0.015)	(0.021)	(0.010)

Table A12 (Continued). Heterogeneity by program career clusters: Impact on program participation and postsecondary outcomes.

	(c) 2-year college enrollment						(d) 4-year college enrollment					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Overall	SWD	Female	Male	URM	N-URM	Overall	SWD	Female	Male	URM	N-URM
[Education]												
Pre ATT	0.002	0.003	0.003	0.000	0.006	0.001	-0.002	-0.000	-0.001	-0.003	-0.001	-0.005
	(0.002)	(0.005)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)
Post ATT: Robust	-0.005	-0.010	-0.010	0.000	-0.017	0.000	0.009	0.011	0.022+	-0.004	0.027	-0.002
	(0.008)	(0.014)	(0.009)	(0.009)	(0.014)	(0.009)	(0.010)	(0.012)	(0.012)	(0.012)	(0.021)	(0.011)
[Health Services]												
Pre ATT	0.002	0.003	0.003	0.002	0.002	0.002	-0.008***	-0.006	-0.007**	-0.008**	-0.010***	-0.003
	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Post ATT: Robust	-0.009	-0.026*	-0.003	-0.015	-0.011	-0.001	-0.001	-0.003	-0.010	0.009	0.018	-0.014
	(0.007)	(0.012)	(0.009)	(0.010)	(0.011)	(0.007)	(0.008)	(0.014)	(0.011)	(0.011)	(0.012)	(0.009)
[IT]												
Pre ATT	-0.004	-0.002	-0.003	-0.004	-0.000	-0.004	-0.000	-0.000	0.000	-0.000	-0.001	-0.000
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)
Post ATT: Robust	-0.004	-0.009	-0.004	-0.005	-0.017	0.005	-0.009	0.009	-0.003	-0.019+	0.019+	-0.023**
	(0.006)	(0.013)	(0.007)	(0.009)	(0.012)	(0.006)	(0.007)	(0.011)	(0.011)	(0.010)	(0.010)	(0.008)
[Transportation]												
Pre ATT	0.001	0.002	0.001	0.002	-0.005	0.004	-0.006	-0.004	-0.005	-0.008	-0.000	-0.001
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.006)	(0.004)	(0.007)	(0.005)	(0.003)	(0.004)
Post ATT: Robust	-0.004	-0.015	-0.007	-0.002	-0.004	0.000	-0.014*	0.002	-0.017*	-0.009	0.004	-0.027**
	(0.008)	(0.018)	(0.009)	(0.009)	(0.010)	(0.010)	(0.007)	(0.010)	(0.008)	(0.010)	(0.015)	(0.009)
[MET]												
Pre ATT	-0.001	-0.001	-0.003	0.001	-0.002	-0.000	-0.002	-0.002	0.003	-0.005*	-0.003	-0.001
	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Post ATT: Robust	0.007	-0.015	0.015	-0.001	0.004	0.013+	-0.031*	-0.007	-0.037*	-0.027+	-0.008	-0.044***
	(0.007)	(0.013)	(0.010)	(0.009)	(0.015)	(0.007)	(0.013)	(0.013)	(0.015)	(0.015)	(0.022)	(0.007)
[Construction]												
Pre ATT	-0.000	-0.001	0.000	-0.000	0.003	-0.002	-0.006**	0.001	-0.006**	-0.006*	-0.002	-0.004+
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
Post ATT: Robust	-0.025*	0.025	-0.026*	-0.024	-0.025+	-0.005	-0.015*	-0.027	-0.007	-0.023*	-0.009	-0.019*
	(0.012)	(0.018)	(0.011)	(0.017)	(0.014)	(0.009)	(0.007)	(0.019)	(0.017)	(0.011)	(0.011)	(0.008)
[ACS]												
Pre ATT	0.000	-0.005	0.000	-0.000	-0.001	0.002	-0.002	0.003	-0.001	-0.004	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.003)
Post ATT: Robust	0.010	0.001	0.008	0.013	0.026*	0.008	-0.005	-0.001	-0.007	-0.000	0.023	-0.030**
	(0.008)	(0.018)	(0.008)	(0.012)	(0.011)	(0.009)	(0.012)	(0.016)	(0.017)	(0.012)	(0.024)	(0.010)
[BCS]												
Pre ATT	-0.004+	-0.003	-0.006+	-0.003	-0.002	-0.004*	-0.005*	-0.004+	-0.002	-0.008**	-0.005*	-0.005
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Post ATT: Robust	-0.016+	-0.020	-0.019	-0.014	-0.021+	0.001	0.005	0.021*	0.006	0.002	0.017	-0.008
	(0.009)	(0.020)	(0.013)	(0.010)	(0.012)	(0.011)	(0.014)	(0.008)	(0.020)	(0.012)	(0.016)	(0.015)

Table A12 (Continued). Heterogeneity by program career clusters: Impact on program participation and postsecondary outcomes.

	(e) Any college completion						(f) Number of quarters with earnings					
	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) N-URM
[Education]												
Pre ATT	-0.001	0.004	0.000	-0.002	-0.000	-0.002	0.093	0.109	0.020	0.166	0.086	0.085
	(0.002)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.080)	(0.163)	(0.106)	(0.120)	(0.119)	(0.086)
Post ATT: Robust	0.004	-0.002	0.018+	-0.007	0.017	-0.003	-0.070	0.903+	-0.067	-0.075	0.346	-0.108
	(0.009)	(0.012)	(0.009)	(0.014)	(0.019)	(0.012)	(0.268)	(0.536)	(0.289)	(0.373)	(0.485)	(0.287)
[Health Services]												
Pre ATT	-0.008**	-0.003	-0.010**	-0.005*	-0.011***	-0.003	-0.024	0.268*	-0.037	-0.013	-0.048	-0.043
	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.068)	(0.112)	(0.090)	(0.076)	(0.091)	(0.083)
Post ATT: Robust	-0.004	-0.010	0.004	-0.005	0.008	-0.012	-0.249	-0.308	-0.373	-0.086	-0.031	-0.359
	(0.010)	(0.016)	(0.015)	(0.010)	(0.015)	(0.009)	(0.288)	(0.435)	(0.404)	(0.337)	(0.313)	(0.349)
[IT]												
Pre ATT	-0.000	0.006	-0.002	0.002	0.003	-0.003	0.021	0.059	-0.053	0.099	0.064	0.008
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.059)	(0.179)	(0.083)	(0.098)	(0.114)	(0.066)
Post ATT: Robust	0.004	0.004	0.020*	-0.016	0.027*	-0.008	-0.478**	-0.339	-0.315	-0.663**	-0.489	-0.422*
	(0.007)	(0.016)	(0.009)	(0.010)	(0.012)	(0.009)	(0.175)	(0.643)	(0.271)	(0.245)	(0.365)	(0.182)
[Transportation]												
Pre ATT	-0.006	0.001	-0.008	-0.004	-0.001	-0.001	-0.063	-0.198	-0.112	-0.007	-0.170	0.054
	(0.007)	(0.005)	(0.008)	(0.006)	(0.005)	(0.004)	(0.092)	(0.185)	(0.108)	(0.106)	(0.142)	(0.098)
Post ATT: Robust	-0.019**	0.006	-0.025*	-0.010	-0.005	-0.025***	0.266	0.288	0.011	0.535	0.792**	-0.032
	(0.006)	(0.017)	(0.010)	(0.010)	(0.017)	(0.005)	(0.171)	(0.877)	(0.265)	(0.329)	(0.272)	(0.202)
[MET]												
Pre ATT	0.000	0.003	0.003	-0.002	0.000	-0.001	0.037	-0.005	0.100	-0.027	-0.086	0.091
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.070)	(0.118)	(0.087)	(0.079)	(0.128)	(0.078)
Post ATT: Robust	0.007	0.012	0.005	0.011	0.038**	-0.016	-0.357	0.121	-0.652	-0.075	-0.240	-0.353
	(0.012)	(0.014)	(0.014)	(0.012)	(0.014)	(0.011)	(0.280)	(0.324)	(0.406)	(0.240)	(0.440)	(0.352)
[Construction]												
Pre ATT	-0.003	0.002	-0.005+	-0.001	-0.001	-0.000	0.010	0.134	0.037	-0.039	0.064	-0.024
	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.071)	(0.129)	(0.082)	(0.095)	(0.126)	(0.091)
Post ATT: Robust	-0.009	0.004	0.012	-0.028+	0.008	-0.018	-0.119	1.152*	-0.269	-0.007	0.243	-0.144
	(0.012)	(0.020)	(0.011)	(0.015)	(0.009)	(0.015)	(0.354)	(0.563)	(0.509)	(0.469)	(0.394)	(0.407)
[ACS]												
Pre ATT	0.001	0.007	0.001	-0.000	0.002	0.000	0.132	0.042	0.168	0.098	0.169	0.161
	(0.004)	(0.006)	(0.004)	(0.004)	(0.007)	(0.002)	(0.150)	(0.214)	(0.166)	(0.177)	(0.177)	(0.224)
Post ATT: Robust	0.003	0.019	-0.004	0.015+	0.016	-0.013	0.326	0.285	0.426	0.273	0.703*	0.192
	(0.011)	(0.016)	(0.017)	(0.008)	(0.022)	(0.010)	(0.337)	(0.685)	(0.398)	(0.433)	(0.350)	(0.446)
[BCS]												
Pre ATT	0.000	0.005	-0.000	0.001	-0.001	0.001	-0.059	0.189	-0.135	0.014	-0.005	-0.109
	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.077)	(0.124)	(0.088)	(0.091)	(0.108)	(0.077)
Post ATT: Robust	0.013	0.019	0.019	0.004	0.015	0.001	-0.233	0.454	-0.472	-0.117	0.291	-0.455
	(0.008)	(0.017)	(0.012)	(0.016)	(0.015)	(0.010)	(0.374)	(0.757)	(0.496)	(0.324)	(0.452)	(0.442)

Table A12 (Continued). Heterogeneity by program career clusters: Impact on program participation and postsecondary outcomes.

	(g) Log initial earnings: 1-year after HS graduation						(h) Log age 23 earnings: 5-year after HS graduation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Overall	SWD	Female	Male	URM	N-URM	Overall	SWD	Female	Male	URM	N-URM
[Education]												
Pre ATT	0.015	0.023	0.011	0.019	0.014	0.016	-0.004	0.013	-0.005	-0.005	0.008	-0.007
	(0.010)	(0.018)	(0.010)	(0.014)	(0.016)	(0.011)	(0.009)	(0.020)	(0.012)	(0.013)	(0.018)	(0.010)
Post ATT: Robust	-0.040	0.066	-0.078*	0.002	-0.050	-0.030	0.010	0.041	0.046	-0.027	-0.028	0.022
	(0.028)	(0.075)	(0.031)	(0.033)	(0.035)	(0.033)	(0.025)	(0.072)	(0.046)	(0.035)	(0.060)	(0.030)
[Health Services]												
Pre ATT	0.007	0.019	0.011	0.002	0.003	0.003	-0.011	-0.006	-0.016	-0.005	-0.010	-0.015
	(0.009)	(0.018)	(0.009)	(0.011)	(0.010)	(0.010)	(0.011)	(0.013)	(0.011)	(0.013)	(0.010)	(0.014)
Post ATT: Robust	-0.000	-0.001	0.011	-0.018	-0.009	-0.003	0.032	0.012	0.094	-0.034	-0.038	0.069
	(0.023)	(0.074)	(0.035)	(0.045)	(0.040)	(0.030)	(0.048)	(0.051)	(0.061)	(0.053)	(0.051)	(0.058)
[IT]												
Pre ATT	0.021**	0.011	0.025**	0.016	0.045***	0.008	0.011	0.027	-0.009	0.031**	0.019	0.001
	(0.008)	(0.021)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)	(0.019)	(0.011)	(0.012)	(0.018)	(0.009)
Post ATT: Robust	-0.028	0.030	-0.054	0.003	-0.074+	-0.010	-0.003	-0.016	-0.002	0.002	0.052	-0.016
	(0.027)	(0.052)	(0.038)	(0.024)	(0.043)	(0.028)	(0.030)	(0.072)	(0.043)	(0.042)	(0.086)	(0.033)
[Transportation]												
Pre ATT	0.010	0.009	0.022	-0.003	0.009	0.007	0.020+	0.045**	0.014	0.026+	0.037*	0.003
	(0.012)	(0.020)	(0.013)	(0.014)	(0.013)	(0.012)	(0.010)	(0.017)	(0.013)	(0.013)	(0.015)	(0.012)
Post ATT: Robust	0.046*	0.089	0.026	0.069*	0.072	0.022	-0.033	-0.035	-0.089*	0.024	-0.095**	-0.013
	(0.023)	(0.079)	(0.030)	(0.030)	(0.052)	(0.023)	(0.029)	(0.066)	(0.039)	(0.034)	(0.035)	(0.035)
[MET]												
Pre ATT	-0.004	0.004	-0.003	-0.005	0.013	-0.014+	-0.002	-0.003	0.001	-0.005	0.003	-0.005
	(0.007)	(0.014)	(0.009)	(0.007)	(0.009)	(0.007)	(0.005)	(0.014)	(0.008)	(0.006)	(0.013)	(0.007)
Post ATT: Robust	0.029	0.086	0.002	0.058+	0.004	0.041	0.033	0.022	0.006	0.065+	-0.074	0.058*
	(0.025)	(0.061)	(0.034)	(0.030)	(0.029)	(0.031)	(0.022)	(0.093)	(0.024)	(0.038)	(0.054)	(0.029)
[Construction]												
Pre ATT	0.017*	0.014	0.023**	0.010	0.012	0.014+	-0.006	-0.006	0.001	-0.012	-0.024+	0.014
	(0.007)	(0.020)	(0.008)	(0.009)	(0.013)	(0.008)	(0.011)	(0.019)	(0.013)	(0.012)	(0.013)	(0.011)
Post ATT: Robust	0.019	0.039	-0.043	0.091	-0.011	0.037	0.095	0.086*	0.155	0.027	0.080**	0.110
	(0.037)	(0.149)	(0.050)	(0.055)	(0.059)	(0.027)	(0.075)	(0.041)	(0.124)	(0.035)	(0.029)	(0.103)
[ACS]												
Pre ATT	0.024*	0.032	0.024*	0.026*	0.031*	0.025+	0.007	0.003	0.005	0.011	-0.002	0.010
	(0.009)	(0.028)	(0.012)	(0.012)	(0.012)	(0.014)	(0.011)	(0.020)	(0.014)	(0.015)	(0.017)	(0.010)
Post ATT: Robust	-0.041	-0.099	-0.045+	-0.041	-0.097+	-0.025	0.015	0.001	-0.041	0.079	0.049	0.002
	(0.025)	(0.103)	(0.027)	(0.043)	(0.051)	(0.025)	(0.040)	(0.078)	(0.061)	(0.054)	(0.030)	(0.048)
[BCS]												
Pre ATT	0.015	-0.001	0.015	0.016	0.022**	0.001	0.003	0.012	0.008	-0.003	0.000	-0.002
	(0.010)	(0.022)	(0.010)	(0.012)	(0.008)	(0.011)	(0.007)	(0.023)	(0.007)	(0.008)	(0.012)	(0.009)
Post ATT: Robust	0.009	0.201*	-0.011	0.032	0.038	-0.021	0.109**	0.131+	0.073+	0.137**	0.051	0.120***
	(0.037)	(0.087)	(0.050)	(0.044)	(0.043)	(0.039)	(0.037)	(0.079)	(0.042)	(0.042)	(0.084)	(0.028)

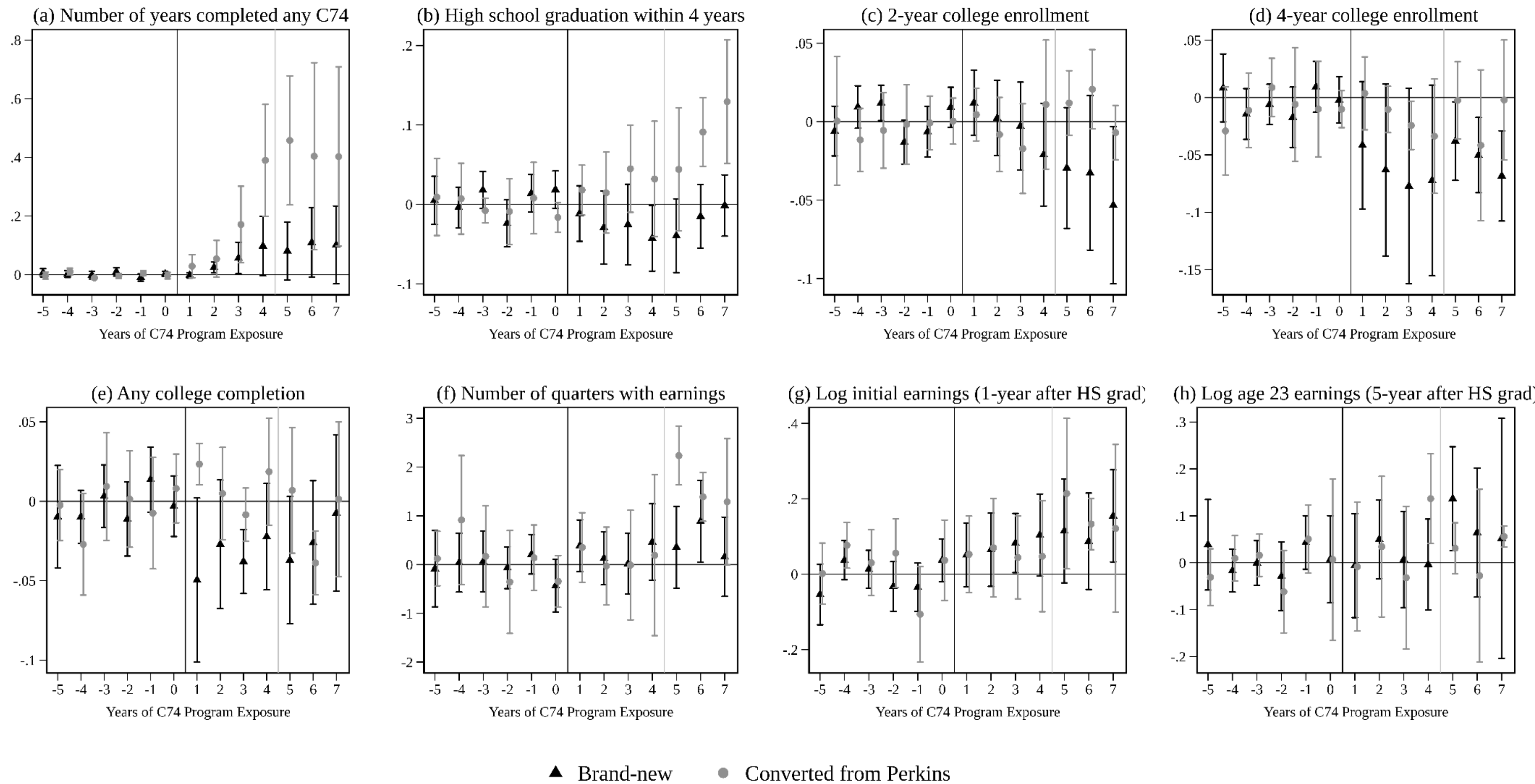
Notes: This table presents event study estimates for each student demographic group: the impact of exposure to each career cluster program. For example, the cells under row "Education" and column "Female" represents the impact of exposure to Education Chapter 74 program on female students' Education Chapter 74 program take-up and postsecondary outcomes. In each group, "Pre–treat ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post–treat ATT: Robust" presents post-treatment ATT estimates from a conservative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors (in parentheses) are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table A13. Number of credits earned (SCS dataset): Impact on program participation.

	(1) Overall	(2) SWD	(3) Female	(4) Male	(5) URM	(6) Non-URM
Pre–treat ATT	0.024	0.020	0.022	0.026	0.022	0.017
	(0.019)	(0.032)	(0.020)	(0.025)	(0.031)	(0.022)
Post–treat ATT: Main	0.668**	0.673**	0.606*	0.733**	0.626*	0.598**
	(0.234)	(0.221)	(0.240)	(0.247)	(0.297)	(0.218)
Post–treat ATT: Robust	0.334	0.292	0.270	0.401+	0.350	0.291+
	(0.220)	(0.214)	(0.221)	(0.237)	(0.306)	(0.172)
Unexposed cohorts						
$t-5$	0.115	0.280	0.079	0.158	0.392*	-0.025
	(0.108)	(0.220)	(0.103)	(0.141)	(0.192)	(0.090)
$t-4$	0.009	-0.163	-0.002	0.018	-0.177	0.067
	(0.043)	(0.168)	(0.052)	(0.067)	(0.143)	(0.055)
$t-3$	0.058	0.005	0.054	0.058	0.000	0.063
	(0.074)	(0.124)	(0.056)	(0.109)	(0.060)	(0.125)
$t-2$	0.045	0.070	0.092	0.001	0.104+	-0.006
	(0.065)	(0.064)	(0.087)	(0.095)	(0.060)	(0.080)
$t-1$	0.031	0.167	0.008	0.054	-0.065	0.082
	(0.088)	(0.175)	(0.121)	(0.079)	(0.111)	(0.108)
$t+0$	-0.114+	-0.241	-0.096	-0.130+	-0.124	-0.077
	(0.062)	(0.159)	(0.062)	(0.078)	(0.115)	(0.062)
Exposed cohorts						
[Unexpectedly exposed]						
$t+1$	-0.013	-0.173	-0.056	0.029	-0.058	0.004
	(0.072)	(0.141)	(0.073)	(0.105)	(0.122)	(0.080)
$t+2$	0.025	0.059	-0.002	0.057	-0.094	0.121
	(0.075)	(0.164)	(0.107)	(0.072)	(0.102)	(0.110)
$t+3$	0.256	0.107	0.233	0.284	0.310	0.196
	(0.213)	(0.186)	(0.229)	(0.216)	(0.346)	(0.135)
$t+4$	1.068+	1.174*	0.904	1.236+	1.243	0.844+
	(0.645)	(0.582)	(0.599)	(0.723)	(0.859)	(0.473)
[Expectedly exposed]						
$t+5$	1.242*	1.130*	1.094+	1.401*	1.164+	1.365*
	(0.581)	(0.523)	(0.625)	(0.554)	(0.632)	(0.580)
$t+6$	0.866**	1.312*	0.858*	0.876***	0.717+	0.766**
	(0.296)	(0.549)	(0.339)	(0.262)	(0.385)	(0.296)
$t+7$	1.233**	1.104**	1.213**	1.250*	1.097+	0.892**
	(0.440)	(0.374)	(0.400)	(0.515)	(0.582)	(0.284)
N	363,218	53,751	185,120	178,098	80,629	282,589

Notes: This table presents the event study estimates using the alternative measure of program participation from SCS: the number of Chapter 74 credits earned before high school graduation. "Pre–treat ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post–treat ATT: Main" reports post-treatment ATT estimates from our main specification, which includes both unexpectedly and expectedly exposed cohorts in the treated group (t+1 to t+7). "Post–treat ATT: Robust" presents post-treatment ATT estimates from an alternative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors (in parentheses) are clustered at the level of the first enrolled high school. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Figure A6. Comparison between the impacts of brand-new and converted program offering.



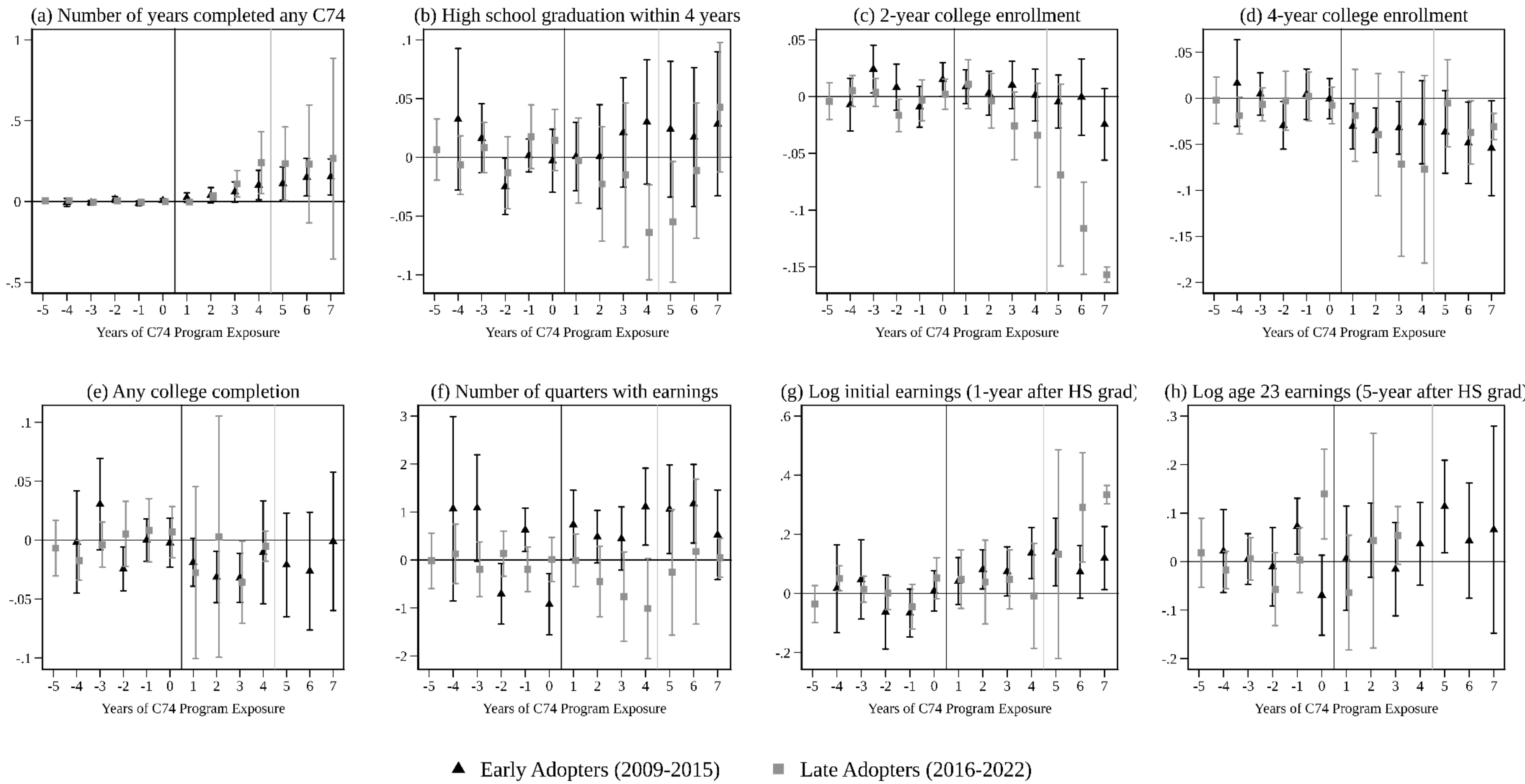
Notes: This set of figures compares event estimates from two models: one for the impact of brand-new program offerings (black-colored) and another for reauthorized program offerings (converted from Perkins-only programs into Chapter 74 program; gray-colored). In each panel, estimates for zero and negative exposure values correspond to unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Standard errors for the 95% confidence intervals are clustered at the level of students' first enrolled high school. Corresponding pre-treatment and post-treatment average treatment effect estimates for each model are reported in Table A14.

Table A14. Comparison between the impacts of brand-new and converted program offering.

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Take-up		HS grad		2-year		4-year		Col grad		Qtrs. Emp		Log: Initial		Log: Age23	
	BN	CV	BN	CV	BN	CV	BN	CV	BN	CV	BN	CV	BN	CV	BN	CV
Pre ATT	0.002+	-0.001	0.005+	-0.001	0.001	-0.003	-0.004	-0.010***	-0.003	-0.003	-0.045	0.107	-0.006	0.016	0.007	-0.002
	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.102)	(0.151)	(0.009)	(0.017)	(0.011)	(0.016)
Post ATT: Main	0.067+	0.273***	-0.024	0.054*	-0.018	0.002	-0.059*	-0.016	-0.030*	0.001	0.342	0.773*	0.094*	0.098+	0.043	0.027
	(0.036)	(0.079)	(0.017)	(0.023)	(0.014)	(0.009)	(0.024)	(0.014)	(0.013)	(0.008)	(0.292)	(0.322)	(0.044)	(0.051)	(0.052)	(0.040)
Post ATT: Robust	0.044*	0.161***	-0.027	0.027	-0.002	-0.002	-0.064+	-0.016	-0.034**	0.010	0.248	0.125	0.076+	0.054	0.012	0.033
	(0.020)	(0.044)	(0.020)	(0.025)	(0.012)	(0.012)	(0.037)	(0.011)	(0.013)	(0.006)	(0.280)	(0.484)	(0.042)	(0.051)	(0.042)	(0.057)
Unexposed cohorts																
$t-5$	0.007	-0.003	0.005	0.009	-0.006	0.000	0.008	-0.029	-0.010	-0.002	-0.086	0.123	-0.054	0.002	0.038	-0.031
	(0.007)	(0.006)	(0.015)	(0.025)	(0.008)	(0.021)	(0.015)	(0.020)	(0.016)	(0.011)	(0.399)	(0.285)	(0.041)	(0.041)	(0.049)	(0.031)
$t-4$	0.002	0.011+	-0.004	0.007	0.009	-0.012	-0.014	-0.011	-0.010	-0.027+	0.039	0.915	0.037	0.077*	-0.017	0.009
	(0.006)	(0.006)	(0.013)	(0.023)	(0.007)	(0.010)	(0.011)	(0.017)	(0.009)	(0.016)	(0.308)	(0.674)	(0.027)	(0.031)	(0.023)	(0.025)
$t-3$	-0.001	-0.011***	0.018	-0.008	0.012*	-0.006	-0.006	0.009	0.003	0.009	0.065	0.168	0.013	0.030	-0.001	0.016
	(0.007)	(0.002)	(0.012)	(0.008)	(0.006)	(0.012)	(0.009)	(0.013)	(0.010)	(0.017)	(0.317)	(0.528)	(0.026)	(0.045)	(0.024)	(0.023)
$t-2$	0.010	-0.004	-0.024	-0.009	-0.013+	-0.002	-0.017	-0.006	-0.011	0.001	-0.066	-0.357	-0.033	0.056	-0.029	-0.062
	(0.007)	(0.005)	(0.015)	(0.021)	(0.007)	(0.013)	(0.013)	(0.025)	(0.012)	(0.015)	(0.218)	(0.539)	(0.034)	(0.047)	(0.037)	(0.045)
$t-1$	-0.010	0.005	0.014	0.008	-0.006	-0.001	0.009	-0.010	0.014	-0.007	0.210	0.139	-0.035	-0.106	0.043	0.051
	(0.006)	(0.004)	(0.012)	(0.023)	(0.008)	(0.009)	(0.011)	(0.021)	(0.010)	(0.018)	(0.207)	(0.343)	(0.033)	(0.065)	(0.029)	(0.037)
$t+0$	0.003	-0.003	0.019	-0.016+	0.009	0.000	-0.002	-0.010	-0.003	0.008	-0.432	-0.344	0.037	0.037	0.007	0.007
	(0.004)	(0.006)	(0.012)	(0.010)	(0.007)	(0.007)	(0.010)	(0.008)	(0.010)	(0.011)	(0.275)	(0.270)	(0.029)	(0.054)	(0.047)	(0.088)
Exposed cohorts																
[Unexpectedly exposed]																
$t+1$	-0.002	0.029	-0.011	0.018	0.012	0.004	-0.042	0.004	-0.050+	0.023***	0.385	0.350	0.051	0.053	-0.006	-0.008
	(0.005)	(0.020)	(0.018)	(0.016)	(0.011)	(0.009)	(0.028)	(0.016)	(0.026)	(0.007)	(0.270)	(0.364)	(0.043)	(0.052)	(0.057)	(0.070)
$t+2$	0.025*	0.054+	-0.029	0.015	0.002	-0.008	-0.063+	-0.010	-0.027	0.005	0.128	-0.031	0.065	0.070	0.050	0.034
	(0.010)	(0.032)	(0.023)	(0.026)	(0.012)	(0.012)	(0.038)	(0.010)	(0.021)	(0.015)	(0.278)	(0.408)	(0.050)	(0.067)	(0.043)	(0.076)
$t+3$	0.057*	0.171*	-0.025	0.045	-0.003	-0.017	-0.077+	-0.024*	-0.038***	-0.008	0.018	-0.010	0.083*	0.044	0.007	-0.032
	(0.027)	(0.067)	(0.026)	(0.028)	(0.014)	(0.015)	(0.043)	(0.011)	(0.010)	(0.009)	(0.319)	(0.574)	(0.040)	(0.056)	(0.052)	(0.078)
$t+4$	0.098+	0.390***	-0.043*	0.032	-0.021	0.011	-0.072+	-0.034	-0.022	0.019	0.463	0.191	0.104+	0.048	-0.004	0.137**
	(0.052)	(0.097)	(0.021)	(0.037)	(0.017)	(0.021)	(0.042)	(0.025)	(0.017)	(0.017)	(0.400)	(0.842)	(0.056)	(0.075)	(0.049)	(0.049)
[Expectedly exposed]																
$t+5$	0.081	0.458***	-0.039+	0.044	-0.029	0.012	-0.038*	-0.002	-0.037+	0.007	0.354	2.235***	0.115	0.214*	0.137*	0.031
	(0.051)	(0.112)	(0.024)	(0.039)	(0.020)	(0.011)	(0.017)	(0.017)	(0.020)	(0.020)	(0.429)	(0.307)	(0.070)	(0.102)	(0.056)	(0.028)
$t+6$	0.110+	0.404*	-0.015	0.091***	-0.033	0.021	-0.050**	-0.042	-0.026	-0.039***	0.886*	1.389***	0.087	0.133***	0.064	-0.028
	(0.061)	(0.163)	(0.020)	(0.022)	(0.025)	(0.013)	(0.017)	(0.034)	(0.020)	(0.010)	(0.428)	(0.255)	(0.065)	(0.035)	(0.070)	(0.094)
$t+7$	0.102	0.403**	-0.001	0.129**	-0.053*	-0.007	-0.068***	-0.002	-0.007	0.001	0.161	1.287+	0.155*	0.121	0.052	0.056***
	(0.068)	(0.156)	(0.020)	(0.040)	(0.026)	(0.009)	(0.020)	(0.027)	(0.025)	(0.025)	(0.415)	(0.660)	(0.062)	(0.114)	(0.131)	(0.011)
N	694,542	631,244	694,362	631,100	648,523	589,970	648,523	589,970	506,897	463,160	494,446	453,748	387,979	356,262	304,443	279,522

Notes: This table presents the event study estimates from two models: one estimating the impact of brand-new program offerings ("BN") and another for reauthorized program offerings ("CV"). "HS Grad" refers to on-time high school graduation, "2yr Col" and "4yr Col" refer to 2-year and 4-year college enrollment, "Col grad" refers to any college completion, and "Qrts. Emp" refers to the number of quarters with earnings. "Pre ATT" refers to average treatment effects (ATT) in the pre-treatment period. "Post ATT: Main" reports post-treatment ATT estimates from our main specification, which includes both unexpectedly and expectedly exposed cohorts in the treated group (t+1 to t+7). "Post ATT: Robust" presents post-treatment ATT estimates from an alternative specification that restricts the treated group to only the unexpectedly exposed cohorts (by t+4). Standard errors for the 95% confidence intervals are clustered at the first enrolled high school level. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

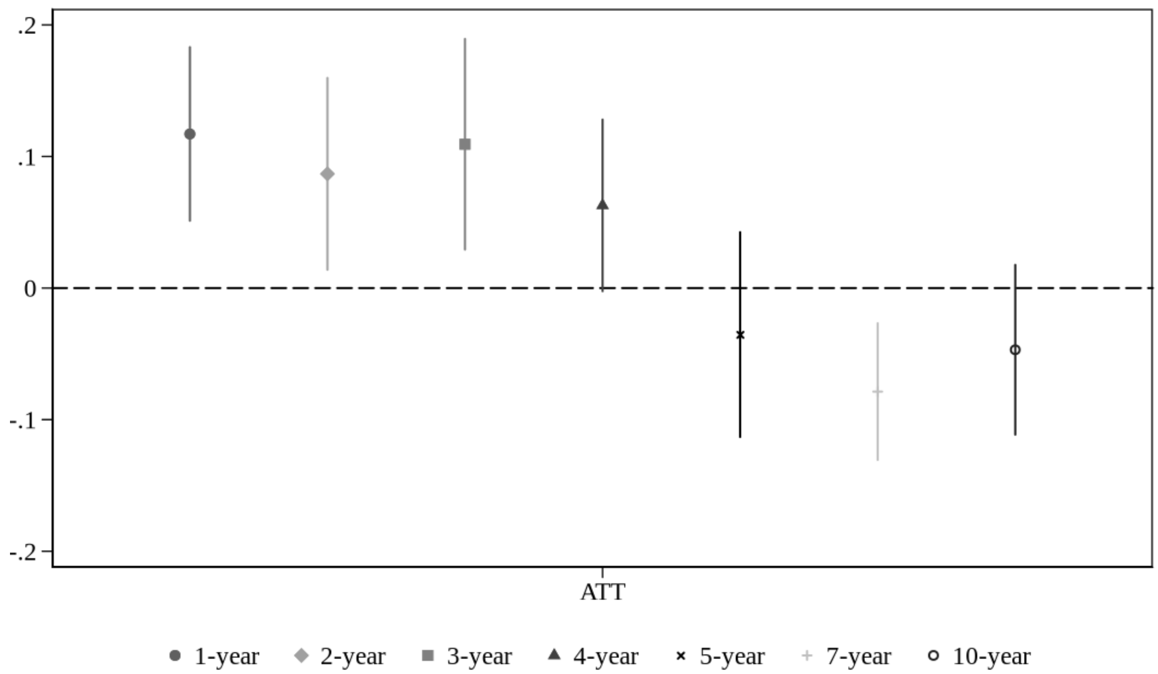
Figure A7. Comparison between early adopters and late adopters.



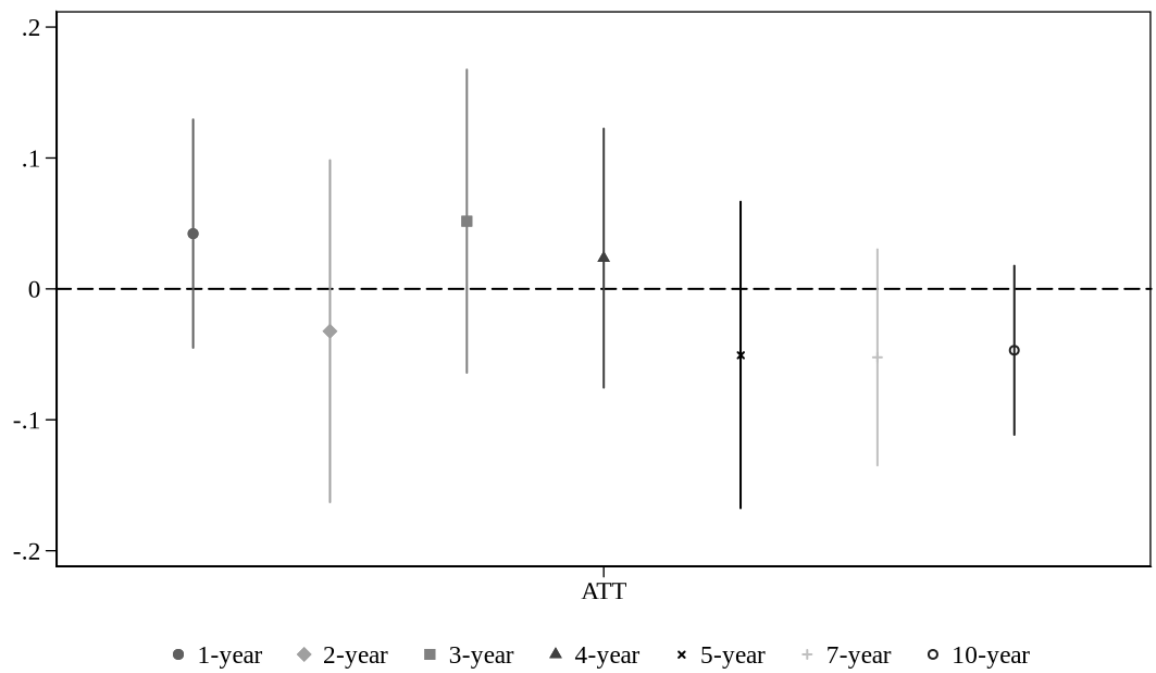
Notes: This set of figures compares event estimates for two subsamples: early adopters—schools that launched their first Chapter 74 program between 2009 and 2015 (black; N = 22)—and late adopters—schools that introduced the program between 2016 and 2022 (gray; N = 30). In each panel, estimates for zero and negative exposure values correspond to unexposed cohorts, while positive values represent exposed cohorts (1 to 4: unexpectedly exposed; 5 to 7: expectedly exposed). Standard errors for the 95% confidence intervals are clustered at the level of students' first enrolled high school.

Figure A8. Impact on earnings: log earnings from 1 to 10 years after high school graduation.

(a) Full 9th-grade Cohorts



(b) Restricted 9th-grade Cohorts: 2005–2006 through 2009–2010



Notes: This figure presents ATT estimates of the impact of exposure to any Chapter 74 program on log earnings, measured from one to ten years after high school graduation. 95% confidence intervals are based on standard errors clustered at the level of the first enrolled high school. The top panel includes all available cohorts (e.g., 1-year: cohorts 2006–2019; 2-year: cohorts 2006–2018; 5-year: cohorts 2006–2015), while the bottom panel restricts the sample to the 2006–2010 cohorts to enable consistent observation of earnings outcomes up to ten years post-graduation.