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Do Dual Enrollment Students Realize Better Long-Run Earnings? Variations in Financial Outcomes Among Key Student Groups

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Abstract

This study considers whether dual enrollment is associated with students' financial outcomes over a longer, twelve-year time horizon after high school graduation than previously analyzed in the existing literature. Using longitudinal administrative data that span K-12, higher education, and the workforce, we conduct a propensity score analysis to understand how dual credit participation among the class of 2011 graduates from high schools in one metropolitan area in Texas correlates with wages and student debt measured through the second quarter of 2023. While we find that dual credit participants are more likely to hold student loan debt on average than non-participants, we also observe higher annual earnings on average among dual credit students—4% to 9% more—compared to non-participants, despite the impact of COVID-19. While earnings become more nuanced when restricting our sample by student population, our results generally suggest that dual credit relates positively to distal measures of students' financial wellbeing.

Keywords

Dual Enrollment, Earnings, Student Debt, Equity, Postsecondary

Introduction

States and postsecondary institutions have expanded dual credit[1] policies and pathways to propel students into the college pipeline early, increasing their odds of persistence and degree attainment, reducing college costs, and decreasing the time required to complete a degree (Ozmun, 2013; Taylor, 2015; Zinth, 2014). States vary in their implementation of dual credit programs; while many states, like Texas and Virginia, have standardized dual credit policies and funding streams, dual credit programs in other states, such as Nebraska, are articulated at the local and institutional level (Lee et al., 2022; Pretlow & Wathington, 2014). General approximations indicate that 1.4 million or roughly 9% of all high school students participate in college courses every year, but it is challenging to measure the expansion of dual credit programs at the national level due to the lack of data. State-level data suggest that dual enrollment has grown tremendously not only in terms of the rates at which students are participating, but also by the number of courses students are taking (Taylor et al., 2022). For example, the proportion of high school graduates with dual enrollment credits in Indiana increased by 21 percentage points from 2012 to 2018 (39% to 60%; Indiana Commission for Higher Education, 2021). In Oregon, the average number of dual credit courses completed increased from 6.8 to 10.4 from 2011 to 2018 (Cox et al., 2019). In Texas, the transformation of dual credit policy over the past three decades has changed dual credit delivery from a limited set of core coursework options prior to 2015 to numerous postsecondary curricula in associate degree and career and technical education (CTE) pathways after the enactment of House Bill 505[2], with many dual credit courses offered at Early College High Schools (ECHS) and Pathways in Technology Early College High Schools (P-TECH) (Miller et al., 2017).

Despite this expansion, findings in the literature regarding the outcomes of dual credit students have been mixed. Research on historical, less comprehensive implementations of dual credit versus the ECHS and P-TECH models–wherein courses taken are not always intentionally aligned to a degree program or pathway–has found positive associations between dual credit participation and achievement both in high school and in postsecondary. However, there is a lack of consensus in these studies regarding the benefits of dual credit for traditionally underserved populations; some studies suggest dual credit participation favors college matriculation and completion for minoritized and underserved students (Blankenberger et al., 2017; Lee et al., 2022; Liu et al., 2020), while others find that these benefits are limited or naught (Lee & Villarreal, 2023; Moreno et al., 2019).

This mixed evidence raises questions about the equity implications of dual enrollment in states continuing to grow and refine their offerings. Furthermore, there is little research assessing the long-term financial outcomes of some of the earliest cohorts of dual credit participants. Very few studies investigate the relationship between dual credit participation and wages and student debt, and those that do have a limited time horizon, assessing only six years or less after high school graduation (Henneberger et al., 2022; Hu & Ortagus, 2023; Phelps & Chan, 2016). Studying these relationships is necessary to understand whether the benefits of taking a dual credit course extend to the labor market and support students' financial wellbeing, both overall and by student subgroup. As a broader swath of states continues to develop dual credit policy, Texas's long history of dual enrollment now offers more than a decade of evidence to help fill these gaps in the literature and inform these policy efforts.

Our study uses the 2011 high school graduating class from a Texas metropolitan region to examine relationships between dual enrollment and student loan debt and earnings outcomes over a twelve-year period; we analyze how relationships between dual credit participation and outcomes vary across specific student populations, such as economically disadvantaged, limited English proficient (LEP), and academically disadvantaged student groups. Disaggregating results by key demographic and academic groups allows us to gauge whether the benefits of dual credit are equitable. We conclude that participation in dual enrollment is generally associated with positive earnings outcomes, but such benefits do not reach all underserved student groups. While our population of focus predates the current dual credit landscape in the State, which now offers numerous ECHSs and P-TECHs, the 2010-2011 dual credit program in Texas is comparable to many dual enrollment models operating today in other regions within the United States. Furthermore, with the development of more technical and CTE dual credit programming over the past few years, there is greater emphasis on the investigation of career- and labor market-focused outcomes. We aim to assess if dual enrollment in its traditional and historical format led to higher earnings over time as a precursory examination to the long-run outcomes of more contemporary implementations of dual enrollment.

Landscape of Dual Credit in Texas, 2007-2010

During the 2007-2008 through the 2009-2010 academic years, the majority of students who enrolled in dual credit courses in Texas were in grades 11 and 12 with students in 12th grade enrolling at the greatest proportions (American Institutes for Research, 2011). 88% of dual credit courses were offered to students at community colleges and taught by college instructors (Greater Texas Foundation, 2016). Dual credit participation was not equitably distributed across demographic groups during this period; on average, almost 50% of students were White, approximately 40% were Hispanic, and under 10% were African American. Economically disadvantaged and limited English proficient students were underrepresented in dual enrollment.

Almost 98% of students were not LEP in 2009-2010, and approximately two-thirds of students were not economically disadvantaged in 2007-2008; however, the proportion of not economically disadvantaged decreased to approximately 50% by 2009-2010. On average, a little over one-third of courses taken for dual credit in Texas were in social studies or history, a little over a quarter of courses were in English, and approximately 10% of courses taken were in CTE. Over 90% of all students who participated in dual enrollment, irrespective of the type of courses taken, passed exit-level State standardized exams in high school. The majority of higher education (primarily community colleges), school district, and high school administrators reported that dual credit courses were rigorous across all course types, including courses offered both on high school and college campuses—the quality of courses attributed to a standardized monitoring process of instructor/teacher quality, curriculum, and pedagogy as well as curriculum alignment of courses with the State's knowledge and skills standards (TEKS). 88% of school district and high school administrators affirmed dual credit courses were either "effective" or "very effective" in aiding college enrollment, while 75-78% reported that International Baccalaureate (IB) programs and Advanced Placement (AP) classes were effective/very effective in preparing students for college (American Institutes for Research, 2011). Possible factors contributing to the efficacy of dual enrollment on college going may have been related to the college campus experience; attending dual credit courses on college campuses may have allowed students to become accustomed to the college environment, and relationships with college instructors may have increased students' motivation to enroll after high school graduation. With evidence suggesting that dual enrollment during this early period promoted high school academic achievement and college enrollment, whether the program also enabled positive outcomes in the longer run is worth examining, as our study aims to accomplish.

Literature Review

Existing studies clearly demonstrate an association between dual credit participation and short-term college-going outcomes, including increased academic momentum in high school, the likelihood of college enrollment and persistence, and degree completion. In relation to high school success, some studies indicate that dual credit participation increases student achievement by way of improved test scores, increased accumulation of dual credit hours, increased likelihood of graduation and improvement in four-year high school graduation rates, as well as improved college application rates (Haskell, 2016; Villarreal, 2018; Lee et al., 2022). Regarding college outcomes, some studies find more robust and positive associations between dual enrollment and college access, persistence, and completion for traditionally underserved populations such as low-income students, underrepresented racial and ethnic groups, women, first-generation, and academically struggling students (An, 2013; Henneberger et al., 2022; Liu et al., 2020; Blankenberger et al., 2017; Lee et al., 2022; An & Taylor, 2019); other studies find less positive or insignificant relationships between dual credit participation and college outcomes for some or all underserved student groups examined (Kremer, 2022; Lee & Villarreal, 2023; Moreno et al., 2019; Phelps & Chan, 2016; Struhl & Vargas, 2012;). These studies employ ordinary least squares (OLS), propensity matching, and other correlational estimation approaches, such as fixed effects, to control for a range of student baseline characteristics.

Experimental studies investigating the effects of dual enrollment outside of the ECHS and P-TECH models observe more subdued impacts on student outcomes than the research which utilizes selection on observables and correlational approaches. Two studies uncover modest causal effects of dual credit participation on college choice (selection of a 4-year over a 2-year institution), enrollment, and completion. Hemelt, Schwartz, and Dynarski (2019) conduct a randomized controlled trial of the impact of dual enrollment math courses on a set of high school and college outcomes in Tennessee and observe that the enrollment in an advanced dual credit algebra course increases enrollment in more rigorous math courses but has no effect on college enrollment. Miller et al. (2018) use instrumental variables in conjunction with differences-in-differences and fixed effects approaches to control for both observable and unobservable variables influencing selection into dual credit courses and college enrollment and completion. The authors find moderate effects of dual credit participation on increased college enrollment and credential completion, particularly in two-year institutions, and even less positive effects for low-income and minoritized students compared to more high-income and White students, which is attributed to lesser academic preparedness.

The research pertaining to the assessment of ECHS and P-TECH programs employs more robust causal designs to estimate the effects of dual enrollment, yielding positive impacts on student outcomes. Through randomized experiments of ECHSs which use a lottery-based admissions process, Berger et al. (2014) and Zeiser et al. (2019) conclude that dual credit participation had a significant impact on college enrollment and degree completion for students who enrolled in early college high schools compared to those who did not enroll. Another randomized controlled trial of New York City's six-year P-TECH program from grade levels 9 through 14 (sophomore year in postsecondary) finds significant effects on students attempting and earning more college credits and passing Regents exams (required for admission into City College of New York schools); the study's findings also suggest that the program helps at risk students achieve high school success and become prepared for college (Dixon & Rosen, 2022).

Our contribution to the scholarship is on the long-term outcomes of dual enrollment and not on the causal impact of dual credit participation. To date and to the authors' knowledge, only two studies examine dual enrollment and post-college earnings through propensity score and/or linear regression methods, evaluating outcomes only three to six years after high school graduation (Henneberger et al., 2022; Phelps & Chan, 2016); one other study addresses the relationship between dual credit participation and student loan debt (Hu & Ortagus, 2023). Henneberger, Witzen, and Preston (2022) estimate earnings at the 6th year after high school graduation for Maryland's 2010 cohort and observe a significant and positive relationship between dual credit participation and early labor market earnings, with such benefits more robust for traditionally underrepresented students, specifically African American, other race, and free/reduced lunch-eligible students. Phelps & Chan (2016) examine the relationship between CTE dual credit course completion at a Wisconsin community college from 2008 to 2010 and their short-term earnings three to five years after high school graduation; their findings suggest a significant and positive association between CTE dual credit course completion and earnings—particularly for those who completed dual credit courses on a high school campus with high school instructors, had higher Accuplacer math and reading scores, and pursued longer-term credentials in STEM and engineering pathways. Hu and Ortagus (2023) observe no statistically significant differences between dual enrollment and the likelihood of taking student loans or the amount of student debt accumulated among borrowers six years after college entry; they observe a statistically significant negative relationship between dual credit participation and borrowing student loans among non-White student groups, excluding Asian/Pacific Islander students. While these studies generally show positive earnings and student debt outcomes among underrepresented student populations, they estimate these outcomes over a narrow time horizon and do not examine differences for a wider-ranging set of student groups.

We contribute to the existing literature in two ways. First, we examine the relationships between dual credit education and distal financial outcomes—earnings and student debt up to twelve years post-high school graduation. Second, we analyze how these relationships vary across several student subgroups, including students who were economically or academically disadvantaged. We adopt the commonly used methods of mixed effects modeling and propensity score analysis to mitigate selection bias when examining these financial outcomes; while this strategy relies on a selection on observables approach and not a random assignment mechanism, we are still able to include a rich set of control variables to examine longer-term outcomes. We also analyze heterogeneity in the relationships between dual credit participation and outcomes to determine if these associations differ for minoritized, disadvantaged, limited English proficient, female, and lower-performing students. Generally, we find few differences in student loan debt amounts between dual credit participants and non-participants in the overall sample and subgroups over the twelve-year timeframe, with the exception of the African American and the State standardized exam ‘passing’ student populations. With earnings, however, we find that the benefits of dual credit participation do extend to longer-term wage outcomes for the general sample, but such benefits are not always equitable across key student subgroups.

Data and Methods

Data

We draw on individual-level administrative data from a statewide longitudinal data system (UT Dallas Education Research Center) to analyze outcomes of interest for the 2011 high school graduating class in independent school districts within the service area of a large Texas community college system. The ERC holds longitudinal student- and person-level records from the State’s K-12 agency, higher education coordinating board, and workforce commission. Our dataset included a range of explanatory variables from 8th through 12th grade, including comprehensive academic records, demographic characteristics, and environmental characteristics of their middle and high schools (campus ratings and graduation rates). For the outcome variables, records included quarterly wages earned from employers covered by the State's unemployment insurance system, yearly student loan amounts awarded from federal and state student loan programs, and enrollment and credential completion (associate, baccalaureate, graduate degree, etc.) from two-year, four-year, private, and health-science higher education institutions in Texas[3].

Sample

Our study considered students who graduated from 22 independent school districts (ISDs) in the service area of a large community college system in Texas during the 2010-2011 school year. These districts were selected based on their dual-credit and data-sharing agreements with the College and their proximity to the College's campuses. The 2011 graduating cohort was selected to allow for up to a twelve-year window after high school graduation in which to measure students' earnings and debt outcomes. The sample was restricted to students who were enrolled in non-alternative education (such as disciplinary alternative education and juvenile justice education) campuses in 11th and 12th grade, as these programs did not offer dual credit courses in the 2009-2010 and 2010-2011 academic years. The sample was also restricted to students enrolled in the appropriate academic years (or in their grade level) at a public school in the State from 8th grade (2006-2007) through 12th grade (2010-2011) to preclude missing data due to student movement and grade repetition or acceleration. Further reduction of the sample entailed the exclusion of students who did not have records for 8th grade math and reading test scores on the State's standardized assessment. Aligning with conventional approaches in the literature to control for academic achievement and ability (Fernandez, Ro & Suh, 2022; Lee & Villareal, 2022; Struhl & Vargas, 2012), we used students' performance on State math and reading assessments as proxies for academic preparation in high school. The final sample comprised 20,858 students, 3,783 (18.14%) of whom enrolled in at least one dual credit course in 11^{th} or 12^{th} grade, and 17,075 (81.86%) of whom did not take any dual credit courses. Table 1 presents summary statistics for our sample and demonstrates that White, female, and more affluent students and students with higher scores in 8^{th} grade standardized assessments were most likely to participate in dual credit.

In addition to analyzing results for our full sample, we divided the sample into groups based on gender, race and ethnicity, socioeconomic status (disadvantaged and non-disadvantaged according to free/reduced lunch program participation), limited English proficiency status, and performance brackets for the 8^{th} grade State standardized math and reading exams to examine differential associations between dual credit participation and key student populations. Our objective for conducting analyses with these subsamples was to ascertain if the most underserved student groups in our data benefited from dual credit participation in terms of their educational and financial outcomes.

Table 1. Subgroup Proportions in the Unweighted Sample (*N* = 20,858)

Socioeconomic Status	
Disadvantaged - received free/reduced lunch (n = 10,386)	49.79%
Not Disadvantaged - did not receive free/reduced lunch (n = 10,472)	50.21%
Race/Ethnicity	
White (n = 7,545)	36.17%
African American (n = 4,420)	21.19%
Hispanic (n = 7,644)	36.65%
Asian (n = 1,153)	5.53%
Native American (n = 96)	< 1%
Gender	
Female (n = 10,912)	52.32%
Male (n = 9,946)	47.68%
English Proficiency	
Limited English Proficient (n = 1,612)	7.73%
Not Limited English Proficient (n = 19,246)	92.27%
8th Grade Standardized Test Performance	
Passed Math & Reading/Commended in at least one (n = 8,739)	41.9%
Passed Math & Reading/Commended in neither (n = 7,627)	36.57%
Failed at least one test (n = 4,429)	21.54%

Variables

The primary independent variable for dual credit participation was a dichotomous indicator measuring whether a student enrolled in at least one dual credit course in 11th or 12th grade. The dependent variable for wages was (the natural log of) annual earnings over a twelve-year period from the time of high school graduation, measured between Q3 2011 and Q2 2023 and adjusted to Q1 2023 dollars using CPI-U (Federal Reserve Bank of St. Louis, n.d.)[4]. The dependent variable for student loan debt was the annual total amount of all student loans borrowed (federal, state, and other) over the twelve-year period from the time of high school graduation, measured between Q3 2011 and Q2 2023, adjusted to Q1 2023 dollars, and conditional upon enrollment in a Texas higher education institution. Annual enrollment in a Texas higher education institution over the twelve-year period from the time of high school graduation was also estimated as a dependent variable to assess whether variations in earnings trajectories over time of dual credit participants vs. non-participants were dependent on the probability of being enrolled in college. Control variables included student-level demographic indicators, math and reading scores from 8th-grade State standardized assessments to control for students' academic ability and preparation for dual credit courses in high school, and indicators for whether students attended an early college high school or an alternative education school between 8th and 10th grade. School-level covariates included the graduation rates of students' high schools attended in 10th grade, as well as middle and high school State accountability ratings in their 8th and 10th grades, respectively. All covariates were known prior to each student's first opportunity to take a dual credit class. Appendix 7 includes more detailed descriptions of all variables.[5]

Analysis

For this paper, we use propensity score analysis to statistically adjust for potential confounding variables that could bias our estimates because students were not randomly assigned to participate in dual credit education. This method is designed to mitigate selection bias by controlling for observable baseline characteristics when measuring the relationship between dual credit participation and the outcomes of focus. We chose inverse probability weighting (IPW) to estimate the propensity to be treated and establish comparability between the treatment and comparison groups; selection of IPW rather than using other matching techniques allowed us to retain most of the students in our full sample, preserving our sample size for subgroup analysis (Braitman & Rosenbaum, 2002; Guo & Fraser, 2015; Huber, 2014; Rosenbaum & Rubin, 1983). Keeping with established approaches to selecting covariates (Newgard et al., 2004; Stone & Tang, 2013), we included a set of pretreatment predictors (secondary independent variables described above) to estimate a student's probability of participating in dual credit using logistic regression to determine a propensity score for each unit or student. Using IPW, we estimated the average treatment effect on the treated (ATT)[6] to evaluate how taking dual credit courses influenced participants' outcomes, by comparing their observed outcomes to the reweighted outcomes of non-participants that serve as a counterfactual. After applying weights, the standardized differences in means between the treatment and comparison groups were minimal for the majority of the pretreatment variables, and balance was achieved. Table 2 depicts the sample means and the standardized differences for the treatment (dual credit participation) and control (untreated/no participation) groups in the full sample pre- and post-weighting. To illustrate that our sample met the common support assumption of IPW—that a range of propensity scores exist for which there are students in both the treatment and comparison groups (sufficient overlap present)—density plots comparing pre-weighted and post-weighted estimated propensity scores for the full sample are shown in Figure 1. Observations with propensity scores falling outside the common support were dropped.

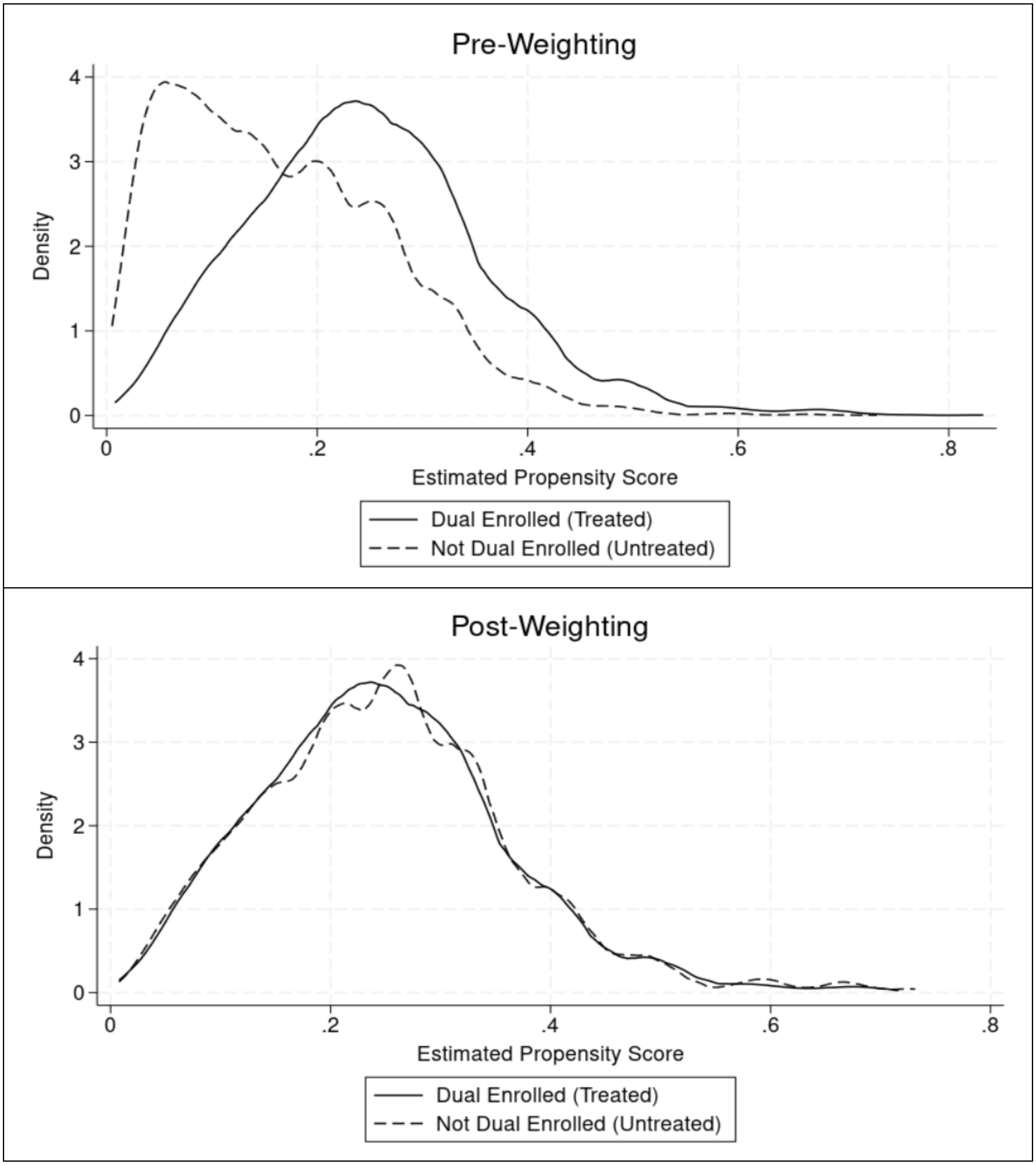
We applied these inverse probability weights to mixed effects models with time fixed effects and individual random effects, using ordinary least squares (OLS) to estimate log annual earnings and annual total student debt and a linear probability model (LPM) to estimate annual enrollment, while controlling for all aforementioned student-level and school-level pretreatment variables. A baseline model measured the association between dual credit participation and each outcome over time (log annual earnings, annual total student debt, annual enrollment) for each period or year for twelve years (2011-2023) for the full sample; five additional subgroup models incorporated interactions between dual credit participation, a single demographic group (economic status, race/ethnicity, gender, LEP status, and standardized test performance), and one period at a time to estimate the relationship between dual credit and each outcome by year and by subgroup.

To explain how students' earnings trajectories varied over time following dual credit participation, we aggregated quarterly wages to an annual frequency in a panel format. We took a simple sum of all quarters with non-missing data rather than interpolating missing quarters to aggregate quarterly wages, and we organized years from Q3 to Q2 of the following year to better align with the academic calendar and the timing of students' high school graduations. For example, we defined the first year after high school graduation from Q3 2011 to Q2 2012, the second from Q3 2012 to Q2 2013, and so on, with the final year we observed being from Q3 2022 to Q2 2023. The same time mapping was used for yearly total student debt and yearly enrollment. In addition to these outcomes of financial wellbeing, we also estimated college enrollment and attainment outcomes up to six years after high school graduation for the cohort via logistic regression, and the results were broadly consistent with past studies. These supplemental findings are presented in Appendix 6.

Table 2. Means and Standardized Differences for the Dual Credit and Non-Dual Credit Groups of the Full Sample

	Pre-weighting (N = 20,858)			*Post-weighting* (N = 20,835)		
	Mean, Dual Credit	Mean, Non-Dual Credit	Standardized difference	Mean, Dual Credit	Mean, Non-Dual Credit	Standardized difference
Male	0.41	0.49	-0.173	0.41	0.4	0.006
Female	0.59	0.51	0.173	0.59	0.6	-0.006
Race/Ethnicity						
African American	0.18	0.22	-0.095	0.18	0.18	0.003
Asian	0.09	0.05	0.158	0.09	0.09	-0.01
Hispanic	0.27	0.39	-0.245	0.27	0.27	-0.001
Native American	0.01	0	0.033	0.01	0.01	0.005
White	0.45	0.34	0.227	0.45	0.45	0.003
Limited English Proficiency	0.02	0.09	-0.324	0.02	0.02	0.001
Special Education	0.02	0.06	-0.201	0.02	0.02	0.001
Gifted & Talented	0.28	0.17	0.278	0.28	0.29	-0.016
At Risk	0.26	0.52	-0.555	0.26	0.26	0.005
Economic Disadvantage	0.38	0.52	-0.298	0.38	0.38	0.002
Early College High School	0.02	0	0.132	0.02	0.02	-0.027
Alternative Education	0	0.01	-0.032	0	0	0.001
Graduation rate of high school student attended in 10th grade	0.88	0.85	0.338	0.88	0.88	-0.005
8th Grade Standardized Math & Reading scores						
Commended on one/both tests	0.6	0.38	0.466	0.6	0.61	-0.005
Passed both tests	0.32	0.38	-0.129	0.32	0.31	0.004
Failed one/both tests	0.08	0.25	-0.459	0.08	0.08	0.002
School rating in 10th grade						
Academically Unacceptable	0.02	0.08	-0.261	0.02	0.02	-0.001
Academically Acceptable	0.45	0.41	0.087	0.45	0.45	0.012
Recognized	0.33	0.36	-0.063	0.33	0.33	0.004
Exemplary	0.19	0.15	0.114	0.19	0.2	-0.02
Not Rated	0	0	-0.015	0	0	-0.002
School rating in 8th grade						
Academically Unacceptable	0.01	0.02	-0.096	0.01	0.01	0.001
Academically Acceptable	0.49	0.58	-0.179	0.49	0.49	-0.001
Recognized	0.34	0.3	0.098	0.34	0.35	0.016
Exemplary	0.13	0.09	0.122	0.13	0.13	-0.005
Not Rated	0.03	0.01	0.109	0.03	0.03	0.002

Figure 1. Pre-/Post-Weighted Estimated Propensity Scores for Full Sample



Findings

Annual Earnings

Table 3 presents the marginal effects of dual credit participation on the log wages, enrollment, and total debt in each annual period from Q3 2011 to Q2 2023 for the full sample. Linear probability/OLS models with IPW and all pre-treatment controls used to compute propensity scores included were employed to generate these results, which interact dual credit participation with each period to determine the effect of dual enrollment in each period on the outcomes of focus. The regression coefficients of these models for the full sample and subgroups are available upon request. Figure 2.1 shows the percent change in earnings for dual credit participants over twelve years post high school graduation in relation to students who did not take dual credit for the full sample; Figure 2.2 depicts the percentage point change in the probability of enrollment from dual credit participation for the full sample. The dashed lines in the subsequent figures denote the 95 percent confidence interval. Our earnings results in Figure 2.1 show that dual credit participants had lower workforce participation in the first four years following high school graduation wherein they were most likely to enroll in postsecondary education than non-participants. For example, in year one, dual credit participants had 15% lower earnings than non-participants, and in year three, participants had 11% lower earnings than non-participants. However, this gap diminished by year six, and by twelve years after high school graduation, we observed highly significant to moderately significant higher earnings, ranging from 4% to 9%, for dual credit participants compared to non-participants. While effects from COVID-19 in years nine through twelve may have contributed to variation in earnings from dual credit participation, participants still fared better than non-participants, experiencing 5% higher earnings from year eleven to twelve (2021-2023).

In order to more holistically explain why earnings were lower for dual credit participants than non-participants in the first years after high school graduation, we examined the probability of enrollment in college for dual credit participants over the twelve-year timeframe to determine if dual credit students were more likely to enroll in college right after high school and, thereby, less likely to be in the workforce or work full-time. From the annual enrollment results for the full sample shown in Figure 2.2, we found an 18-percentage point increase in the probability of enrollment for dual credit participants versus non-participants in the first two years after high school graduation, with this positive trend continuing in subsequent years; these differences were highly significant at the 1% level. While the probability of annual enrollment for dual credit students gradually declined after the second year post high school graduation, percentage point differences remained positive and highly significant in comparison to non-participants. On the whole, a comparison between the earnings and enrollment trajectories shows that the likelihood of dual credit students to pursue postsecondary education immediately after high school may significantly account for why they are likely to have lower wages than non-participants during this time.

Table 3. Marginal Effects of Dual Credit Participation for Linear Probability Models Estimating Log Wages, Enrollment, and Debt for Full Sample

	Y-1 (Q3 2011-Q2 2012)	Y-2 (Q3 2012-Q2 2013)	Y-3 (Q3 2013-Q2 2014)	Y-4 (Q3 2014-Q2 2015)	Y-5 (Q3 2015-Q2 2016)	Y-6 (Q3 2016-Q2 2017)	Y-7 (Q3 2017-Q2 2018)	Y-8 (Q3 2018-Q2 2019)	Y-9 (Q3 2019-Q2 2020)	Y-10 (Q3 2020-Q2 2021)	Y-11 (Q3 2021-Q2 2022)	Y-12 (Q3 2022-Q2 2023)
Log Wages	-0.15*** (0.030) (*n* = 12,887)	-0.13*** (0.028) (*n* = 13,996)	-0.11*** (0.028) (*n* = 14,085)	-0.05* (0.027) (*n* = 14,176)	0.02 (0.025) (*n* = 14,623)	0.07*** (0.024) (*n* = 14,620)	0.09*** (0.024) (*n* = 14,496)	0.06*** (0.024) (*n* = 14,407)	0.04* (0.023) (*n* = 14,288)	0.06** (0.024) (*n* = 13,876)	0.04* (0.023) (*n* = 13,965)	0.09*** (0.022) (*n* = 13,837)
Enrollment	0.18*** (0.008) (*n* = 12,654)	0.18*** (0.008) (*n* = 11,260)	0.16*** (0.009) (*n* = 10,093)	0.14*** (0.009) (*n* = 9,066)	0.09*** (0.009) (*n* = 6,708)	0.07*** (0.009) (*n* = 4,788)	0.04*** (0.009) (*n* = 3,683)	0.03*** (0.007) (*n* = 2,878)	0.03*** (0.006) (*n* = 2,260)	0.03*** (0.006) (*n* = 1,802)	0.03*** (0.006) (*n* = 1,443)	0.02*** (0.005) (*n* = 1,151)
Debt (in dollars $)	353.35 (243.183) (*n* = 4,324)	459.65* (248.534) (*n* = 3,608)	479.09* (280.502) (*n* = 3,540)	375.18 (300.883) (*n* = 3,434)	-288.33 (359.457) (*n* = 2,553)	-255.20 (515.637) (*n* = 1,707)	86.86 (712.587) (*n* = 1,282)	344.79 (877.060) (*n* = 950)	1,044.60 (983.152) (*n* = 719)	1,331.53 (1,040.526) (*n* = 576)	1,422.04 (1,061.046) (*n* = 438)	1,123.98 (1,179.108) (*n* = 337)

*** p < 0.01, ** p < 0.05, * p < 0.1

Figure 2.1. Percent Change in Total Annual Earnings from Participation in Dual Credit Over Twelve Years - Full Sample

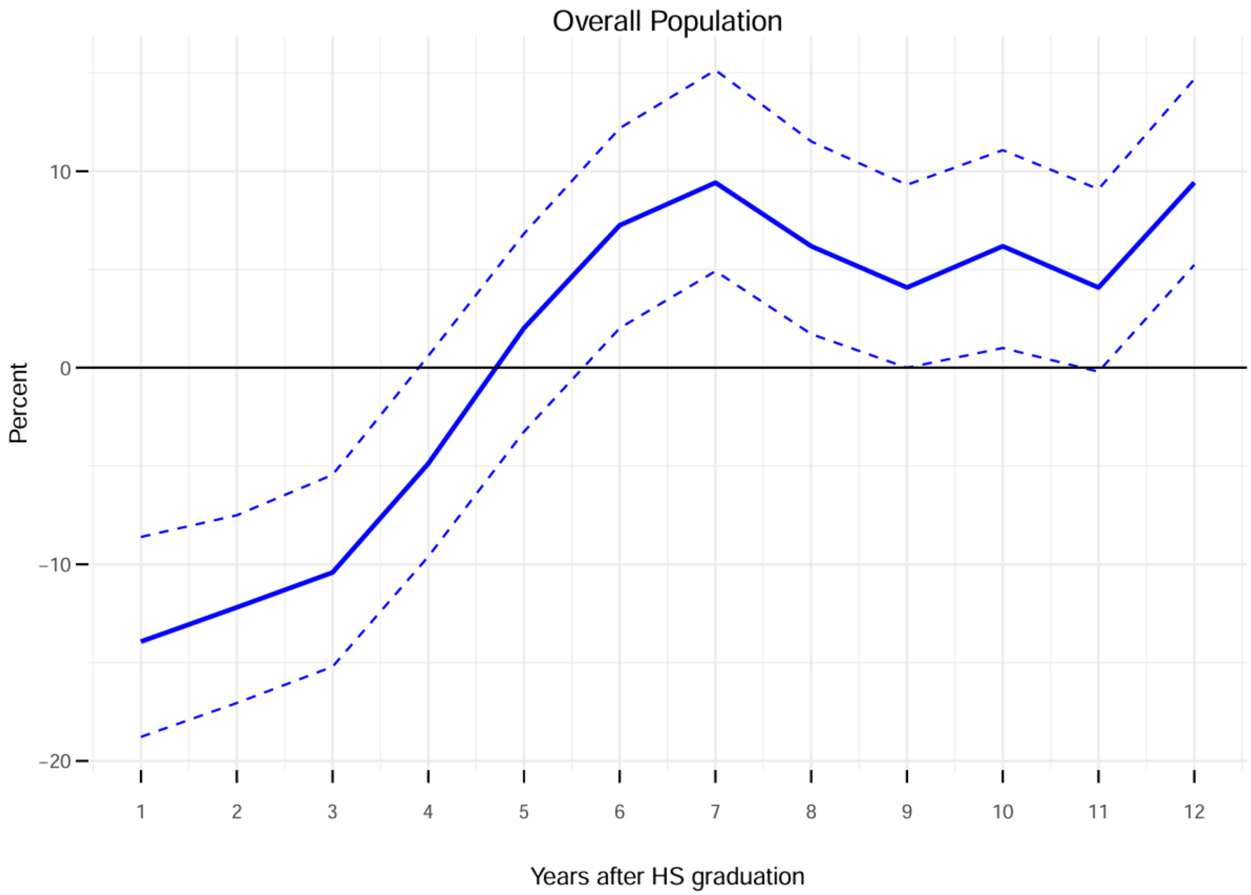
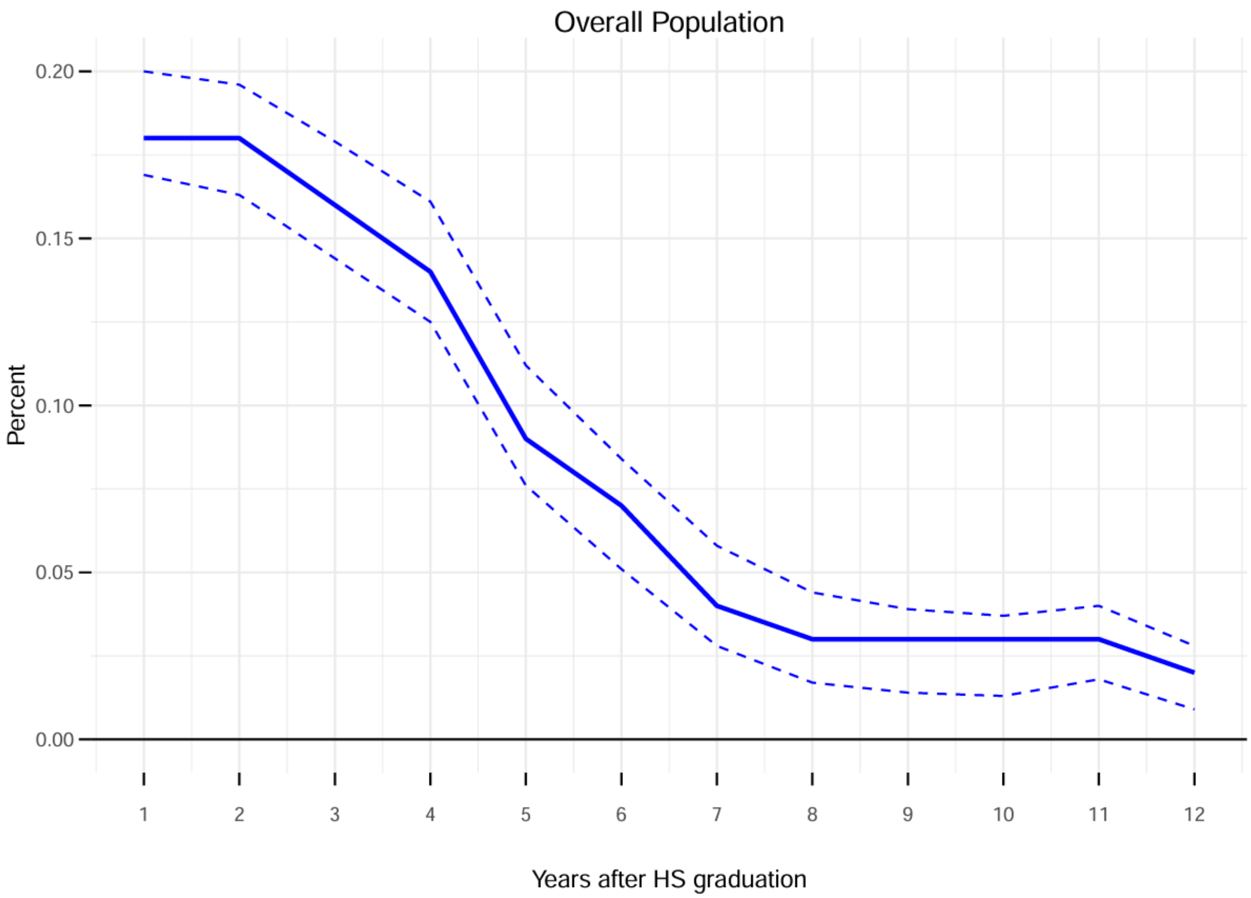


Figure 2.2. Percentage Point Change in Probability of Enrollment from Participation in Dual Credit Over Twelve Years - Full Sample



Figures 3.1-3.5 present earnings results for the demographic subpopulations, showing the percent change in earnings for dual credit participants in each subgroup compared to non-participants in that subgroup for each period over twelve years following high school graduation. Figures 4.1-4.5 in Appendix 4 depict parallel trajectories for probability of enrollment for the subgroups. Margins results tables for the subgroups are reported in Appendices 1, 2 and 3. Earnings and enrollment trajectories for dual credit participants versus non-participants for the gender group (men and women) were rather similar and closely mirrored the earnings and enrollment trajectories of the full sample (Figure 3.3); but a significant increase in earnings was

more discernible for men than women during last six years after high school graduation. Within the English proficiency groups, we observed little to no statistically significant differences in earnings by dual credit participation for LEP students. Non-LEP students benefited more from dual credit participation with high to modest significant differences earnings across the twelve-year horizon; their earnings and enrollment trajectories were comparable to the respective trajectories for the full sample (Figure 3.4).

Differences in earnings with regard to racial and ethnic groups indicate that dual credit participation benefited White students more than African American, Hispanic, Asian, and Native American students (Figure 3.1). When dual credit participants were compared to non-participants in other student groups, we observed a highly significant 8% to 13% annual increase in earnings from year six onwards for White dual credit participants, while African American dual credit participants had moderately significant to no significant increases in earnings from years six to twelve after high school graduation. Hispanic dual credit participants did not experience any differences in earnings in comparison to non-participants from year six onwards. In terms of socioeconomic status, we found economically disadvantaged students benefited more from dual credit participation than non-disadvantaged dual credit students; while both groups had significant declines in the earnings during the first three to four years after high school completion, disadvantaged dual credit participants experienced more years of significant growth in wages from years six to twelve. Non-disadvantaged dual credit participants had a 9% to 12% annual increase in earnings from year six to seven, but subsequently, did not see a significant increase in wages until year twelve (12%). Disadvantaged students have more consistent annual increase in earnings, ranging from 7% to 14% from years seven to twelve. Furthermore, disadvantaged and non-disadvantaged dual credit participants had rather different wage trajectories; non-disadvantaged dual credit participants had an earnings trajectory similar to the full sample with nonlinear increases and declines in wages over the twelve-year period, while disadvantaged dual credit participants experienced a more linear increase in the earnings with less decrease in the first four years after high school graduation (Figure 3.2). One possible explanation is that dual credit participants with limited financial resources were employed at higher rates while enrolled in college than their counterparts and, therefore, had higher earnings in the first years. Among standardized test performance groups, we observed dual credit participation benefited the middle-performing students more than high achieving and underperforming students (Figure 3.5). Earnings increases from dual credit participation were generally highly significant for the passing/not commended group in the latter half of the twelve-year timeframe (13% and 14% increases in the likelihood of earnings in year seven and eight respectively), but not for the commended or failing groups to the same extent. Possible explanations for these results are a) commended performers may already have had robust earnings outcomes without dual enrollment, and b) failing students may have struggled in the labor market due to factors unrelated to dual credit participation.

The general finding of dual credit participation being associated with lower earnings in the initial years following high school graduation and greater earnings in subsequent years aligns with the well-established idea that college-going can be an important determinant of better earnings outcomes. Overall, our analysis demonstrates that dual credit participants are more likely to enroll in college than non-participants in the beginning years after high school completion. This explicates the negative earning trajectories of dual credit students initially when they allocate more time to postsecondary education than students who did not partake in dual credit. The majority of those who did not participate were more likely to never pursue postsecondary education and thus work and earn more during the first three to four years after high school graduation. After these initial years, however, dual credit participants commanded higher wages than non-participants from years six to twelve after high school graduation because greater shares of them now have had some postsecondary experience or a credential compared to non-participants, and fewer were concurrently enrolled during those years.

Figure 3.1. Percent Change in Earnings Within Subsamples – Race/Ethnicity

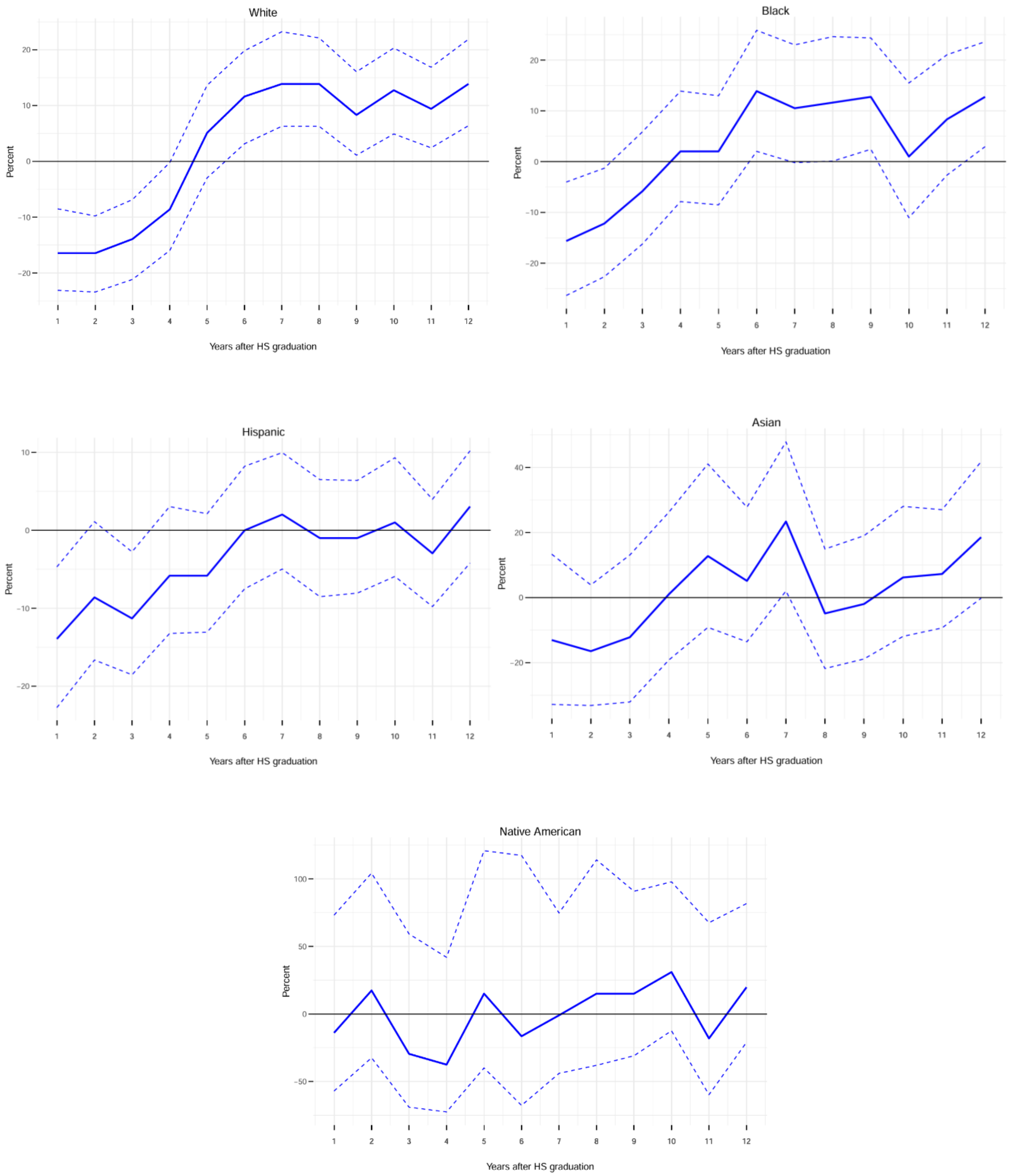


Figure 3.2. Percent Change in Earnings Within Subsamples – Socioeconomic Status

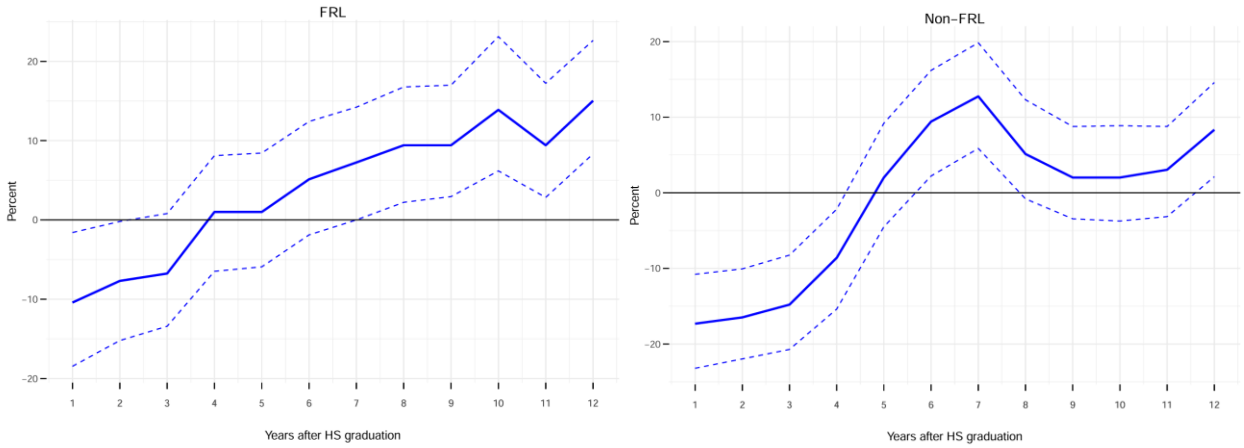


Figure 3.3. Percent Change in Earnings Within Subsamples – Gender

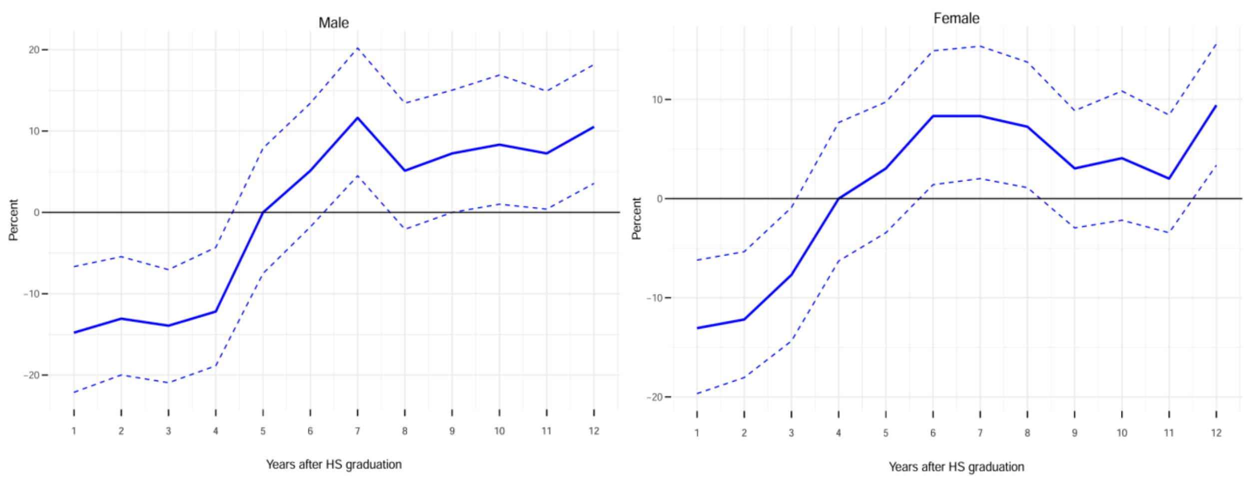


Figure 3.4. Percent Change in Earnings Within Subsamples – English Proficiency

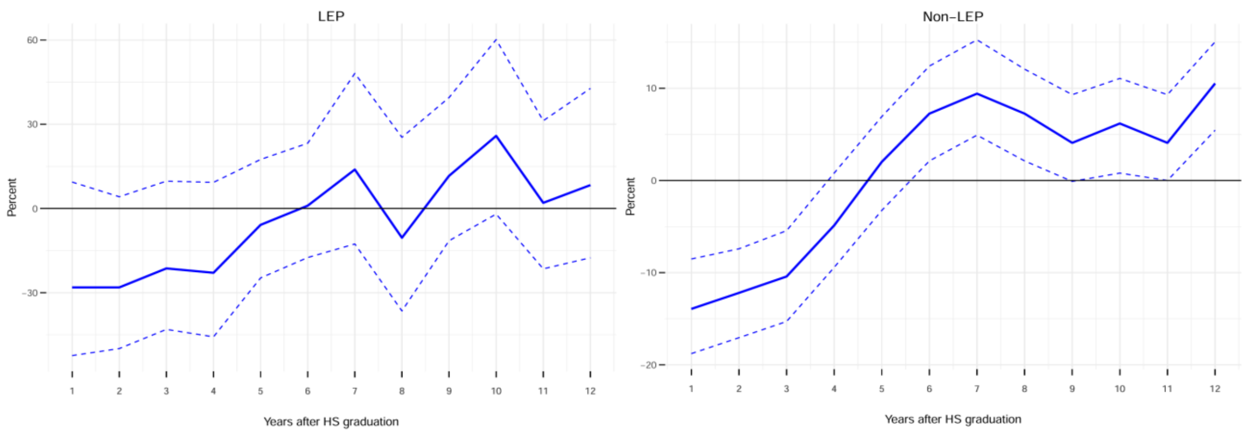
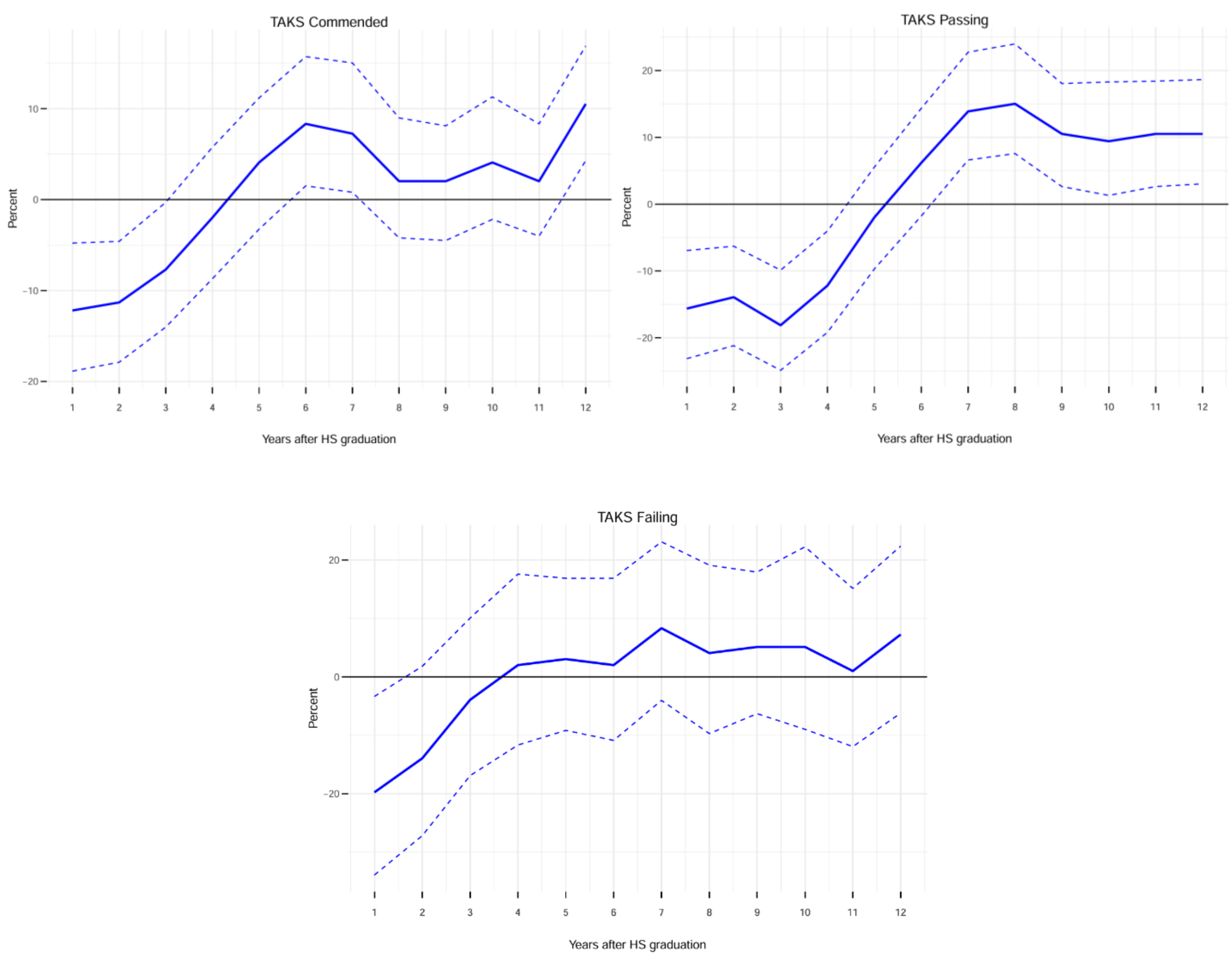


Figure 3.5. Percent Change in Earnings Within Subsamples – Standardized Test Performance



Student Loan Debt

Figure 5.1 presents the *X* dollar ($) increase or decrease in student debt from participation in dual credit compared to non-participation (conditional upon postsecondary enrollment) over twelve years after high school completion for the full sample. We found weakly significant differences in annual total student loan amounts for the initial years post high school graduation; participation in dual credit was associated with a $459.65 increase in student debt in year two and a $479.09 increase in year three. While debt amounts for the full sample decreased in years five and six for dual credit participants compared to non-participants and then increased again in year seven onwards, these differences were not statistically significant. Given that the confidence intervals substantially widened for annual debt dollars from year five onwards both in the full sample and subsamples due to the diminishing sample sizes of dual enrollment students holding debt, estimates may be inconclusive for the latter part of the twelve-year period. Despite the overall non-significant relationship between dual credit participation and debt for the full sample, subsample analyses indicate significant increases in debt for specific periods for certain student groups including economically disadvantaged students, African American students, and standardized test passing/not commended students. Among the strongly significant results observed in the subpopulation analyses shown in Figures 5.2 to 5.6, we found a $831.08 to $855.49 increase in debt from year three to year four for economically disadvantaged dual credit participants compared to non-participants, a $1,231.84 to $1,055.63 increase in debt from years one through four for African American dual credit participants compared to non-participants, and a $1,122.83 to $1,085.63 increase in debt from year one to two for the standardized test passing/not commended dual credit participants compared to non-participants. While dual credit students in the passing performance bracket saw a decline in debt in years five through nine, the results were largely not significant. Negative but primarily non-significant differences between dual credit participation and annual student debt were generally observed for Asian and Hispanic dual credit participants from immediately after high school graduation through approximately year seven to year ten—groups that are determined to traditionally be debt averse in the literature. Consistent with the research related to student debt decision-making, our findings indicate Asian and Hispanic dual enrollment students were less disposed to carrying more debt than African American and White dual credit participants (Elengold et al., 2021; Boatman et al., 2017; Cunningham & Santiago, 2008). Overall, our results did not demonstrate that dual credit participation helped students, specifically underserved students, attend college with less debt.

Figure 5.1. Dollar ($) Change in Student Debt from Participation in Dual Credit Over Twelve Years - Full Sample

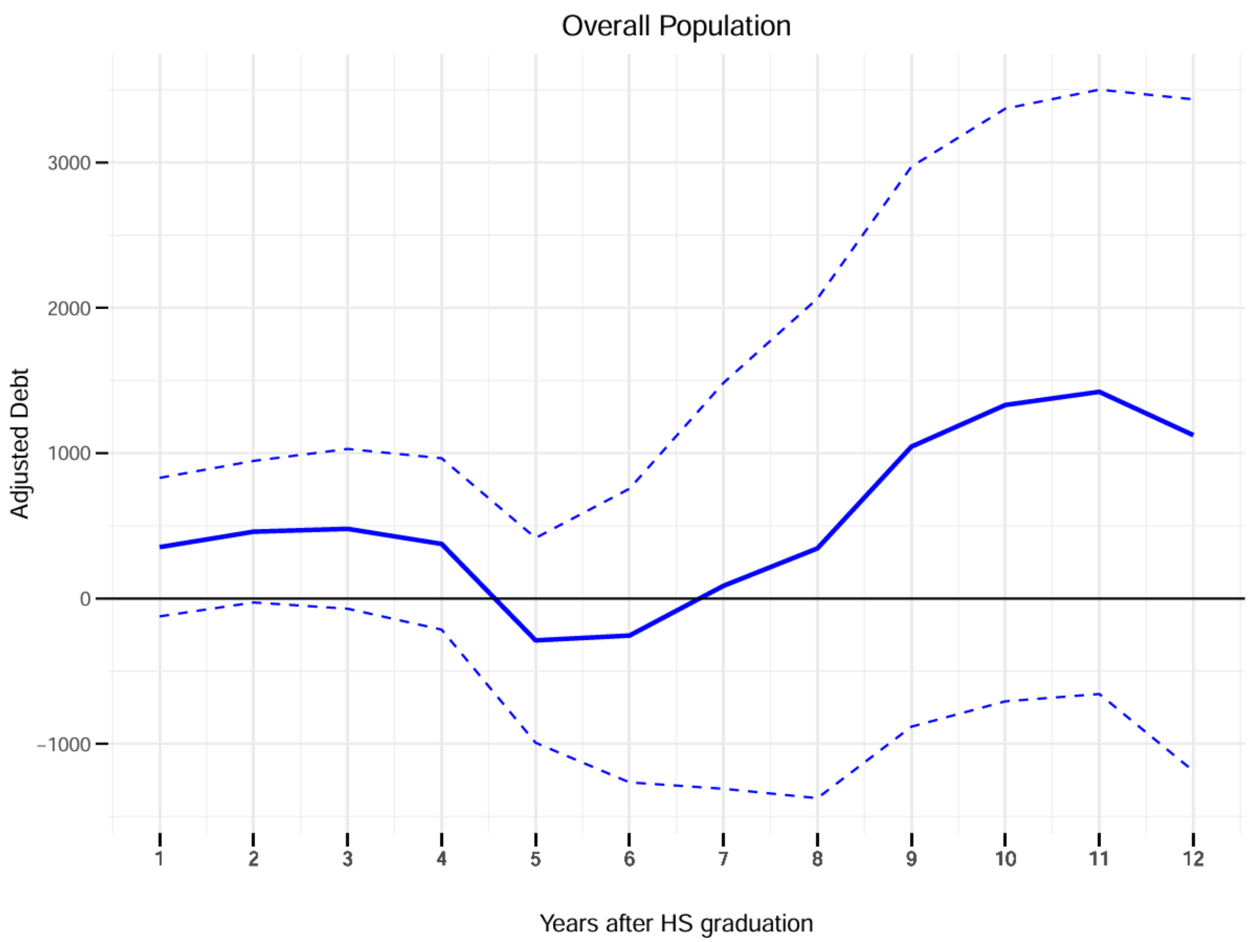


Figure 5.2. Dollar ($) Change in Student Debt Within Subsample - Race/Ethnicity

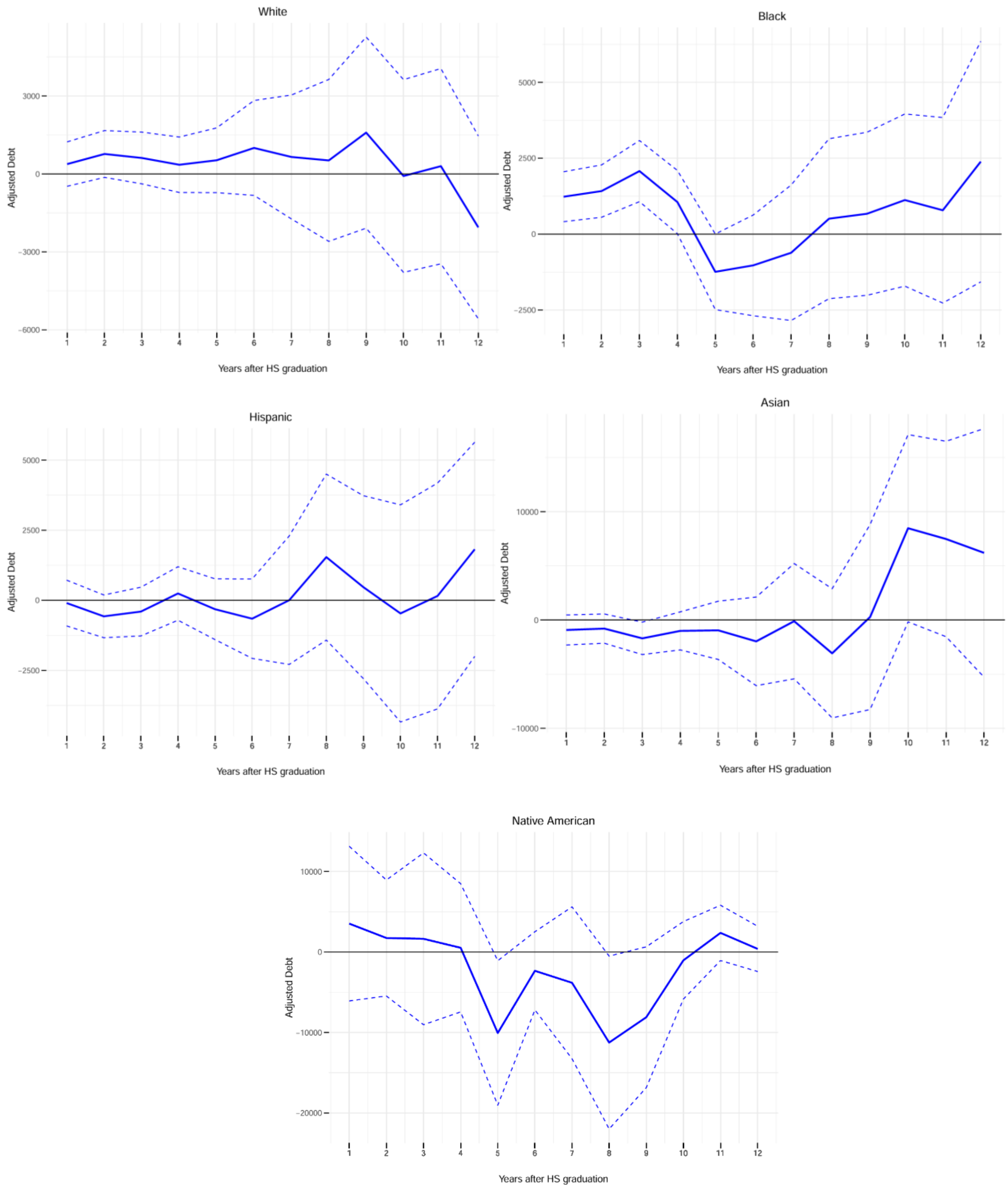


Figure 5.3. Dollar ($) Change in Student Debt Within Subsample - Socioeconomic Status

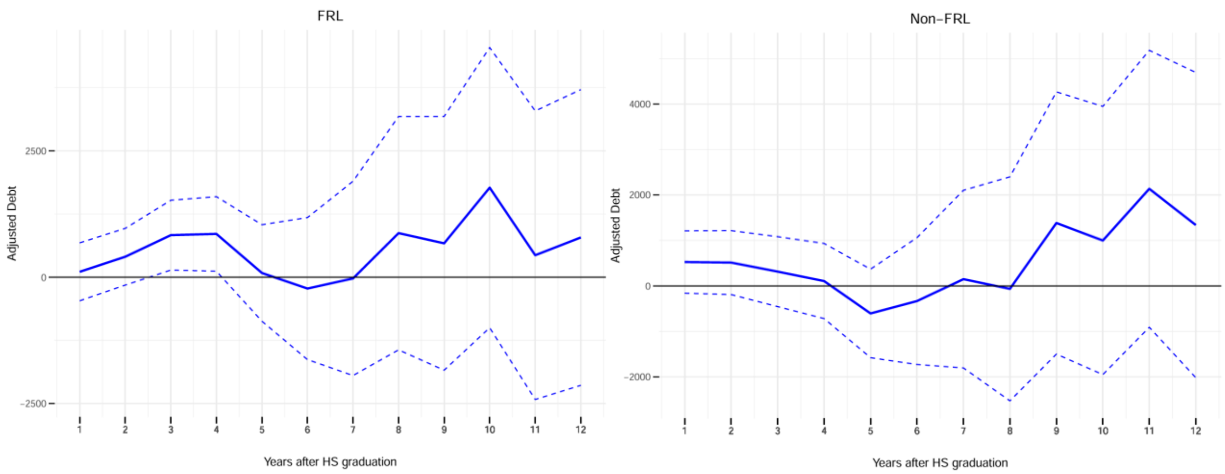


Figure 5.4. Dollar ($) Change in Student Debt Within Subsample - Gender

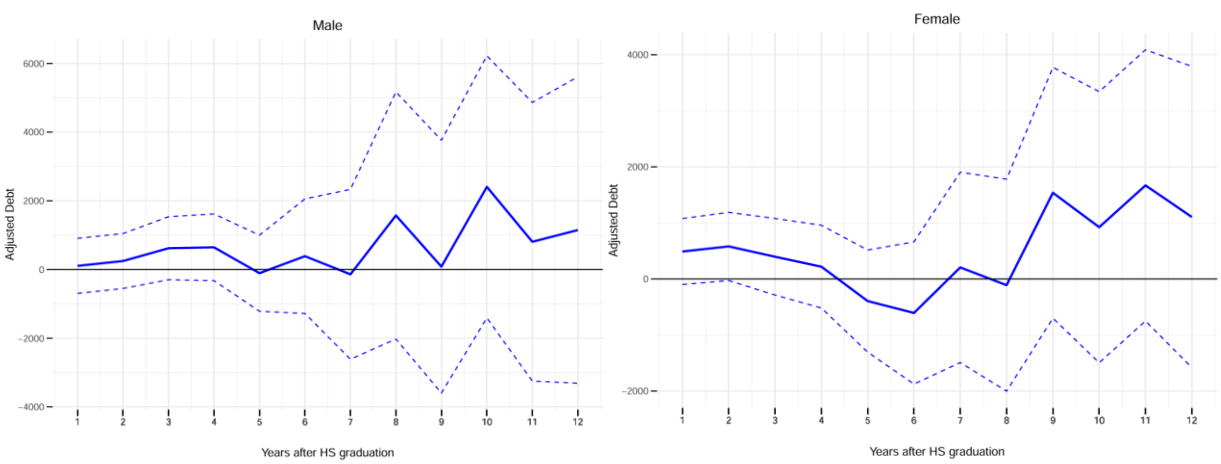


Figure 5.5. Dollar ($) Change in Student Debt Within Subsample - English Proficiency

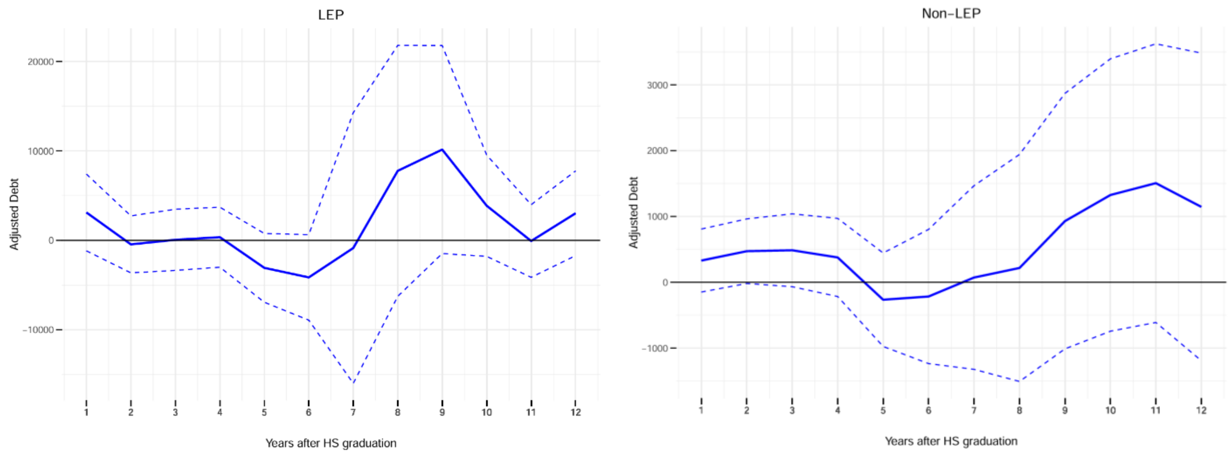
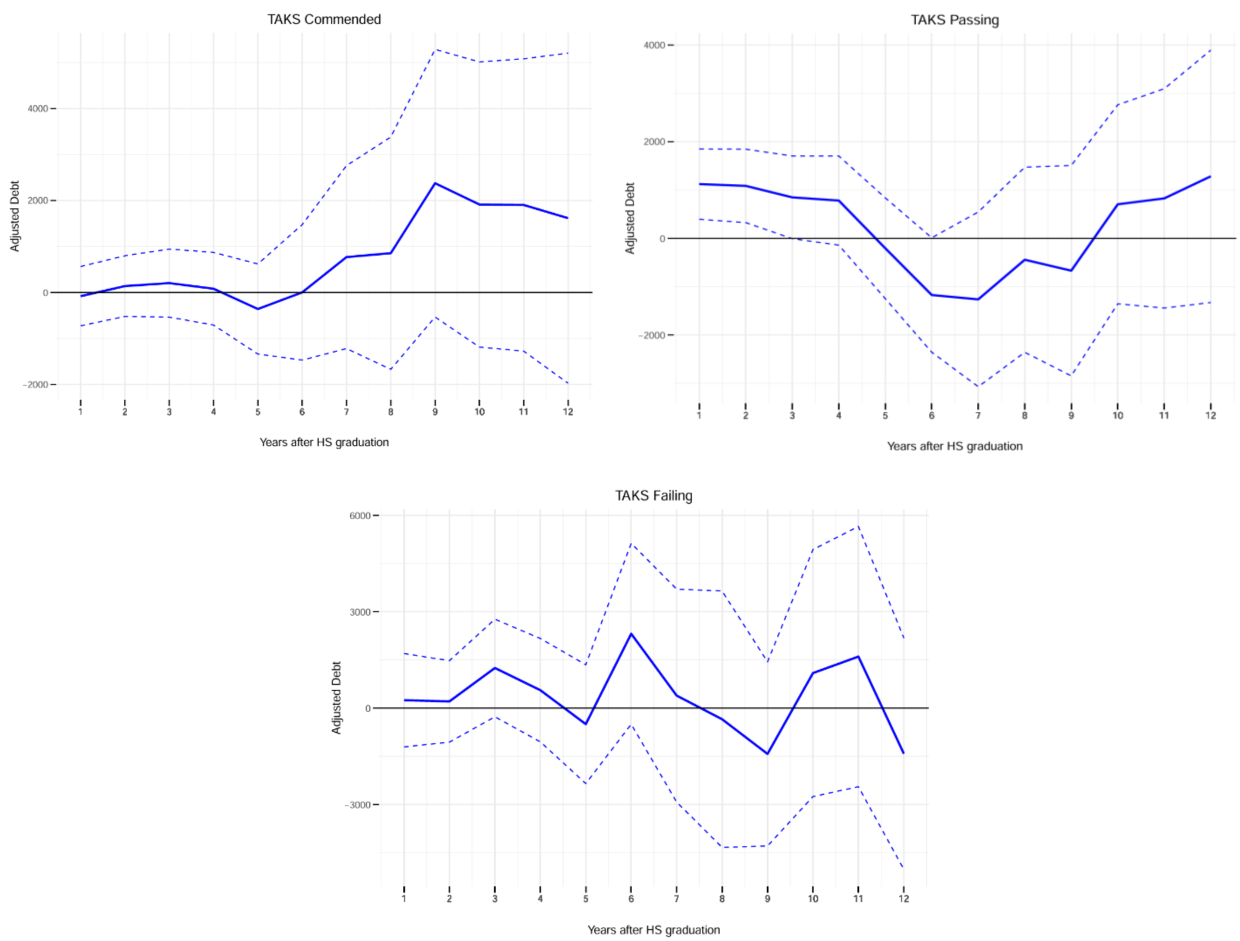


Figure 5.6. Dollar ($) Change in Student Debt Within Subsample - Standardized Test Performance



Discussion and Implications

This study contributes to the literature on long-run outcomes of dual enrollment. While it cannot address the causal mechanism of *why* dual credit affects our outcomes of focus, it establishes key associations between dual credit participation and financial outcomes of students through inverse probability weighting and the inclusion of a rich set of controls to diminish selection bias. We estimate differences in the probability of annual earnings and annual student debt amounts between participants of dual credit and non-participants using a longer timeframe and for more student subgroups than are found in the literature. More importantly, the study assesses whether dual credit is a lever for positive financial outcomes and concludes that such benefits do not reach all students, particularly several underserved groups. In terms of earnings in our overall sample, we find strong evidence that dual credit participants had higher earnings than non-participants in years six to twelve after high school graduation, despite lower earnings in initial years; however, this is not the case for some subgroups. Some student populations—White, non-LEP students and male students—who may already have had considerable chances of selecting into dual credit coursework—also exhibited the most favorable earnings outcome through dual credit participation. For other groups like African American, Hispanic, LEP, and standardized-assessment-failing students, we do not consistently find significant evidence of a favorable relationship between dual credit participation and earnings or observe weak to moderate evidence. Nevertheless, participation in dual credit did benefit economically disadvantaged students in our sample during the latter part of the twelve-year period. Comparing across demographic groups, we observe relatively low earnings differentials for Hispanic students in relation to African American and White students, and positive and, more or less, statistically similar earnings for disadvantaged and non-disadvantaged students. In terms of student loan debt, dual credit participants in the overall sample and most subsamples are generally more likely to have higher annual student loan amounts than non-participants, conditional on enrollment in postsecondary education, perhaps because of greater persistence and retention rates in college, and hence more years enrolled overall; however, the results are largely statistically non-significant.

Coined “programs of privilege” or “random acts of dual credit” in Community College Research Center’s study on dual enrollment equity pathways, the conventional dual enrollment model, the authors contend, lacks intentionality and a meaningful advising system to ensure students are completing courses that are aligned to college pathways (Fink & Jenkins, 2023). Alignment with degree programs and credential pathways as well as robust and continuous academic counseling beginning from the onset of dual credit enrollment are two of several factors that can ensure the dual enrollment experience closes equity gaps in postsecondary enrollment, credential attainment, and, ultimately, in earnings and financial outcomes. Dual enrollment can also serve as a mitigator for inequitable outcomes if the impetus and enthusiasm for college-going is established early with underserved students and their families. School districts, in partnership with local colleges, can engage with elementary and middle school students and parents in socioeconomically disadvantaged communities and communities of color to establish a college-going culture and promote dual credit programs. College and high school administrators can collaborate to ensure talented instructors with strong mentorship skills, trained in culturally responsive teaching, and committed to dual credit students’ success are those teaching dual enrollment courses both in college and high school settings (Mehl et al., 2020; Perry, 2023; Duncheon et al., 2023). Akin to the early college high school model, these characteristics highlight a more robust and holistic dual enrollment infrastructure that allows students to socialize and transition into higher education through the experiences of engaging in college courses, receiving meaningful academic advising and support, and building independence and confidence (Duncheon, 2020). If these characteristics were incorporated into the brand of dual enrollment programming that is of focus in our study, it is likely more positive and equitable financial outcomes would be observed across our sample. Nevertheless, qualitative investigation shows that a traditional dual enrollment experience in one or two courses can not only increase students' academic readiness, but also shift their behavior, thinking, and ways of interacting based on the expectations of college (Karp, 2012).

One limitation of the study is our inability to assess the relationship between dual credit participation and student debt and earnings for high school graduates enrolled in college or employed out-of-state, as the dataset tracks college enrollment, employment, and wages earned in Texas only. Another limitation with the selection of a high school graduating cohort as opposed to a cohort of students from a lower grade level such as 8th or 9th grade is that the non-dual credit participants in our sample may have outcomes which are biased upwards because every student graduated. If our cohort included students who did not graduate high school, the true gap between the outcomes of dual credit and non-dual credit students in the sample would likely be greater. While our 2011 graduating cohort antedates the current trend in Texas of scaling stronger dual credit models like ECHSs and P-TECHs, it is still a relevant population to study, as the dual enrollment model in Texas in 2011 is similar to the dual enrollment programs of many other states today. Accordingly, our analysis can be replicated in other locales that have a similar dual enrollment infrastructure.

Conclusion

Taken together, our results affirm that while dual credit does have the potential to generate favorable outcomes overall with respect to earnings, additional work is necessary to ensure that these benefits extend to all students. Future quasi-experimental designs focusing on dual credit and economic outcomes would benefit from the inclusion of additional covariates beyond the demographic and environmental characteristics conventionally collected in state longitudinal data systems such as measures of students' motivation to attend college and parents' academic characteristics, which could more effectively explain the disparities in outcomes for underrepresented and underserved populations. More experimental and causal designs assessing the impact of dual credit on postsecondary and labor market outcomes are also needed in this sphere of research. In the context of recent dual credit programming and policy shifts in Texas, it is critical to understand, through causal and more robust non-experimental research approaches, more recent cohorts who have experienced new forms of dual credit delivery, such as P-TECHs, than were observed in this study. The question of who benefits from dual credit participation and whether those benefits extend forward in time should continue to be revisited as more historical data becomes available for more recent cohorts. All in all, our research implies that collective work at the national, state, community, and institutional levels is necessary to ensure that the long-term benefits of dual enrollment are equitable across all populations. An additional benefit of such analyses is the ability to gauge the success of significant government- and taxpayer-funded initiatives tied to the exponential growth of dual credit programs before evidence of successful outcomes.

Statements and Declarations

Declaration of conflicting interest
The authors are employed as full-time staff and administrators at a metropolitan community college. The project was not requested by the community college, nor was it directly influenced by personnel other than the research team.

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The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The authors (research team) are full-time employees of a metropolitan community college; this project consumed less than 25% of employee hours over a two-year period. Two full-time professors from a four-year public research institution worked on the project without compensation, contributing less than a total of ten hours over a two-year period.

Notes

[1] Dual credit, interchangeably used with "dual enrollment" or "concurrent enrollment", refers to the option for high school students to enroll in a college course that simultaneously confers high school and college credit, conditional on their performance in the course (Barnett & Stamm, 2010).

[2] In 2015, the 60X30TX higher education strategic plan set forth the principal goal of 60% of Texans ages 25-34 completing a postsecondary credential by 2030 (THECB, 2015), and the State legislature enacted HB 505, which expanded dual credit access by lifting restrictions on the provision of dual credit education to only 11th and 12th grade students and prohibiting school districts and postsecondary institutions from capping the number of dual credit courses students can attempt in an academic year (Miller et al., 2017).

[3] We considered expanding the dataset's time horizon to include the 2011 high school graduating cohort's records from elementary grades; however, this approach reduced the sample size by almost 7,000 students due to missing values and further restricted sample sizes for accompanying subgroup analyses of specific student populations.

[4] Only those students with at least one quarter of wage data for a given year were included in the earnings records for that year. Zero-dollar wages ($0) were not assigned to a student in a given year if wage records were not available for that individual.

[5] We were unable to control for students' prior coursework and GPA, which are often employed in the literature as proxies for aptitude and motivation for attending college. We also could not include other standardized assessment predictors such as SAT and ACT scores and the graduation plans under which students completed high school (another possible proxy for motivation to attend college) since these indicators are typically measured during the time of treatment (in 11th and 12th grades when students can opt to take dual credit) or post-treatment. Following the conventions of propensity score analysis we only used pre-treatment covariates to estimate propensities and used weighting to create a comparable control group to the treatment group as well as to estimate the correlations between dual credit participation and our outcomes.

[6] Dual credit students were assigned to the treatment group (participated in dual credit) and the artificial comparison group (if they had not participated in dual credit) through weights (IPW). The average effect of the treatment (dual credit) on students who participated in dual credit (treated) is calculated via $ATT = E[Y_1 - Y_0 | D = 1]$, where

Y_1 is the potential outcome when treated;
Y_0 is the potential outcome when not treated;
D is the treatment indicator variable (1 if treated, 0 if not treated);
E denotes the expected value.

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Appendix 1: Marginal Effects for Log Wages Among Subsamples

Table 4. Marginal Effects of Dual Credit Participation for Ordinary Least Squares Models Estimating Log Wages for Subsamples

	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6	Y-7	Y-8	Y-9	Y-10	Y-11	Y-12
Socioeconomic/ Free-Reduced Lunch Status												
Disadvantaged/ FRL	-0.11** (0.048)	-0.08** (0.042)	-0.07* (0.039)	0.01 (0.037)	0.01 (0.036)	0.05 (0.035)	0.07* (0.034)	0.09*** (0.034)	0.09*** (0.033)	0.13*** (0.038)	0.09*** (0.033)	0.14*** (0.032)
Not Disadvantaged/ Non-FRL	-0.19*** (0.038)	-0.18*** (0.036)	-0.16*** (0.037)	-0.09** (0.037)	0.02 (0.034)	0.09*** (0.033)	0.12*** (0.032)	0.05* (0.032)	0.02 (0.030)	0.02 (0.031)	0.03 (0.030)	0.08*** (0.029)
Race/Ethnicity												
White	-0.18*** (0.044)	-0.18*** (0.042)	-0.15*** (0.043)	-0.09** (0.044)	0.05 (0.040)	0.11*** (0.038)	0.13*** (0.038)	0.13*** (0.035)	0.08** (0.035)	0.12*** (0.035)	0.09*** (0.034)	0.13*** (0.035)
African American	-0.17** (0.068)	-0.13** (0.062)	-0.06 (0.060)	0.02 (0.054)	0.02 (0.054)	0.13** (0.054)	0.10* (0.053)	0.11** (0.056)	0.12** (0.049)	0.01 (0.067)	0.08 (0.056)	0.12*** (0.047)
Asian	-0.14 (0.133)	-0.18 (0.113)	-0.13 (0.130)	0.01 (0.114)	0.12 (0.112)	0.05 (0.100)	0.21** (0.095)	-0.05 (0.098)	-0.02 (0.098)	0.06 (0.096)	0.07 (0.086)	0.17* (0.089)
Hispanic	-0.15*** (0.054)	-0.09* (0.049)	-0.12*** (0.045)	-0.06 (0.044)	-0.06 (0.041)	0.00 (0.040)	0.02 (0.037)	-0.01 (0.039)	-0.01 (0.037)	0.01 (0.038)	-0.03 (0.036)	0.03 (0.036)
Native American	-0.15 (0.355)	0.16 (0.282)	-0.35 (0.417)	-0.47 (0.419)	0.14 (0.332)	-0.18 (0.486)	-0.01 (0.290)	0.14 (0.316)	0.14 (0.259)	0.27 (0.208)	-0.20 (0.364)	0.18 (0.212)
Gender												
Male	-0.16*** (0.046)	-0.14*** (0.042)	-0.15*** (0.041)	-0.13*** (0.042)	-0.00 (0.039)	0.05 (0.037)	0.11*** (0.036)	0.05 (0.037)	0.07* (0.036)	0.08** (0.037)	0.07** (0.035)	0.10*** (0.034)
Female	-0.14*** (0.040)	-0.13*** (0.037)	-0.08** (0.037)	0.00 (0.035)	0.03 (0.033)	0.08** (0.032)	0.08*** (0.031)	0.07** (0.030)	0.03 (0.029)	0.04 (0.032)	0.02 (0.030)	0.09*** (0.029)
English Proficiency Status (LEP)												

LEP	-0.33 (0.212)	-0.33* (0.187)	-0.24 (0.167)	-0.26 (0.179)	-0.06 (0.114)	0.01 (0.102)	0.13 (0.135)	-0.11 (0.174)	0.11 (0.116)	0.23* (0.125)	0.02 (0.131)	0.08 (0.140)
Not LEP	-0.15*** (0.030)	-0.13*** (0.028)	-0.11*** (0.028)	-0.05* (0.027)	0.02 (0.025)	0.07*** (0.025)	0.09*** (0.024)	0.07*** (0.024)	0.04* (0.023)	0.06** (0.025)	0.04* (0.023)	0.10*** (0.022)
8th Grade Standardized Test Performance Status												
Commended in at least one test	-0.13*** (0.041)	-0.12*** (0.038)	-0.08** (0.038)	-0.02 (0.038)	0.04 (0.035)	0.08** (0.034)	0.07** (0.034)	0.02 (0.033)	0.02 (0.032)	0.04 (0.033)	0.02 (0.031)	0.10*** (0.029)
Passed both/ Commended in neither	-0.17*** (0.049)	-0.15*** (0.044)	-0.20*** (0.047)	-0.13*** (0.044)	-0.02 (0.040)	-0.02 (0.040)	0.13*** (0.036)	0.14*** (0.036)	0.10*** (0.036)	0.09** (0.040)	0.10*** (0.036)	0.10*** (0.036)
Failed at least one test	-0.22** (0.097)	-0.15* (0.085)	-0.04 (0.072)	0.02 (0.073)	0.03 (0.064)	0.02 (0.069)	0.08 (0.064)	0.04 (0.070)	0.05 (0.059)	0.05 (0.075)	0.01 (0.068)	0.07 (0.068)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix 2: Marginal Effects for Enrollment Among Subsamples

Table 5. Marginal Effects of Dual Credit Participation for Linear Probability Models Estimating Enrollment for Subsamples

	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6	Y-7	Y-8	Y-9	Y-10	Y-11	Y-12
Socioeconomic/ Free-Reduced Lunch Status												
Disadvantaged/ FRL	0.27*** (0.013)	0.25*** (0.014)	0.23*** (0.014)	0.21*** (0.015)	0.15*** (0.015)	0.12*** (0.014)	0.09*** (0.013)	0.08*** (0.012)	0.06*** (0.011)	0.05*** (0.010)	0.05*** (0.010)	0.02** (0.008)
Not Disadvantaged/ Non-FRL	0.13*** (0.010)	0.13*** (0.011)	0.12*** (0.011)	0.10*** (0.012)	0.06*** (0.012)	0.03*** (0.011)	0.01 (0.010)	-0.00 (0.009)	0.01 (0.008)	0.01 (0.007)	0.01** (0.007)	0.02*** (0.006)
Race/Ethnicity												
White	0.13*** (0.012)	0.13*** (0.013)	0.11*** (0.013)	0.09*** (0.014)	0.03** (0.014)	0.02 (0.012)	0.01 (0.011)	-0.01 (0.009)	-0.01 (0.008)	-0.00 (0.008)	0.01 (0.007)	0.01 (0.007)
African American	0.12*** (0.018)	0.12*** (0.020)	0.13*** (0.021)	0.14*** (0.021)	0.10*** (0.021)	0.07*** (0.020)	0.04** (0.018)	0.03* (0.016)	0.03** (0.016)	0.02 (0.014)	0.02 (0.021)	0.02 (0.018)
Asian	0.24*** (0.024)	0.25*** (0.026)	0.23*** (0.027)	0.20*** (0.029)	0.14*** (0.033)	0.10*** (0.033)	0.03 (0.031)	0.03 (0.029)	0.03 (0.026)	0.01 (0.022)	0.07 (0.086)	0.17* (0.089)
Hispanic	0.30*** (0.015)	0.29*** (0.016)	0.25*** (0.017)	0.21*** (0.017)	0.18*** (0.017)	0.14*** (0.017)	0.10*** (0.015)	0.09*** (0.015)	0.08*** (0.013)	0.08*** (0.012)	0.07*** (0.011)	0.04*** (0.010)
Native American	0.15 (0.101)	0.13 (0.107)	0.03 (0.118)	0.05 (0.120)	-0.08 (0.114)	-0.11 (0.111)	0.03 (0.111)	0.00 (0.094)	-0.01 (0.083)	0.04 (0.089)	0.02 (0.046)	0.04 (0.042)
Gender												
Male	0.18*** (0.012)	0.18*** (0.013)	0.16*** (0.014)	0.16*** (0.014)	0.09*** (0.014)	0.06*** (0.013)	0.03*** (0.011)	0.01 (0.010)	0.02* (0.009)	0.02** (0.008)	0.02** (0.008)	0.01** (0.007)
Female	0.19*** (0.010)	0.18*** (0.011)	0.16*** (0.012)	0.14*** (0.012)	0.10*** (0.012)	0.07*** (0.011)	0.05*** (0.011)	0.04*** (0.010)	0.03*** (0.009)	0.03*** (0.008)	0.04*** (0.008)	0.02*** (0.007)
English Proficiency Status (LEP)												

LEP	0.47*** (0.052)	0.46*** (0.055)	0.36*** (0.060)	0.33*** (0.060)	0.25*** (0.060)	0.18*** (0.057)	0.16*** (0.054)	0.13** (0.050)	0.09** (0.044)	0.05 (0.038)	0.09** (0.041)	0.04 (0.032)
Not LEP	0.18*** (0.008)	0.17*** (0.009)	0.16*** (0.009)	0.14*** (0.009)	0.09*** (0.009)	0.07*** (0.009)	0.04*** (0.008)	0.03*** (0.007)	0.03*** (0.007)	0.02*** (0.006)	0.03*** (0.006)	0.02*** (0.005)
8th Grade Standardized Test Performance Status												
Commended in at least one test	0.16*** (0.010)	0.15*** (0.011)	0.14*** (0.012)	0.12*** (0.012)	0.07*** (0.012)	0.06*** (0.011)	0.04*** (0.010)	0.03*** (0.009)	0.02** (0.008)	0.02** (0.008)	0.02*** (0.007)	0.02*** (0.006)
Passed both/ Commended in neither	0.22*** (0.013)	0.22*** (0.014)	0.19*** (0.015)	0.18*** (0.016)	0.12*** (0.016)	0.08*** (0.015)	0.04*** (0.013)	0.03*** (0.012)	0.04*** (0.011)	0.04*** (0.010)	0.03*** (0.009)	0.01 (0.008)
Failed at least one test	0.23*** (0.026)	0.25*** (0.028)	0.19*** (0.030)	0.17*** (0.030)	0.14*** (0.029)	0.09*** (0.026)	0.09*** (0.025)	0.04* (0.022)	0.04* (0.021)	0.02 (0.019)	0.05** (0.019)	0.04** (0.018)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix 3: Marginal Effects for Debt Among Subsamples

Table 6. Marginal Effects of Dual Credit Participation for Ordinary Least Squares Models Estimating Debt ($) for Subsamples

	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6	Y-7	Y-8	Y-9	Y-10	Y-11	Y-12
Socioeconomic/ Free-Reduced Lunch Status												
Disadvantaged/ FRL	106.18 (292.177)	404.15 (286.365)	831.08** (352.364)	855.49** (376.329)	82.83 (486.967)	-226.20 (717.026)	-25.23 (980.709)	871.14 (1,178.208)	669.08 (1,281.142)	1,771.11 (1,414.314)	433.85 (1,456.707)	784.92 (1,492.768)
Not Disadvantaged/ Non-FRL	525.77 (349.945)	513.03 (358.898)	313.83 (392.362)	107.07 (421.133)	-605.32 (496.416)	-332.89 (711.352)	149.18 (996.467)	-64.31 (1,256.634)	1,383.31 (1,470.467)	998.36 (1,504.338)	2,135.18 (1,553.319)	1,338.40 (1,711.915)
Race/Ethnicity												
White	379.56 (436.029)	768.58* (459.674)	614.06 (508.022)	353.16 (543.744)	526.31 (635.585)	1,000.64 (931.902)	652.75 (1,216.269)	519.87 (1,589.669)	1,590.22 (1,876.401)	-79.99 (1,892.442)	298.80 (1,917.050)	-2,054.83 (1,794.428)
African American	1,231.84*** (419.453)	1,417.44*** (439.705)	2,075.96*** (513.662)	1,055.63** (531.553)	-1,242.17* (635.193)	-1,029.34 (846.221)	-614.47 (1,138.321)	508.47 (1,343.932)	670.15 (1,369.980)	1,121.84 (1,446.750)	785.59 (1,558.812)	2,386.43 (2,020.975)
Asian	-925.34 (707.633)	-797.15 (689.508)	-1,698.69** (763.498)	-1,008.74 (895.101)	-956.99 (1,371.393)	-1,976.08 (2,086.679)	-112.80 (2,715.614)	-3,080.30 (3,043.103)	274.55 (4,357.153)	8,470.30* (4,410.802)	7,474.88 (4,601.487)	6,196.85 (5,852.166)
Hispanic	-97.54 (416.626)	-571.66 (388.887)	-401.77 (443.426)	244.15 (486.635)	-318.21 (552.876)	-654.95 (722.406)	4.43 (1,169.002)	1,541.06 (1,510.002)	468.53 (1,664.184)	-467.40 (1,975.758)	156.31 (2,054.781)	1,817.32 (1,948.727)
Native American	3,517.82 (4,899.891)	1,735.08 (3,675.385)	1,634.60 (5,443.676)	520.59 (4,062.211)	-10,057.89** (4,577.356)	-2,340.67 (2,477.727)	-3,825.24 (4,810.260)	-11,246.80** (5,475.913)	-8,107.40* (4,463.224)	-1,037.69 (2,456.385)	2,370.65 (1,752.164)	383.11 (1,434.101)
Gender												
Male	104.46 (408.983)	246.90 (408.332)	618.78 (467.408)	644.94 (494.734)	-108.49 (565.592)	388.12 (851.504)	-142.39 (1,261.504)	1,573.51 (1,835.697)	82.32 (1,877.989)	2,405.47 (1,946.932)	806.41 (2,069.721)	1,148.27 (2,276.347)
Female	490.32 (300.313)	581.45* (310.823)	397.20 (348.314)	220.53 (376.758)	-393.43 (464.457)	-605.53 (647.277)	207.28 (866.378)	-110.19 (964.722)	1,538.39 (1,141.723)	924.77 (1,233.642)	1,670.21 (1,234.240)	1,106.71 (1,370.576)
English Proficiency Status (LEP)												
	3,115.22	-451.91	59.53	353.84	-3,075.03	-4,140.91*	-859.08	7,767.34	10,146.31*	3,868.50	-73.01	3,027.60

LEP	(2,187.831)	(1,623.643)	(1,745.418)	(1,710.710)	(1,960.464)	(2,438.164)	(7,719.075)	(7,154.224)	(5,929.041)	(2,887.692)	(2,071.890)	(2,414.366)
Not LEP	329.97 (244.322)	472.40* (250.274)	486.52* (282.552)	376.93 (302.949)	-265.10 (362.382)	-216.36 (520.317)	72.20 (712.183)	217.28 (880.258)	929.36 (990.502)	1,326.03 (1,056.154)	1,506.55 (1,080.306)	1,145.92 (1,192.728)
8th Grade Standardized Test Performance Status												
Commended in at least one test	-82.24 (329.043)	137.17 (336.484)	202.12 (377.625)	79.96 (403.009)	-361.36 (499.965)	0.18 (751.731)	768.07 (1,014.917)	852.73 (1,288.793)	2,374.40 (1,484.920)	1,911.77 (1,582.061)	1,901.62 (1,622.061)	1,614.71 (1,831.853)
Passed both/ Commended in neither	1,122.83*** (371.131)	1,085.63*** (387.719)	848.62* (436.526)	782.23* (470.535)	-205.18 (531.931)	-1,172.39* (604.169)	-1,262.38 (922.319)	-442.69 (977.340)	-668.55 (1,110.750)	704.47 (1,050.423)	827.10 (1,158.206)	1,283.00 (1,331.927)
Failed at least one test	244.79 (741.301)	209.93 (647.019)	1,249.04 (774.945)	557.51 (820.792)	-499.14 (943.491)	2,313.69 (1,436.079)	389.74 (1,690.645)	-346.12 (2,035.339)	-1,425.30 (1,462.386)	1,090.14 (1,961.046)	1,603.33 (2,066.276)	-1,418.48 (1,837.046)

*** p < 0.01, ** p < 0.05, * p < 0.1

Appendix 4: Probability of Enrollment Trajectories Among Subsamples

Figure 4.1. Percentage Point Change in Probability of Enrollment Within Subsample – Race/Ethnicity

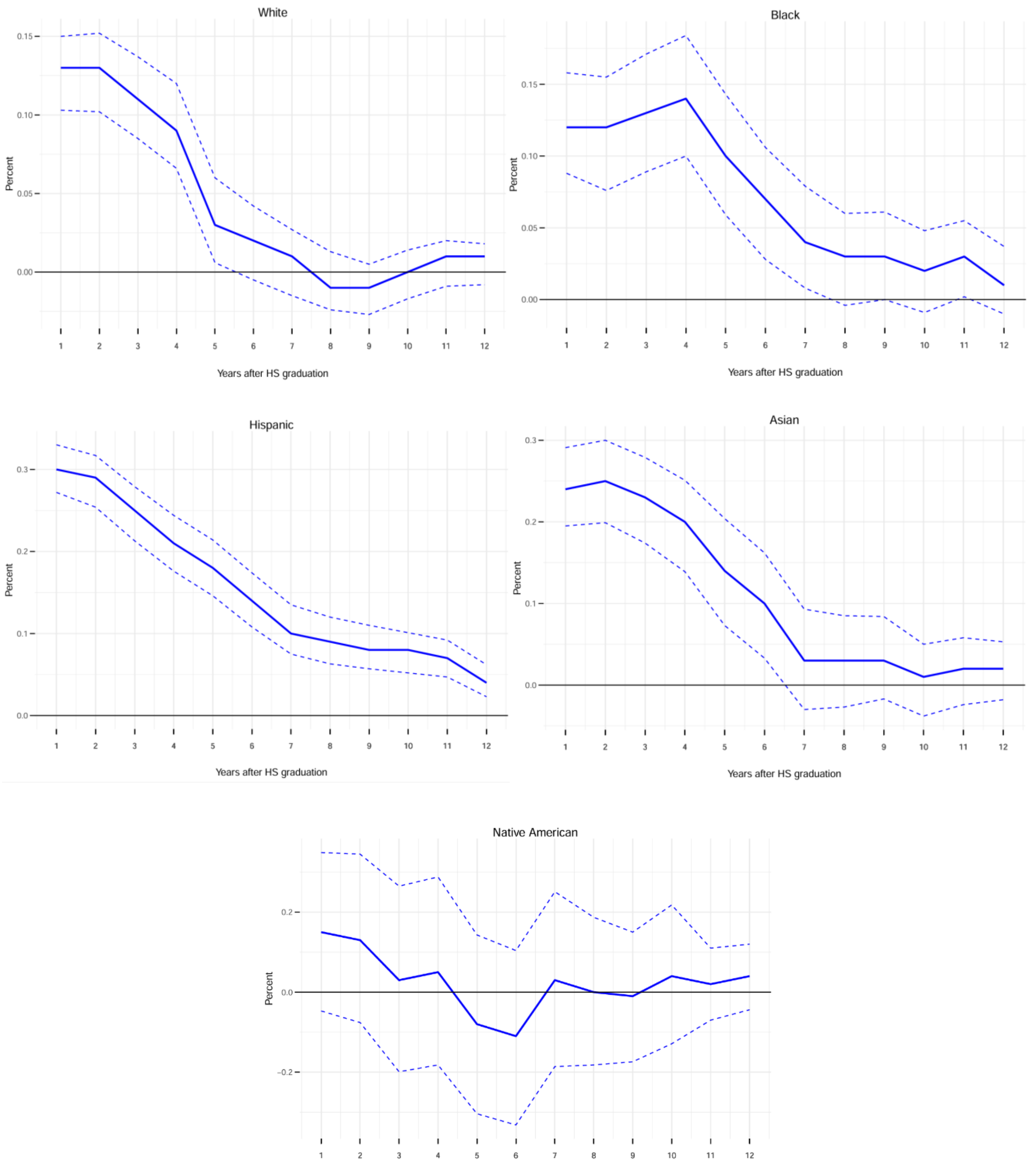


Figure 4.2. Percentage Point Change in Probability of Enrollment Within Subsample – Socioeconomic Status

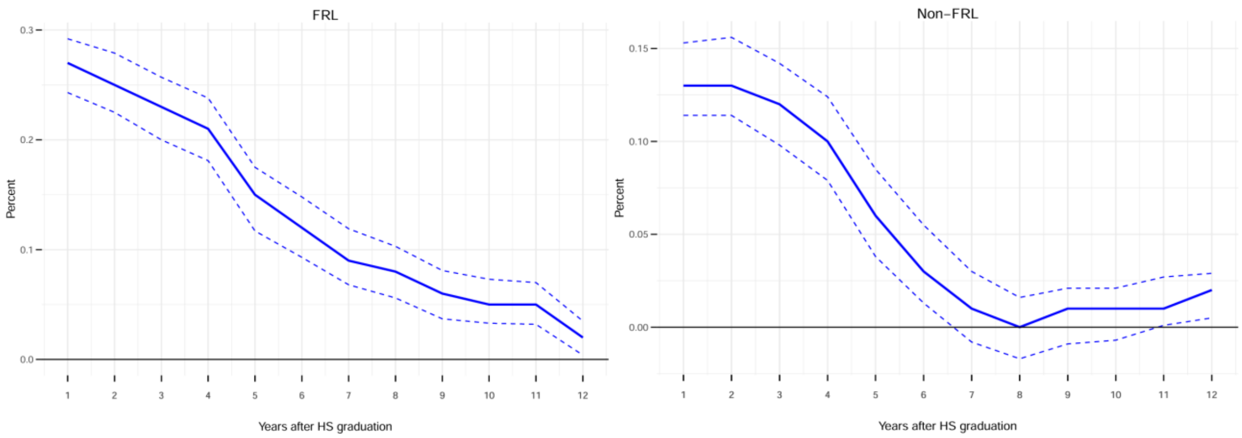


Figure 4.3. Percentage Point Change in Probability of Enrollment Within Subsample – Gender

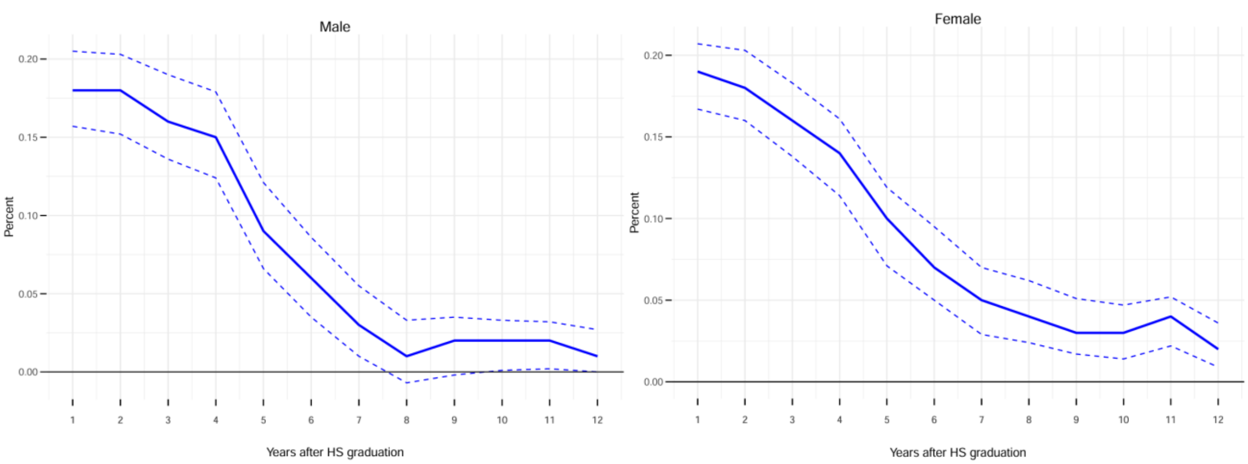


Figure 4.4. Percentage Point Change in Probability of Enrollment Within Subsample – English Proficiency

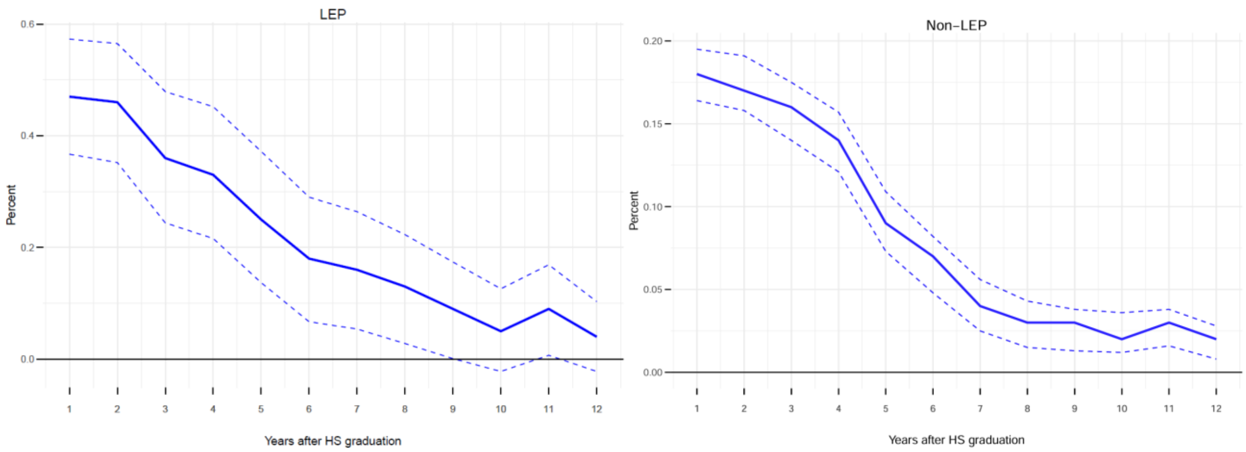
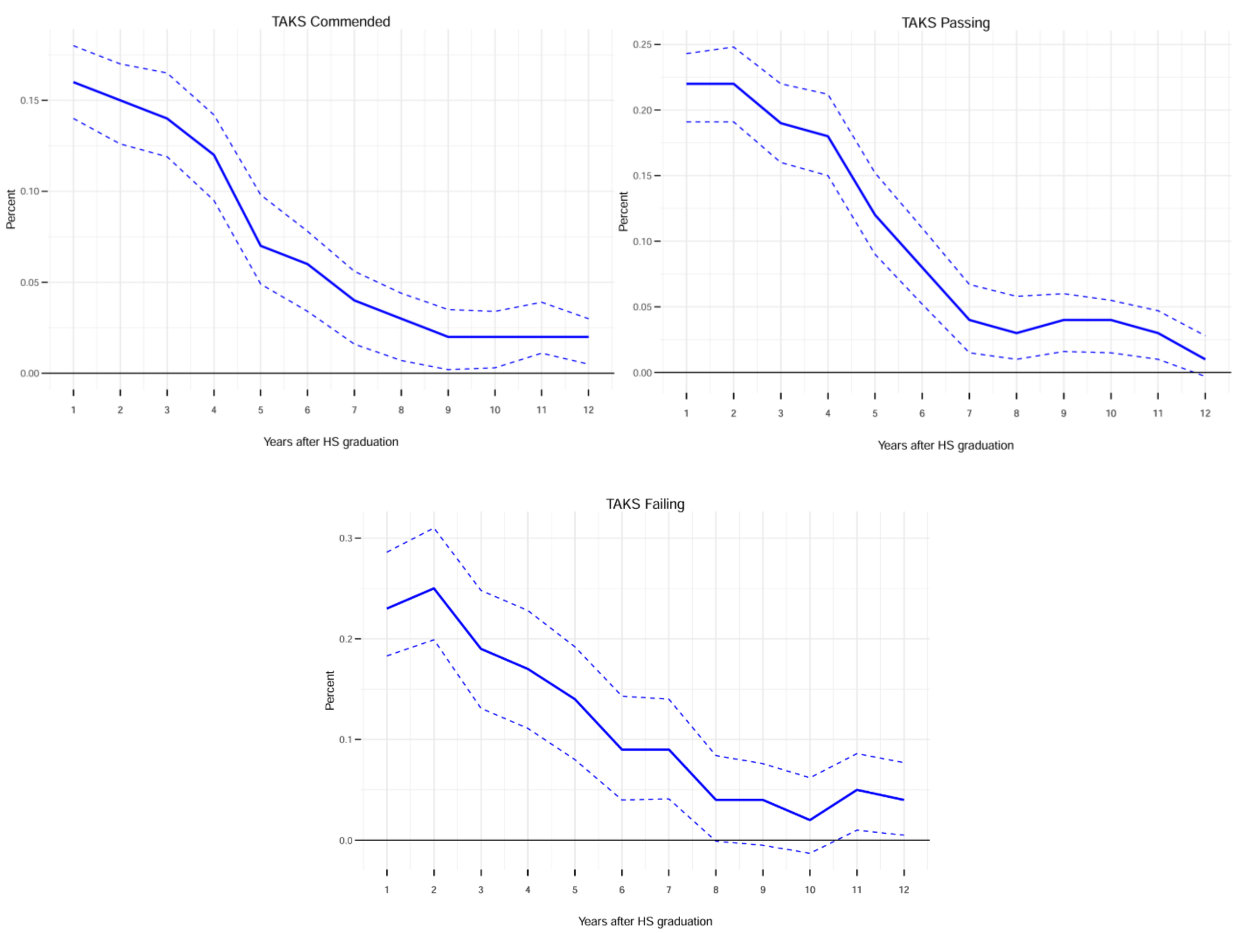


Figure 4.5. Percentage Point Change in Probability of Enrollment Within Subsample – Standardized Test Performance



Appendix 5: First Stage Results - Propensity Weighting and Balance

The first stage in our analysis was to estimate the logistic regression model which predicted the likelihood that students would participate in at least one dual credit class in 11th or 12th grade. Table 5 shows the control variables or students' demographic, socioeconomic, program, and environmental characteristics in the model and their association with the probability to take dual credit. 'White' was used as the reference category for the multinomial race/ethnicity variable; 'Academically Acceptable' was used as the reference level for school ratings; the reference level for standardized test performance was 'Passed both tests/Commended in neither'. Overall, we found that student groups that traditionally experience higher academic achievement were also more likely to take dual credit in our sample, and students who were more academically and socioeconomically vulnerable were less likely to participate in dual credit. Asian students were significantly more likely to participate in dual credit than White students, while African American students were significantly less likely to participate than White students; Hispanic students were also less likely to participate, albeit the difference was not statistically significant. Native American students were more likely to participate than White students, but this estimate may be somewhat biased given the small sample size of Native students. Female and Gifted and Talented students as well as those who achieved Commended performance in at least one standardized exam in 8th grade were also significantly more likely to take dual credit than their counterparts. Students who attended an Early College High School in their 10th grade year had a high propensity to participate in dual credit classes, and the graduation rate of the high school students attended in 10th grade was positively associated with dual credit participation. This implied that students who attended high schools with high graduation rates were significantly more likely to take dual credit than those who attended high schools with lower graduation rates. Students classified as at risk, economically disadvantaged based on free/reduced lunch qualification, designated as limited English proficient, in special education, and who failed at least one standardized exam in 8th grade were significantly less likely to participate in dual credit than their counterparts. Interestingly, we also found that students from the highest and lowest performing high schools were less likely to take dual credit than students from average performing schools.

Table 7. Logistic Regression Results for the Propensity to Participate in Dual Credit After IPW and Balancing

	Variables	β	Standard Error
Demographic	Female	0.35***	0.042
	African American	-0.17**	0.066
	Asian	0.42***	0.075
	Hispanic	-0.08	0.057
	Native American	0.35	0.246
Special Programs	Limited English Proficiency	-0.83***	0.134
	Special Education	-0.41***	0.124
	Gifted & Talented	0.28***	0.046
	Early College High School	2.27***	0.190
	Alternative Education	-0.20	0.367
Socioeconomic	Economic Disadvantage	-0.13**	0.049

	At Risk	-0.56***	0.051
School Environment	Grad. rate of high school in 10th grade	2.77***	0.302
	School rating in 10th grade		
	Unacceptable	-0.75***	0.129
	Not Rated	0.03	0.730
	Recognized	-0.66***	0.051
	Exemplary	-0.87***	0.072
	School rating in 8th grade		
	Unacceptable	-0.22	0.214
	Not Rated	0.37***	0.133
	Recognized	0.05	0.045
	Exemplary	0.00	0.073
Assessment	Commended in at least one 8th grade standardized test	0.30***	0.045
	Failed at least one 8th grade standardized test	-0.48***	0.075
	Constant	-3.54***	0.263

*** p < 0.01, ** p < 0.05, * p < 0.1

Appendix 6: Educational Outcomes

In addition to examining longer-term financial outcomes of dual credit students, we also investigated their educational outcomes using logistic regression to estimate relationships between dual credit participation and the probability of a) enrolling in college immediately and within two years (delayed) after high school graduation and b) attaining any higher education credential from a two-year, public four-year, private four-year, or health science school within six years following high school graduation (Table 8). Consistent with prior research, we found strong evidence that dual credit participation was associated with greater odds of college enrollment and credential attainment, and such a correlation remained highly significant across all subsamples we analyzed.

Table 8: Relationship Between Dual Credit Participation and College Enrollment and Credential Attainment for Full Sample and Subsamples

	Immediate Enrollment	Delayed Enrollment	Any Credential Attainment
Full Sample (n = 20,835)	0.72*** (0.041)	0.80*** (0.045)	0.74*** (0.040)
Disadvantaged/FRL (n = 10,339)	1.02*** (0.068)	1.10*** (0.074)	0.95*** (0.070)
Not Disadvantaged/Non-FRL (n = 10,417)	0.51*** (0.052)	0.59*** (0.059)	0.63*** (0.051)
White (n = 7,387)	0.46*** (0.061)	0.51*** (0.068)	0.60*** (0.060)
African American (n = 4,296)	0.46*** (0.096)	0.37*** (0.104)	0.84*** (0.097)
Asian (n = 1,150)	1.19*** (0.170)	1.24*** (0.187)	1.03*** (0.154)
Hispanic (n = 7,607)	1.25*** (0.081)	1.48*** (0.092)	0.88*** (0.081)
Male (n = 9,923)	0.73*** (0.062)	0.77*** (0.069)	0.73*** (0.062)
Female (n = 10,863)	0.69*** (0.054)	0.81*** (0.061)	0.75*** (0.053)
Commended in at least one 8th grade standardized test/passed both (n = 8,732)	0.64*** (0.054)	0.73*** (0.060)	0.64*** (0.052)
Passed both 8th grade standardized tests/Commended in neither	0.82*** (0.071)	0.87*** (0.079)	0.91*** (0.070)

(*n* = 7,536)			
Failed at least one 8th grade standardized test (*n* = 4,393)	0.89*** (0.133)	0.94*** (0.143)	0.96*** (0.149)

Appendix 7: Description of Variables

Primary Independent Variable

Dual Credit Participation. Participation in dual credit was measured as a dichotomous indicator for whether or not a student (who graduated from 12th grade in spring 2011) participated in one or more dual credit courses in their 11th and/or 12th grade year.

Outcome Variables

Log Annual Earnings. A continuous variable for the natural log of annual earnings over a twelve-year period from Q3 2011 to Q2 2023, adjusted for Q1 2023 dollars and with no restrictions on concurrent enrollment. Years are measured from Q3 to Q2 of the following year to better align fiscal years with academic years. Log annual earnings are estimated for the full sample and subsamples.

Annual Total Student Debt. A continuous variable for the annual total amount of all student loans (federal, state, and other) a student incurred over a twelve-year period from Q3 2011 to Q2 2023, adjusted for Q1 2023 and conditional upon postsecondary enrollment. Years are measured from Q3 to Q2 of the following year to better align fiscal years with academic years. Students with debt amounts greater than zero and equal to zero were included, so as long they were enrolled in certain period. Annual total student debt amounts are estimated for the full sample and subsamples.

Annual Enrollment. A continuous variable for the annual or year-by-year enrollment in a Texas higher education institution—two-year, four-year, health, or independent (private)—over a twelve-year period from Q3 2011 to Q2 2023. Years are measured from Q3 to Q2 of the following year to better align academic years with fiscal years. Annual enrollment in postsecondary education is estimated for the full sample and subsamples.

Immediate Enrollment. A dichotomous variable that measured whether or not a student was enrolled in a Texas higher education institution—two-year, four-year, health, or independent (private)—in the summer or fall of 2011.

Delayed Enrollment. A dichotomous variable that measured whether or not a student was enrolled in a Texas higher education institution—two-year, four-year, health, or independent (private)—during at least one term between summer of 2011 and fall of 2013 (within two years of high school graduation).

Attainment. A dichotomous variable that measured if a student obtained a postsecondary credential (highest credential earned excluding baccalaureate- and graduate-level certificates, post-master certificates, and first professional certificates) in Texas from any institution (two-year, public four-year, private four-year, health school) within six years following high school graduation (by end of summer 2017).

Controls

Gender (female and male). A dichotomous indicator based on students' TEA graduation records.

Race and Ethnicity (White, African American, Hispanic, Asian, and Native American). A multinomial indicator based on students' 10th grade TEA records. The Hispanic category encompasses all races and origins of Latin or Spanish-speaking countries and cultures. White, African American, Asian, and Native American categories are exclusive of Hispanic origin.

Limited English Proficiency. A dichotomous variable indicating if a student demonstrated limited English proficiency or was assessed for limited English proficiency at any time from 8th to 10th grade in TEA records.

Special Education. A dichotomous variable indicating if a student participated in special education in at least one year between 8th and 10 grade in TEA records.

Gifted and Talented. A dichotomous variable indicating if a student participated in the Talented and Gifted program in at least one year between 8th and 10 grade in TEA records.

At Risk. A dichotomous indicator to identify if a student was "at risk" of not meeting standards withdrawing from middle and/or high school based on a set of State-defined criteria in at least one year between 8th and 10 grade in TEA records.

Free or Reduced Lunch Status. A dichotomous indicator to identify if a student ever qualified for the free/reduced lunch (FRL) program in at least one year between 8th and 10 grade in TEA records. This predictor serves as proxy for students' socioeconomic status (disadvantaged or not disadvantaged).

Early College High School. A dichotomous variable indicating whether or not a student attended an ECHS (offering extensive dual credit programs and postsecondary credential pathways) in their 10th grade year in TEA records. Only four high schools in our districts of focus were ECHSs in the 2008-2009 academic year.

Alternative Education. A dichotomous variable indicating if a student attended an alternative education school at any time between 8th and 10 grade in TEA records. Campuses include alternative education and juvenile justice institutions and also disciplinary alternative education programs.

State Standardized Math and Reading Test Performance - 8th Grade. A multinomial indicator based on students' 8th grade State standardized assessment scores in TEA records. Performance categories include a) passing both assessments and attaining Commended performance on at least one, b) passing both assessments but not achieving Commended status in either, and c) failing one or both assessments. Performance on State-mandated assessments was used as a proxy to control for students' academic ability and preparation for dual credit courses in high school.

2009 High School Graduation Rate. A continuous variable for the graduation rate of a student's high school in their 10th grade year as reported by the TEA. Graduation rates may control for heterogenous differences across high schools such as academic rigor and education/teacher quality.

2009 High School Accountability Rating – 10th Grade. A multinomial indicator for TEA's rating of a student' high school for the 2008-2009 academic year. Ratings are based on State standardized assessment performance and comprise of four levels: Unacceptable, Acceptable, Recognized, Exemplary, and Not Rated. Ratings may also control for heterogenous variations across high schools.

2008 Middle School Accountability Rating – 8th Grade. A multinomial indicator for TEA's rating of a student' middle school for the 2006-2007 academic year. Ratings are based on State standardized assessment performance and comprise of four levels: Unacceptable, Acceptable, Recognized, Exemplary, and Not Rated. Ratings may control for heterogenous variations across middle schools.