RUNNING HEAD: Easing the Transition to College and Career for Emerging Adults

A Longitudinal Study Examining Dual Enrollment as a Strategy for Easing the Transition to College and Career for Emerging Adults

Dr. Angela K. Henneberger[1], Dr. Heath Witzen[2], & Alison M. Preston[1]

[1]University of Maryland School of Social Work

[2]University of Maryland College Park

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Abstract

Successfully transitioning to adulthood requires a successful transition from high school into college or the workforce. Yet, for many emerging adults, this transition is not successful, leading to disengagement from school and work. Dual enrollment, where high school students enroll in college coursework, may help to facilitate this important life transition. This study applied propensity score matching to statewide administrative data to investigate the effects of dual enrollment on college and early labor market outcomes. We found a significant effect of dual enrollment on 2-year and 4-year college enrollment, degree attainment, and early labor market earnings six years after high school, with stronger effects for students who are traditionally under-represented (e.g., Black and Other-race students and students eligible for free and reduced price meals). This study highlights the potential for targeting dual enrollment programs toward under-represented students to improve the transition into college and the workforce for emerging adults.

Keywords: dual enrollment, transition to adulthood, high school, college, earnings

A central developmental task for adolescents moving into emerging adulthood is the successful transition from high school into college or the workforce (Arnett, 2012). Emerging adults who successfully manage this transition experience better physical health, mental health, and social relationships (Arnett, 2012; Nelson & Padilla-Walker, 2013). Some subgroups of students, such as low-income students and minority students, are at higher risk for not successfully managing this important life transition. For example, low-income and minority students are disproportionately likely to be disengaged from both college and the workforce following high school (Belford, Levin, & Rosen, 2012).

Recent national and state-level policy decisions have focused on ensuring that high schools are adequately preparing emerging adults for a successful transition to college and the workforce. One such policy focus has been an increase in dual enrollment, a program whereby high school students enroll in college coursework. Evidence suggests that dual enrollment has positive outcomes for students transitioning into college (Grubb, Scott, & Good, 2017; Taylor 2015; Wang, Chan, Phelps, & Washbon, 2015), and research suggests that this may be particularly true for low-income students (An, 2013; Karp et al., 2007), academically disadvantaged students (Struhl & Vargas, 2012), and male minority students (Haskell, 2016). However, findings are mixed, and there remains a need to better understand the heterogeneity in effects on college and career outcomes for under-represented students to help target dual enrollment programs and policies to the students that may benefit the most in the transition to emerging adulthood.

Dual Enrollment as a Strategy to Ease the Transition into College

Dual enrollment programs, also called dual credit or concurrent enrollment, provide students with the opportunity to complete college courses prior to high school graduation. Recent data from the High School Longitudinal Study of 2009 (HSLS:09), a nationally representative study of more than 23,000 ninth-graders in 2009, showed that approximately 1/3 of ninth graders took courses for college credit in high school (Shivji & Wilson, 2019). Dual enrollment programs take a variety of forms across the nation (Lewis & Overman, 2008). For example, courses can be offered individually or in a defined program, taught at high schools or colleges, taught by high school teachers or by college professors, and may be academic or career and technical education (CTE; Lewis & Overman, 2008). In some cases, dual enrollment courses are taken for college credit, and in other cases dual enrollment courses do not offer college credit but are taken to increase academic rigor. Middle college high schools offer college programs on campus to high school students (Lewis & Overman, 2008), and the Early College High School Initiative offers enough credits for an associate degree or up to two years of a baccalaureate degree depending on the specific program (Berger et al., 2013; Lewis & Overman, 2008). Local school system agreements between high schools and colleges may define the specific characteristics of the dual enrollment program (e.g., tuition reimbursement, student eligibility).

Dual enrollment programs are specifically designed to increase academic rigor and improve college degree completion rates (Cowan & Goldhaber, 2015). Dual enrollment programs are designed to help high school students face a number of challenges experienced as they consider where to attend college and how to afford it (Bailey, Hughes, & Karp, 2002). For example, dual enrollment may ease the financial burden on students by enabling students to earn credits in high school, thereby shortening the amount of time and money spent in college through decreasing the number of credits a student needs to earn in order to graduate with a college degree (Cowan & Goldhaber, 2015; Speroni, 2011b). Moreover, dual enrollment may act as a bridge between high school and college, aiding students with determining a course of study and balancing the demands of college and life (Bailey et al., 2002). In addition to these more obvious benefits of dual enrollment, there are psychological benefits for emerging adults who are making the leap from high school to college. Participation in rigorous college coursework during the senior year can increase motivation at a time when many students lose motivation to challenge themselves academically (Bailey et al., 2002). This increase in motivation and opportunity can generate academic momentum, which could positively influence college outcomes by better preparing students for the full college experience (Wang et al., 2015). Furthermore, students who have a better understanding of the college experience and expectations can make better decisions about where to attend and what to study, decreasing the likelihood of a mismatch between student and institution and increasing the possibility for positive outcomes (Speroni, 2011b). Students who drop out of college often blame non-academic factors, such as being overwhelmed in a new environment or being unaware of the expectations of college life, but dual enrollment programs can support students through exposure to on-campus resources and environments, increasing confidence and the ability to navigate the transition from high school to college (Bailey et al., 2002).

Prior Research on the Effects of Dual Enrollment

Prior research indicates that dual enrollment program participation is associated with positive postsecondary outcomes, including college enrollment and degree attainment (An, 2013; Giani, Alexander, & Reyes, 2014; Grubb, et al., 2017; Karp, Calcagno, Hughes, Jeong, & Bailey, 2007; Speroni, 2011a). Additionally, dual enrollment has been associated with earning more college credits (Allen & Dadgar, 2012; Kim & Bragg, 2008), persisting in college to the second year (Cho & Karp, 2013), and earning a higher college GPA (Allen & Dadgar, 2012). Many prior studies on dual enrollment have been limited by selection bias, whereby dual enrollment program participants who select into the program are very different than non-participants on baseline characteristics (Lewis & Overman, 2008). Indeed, studies have found that students who participate in dual enrollment programs are more likely to be White, non-Hispanic, female, and not eligible for free or reduced-price meals (Allen et al., 2012; Henneberger, Cohen, Shipe, & Shaw, 2016; Jones, 2014; Kim & Bragg, 2008). Students who participate in dual enrollment programs are also more likely to be high achieving students, with higher grade point averages, higher test scores, and a more rigorous course of study (Allen et al., 2012; An, 2013). The demographic characteristics and academic profiles of students who are more likely to participate in dual enrollment programs are also associated with more positive postsecondary outcomes (Berger et al, 2013; Fry, 2009; Long, Conger, & Iatarola, 2012), creating difficulty in determining whether positive postsecondary outcomes are due to program participation or to prior baseline characteristics.

There is one known experimental study of dual enrollment that was conducted using statewide data from Tennessee (Hemelt, Schwartz, & Dynarski, 2019). Fifty-three schools were assigned to the treatment condition, which required schools to offer a dual-credit advanced algebra course, and 50 schools were assigned to the comparison condition using blocked random assignment (blocked on region). Results indicated that participation in the dual-credit advanced algebra course reduced enrollment in remedial math and increased enrollment in precalculus and Advanced Placement math courses in high school. No effect was found on college enrollment overall, but some students selected four-year institutions rather than two-year institutions.

One line of quasi-experimental research focuses on the use of a lottery for student admittance to Early College programs, which are dual enrollment programs funded by the Bill & Melinda Gates Foundation to provide underserved students with the opportunity to earn up to two years of college credit or an associate degree while in high school (Berger et al., 2013). Program participants (*N* = 1,044 students from 10 Early College Sites in 5 states) were more likely than non-participants (*N* = 1,414 students in 62 comparison schools) to graduate from high school, enroll in college, and subsequently graduate from college as a result of attending an Early College (Berger et al., 2013). The long-term magnitude of these effects varies from approximately 5 to 21 percentage points when the outcomes are examined several years after ninth grade. Some studies also examined the impact of Early College participation on students while still in high school, and findings indicated that ninth grade students were increasingly enrolling in and succeeding at college preparatory courses, had higher attendance and lower suspension rates (Edmunds et al., 2012), and were positively impacted by participation in Early College, especially at lower quality schools (Miratrix et al., 2017). Edmunds et al. (2010) also found that college preparatory course enrollment in high school increased with the introduction of Early Colleges, but increased access and enrollment was associated with lower pass rates in some courses.

An additional line of quasi-experimental research applies a regression discontinuity design to capitalize on a statutorily mandated requirement for high school students to have a 3.0 GPA to participate in dual enrollment programs (Speroni, 2011b). Results from administrative data in Florida used data from two high school cohorts (2000-2001 and 2001-2002) in selected Florida districts and indicated that dual enrollment program participation did not improve rates of high school graduation, college enrollment, or college degree attainment (Speroni, 2011b). Results from this approach are somewhat inconsistent with the growing body of evidence for the positive postsecondary effects of dual enrollment.

An additional growing body of quasi-experimental research applies propensity score matching (Rosenbaum & Rubin, 1983; Schafer & Kang, 2008) to limit the selection bias that may be introduced due to measured confounders. Several studies have implemented propensity score matching with dual enrollment programs, and results indicate that dual enrollment participants were more likely than nonparticipants to enroll in college, persist for a second year of college, and complete a college degree (An, 2013; Giani, et al., 2014; Struhl & Vargas, 2012). The magnitude of effect for these outcomes is generally between two and twenty percentage points, with the greatest magnitudes for enrollment and persistence. A study of Tennessee community college students who demonstrated a commitment to attending college through the completion of ACT testing and the first semester of college with a full-time, degree-seeking status showed that the students who participated in dual enrollment programs were 26% more likely to graduate in two years, 28% more likely to graduate in three years, and 9% less likely to take remedial courses than students who did not participate in dual enrollment (Grubb et al., 2017).

Dual Enrollment may be Differentially Effective for Under-Represented Student Groups

Dual enrollment program participation may be differentially effective for students who are traditionally under-represented in the college attending and degree completing population. Dual enrollment may serve as an introduction to college for students who have little knowledge about and experience with college, such as first-generation college students, which historically are more likely to be minority and low-income students (Engle, 2007). Research indicates that high achieving, low-income students are not well-informed about college, and apply to and enroll in college at lower rates and at less-selective colleges (Hoxby & Turner, 2013). This disparity could be attributed to a lack of accessible information for these students, a lack of local selective institutions, paperwork or fee deterrents, or community expectations (a high-achieving student in a lower-achieving school may prefer to attend less-selective institutions with their peers; Hoxby & Turner, 2013). Additionally, difficulties with successfully enrolling and completing college may arise due to lack of academic preparation, financial issues, or struggles with the need to balance school and work (Bailey et al., 2002), and these struggles disproportionately impact students from lower-income backgrounds (An, 2013; Edmunds et al., 2017) and under-represented minority students (Edmunds et al., 2012; Reason, 2003). Minority students face particular challenges when transitioning into college, including struggles with racism and discrimination that may hinder their chances of completing a college degree (Rankin & Reason, 2005). Furthermore, the disproportionately high rates of enrollment in remedial coursework for minority and low-income students indicates that many under-represented students who do enroll in college are not academically prepared to do so (Chen, 2016; Uretsky, Shipe, & Henneberger, 2019), which may lead to lower likelihood of persisting to a degree. Intervention programs, such as dual enrollment, are often designed to encourage students to apply, enroll in, and complete college, which may help to decrease some of the barriers that are differentially experienced by minority and low-income students. Indeed, prior research indicates that dual enrollment is associated with greater gains in college degree attainment rates for students with less educated parents when compared to students with college-educated parents (An, 2013; Edmunds et al., 2017; Karp et al., 2007) as well as low-income students when compared to higher-income students (Edmunds et al., 2017; Struhl & Vargas, 2012). Additionally, students who are members of under-represented racial or ethnic groups had greater gains in postsecondary credential attainment rates when compared to students who are not members of the under-represented racial or ethnic groups (Edmunds et al., 2017).

Dual Enrollment and Early Labor Market Earnings

A long line of research indicates that students who enter the workforce after obtaining a college degree earn more in the labor market when compared to students who enter the workforce directly after high school (Jaeger & Page, 1996; Sanchez & Laanan, 1997). For example, results from a study using administrative data from California indicated that completing an associate's degree was associated with a 59% earnings increase three years after graduating from community college (Sanchez & Laanan, 1997). Since dual enrollment is hypothesized to increase college enrollment and degree attainment (Cho & Karp, 2013; Speroni, 2011a), it follows that dual enrollment may subsequently increase early labor market earnings. However, evidence suggests heterogeneity in the labor market earnings that follow degree attainment (Jacobsen, LaLonde, & Sullivan, 2005; Scott-Clayton, 2016). For example, Perna (2005) reported greater earnings benefits for African American students when compared to white students, and Loury and Garman (1995) reported greater returns for college selectivity for Black students when compared to white students. To date, no published studies have examined the relationship between dual enrollment program participation in high school and future workforce earnings. As such, it remains an open question whether there exists heterogeneity in the hypothesized mechanism whereby dual enrollment increases college degree attainment and subsequently increases early labor market earnings.

The Current Study

The current study implemented propensity score matching with statewide linked administrative data from the Maryland Longitudinal Data System (MLDS) to examine the effect of dual enrollment participation in high school on college enrollment, degree attainment, and workforce earnings. A major assumption of propensity score matching is the assumption that there are no unmeasured confounders. That is, we can only control for selection effects due to variables that are observed in our dataset. As such, any unmeasured confounders may bias our results and could lead to overestimation of the relationship between dual enrollment and outcomes. To help improve our estimates of the relationship between dual enrollment and outcomes, we used rich statewide longitudinal data, which provided us with the ability to control for a number of confounding variables, including demographic characteristics, academic indicators, and distance to the nearest college. Additionally, important to consider when using propensity score matching is the counterfactual (i.e., what is the comparison condition?). Here, the counterfactual is business as usual, which means that students in the comparison condition could be enrolled in advanced placement (AP) or International Baccalaureate (IB) coursework. Furthermore, dually enrolled students could be enrolled in dual enrollment courses and AP or IB coursework simultaneously.

Method

Data and Cohort

Data were from the Maryland Longitudinal Data System (MLDS), Maryland's statewide repository for education and workforce data. The purpose of the MLDS is to generate timely and accurate information about student performance that can be used to improve the State's education system and guide decision makers at all levels. The MLDS links longitudinal data from Pre-K-12, postsecondary education, and the workforce from three state agencies: the Maryland State Department of Education (MSDE), the Maryland Higher Education Commission (MHEC), and the Department of Labor Licensing and Regulation (DLLR). Data from the National Student Clearinghouse (NSC) are linked to provide out-of-state college information. For part of the timeframe examined in this study, MHEC only collected college enrollment data on students that were enrolled in fall terms. Data on enrollment for spring terms were derived from NSC records to supplement MHEC data from this period. At the time this study was published, data existed from academic year 2007-2008 through 2015-2016. This study used data from the 2009-2010 cohort (*N* = 63,790 students) of 12th grade students in Maryland public high schools. This cohort was selected because it provided the ability to have one year of data prior to dual enrollment to measure confounding variables and provided the ability to examine college outcomes through degree attainment and into the labor market six years after high school. Fifty percent of 12th grade students in Maryland were White and 37% were Black (see Table 1). A little less than a third (28%) of Maryland 12th grade students were eligible for free and reduced price meals (FARMs).

INSERT TABLE 1 ABOUT HERE

Measures

Dual enrollment participation. Dual enrollment program participation was measured by examining overlap in enrollment dates in a Maryland public high school and a Maryland college during the 12th grade academic year. Students whose only overlapping enrollment date occurred after May were not categorized as dually enrolled. Seven percent of 12th grade students (N = 4,264) were dually enrolled in the 2009-2010 academic year. Dually enrolled students were predominantly female (61%), White (77%), and not eligible for FARMs (89%; see Table 1). Dual enrollment rates vary across the 24 school districts in Maryland and range from about 2% to 30%. At the time of data collection, each school district in Maryland had a separate agreement with the local colleges to provide dual enrollment courses to students, which is the main contributor to variation in dual enrollment rates across school districts.

College enrollment. Two and 4-year college enrollments in Maryland and out-of-state colleges were examined yearly for four academic years after 12th grade. Twenty-seven percent of 12th grade students in the 2009-2010 cohort enrolled in a 2-year and 33% enrolled in a 4-year college in the year following 12th grade (see Table 1). In comparison, 45% and 42% of dually enrolled 12th grade students enrolled in a 2-year and 4-year college, respectively.

College degree. Associate, bachelor's, and certificate degrees earned at Maryland colleges and out-of-state colleges were examined in any year following 12th grade. Ten percent of 12th grade students earned an associate degree and 32% earned a bachelor's degree (see Table 1). For dually enrolled students, 22% earned an associate degree and 50% earned a bachelor's degree.

Workforce earnings. Maryland workforce earnings were provided for individuals who worked for employers subject to Maryland unemployment insurance. The MLDS workforce data do not include earnings for federal employees, military employees, independent contractors, and individuals who are self-employed. Additionally, the data do not include earnings for individuals working outside of the State. As such, our estimate of the effect of dual enrollment on workforce earnings also includes any change in students' propensity to work in Maryland.

Earnings were calculated six years after the 12th grade year (2015-2016 academic year) for the 2009-2010 cohort of 12th grade students. For this study, Quarters 3 (July - September) and 4 (October- December) of 2015 and Quarters 1 (January- March) and 2 (April – June) of 2016 were used to calculate workforce earnings. Sixty-seven percent of the dually enrolled 12th grade students and 62% of the non-dually enrolled 12th grade students in our sample had wages in the sixth year after 12th grade. The average earnings for the 2009-2010 cohort of 12th grade students six years after 12th grade was approximately $20,900 (average includes 0s; see Table 1). The average earnings for dually enrolled students was approximately $25,400 while the average earnings for non-dually enrolled students was $20,514.

Confounding Variables

Demographic characteristics (e.g., gender, race, eligibility for FARMs), academic indicators (e.g., Maryland high school assessment [HSA] scores, number of advanced placement (AP) tests taken, attendance), and distance from the high school attended to the nearest college were used as confounding variables in this study. The HSA was Maryland's statewide assessment during the time of this study and scores ranged from 240 to 650 with a score of 396 indicating proficiency in English and a score of 412 indicating proficiency in Algebra, and a score of 429 indicating advanced in English and a score of 450 indicating advanced in Algebra. Dummy indicators for local school system (Maryland's equivalent of school district) were included to account for any differences in local dual enrollment agreements between school systems and community colleges. A summary of confounder variables can be found in Table 2.

INSERT TABLE 2 ABOUT HERE

Data Analyses

Data analyses proceeded in the following steps. First, missing data were imputed (Little & Rubin, 1989; Schafer & Graham, 2002) in R using the Multivariate Imputation via Chained Equations (MICE) package, which uses predictive mean matching (van Buuren & Groothuis-Oudshoorn, 2011). All variables used in analyses were imputed, except the data for the Algebra HSA for the 2009-2010 cohort were not imputed due to high rates of missingness (>70% missing) and low likelihood that data were missing at random. In Maryland, the Algebra HSA is typically taken in 9th or 10th grade, and data for this cohort of students were not available during the time period. Analyses were conducted on the imputed dataset and on the dataset with missing values, and results remained largely consistent. Results reported here are from the imputed dataset. Second, propensity scores were estimated for each student using logistic regression with confounding variables predicting dual enrollment program participation (dual enrollment = 1). Propensity scores range from 0-1 and represent the probability that a student would be in the treatment group given the predictors used in the model (see Rosenbaum & Rubin, 1983; Shafer & Kang, 2008). In this study, a higher propensity score indicated a higher probability of the student being dually enrolled. Third, the 'MatchIt' package (Ho, Imai, King, & Stuart, 2018) in R was used to implement one-to-one nearest neighbor matching (caliper = 0.20) to match each dually enrolled student to a similar student who was not dually enrolled.

Using the nearest neighbor matching process on the propensity score, our method identifies the average treatment on the treated (ATT). Using a Rosenbaum and Rubin (1983) framework, we can describe potential outcomes Y_0 and Y_1 as the possible outcomes for an individual if they were to have treatment status D, equal to zero or 1, respectively. We can also define the propensity score as the probability of receiving the treatment based on a vector of covariates X, or $P(D = 1 \,|X)$ (or more succinctly, $P(X)$). For identification of the causal effect, two assumptions are required:

(1) *Unconfoundedness*: Conditional on the propensity score (and thus the covariates), the assignment to treatment is independent of the outcomes.

$$(Y_0, Y_1) \perp D \mid P(X)$$

(2) *Overlap:* The probability of being treated is bounded away from 0 or 1.

$$0 < P(X) < 1$$

Our matching procedure estimates the propensity score, and then matches treated individuals to untreated control individuals with similar propensity scores using a nearest-neighbor process. Under these assumptions, we identify the ATT, the treatment effect of dual enrollment for those who are treated, or:

$$ATT = E[Y_1 - Y_0 \mid D = 1, X]$$

Standardized mean differences (SMD) between the treatment and comparison groups pre- and post-matching were used to examine balance between the two groups on confounders (see Table 2). A SMD under 0.2 indicated that the groups were similar on the confounder, a small effect according to Cohen (1988). After matching, all confounders had a SMD below 0.2 for both cohorts. Finally, outcome models were run with the matched data. A series of logistic regressions were used to examine the effect of dual enrollment on college enrollment and college degree completion. Linear regression was used to examine the effect of dual enrollment on workforce earnings six years after the 12th grade. All confounders were included as covariates in the outcome analyses to ensure proper control.

Results

Effects of Dual Enrollment on College Enrollment and Degree Attainment

Overall, dual enrollment in 12th grade had positive effects on college enrollment (see Table 3). The marginal effect of dual enrollment for each outcome can be interpreted as the average percentage point increase in the outcome for dually enrolled students when compared to similar students who were not dually enrolled. In the first year following high school, dual enrollment had a large effect on 2-year college enrollment (+20 percentage points) and had no significant effect on 4-year college enrollment. Four years after high school, dually enrolled students were more likely to be enrolled in 2-year colleges (+4 percentage points) and 4-year colleges (+7 percentage points). The larger effect of dual enrollment on 4-year college enrollment in the fourth year when compared to the effect observed in the first year is consistent with a shift in enrollment from 2-year colleges to 4-year colleges between years one and four. The results for the heterogeneity analyses (see Table 5) indicated that the effect of dual enrollment on 2-year college enrollment was smaller for Black students when compared to white students (B = -0.168, $p < .01$), but the effect on 4-year college enrollment was larger for Black students when compared to white students (B = 0.166, $p < .01$). Additionally, the effect of dual enrollment on 2-year college enrollment was larger for students who were eligible for FARMs when compared to students who were not eligible for FARMs (B = 0.085, $p < .01$).

Dual enrollment in 12th grade also had positive effects on college degree attainment (see Table 3). Dual enrollment had a large effect (+15 percentage points) on the likelihood of attaining any college degree. Dually enrolled students were 8 percentage points more likely to earn an associate degree and 9 percentage points more likely to earn a bachelor’s degree, when compared to similar students who were not dually enrolled in 12th grade. The results for the heterogeneity analyses (see Table 5) indicated that the effect of dual enrollment on earning an associate degree was smaller for Black students when compared to white students (B = -0.068, $p < .01$), but the effect of dual enrollment on earning a bachelor’s degree was larger for Black students when compared to white students (B = 0.090, $p < .01$). A heterogeneous effect similar in magnitude was found for Other-race students when compared to White students.

INSERT TABLE 3 ABOUT HERE

Effects of Dual Enrollment on Workforce Earnings Six Years after High School

Overall, dual enrollment in 12th grade had positive effects on workforce earnings six years after high school (see Table 4). First, we predicted the probability of having nonmissing Maryland earnings in the 6th year, and we find that dually enrolled students had a higher likelihood of having present earnings (+3 percentage points) than the matched comparison group. Dually enrolled students earned approximately $1,800 more in annual earnings than similar non-dually enrolled students six years after high school graduation. We used a trimming procedure (Lee, 2009) to estimate the sensitivity of our analyses to missing earnings in the comparison group. The lower bound trimmed the top 3% of earners from the dual enrollment completers, and the upper bound trimmed the bottom 3% of earners from the dual enrollment completers. Our results indicated that we cannot be sure that the positive effect of dual enrollment on earnings was not due to differences in the rate of observing earnings between the dual enrollment and comparison groups. Results for the heterogeneity analyses (see Table 5) showed no significant differences in the association between dual enrollment and earnings across the subgroups examined.

INSERT TABLES 4 AND 5 ABOUT HERE

Discussion

Prior research on dual enrollment implementing rigorous quasi-experimental designs reported positive effects on college enrollment (Giani et al., 2014; Struhl & Vargas, 2012) and degree attainment (An, 2013; Giani et al., 2014; Grubb et al., 2013; Struhl & Vargas, 2012). However, a recent experimental study found no significant effects on college enrollment (Hemelt et al., 2019), and a prior study using a regression discontinuity approach also reported no significant effects (Speroni, 2011b). Furthermore, few studies have examined the heterogeneity in effects to determine whether dual enrollment may be differentially effective for under-represented students (for exceptions, see Edmunds, 2017; Struhl & Vargas, 2012). In the current study, we leveraged statewide administrative data from Maryland and implemented a propensity score matching approach to limit the bias of observed variables. Dual enrollment had significant positive effects on college enrollment, degree attainment, and early labor market earnings. Furthermore, the effects of dual enrollment on college outcomes were stronger for traditionally under-represented student populations (e.g., minority students and students eligible for FARMs).

Dual enrollment in the 12th grade year had significant positive effects on college enrollment, persistence, and degree attainment, which is consistent with prior studies that implemented propensity score matching procedures (An, 2013; Giani et al., 2014; Grubb et al., 2017; Struhl & Vargas, 2012). The effects of dual enrollment on 2-year college enrollment were stronger in the year following 12th grade, an increase of 20 percentage points, while there was no increase for 4-year college enrollment in the year immediately following high school. However, the effects of dual enrollment on 4-year college enrollment got stronger over time, and four years after high school completion there was a seven percentage point increase in enrollment at 4-year colleges, while only a four percentage point increase at 2-year colleges. This suggests that dually enrolled students are beginning their college careers at 2-year colleges and then transferring to 4-year colleges. This finding is consistent with an evaluation of a dual enrollment program in Washington State, “Running Start”, where students who participated were 5.4 percentage points more likely to attend any college in the year after 12th grade, but were 9.1 percentage points less likely to attend a 4-year college in the year after 12th grade, indicating higher rates of initial enrollment at 2-year colleges (Cowan & Goldhaber, 2015). Theory indicates that dual enrollment may act as a bridge between high school and college, whereby dual enrollment helps students to understand the financial, academic, psychological, and social demands of college (Bailey et al., 2002). Most dually enrolled students dually enroll in coursework at 2-year colleges (Henneberger et al., 2016), and the most recent statewide statistics from the MLDS Center indicated that in 2017-2018, about 50% of dually enrolled students who subsequently enrolled in college in-state enrolled in the community college in which they were dually enrolled in high school (MLDS Center, n.d.a). However, this percentage varied greatly by school district. It is likely that, for many students, the introduction to college life provided by dual enrollment then facilitates the transition to enrollment in that same 2-year college, which may then help to facilitate a successful transition to a 4-year college. Not addressed in the current study, it is also possible that some students began in 4-year colleges and then enrolled in 2-year colleges. More research is needed to clearly identify the pathways for students from high school in and out of 2- and 4-year colleges.

Also consistent with prior research, dually enrolled students were more likely to earn a college degree. Our effect of about 15 percentage points for any degree attainment is similar to the effect reported by Struhl and Vargas (2012), who report an effect of about 17 percentage points for their study conducted on students in Texas. However, we found an effect for bachelor's degree attainment of about 9 percentage points, whereas Struhl and Vargas (2012) found a larger effect of about 17 percentage points. The difference in effect sizes may be due to the timeline of the study, as this study examined effects at four years following high school graduation and the study by Struhl and Vargas (2012) examined effects at six years following high school graduation. Additionally, we found an effect on associate degree attainment of about 8 percentage points, which is similar to the effect reported by Grubb et al. (2016) of 9 percentage points for the effect of dual enrollment on associate degree attainment three years following high school. It is important to consider the possibility of selection bias because our results for degree attainments are not independent of our results for college enrollment. As such, it is possible that the degree effects are actually due to the increase in enrollment in college seen for dually enrolled students.

The effects of dual enrollment in 12th grade were stronger for students who are traditionally under-represented in the college going population (e.g., Black and Other-race students and students eligible for FARMs). These findings are consistent with prior research reporting that students with less educated parents and low-income students benefit most from dual enrollment (An, 2013; Karp et al., 2007; Struhl & Vargas, 2012). Dual enrollment had stronger effects for Black students' enrollment in 4-year colleges and for Black and Other-race students' attainment of a bachelor's degree. This is consistent with the theory that dual enrollment may help under-represented students become familiar and comfortable with college early-on, making them more likely to enroll in 4-year colleges after high school (An, 2013; Bailey et al., 2002). The differential effect for Black students extends to bachelor's degree earning, but the heterogeneous effect of dual enrollment on bachelor's degree earning for Hispanic students and students eligible for FARMs is not significant. This may indicate the utility of targeted programs aimed at helping these populations of under-represented students persist to earning a bachelor's degree. The current study is the first to report on the differential effects of dual enrollment on workforce earnings, and we found no significant differential effects.

Dual enrollment in the 12th grade year also had significant positive effects on workforce earnings in the sixth year following the 12th grade, with dually enrolled students earning $1,800 more than similar non-dually enrolled students. A number of possible mechanisms could help to explain the positive causal effect of dual enrollment on workforce earnings. Dually enrolled students often earn college credits for their coursework, so it may be that dually enrolled students are completing college and subsequently entering the workforce sooner than their non-dually enrolled peers. Selection bias may also be an issue, as our results indicate that dual enrollment is linked to attaining a bachelor's degree, and it may be that dually enrolled students have higher earnings by virtue of degree completion (Jaeger & Page, 1996; Sanchez & Laanan, 1997. An additional possibility not explored in the current study is that dually enrolled students work in sectors that provide higher earnings (e.g., science, technology, engineering, and math [STEM]). This may be especially true if dually enrolled students are dually enrolled in advanced STEM coursework in high school. More research is needed to further explore the mechanisms through which dual enrollment affects future earnings. There were no differential effects for earnings in the current study, which was contrary to prior research indicating that the returns to a degree may differ for some students (e.g., see Jacobsen et al., 2005; Loury & Garman, 1995; Perna, 2005; Scott-Clayton, 2016).

The Maryland workforce data are limited because they do not include earnings for federal employees, military employees, independent contractors, and individuals who are self-employed. Our results may be biased to the degree that students who were dually enrolled were more likely to work outside of Maryland than students who were not dually enrolled (or vice versa). The Lee (2009) bounding procedure we used indicated that we cannot be completely sure that the earnings effects we see are not due to differential rates of observed earnings. However, unobserved earnings could indicate unemployment or could indicate moving outside of Maryland for employment. One proxy to estimate the percentage of students leaving the State for employment might be the percentage of students who are going to out-of-state colleges. The most recent statistics from the MLDS Center reported that 72% of students who were dually enrolled in 2017-2018 and subsequently enrolled in college in the Fall of 2018 enrolled in a college in Maryland (MLDS Center, n.d.a). Only 28% of dually enrolled students enrolled in a college out-of-state. These statistics align very well with the percentage of the total Maryland population of high school graduates who enroll in-state (73%) and out-of-state (27%) between 2007-2008 and 2016-2017 (MLDS Center, n.d.b). The results of these analyses help us to be more confident that the differential rates of observation in the Maryland workforce could be due to differential rates of unemployment, which would also contribute to the earnings effect found for dual enrollment students. Additional follow-up analyses examined the rates of continuing to be enrolled in school in the sixth year. Dually enrolled students were more likely to be enrolled in college in the sixth year following high school, which combined with the result indicating their higher likelihood of attaining a bachelor's degree, may suggest that dually enrolled students are differentially enrolled in graduate schools. Students who are enrolled in graduate school in Maryland may be differentially likely to also be observed in the workforce in Maryland.

The results of this study should be interpreted within the context of the following limitations. First, it is important to consider the counterfactual, which in the current study is business as usual. Students in the comparison condition could be enrolled in AP and IB coursework, which would lead us to underestimate the effects of dual enrollment. Additionally, dually enrolled students could be enrolled in AP or IB coursework simultaneously, which would lead us to overestimate the effect of dual enrollment. This is especially important to consider given the differential cost of dual enrollment and AP coursework. In many states, there are agreements in which the tuition for dual enrollment courses is subsidized by the State, and in some cases, such as for low-income students, the tuition is free to the student. In some instances, the cost of AP courses/exams is also subsidized. However, more information is needed to determine the relative cost/benefit of dual enrollment in comparison to AP or IB coursework.

Additionally, the use of propensity score matching assumes no unmeasured confounders. Critical unobserved confounders that were not measured in this dataset may include high school behavioral problems, parental income and education, academic motivation, etc. Our results are robust to this limitation to the degree that unobserved variables are highly correlated with measured confounders. However, it is possible that unobserved variables may explain part of the effect of dual enrollment found in this study. The MLDS data do not offer the granularity needed to provide more nuanced comparisons of the effects of different types of dual enrollment program participation on college and workforce outcomes. For example, we were unable to compare the causal effects of dual enrollment participation specific to an Early Middle College program or specific to characteristics of local school system dual enrollment partnership agreements (e.g., credit offerings, tuition and fees). At the time of this study, dual enrollment opportunities were differentially available across high schools in Maryland. The results of the current study are limited because school factors were not accounted for when examining the effects of dual enrollment and the differential availability of dual enrollment opportunities may bias results. Finally, this study focused on students who were dually enrolled in the 12th grade, but it is possible for a student to dually enroll in any high school grade. Future research may benefit from examination of whether the long-term outcomes of students differ by the high school grade in which a student dually enrolled and whether students who dually enrolled for longer periods of time have more positive outcomes.

Conclusion

Successfully transitioning from adolescence into adulthood requires a successful transition from high school into college or the workforce (Arnett, 2012). Yet, many youth do not successfully manage this transition, setting them up for significant lifelong physical, psychological, and social problems (Arnett, 2012; Nelson & Padilla-Walker, 2013), and minority and low-income youth tend to have more difficulty with the transition into adulthood (Belford et al., 2012). Our results indicate that dual enrollment may be a strategy to help facilitate the transition from high school into college and career, especially for under-represented students, including minority and low-income students. We used propensity score matching to limit the selection effects of observable variables and found positive effects of dual enrollment in 12th grade on college enrollment, degree attainment, and early labor market earnings. Furthermore, the effects of dual enrollment were stronger for students who are traditionally under-represented in college-going populations (e.g., Black and Other-race students and students eligible for FARMs). Our results indicate that dual enrollment may be one strategy to help under-represented youth successfully navigate this transition. The findings of the current study highlight the positive long-term outcomes associated with dual enrollment and the potential for implementation of additional programs and policies that support under-represented students to dually enroll (e.g., tuition reimbursement for low-income students; mentoring programs for dually enrolled under-represented students). It may be particularly beneficial to provide ongoing support (e.g., mentoring, college advising, campus engagement) for under-represented students once they enroll in college in order to support persistence to degree attainment.

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Table 1

Means of selected variables by dual enrollment status

	All	DE	no DE
Male	50%	39%	51%
White	50%	77%	49%
Black	37%	14%	38%
Hispanic	8%	4%	8%
FARMS	28%	11%	29%
Special Education	11%	3%	11%
Has HSA Algebra	28%	8%	30%
HSA Algebra	411	423	411
Has HSA English	91%	92%	91%
HSA English	417	428	416
Has HSA Biology	72%	59%	73%
HSA Biology	420	434	420
Weeks Absent	2.865	2.005	2.925
Distance to 2-Year	7.289	7.557	7.267
3.0 GPA	33%	57%	32%
Initial 2-year	27%	45%	25%
Initial 4-year	33%	42%	32%
Associate Degree	10%	22%	9%
Bachelor's Degree	32%	50%	30%
Earnings - 6 years	$20,862	$25,389	$20,514
Observations	63,790	4,264	59,526

Note. DE = dual enrollment; FARMS = eligibility for free and reduced price meals; HSA = high school assessment; GPA = grade point average.

Table 2

Standardized differences between treatment and control, before and after matching

	Unmatched	Matched
Male	0.248	0.001
White	0.619	0.016
Asian	0.056	0.006
Black	0.583	0.012
Hispanic	0.165	0.005
FARMS	0.463	0.028
Homeless	0.105	0.010
Special Education	0.325	0.001
Has HSA Algebra	0.053	0.014
HSA Algebra	0.564	0.025
Has HSA English	0.518	0.012
HSA English	0.456	0.005
Has HSA Biology	0.576	0.026
HSA Biology	0.475	0.013
Weeks absent	0.301	0.047
Distance to 2-Year	0.047	0.025
3.0 GPA	0.024	0.006

Note. FARMS = eligibility for free and reduced price meals; HSA = high school assessment; GPA = grade point average.

Table 3

Effects of dual enrollment on college enrollment one year and four years after high school

	One Year Later		Four Years Later					
Dependent Variable:	2-Year	4-Year	2-Year	4-Year	Any Degree?	Associate	Bachelor's	Certificate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dual Enrollment	0.908***	0.032	0.367***	0.277***	0.605***	0.684***	0.356***	0.407***
	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)	(0.14)
Odds Ratio	2.48	1.033	1.44	1.32	1.83	1.98	1.43	1.5
Marginal Effect	0.2	0.008	0.04	0.07	0.15	0.08	0.09	0.01
Dep. Mean	0.36	0.42	0.14	0.49	0.56	0.17	0.47	0.03
McFadden's Psuedo-R2	0.11	0.236	0.05	0.23	0.25	0.07	0.25	0.07
Observations	8,528	8,528	8,528	8,528	8,528	8,528	8,528	8,528

Note. *p < .10; ** p <.05; ***p<.01. Standard errors in parentheses.

Table 4

Effects on early labor market earnings six years after high school graduation

Dependent Variable:	Nonmissing earnings (1)	Earnings 6 years later (2)
Dual Enrollment	0.030***	1,787.381***
	(0.01)	(482)
Dep. Mean	0.66	24,510
Lee (2009) bound on wage effect		(-487, 3053)
Observations	8,528	5,588

Note. *p < .10; ** p <.05; ***p<.01. Standard errors in parentheses. Column (1) reports the probability of having nonmissing earnings in the MLDS data. A student was counted as having nonmissing earnings after six years if the student was present in the MLDS wage data six years after high school graduation. Column (2) estimates the effect using only students with nonmissing earnings. The Lee bounds follow the procedure in Lee (2009) using a trimming procedure to set sharp bounds on the earnings effect that may be due to the statistically significant difference in nonmissing wages found in Column (1).

Table 5

Heterogeneity in initial college enrollment, degree, and earnings effects

Dependent Variable:	Two-year	Four-year	Associate	Bachelor's	Earnings
	(1)	(2)	(3)	(4)	(5)
Dual Enrollment	0.160***	-0.040***	0.116***	0.045***	1,727***
	(0.015)	(0.014)	(0.012)	(0.014)	(615)
Dual Enrollment x					
Asian	-0.095**	0.027	-0.030	0.016	-1,188
	(0.047)	(0.044)	(0.038)	(0.044)	(1,947)
Black	-0.168***	0.166***	-0.068***	0.090***	1,587
	(0.030)	(0.028)	(0.025)	(0.028)	(1,242)
Other	-0.050	0.052	-0.073*	0.087*	2,762
	(0.050)	(0.047)	(0.041)	(0.047)	(2,078)
Hispanic	0.003	0.041	0.033	-0.006	-72
	(0.053)	(0.050)	(0.043)	(0.049)	(2,196)
FARMs	0.085***	0.022	-0.025	-0.013	1,144
	(0.032)	(0.031)	(0.027)	(0.030)	(1,353)
Observations	8,528	8,528	8,528	8,528	8,528
R^2	0.137	0.277	0.060	0.297	0.033

*Note.**p < .10; ** p <.05; ***p<.01. Standard errors in parentheses; FARMs = eligibility for free and reduced price meals; models also included gender (male = 1) and academic achievement scores (> Median HSA English score = 1).