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Dual Enrollment in Maryland: What are the Causal Effects on College and Workforce Outcomes and do Effects Differ by Student Subgroup?

Submitted by:

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If you have questions regarding this publication, please contact mlds.center@maryland.gov.

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Executive Summary

Dual enrollment, where high school students enroll in college coursework, is implemented in Maryland with the goal of improving college and career outcomes for students. Prior research on dual enrollment finds a positive relationship between participation in dual enrollment programs and college outcomes, including college enrollment and degree attainment. However, few studies have used causal designs that can determine the causal effect of dual enrollment on long-term college outcomes, and there have been no studies to date that causally link dual enrollment program participation with long-term workforce wages. This study used data from the Maryland Longitudinal Data System (MLDS) to examine the causal effect of dual enrollment participation in high school on college enrollment, persistence, degree attainment, and wages six years after the 12th grade for two academic cohorts of Maryland public high school students. Findings indicated that dually enrolled students were more likely to enroll in college, persist in college, and earn a college degree, including associate, bachelor's, and certificate degrees, when compared to similar students who were not dually enrolled. Additionally, dually enrolled students earned significantly higher wages (+$2,100) six years after the 12th grade when compared to similar students who were not dually enrolled. Dual enrollment had stronger effects for students who are traditionally under-represented in the college population (e.g., Black and Hispanic students and students eligible for free and reduced price meals [FARMS]). This report discusses policy implications and directions for future research on dual enrollment in Maryland.

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Introduction

The College and Career Readiness and College Completion Act (CCR-CCA) of 2013 (Chapter 533, Senate Bill 740, 2013) passed the Maryland General Assembly with the goal of improving college and career outcomes. One policy lever included in the legislation was a cost reduction for select high school students who dually enroll in college courses. The number of students participating in dual enrollment programs in Maryland has been on the rise in recent years (Henneberger, Cohen, Shipe, & Shaw, 2016; MLDS Center, 2017). Yet, few studies have used advanced statistical methods to evaluate the effects of dual enrollment program participation on long-term outcomes, such as college enrollment, degree attainment, and workforce wages. Preliminary analyses on the college enrollment outcomes of dually enrolled students in Maryland indicated that 89% enrolled in college the following academic year, compared to only 64% of non-dually enrolled students (Henneberger et al., 2016; MLDS Center, 2017). Dually enrolled students in Maryland are disproportionately female, white, and not eligible for free and reduced price meals (FARMS; Henneberger et al., 2016; MLDS Center 2017), which are characteristics of students who are also more likely to enroll in college (Alexander, Riordan, Fennessey, & Pallas, 1982; Tracey & Sedlacek, 1986). This makes it difficult to determine whether positive outcomes are actually due to dual enrollment participation or due to the characteristics and backgrounds of students who participate in dual enrollment.

The goal of this study is to improve the ability to causally link dual enrollment program participation with postsecondary outcomes through the use of a quasi-experimental method known as propensity score matching (PSM; Rosenbaum & Rubin, 1983; Schafer & Kang, 2008) using data from the Maryland Longitudinal Data System (MLDS). PSM is used to match students who participated in dual enrollment programs to similar students who did not participate in dual enrollment programs. The matched sample is then used to examine the relationship between dual enrollment program participation and outcomes. This approach is beneficial because it controls for differences between the dual enrollment participants and non-participants, improving the ability to link outcomes with participation in dual enrollment. This study reports on the causal effects of dual enrollment on college enrollment at Maryland and out-of-state 2- and 4-year colleges, college persistence, college degree attainment, and wages six years after the 12th grade. Differential effects of dual enrollment on outcomes by gender, race, ethnicity, eligibility for free and reduced price meals (FARMS), and high school academic achievement are also examined.

Background

Dual enrollment participation is linked to positive postsecondary outcomes at 2- and 4-year institutions, including a greater likelihood of enrollment in college, persisting past the first semester of college, and earning a higher grade point average (GPA; Karp, Calcagno, Hughes, Jeong, & Bailey, 2007). Determining whether dual enrollment participation causes these outcomes is more difficult, especially in the absence of an experimental study (Shadish, Cook, &

Campbell, 2002), as students typically self-select into dual enrollment participation (Lewis & Overman, 2008). Confounders influence both the predictor of interest (dual enrollment) and the outcomes (e.g., college enrollment), and are likely to be present when students self-select into a program (Rosenbaum & Rubin, 1983). In a non-experimental design using observational data, the relationship between the predictor and outcome could be explained by a confounder, which means that causation cannot be determined (Robins, 1989; Schafer & Kang, 2008). For a study to identify a causal effect it needs to isolate the effect of the treatment from possible confounders. Experimental methods achieve this by randomized assignment of treatment and control, while quasi-experimental methods, like PSM, do so by using statistical methods or natural experiments that mimic random assignment under certain assumptions (Shadish, Cook, & Campbell, 2002). Matching procedures, such as PSM, provide a method for matching students based on observable characteristics so that functionally equivalent treatment and control groups can be generated (Ho, Imai, King, & Stuart, 2007; Rosenbaum & Rubin, 1983; Schafer & Kang, 2008). Differences in the outcome of interest are examined using the matched groups, and any difference in the outcome can be considered to be caused by the predictor of interest due to the control of potential confounders. This method assumes no unmeasured confounders (Rosenbaum & Rubin, 1983), which means that all important confounding variables (or variables that are highly correlated with important confounding variables) are included in the propensity score model. The limitations of this study relevant to this assumption are further discussed later in this report.

Prior Research on Dual Enrollment Using a Matching Approach

Several researchers have applied PSM to longitudinal data to determine whether participation in dual enrollment has a causal impact on postsecondary outcomes. Struhl and Vargas (2012) examined longitudinal data from Texas and matched students based on gender, race/ethnicity, Limited English Proficiency (LEP) status, income, and standardized test scores. Students who participated in dual enrollment programs were more likely to enroll in college, return for a second year of college, and complete a college degree when compared to students who did not participate in dual enrollment (Struhl & Vargas, 2012). These same increases in positive outcomes for dually enrolled students in Texas were found in a similar study conducted by Giani, Alexander, and Reyes (2014). Another study that used PSM to match students using early college measures, academic indicators, and contextual school factors from the National Education Longitudinal Study of 1988 (NELS: 88) concluded that participation in dual enrollment programs increased the likelihood of college degree attainment (An, 2013). Grubb, Scott, and Good (2017) used PSM with Tennessee community college data to match dual enrollment participants to non-participants using academic and demographic covariates. They found that students who participated in dual enrollment were less likely to need remedial courses in college and more likely to graduate with a degree in two or three years when compared to students who did not participate in dual enrollment (Grubb et al., 2017). The use of PSM in

these studies strengthened the causal relationship between dual enrollment participation and the postsecondary outcomes because potential confounding variables were controlled.

Differential Effects of Dual Enrollment by Student Characteristics

Prior research indicates that dual enrollment programs may be more effective for some student groups than others. For example, dual enrollment has been 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; Karp et al., 2007). Additionally, Struhl and Vargas (2012) found that males, low-income students, and students with lower GPAs in high school benefitted more from participation in dual enrollment programs when compared to females, high-income students, and students with higher GPAs, respectively, in terms of college access, persistence, and completion. The student groups which benefit the most from dual enrollment participation, such as low-income students or students with lower high school GPAs, are those groups which are less likely to enroll in college or obtain a degree in the general population (Karp et al., 2007). Dual enrollment may serve as an introduction to college for students who have little knowledge or experience with college enrollment.

The Current Study

In order to examine the causal effect of dual enrollment participation on college and workforce outcomes in Maryland, this study used data from the MLDS and applied a PSM (Rosenbaum & Rubin, 1983; Schafer & Kang, 2008) approach to match students who participated in dual enrollment programs to similar students who did not participate in dual enrollment programs. The matched pairs were then used to examine the causal effect of dual enrollment on college enrollment at 2- and 4-year colleges, college persistence, college degree attainment, and wages six years after the 12th grade. The differential effects of dual enrollment on outcomes were examined by gender, race, ethnicity, eligibility for FARMS, and academic achievement.

This study expands upon prior research on dual enrollment in three main ways. First, there have been no research studies that have looked at the relationship between dual enrollment participation in high school and future workforce wages. The linked longitudinal education and workforce data within the MLDS enable such analyses. Second, the research applying quasi-experimental designs (e.g., PSM) to examine the college outcomes that can be attributed to dual enrollment program participation is relatively sparse. The high school data within the MLDS provide a rich set of confounder variables, optimal for PSM designs. Third, few studies have examined the differential effects of dual enrollment program participation by student characteristics. This research is particularly important for targeting dual enrollment programs and policy toward the students who may benefit the most.

Research Questions

This report responds to the Maryland Longitudinal Data System (MLDS) Center Research Agenda questions:

- *Are Maryland students academically prepared to enter postsecondary institutions and complete their programs in a timely manner?*
- *Are exiters of Maryland colleges successful in the workforce?*

Method

The data used for this report are from the Maryland Longitudinal Data System (MLDS), which contains linked longitudinal data from three State agencies.[1] The Maryland State Department of Education (MSDE) provides data for public preK-12 students and schools. The Maryland Higher Education Commission (MHEC) provides data for Maryland public and private college students and colleges. The Department of Labor Licensing and Regulation (DLLR) provides data for Maryland citizens employed by employers who are subject to Maryland's unemployment insurance. The workforce data do not include information for federal employees, military employees, individuals who are self-employed, or private contractors. Out-of-state college enrollments and degrees are obtained through the National Student Clearinghouse (NSC)[2] for students who were in a Maryland public high school for the 12th grade. 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.

Sample Selection

Maryland public high school 12th grade students from two academic cohorts were selected: (1) the 2009-2010 cohort of 12th grade students (*N* = 64,000) was used to examine college enrollment, persistence, degree attainment, and workforce outcomes six years following the 12th grade year (2015-2016) and (2) the 2013-2014 cohort of 12th grade students (*N* = 63,000) was used to examine college enrollment and persistence with the most recent data available at the time this report was published. This report focuses on 12th grade students because (1) they constitute the majority of dual enrollment program participants in Maryland (see Henneberger et al., 2016) and (2) focusing on 12th grade students provided the ability to examine the transition to college and the workforce.

[1] For more information on the sources and data elements included in the MLDS, see https://mldscenter.maryland.gov/.

[2] For more information, see http://www.studentclearinghouse.org/.

Measures

Students were classified as dually enrolled if they had overlapping enrollment dates in a Maryland public high school and a Maryland college in their 12th grade year. College enrollments that occurred in the summer semester prior to the student's June high school graduation date were not classified as dual enrollments (see MLDS Center, 2017 for an in-depth definition of dual enrollment). Seven percent (*N* = 4,263) of students in the 2009-2010 cohort of 12th grade students were dually enrolled, and 8% (*N* = 4,909) of students in the 2013-2014 cohort of 12th grade students were dually enrolled. Figure 1 presents the sample selection and dual enrollment definition criteria for this study.

Figure 1. Sample Selection and Dual Enrollment Definition

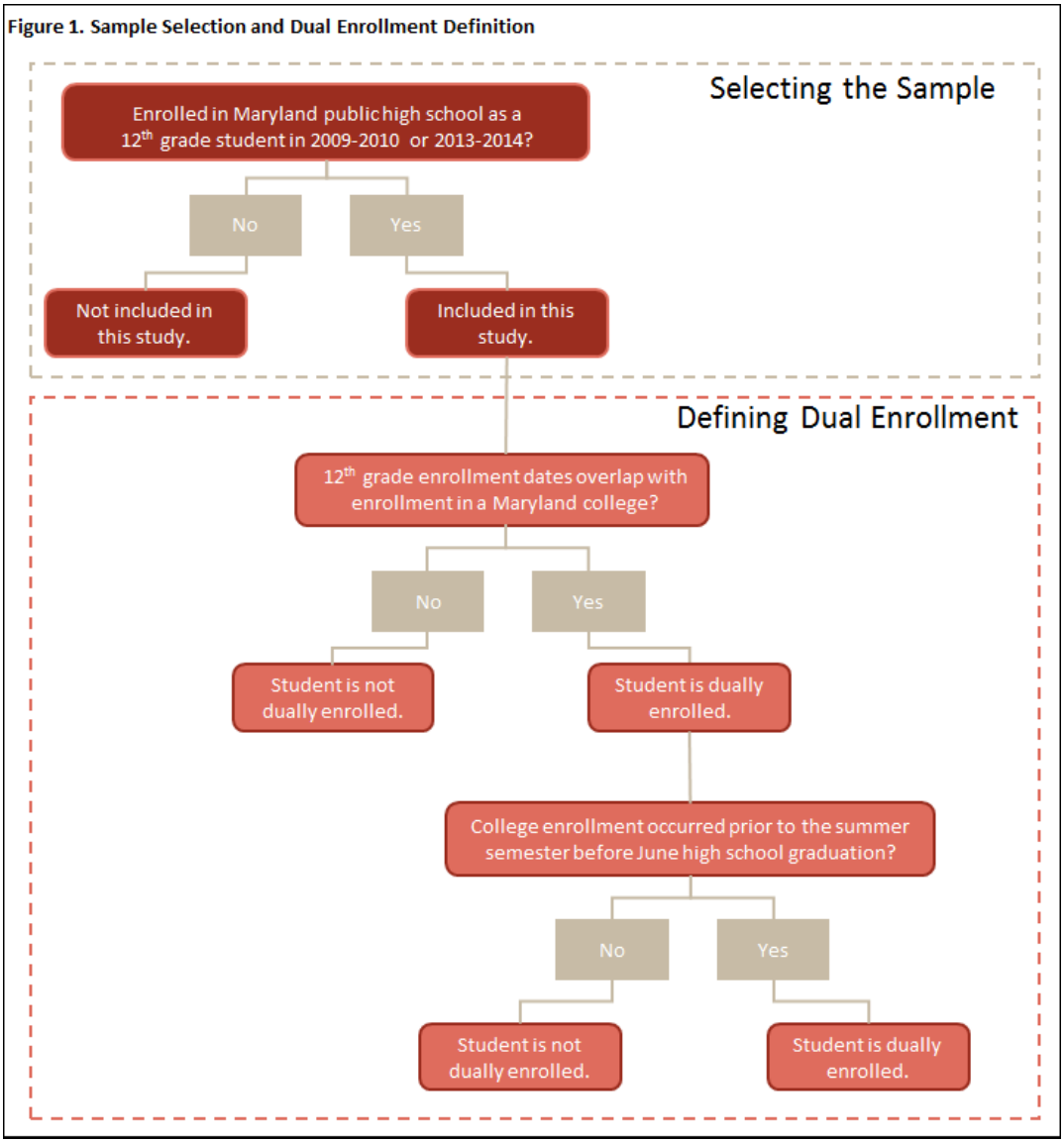


Table 1 presents the descriptive statistics for dually enrolled students compared to non-dually enrolled students for both cohorts used for analyses. Lower percentages of dually enrolled students were male, Black, and eligible for free and reduced price meals (FARMS) when compared to non-dually enrolled students. Descriptive statistics for outcome variables by dually enrolled status for each cohort can be found in Appendix A.

Table 1. Descriptive Statistics for Dually Enrolled Students Compared to Non-Dually Enrolled Students

	2009-2010 Cohort		2013-2014 Cohort	
	Dually Enrolled (*N* = 4,263)	Non-Dually Enrolled (*N* = 59,700)	Dually Enrolled (*N* = 4,909)	Non-Dually Enrolled (*N* = 58,100)
	%	%	%	%
Male	39	51	39	51
White	77	49	74	48
Black	14	38	15	38
Other	9	13	11	14
Hispanic	4	8	6	11
FARMS	11	29	18	35

Note. FARMS = eligibility for free and reduced price meals.

College enrollment and persistence in 2-year and 4-year in-state and out-of-state colleges was examined for years 1-4 following 12th grade for the 2009-2010 cohort and for years 1-2 following 12th grade for the 2013-2014 cohort. Postsecondary degrees attained from in-state and out-of-state colleges after high school were classified as associate, bachelor's, or certificate. The degree was coded as present if the student earned the degree in any year following high school. Maryland workforce wages were calculated in the sixth year following high school (2015-2016) by summing all quarterly wages[3] in the academic year for each student. Quarters where a student did not have wages were added into the sum as zero wages. 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.

Analyses proceeded in a series of steps. First, rates of missing data were examined for each cohort, and missing data were imputed (see Appendix B for details). Second, propensity scores were calculated by fitting a logistic regression model with dual enrollment program participation as the outcome and confounding variables as the predictors (see Appendix C for details). Confounding variables included demographic characteristics (e.g., gender, race, eligibility for FARMS), academic indicators (e.g., high school assessment [HSA] scores, number of advanced placement [AP] courses), and local school system was included to account for any

[3] The MLDS workforce data include quarterly wages. 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 wages.

differences in dual enrollment and outcomes that may be systematic by school system. Third, propensity scores were used to match students in the treatment group (dual enrollment program) to students in the control group (not dually enrolled or business as usual). Finally, the matched data were used to examine the causal effect of dual enrollment program participation on college and workforce outcomes using a series of logistic regressions for binary outcomes (college enrollment, persistence, and degree attainment) and linear regression for continuous outcomes (workforce wages). All confounding variables were also included as control variables in the outcome models with the matched sample.

Findings

Table 2 presents the causal effects of dual enrollment in 12th grade on college enrollment, persistence, degree attainment, and workforce wages.[4] The marginal effect of dual enrollment on each binary outcome (college enrollment, persistence, and degree attainment) can be interpreted as the average percentage point increase in the outcome caused by dual enrollment for students who were dually enrolled when compared to similar students who were not dually enrolled. The marginal effect of dual enrollment on workforce wages can be interpreted as the average dollar amount increase caused by dual enrollment for students who were dually enrolled when compared to similar students who were not dually enrolled.

Overall, dual enrollment participation in 12th grade had a significant positive causal effect on college enrollment, persistence, degree attainment, and workforce wages. Dual enrollment had a larger effect on 2-year college enrollment when compared to 4-year college enrollment (see Figure 2). However, the causal effect of dual enrollment on 4-year college enrollment was the largest in the third year after the 12th grade (9 percentage points), suggesting that dually enrolled students may be beginning their college careers in 2-year colleges and transferring to 4-year colleges. Dually enrolled students were more likely than similar students to earn an associate degree and a bachelor's degree (see Figure 2).

Dually enrolled 12th grade students earned significantly higher wages six years after the 12th grade than similar students who were not dually enrolled, earning about $2,100 more in the 2015-2016 academic year (see Figure 3). To determine whether dually enrolled students may still be enrolled in college, a logistic regression model using dual enrollment program participation to predict enrollment in college 6 years after the 12th grade was run. Dually enrolled students were more likely to still be enrolled in college in the 2015-2016 academic year when compared to students who were not dually enrolled. This means that the workforce wages estimate is likely an underestimate because some dually enrolled students are still enrolled in college.

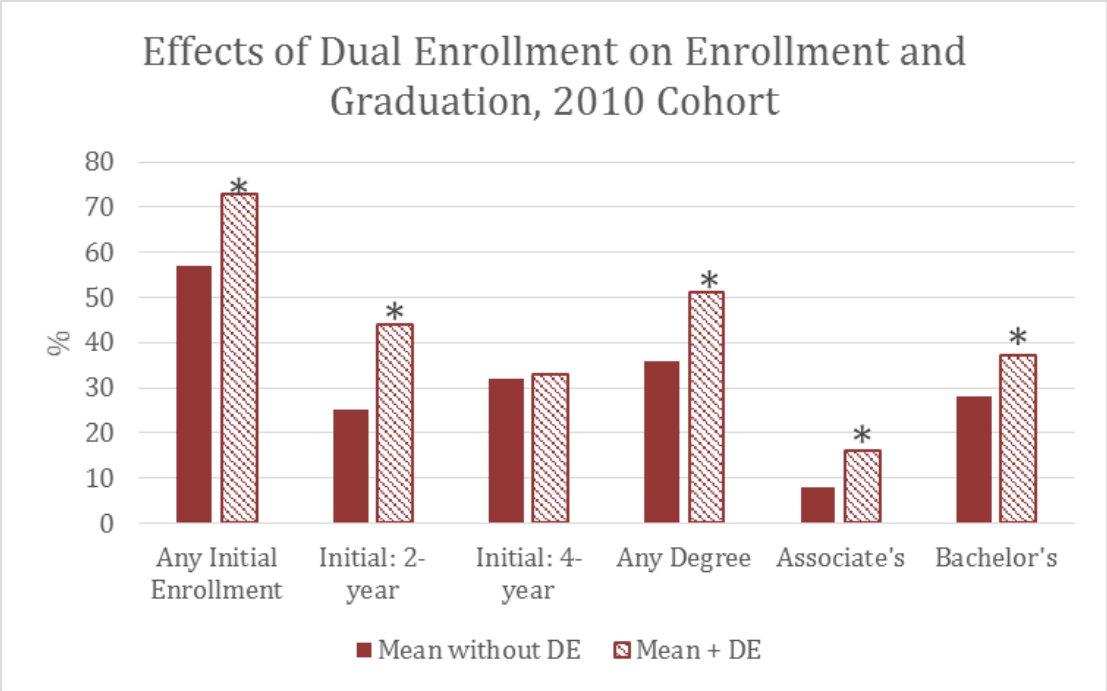
[4] Full tables are available from the MLDS Center upon request.

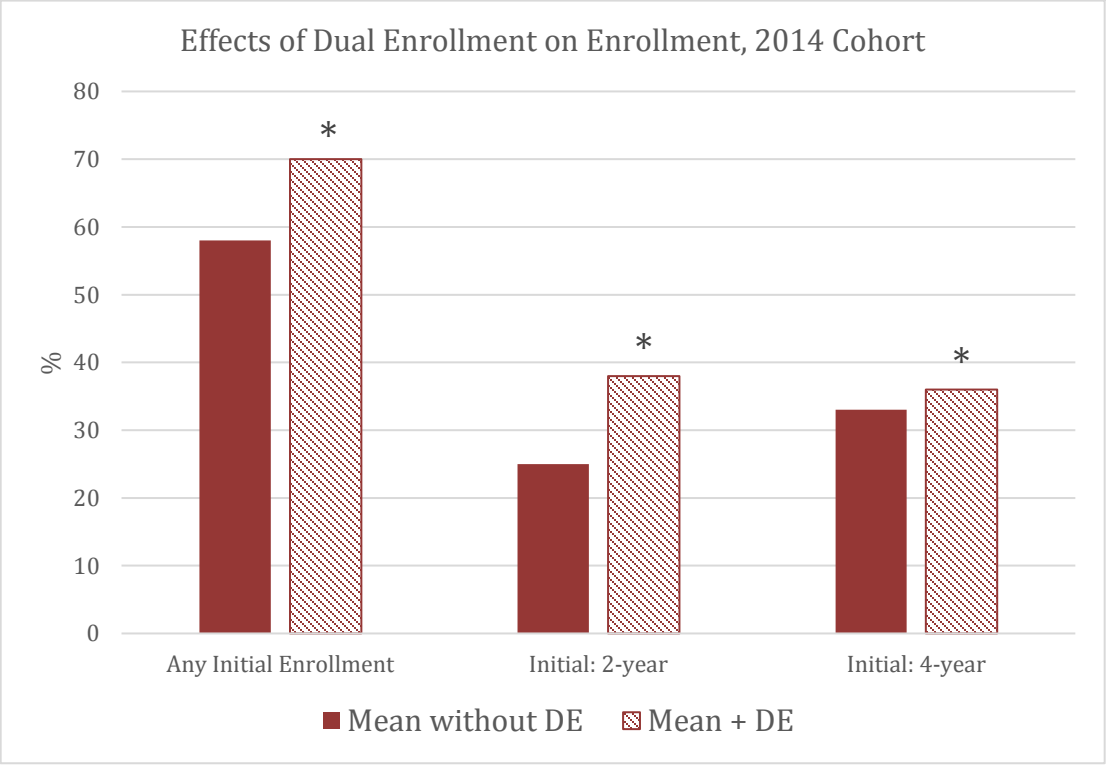
Table 2. Effects of 12th Grade Dual Enrollment on College Enrollment, Persistence, Degree Attainment, and Workforce Wages

	2009-2010 Cohort (*N* = 8,526)	2013-2014 Cohort (*N* = 9,818)
College Enrollment (Any)		
First Year	0.16	0.12
Second Year	0.14	0.10
Third Year	0.13	.
Fourth Year	0.10	.
College Enrollment (2-Year)		
First Year	0.19	0.13
Second Year	0.12	0.08
Third Year	0.06	.
Fourth Year	0.04	.
College Enrollment (4-Year)		
First Year	*NS*	0.03
Second Year	0.03	0.05
Third Year	0.09	.
Fourth Year	0.07	.
College Degree		
Any Degree	0.15	.
Associate Degree	0.08	.
Bachelor's Degree	0.09	.
Certificate	0.01	.
Wages	2099.90	.

Notes. Marginal effects are reported for the population of 12th grade dually enrolled students matched to similar 12th grade non-dually enrolled students. *NS* = not significant. . = marginal effect is not reported because not enough years of longitudinal data were available to analyze the effect for this cohort of students.

Figure 2. Effects of 12th Grade Dual Enrollment on Enrollment and Graduation





Note: Means of the dependent variable for non-DE students are represented in the solid bar. The mean for students who participate in DE are in the patterned bar. A "*" indicates a statistically significant effect.

Highlights of the Main Effects of 12th Grade Dual Enrollment on College Enrollment, Persistence, and Degree Earning

Dual enrollment participation in 12th grade had a significant positive causal effect on college enrollment, persistence, and degree attainment.

Any college enrollment:

- Dual enrollment had a significant effect on any college enrollment in each of the first four years following the 12th grade (+16 percentage points).

Two-year college enrollment:

- Dual enrollment had a significant effect on 2-year college enrollment in each of the first four years following the 12th grade (+19 percentage points in the year following 12th grade).

Four-year college enrollment:

- The effect of dual enrollment on 4-year college enrollment increased over time (+9 percentage points in the third year after 12th grade).

College degree attainment:

- Dual enrollment had a significant effect on attaining a college degree (15 percentage points).
    - The effect of dual enrollment on associate degree attainment was 8 percentage points.
    - The effect of dual enrollment on bachelor's degree attainment was 9 percentage points.

Figure 3. Effects of 12th Grade Dual Enrollment on Wages

Note: Means of the dependent variable for non-DE students are represented in the solid bar. The mean for students who participate in DE are in the patterned bar. A "*" indicates a statistically significant effect.

Highlights of the Main Effects of 12th Grade Dual Enrollment on Workforce Wages 6 Years after the 12th Grade:

Dual enrollment participation in the 12th grade had a significant positive causal effect on workforce wages, with dually enrolled students earning about $2,100 more when compared to similar students who were not dually enrolled.

+$2,100

Table 3 presents the results for the differential causal effects of dual enrollment by gender, race, ethnicity, academic achievement, and eligibility for FARMS.

2009-2010 Cohort. The effect of dual enrollment in 12th grade on 2-year college enrollment was stronger for white students when compared to Black students (see Figure 4) and stronger for students with higher median HSA scores when compared to students with lower median HSA scores. The effect of dual enrollment in 12th grade on 4-year college enrollment was stronger for Black students when compared to white students, was stronger for Hispanic students when compared to non-Hispanic students and was stronger for students eligible for FARMS when compared to students not eligible for FARMS (see Figure 5). Dual enrollment had a stronger effect on 4-year college enrollment for male students when compared to female students at a marginally significant level ($p < .10$). The effect of dual enrollment on associate degree earning was stronger for female students when compared to male students and white students when compared to Black students (see Figure 6). The effect of dual enrollment on bachelor's degree earning was stronger for Black students when compared to white students (see Figure 7). The effect of dual enrollment on workforce wages was stronger for Other race students when compared to white students and was stronger for Hispanic students when compared to non-Hispanic students (see Figure 8). The effect of dual enrollment on workforce wages was stronger for Black students when compared to white students at a marginally significant level ($p < .10$).

2013-2014 Cohort. The effect of dual enrollment in 12th grade on 2-year college enrollment was stronger for white students when compared to Black students, and stronger for Hispanic students compared to non-Hispanic students, and stronger for students with higher median HSA scores compared to students with lower median HSA scores. The effect of dual enrollment in 12th grade on 4-year college enrollment was stronger for male students compared to female students, stronger for students with lower median HSA scores compared to students with higher HSA scores and was stronger for students eligible for FARMS when compared to students not eligible for FARMS.

What is a differential effect?

- Examining differential effects enables researchers to determine for which student subgroups an intervention has the strongest effect.
- Differential effects are also called heterogeneous effects.

Table 3. Differential Effects of 12th Grade Dual Enrollment by Gender, Race, Ethnicity, Academic Achievement, and Eligibility for FARMS

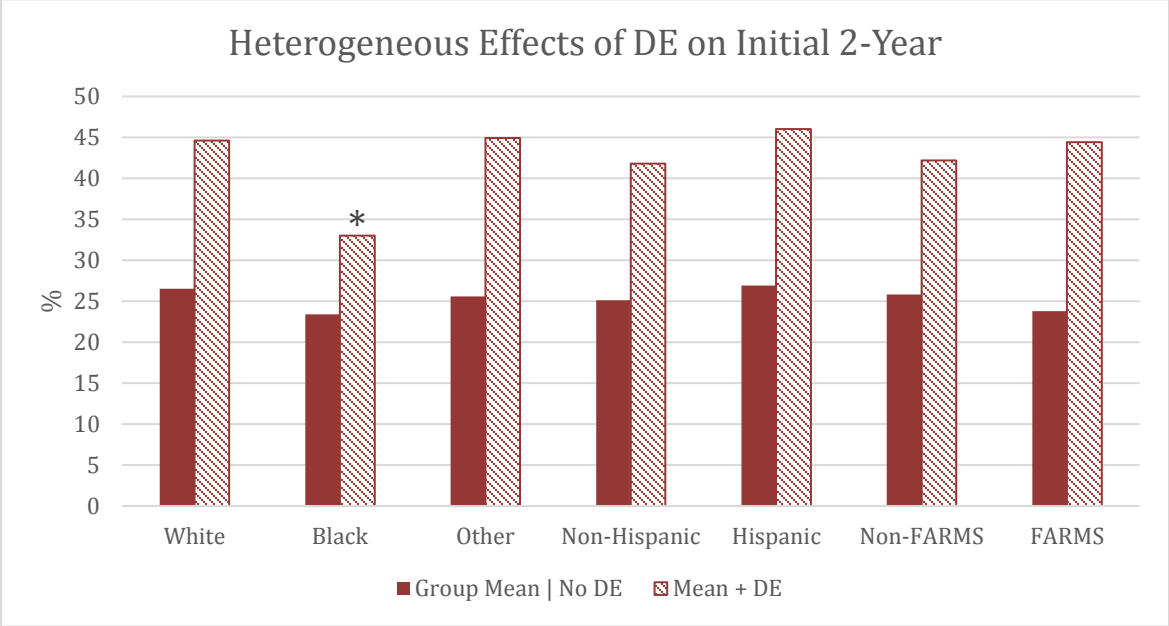
	College Enrollment		Degree Attainment		Wages
	2-Year	4-Year	Associate	Bachelor's	
2009-2010 Cohort (*N* = 8,526)					
DE x Male	*NS*	0.032[a]	-0.04	*NS*	*NS*
DE x Asian	*NS*	*NS*	*NS*	*NS*	*NS*
DE x Black	-0.085	0.136	-0.062	0.052	2,137[a]
DE x Other	*NS*	*NS*	*NS*	*NS*	4,202
DE x Hispanic	*NS*	0.092	*NS*	*NS*	*NS*
DE x HSA	0.088	*NS*	*NS*	*NS*	*NS*
DE x FARMS	*NS*	0.067	*NS*	*NS*	*NS*
2013-2014 Cohort (*N* = 9,818)					
DE x Male	*NS*	0.039	.	.	.
DE x Asian	*NS*	*NS*	.	.	.
DE x Black	-0.052	*NS*	.	.	.
DE x Other	*NS*	*NS*	.	.	.
DE x Hispanic	0.065	*NS*	.	.	.
DE x HSA	0.093	-0.03	.	.	.
DE x FARMS	*NS*	0.058	.	.	.

Notes. Marginal effects are reported for the population of 12th grade dually enrolled students matched to similar 12th grade non-dually enrolled students. *NS* = not significant. . = marginal effect is not reported because not enough years of longitudinal data were available to analyze the effect for this cohort of students. [a] = $p < .10$ (marginal significance). DE = dual enrollment. Asian, Black, and Other race were compared to White. HSA = median high school assessment score for English. FARMS = eligibility for free and reduced price meals.

Highlights of the Differential Effects of 12th Grade Dual Enrollment on Initial College Enrollment

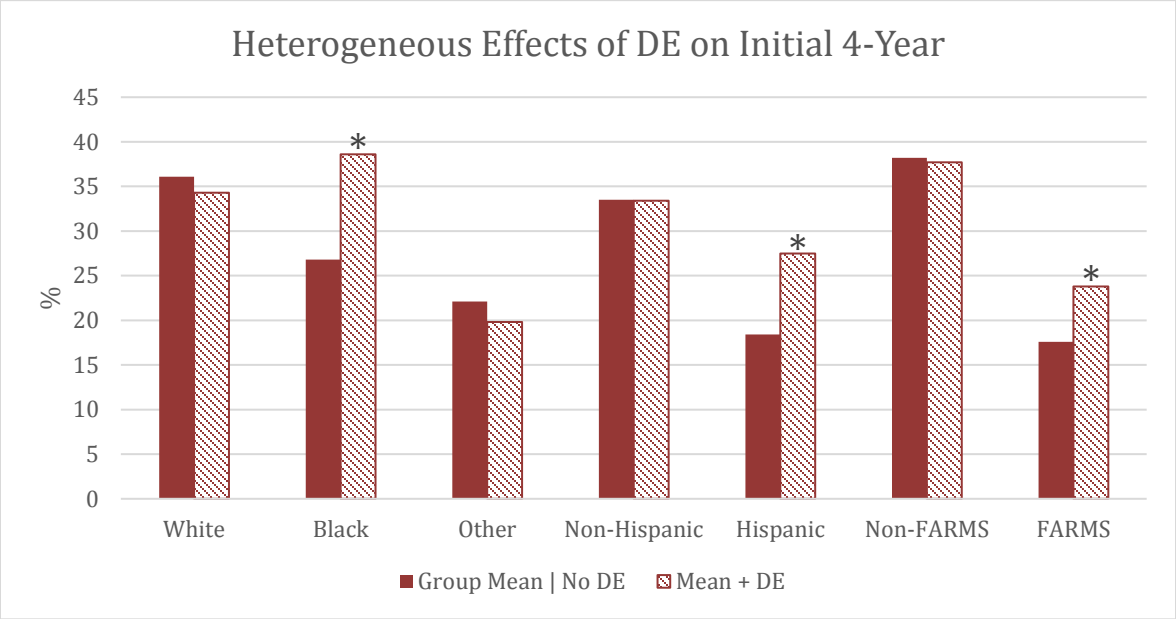
- Dual enrollment had a stronger effect on 4-year college enrollment for males when compared to females.
- Dual enrollment had a stronger effect on 4-year college enrollment for Black students when compared to White students and had a stronger effect on 2-year college enrollment for White students when compared to Black students.
- Dual enrollment had a stronger effect on 4-year college enrollment for Hispanic students when compared to non-Hispanic students.
- Dual enrollment had a stronger effect on 2-year college enrollment for students with higher high school assessment (HSA) scores when compared to students with lower HSA scores.
- Dual enrollment had a stronger effect on 4-year college enrollment for students who were eligible for free or reduced price meals (FARMS) when compared to students who were not eligible.

Figure 4. Heterogeneous Effects of 12th Grade Dual Enrollment on Initial 2-year Enrollment by Subgroup, 2010 Cohort



Note: Means of the dependent variable for non-DE students are represented in the solid bar. The mean for students who participate in DE are in the patterned bar. A "*" indicates a statistically significant difference in the effect of DE for the subgroup versus its comparison.

Figure 5. Heterogeneous Effects of 12th Grade Dual Enrollment on Initial 4-year Enrollment by Subgroup, 2010 Cohort

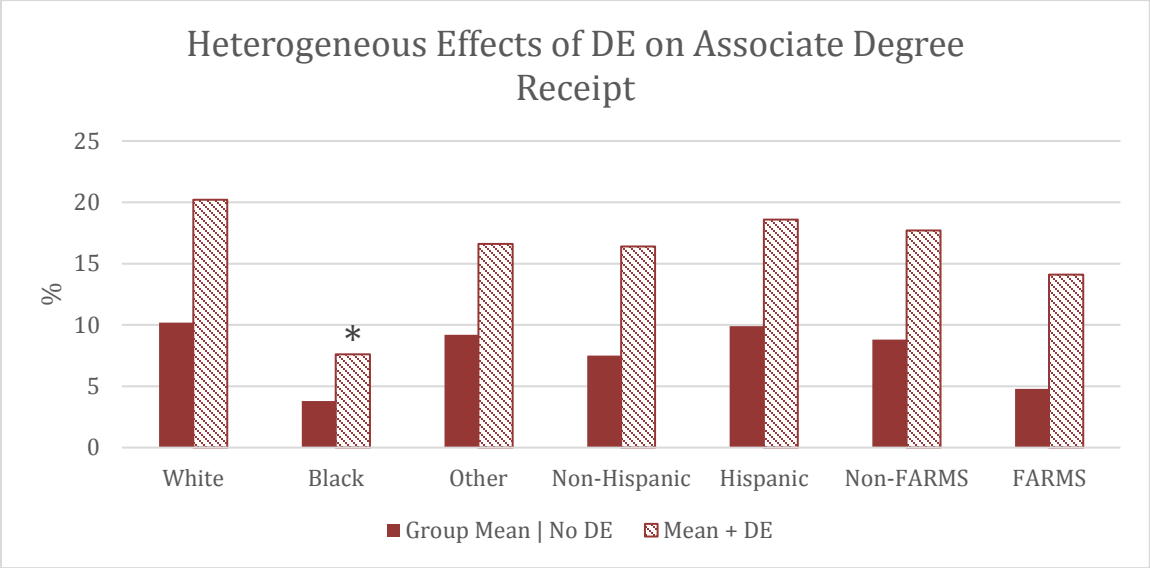


Note: Means of the dependent variable for non-DE students are represented in the solid bar. The patterned bars display the effect of DE, including a subgroup specific effect. A "*" indicates a statistically significant difference in the effect of DE for the subgroup versus its comparison.

Highlights of the Differential Effects of 12th Grade Dual Enrollment on College Degree Attainment

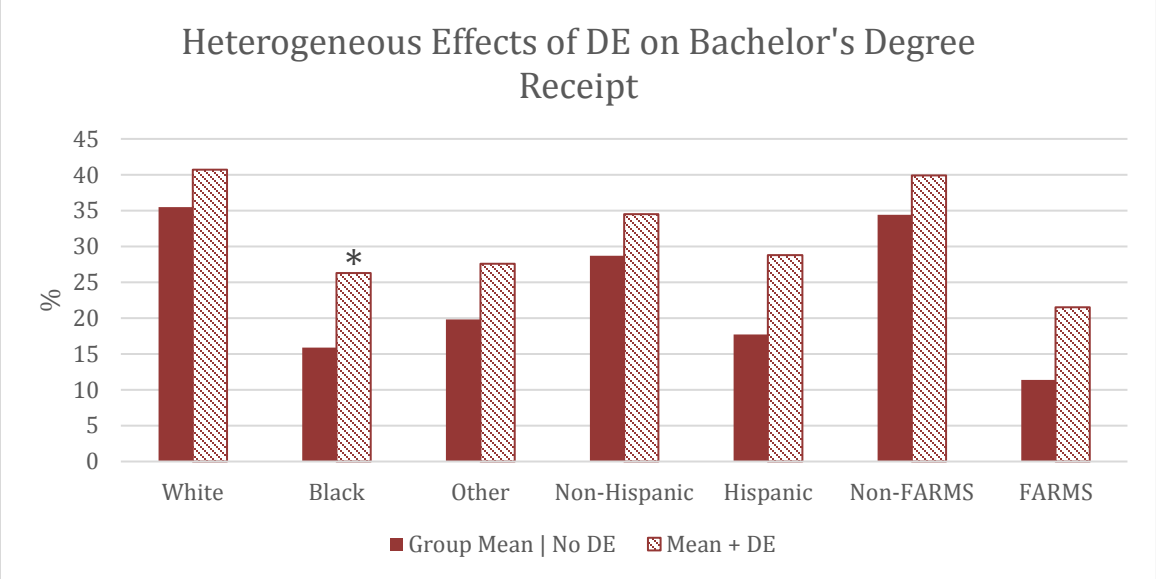
- Dual enrollment had a stronger effect on earning an associate degree for female students when compared to male students.
- Dual enrollment had a stronger effect on earning a bachelor's degree for Black students when compared to White students and had a stronger effect on earning an associate degree for White students when compared to Black students.

Figure 6. Heterogeneous Effects of 12th Grade Dual Enrollment on Associate Degree Receipt by Subgroup, 2010 Cohort



Note: Means of the dependent variable for non-DE students are represented in red. The patterned bars display the effect of DE, including a subgroup specific effect. A "*" indicates a statistically significant difference in the effect of DE for the subgroup versus its comparison.

Figure 7: Heterogeneous Effects of 12th Grade Dual Enrollment on Bachelor's Degree Receipt by Subgroup, 2010 Cohort

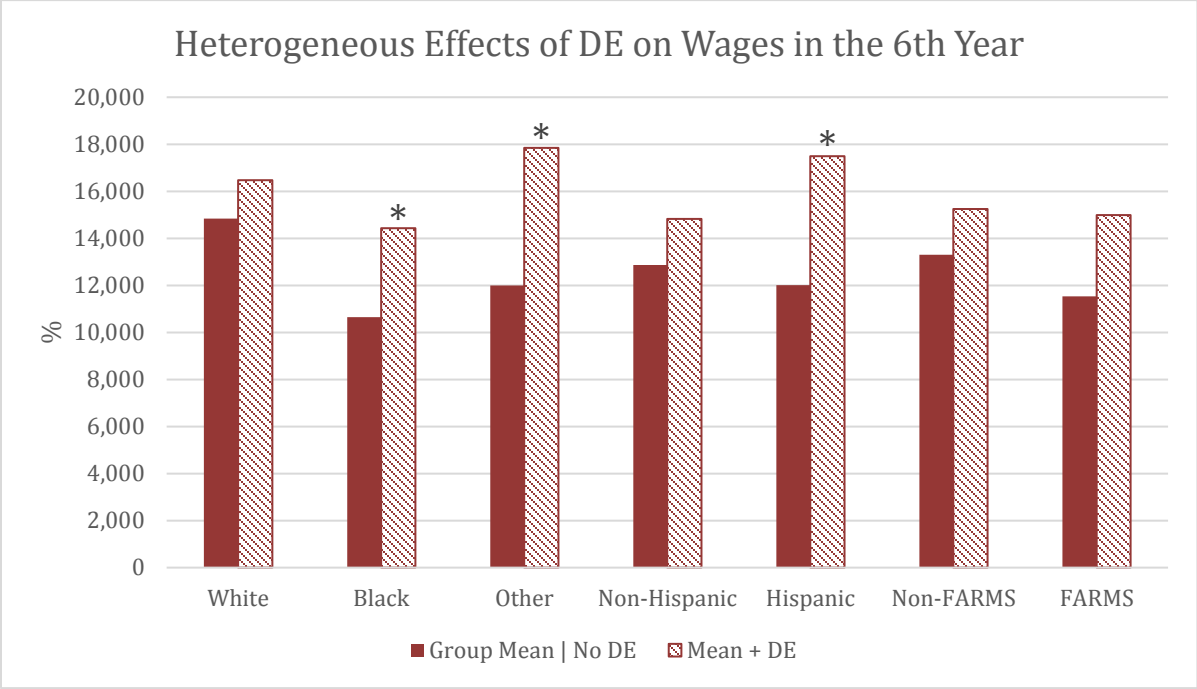


Note: Means of the dependent variable for non-DE students are represented in red. The patterned bars display the effect of DE, including a subgroup specific effect. A "*" indicates a statistically significant difference in the effect of DE for the subgroup versus its comparison.

Highlights of the Differential Effects of 12th Grade Dual Enrollment on Workforce Wages 6 Years after 12th Grade

- Dual enrollment had a stronger effect on workforce wages for Black and Other race students when compared to White students.
- Dual enrollment had a stronger effect on workforce wages for Hispanic students when compared to non-Hispanic students.

Figure 8. Heterogeneous Effects of 12th Grade Dual Enrollment on Wages by Subgroup, 2010 Cohort



Note: Means of the dependent variable for non-DE students are represented in red. The patterned bars display the effect of DE, including a subgroup specific effect. A "*" indicates a statistically significant difference in the effect of DE for the subgroup versus its comparison.

Summary of Findings

Dual enrollment in 12th grade had positive causal effects on college and workforce outcomes, including higher likelihood to enroll in college, attain a college degree, and earn higher workforce wages when compared to similar students who were not dually enrolled in 12th grade. In the year following 12th grade for the 2009-2010 cohort of 12th grade students, dually enrolled students were significantly more likely to enroll in 2-year (19 percentage points), but not 4-year, colleges when compared to similar students who were not dually enrolled. However, for the 2013-2014 cohort of 12th grade students, dually enrolled students were more likely than students who were not dually enrolled to enroll in 2-year (13 percentage points) and 4-year (2.6 percentage points) colleges in the year following 12th grade. Degree attainment and workforce wages were examined using data from the 2009-2010 cohort of 12th grade students. Students who were dually enrolled were more likely to earn an associate (8 percentage points), bachelor's (9 percentage points), and certificate (1 percentage point) degree than similar students who were not dually enrolled. Additionally, students who were dually enrolled in 12th grade earned about $2,100 more in the academic year that corresponded to 6 years after 12th grade than similar students who were not dually enrolled.

Dual enrollment in 12th grade had stronger positive effects on college and workforce outcomes for students who are traditionally underrepresented in college. Dual enrollment had stronger effects on 4-year college enrollment for Black students when compared to White students, for Hispanic students when compared to non-Hispanic students, and for students who were eligible for FARMS when compared to students who were not eligible. Additionally, dual enrollment had a stronger effect on earning a bachelor's degree for Black students when compared to White students and had a stronger effect on workforce wages for Black and Other race students when compared to White students and for Hispanic students when compared to non-Hispanic students.

Discussion

This study used PSM with MLDS data to causally evaluate the effect of dual enrollment participation in 12th grade on college enrollment, persistence, degree attainment, and workforce wages. Dual enrollment program participation had positive causal effects on all outcomes examined, and had stronger effects for students who are traditionally underrepresented in the college population (i.e., Black students, Hispanic students, and students eligible for FARMS). The use of PSM helped to ensure proper control for confounding variables, and improved the ability to make causal claims about the effect of dual enrollment on long term college and career outcomes in Maryland.

Students who participated in dual enrollment in 12th grade earned $2,100 more than similar students who did not participate in dual enrollment six years after the 12th grade. This effect may be compared to other programs to determine the relative effect size of dual

enrollment. For example, studies examining the effect of the Job Corps[5] program, which is a well-established program designed to improve education and career outcomes, have reported that participants earned approximately $1,150 more annually compared to a non-participant control group two years following the program (Burghardt et al., 2001). The dual enrollment effect on workforce wages found in the current study was approximately double the effect found for Job Corps, but the current study examined workforce wages six years following the 12th grade, whereas the Job Corps evaluation examined workforce outcomes two years following program participation. The current study is among the first to causally link dual enrollment program participation with workforce wages.

The results of the current study highlight a positive causal effect of dual enrollment program participation in 12th grade on college enrollment, persistence, and degree attainment. These results are consistent with prior research that implemented matching procedures to examine the causal effects of dual enrollment (e.g., An, 2013; Giani et al., 2014; Grubb et al., 2017; Struhl & Vargas, 2012). The effects found in this study can be compared to other program effects to determine the relative effect size of dual enrollment. For example, Long, Conger, and Iaterola (2012) examined the causal impact of rigorous course-taking during high school on college outcomes. In this case, advanced courses included AP courses, IB courses, and other honors or accelerated courses. Long and colleagues (2012) reported that rigorous course-taking increased the likelihood of attending a 4-year college by 7 to 9 percentage points, while reducing the likelihood of attending a 2-year college. Additionally, Long and colleagues (2012) reported that rigorous course-taking increased the likelihood of attaining a bachelor's degree within 4 years by 5 to 9 percentage points. The size of the effects reported by Long and colleagues (2012) depended on the subject of the coursework taken. In comparison to the findings of Long and colleagues (2012), this study found that dual enrollment participation increased the likelihood of attending a 4-year college by 1 percentage point in the year following 12th grade and 9 percentage points in the third year following 12th grade. The current study found a large effect of dual enrollment, a 19 percentage point increase, on attending a 2-year college in the year following 12th grade. The effect size reported here for dual enrollment on bachelor's degree attainment, approximately 9 percentage points, is comparable to that reported by Long and colleagues (2012) for rigorous course-taking.

The findings of the current study suggest that 12th grade dually enrolled students may be beginning their college careers in 2-year colleges and then transferring to 4-year colleges. For the 2009-2010 cohort of 12th grade students, dually enrolled students were significantly more likely to enroll in 2-year, but not 4-year, colleges, when compared to students who were not dually enrolled. These results suggest that dually enrolled students may be beginning their college careers in 2-year colleges and then transferring to 4-year colleges. For the 2013-2014 cohort of 12th grade students, dually enrolled students were more likely than students who were not dually enrolled to enroll in both 2-year and 4-year colleges in the year following 12th grade, but the strength of the effect for 4-year college enrollment increases over time. Prior

[5] For more information, see https://www.jobcorps.gov/.

research reports that dual enrollment is associated with enrollment in both 2-year and 4-year colleges in Florida and New York (Karp et al., 2007) and in Texas (Miller et al., 2017), but Miller and colleagues reported that the increase in the likelihood of enrolling in a 4-year college following participation in dual enrollment was much greater than the increase in the likelihood of enrolling in a 2-year college. Differences in sample characteristics, analytic procedures, and the cohorts used in the studies may account for the differences in findings. More research is needed to determine the nature of the relationship between dual enrollment program participation and enrollment in 2-year and 4-year colleges in the year following 12th grade.

Few prior studies have focused on examining the differential effects of dual enrollment on college and career outcomes by student groups. Some evidence is available to suggest that students with less-educated parents, male students, low-income students, and students with lower GPAs benefitted more from participation in dual enrollment (An, 2013; Karp et al., 2007; Struhl & Vargas, 2012). The results of the current study are consistent with prior research, in that male students and students who were eligible for FARMS had stronger effects from participating in dual enrollment. The findings of the current study are among the first to indicate that Black students and Hispanic students may benefit more from participation in dual enrollment.

This study is strengthened by the use of PSM, but results should be interpreted within the context of the following limitations. First, the design controls for variables that are included as confounders, but selection of the covariates used for calculating propensity scores is a critical part of the process and is limited to measured confounders. Critical confounders that are not included in this design may include high school behavioral problems, parental income and education, academic motivation, etc. This study is robust to this limitation to the degree that unobserved variables are highly correlated with confounders included in this study. However, it is possible that unobserved variables may explain part of the effect of dual enrollment. Second, the Maryland workforce data are limited because they do not include wages for federal employees, military employees, independent contractors, and individuals who are self-employed. The findings of this report are robust to this limitation to the degree that students who participated in dual enrollment in 12th grade and students who did not participate in dual enrollment in 12th grade work as federal employees, military employees, independent contractors, and are self-employed at similar rates. Third, 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). This research would be helpful to determine the types of dual enrollment programs that are most effective, and for whom. 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 enrolls and whether students who dually enroll for longer periods of time have more positive outcomes.

This study supports the growing body of literature that establishes dual enrollment programs as a tool for improving postsecondary outcomes for students. Additionally, this study is among the first to establish dual enrollment programs as an effective means of increasing workforce wages. Furthermore, this study is among the first to report stronger effects of dual enrollment for students who are traditionally underrepresented in the college population (i.e., male students, Black students, Hispanic students, students eligible for FARMS).

Policy Implications

This study causally evaluated the long-term effects of 12th grade dual enrollment program participation on college and workforce outcomes in Maryland, and positive effects were found for college enrollment, persistence, degree attainment, and workforce wages. The CCR-CCA of 2013 was passed by the Maryland General Assembly to support the improvement of college and career outcomes through opportunities such as dual enrollment program participation. Although this study does not explicitly evaluate policies implemented as part of the CCR-CCA, the results of this study highlight the positive long-term outcomes associated with dual enrollment and suggest that policy to encourage dual enrollment participation may be beneficial in the long-run. Additionally, Black students, Hispanic students, and students eligible for FARMS, students who are traditionally underrepresented in college-going populations, benefit the most from dual enrollment in terms of college and career outcomes. Additional program and policy that encourages or incentivizes these student groups to dually enroll in high school may be particularly beneficial.

Future Research

Future research on dual enrollment in Maryland will focus on evaluating the effects of CCR-CCA on dual enrollment program participation and long-term outcomes, including college and career outcomes. This will be undertaken by causally examining the numbers of students eligible for free and reduced price meals that dually enrolled prior to the passing of CCR-CCA compared to after the passing of CCR-CCA. Additionally, future research will investigate the effects of dual enrollment on additional postsecondary outcomes, such as college credit attainment, college GPA, need for remediation in college, and graduate school enrollment. Furthermore, a more nuanced examination of dual enrollment courses taken may provide information about the link between specific coursework and college and workforce outcomes. Dual enrollment program participation may also be compared to other specialized coursework, such as advanced placement (AP), international baccalaureate (IB), and career and technical education (CTE) completion. Future research could also benefit from a more nuanced and expanded examination of workforce outcomes. For example, research could examine the causal effect of dual enrollment on working in specific types of industries and on wage trajectories

over time. Another fruitful area for future research may be the examination of the link between dual enrollment coursework, college major, and workforce industry. For example, students who take science technology engineering and math (STEM) dual enrollment courses may be more likely to have a STEM major in college and/or work in a STEM industry. Additional research may also investigate whether this is particularly true for disadvantaged students who have historically had lower levels of access to STEM coursework.

Although we used a quasi-experimental design, the effects of dual enrollment presented here are limited because quasi-experimental designs make a number of assumptions. Additional designs that examine the effects of dual enrollment using randomization would be helpful to confirm the effects of dual enrollment on long-term college and career outcomes. One such approach that could be feasible in Maryland may be a lottery system. This type of design randomly assigns students to participate in a program in which more students apply for program participation than the program has the ability to serve (Shadish et al., 2002). This approach has been used to evaluate the Early College program, funded to provide dual enrollment for underserved students, providing them the opportunity to earn up to two years of college credit or an associate degree while in high school (Berger et al., 2014). Program participants in 5 states were more likely than non-participants to graduate from high school, enroll in college, and graduate from college after attending an Early College (Berger et al., 2014). The generalizability of findings from lottery studies is limited because, in a typical lottery study, students are randomly chosen from students who applied for the lottery (i.e., volunteered for the program). Keeping this limitation in mind, replicating the findings of the current study using a lottery design would help to strengthen the body of knowledge about the causal effects of dual enrollment.

Conclusion

This report used propensity score matching (PSM) to examine the causal effect of dual enrollment participation in 12th grade on college and career outcomes for Maryland students. Consistent with prior research, this analysis found that participation in dual enrollment programs had a positive effect on postsecondary outcomes. Dually enrolled students were more likely to enroll in college, persist to the second year, and earn college degrees, including associate, bachelor's, and certificate degrees when compared to similar non-dually enrolled students. Additionally, dually enrolled students earned significantly higher wages (+$2,100) six years after 12th grade in comparison to similar non-dually enrolled students. The effects of dual enrollment were greater for Black students, Hispanic students, and students eligible for FARMS, students who are traditionally underrepresented in the college-going population.

This study contributes to the knowledge on the effects of dual enrollment program participation in several ways. First, this study is the first known study linking dual enrollment program participation in high school to long-term workforce wages. Second, this study adds to the few prior studies that have implemented rigorous quasi-experimental designs (e.g., PSM) to examine the effects of dual enrollment on long-term college and career outcomes. Third, this

study adds knowledge about the differential effects of dual enrollment program participation by student characteristics. Overall, this study provides the basis for future research on the effects of dual enrollment program participation in Maryland and the implementation of PSM as a strategy for examining causal relationships using the MLDS.

References

Alexander, K. L., Riordan, C., Fennessey, J., & Pellas, A. M. (1982). Social background, academic resources, and college graduation: Recent evidence from the National Longitudinal Survey. *American Journal of Education, 90*(4), 315-333.

An, B. P. (2013). The impact of dual enrollment on college degree attainment: Do low-SES students benefit? *Educational Evaluation and Policy Analysis, 35*(1), 57-75.

Berger, A., Turk-Bicaki, L., Garet, M., Song, M., Knudson, J., Haxton, C., Zeiser, K., Hoshen, G., Ford, J., Stephan, J., Keating, K., & Cassidy, L. (2013). *Early college, early success: Early College High School Initiative impact study*. Washington, DC: American Institutes for Research.

Burghardt, J., Schochet, P. Z., McConnell, S., Johnson, T., Gritz, R. M., Glazerman, S., Hamrighausen, J., & Jackson, R. (2001). *Does Job Corps Work? Summary of the National Job Corps Study.* Washington, DC: Mathematica Policy Research.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.

Giani, M., Alexander, C., & Reyes, P. (2014). Exploring variation in the impact of dual-credit coursework on postsecondary outcomes: A quasi-experimental analysis of Texas students. *High School Journal, 97*(4), 200-218.

Grubb, J. M., Scott, P. H., & Good, D. W. (2017). The answer is yes: Dual enrollment benefits students at the community college. *Community College Review, 45*(2), 79-98.

Gueron, J. M. (2002). The politics of random assignment: Implementing studies and impacting policy. In F. Mosteller & R. Boruch (Eds.), *Evidence matters: Randomized trials in education research* (pp. 15-49). Washington, DC: Bookings Institution Press.

Henneberger, A. K., Cohen, M. K., Shipe, S. L., & Shaw, T. V. (2016). *Dual enrollment in Maryland: A report to the Maryland General Assembly and Governor Larry Hogan.* Baltimore, MD: Maryland Longitudinal Data System Center.

Ho, D., Imai, K., King, G., Stuart, E. (2018). *MatchIt: Nonparametric processing for parametric causal inference.* Retrieved January 19, 2018 from https://gking.harvard.edu/matchit

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2007). Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis, 15*, 199-236.

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007). The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states. St. Paul, MN: University of Minnesota, National Research Center for Career and Technical Education.

Lewis, M. V., & Overman, L. (2008). Dual and Concurrent Enrollment and Transition to Postsecondary Education. *Career and Technical Education Research, 33*(3), 189-202.

Little, R. J., & Rubin, D. B. (1989). The analysis of social science data with missing values. *Sociological Methods & Research, 18*(2-3), 292-326.

Long, M.C., Conger, D., & Iatarola, P. (2012). Effects of high school course-taking on secondary and postsecondary success. *American Educational Research Journal, 49*(2), 285-322.

Miller, T., Kosiewicz, H., Wang, E. L., Marweh, E.V.P., Delhommer, S., Daugherty, L. (2017). *Dual Credit Education in Texas.* Santa Monica, CA: RAND Corporation.

MLDS Center. (2017). *Dual Enrollment in Maryland: Annual Report to the General Assembly and Governor Larry Hogan*. Baltimore, MD: Maryland Longitudinal Data System Center.

Robins, J. M. (1989). The control of confounding by intermediate variables. *Statistics in Medicine, 8,* 679-701.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*, 41-55.

Schafer, J. L., & Graham, J. W. (2002). Missing data: our view of the state of the art. *Psychological methods, 7*(2), 147-177.

Schafer, J. L., & Kang, J. (2008). Average causal effects from nonrandomized studies: A practical guide and simulated example. *Psychological Methods, 13*(4), 279-313.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston, MA: Houghton Mifflin.

Struhl, B., & Vargas, J. (2012). *Taking college courses in high school: A strategy for college readiness.* Washington, DC: Jobs for the Future.

Tracey, T. J., & Sedlacek, W. E. (1987). Prediction of college graduation using noncognitive variables by race. *Measurement and Evaluation in Counseling and Development, 19*, 177-184.

Appendix A

Table A.1. Descriptive Statistics for Outcome Variables for 12th Grade Dually Enrolled Students Compared to 12th Grade Non-Dually Enrolled Students

	2009-2010 Cohort		2013-2014 Cohort	
	Dually Enrolled (*N* = 4,263)	Non-Dually Enrolled (*N* = 59,700)	Dually Enrolled (*N* = 4,909)	Non-Dually Enrolled (*N* = 58,100)
	%	%	%	%
Enroll 2-Year	45	25	39	25
Enroll 4-Year	42	32	47	33
2-Year Degree	20	8	.	.
4-Year Degree	47	28	.	.
	M (SD)	*M(SD)*		
Wages	17,000 (19,400)	12,800 (16,500)	.	.

Note. M = mean; *SD* = standard deviation; . = a statistic that is not reported because not enough years of longitudinal data were available for this cohort of students.

Appendix B

Missing Data Procedure

Missing data rates were checked using descriptive statistics (see Table B.1). Variables with missing data were imputed using a model-based approach (Little & Rubin, 1989; Schafer & Graham, 2002). Data imputation is a procedure that uses an individual's observed values and patterns across variables to impute the likely values for the variables the individual is missing. The imputation model was based on existing academic variables, including high school assessment (HSA scores). 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. The Algebra HSA is typically taken in 9th or 10th grade in Maryland, and data for this cohort of students were not available during the time period corresponding to 9th and 10th grades. Propensity score models included an interaction term of the indicator for presence/absence of a HSA score by the HSA score for each subject. This enabled matching on the HSA score when the score was present. Analyses were conducted on the imputed dataset and on the dataset with missing values, and results remained largely consistent. Results reported in this report use the imputed data.

Table B.1 Missing Data Rates

	2009-2010 Cohort	2013-2014 Cohort
Variable	Missing (%)	Missing (%)
HSA Algebra	72%	9%
HSA English	11%	6%
HSA Biology	28%	7%
GPA 3.0 Indicator	2%	2%

Note. HSA = high school assessment; GPA = grade point average.

Appendix C

Propensity Score Matching (PSM) Procedure

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; Schafer & Kang, 2008). In this study, a higher propensity score indicated a higher probability of a student being dually enrolled. To estimate propensity scores, a logistic regression model was used with dual enrollment as the outcome variable, and confounding variables, such as demographic characteristics and academic indicators, were used as predictors. Table C.1 provides a list of confounding variables used in this study.

Table C.1 Confounding Variables Used to Match 12th Grade Dually Enrolled Students with 12th Grade Non-Dually Enrolled Students

Variable	Measurement
Gender	Male = 1
Race	White; Asian; Black; Hawaiian; Native American; Two or More Races
Ethnicity	Hispanic (any race) = 1
Eligibility for free and reduced price meals (FARMS)	Eligible within the academic year = 1
Homelessness	Student was homeless within the academic year = 1
Special Education	Student received special education services within the academic year = 1
HSA Algebra	Student has a score for the Algebra HSA
HSA Algebra Score	Student's score on the Algebra HSA
HSA English	Student has a score for the English HSA
HSA English Score	Student's score on the English HSA
HSA Biology	Student has a score for the Biology HSA
HSA Biology Score	Student's score on the Biology HSA
Absences	Weeks absent in the 12th grade academic year
Distance	Distance from student's 12th grade high school to the nearest 2-year college
AP	Number of AP tests taken
Math/Computer Science AP	Number of Math and Computer Science AP tests taken
English AP	Number of English AP tests taken
3.0 GPA	Indicator of whether the student had a GPA above 3.0
Local School System	Local school system of the student's high school

Notes. HSA = high school assessment; AP = advanced placement; GPA = grade point average.

Once propensity scores were estimated for each individual, they were used to create a matched sample. Students who did participate in dual enrollment programs were matched with students who did not participate in dual enrollment programs but had a very similar propensity to participate (matched on propensity score). One to one nearest neighbor matching with a caliper set to 0.2 was implemented using the 'MatchIt' package in R (Ho, Imai, King, & Stuart, 2018). Each dual enrollment participant was matched with one and only one student who was not dually enrolled. For each cohort, there were fewer than 10 dual enrollment participants (treatment group) who were not able to be matched to a unique student who did not participate in dual enrollment (control group).

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 $P(D = 1 \mid X)$ (or more succinctly, $P(X)$). For identification of the causal effect, two assumptions are required:

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

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

- *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:

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

Following matching, the groups were evaluated for overlap (see Figure C.1) and balance (see Figure C.2) to determine whether the matching procedure created equivalent groups. Balance was evaluated for each confounder using the Standardized Mean Difference (SMD) to determine the similarity between the treatment and control groups before and after matching. A SMD under 0.2, a small effect according to Cohen (1988; 1992), indicated that the groups were very similar for that particular confounder. After matching, all confounders had a SMD below 0.2 for both cohorts, indicating that the matched groups were balanced on the measured confounders and can be considered equivalent groups. All confounders were also included in the outcome analyses to ensure proper control for covariates.

Figure C.1 Overlap (Common Support)

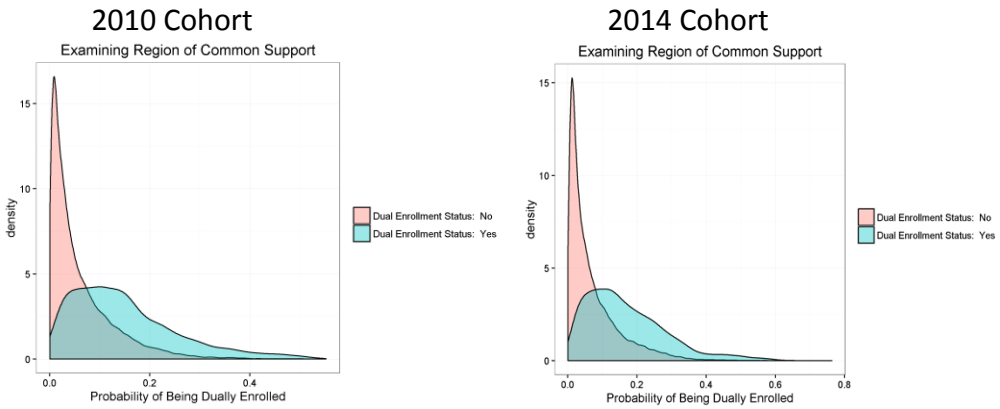


Figure C.2 Standardized Mean Differences (SMD) on Confounders Before and after Matching