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# *How Much of a "Running Start" do Dual Enrollment Programs Provide Students?*

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## How Much of a "Running Start" do Dual Enrollment Programs Provide Students?

James Cowan & Dan Goldhaber
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## Abstract

We study a popular dual enrollment program in Washington State using a new administrative database linking high school and postsecondary enrollments. Conditional on prior high school performance and basic demographic and economic covariates, dual enrollment students are more likely to attend any college, but they are no more likely to attend college full-time and are less likely to attend a four-year college. Supplementary analyses suggest selection on pre-treatment college enrollment plans explains some of the initial diversionary effect of dual enrollment. Finally, we consider the role of common data limitations in interpreting results of dual enrollment studies.

# 1. Introduction

Dual-credit programs, which allow students to earn college credits while still enrolled in high school, have become the second most popular college preparatory program nationally after Advanced Placement with more than 2 million students participating (Thomas, Marken, Gray, Lewis, and Ralph, 2013). The first dual enrollment programs began in the 1970s, with several states authorizing them during the 1980s (Allen, 2010). By 2011, 82% of high schools nationwide had students enrolled in dual enrollment programs, compared with 69% with students enrolled in Advanced Placement and International Baccalaureate (Thomas et al., 2013).

Because students earn college and high school credit simultaneously, these programs may be a cost-effective way of increasing college readiness and college enrollment among high school students (An, 2013b; Bailey and Karp, 2013; State Board for Community and Technical Colleges, 2011). But, as we go on to describe below, there is relatively little empirical evidence on the impact of these programs on students' postsecondary college enrollment choices or success in college. We use statewide data from Washington to investigate the effects of Running Start, Washington's dual enrollment program, on high school graduation and college enrollment.

We contribute to the literature on dual enrollment in two primary ways. First, we use a rich dataset that allows us to track students from early in their high school careers through college attendance. Unlike several earlier studies, this allows us to condition on measures of academic ability taken before participation in any dual enrollment programs. The linked high school and college enrollment data additionally allow us to assess threats to identification from differences in pre-treatment college preparation. Second, our dataset includes postsecondary enrollment for almost all students, including students attending private or out-of-state colleges.

Based on OLS regressions, we find positive postsecondary enrollment effects that are attributable to the ability to earn an associate degree by graduation and greater part-time enrollment following high school graduation. We find no evidence that participation in dual enrollment increases full-time college attendance and some evidence that participation raises enrollment at two-year colleges at the expense of enrollment in four-year colleges. However, when we include measures of college intent and college preparation, we find that differences in pre-participation college plans likely explain at least part of this effect. Our analyses also suggest that omitting students outside the public university system has substantial effects on the estimated effects of dual enrollment programs. In particular, the current study illustrates the value of integrating secondary and postsecondary datasets for researching high school programs that influence college outcomes.

## 2. Washington State's Running Start Program

In this study, we analyze the college-going behavior of participants in Washington's dual enrollment program, Running Start, which started statewide in 1992 and has enrolled more than 10% of the state's high school juniors and seniors since the 2007-2008 school year (State Board of Community and Technical Colleges, 2009). As with many other dual enrollment programs, Running Start allows juniors and seniors to take courses tuition-free at any of the state's 34 community colleges.[1] In Washington State, community colleges alone determine eligibility, which typically requires placement into a college-level English or mathematics course using a

[1] Three universities also participate in the program, however we focus here on Running Start participation at the community college level because we have incomplete data on participants at four-year colleges and it is difficult to distinguish the four-year college participants from students taking other transitional courses, such as College in the High School programs, in which students earn credit from courses taught on high school campuses by high school faculty members. More than 98% of students participate at a community or technical college. During the years we consider, 300-400 students participated each year at four-year colleges, while more than 16,000 participated each year at two-year colleges (State Board of Community and Technical Colleges, 2006, 2008, 2009, 2010a).

placement exam such as COMPASS or Accuplacer. Washington law specifically prohibits high schools from conditioning participation on administrator approval or high school academic record. This arrangement is less restrictive than the norm for dual enrollment programs with 77% of schools nationwide requiring the permission of a counselor or administrator and 49% requiring a minimum cumulative grade point average (Thomas et al., 2013).[2]

Tuition is paid by the student's school district, which pays the receiving college 93% of the state basic education allotment. The state estimates the total tuition subsidy cost $41.3 million for the 2009-2010 school year (State Board of Community and Technical Colleges, 2011). This funding arrangement has significant financial consequences for the colleges as well: as of 2010, colleges received $4,500 per full-time equivalent Running Start student, which represented only 60% of the cost of educating a two-year college student (State Board of Community and Technical Colleges, 2010b, 2011).

Once students enroll in Running Start, they may take a combination of high school and college courses. Although all community colleges offer some distance education (mostly online) and many Running Start students take courses online, less than 1% of Running Start students take all their courses online.[3] By contrast, nationally, only 43% of schools with participants in academic-oriented dual enrollment programs have students attending school on a postsecondary campus (Thomas et al., 2013). Whether or not they attend class at a high school, students must complete their district's graduation requirements to receive a high school diploma and districts generally count specific courses taken at community colleges toward the graduation requirements.[4] Consequently, many students take community college courses in

[2] Since 2010, Running Start has required students to meet with a counselor to complete their registration. However, high schools may not condition participation on the approval of a counselor.
[3] 10% of Running Start students take a majority of their courses online.
[4] Students who complete an associate degree before graduation can apply for a high school completion certificate from their college.

similar content areas as those offered by high schools as part of their core curriculum. More than half of Running Start students take courses full-time at a community college (State Board of Community and Technical Colleges, 2011). In our sample, Running Start students attempt an average of 44 credits, or nearly one academic year, while in high school. Additionally, 11% of participants earn an associate degree.

Upon graduation from high school, Running Start students have some flexibility in how they apply for college. Although they may have a substantial number of credits, the in-state public universities treat Running Start students who have not completed an associate degree as freshmen for admissions purposes. Moreover, the four-year public universities have agreements with the state community colleges regarding the transfer of credits. Students may also continue in the community college system and earn an associate degree if they have not done so already. If they choose to complete an associate degree, Running Start students may apply to public four-year colleges as transfer students. Transfer policies for community college graduates vary across the four-year public universities, but transfer students are typically afforded some admission advantage. Given the myriad college pathways open to participants, Running Start students may have varied college plans at the time of enrollment. Using data collected during the registration process, we estimate that 21% of Running Start students plan to complete an associate degree and transfer to a four-year college, 43% have no plans for an associate degree but do plan to attend a four-year college, 7% plan to complete an associate degree only, and 29% have no specific plans for college.[5] Following high school, 67% of Running Start students enroll in any college and 32% enroll full-time in a four-year college.

[5] We construct college enrollment intent using two questions asked of incoming community college students. The first asks about students' planned length of attendance at the community college and the second about the purpose of enrolling. We use the following classification:
*AA and BA*: Purpose is "Transfer to a four-year college" and planned attendance is "Long enough to complete a degree"

## *Data*

We use data on high school and college students from the Education Research and Data Center warehouse in Washington State. The data include high school enrollment and standardized test records for 2005-2012 from the Washington Office of the Superintendent of Public Instruction (OSPI); community college attendance, transcript, and degree completion data for 2005-2012 from the Washington State Board of Community and Technical Colleges (SBCTC); and university attendance, transcript, and degree completion data for 2007-2012 from the Public Higher Education Enrollment System (PCHEES). Data on current and former Running Start participation are included in the SBCTC and PCHEES data systems. In addition to data on enrollments in public colleges in the state, we obtain information on enrollment in private and out-of-state enrollments from the National Student Clearinghouse (NSC).

We focus on the cohorts of high school students who first enrolled in ninth grade during a three-year period from 2004-2007. Our analysis dataset contains all students who enrolled in a standard high school during their sophomore year and continued their enrollment in the fall of their junior year.[6] As students have the option of enrolling in Running Start during the 11th and 12th grades, we study the outcomes for students participating in Running Start for school years 2006-2007 through 2010-2011. Our analytic sample includes 177,863 students.[7] **Table 1**

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*BA only*: Purpose is "Transfer to a four-year college" and planned attendance is "One quarter", "Two quarters", "1 year", or "Up to 2 years, no degree planned"
*AA only*: Purpose is "Take courses related to current or future work", "High school diploma or GED certificate", "Explore career direction", or "Personal enrichment" and planned attendance is "Long enough to complete a degree"
*No degree*: Purpose is "Take courses related to current or future work", "High school diploma or GED certificate", "Explore career direction", or "Personal enrichment" and planned attendance is "One quarter", "Two quarters", "1 year", or "Up to 2 years, no degree planned"

[6] We exclude students enrolled in alternative high schools, some of which participate in Running Start or other dual enrollment programs, from this analysis. We also exclude private school and home school students who enroll part-time in a public high school.

[7] This represents 78% of the total number of students enrolled statewide in all types of high schools during this period.

provides mean student characteristics for students who participate in Running Start and those who do not.

We construct outcome measures using graduation records from OSPI and SBCTC and college registration records from SBCTC, PCHEES, and NSC. The OSPI student reporting system explicitly codes students confirmed to have dropped out of school. Our dropout variable is defined using this code and may exclude students whose status is not confirmed by the reporting school. We obtain records on GED attainment from both OSPI, which records receipt of the GED as a possible graduation outcome, and SBCTC, which administers the test. When constructing the GED measure, we exclude students who otherwise obtain a valid high school diploma. Because Running Start students may obtain a high school diploma equivalent from their community college for completion of the associate degree, we include any credit-based form of high school completion in our high school diploma measure. This definition is consistent with prior research that has found a distinction between credentials awarded for credit and those awarded for passing a test (Cameron and Heckman, 1993). For all high school completion variables, we include only outcomes that occur within four years of student's initial high school enrollment. Therefore, our outcomes properly measure on-time high school completion. We consider students to have enrolled in college if they register for a positive number of credits in the quarter immediately following scheduled high school graduation. We define full-time college enrollment as registering for at least 12 quarter-credits.[8] As Running Start students may earn an associate degree during high school, the measures of college enrollment we use in our regressions include students who have enrolled in a two-year or four-year college or have completed an associate degree. We additionally identify students whose initial enrollment is in a

[8] Washington State University is on the semester schedule and we convert semester credits to quarter credits. While we do not have enrolled credits for students in the NSC, we do have their part- or full-time status.

four-year college following high school graduation. As is apparent from Table 1, Running Start students are more likely to attend college after graduation than non-participants. Sixty-seven percent of Running Start students attend any college in the year after they graduate and 54% do so full time. Both are far higher than the corresponding statewide means of 52% and 44%.

All tenth graders in the state take a standardized exam in reading, mathematics, science, and writing that we use in this analysis. Data on student grades, demographics, and program participation are also available from OSPI. Information on school location, enrollment, and demographics are derived from the Common Core of Data. All student characteristics are taken from the end of the sophomore year to avoid controlling for factors such as grades, special education status, or free or reduced price lunch eligibility, which may be endogenous to Running Start participation. Running Start students have much better academic performance than the overall population of high school students. They score about 0.4 standard deviations higher on all tenth grade standardized tests (0.50-0.57) than the sample average (0.11), they have an average tenth grade GPA (3.19) that is 0.5 points higher than the state average (2.78), and are less likely to participate in special education, bilingual education, Title I, and free or reduced price lunch programs.

## 3. Dual Enrollment and Educational Attainment: An Overview

There are three general mechanisms through which dual enrollment programs are thought to increase the likelihood of students attending and graduating from college. First, dual enrollment programs often represent a substantial subsidy to students toward the cost of a college degree. In Washington, this amounts to the $4,000 full-time tuition at state two-year colleges. During the time period covered in this study, the aggregate annual tuition subsidy for the program we consider ranged from $27.9 million to $39.7 million, which amounted to about

$2,000 per student per year (State Board of Community and Technical Colleges, 2006, 2010a). Second, these programs may provide high school students a more rigorous curriculum and valuable information about college that informs their college preparatory and college-going behavior. Third, the dual enrollment program we study is offered mostly by community colleges in the state and students participating full-time may make substantial progress toward completing an associate degree while in high school. Hence, if students become accustomed to their two-year college or wish to bank the labor market returns to a two-year degree, students may be more likely to initially enroll in a community college, which may influence their later likelihood of completing a four-year degree.

In cases where credits earned while participating in a dual enrollment program transfer to a postsecondary institution, students may substantially reduce the financial and time costs of a college degree by participating (Bailey and Karp, 2003).[9] By reducing the cost of obtaining a postsecondary degree, dual enrollment programs should unambiguously increase the likelihood that students enroll in some type of college after high school (Dynarski, 2003; Kane, 2007; van der Klaauw, 2002). However, while reducing the cost of higher education should increase college enrollment, it may not increase college completion as reducing the cost of college should induce more students with a higher probability of dropout to enroll (Manski, 1989).

However, the informational benefits of participation in dual enrollment may increase college completions. Research on the college dropout decision suggests that students respond to new information about their college-specific ability when deciding to continue investing in education (Arcidiacono, 2004; Stange, 2012; Stinebrickner and Stinebrickner, 2012). Dual enrollment programs may play a similar role for some students by providing them with low-cost information about their ability to succeed in college before making the more costly decision to

[9] In the Washington State program, the average student takes 11 credits per quarter, or more than 60 credits if enrolled for both junior and senior years (State Board for Community and Technical Colleges, 2011).

enroll full-time. Consequently, dual enrollment programs may lead some students on the margin of college attendance to switch their enrollment plans. Given that some portion of the benefit of completing high school is the option value of college enrollment, such decisions may also influence the high school completion rate (Comay, Melnik, and Pollatschek, 1973). To the extent that participation in actual college courses provides students with a better signal of their own likelihood to succeed in college, participating students should make better decisions about their postsecondary plans, leading to higher completion rates and a better match between students and the colleges they choose to attend. Previous research has highlighted the important role of the quality of student-institutional matches in postsecondary persistence and completions (Arcidiacono, 2004; Light and Strayer, 2000). This suggests there may be heterogeneous dual enrollment effects, depending on students' college-readiness at the point of program participation.

Finally, dual enrollment programs may initially divert some students into community colleges who would otherwise enroll directly in a four-year college out of high school. If college completion outcomes are uncertain, students who have nearly completed an associate degree may choose to enroll in a two-year college to take advantage of any sheepskin effects of the two-year degree (Light and Strayer, 2004). There is some debate about the effects of initial two-year college enrollment on overall educational attainment. Several papers suggest that students with who first enroll in a two-year college with plans to transfer are less likely to complete a bachelor's degree than first-time enrollees at four-year colleges (Leigh and Gill, 2003; Long and Kurlaender, 2008; Rouse, 1995). It is therefore possible that dual enrollment programs increase postsecondary enrollment yet reduce the number of students completing bachelor's degrees. However, there is also some evidence that the "diversionary" effect of two-year colleges reflects differences in educational plans (Leigh and Gill, 2003). Community colleges may also better

prepare some students for college-level work and provide an opportunity to transfer to a higher quality college (Hilmer, 1997). Overall, the direction of the effect of dual enrollment on the completion of four-year degrees is unclear.

## *Review of the Dual Enrollment Literature*

Despite their popularity, there is relatively little evidence on the effects of dual enrollment programs on college attendance or completion. This partially reflects the difficulty in collecting information on student's high school academic history and college enrollment patterns. While a few studies, such as Speroni (2011a) and Struhl and Vargas (2012), rely on data systems that track students from high school into college, many studies rely on databases with either incomplete high school or college enrollment data. Consequently, the estimated dual enrollment effects are not always comparable across studies. To provide context for the various empirical findings, we briefly consider a potential outcomes model of dual enrollment that encompasses the treatment effects commonly estimated.

Let college registration ($R_i$) and college completion ($C_i$) be the two outcomes of interest.[10] We are interested in estimating the difference in outcomes that we would observe absent dual enrollment participation ($R_{0i}$, $C_{0i}$) with those we would observe with dual enrollment participation ($R_{1i}$, $C_{1i}$) for particular groups of students. Two obvious quantities of interest are the effect of dual enrollment on college registration and college completion for those students who participate in dual enrollment; that is, we wish to estimate

$$\mathrm{E}[R_{1i} - R_{0i} \mid D_i = 1] \tag{1}$$

$$\mathrm{E}[C_{1i} - C_{0i} \mid D_i = 1] \tag{2}$$

[10] A number of studies restrict the sample to high school graduates or students who enroll in a particular college system. The framework we present can be directly extended to these scenarios.

As is the case is most prior research on dual enrollment, we assume conditional independence of $D$ and ($R_{0i}$, $C_{0i}$) given some vector of observables.[11] Given this assumption, we could obtain estimates of Eq. (1) and Eq. (2) by comparing the college enrollment and completion outcomes for a sample of students chosen before their participation in dual enrollment. However, such a sample has not always been available to researchers. Instead, consider a comparison of college completion outcomes by dual enrollment status for students who are observed to attend college. As we only observe the realized college registration outcome, the contrast estimates

$$\mathrm{E}[C_i \mid D_i = 1, R_i = 1] - \mathrm{E}[C_i \mid D_i = 0, R_i = 1]$$

Using the independence of $D$ and ($R_{0i}$, $C_{0i}$), we can write this as

$$\mathrm{E}[C_{1i} - C_{0i} \mid D_i = 1, R_{1i} = 1] + (\mathrm{E}[C_{0i} \mid D_i = 1, R_{1i} = 1] - \mathrm{E}[C_{0i} \mid D_i = 1, R_{0i} = 1]) \quad (3)$$

The first term above is the effect of dual enrollment on college completion for students who participate in dual enrollment and register for college ($R_{1i}$ = 1) and is an estimate of the treatment effect for a subset of the students included in (2). The second term is the difference in counterfactual completion rates for students who would attend college with dual enrollment participation and those who would attend college without participation. Eq. (3) reflects the fact that dual enrollment affects the likelihood of completing college and the composition of those who enroll (Angrist, 2001). Direct comparisons of matriculated students are therefore unlikely to yield unbiased estimates of the effects on degree completion.

The literature on dual enrollment is unclear on the sign of the second term in Eq. (3). On the one hand, dual enrollment may have a monotone effect on college enrollment and expand

[11] We suppress the conditioning on $X$ throughout. Selection on observables is clearly a strong assumption, but we impose it here as it is consistent with most prior studies and to clarify the estimation issues under ideal assumptions. Suppressing discussion of the vector $X$ also obscures the influence of different choices of control vectors on the estimates. Like most prior work, we control for the types of variables typically included in statewide K-12 student data systems, such as standardized test scores and participation in free-lunch programs. A notable exception is An (2013a), which relies on the much richer vector of control variables contained in the National Educational Longitudinal Study 1988 (NELS:88).

access to college for students who would not otherwise attend. If this were the case, the second term in Eq. (3) is likely negative and estimates of dual enrollment effects conditional on college registration are biased downward. However, the literature also raises another possibility. Dual enrollment may provide students with more accurate information about their ability to succeed in college (An, 2013b; Bailey and Karp, 2003). If this were the case, dual enrollment may reduce college enrollment for students unlikely to succeed in college and increase college enrollment for students likely to complete a degree. If this were the case, then the bias term in Eq. (3) is positive and such comparisons overstate the effect of dual enrollment.

Speroni (2011a) and Struhl and Vargas (2012) estimate Eq. (2) directly, although both studies lack data on college completions for students who attend private or out-of-state colleges. Speroni (2011a) exploits an eligibility condition based on cumulative high school GPA and uses a regression discontinuity design to study the effects of dual enrollment and participation in a particular math class on college enrollment and completion. She finds dual enrollment students are less likely to complete a four-year degree, although students who participate in an advanced math class are substantially more likely to complete a degree. Struhl and Vargas (2012) use a propensity score matching estimator and find that dual enrollment students in Texas are about 17 percentage points more likely to complete a four-year degree at a Texas public university.

A number of studies estimate Eq. (3) conditional on different sets of registrations. An (2013a) estimates the college completion effects of dual enrollment for students who enroll in college in the National Educational Longitudinal Study 1988 (NELS:88) using a propensity score matching technique. He finds that dual enrollment students are 8 percentage points more likely to compete any degree and 7 percentage points more likely to complete a bachelor's degree, with the effect concentrated among students whose parents' educational attainment was some

college or less. Allen and Dadgar (2012) consider first-time students in CUNY colleges and find that students who had previously participated in the college's dual enrollment program were approximately 5 percentage points more likely to persist to the second semester. Karp et al. (2007) study dual enrollment in Florida and find that participants who enroll in Florida public colleges are 5 percentage points more likely to persist to the second year of college.

Previous research has also considered the effect of dual enrollment on college attendance. Karp et al. (2007) find that dual enrollment participants are 17 percentage points more likely to enroll in any state college and 8 percentage points more likely to enroll in a four-year public university immediately following graduation. Struhl and Vargas (2012) find that dual enrollment students in Texas are more likely to enroll in public colleges in the state. Speroni (2011a) finds no statistically significant effect of dual enrollment on postsecondary attendance. However, the estimates are imprecise and the confidence intervals contain the estimates derived in other work. Both Karp et al. (2007) and Struhl and Vargas (2012) rely on records that track only in-state, public college enrollments.

As with dual enrollment, there is relatively little evidence on the efficacy of other high school transitional programs on postsecondary outcomes. Research has documented that the rigor of high school curriculum explains both high school completion and success in college (Adelman, 2006). Cellini (2006) finds positive overall college enrollment effects, but negative effects on initial enrollment in a four-year college, for participants in TechPrep. Berger at al. (2013) study early college high schools using admissions lottery results as an instrument and find that students in such high schools are about 3 percentage points more likely to attend college after high school completion. Several papers have found positive effects on college enrollment, completion, and grades of Advanced Placement courses conditional on high school academic

performance.[12] However, these differences may be attributable to taking a rigorous high school curriculum rather than the dual credit component of Advanced Placement (Klopfenstein and Thomas, 2006). Speroni (2011b) compares AP to dual enrollment and finds positive college enrollment effects of both programs relative to students who participate in neither. AP courses appear to have greater effects on enrollment in a four-year college, while dual enrollment courses appear to have a greater effect on overall college enrollment.

## 4. The Effects of Dual Enrollment on High School Completion and College Attendance

In this paper, we are concerned with estimation of the effect of Running Start participation on the probability of high school completion and college enrollment. As with much of the previous research on dual enrollment, we employ a selection on observables design to estimate the effects of participation.[13] That is, we estimate

$$Y_i = 1(X_i\beta + \delta RS_i + \epsilon_i > 0), \quad (4)$$

where *Y* denotes high school completion or college enrollment, *X* denotes the vector of observed student covariates, and *RS* denotes participation in Running Start. We begin by estimating linear probability models that condition on a number of student characteristics that may influence postsecondary enrollment decisions. These include a cubic polynomial in sophomore grade point average and test scores in mathematics, reading, science, and writing from a state standardized test administered at the end of tenth grade, student gender, ethnicity, free and reduced price lunch status, student learning disability status, participation in a bilingual education program, an indicator for a primary language other than English, participation in a targeted Title I program, participation in gifted and talented classes, AP classes, migrant status,

[12] Recent examples include Dougherty, Mellor, and Jian (2006) and Morgan and Klaric (2007).
[13] Speroni (2011a), which uses a regression discontinuity design, is an exception.

and unexcused absences. All student controls are measured during the student's tenth grade year before eligibility for Running Start. In addition, we include school-by-cohort fixed effects in all regressions and cluster standard errors at the school level. The treatment effect $\delta$ is identified only under the assumption that unobserved factors associated with high school completion and college enrollment, $\epsilon_i$, are uncorrelated with Running Start participation. This requires that students participating in a college preparatory program have similar college plans as observationally similar non-participants, an assumption that is unlikely to hold. We return to the plausibility of this assumption below.

We display the OLS results in **Table 2**. In Panel A, we show the average effects of Running Start participation on high school completion and college attendance. Compared to similar students, Running Start participants are less likely to earn a traditional high school diploma and more likely to drop out of school. We estimate Running Start students are 3 percentage points less likely to earn a credit-based diploma, 1.8 percentage points more likely to drop out of school and 0.5 percentage points more likely to earn a GED. All estimated coefficients are statistically significant at the 1% level. In results not shown, we additionally find that Running Start participants are only 1.3 percentage points more likely to neither complete a high school degree nor remain enrolled in college. It appears that, beyond the increased risk of dropout, the reduction in the likelihood of earning a high school credential may reflect a delay in completing graduation requirements.

In columns (4) – (6), we consider college enrollment immediately after scheduled high school graduation. Running Start students are 5.5 percentage points more likely to either attend any college or have already earned an associate degree, but are no more likely to have either already earned a degree or to attend college full-time. Furthermore, Running Start students are 8.1 percentage points less likely than similar non-participants to attend a four-year university

full-time. Among all high school students in our sample, 26% attend a four-year college after graduation. Hence, at the mean, the estimated effect on four-year enrollment represents a one-third reduction in the probability of enrollment.

While the findings in Table 2 suggest that Running Start may shift some of the initial college enrollment toward two-year colleges, the results may not generalize to overall educational attainment. Among the 2011 graduating classes at Washington public universities, 40% of students had transferred from two-year colleges (Washington State Board for Community and Technical Colleges, 2013). Therefore, it is likely that some of these students will eventually transfer to four-year colleges. An (2013a) provides some support for this view, suggesting that dual enrollment students who enroll in any college are more likely to complete a bachelor's degree than similar non-participants. Hence, these results should be interpreted as a short-run effect and are not necessarily indicative of overall educational attainment.

### *Heterogeneity in Outcomes by Student Characteristics*

The discussion in Section III suggests that the effect of Running Start may depend on students' college plans or academic ability. For instance, the financial incentives embedded in Running Start may be more important for poor or minority students. More capable students, or those who receive positive signals about their college-specific academic ability while participating in Running Start, may be more likely to continue their postsecondary studies. On the other hand, students with weaker performance in college courses in Running Start may be less likely than observationally similar students to pursue further postsecondary study. To assess this possibility, we interact the Running Start indicator with student sex and ethnicity in Table 2 and flexible functions of students' sophomore standardized test results and total Running Start credits attempted in Figures 1 and 2.

The results in Panel B of Table 2 suggest several differences in responses to Running Start across demographic groups. Female and Hispanic Running Start students are 4.4 and 4.5 percentage points less likely to graduate high school on-time than non-participants, with both differences statistically significantly different than the baseline Running Start effect. Hispanic students are 2.1 percentage points more likely to complete high school with a GED than non-participants and female Running Start students are 1.9 percentage points more likely to drop out of high school. Students eligible for the free lunch program have better high school completion rates than other Running Start participants and are no less likely than non-participants to earn a high school diploma. Looking to college enrollment outcomes, free lunch eligible Running Start students are 7.1 percentage points more likely to attend any college, compared to a baseline effect of 5.3 percentage points. We also find that Asian and African-American Running Start students are more likely to initially attend a four-year university. African-American Running Start students are 0.9 percentage points more likely to attend a four-year university than non-participants, although the combined effect is not statistically significant.

We present the results by standardized test scores in Figure 1. We plot the estimated effects and 95% confidence intervals for 20 quantiles of student achievement. We also plot the histogram of Running Start students obtaining each test score quantile. The negative effect on high school completion seems to be strongest for low-scoring students, although the effects for these students are not precisely estimated. We find positive effects on college enrollment across the test score distribution with the largest effects among low-scoring students. Hence, it appears that Running Start carries a trade-off for students in the lower end of the academic achievement distribution: participants are both more likely to attend college and fall behind in their high school work. Consistent with the diversionary hypothesis, Running Start appears to

have the strongest negative four-year college enrollment effects among high-scoring students, although most quintiles have statistically significant negative effects.

In Figure 2, we present results by the number of college credits students attempt while participating in Running Start. We estimate Running Start effects for categories of credits attempted that roughly correspond to the number of full-time quarters for which students enroll.[14] As the figures indicate, many students either enroll for only one quarter or for the entire two years of eligibility. Across all outcomes, it appears that much of the benefit of Running Start accrues to students who participate full-time over two years. Students with 76 or more credits are about 15 percentage points more likely than non-participants to earn an associate degree or enroll in college after high school graduation, with most of the increase due to the ability to earn an associate degree during high school. The short-run diversionary effect of dual enrollment is also weaker among students who have 76 or more credits. Unsurprisingly, the closer students are to the number of credits needed to earn an associate degree, the likelier they are to continue attending a two-year college, rather than a four-year college, immediately after high school. This finding highlights the importance of considering overall educational attainment separately from college enrollment.

### *Robustness Checks*

The analyses in Section V assume that a limited set of academic and financial information sufficiently control for differences in educational attainment between Running Start and non-Running Start students. However, as the discussion in Section III makes clear, students may select into Running Start based on financial and academic factors that are unobserved. Because dual enrollment programs offer very clear benefits to students who intend to enroll in

[14] The categories in Figure 2 are 1-15 credits, 16-30 credits, 31-45 credits, 46-60 credits, 61-75 credits, and 76+ credits.

college after high school, we might expect estimation strategies that assume selection on observables to overstate the true effect of these programs on the probability of college enrollment. On the other hand, the literature on college dropouts suggests that the informational benefit of dual enrollment programs may be greatest for students with the most uncertainty about their ability to succeed in college (Stange, 2012). If this is the case, students who choose to participate may be otherwise less likely to attend and persist in college than observationally similar students. Estimated program effects that control only for student background may also overstate the diversionary effect of dual enrollment programs. Because students can make considerable progress toward an associate degree while in high school, dual enrollment students may at baseline be more likely to plan to initially enroll in a two-year college.

We use two additional sources of information on student college attendance plans to test the plausibility of the selection on observables assumption. The state community colleges collect information on future enrollment plans for all incoming students. We use Running Start students' self-reported enrollment plans at the beginning of dual enrollment to test whether differences in college-going plans can explain our results. We also have high school course transcript data for a subset of students who graduate high school in 2010 - 2011. Because the state imposes a minimum curriculum for students planning to attend the state four-year colleges, we use course-taking patterns from before dual enrollment participation as an additional control. The robustness checks suggest conflicting evidence on the identification strategy. While our estimates are not sensitive to controlling for high school course histories, we find that the diversionary effect of Running Start is most concentrated among students declaring an intention to first obtain an associate degree.

The community colleges offering dual enrollment programs survey incoming students about their enrollment plans and reasons for attending college. From these variables, we generate four categories of students: those who plan to complete a degree at the community college and transfer to a four-year institution, those who do not plan to complete a degree at the community college before transferring to a four-year institution, those who plan to complete a degree at the community college and not transfer to a four-year institution, and those who plan neither to complete a degree at the community college nor to transfer to a four-year institution.[15]

Unfortunately, this data is limited to students who participate in Running Start and we cannot include college attendance plans in our regression models. Instead, we interact college plans with the Running Start indicator as a check on the most plausible interpretations of the results in Table 2. For instance, the discussion in Section III suggests we might see negative four-year enrollment effects among students who initially planned to attend a four-year institution because of learning or peer effects. Similarly, if dual enrollment increases overall college enrollment due to student learning or better preparation for college courses, we should see increases in college attendance rates among students who previously would not have planned to attend college.

We present estimates of the Running Start effect interacted with pre-participation college plans in **Table 3**. In column (4), we find that the estimated effects of Running Start on any college enrollment are strongest for students who indicate intent to complete a college degree. Although statistically significant, the effect of Running Start for students who indicate no college degree plans is only 0.017. In column (5), we find that Running Start increases full-time college attendance only for students who intend to transfer to a four-year college. The

[15] The classification is described further in footnote 5 above.

estimated effects for students seeking an associate degree and for students with no college plans are -0.042 and -0.025, respectively, and are significant at the 1% level. In column (6), we find that the effects of Running Start on four-year enrollment are strongest for students who indicate intent to complete an associate degree. While we find an estimate of -0.132 for students who plan to complete an associate degree before transferring to a four-year institution, we find an effect of only -0.058 for students planning to enroll directly in a four-year institution. It appears that the short-run diversionary effect is at least partially explained by differences in college plans. Nonetheless, we do find positive college enrollment results and negative four-year enrollment results across all groups.

We also use transcript data for a subset of high school seniors from the graduating classes of 2010 and 2011 to control for high school course-taking behavior. Because this data is only available for students still enrolled in 2010-2011, we limit the sample to students enrolling in their senior year in 2010 or 2011 who have not previously participating in Running Start.[16] For English language arts and social studies, most students follow the state core course curriculum. However, there is much more variation in the timing of mathematics and science courses. Hence, we include indicators for each sequence of math and science core courses in grades 9-11.[17] For instance, we include an indicator that is equal to 1 for all students who take Algebra I in 9$^{th}$ grade, Geometry in 10$^{th}$ grade, and Algebra II in 11$^{th}$ grade, and 0 for all other students. We

[16] Washington State switched to a new longitudinal student data system during the 2009-2010 school year. The new data system calls for high schools to submit the entire transcript history for each high school student using a uniform course coding system for a number of common courses. Because some high schools in 2010 had not yet switched to the uniform state coding system or had not yet provided the entire high school transcript, we do not have complete data on the rising high school senior class of 2009-2010. We limit our sample to schools that have at least 50% of their courses linked to the state coding scheme and with at least 70% of high school seniors matched to four-year course histories. Including students dropped due to junior-year participation in Running Start, the sample for this analysis contains 33,827 of 118,752 total students and 1,945 Running Start students.

[17] The core math courses we include are Algebra I, Geometry, Algebra II, Integrated Math 1-4, Trigonometry/Algebra, and Pre-calculus. The science courses we include are Biology, Microbiology, Chemistry, Physics, Physical Science, and Integrated Science.

also include indicators for whether the student took a foreign language in each grade. The course indicators may reflect differences in college plans across students that may be correlated with Running Start participation. For graduation, Washington State only requires two years of math and science. Admission to the state university system requires 3 years of math, including one advanced math class, 2 years of science, and 2 years of foreign languages. The state additionally recommends 3-4 years of math, science, and foreign languages for students interested in applying to selective colleges.

In Panel B, we display estimates of the effect of Running Start participation for the sample of students with high school transcripts. Overall, results are similar for the group of high school senior participants as those reported in Table 2, although students are more likely to drop out of high school and less likely to attend a four-year college. In Panel C, we display results for regressions that additionally include the course history indicators. Across all specifications, variation in course-taking explains little of the estimated effects of Running Start participation.

### *Using State Longitudinal Data Systems to Study Dual Enrollment Policies*

Analyses of dual enrollment programs are complicated by the difficulty in obtaining reliable data on both high school experiences and postsecondary educational attainment. Although it precludes conclusions about the longer-term consequences of dual enrollment programs, our dataset provides two advantages over those used in existing studies. First, we have more detailed high school transcript data, including individual course records for a subset of students. This allows us to use measures of academic proficiency from before students participate in dual enrollment. Second, our public college attendance records are supplemented with records from private and out-of-state institutions. We now examine how the availability of this data influences our results.

The effect of misclassifying college attendance depends on the relationship between dual enrollment participation and the included covariates. In dual enrollment studies, the misclassification almost always consists of students who actually attend college but for whom enrollment records are missing. Typically, college students lack enrollment records because they attend private or out-of-state schools that are not included in state administrative databases. Of the several studies that consider the college attendance effects of dual enrollment described earlier, only Speroni (2011a) includes data obtained from the National Student Clearinghouse on college enrollments outside the public university system. If the rate of enrollment in such institutions is equal across participants and non-participants, conditional on other covariates, then the estimated effects of dual enrollment participation will tend to be attenuated toward zero (Hausman, Abrevaya, and Scott-Morton, 1998; Meyer and Mittag, 2013). The degree of attenuation will be approximately equal to the percent of students attending non-covered colleges, which is 15-20% in states considered in several existing studies (Education Research and Data Center, 2010; Speroni, 2011b; Struhl and Vargas, 2012).

Empirically, however, we observe that Running Start students are more likely to attend in-state public colleges than other similar students. This is unsurprising given that they have already begun enrollment in a public college and it is presumably easier to transfer credits to another college in the public university system. Thus, it is likely that, without data on enrollments in private colleges or out-of-state public colleges, estimates of dual enrollment effects are biased downward. We test this in Table 4 by repeating the baseline regressions in Table 2 using only enrollments in state public two- and four-year colleges as our outcomes. In our sample, 82% of first-time college students enroll in a Washington State public college. Although the majority of college students is correctly classified, the omission of private and out-of-state enrollments substantially alters our estimates of college enrollment effects. Excluding

private or and out-of-state enrollments, the estimated effect of Running Start on any college enrollment increases from 0.055 to 0.121. We see similar increases in full-time and four-year enrollments, which increase from 0.001 to 0.064 and from -0.081 to -0.044, respectively.

Some previous studies have relied on samples of high school graduates with retrospective information on dual enrollment participation. The results in Table 2 suggest that dual enrollment may influence the likelihood that students complete high school and thus appear in the data. Additionally, cumulative high school grade point averages may be endogenous to dual enrollment participation. Dual enrollment may influence students' academic preparation and final high school grades (Karp et al., 2007). Additionally, the colleges hosting dual enrollment courses may have stricter grading standards than high schools and the grades of dual enrollment students may reflect different levels of underlying college preparedness. In order to assess the influence of restricting the sample to high school graduates and using a measure of academic performance taken after dual enrollment participation, we repeat our analyses in Table 2 using this sample. In Panel B, we restrict the sample to high school graduates. Despite the loss of some students who drop out of high school, the results are similar to those with the full sample. However, we do find notable differences when we include the final cumulative high school GPA as a regressor. In this case, we find a statistically significant effect of Running Start on full-time college attendance of 0.031 and the effect on four-year enrollment increases from -0.081 to -0.057. It appears that assumptions about missing data, sample selection, and the endogeneity of regressors have meaningful consequences for estimating the effects of dual enrollment programs on college attendance.

## 5. Conclusion

We use a state longitudinal data system to evaluate the influence of a popular dual enrollment program on college attendance. The data used in this study improves on that used in recent studies of dual enrollment programs by including a more complete record of college enrollment and a sample of students taken before participation in the program. We find that students who participate in dual enrollment are more likely to attend any college immediately after high school graduation, but are no more likely to attend college full-time and are less likely to attend a four-year university.

Given the likelihood of selection into Running Start based on unobserved determinants of college attendance, we are cautious about drawing causal inferences based on the present analyses. In particular, our control vector is limited to high school academic variables and a limited set of socioeconomic variables. Using students' observed course-taking patterns in high school and the stated college intent at the time of entrance into Running Start, we present some evidence that selection may explain part of our results. In particular, we find that the diversionary effect of Running Start is likely biased downward by differences in pre-treatment college plans. We also provide some evidence that the diversionary effect is strongest among students who have nearly completed an associate degree and that the short-run effect on enrollment may not be predictive of longer-run effects on baccalaureate completion.

The increasing prevalence of state data warehouses that combine records from K-12 and postsecondary agencies with private and out-of-state college attendance should provide an opportunity to better study dual enrollment programs, including more quasi-experimental evidence of program impacts. As we discuss in Section III, the use of samples taken before program participation with more complete information on college enrollment expands the range of causal questions that can be posed. In particular, rigorous analysis of the effects of dual

enrollment participation on overall educational attainment remains an important topic for future research.

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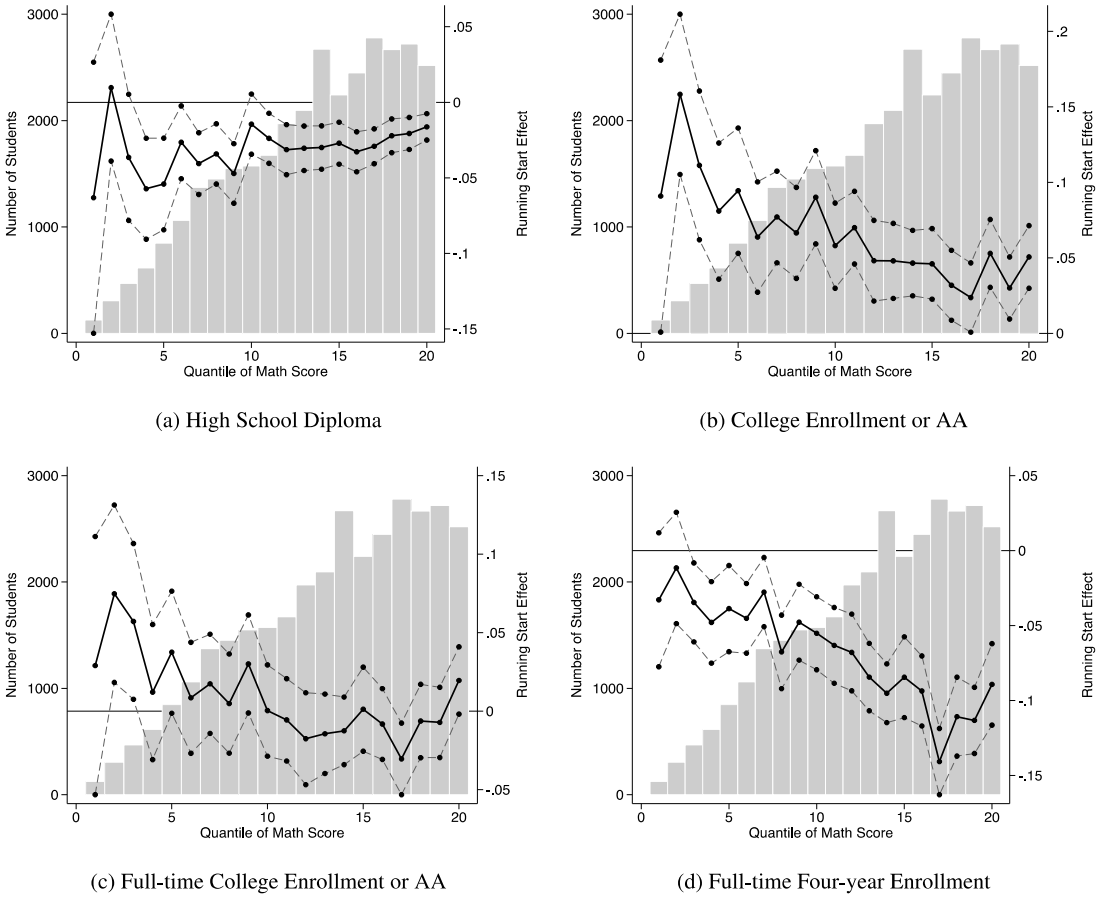
# Figures

## Figure 1. The Effect of Running Start by Student Standardized Math Scores




(a) High School Diploma

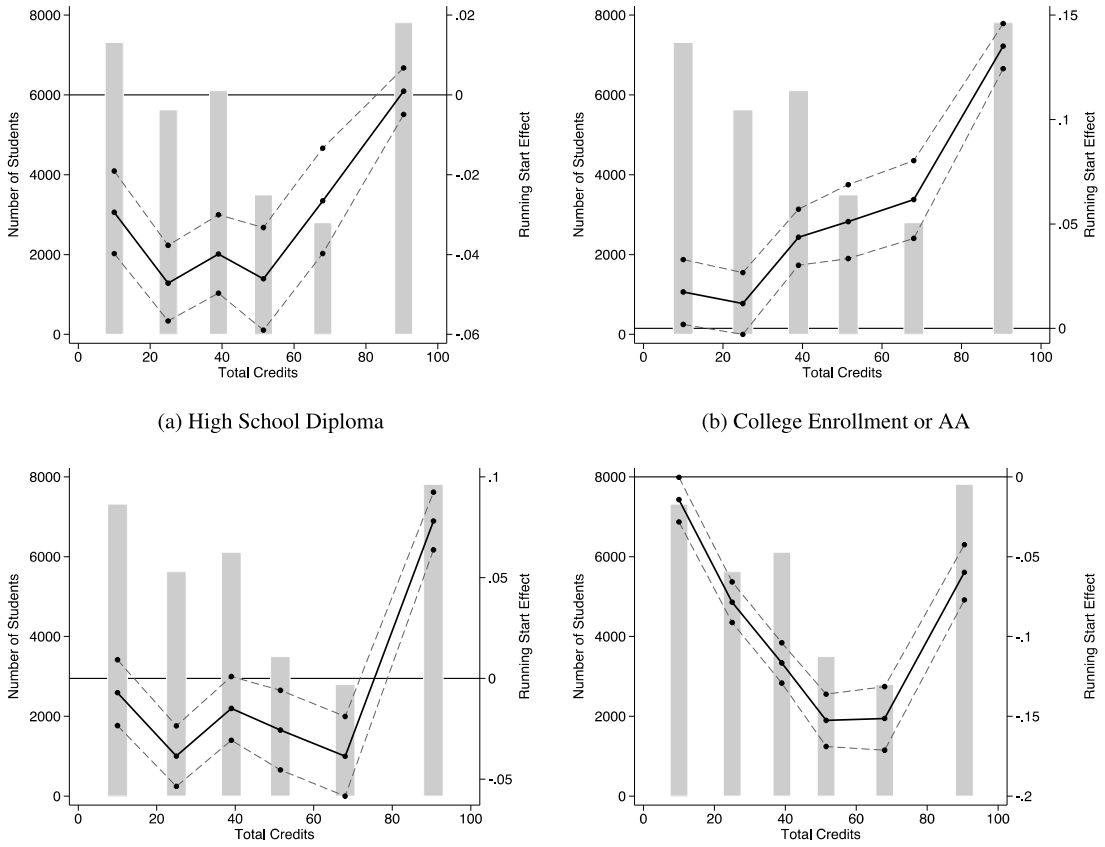
(b) College Enrollment or AA

(c) Full-time College Enrollment or AA

(d) Full-time Four-year Enrollment

Notes: Estimated effects are over 20 quantiles of 10th grade standardized math score. Bars depict the number of Running Start students in each test score quantile. Dashed lines depict 95% confidence interval.

## Figure 2. The effect of Running Start by total credits attempted




(a) High School Diploma

(b) College Enrollment or AA

(c) Full-time College Enrollment or AA

(d) Full-time Four-year Enrollment

Notes: Estimated effects are over ranges of credits attempted in Running Start. We estimate effects for 1-15, 16-30, 31-45, 46-60, 61-75, and 76+ credits. Dashed lines depict 95% confidence interval. Bars depict the number of Running Start students who attempted each number of credits. Coefficients are plotted at the median number of credits in each category.

# Tables

## Table 1. Summary statistics

| | RS Students | | Non-RS Students | | All Students | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| *Student outcomes:* | | | | | | |
| HS Dropout | 0.04 | (0.19) | 0.05 | (0.22) | 0.05 | (0.22) |
| GED | 0.02 | (0.14) | 0.03 | (0.18) | 0.03 | (0.17) |
| HS Diploma | 0.90 | (0.29) | 0.84 | (0.37) | 0.85 | (0.36) |
| Earns associate degree | 0.11 | (0.31) | 0.00 | (0.02) | 0.02 | (0.12) |
| Any college enrollment | 0.67 | (0.47) | 0.50 | (0.50) | 0.52 | (0.50) |
| Any full-time college enrollment | 0.54 | (0.50) | 0.42 | (0.49) | 0.44 | (0.50) |
| Any college enrollment (inc. AA) | 0.70 | (0.46) | 0.50 | (0.50) | 0.52 | (0.50) |
| Any full-time college enrollment (inc. AA) | 0.58 | (0.49) | 0.42 | (0.49) | 0.44 | (0.50) |
| Full-time four-year college enrollment | 0.32 | (0.47) | 0.25 | (0.43) | 0.26 | (0.44) |
| *Running Start participation:* | | | | | | |
| Running Start participant, 11th grade | 0.62 | (0.49) | 0.00 | (0.00) | 0.09 | (0.28) |
| Running Start participant, 12th grade | 0.85 | (0.35) | 0.00 | (0.00) | 0.12 | (0.33) |
| Total Running Start credits | 43.94 | (29.99) | 0.00 | (0.00) | 6.11 | (18.87) |
| College intent: AA + BA | 0.21 | (0.41) | 0.00 | (0.00) | 0.03 | (0.17) |
| College intent: BA only | 0.43 | (0.50) | 0.00 | (0.00) | 0.06 | (0.24) |
| College intent: AA only | 0.07 | (0.26) | 0.00 | (0.00) | 0.01 | (0.10) |
| College intent: no degree | 0.29 | (0.45) | 0.00 | (0.00) | 0.04 | (0.20) |
| *Student controls:* | | | | | | |
| Student gender: Female | 0.40 | (0.49) | 0.51 | (0.50) | 0.50 | (0.50) |
| Student race: Asian | 0.11 | (0.31) | 0.08 | (0.27) | 0.08 | (0.28) |
| Student race: Black | 0.03 | (0.17) | 0.04 | (0.20) | 0.04 | (0.20) |
| Student race: Hispanic | 0.05 | (0.22) | 0.11 | (0.31) | 0.10 | (0.30) |
| 10th grade GPA | 3.19 | (0.65) | 2.72 | (0.87) | 2.78 | (0.86) |
| 10th grade math WASL | 0.57 | (0.75) | 0.04 | (0.95) | 0.11 | (0.95) |
| 10th grade reading WASL | 0.54 | (0.80) | 0.04 | (0.95) | 0.11 | (0.95) |
| 10th grade writing WASL | 0.50 | (0.63) | 0.05 | (0.92) | 0.11 | (0.90) |
| 10th grade science WASL | 0.51 | (0.72) | 0.04 | (0.92) | 0.11 | (0.91) |
| FRL Status, 10th grade | 0.16 | (0.37) | 0.26 | (0.44) | 0.24 | (0.43) |
| Bilingual Status, 10th grade | 0.01 | (0.10) | 0.04 | (0.19) | 0.04 | (0.18) |
| Primary language is not English | 0.08 | (0.28) | 0.11 | (0.31) | 0.10 | (0.31) |
| Title I targeted assistance | 0.04 | (0.20) | 0.08 | (0.27) | 0.08 | (0.27) |
| Gifted education | 0.03 | (0.18) | 0.02 | (0.15) | 0.02 | (0.15) |
| Takes AP course in 9th grade | 0.01 | (0.09) | 0.01 | (0.08) | 0.01 | (0.08) |
| Takes AP course in 10th grade | 0.09 | (0.28) | 0.06 | (0.23) | 0.06 | (0.24) |
| Migrant student | 0.00 | (0.06) | 0.02 | (0.13) | 0.02 | (0.12) |
| Unexcused absences | 1.73 | (5.68) | 2.03 | (6.79) | 1.99 | (6.65) |
| N | 24727 | | 153136 | | 177863 | |

## Table 2: The effects of Running Start on high school completion and college enrollment

| | High School Completion | | | College Enrollment | | |
|---|---|---|---|---|---|---|
| | Dropout | GED | Diploma | Any College | Full-time Enroll. | Full-time Four-year |
| *Panel A: Average Effects* | | | | | | |
| Running Start | 0.016*** | 0.005*** | -0.029*** | 0.055*** | 0.001 | -0.081*** |
| | (0.002) | (0.001) | (0.003) | (0.004) | (0.005) | (0.004) |
| $N$ | 177863 | 177863 | 177863 | 177863 | 177863 | 177863 |
| *Panel B: Interactions with Student Characteristics* | | | | | | |
| Running Start | 0.014*** | 0.002* | -0.022*** | 0.053*** | -0.000 | -0.089*** |
| | (0.002) | (0.001) | (0.003) | (0.005) | (0.006) | (0.006) |
| RS * Female | 0.005** | 0.003 | -0.020*** | -0.001 | -0.005 | -0.002 |
| | (0.002) | (0.002) | (0.004) | (0.006) | (0.006) | (0.006) |
| RS * Asian | -0.001 | 0.004 | 0.002 | 0.009 | 0.012 | 0.043*** |
| | (0.004) | (0.003) | (0.007) | (0.011) | (0.013) | (0.011) |
| RS * Black | 0.008 | 0.001 | -0.009 | -0.013 | 0.032 | 0.098*** |
| | (0.009) | (0.005) | (0.012) | (0.021) | (0.023) | (0.020) |
| RS * Hispanic | 0.004 | 0.016*** | -0.023** | -0.000 | -0.014 | 0.024* |
| | (0.006) | (0.005) | (0.010) | (0.014) | (0.014) | (0.013) |
| RS * FRPL | -0.007* | -0.001 | 0.014** | 0.018** | 0.015 | -0.000 |
| | (0.004) | (0.003) | (0.006) | (0.009) | (0.009) | (0.008) |
| $N$ | 177863 | 177863 | 177863 | 177863 | 177863 | 177863 |

Notes: All regressions include the following variables: indicators for student sex, race, migrant status, whether English is the primary language, and 10th grade participation in the free-lunch program, targeted assistance (Title I), bilingual education, gifted education, special education services, Advanced Placement classes, and 10th grade GPA, unexcused absences, and standardized test scores in math, language arts, writing, and science. Regressions additionally include cohort-by-school fixed effects. The first coefficient in Panel B is the coefficient on Running Start status. Additional coefficients are estimated from variables interacting Running Start with the given characteristic. Standard errors clustered by school in parentheses.
$***\ p < 0.01, **\ p < 0.05, *\ p < 0.10$.

## Table 3: Robustness checks

| | High School Completion | | | College Enrollment | | |
|---|---|---|---|---|---|---|
| | Dropout | GED | Diploma | Any College | Full-time Enroll. | Full-time Four-year |
| *Panel A: Running Start Effects by College Intent* | | | | | | |
| Running Start, AA + BA | 0.016*** | 0.005*** | -0.034*** | 0.086*** | 0.014* | -0.133*** |
| | (0.003) | (0.002) | (0.004) | (0.007) | (0.007) | (0.007) |
| Running Start, BA only | 0.014*** | 0.005*** | -0.025*** | 0.068*** | 0.018*** | -0.058*** |
| | (0.002) | (0.001) | (0.003) | (0.006) | (0.006) | (0.006) |
| Running Start, AA only | 0.020*** | 0.006* | -0.048*** | 0.043*** | -0.042*** | -0.165*** |
| | (0.006) | (0.004) | (0.009) | (0.011) | (0.011) | (0.010) |
| Running Start, no degree | 0.018*** | 0.004** | -0.027*** | 0.016** | -0.025*** | -0.055*** |
| | (0.003) | (0.002) | (0.004) | (0.006) | (0.006) | (0.007) |
| $N$ | 177863 | 177863 | 177863 | 177863 | 177863 | 177863 |
| *Panel B: Running Start Effects for Transcript Sample* | | | | | | |
| Running Start | 0.019 | 0.004 | -0.040** | 0.024 | -0.018 | -0.127*** |
| | (0.017) | (0.006) | (0.017) | (0.027) | (0.032) | (0.028) |
| $N$ | 5173 | 5173 | 5173 | 5173 | 5173 | 5173 |
| *Panel C: Running Start Effects in Transcript Sample with Course Fixed Effects* | | | | | | |
| Running Start | 0.013 | -0.002 | -0.037** | 0.021 | -0.016 | -0.138*** |
| | (0.017) | (0.004) | (0.017) | (0.029) | (0.035) | (0.032) |
| $N$ | 5173 | 5173 | 5173 | 5173 | 5173 | 5173 |

Notes: All regressions include the following variables: indicators for student sex, race, migrant status, whether English is the primary language, and 10th grade participation in the free-lunch program, targeted assistance (Title I), bilingual education, gifted education, special education services, Advanced Placement classes, and 10th grade GPA, unexcused absences, and standardized test scores in math, language arts, writing, and science. Regressions additionally include cohort-by-school fixed effects. In Panel A, the college intent variables are interactions of Running Start participation with college intent, which is defined as described in the text. Regressions in Panel C include estimated coefficients with models that additionally include indicators for the progression of courses in math, science, and foreign language. Standard errors clustered by school in parentheses.
$***\ p < 0.01$, $**\ p < 0.05$, $*\ p < 0.10$.

## Table 4: Sensitivity of results to missing data and sample selection

| | Washington Public College | | | Any College | | |
|---|---|---|---|---|---|---|
| | Any College | Full-time Enroll. | Full-time Four-year | Any College | Full-time Enroll. | Full-time Four-year |
| *Panel A: Washington State Public Enrollments Only* | | | | | | |
| Running Start | 0.121*** | 0.064*** | -0.044*** | 0.055*** | 0.001 | -0.081*** |
| | (0.004) | (0.005) | (0.004) | (0.004) | (0.005) | (0.004) |
| $N$ | 177863 | 177863 | 177863 | 177863 | 177863 | 177863 |
| *Panel B: High School Graduates* | | | | | | |
| Running Start | 0.134*** | 0.074*** | -0.045*** | 0.064*** | 0.006 | -0.083*** |
| | (0.005) | (0.005) | (0.004) | (0.004) | (0.005) | (0.005) |
| $N$ | 146751 | 146751 | 146751 | 146751 | 146751 | 146751 |
| *Panel C: High School Graduates with Final GPA* | | | | | | |
| Running Start | 0.143*** | 0.086*** | -0.030*** | 0.085*** | 0.031*** | -0.057*** |
| | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) | (0.005) |
| $N$ | 146751 | 146751 | 146751 | 146751 | 146751 | 146751 |

Notes: All regressions include the following variables: indicators for student sex, race, migrant status, whether English is the primary language, and 10th grade participation in the free-lunch program, targeted assistance (Title I), bilingual education, gifted education, special education services, Advanced Placement classes, and 10th grade GPA, unexcused absences, and standardized test scores in math, language arts, writing, and science. Regressions additionally include cohort-by-school fixed effects. Standard errors clustered by school in parentheses.
$***\ p < 0.01$, $**\ p < 0.05$, $*\ p < 0.10$.