Title
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Out of the Gate: The Relationship Between Dual Enrollment Gateway Course-Taking and College Academic Momentum

This study explores the relationship between dual enrollment (DE) math and English gateway course-taking and academic momentum indicators—earning 30 credits by the end of the first year, first-year credit accumulation, and persistence to the third semester. The study is based on a sample of first-time freshmen at the City University of New York who participated in the citywide DE program, College Now, and utilizes quasi-experimental methodology to identify a balanced sample of former DE students who took math and English gateway courses in DE compared to former DE students who did not. Taking DE gateway courses has a modest, but positive association with credit momentum, particularly first-year credit accumulation when DE credits are included, but had no relationship with persistence. We found an increase in credit momentum for Black/African American students who took a math gateway DE course, as compared to Black/African American and students of any race who did not take a math gateway DE course. Findings suggests that school–university partnerships with DE programs should investigate the experiences of students who initiated academic momentum earlier in high school but struggled to sustain it during their first year when they enroll in the university system where they participated in DE.

Keywords: dual enrollment, academic momentum, gateway courses, credit momentum, credit accumulation, persistence

Introduction

Studying *academic momentum*—the early accumulation of college-level credits and behaviors predictive of postsecondary success (Adelman, 2006; Attewell et al., 2012; Attewell & Monaghan, 2016; Barnett, 2016; Belfield et al., 2016; Henneberger et al., 2020)—is critical because the pace and intensity of students' initial engagement with college-level coursework typically predicts longer-term outcomes such as persistence and degree attainment (Attewell et al., 2012). Without this momentum, students are more vulnerable to course withdrawal, stop-out, or non-completion (Barnett, 2016). Academic momentum milestones include earning 30 credits by the end of the first year of college and persisting to the second year (Clovis & Chang, 2021; Davidson & Blankenship 2017; Schudde & Keisler, 2019). Importantly, studying the antecedents of near-term student success is important for improving student support systems (Jenkins & Bailey, 2017; Yanagiura, 2023).

Dual enrollment (DE) is a promising strategy for promoting academic momentum (Bailey & Karp, 2014; D'Amico et al., 2013; Hu & Chan, 2021; Karp et al., 2007; Kim et al., 2006; Moreno et al., 2021; Wang et al., 2015). It supports momentum by enabling students to earn college credits and build familiarity with college expectations, which in turn is associated with greater engagement in full-time coursework, reduced remediation, and stronger progress toward degree completion (Barnett, 2016; Henneberger et al., 2020; Bailey & Karp, 2014). Varying types of DE course also shape outcomes; for instance, experimental evidence shows that dual-credit advanced algebra increases middleachieving students' likelihood of enrolling in four-year institutions rather than two-year colleges (Hemelt et al., 2020). Given the dearth of empirical studies, more research is needed on how particular types of DE courses influence academic momentum milestones (Kim et al., 2006; Wang et al., 2015).

In this study, we explore the benefits of taking gateway courses in DE for academic momentum, an area not yet systematically studied. *Gateway courses* are entry-level, college-credit courses in the core curriculum or major sequence (Bloemer et al., 2017; Koch, 2017; Vandal, 2014), and are critical predictors of college retention; they generally have high failure and withdrawal rates (Bloemer et al., 2017; Bloemer et al., 2018; Koch & Pistilli, 2015). We focus on math and English gateway courses, which fulfill general education requirements across majors (Complete College America, 2017) and are increasingly available through DE. Although completing these courses is itself an academic momentum milestone (Calcagno at al., 2007; Jenkins & Bailey, 2017), we conceptualize them as antecedents to later milestones by examining their take-up during high school.

Importantly, our study examines DE gateway course-taking and academic momentum within local contexts where colleges seek to maximize the localized impact of DE investments. Prior work highlights key questions about benefits to colleges and pathway design (Hofmann & Voloch, 2012; Kinnick, 2012; Meade, 2012). Evidence suggests that alignment in course structures, expectations, and norms between high schools and partner colleges can ease transitions and reduce credit loss, especially with strong articulation agreements (Moore & Williams, 2022; Ryu et al., 2024; Steiger et al., 2024).

Students who enroll at the host institution or within the same system may benefit from smoother credit transfer (Steiger et al., 2024), campus familiarity, and faculty connections that support momentum (Johnson et al., 2021; Moore & Williams, 2022). However, barriers persist, including undermatching among students who later enroll at the same university (Jagesic et al., 2022).

Evidence remains limited on which DE courses most effectively increase academic momentum, particularly for historically disadvantaged students with lower rates of college completion. Our study provides evidence on the relationship between taking DE courses that fulfill general education college requirements and early postsecondary outcomes. Amid declining college enrollment for some groups and stagnant college completion rates, many locales are expanding DE to build college readiness and sustain local college enrollment. Taking a local lens to understanding how DE shapes academic momentum helps institutions better target DE course offerings to improve student success and institutional performance (Barnett, 2016; Hofmann & Voloch, 2012; Kinnick, 2012).

This study is based on the DE partnership between the City University of New York (CUNY) and the New York City Public Schools (NYCPS) through the College Now (CN) DE program from 2015 through 2018 after CUNY's streamlined its general core requirements and credit transfer policies. The program spans 18 CUNY colleges and 440 NYCPS high schools. This context is especially instructive: over 70% of CUNY first-time freshmen are NYCPS graduates, and more than 30% participated in DE—approximately 32% (15,952) as of 2018. While our sample comprises CUNY freshmen who previously participated in DE, which limits internal and external validity, our findings could be instructive to districts with DE programs where most of the high school graduates enroll in the local college system where they took DE—more than 50% of districts in some states (Velasco, 2024).

CN program is a systemwide DE initiative that is centrally coordinated but locally implemented (Meade, 2012), with colleges partnering with high schools based on context and proximity. However, as Meade (2012) noted in a CUNY DE report, this model requires each college to ensure DE offerings will benefit students when they enroll at any campus in the CUNY system. Since the 2012 CUNY DE report, the system has strengthened this approach by establishing a general education core that facilitates transfer of gateway courses across campuses (CUNY, 2023a; Hofmann & Voloch, 2012).

We estimate the relationship between taking DE English and math gateway courses and academic momentum using propensity score matching and marginal mean weighting through stratification. Outcomes are first-year credit accumulation, credit milestones, and second-year persistence, comparing students who took gateway versus non-gateway DE courses. We further examine differences by race/ethnicity and gender; the sample is not sufficiently powered to assess their intersection. Our study investigated the following research questions:

1. Compared to similar DE students who did not take a gateway course, what is the relationship between taking math and English gateway courses while dually enrolled and achieving three academic momentum milestones: first-

year credit accumulation, first-year 30-credit milestone, and persistence to the second year?

2. Does the relationship between taking DE math and English gateway courses and academic momentum vary by race/ethnicity or gender?

This study begins to answer questions about how specific types of DE courses relate to student success among those who matriculate to the same university system and how they vary by gender and race/ethnicity.

Literature Review

Gateway Courses

Academic momentum studies have examined the role of gateway course completion in the first two years of college in on-time degree completion and other academic outcomes. Moore and Shulock's (2009) review showed that taking and passing math and English gateway courses within the first two years of college is associated with an increased likelihood of earning a degree or transferring from a two-year to a four-year program. Flanders (2017) found that a positive association exists between taking and passing gateway courses and college persistence into the second year. Importantly, persistence rates were higher for students who completed gateway courses in their major when compared both to students who took another course in their major and students who did not take a course in their major. Swan et al. (2017), in a descriptive study of gateway courses at one university, suggested that the timing of gateway course-taking serves as a mediating variable in the relationship between gateway course-taking and persistence.

For example, college students taking a gateway course by the second year of enrollment were more likely to persist compared to those who took a gateway course in the third year or later.

Academic Momentum

Academic momentum involves both structural issues, in the sense of credit thresholds, institutional policies, the availability of gateway courses and advising systems that guide students into coherent programs of study, and behavioral issues, in students' choices about how actively and continuously they pursue their studies (Attewell et al., 2012; Barnett, 2016; Complete College America, 2013). Scholars often use different combinations of metrics such as full-time enrollment status, credit accumulation in the general education core, credit accumulation in the program of study, course completion ratios, and persistence across semesters. Common operationalization involves whether students attempt or accumulate 30 or more credits in their first year, persist into the second semester, and enroll in college-level math and English early (Belfield et al., 2016; Jenkins & Bailey, 2017). Credit accumulation, 30-credit milestone, and term-to-term persistence have become key indicators because they are relatively easy to measure and strongly predictive of longer-term outcomes (Attewell et al., 2012; Complete College America, 2013; Davidson & Blankenship, 2017).

One tension in the academic momentum literature lies in the extent to which academic momentum reflects student agency versus structural advantage in college policies. For instance, course pathways may not be structured to facilitate academic momentum (Karp, 2013) or students may choose to pursue their postsecondary education at a slower pace given competing demands on their time (Chan, 2022). Tensions such as these have prompted calls for more equity-focused momentum models that account for differences in how opportunity structures meet student needs (Karp, 2013).

Statewide and local campaigns around academic momentum often emphasize enrolling in 15 credits per semester (Attewell & Monaghan, 2016; Complete College America, 2017; 2022), with some states recommending this benchmark and others tying it to financial aid. Research on these initiatives has reported gains in persistence, GPA, and degree completion (Belfield et al., 2016; Davidson & Blankenship, 2017; CUNY, 2023b). Yet evidence of impact varies by context: students at selective residential four-year institutions showed GPA and credit gains, while students at nonresidential urban colleges did not (Chan, 2020). Community college students attempting 15 credits did not see higher completion rates (Burridge et al., 2024), and Indiana's campaign improved credit accumulation and grades for first-generation students but not degree attainment (Chan, 2022).

Study Context

At CUNY, gateway courses—English composition and quantitative reasoning–are required across the university system as part of the general education core (CUNY, 2023a). The DE program offers all the required math and English gateway courses. Gateway course availability varies by campus and year: 82%–84% of DE courses are non-gateway, while 7.5%–8% fulfill English gateway requirements and 5.4%–7% meet math requirements.

Three of 18 colleges consistently offered more than 20 English gateway courses, three offered none, and others offered two to six annually. For math, 16 colleges offered two to six courses per year, with one college accounting for 36%–40% of all offerings. During the study period, introductory humanities and social science courses were most popular in CN, likely reflecting student interest, ~~and~~ course availability, and ~~minimal prerequisites –~~ requiring only college-level ELA and/or Math readiness with no additional placement testing.

Methods

Data

We merged student-level administrative data from DE program records, district education records, and CUNY's databases. DE data included course enrollment, outcomes, and credits attempted and earned. District data provided enrollment and academic information, including state assessment scores. CUNY data included enrollment, demographics, credits attempted and earned, credits transferred (including those earned from DE).

Sample

The sample includes CUNY first-time freshmen who graduated from NYCPS within six months of enrolling in CUNY between fall 2015 and fall 2018 and participated in CN DE. To ensure comparability, we limited the sample to DE participants who were college-credit-eligible based on state (or SAT/ACT) scores. Of 22,937 such students, 70% (16,148) were eligible for math gateway courses and 96% (22,091) for English. Eligibility was determined by subject-specific scores, using students' highest pre-program results, so separate math and English treatment and control groups were constructed. Treatment groups included eligible students who took at least one gateway course; controls were eligible students who did not. Among eligible students, about 10% (2,511) took an English gateway course and 11% (1,312) took a math gateway course.

Measures

Gateway Courses

All degree-seeking students in the CUNY system must complete an English composition course and one mathematical or quantitative reasoning course to graduate (CUNY, 2023a). We identified gateway courses in DE enrollment records using course codes and created subject-specific indicators of gateway course-taking.

Academic Momentum

We measure academic momentum using three outcomes: 1) earning 30 credits by the end of the first year; 2) credit accumulation was captured as: a) total first-year credits including transferred and DE credits and b) total first-year credit accumulation excluding DE credits but including credits transfers; and 3) persistence to the second year (third semester; enrollment in the subsequent fall or spring after a student's initial matriculation term). We refer to the first two outcomes as *credit momentum* (Jenkins & Bailey, 2017). While non-DE transfer sources are not distinguished, DE credits are identified via the CN database. Consistent with prior work (Allen & Dadgar, 2012; Attewell et al., 2012), we use 15- and 30-credit benchmarks. Academic momentum reflects both behavior (attempted credits; Barnett, 2016) and outcome (earned credits; Attewell et al., 2012), but we focus on earned credits as a clearer indicator of progress, diverging from studies that rely solely on attempted credits. The persistence measure does not capture continuous enrollment but aligns with common approaches in higher education research (Complete College America, 2017; National Student Clearinghouse Research Center, 2019). It is systemwide, capturing enrollment at any CUNY undergraduate institution.

Pretreatment Covariates

Pretreatment covariates (Appendix 1) include age, gender, race/ethnicity (with interaction terms by gender), language and nativity, English learner and disability status, and socioeconomic disadvantage. Academic background measures include 10th-grade GPA (overall, English, and math) and DE course-taking indicators such as attempting gateway science courses or earning at least three DE credits. We also include high school DE enrollment size and fixed effects for DE college and students' baseline neighborhoods.

Handling Missing Data

We used multiple imputation (multivariate normal) for five continuous covariates. Tenth-grade GPA (overall, English, math) was 29% missing; others had <5 missing cases. Missingness was weakly related to treatment ($r=0.02–0.13$) and highly correlated across GPA measures, supporting missing-at-random assumptions. We imputed using demographics and DE predictors, generating 20 datasets and checking the comparability distributions. Three binary covariates (disability, multilingual learner, poverty) had 26% missing; the remaining 17 binaries had <1% missing. Binaries retained a "missing" category. Propensity scores were estimated in each imputed dataset and averaged per student.

Analytic Strategy

As there is no random assignment of students, we utilized propensity score methodology to identify treatment and control DE student groups with similar probability of taking a gateway course. This approach allows us to compare students who 1) are enrolled in DE college credit bearing courses and 2) have similar baseline characteristics, particularly characteristics related to college enrollment. Students typically learn about DE from teachers, counselors, program staff, or personal networks. Also, DE course offerings (including gateway courses) are based on the partner college and the availability of instructors to teach these courses. Because schools/counselors help to register students, access is likely nonrandom; academic, demographic, and school/program factors also likely influence who takes English and math gateway courses. Although we use a quasi-experimental design to mitigate selection bias, unobserved bias may remain, so estimates are interpreted as descriptive.

We estimated propensity scores using pretreatment covariates (Appendix 1). Because about one-third of schools had fewer than 10 students in DE, within-school treatment/control identification was not feasible for a substantial proportion of schools. Therefore, we estimated a single-level model. To proxy institutional capacity and program maturity, we grouped DE program enrollment into seven categories (<10 to >400) and included these school-level measures at the student level, recognizing that larger programs typically reflect stronger postsecondary partnerships and more developed DE infrastructure. The model also included student demographics, neighborhood as fixed effects, semester and DE-college indicators, and prior performance (10th-grade GPA; math/English grades)—102 variables in total.

To balance the sample of students on the likelihood of receiving treatment across pretreatment covariates, multivariate logistic regression analysis assigned all students probabilities of being treated irrespective of whether they were treated. Equation 1 (Hong & Raudenbush, 2005) reflects this assignment of propensity scores, showing the conditional probability, $\widehat{Q}_i$, of assigning student *i* to the treatment condition, $D_i = 1$, as independent of observed student-level pretreatment covariates, W_i.

$$\widehat{Q}_i = Pr(D_i = 1) \vee W_i \tag{1}$$

[Insert Table 1 here]

We used two propensity methods to identify balanced treatment and comparison groups: propensity score matching (PSM; Hong & Raudenbush, 2005) and marginal mean weighting through stratification of the propensity scores (MMWS; Hong, 2015). Both estimate the average treatment effect on treated (ATT), and MMWS further also allows estimation of the population average treatment effect (ATE; Hong, 2015). Consistent balance and estimates across methods strengthen confidence in the results. Differential effects by gender and race/ethnicity were examined using treatment subgroup interaction in the outcome models.

[Insert Figures 1 & 2 here]

English and math gateway models were analyzed separately. We used single nearest-neighbor PSM with a caliper of one-fifth of a standard deviation; controls outnumbered treatments cases about 9:1 (English) and about 12:1 (math). Matching with replacement generated control weights (mostly 1-2; about 10% at 3-9) and achieved an 83 percent bias reduction for both models (Table 1). Final samples included 1,670 treated and 1,174 controls (English), and 1,275 treated and 1,026 controls (math). Figures 1 and 2 show common support. Treatment effects were estimated via regression adjustment with DE-college indicators to account for remaining bias.

[Insert Figures 3 & 4 here]

In MMWS, we assume the pretreatment sample reflects population's treatment/non-treatment probabilities. In our data, these are 0.10 for gateway English (2,511/24,072) and 0.08 for gateway math (1,312/16,425). Using the same propensity scores and restricting to common support, we stratify on the logit of the score and apply stratum-specific weights to the treatment group under Equation 2 (Hong, 2012), where n_s is the number of observations in stratum, s; $Pr(Z=z)$ is the marginal treatment probability (e.g., 0.10 for English); and $n_{Z=z,s}$ is the number of treated observations, z, in stratum, s.

$$\frac{n_s \times Pr(Z=z)}{n_{Z=z,s}} \tag{2}$$

After weighting, we assessed balance by comparing logit-propensity score distributions (Figures 3–4), testing within-stratum mean differences, conducting a global F test across the 20 stratum-by-treatment means, and examining standardized bias across 102 covariates (Hong, 2012; 2015; Tables 2–3). MMWS produced 10 strata per model. For English, the global F statistic was 0.1050 ($p = 0.000$), strata were balanced, the overall difference was -0.1118 ($SE = 0.0065$) and not significant, and no covariates exceeded a 0.20 standardized bias threshold or showed significant differences. For math, the global F statistic was also 0.1050 ($p = 0.000$), strata were balanced, mean difference was -0.0720 ($SE = 0.0050$) and not significant, and only 3% of covariates showed standardized bias above 0.20 while 2% showed significant differences. Treatment and control groups did not differ significantly across strata in either model (Tables 4 and 5).

[**Insert Tables 2 and 3 here]**

The weighted mean difference between treatment and control groups estimates the average treatment effect. For simplicity, we report model-based estimates using the MMWS weighted sample only.

[**Insert Tables 4 and 5 here]**

Limitations

A key limitation is generalizability, as the sample is restricted to first-time freshmen in a single urban university system who previously participated in its DE program, making results most applicable to systems where strong secondary–postsecondary ties exist. However, given that two thirds of students attend colleges within 50 miles of their home (Hillman, 2023), this study has implications for DE course design in a broad range of settings.

At the same time, the design introduces potential selection bias, as the analytic sample conditions on both college enrollment and enrollment within CUNY. Although the propensity score approaches improve balance on observed pre-treatment characteristics related to college-going, they do not address selection into college enrollment or institutional choice based on unobserved factors. Descriptive enrollment patterns provide important context: among CN participants, college-going rates are high (84–90%), and while 30–34% enroll outside of CUNY, the majority (51–56%) matriculate within the system, and remain stable across years. Thus, while selection into the analytic sample is present, most CN participants are represented within it. To the extent that selection into CUNY reflects higher levels of college readiness or institutional attachment—factors also associated with persistence—any resulting bias would likely be upward. Alternative approaches would require a valid exclusion restriction variable that predicts CUNY enrollment but is unrelated to postsecondary outcomes. No such instrument is readily available in our data. Finally, the analytic approach is necessary for the research questions as administrative data enable detailed measurement of academic momentum (e.g., credit accumulation), which is not available in broader national datasets such as the National Student Clearinghouse.

A third limitation is model specification. While we balance school characteristics such as overall DE participation, future work should incorporate richer school-level measures which were not available (e.g., indicators of advisement practices) that may influence how students are guided into DE opportunities and therefore treatment assignment.

Findings

Credit Momentum and Persistence

PSM results show that freshmen who took at least one English or math gateway course in DE earned about one additional credit in the first year (1.14 and 1.32 respectively) compared to matched peers when all credits, including DE, were counted (Table 6). Excluding DE credits, English gateway students earned about 0.7 fewer credits. The math association was negative but not significant. English gateway participation increased the odds of earning 30 credits in the first year by 23%, but math gateway participation showed no association.

MMWS estimates were consistent. Including DE credits, gateway participation yielded roughly one additional credit; excluding DE credits, English gateway participation was negatively associated with credits earned (coef. = -0.777; SE = 0.325; t = -2.39), while math remained negative but nonsignificant. MMWS also indicated a 35% increase in the odds of reaching the 30-credit benchmark for English gateway students, with no effect for math. Neither model found an effect on persistence to the third semester.

Heterogeneity

Using MMWS, we found no significant gender differences in how DE gateway course-taking related to credit momentum (Tables 7–8). Women were generally more likely than men to reach the 30-credit benchmark and earned more credits overall—about 1.6 to 1.9

more depending on the model—but treatment by gender interactions were not significant.

For race/ethnicity, Black and Hispanic students were less likely than White students to meet the 30-credit benchmark, with reductions in log odds ranging from 31% to 60% across models. They also accumulated fewer credits: Black students earned 2.3–3.8 fewer and Hispanic students 1.8–2.3 fewer depending on the model. Treatment effects did not differ significantly by race/ethnicity, with one notable exception: Black students who took a math gateway course earned about 3 more credits than White students and those of other races who did not. Including treatment–race interactions removed the significance of overall treatment effects.

Sensitivity Analysis

As a robustness check, we re-estimated the models in a restricted sample limited to schools with at least 10 treated and 10 comparison students and including high school fixed effects. This restriction addresses the possibility that estimates could be influenced by schools with very small DE programs, where treatment-control comparisons may be less stable. Results from the analysis of the restricted sample were comparable to those from the full sample.

We further conducted sensitivity analyses using outcome models that included gender, treatment-by-gender interaction, race/ethnicity, and DE college. Following Rosenbaum (2002), we assessed omitted variable bias by examining the impact of excluding comparable measured covariates. Using the threshold method (Frank et al., 2013), which quantifies the robustness of inferences by estimating the proportion of cases that would need to be replaced with null-effect cases to overturn conclusions and the KonFound-It! application (Rosenberg et al., 2022), results indicated only moderate robustness to replacement. For first-year credit accumulation, invalidating the inference would require bias accounting for 4.82% of the English gateway effect (135 cases) and 1.37% of the math gateway effect (31 cases), based on thresholds of 1.213 and 1.184, respectively. For the English gateway 30-credit milestone, 834 treatment success cases (equivalent to transferring 75 cases to failure) would be needed to overturn the inference.

Discussion

Using quasi-experimental propensity score method, we created a balanced sample of CUNY first-time freshmen who participated in the DE gateway courses and comparable peers who did not. We estimated the association of taking English and math gateway courses with first-year credit accumulation and persistence to the second year, interpreting results as descriptive given the potential for unmeasured confounding. Conducted within a local school–university DE partnership~~, a common arrangement~~ where most freshmen are local public-school graduates (Hughes, 2010; Roggow, 2014; Taylor & Pretlow, 2015), the study finds that English gateway participation increases the likelihood of reaching 30 credits, and both English and math gateway courses are associated with higher total credits when DE and transfer credits are included. However, this advantage disappears when excluding DE credits, and gateway course-taking is not associated with second-year persistence.

The findings align with prior quasi-experimental studies showing gains in credit accumulation but not persistence (Burridge et al., 2024; Chan, 2022). Here, gateway course-taking in DE is associated with higher first-year credits only when DE credits are included, with modest effects—below the typical 3-credit value. This likely reflects a mix of course non-completion, limited credit transfer though unlikely given CUNY policies, or reduced first-year course-taking and/or completion. ~~One plausible hypothesis is~~ S~~s~~tudents may ~~intentionally~~ enroll in fewer credits to prioritize academic performance.~~— an approach that is not captured with credit accumulation alone.~~ The negative association when excluding DE credits suggests DE credits may offset early credit shortfalls rather than increase total non-DE accumulation, raising structural and behavioral considerations related to academic momentum. Structural elements such as student support strategies or credit transfer policies likely shape the conditions under which students ~~can~~ achieve academic momentum (Barnett, 2016; Karp, 2013). Behavioral aspects reflect student choices (e.g., course attempts) (Barnett, 2016; Belfield et al., 2016). That is, completing gateway courses in DE may not ~~itself produce momentum behaviors and changes future choices about credit attempts in the first year but~~ may primarily represent attainment of a ~~leading~~ momentum milestone during high school and require additional guidance for students on optimal course taking pathways in order to increase credits attempted in college (see Velasco et al., 2026). According to CCRC's dual enrollment equity pathways (DEEP) framework based on a case study of four states, DE is more likely to build sustained momentum when DE courses are connected to a coherent program of study and accompanied by academic and career exploration and planning (Fink et al., 2023). Future research should examine whether early gateway completion is more effective when it initiates a sequence of pathway-aligned coursework that structures students' subsequent academic choices versus an isolated collection of courses.

Although the impacts of DE gateway course-taking on credit accumulation and momentum credit milestones are modest, these findings extend previous research showing CN DE students earn more credits than peers without DE coursework (Allen & Dadgar, 2012). We add by focusing on gateway course-taking and examining how DE credit accumulation contributes to first-year momentum. Our results support the conclusion that gateway course-taking in DE can be a strategy for helping students to overcome first-year challenges in college. Indeed, allowing DE credits in the credit momentum measure operationalizes what Barnett (2016) and Adelman (2006) have posited as the momentum-building activities that ought to occur in high schools. Though beyond the scope of our study, Barnett (2016) and Adelman (2006) explicitly called for institutional commitment to enable students to earn six college credits by the end of high school as part of the first-year credit accumulation milestone. Furthermore, understanding how DE credits can contribute to credit accumulation is critical, as research has found that DE credits can sometimes go unused due to misalignment with majors or lack of articulation agreements (Richardson & Knight, 2024).

The association between math gateway course-taking in DE and reaching the 30-credit milestone for Black/Non-Hispanic students points to a concrete strategy for improving academic momentum in this subgroup. No similar effect was observed for other racial/ethnic or gender groups. Results also suggest greater overall credit accumulation for Black students who took DE math gateway courses, though they were only marginally significant. Once race/ethnicity interactions were included, however, the previously significant overall treatment effects were no longer detectable. This attenuation suggests that the benefits of taking gateway courses in DE may be contingent upon how experiences linked to student background intersect with course-taking pathways. Notably Black male students have historically been underrepresented in CN, underscoring the importance of targeted efforts to expand DE access.

We find no positive relationship between taking gateway courses in DE and persistence to the second year, consistent with institution-specific studies (Burridge et al., 2024; Chan, 2022) but contrasting with broader evidence of DE benefits for persistence (An, 2013). Several factors could be at play. Students could have transferred out of the university system after the first year. Data from CUNY aggregate reporting shows comparable first year transfer-out rates during the study period between CUNY first-time freshmen non-CN NYCPS and CN alumni (≈4%). Similarly, transfer-out rates for CUNY freshmen who took English or math gateway courses in CN ranged from 3% to 4%. While a 3-4% transfer-out can be substantial enough to explain the null findings, the comparably low rates across groups reveal that this outcome is more likely germane to first-time freshmen at CUNY. Still, null findings would resonate with questions facing institutions with DE partnerships regarding student success following DE gateway participation

(Kinnick, 2012; Meade, 2012). Considering the credit accumulation and credit milestones findings, it is also likely that even with gateway courses, students are still struggling upon enrollment in CUNY. Studying stop-out patterns could yield additional insight. For example, our definition of persistence does not consider whether students were enrolled continuously. Prior work shows that students who stop out might be less likely to persist than continuously enrolled peers (Mabel & Britton, 2018). Moreover, remaining at the DE institution—especially when it is a less-selective two-year college—can increase the risk of academic undermatch and lower bachelor's completion rates (Jagesic et al., 2022).

Findings should also be considered in the context of large-scale expansion of DE across the country. From 2013 to 2023, the number of students taking DE nearly doubled nationally, reaching 2.8 million in 2023–24 (Velasco et al., 2024), and 31 states have set state policy requiring that all high schools participate as of 2022 (Education Commission of the States, 2022). However, DE students complete college at only a modestly higher rate than non-DE (36% compared to 34% for students enrolling in four-year colleges; Velasco et al., 2024) thus the relatively weak association with credit accumulation raises concern about whether DE is paying off for college completion as much as expected (Barshay, 2024).

Implications for Practice and Future Research

Altogether, these findings underscore the need for closer scrutiny of structural and behavioral factors influencing academic momentum even after students have taken a key momentum step such as gateway course-taking in the same university system. Future qualitative could unpack the factors shaping students' decision to not take additional credits in their first year. ~~A understanding~~ Local school–university partnerships with DE programs could establish task forces to understand the unique experiences of students who took specific steps toward academic momentum earlier in high school~~,~~ but lost that momentum later in their first year. The absence of persistence effects suggests that DE alone is insufficient to sustain academic momentum for students who matriculate to the university where they took DE.

Conclusion

The study contributes to the literature on DE and academic momentum by exploring whether alumni from a large urban DE program have an advantage in academic momentum for those who enroll at the partnering university system if they took math and English gateway courses in high school. It contributes perspective for school-university DE partnerships seeking to maximize these partnerships for student and university success. Our findings suggest that taking gateway courses in DE programs offers some advantage for students when they enroll in the same university system, ~~but~~though not as much as expected. DE gateway courses could be offsetting other challenges to academic momentum such as taking too few credits in freshman year. Furthermore, the study adds a direct test of the relationship between DE gateway course-taking and longer-term outcomes to the DE literature, an important contribution given the expansion in DE programs and the dearth of literature on the types of DE courses that might matter most.

There are implications for both K-12 and university systems to consider structures like linked pathways and accompanying advisement that continues in college ~~that can better boost~~to inform student trajectories. Extending recent work on undermatching in DE-university partnership contexts (Jagesic et al., 2022), future research should ~~uncover~~explore the range of inhibitors to academic momentum within such institutional arrangements, including the role of transfer-out of the university system and stop-out.

Declaration of Interest Statement: The author declares that there are no competing interests that influenced the work reported in this paper.

References

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. U.S. Department of Education. https://www.ed.gov/sites/ed/files/rschstat/research/pubs/toolboxrevisit/toolbox.pdf

Allen, D., & Dadgar, M. (2012). Does DE increase students' success in college? Evidence from a quasi-experimental analysis of DE in New York City. *New Directions for Higher Education*, *2012*(158), 11–19. https://doi.org/10.1002/he.20010

An, B. P. (2013). The influence of DE on academic performance and college readiness: Differences by socioeconomic status. *Research in Higher Education*, *54*(4), 407–432. https://doi.org/10.1007/s11162-012-9278-z

Attewell, P., Heil, S., & Reisel, L. (2012). What is academic momentum? And does it matter? *Educational Evaluation and Policy Analysis*, *34*(1), 27–44. https://doi.org/10.3102/0162373711421958

Attewell, P. & Monaghan, D. (2016). How many credits should an undergraduate take? *Research in Higher Education*, *57*(6), 682–713. https://doi.org/10.1007/s11162-015-9401-z

Bailey, T. R., & Karp, M. M. (2014). Bridging the high school-college divide. *Handbook of research in education finance and policy*, 640–653.

Barnett, E. (2016, February). *Building student momentum from high school into college. Ready or not: It's time to rethink the 12th grade*. Jobs for the Future. https://files.eric.ed.gov/fulltext/ED564836.pdf

Barshay, J. (2024, October 28). Dual enrollment has exploded. But it's hard to tell if it's helping more kids get a college degree. *The Hechinger Report*. https://hechingerreport.org/proof-points-dual-enrollment-national-analysis/

Belfield, C., Jenkins, P. D., & Lahr, H. E. (2016). Momentum: The academic and economic value of a 15-credit first-semester course load for college students in Tennessee. Columbia University. https://academiccommons.columbia.edu/doi/10.7916/D84T6JJM

Bloemer, W., Day, S., & Swan, K. (2017). Gap analysis: An innovative look at gateway courses

and student retention. *Online Learning*, *21*(3), 5–14. https://doi.org/10.24059/olj.v21i3.1233

Bloemer, W., Swan, K., Day, S., & Bogle, L. (2018). Digging deeper into the data: The role of gateway courses in online student retention. *Online Learning*, *22*(4), 109–127. https://doi.org/10.24059/olj.v22i4.1515

Burridge, A. B., McKinney, L., Bourdeau, G. V., Lee, M. M., & Barnes, Y. M. (2024). The power of one more course: How different first semester credit loads affect community college student persistence. *The Journal of Higher Education, 95*(7), 879–916. https://doi.org/10.1080/00221546.2023.2251867

Calcagno, J. C., Crosta, P., Bailey, T., & Jenkins, D. (2007). Stepping stones to a degree: The impact of enrollment pathways and milestones on community college student outcomes. *Research in Higher Education, 48*(7), 775–801. https://doi.org/10.1007/s11162-007-9053-8

Chan, R. Y. (2020). *How does the 15 to finish initiative affect academic outcomes of low income, first-generation students? Evidence from a college promise program in Indiana* (Publication No. 2385698901) [Doctoral dissertation, Indiana University, Bloomington]. ProQuest Dissertations Publishing. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3319082

Chan, R. Y. (2022). Do credit momentum policies through the 15 to Finish improve academic progression and completion of low-income, first-generation students? Evidence from a college promise program. *Research in Higher Education, 63*(8), 1394–1426. https://doi.org/10.1007/s11162-022-09687-7

City University of New York. (2023a). *Required common core.* https://www.cuny.edu/about/administration/offices/undergraduate-studies/pathways/gened/

City University of New York. (2023b). *Academic momentum 2.0.* https://www.cuny.edu/academics/current-initiatives/academic-momentum/

Clovis, M., & Chang, M. (2021). Effects of academic momentum on degree attainment for students beginning college at 2-year institutions. *Journal of College Student*

Retention: Research, Theory & Practice, *23*(2), 322–336. https://doi.org/10.1177/1521025119826245

Complete College America. (2013). *The game changers*. Indianapolis. https://completecollegeamerica.s3.us-east-2.amazonaws.com/wp-content/uploads/2017/11/05151306/CCA-Nat-Report-Oct18-FINAL-singles.pdf

Complete College America. (2017). *Complete College America common college completion metrics technical guide*. https://completecollegeamerica.s3.us-east-2.amazonaws.com/wp-content/uploads/2017/08/05150031/2017MetricsTechnicalGuide.pdf

Complete College America. (2022). *Building on completion gains: Amplifying progress and closing persistent gaps*. https://completecollegeamerica.s3.us-east-2.amazonaws.com/wp-content/uploads/2022/11/05141621/CCA-BuildingOnCompletionGains.pdf

D'Amico, M. M., Morgan, G. B., Robertson, S., & Rivers, H. E. (2013). Dual enrollment variables and college student persistence. *Community College Journal of Research and Practice*, *37*(10), 769–779. https://doi.org/10.1080/10668921003723334

Davidson, J. C. & Blankenship, P. (2017). Initial academic momentum and student success: Comparing 4- and 2-year students. *Community College Journal of Research and Practice*, *41*(8), 467–480. https://doi.org/10.1080/10668926.2016.1202158

Fink, J., Griffin, S., Garcia Tulloch, A., Jenkins, D., Fay, M. P., Ramirez, C., Schudde, L., & Steiger, J. (2023). *DEEP insights: Redesigning dual enrollment as a purposeful pathway* *to college and career opportunity*. Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/publications/deep-insights-redesigning-dual-enrollment.html

Flanders, G. R. (2017). The effect of gateway course completion on freshman college student retention. *Journal of College Student Retention: Research, Theory & Practice*, *19*(1), 2–24. https://doi.org/10.1177/1521025115611396

Frank, K. A., Maroulis, S., Duong, M., & Kelcey, B. (2013). What would it take to change an inference? Using Rubin's causal model to interpret the robustness of causal inferences. *Education, Evaluation and Policy Analysis*, *35*(4), 437–460. https://doi.org/10.3102/0162373713493129

Hemelt, S. W., Schwartz, N. L., & Dynarski, S. M. (2020). Dual-credit courses and the road to college: Experimental evidence from Tennessee. *Journal of Policy Analysis and Management*, *39*(3), 686–719. https://doi.org/10.1002/pam.22180

Henneberger, A. K., Witzen, H., & Preston, A. M. (2020). A longitudinal study examining dual enrollment as a strategy for easing the transition to college and career for emerging adults. *Emerging Adulthood*, *10*(1), 225–236. https://doi.org/10.1177/2167696820922052

Hillman, N. (2023). *How far do students travel for college?* (Geography of Opportunity Brief No. 2). The Institute for College Access & Success.

https://ticas.org/wp-content/uploads/2023/11/HIllman-Geography-of-Opportunity-Brief-2_2023.pdf

Hofmann, E., & Voloch, D. (2012). Dual enrollment as a liminal space. *New Directions for Higher Education*, *2012*(158), 101–107. https://doi.org/10.1002/he.20019

Hong, G. (2012). Marginal mean weighting through stratification: A generalized method for

evaluating multi-valued and multiple treatments with non-experimental data. *Psychological Methods*, *17*(1), 44–60. https://doi.org/10.1037/a0024918

Hong, G. (2015). *Causality in a social world: Moderation, mediation and spill-over*. Wiley.

Hong, G., & Raudenbush, S. W. (2005). Effects of kindergarten retention policy on children's

cognitive growth in reading and mathematics. *Educational Evaluation and Policy Analysis*, *27*(3), 205–224. https://doi.org/10.3102/01623737027003205

Hu, X., & Chan, H.-Y. (2021). Does delivery location matter? A national study of the impact of dual enrollment on college readiness and early academic momentum. *Teachers College Record*, *123*(4), 1–32. https://doi.org/10.1177/016146812112300401

Hughes, K. L. (2010). Dual enrollment: Postsecondary/secondary partnerships to prepare students. *Journal of College Science Teaching*, *39*(6), 12. https://ccrc.tc.columbia.edu/wp-content/uploads/2010/07/dual-enrollment-postsecondary-secondary-partnerships.pdf

Jagesic, S., Ewing, M., Wyatt, J. N., & Feng, J. (2022). Unintended consequences:

Understanding the relationship between dual enrollment participation, college undermatch, and bachelor's degree attainment. *Research in Higher Education, 63*(1), 119–139. https://doi.org/10.1007/s11162-021-09643-x

Jenkins, D., & Bailey, T. (2017). *Early momentum metrics: Why they matter for college improvement* (CCRC Research Brief No. 65). Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/publications/early-momentum-metrics.html

Johnson, J. M., Paris, J. H., Curci, J. D., & Horchos, S. (2021). Beyond college access: An exploration of the short-term impact of a dual enrollment program. *Journal of College Student Retention: Research, Theory & Practice*, *26*(1), 41–63. https://doi.org/10.1177/15210251211056319

Karp, M. M. (2013). *Entering a program: Helping students make academic and career decisions* (CCRC Working Paper No. 59). Community College Research Center. https://ccrc.tc.columbia.edu/publications/entering-a-program-helping-students.html

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007, October). *The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states*. Community College Research Center, Columbia University. https://files.eric.ed.gov/fulltext/ED498661.pdf

Kim J., Kirby C., Bragg D. D. (2006, May). *Dual credit: Then and now*. Office of Community College Research and Leadership, University of Illinois. https://files.eric.ed.gov/fulltext/ED495242.pdf

Kinnick, K. N. (2012), The impact of dual enrollment on the institution. *New Directions for Higher Education*, *2012*(158), 39–47. https://digitalcommons.kennesaw.edu/cgi/viewcontent.cgi?article=3235&context=facpubs

Koch, D. & Pistilli, M. (2015). Analytics and gateway courses: Understanding and overcoming roadblocks to college completion. https://www.insidehighered.com/sites/default/files/files/Analytics%20and%20Gateway%20Courses%20PPt.pdf

Koch, A. K. (2017). It's about the gateway courses: Defining and contextualizing the issue. *New Directions for Higher Education*, *2017*(180), 11–17. https://doi.org/10.1002/he.20257

Mabel, Z., & Britton, T. A. (2018). Leaving late: Understanding the extent and predictors of college late departure. *Social Science Research, 69*, 34–51. https://psycnet.apa.org/doi/10.1016/j.ssresearch.2017.10.001

March, D., Fink, J., & Velasco, T. (2024). State findings: Dual enrollment student outcomes [Data dashboard]. Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/dashboard/dual-enrollment.html

Meade, T. (2012). Dual enrollment lessons and the development of the New Community College at CUNY. *New Directions for Higher Education*, *2012*(158): 91–100. https://doi.org/10.1002/he.20018

Moore, C., & Shulock, N. (2009). *Student progress toward degree completion: Lessons from the research literature.* California State University, Sacramento, Institute for Higher Education Leadership & Policy. https://www.csuchico.edu/gradinitiative/_assets/documents/ihelp-student-progress-toward-degree-completion.pdf

Moore, K. P., & Williams, M. R. (2022, Spring). Factors encouraging student enrollment following dual enrollment participation. *The Community College Enterprise*, 9–13. https://home.schoolcraft.edu/cce/28.1.9-27.pdf

Moreno, M., McKinney, L., Rangel, V. S., Burridge, A., & Carales, V. D. (2021). Access for whom? The impact of academic momentum on postsecondary matriculation among early college high school students. *Community College Journal of Research and Practice*, *45*(4), 307–326. https://doi.org/10.1080/10668926.2019.1688734

National Center for Education Statistics. (2024). Immediate College Enrollment Rate. *Condition of Education*. U.S. Department of Education, Institute of Education Sciences. https://nces.ed.gov/programs/coe/indicator/cpa.

National Student Clearinghouse Research Center. (2019). *Persistence & retention – 2019.* https://nscresearchcenter.org/snapshotreport35-first-year-persistence-and-retention/

NYC Mayor's Office for Economic Opportunity (n.d.). Education Equity Outcomes. Retrieved from https://dev.equity.nyc.gov/domains/education/college-enrollees

Richardson, A. J., & Knight, D. B. (2024). Earned credit could be lost credit. *AERA Open, 10*. https://doi.org/10.1177/23328584241289377

Roggow, M. J. (2014). Improving student performance outcomes and graduation rates through institutional partnerships. *New Directions for Community Colleges, 2014*(165), 25–36. https://doi.org/10.1002/cc.20088

Rosenbaum, P. R. (2002). *Observational studies* (2nd ed.). Springer. https://doi.org/10.1007/978-1-4757-3692-2

Rosenberg, J. M., Xu, R., Lin, Q., & Frank, K. A. (2022). *Konfound-It!: Quantify the robustness of causal inferences*. http://konfound-it.com.

Ryu, W., Schudde, L., & Pack-Cosme, K. (2024). Dually noted: Examining the implications of dual enrollment course structure for students' course and college enrollment outcomes. *American Educational Research Journal*, *61*(4), 803–841. https://doi.org/10.3102/00028312241257453

Schudde, L., & Keisler, K. (2019). The relationship between accelerated dev-ed coursework and

early college milestones: Examining college momentum in a reformed mathematics pathway. *AERA Open, 5*(1). https://doi.org/10.1177/2332858419829435

Steiger, J., Fink, J., & Perry, A. (2024). *How states and systems can support practitioner efforts to strengthen dual enrollment*. Community College Research Center, Teachers

College, Columbia University; College in High School Alliance. https://ccrc.tc.columbia.edu/publications/states-systems-practitioner-efforts-dual-enrollment.html

Swan, K., Bloemer, W., & Day, S. (2017). Gap analysis: An innovative look at gateway courses and student retention. *Online Learning*, *21*(3), 5–14. https://doi.org/10.24059/olj.v21i3.1233

Taylor, J. L., & Pretlow, J. (2015). *Dual enrollment policies, pathways, and perspectives*. John Wiley & Sons.

Velasco, T., Sparks, D., Schudde, L., Levin, E., Lin, Y., Ryu, W., & Fink, J. (2026). *Dual enrollment momentum metrics: Leading indicators for program improvement*. Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/publications/dual-enrollment-momentum-metrics.html

Velasco, T., Fink, J., Bedoya, M., & Jenkins, D. (2024). The postsecondary outcomes of high school dual enrollment students: A national and state-by-state analysis (Revised August 2025). Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/publications/postsecondary-outcomes-dual-enrollment-students.html

Vandal, B. (2014). *Promoting gateway course success: Scaling corequisite academic support.* Complete College America. https://files.eric.ed.gov/fulltext/ED558791.pdf

Wang, X., Chan, H. Y., Phelps, L. A., & Washbon, J. I. (2015). Fuel for success: Academic momentum as a mediator between dual enrollment and educational outcomes of two-year technical college students. *Community College Review*, *43*(2), 165–190. https://doi.org/10.1177/0091552115569846

Yanagiura, T. (2023). How accurately can short-term outcomes approximate long-term outcomes? Examining the predictive power of early momentum metrics for community college credential completion using machine learning. *Community College Review, 51*(3), 367–395. https://doi.org/10.1177/00915521231163895

Appendix 1

Descriptive Statistics of Variables in the Propensity Score Model

Variable	Mean	Std. dev.
Age (2016)	17.26	1.31
Female	0.62	0.49
Amer. Ind. or Native Alaskan	0.01	0.09
Asian/Pacific Islander	0.28	0.45
Black/Non-Hispanic	0.18	0.38
Hispanic	0.36	0.48
Other Race	0.00	0.05
Unknown Race	0.00	0.07
White	0.18	0.38
High School DE Enrollment		
<10	0.02	0.13
>=10 & <50	0.17	0.38
>=50 & <100	0.13	0.33
>=100 & <200	0.08	0.27
>=200 & <300	0.03	0.17
>=300 & <400	0.10	0.30
>400	0.47	0.50
English Home Language	0.42	0.49
Born in US	0.32	0.47
English Language Learner	0.01	0.11
Student with Disability	0.05	0.22
Poverty	0.75	0.43
Female*Amer. Ind. or Native Alaskan	0.01	0.07
Female*Asian/Pacific Islander	0.16	0.37
Female*Black/Non-Hispanic	0.12	0.32
Female*Hispanic	0.23	0.42
Female*Other Race	0.00	0.04
Female*Unknown Race	0.00	0.05
Female*White	0.10	0.30
English GPA in Grade 10	85.91	8.15
Total GPA in Grade 10	85.19	7.04
Math GPA in Grade 10	82.28	9.56
Took At least 3 College Credits in DE	0.81	0.39

Took Gateway Science	0.03	0.17
First Semester Took a College Credit Course 1	0.00	0.05
First Semester Took a College Credit Course 2	0.07	0.25
First Semester Took a College Credit Course 3	0.09	0.29
First Semester Took a College Credit Course 4	0.01	0.10
First Semester Took a College Credit Course 5	0.12	0.32
First Semester Took a College Credit Course 6	0.11	0.31
First Semester Took a College Credit Course 7	0.01	0.10
First Semester Took a College Credit Course 8	0.12	0.33
First Semester Took a College Credit Course 9	0.12	0.33
First Semester Took a College Credit Course 10	0.01	0.10
First Semester Took a College Credit Course 11	0.12	0.33
First Semester Took a College Credit Course 12	0.12	0.32
First Semester Took a College Credit Course 13	0.01	0.08
First Semester Took a College Credit Course 14	0.06	0.25
First Semester Took a College Credit Course 15	0.03	0.16
College 1	0.03	0.16
College 2	0.02	0.16
College 3	0.03	0.16
College 4	0.03	0.18
College 5	0.01	0.12
College 6	0.03	0.18
College 7	0.00	0.01
College 8	0.03	0.17
College 9	0.02	0.14
College 10	0.03	0.16
College 11	0.26	0.44
College 12	0.21	0.41
College 13	0.05	0.22
College 14	0.01	0.12
College 15	0.03	0.18
College 16	0.10	0.31
College 17	0.03	0.16
College 18	0.00	0.07
College 19	0.06	0.24
Neighborhood 1	0.01	0.09
Neighborhood 2	0.02	0.15
Neighborhood 3	0.04	0.19
Neighborhood 4	0.05	0.22
Neighborhood 5	0.03	0.16

Neighborhood 6	0.01	0.09
Neighborhood 7	0.00	0.05
Neighborhood 8	0.05	0.22
Neighborhood 9	0.02	0.15
Neighborhood 10	0.01	0.09
Neighborhood 11	0.03	0.18
Neighborhood 12	0.01	0.08
Neighborhood 13	0.02	0.16
Neighborhood 14	0.04	0.19
Neighborhood 15	0.03	0.17
Neighborhood 16	0.01	0.12
Neighborhood 17	0.00	0.03
Neighborhood 18	0.00	0.06
Neighborhood 19	0.00	0.04
Neighborhood 20	0.02	0.15
Neighborhood 21	0.01	0.11
Neighborhood 22	0.05	0.22
Neighborhood 23	0.00	0.06
Neighborhood 24	0.03	0.18
Neighborhood 25	0.00	0.04
Neighborhood 26	0.00	0.01
Neighborhood 27	0.00	0.02
Neighborhood 28	0.02	0.12
Neighborhood 29	0.00	0.01
Neighborhood 30	0.03	0.16
Neighborhood 31	0.02	0.14
Neighborhood 32	0.04	0.19
Neighborhood 33	0.01	0.10
Neighborhood 34	0.04	0.20
Neighborhood 35	0.03	0.18
Neighborhood 36	0.07	0.25
Neighborhood 37	0.03	0.16
Neighborhood 38	0.03	0.16
Neighborhood 39	0.01	0.09
Neighborhood 40	0.00	0.04
Neighborhood 41	0.00	0.05
Neighborhood 42	0.02	0.12
Neighborhood 43	0.12	0.32
Neighborhood 44	0.00	0.01
Neighborhood 45	0.02	0.13
Neighborhood 46	0.02	0.14

Note. Values represent sample means and standard deviations. Binary variables are coded 1 = yes and 0 = no, so means can be interpreted as proportions. GPA variables are measured on a 0–100 scale based on high school transcript records. High school DE enrollment categories represent the number of students participating in dual enrollment at each student's high school. College and neighborhood indicators represent fixed-effect categories included in the models.

Table 1

Propensity Score Match Results

Sample	Ps R2	LR chi2	p	Mean Bias	Median Bias	B	R	%Var
Math Gateway								
Unmatched	0.216	1843.38	0.000	13.3	9.3	135.5*	0.35*	70
Matched	0.018	60.79	0.999	2.2	1.8	31.4*	0.92	26
English Gateway								
Unmatched	0.309	3101.73	0.000	13.9	9.0	159.4*	0.16*	65
Matched	0.014	65.69	0.994	2.3	2.1	28.1*	0.93	35

* if B>25%, R outside [0.5; 2]

Table 2

MMWS Analysis: Within-Stratum Mean Difference Between Treatment Groups in Logit Propensity Score—Math

	Control			Treated						
Stratum	n	Mean	Std. Deviation	n	Mean	Std. Deviation	Mean Difference	SE	*t*	*p*
1	114	-3.6991	0.6665	112	-3.6785	0.6067	-0.0206	0.0848	-0.2428	0.8084
2	107	-2.7080	0.1581	119	-2.7138	0.1615	0.0058	0.0213	0.2707	0.7869
3	109	-2.3094	0.1131	117	-2.3006	0.1144	-0.0088	0.0151	-0.5805	0.5622
4	106	-1.9825	0.0876	119	-1.9806	0.0896	-0.0019	0.0118	-0.1601	0.8729
5	110	-1.6892	0.0768	116	-1.6906	0.0767	0.0014	0.0102	0.1338	0.8937
6	101	-1.4318	0.0734	125	-1.4294	0.0735	-0.0023	0.0098	-0.2388	0.8115
7	102	-1.1531	0.0885	123	-1.1443	0.0910	-0.0088	0.0120	-0.7300	0.4662
8	100	-0.8696	0.0741	126	-0.8680	0.0712	-0.0016	0.0097	-0.1661	0.8682
9	101	-0.5460	0.1147	125	-0.5502	0.1124	0.0042	0.0152	0.2768	0.7822
10	72	-0.0534	0.2309	153	-0.0225	0.2292	-0.0309	0.0328	-0.9403	0.3481
Total	1,022	-1.7293	1.0434	1,235	-1.5684	1.0575				

Table 3

MMWS Analysis: Within-Stratum Mean Difference Between Treatment Groups in Logit Propensity Score—English

	Control			Treated						
Stratum	n	Mean	Std. Deviation	n	Mean	Std. Deviation	Mean Difference	SE	*t*	*p*
1	137	-3.1857	1.0932	145	-3.1148	0.9628	-0.0708	0.1225	-0.5783	0.5635
2	132	-1.9710	0.1880	149	-1.9627	0.1875	-0.0083	0.0224	-0.3709	0.7110
3	131	-1.4446	0.1280	150	-1.4384	0.1266	-0.0063	0.0152	-0.4119	0.6807
4	121	-1.0749	0.0805	160	-1.0742	0.0797	-0.0007	0.0096	-0.0704	0.9439
5	125	-0.8369	0.0577	156	-0.8329	0.0574	-0.0041	0.0069	-0.5866	0.5580
6	120	-0.6613	0.0464	162	-0.6601	0.0468	-0.0012	0.0056	-0.2155	0.8295
7	113	-0.4737	0.0553	168	-0.4722	0.0559	-0.0015	0.0068	-0.2166	0.8286
8	100	-0.2476	0.0814	181	-0.2423	0.0805	-0.0053	0.0101	-0.5286	0.5975
9	87	0.0683	0.0960	194	0.0792	0.1090	-0.0109	0.0136	-0.8060	0.4209
10	79	0.5655	0.2586	202	0.5794	0.2840	-0.0139	0.0368	-0.3772	0.7063
Total	1,145	-1.0721	1.0964	1,667	-0.81544	1.0470				

Table 4

MMWS Analysis: Frequencies and Weights for Binary Treatment by Stratum (Math Gateway Model)

	Control		Treated	
Stratum	n	Weight	n	Weight
1	114	0.8977	112	1.1041
2	107	0.9564	119	1.0392
3	109	0.9389	117	1.0570
4	106	0.9612	119	1.0346
5	110	0.9303	116	1.0661
6	101	1.0132	125	0.9893
7	102	0.9989	123	1.0010
8	100	1.0234	126	0.9815
9	101	1.0132	125	0.9893
10	72	1.4150	153	0.8047
Total	1,022		1,235	

Table 5

MMWS Analysis: Frequencies and Weights for Binary Treatment by Stratum (English Gateway Model)

	Control		Treated	
Stratum	n	Weight	n	Weight
1	137	0.8381	145	1.1529
2	132	0.8668	149	1.1180
3	131	0.8734	150	1.1105
4	121	0.9456	160	1.0411
5	125	0.9153	156	1.0678
6	120	0.9569	162	1.0319
7	113	1.0126	168	0.9916
8	100	1.1442	181	0.9203
9	87	1.3152	194	0.8587
10	79	1.4483	202	0.8247
Total	1,145		1,667	

Table 6

Average Treatment Effects of Taking Math and English Gateway Course on Early Academic Momentum

	Math Gateway Coefficients		**English Gateway Coefficients**	
	PSM	**MMWS**	**PSM**	**MMWS**
30-Credit Milestone	0.253	0.230	0.269 *	0.302 *
First Year Credits Accumulated With DE	1.323 **	1.201 *	1.136 *	1.275 *
First Year Credits Accumulated Without DE	-0.523	-0.579	-0.701 *	-0.777 *
Persistence to Third Semester	-0.038	-0.045	-0.083	-0.008

+p~0.05; *p<0.05; **p<0.01; ***p<0.001

Table 7

Outcomes Models of the Effects of Taking Math Gateway Course in High School with College, Gender, and Race/Ethnicity Controls (n = 2,256)

	30-Credit Milestone					First Year Credits Accumulated w/DE Credits					First Year Credits Accumulated w/o DE Credits					Persistence to Third Semester				
	Coef.	SE		[95% conf. interval]		Coef.	SE		[95% conf. interval]		Coef.	SE		[95% conf. interval]		Coef.	SE		[95% conf. interval]	
Treated	0.274	0.259		-0.234	0.781	0.873	1.078		-1.242	2.988	-0.907	1.048		-2.963	1.149	-0.196	0.239		-0.664	0.272
College																				
2	0.831	0.693		-0.528	2.189	1.042	1.397		-1.698	3.782	3.186	1.406	*	0.428	5.944	-0.485	0.427		-1.323	0.352
3	-1.333	0.465	**	-2.245	-0.421	-4.172	1.476	**	-7.067	-1.277	-2.410	1.438		-5.230	0.411	-0.685	0.419		-1.506	0.136
4	-0.919	0.424	*	-1.749	-0.089	-3.229	1.237	**	-5.655	-0.803	-1.097	1.205		-3.461	1.267	-1.298	0.410	**	-2.101	-0.494
6	0.191	0.403		-0.599	0.982	1.526	1.152		-0.734	3.785	-0.454	1.099		-2.609	1.700	-0.665	0.312	*	-1.276	-0.054
8	-0.326	0.487		-1.281	0.629	-2.016	1.203		-4.375	0.343	-2.861	1.225	*	-5.263	-0.458	0.061	0.416		-0.753	0.876
9	-0.228	0.458		-1.125	0.669	-0.938	1.669		-4.212	2.335	1.605	1.518		-1.373	4.582	0.196	0.380		-0.548	0.940
10	-2.037	0.728	**	-3.463	-0.611	-8.037	2.875	**	-13.675	-2.399	-5.484	2.905		-11.180	0.213	-1.549	0.713	*	-2.947	-0.152
11	-0.547	0.333		-1.200	0.105	-1.760	0.966		-3.655	0.135	-0.052	0.904		-1.824	1.721	-0.414	0.272		-0.947	0.119
12	-0.843	0.313	**	-1.457	-0.229	-2.928	0.858	**	-4.611	-1.245	-1.929	0.805	*	-3.508	-0.350	-0.495	0.252	*	-0.989	-0.001
13	-0.188	0.413		-0.997	0.621	-0.201	1.207		-2.567	2.166	0.606	1.113		-1.576	2.789	0.059	0.342		-0.611	0.729
14	-0.424	0.764		-1.922	1.074	-2.640	2.188		-6.931	1.651	-0.878	3.159		-7.074	5.317	-2.245	1.134	*	-4.467	-0.023
15	-0.671	0.553		-1.755	0.412	-2.163	2.393		-6.856	2.530	-0.504	2.179		-4.777	3.768	-0.780	0.524		-1.808	0.247
16	-	0.33	**	-	-0.275	-2.498	0.977	*	-4.414	-0.581	-1.452	0.904		-3.225	0.322	-0.211	0.270		-0.739	0.318

	0.921	0		1.567																
17	0.989	0.596		-0.179	2.158	2.045	1.247		-0.401	4.491	3.233	1.200	*	0.880	5.586	-0.090	0.377		-0.828	0.648
18	-1.283	2.252		-5.697	3.130	-8.770	9.643		-27.679	10.139	-6.743	10.278		-26.898	13.411	--	--		--	--
19	-0.868	0.329	**	-1.512	-0.223	-2.829	0.934	**	-4.660	-0.997	-2.365	0.864	**	-4.060	-0.671	-0.183	0.270		-0.711	0.346
Female	0.580	0.141	***	0.304	0.855	1.914	0.555	**	0.826	3.003	1.928	0.543	***	0.864	2.992	-0.044	0.133		-0.304	0.216
Treated*Female	-0.123	0.190		-0.495	0.248	-0.106	0.754		-1.584	1.372	-0.815	0.724		-2.235	0.606	0.060	0.176		-0.285	0.405
Race/Ethnicity																				
Amer. Ind./Native Alaskan	-0.644	0.595		-1.810	0.521	-3.464	1.996		-7.378	0.450	-3.457	2.129		-7.631	0.717	-0.534	0.587		-1.684	0.617
Asian/Pacific Islander	0.225	0.209		-0.185	0.635	-0.408	0.804		-1.984	1.169	0.086	0.792		-1.467	1.639	-0.110	0.193		-0.488	0.269
Black/Non-Hispanic	-0.796	0.284	***	-1.354	-0.239	-3.891	1.121	**	-6.089	-1.693	-3.176	1.124	**	-5.379	-0.972	-0.735	0.276	**	-1.276	-0.193
Hispanic	-0.401	0.226	***	-0.844	0.041	-1.782	0.935		-3.616	0.052	-1.276	0.928		-3.096	0.544	-0.449	0.215	*	-0.871	-0.027
Other	-0.359	1.247		-2.804	2.086	0.037	2.523		-4.911	4.985	-2.823	2.596		-7.914	2.269	-0.713	1.301		-3.263	1.836
Unknown	0.371	0.751		-1.102	1.844	0.269	1.984		-3.621	4.159	1.349	2.005		-2.583	5.280	1.996	1.037	+	-0.037	4.028
Treated*Race/Ethnicity																				
Amer. Ind./Native Alaskan	1.202	0.913		-0.588	2.993	3.411	3.373		-3.202	10.025	3.497	3.233		-2.843	9.836	0.208	0.815		-1.390	1.805
Asian/Pacific Islander	-0.199	0.282		-0.753	0.354	-0.053	1.095		-2.201	2.095	0.454	1.059		-1.622	2.529	0.019	0.255		-0.480	0.519
Black/Non-Hispanic	0.360	0.382		-0.389	1.109	2.985	1.542	+	-0.038	6.008	3.213	1.528	*	0.216	6.209	0.564	0.362		-0.144	1.273
Hispanic	0.034	0.302		-0.559	0.627	0.019	1.224		-2.382	2.420	0.797	1.193		-1.543	3.137	0.423	0.280		-0.126	0.972
Other	--	--		--	--	0.253	4.089		-7.765	8.271	1.625	3.088		-4.431	7.680	--	--		--	--
Unknown	-0.858	1.043		-2.902	1.187	3.848	4.404		-4.788	12.483	1.845	4.611		-7.197	10.886	-1.868	1.286		-4.388	0.653
Constant	1.076	0.363	**	0.365	1.788	34.133	1.123	***	31.932	36.335	27.421	1.079	***	25.306	29.537	0.679	0.303	*	0.086	1.272

Note. Analysis is based on the balanced sample of CUNY first-time freshmen who previously participated in the CN DE program and were college-credit-eligible prior to participation. Analysis based on the sample after propensity score weighting.

+p~0.05; *p<0.05; **p<0.01; ***p<0.001

Table 8

Outcomes Models of the Effects of Taking English Gateway Course in High School with College, Gender, and Race/Ethnicity Controls (n = 2,800)

	30-Credit Milestone					**First Year Credits Accumulated w/DE Credits**					**First Year Credits Accumulated w/o DE Credits**					**Persistence to Third Semester**			
	Coef.	SE		[95% conf. interval]		Coef.	SE		[95% conf. interval]		Coef.	SE		[95% conf. interval]		Coef.	SE	[95% conf. interval]	
Treated	0.136	0.270		-0.393	0.665	1.187	1.115		-1.000	3.374	-0.578	1.078		-2.692	1.537	-0.326	0.253	-0.822	0.171
College																			
2	1.221	0.881		-0.505	2.947	5.518	3.329		-1.010	12.047	7.624	3.241	**	1.270	13.978	0.250	0.655	-1.035	1.534
3	-0.269	0.475		-1.200	0.662	-0.502	1.640		-3.719	2.714	1.567	1.582		-1.535	4.669	-0.288	0.465	-1.199	0.624
4	-0.018	0.586		-1.165	1.130	0.101	1.911		-3.645	3.847	1.357	1.815		-2.202	4.916	-0.978	0.691	-2.333	0.377
5	-0.294	0.421		-1.118	0.531	-1.271	1.329		-3.876	1.335	3.539	1.326		0.940	6.139	0.565	0.410	-0.239	1.368
6	0.369	0.469		-0.552	1.289	3.886	1.676	*	0.599	7.173	2.649	1.607		-0.503	5.800	0.385	0.446	-0.489	1.260
8	-0.135	0.451		-1.019	0.749	-0.439	1.395		-3.174	2.296	2.061	1.369		-0.624	4.745	-0.143	0.438	-1.000	0.715
9	0.079	0.503		-0.908	1.065	0.625	1.997		-3.292	4.541	4.369	2.047	*	0.356	8.382	0.627	0.481	-0.316	1.570
10	-0.090	0.474		-1.019	0.838	-1.531	1.881		-5.220	2.158	0.385	1.830		-3.204	3.973	0.175	0.464	-0.734	1.083
11	-0.998	0.747		-2.462	0.466	-3.282	2.324		-7.840	1.275	-0.562	2.419		-5.306	4.182	--	--	--	--
12	-0.234	0.387		-0.992	0.524	-1.231	1.227		-3.637	1.174	1.237	1.223		-1.162	3.635	-0.042	0.375	-0.776	0.692
13	-0.038	0.397		-0.817	0.741	-0.770	1.290		-3.299	1.759	2.297	1.274		-0.200	4.795	-0.012	0.384	-0.764	0.741
14	-0.477	0.469		-1.397	0.442	-1.729	1.738		-5.136	1.678	2.172	1.768		-1.296	5.639	-0.730	0.479	-1.670	0.209
15	-0.164	0.419		-0.986	0.658	-0.851	1.309		-3.419	1.716	2.612	1.303		0.056	5.167	-0.038	0.406	-0.834	0.758
16	-	0.390		-	0.528	-	1.260		-2.931	2.010	2.200	1.253		-0.257	4.657	0.225	0.378	-	0.966

	0.237			1.002		0.461													0.517	
17	0.711	0.459		-0.188	1.610	2.611	1.396		-0.126	5.348	6.231	1.379	***	3.527	8.936	0.246	0.418		-0.573	1.066
Female	0.406	0.132	**	0.147	0.665	1.649	0.582	**	0.507	2.791	1.377	0.563	**	0.272	2.481	0.060	0.131		-0.196	0.317
Treated*Female	-0.131	0.172		-0.469	0.206	-0.519	0.732		-1.955	0.916	-0.664	0.709		-2.053	0.726	-0.009	0.168		-0.339	0.321
Race/Ethnicity																				
Amer. Ind./Native Alaskan	-0.368	0.561		-1.467	0.731	-2.483	2.438		-7.264	2.299	-2.538	2.342		-7.131	2.054	-0.414	0.528		-1.449	0.622
Asian/Pacific Islander	-0.201	0.220		-0.632	0.230	-0.352	0.921		-2.157	1.453	-0.089	0.884		-1.822	1.644	0.061	0.205		-0.342	0.463
Black/Non-Hispanic	-0.905	0.268	***	-1.429	-0.380	-3.016	1.149	**	-5.269	-0.763	-2.418	1.102	*	-4.579	-0.257	-0.327	0.260		-0.838	-0.183
Hispanic	-0.641	0.212	**	-1.056	-0.226	-2.317	0.863	**	-4.009	-0.624	-1.804	0.825	*	-3.422	-0.187	-0.302	0.200		-0.693	-0.090
Other	--	--		--	--	5.134	1.585		2.027	8.242	7.247	1.310	***	4.679	9.816	0.238	1.395		-2.496	2.971
Unknown	-1.044	0.985		-2.975	0.887	1.113	3.749		-6.237	8.464	-0.843	2.987		-6.700	5.014	0.347	1.016		-1.644	2.339
Treated*Race/Ethnicity																				
Amer. Ind./Native Alaskan	0.584	0.699		-0.787	1.955	3.575	2.811		-1.937	9.087	2.854	2.750		-2.537	8.246	0.932	0.647		-0.335	2.199
Asian/Pacific Islander	0.263	0.289		-0.303	0.829	0.337	1.135		-1.889	2.562	0.651	1.099		-1.505	2.807	0.380	0.266		-0.141	0.901
Black/Non-Hispanic	-0.004	0.336		-0.662	0.655	-1.176	1.402		-3.924	1.573	-0.944	1.350		-3.591	1.702	0.440	0.325		-0.198	1.077
Hispanic	0.161	0.274		-0.376	0.698	0.077	1.076		-2.032	2.186	0.460	1.039		-1.578	2.498	0.306	0.257		-0.198	0.809
Other	--	--		--	--	-3.106	3.954		-10.859	4.646	-6.429	2.653	*	-11.630	-1.227	--	--		--	--
Unknown	1.235	1.516		-1.736	4.207	-0.519	4.258		-8.868	7.830	2.374	3.556		-4.599	9.347	--	--		--	--
Constant	0.713	0.434		-0.139	1.564	31.940	1.529	***	28.943	34.938	24.179	1.499	***	21.239	27.118	-0.092	0.420		-0.915	0.731

Note. Analysis is based on the balanced sample of CUNY first-time freshmen who previously participated in the CN DE program and were college-credit-eligible prior to participation. Analysis based on the sample after propensity score weighting.

+p~0.05; *p<0.05; **p<0.01; ***p<0.001

Figure 1

Propensity Score Histogram by Treatment Status Showing Common and Treated Off Support (Math Gateway Model)

Figure 2

Propensity Score Histogram by Treatment Status Showing Common and Treated Off Support (English Gateway Model)

Figure 3

Balance Checking for the Math Gateway MMWS Model: Density Plot of Mean of Logit Propensity Scores

Figure 4

Balance Checking for the English Gateway MMWS Model: Density Plot of Mean of Logit Propensity Scores