ANNENBERG
BROWN UNIVERSITY

EdWorkingPaper No. 20-301

Happy Together? The Peer Effects of Dual Enrollment Students on Community College Student Outcomes

Vivian Yuen Ting Liu
Teachers College, Columbia University

Di Xu
University of California, Irvine

Nationally, 15% of first-time community college students were high school dual enrollment (DE) students, which raises concerns about how high school peers might influence college enrollees. Using administrative data from a large state community college system, we examine whether being exposed to a higher percentage of DE peers in entry-level (gateway) math and English courses influences non-DE enrollees' performance. Using a two-way fixed effects model, our results indicate that college enrollees exposed to a higher proportion of DE peers had lower pass rates and grades in gateway courses, and higher course repetition rates. Supplemental student-level analysis suggests that greater exposure to DE peers during a student's initial semester in college reduces next-term college persistence.

VERSION: September 2020

Suggested citation: Liu, Vivian Yuen Ting, and Di Xu. (2020). Happy Together? The Peer Effects of Dual Enrollment Students on Community College Student Outcomes. (EdWorkingPaper: 20-301). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/r3ef-hx93

Happy Together? The Peer Effects of Dual Enrollment Students on Community College Student Outcomes

Vivian Yuen Ting Liu*
Community College Research Center
Teachers College, Columbia University

Di Xu
University of California, Irvine

September 2020

Abstract

Nationally, 15% of first-time community college students were high school dual enrollment (DE) students, which raises concerns about how high school peers might influence college enrollees. Using administrative data from a large state community college system, we examine whether being exposed to a higher percentage of DE peers in entry-level (gateway) math and English courses influences non-DE enrollees' performance. Using a two-way fixed effects model, our results indicate that college enrollees exposed to a higher proportion of DE peers had lower pass rates and grades in gateway courses, and higher course repetition rates. Supplemental student-level analysis suggests that greater exposure to DE peers during a student's initial semester in college reduces next-term college persistence.

Address correspondence to:

Vivian Yuen Ting Liu
Postdoctoral Research Associate, Community College Research Center
Teachers College, Columbia University
525 W. 120th St., Box 174
212-678-6639
Email: ytl2102@tc.edu

Funding for this research was provided by Ascendium Education Group. We are grateful for the excellent feedback on prior drafts from Thomas Brock, Judith Scott-Clayton, Michel Grosz, Dylan Conger, and attendees at the 2019 Association for Education Finance and Policy annual conference and the 2019 Association for Public Policy Analysis and Management annual conference. We are also grateful for the editing expertise of Doug Slater, Hayley Glatter, and Andrew Beenken. All errors are our own. The opinions expressed are those of the authors and do not necessarily represent views of the funder or authors' academic affiliations.

1. Introduction

In the fall of 2010, more than 15% of first-time community college students across the nation were high school students taking college coursework through dual enrollment (DE), and there is strong evidence that the number of DE students at community colleges has continued to increase (Fink, Jenkins, & Yanagiura, 2017). Researchers have noted several benefits of these programs for high school students, including that they may increase students' competitive edge in the college application process, better prepare students for college coursework and therefore ease students' transition from high school to college, and reduce the costs and time it takes to earn a postsecondary degree (e.g., Allen & Dadgar, 2012; An, 2013; An & Taylor, 2019; Giani, Alexander, & Reyes; 2014; Miller et al., 2018; Jones, 2014; Speroni, 2011; Karp, Calcagno, Hughes, Jeong, & Bailey, 2007).

In contrast to the general agreement that DE benefits high school students, there is less consensus on how the growing number of DE students at community college may influence "non-DE" college students (i.e., those enrolled as regularly matriculating college students). [1] On the one hand, advocates of DE point out that community colleges may also benefit from the current DE expansion by helping them maintain relatively stable enrollments amid broader postsecondary enrollment decline (Smith, 2017). Additionally, since DE students are often well prepared academically, they may also serve as a positive influence on their community college classmates, thus bringing positive externalities to their peers (Smith, 2017).

On the other end of the debate, college administrators have expressed concerns over the extra burden imposed on instructors to help DE students adjust to college (Jenkins, 2013; Reed, 2018). Since DE students are younger and are new to the college environment, instructors may need to take extra time and effort to help DE students both academically and logistically, such as through giving guidance on book purchases, transportation problems, and scheduling conflicts between high school and college activities (Conley, 2008; Hughes & Edwards, 2012), thereby leaving the other students with less attention and support. Having a greater proportion of younger peers in the classroom may also influence classroom dynamics and peer interactions, making some activities, such as group projects, more challenging (Catron, 2001). Furthermore, since many college instructors grade students on a normal distribution curve, the presence of higher-

[1] Non-DE college students may themselves have had experience as DE students before they matriculated at college. We describe how we address this circumstance in section 3.

performing DE peers in a course may also lower non-DE community college students' class ranking and thus course grades. Lastly, declining state funding has forced many community colleges to rely heavily on tuition to generate revenues; yet, to reduce the financial burden on families and students in DE participation, some states require colleges to charge a reduced rate for dual credit courses.[2] In states where DE programs are free to students and are funded through state appropriation, colleges may be reimbursed at a reduced rate compared to the full tuition depending on the specific funding formula used (Zinth, 2015). For example, some states fund DE through a fixed appropriation where funding does not vary based on enrollment numbers. As a result, the allocation may be insufficient to fully fund DE programs if there is a mismatch between actual spending and the amount appropriated. This can create an additional financial burden on colleges and especially for community colleges that are already under-resourced.

Our paper aims to examine the impact of DE peers on the academic outcomes of non-DE college enrollees. There is little empirical evidence regarding this topic; yet, understanding the externalities of DE peers is important for three reasons. First, DE participation has been increasing steadily during the past decade. A national report showed that one-third of all college enrollees are high school students, and the number of part-time students under the age of 18 in community colleges has doubled between 2007 and 2017 (Azim & Sandra, 2019). In the state where the current study is conducted, for example, the statistics shown in Figure 1 indicate that the presence of DE students in community colleges tripled between 2014 and 2016, hitting close to 18% of total enrollment in 2016. DE participation is likely to continue to grow given rising tuition costs and the increasing value of a college degree.

Second, community colleges play an important role in addressing the national equity agenda by serving a large proportion of students from underserved minority and low-income backgrounds (Horn & Nevill, 2006). Yet, DE students are more likely to be White or Asian and from more affluent backgrounds (Azim & Sandra, 2019; Fink, 2018; Fink et al., 2017). Therefore, if serving DE students comes at the cost of non-DE community college enrollees' educational resources and academic achievement, the expansion of DE programs may further exacerbate educational inequities between different subpopulations.

---

[2] For example, a recent article at Inside HigherEd indicates that Kentucky requires colleges to keep tuition pricing for dual credit courses at one-third of the regular rate (https://www.insidehighered.com/news/2019/10/10/dual-enrollment-helps-student-success-strains-college-resources)

Lastly, peer effects have long been an interest of economists and policymakers. Understanding the possible externalities of one group of students on another and on college functioning is crucial in informing policy and optimizing organizations to maximize education outcomes for each education dollar spent especially in the midst of shrinking budgets. Despite the large volume of studies on peer effects conducted at the K-12 level and four-year postsecondary institutions, no study has been conducted at community colleges. Recent studies have shown the importance of instructor characteristics and quality on the learning outcomes of community college students (e.g., Ran & Xu, 2019; Xu, 2019). It is, therefore, reasonable to also consider how peer characteristics may influence student achievement in the community college setting.

This study provides the first empirical evidence on the effect of DE peers on the academic outcomes of non-DE community college enrollees. We use an administrative dataset of student transcript records from 2012 to 2017 in a large community college system in an anonymous state. Specifically, we estimate the effect of being exposed to a higher percentage of DE peers on non-DE community college students' performance in math and English gateway courses. We also estimate course and student-level downstream outcomes, including repeating the gateway course and college persistence in the following term. We focus on math and English gateway courses because they are the most popular courses among DE students. Additionally, these introductory courses are prerequisites for most degrees and certificates at community colleges. Students who pass these courses are substantially more likely to earn a postsecondary credential (Calcagno, Crosta, Bailey, & Jenkins, 2007). As a result, community colleges tend to be particularly concerned with success rates in these courses and how to improve them (Herzog, 2005). If exposure to DE peers affects the performance of non-DE students in gateway courses, then these short-term impacts may translate into a longer-term influence on a student's academic pathway, degree attainment, and labor market outcomes.

We begin by documenting the differences in observable characteristics between DE students and non-DE community college enrollees. Descriptive statistics show that DE students are more likely to be female, White, younger, and perform better academically than non-DE community college enrollees. These demographic differences are consistent with the existing literature indicating that DE students tend to be higher achieving, White or Asian, and from more affluent backgrounds (Fink, 2018; Fink et al., 2017).

We then move to the main research questions of this study: How does exposure to a greater proportion of DE peers influence non-DE community college students' performance in gateway math and English courses? What are the subsequent downstream outcomes of that influence? Credibly estimating the externalities of DE students is difficult due to methodological challenges. Since students are not randomly assigned to classes at community colleges, it is difficult to tease out exogenous peer effects from endogenous self-selection into different classes. To minimize bias from student self-selection, we implement a two-way fixed effects model. This approach includes both individual-level and course-level fixed effects to addresses any sorting that is fixed either at the student level, such as academic preparation and motivation or at the course level, such as course content and difficulty. We also conduct supplemental analyses at the student-level to examine how the cumulative exposure to DE peers across courses during a non-DE student's initial term in college may influence the student's subsequent college persistence, where we use term-by-term fluctuations in the headcount of DE students at a college as an instrument for a student's overall exposure to DE peers during her initial term in college.

Although the effect sizes are fairly small, our course-level results indicate that exposure to a greater proportion of DE peers has a negative influence on the learning outcomes of community college students. Negative effects are found when examining the probability of passing the gateway courses, their grades in those courses, and an increased probability of repeating the course. Additional heterogeneity analyses by student first-term grade point average (GPA) indicate that the negative externalities from DE peers are equally pronounced among community college students across the whole range of the prior academic performance distribution. Furthermore, supplemental analyses conducted at the student-level using an instrumental variables approach indicate that community college students exposed to a greater proportion of DE peers during their initial term in college are less likely to persist to the next term.

2. National Trends in Dual Enrollment and Relevant Literature

2.1 The Growth of Dual Enrollment

Dual enrollment, also known as concurrent enrollment, refers to programs that allow high school students to enroll in college courses thus earning high school and college credits simultaneously. DE has existed as a college acceleration opportunity for decades (Andrews & Marshall, 1991; Gerber, 1987; Mokher & McLendon, 2009), and its popularity has grown significantly since the early 1990s when more emphasis began to be placed on college readiness and when college tuition began to increase steadily (Karp, 2012). A number of studies have used quasi-experimental designs to estimate the impact of DE participation on high school students' academic choices and postsecondary success (e.g., Allen & Dadgar, 2012; An, 2013; Giani et al., 2014; Hemelt, Schwartz, & Dynarski, 2019; Miller et al., 2018; Speroni, 2011). Except for Speroni (2011), all found that DE participation had a positive impact on students' postsecondary enrollment and performance.

The fast expansion of DE programs, however, has not affected all students equally. Several reports have identified noticeable disparities across subpopulations in both access to and actual participation in DE (e.g., U.S. Government Accountability Office, 2018). Studies have typically found that DE students are more likely than their non-DE peers to be high income, female, White, Asian, and high-achieving (Fink, 2018; Fink et al., 2017). The enrollment gaps among different subgroups were also supported by surveys and interviews with high school administrators. For example, in a recent survey administered to administrators, faculty, and counselors at six high schools in an urban area, more than half of the respondents indicated that students who participated in DE programs tend to come from mid- to high-socioeconomic background (Garcia, Eicke, McNaughtan, & Harwood, 2020).

In an effort to close equity gaps in DE participation, many practitioners and policymakers have advocated for the expansion of DE programs nationwide, especially among students in low-income districts. The Education Commission of the States (Zinth & Barnett, 2018), in particular, has called for broadening DE access to both middle- and low-achieving students by establishing partnerships between local colleges (and most often community college) and exposing high school students to the college environment through DE programs. Yet, some policymakers raised concerns about the financial sustainability of expanding these programs considering that colleges may be reimbursed at a reduced rate compared to the full tuition for DE (Zinth, 2015).

2.2. How DE Peers May Influence College Students

While empirical evidence on the impact of DE peers on non-DE community college enrollees is generally missing, the broader peer effects literature indicates that peers can influence each other's educational experiences and outcomes directly or indirectly (Sacerdote, 2014). Building on previous literature, we discuss below three theoretical models of peer effects, which may help explain how the presence of DE peers influences the academic outcomes of non-DE college enrollees.[3]

Linear-in-means Model. As the most commonly discussed peer effect theory, this model indicates that average peer background, such as prior academic achievement, is correlated with a student's own outcomes. For example, if a student is assigned to a class with a higher incoming ability on average, this student would perform better being placed with her high-achieving peers. Such positive externalities may operate through multiple channels. First, students may learn from each other in and out of class. As a result, greater exposure to high-achieving peers may lead to more productive peer interactions and learning experiences, which are often found to be particularly beneficial for low-achieving students (Kimbrough, McGee, & Shigeoka, 2017). Second, in addition to direct peer-to-peer teaching, peers may also influence each other indirectly in choices and behaviors. For example, based on a sample of high school students in the Netherlands, Kooreman (2007) identified sizable within-class correlations in the time allocated to various activities including studying. Finally, having a greater proportion of high-achieving students in the formal class setting may lead teachers to increase the rigor of instruction, which could benefit all students. For instance, in the context of Kenyan primary schools, Duflo, Dupas, and Kremer (2011) found that teachers who were randomly assigned to classes of higher average achievement levels displayed more instructional efforts.

All of the possible channels mentioned above suggest that the presence of higher ability peers may bring about a positive influence on their classmates. Indeed, experimental and quasi-experimental studies conducted in the setting of higher education generally identified a positive association between peers' prior academic achievement and a student's own academic outcomes (e.g. Brunello, De Paola & Scoppa, 2010; Carrell, Fullerton, & West, 2009; Lyle, 2007; Sacerdote, 2001; Zimmerman, 2003; Stinebrickner & Stinebrickner, 2006). To illustrate, in their study that exploits random assignment of squadron-level peers at the U.S. Air Force Academy,

[3] See Hoxby & Weingarth (2005) for a detailed discussion of different theoretical models of peer effects.

Carrell et al. (2009) reported that a 100-point increase in the average SAT verbal scores among group peers is associated with a 0.4-grade-point increase in own GPA.[4]

Along the same line, the presence of DE students may influence non-DE community college enrollees by changing the classroom achievement composition. Since most states require students to meet eligibility criteria to be admitted to a DE program—such as acquiring teacher-written recommendations, meeting a minimum high school GPA, or passing state-determined postsecondary assessments—students eligible to take college coursework through DE typically have higher academic performance levels than their non-DE community college student peers.[5] In contrast, over half of the community college students are not college-ready, and less than a third of all community college students entering college for the first time in 2014 graduate within 150 percent of normal time for degree completion (Bailey, Jeong, & Cho, 2010; U.S. Department of Education, 2018). As such, exposure to higher achieving DE peers who are committed to doing well academically may lead to positive externalities on community college enrollees through improved motivation and study habits (Smith, 2017).

Invidious Comparison Model. Opposite to the notion of the linear-in-means model, the invidious comparison model suggests that a student's performance in a group is adversely affected by the presence of higher achieving peers as a result of being pushed to a lower rank in the ability distribution (Elsner, B., & Isphording, 2017). Lower ordinal rank may in turn influence self-perceived ability and confidence negatively, which could presumably further affect an individual's educational motivation, her time investment in academic study, and learning outcomes (e.g. Denning, Murphy, & Weinhardt, 2020; Hoxby & Weingarth, 2005; Marsh et al., 2008).

The influence of relative rank in a classroom is likely to exist and may be even more pronounced in the postsecondary setting, where instructors commonly grade students on a curve. Even if a course is not graded on a curve, the knowledge of more high-achieving students in the

---

[4] It is worth mentioning that despite its popularity in use, critics point out that peer effects may not be linear-in-means; instead, peer effects can be non-linear and heterogeneous, and largely depend on a student's own characteristics (e.g. Hoxby & Weingarth, 2005; Sacerdote, 2011).

[5] In 2016, six states included minimum high school grade point average (GPA) as a criterion to be admitted to a dual enrollment program; 17 states required written permission or a recommendation from a teacher or school official; 25 states required DE candidates to meet course prerequisites set by the departments or institutions offering DE programs; and 24 states included other eligibility criteria, such as completion of certain high school courses or passing scores on state-determined high school or postsecondary assessments. For more detailed information, see Zinth (2016).

classroom may lead the teachers to grade differently. Moreover, minority and low-income students who are over-represented in community colleges may be more heavily influenced by their classroom experience than other students, since such students on average have lower levels of confidence and a lower sense of belonging in the academic setting to begin with (Freeman, Anderman, & Jensen, 2007; Hoxby & Avery, 2012; Ostrove & Long, 2007; Strayhorn, 2008, 2018). Indeed, studies conducted at K-12 schools have revealed strong heterogeneity in the influence of ordinal rank by individual characteristics (Murphy & Weinhardt, 2018), where low-income students benefit substantially more from being in the top 25th percentile in their class than their higher income peers. If similar patterns hold in the community college setting—which consists of large proportions of low-income, minority, and first-generation students—then it implies that the benefits of having a relatively higher rank in class for these students could be reduced as a result of the presence of high-achieving high school peers.

Tracking Model. Among the numerous theoretical discussions about how peer effects operate, the tracking model is particularly relevant to the current study (Holmes, 1912; Hoxby & Weingarth, 2005). Specifically, based on the assumption that a student learns best when her achievement level is close to the level of instruction, this model suggests that students benefit from being around other students with similar performance levels (e.g., Borman & Hewes, 2002; Duflo et al., 2011; Hoxby & Weingarth, 2005; Zimmer, 2003). For example, Hoxby and Weingarth (2005) found that students benefit from having more academically homogeneous peers, which the authors attributed to more targeted instruction. Similarly, Duflo et al. (2001) found that students at all levels of the initial achievement spectrum benefited from being tracked into classes by their prior achievement, and such benefits seem to be primarily driven by allowing teachers to more closely match instruction to students' needs. Under these arguments, the presence of DE students could bring additional challenges to instruction due to the wider range of achievement levels of students.

Interviews with high school counselors and administrators further reveal several major non-cognitive differences between high school DE students and college students, in terms of their maturity level, perseverance, independence, responsibility level, ability to ask questions, communication skills, all of which suggests that the presence of high school students in college classrooms may impose additional challenges to class instruction and management (Jordan, Cavalluzzo & Corallo, 2006; Witkowsky & Clayton, 2019). Indeed, surveys with college faculty indicate that DE students often need additional support as a result of the structural, cultural, and functional differences between high school and college (Conley, 2008). For example, some instructors have noted that DE students lack self-directed learning skills, such as skills associated with time management, note-taking, and out-of-class study. As a result, course instructors often need to provide extra assistance to help DE students adapt to the college learning environment (Hughes & Edwards, 2012). Some community college instructors report having to develop age-appropriate course syllabi, choose different textbooks, and work with high school teachers to cater to the particular needs of DE students (Catron, 2001). The additional attention from instructors and the course adjustments made for DE students may influence the level of support and attention non-DE community college students receive.

In addition to the indirect peer effects mediated through teaching practices and attention, another possible mechanism for the tracking model is that students have more positive peer interactions with students of similar ability levels. A handful of studies provide direct empirical support to this possibility (e.g. Booij, Leuven, & Oosterbeek, 2017; Carrell et al., 2009). For example, using random group assignment, Booij et al. (2016) found that both the mean and standard deviation of peers' prior ability have significant impacts on own performance, where a student's achievement increases with mean peer GPA and decreases with the standard deviation of peer GPA. Additional analyses of survey data suggest that low-performing students in groups with homogenous ability composition had more high quality peer interactions, such as being more likely to study together with other students and help each other with study materials. In a similar vein, Carrell et al. (2009) found that low ability students suffered from lower performance when they were intentionally placed into squadrons with a more heterogeneous ability composition, which means greater exposure to more high-achieving peers. Analysis of survey responses indicate that the negative impact is partly due to the fact that high ability and low ability students tend to sort into segregated social networks, which lead to reduced beneficial interactions between students.

2.3 The Current Study

To sum up, it is unclear from a theoretical point of view how the presence of DE peers may influence the outcomes of non-DE college enrollees, nor is there any rigorous empirical evidence on the direction and size of such influence. Our study builds on the peer effects literature and intends to advance understanding of the externalities of DE peers in two ways.

First, while a growing number of studies have examined the impact of DE, they have exclusively focused on how participation in DE influences high school students' academic choices and performance. In contrast, the field has limited knowledge regarding the impact of DE peers on non-DE college enrollees' outcomes. Understanding this issue in the specific setting of community colleges is particularly important since the majority of dual enrollments happen at community colleges rather than four-year institutions. In the academic year of 2015-16, the number of young enrollees (students of age 17 and below, who are most likely to be high school students) reached 745,000 in community college, which is more than double the young enrollees at four-year institutions (Fink et al., 2017). Given the important role community colleges play in DE programs and the ongoing expansion of DE across the nation, it is critical for policymakers to understand whether having DE students in the college classroom serves to crowd out the limited resources available to non-DE community college enrollees who are already disproportionately from disadvantaged backgrounds. Our study fills this research gap by delivering the first quasi-experimental evidence on this issue.

Second, our study extends the general peer effects literature by approaching this topic in an under-examined setting. The majority of peer effects research has been conducted in the K-12 setting (e.g., Betts & Zau, 2004; Boozer & Cacciola, 2001; Burke & Sass, 2013; Hoxby, 2000; Hoxby & Weingarth, 2005; Imberman, Kugler & Sacerdote, 2012; Lavy, Paserman & Schlosser, 2011; Lefgren, 2004; Whitmore, 2005). While a growing number of studies have examined peer externalities at the postsecondary level, they have been conducted at military schools (e.g., Carrell et al., 2009; Lyle, 2007) and elite four-year universities (e.g., Ficano, 2012; Ost, 2010; Sacerdote, 2011; Zimmer, 2003). Given the substantial differences in student composition between an elite four-year college and an open-access institution, it is unclear whether results from these studies can be generalized to open-access colleges, which is where on-campus DE typically occurs. The datasets we use contain detailed transcript data on all community college students at a large state community college system between 2012 and 2017. To the extent that the DE expansion and policies shown in this state resemble the national trends, results from our study may also speak to other community college systems nationwide.

3. Data and Setting

3.1 State Context in Dual Enrollment

The state community college system (referred to as SCCS hereafter) examined in this study comprises a mix of large and small colleges, as well as institutions located in rural, suburban, and urban settings. Appendix Table A1 shows the average student demographics and institutional characteristics of SCCS in fall 2012, based on statistics reported to the Integrated Postsecondary Education Data Systems (IPEDS) database. Compared with the characteristics of nationally representative samples of two-year public institutions, SCCS institutions tend to be smaller, have a higher graduation rate, serve a substantially higher proportion of White students, and have a higher FTE expenditure in instruction. SCCS also seems to rely more heavily on tuition and fees as the main revenues and less heavily on state and local appropriations compared with the national average. Furthermore, SCCS has a lower percentage of full-time instructors than the national average.

During the period of this study, SCCS mandates that all public secondary schools and all public two-year and four-year colleges participate in the statewide DE program. Specifically, each public secondary school is required to develop, in consultation with at least one partnering college, a set of college courses offered to eligible students, which enables high school students to take courses in high school and college simultaneously. In the state, ninth through twelfth-grade students must have at least a high school GPA of 3.0 to be eligible to do so. [6] Although they are not required to develop partnerships with colleges, private secondary schools cannot deny eligible students from participating in DE. The state covers tuition for all DE coursework, associated fees, and materials for all public, chartered, and private high school students. DE primarily takes place during the fall and spring terms, with summer term enrollments accounting for just 10% of total DE participation in the academic year of 2016–17. The average DE participation rate in this state is 10%, with noticeable enrollment gaps between White (11%) and non-White students (4% among Black students and 7% among Hispanic students), which is consistent with overall participation rates and racial/ethnic gaps nationally.[7]

---

[6] Starting from the 2015-16 academic year, students must also meet the qualifying scores on an assessment test, such as SAT, ACT, and Accuplacer, in the subject they wish to enroll in college to be eligible for DE.

[7] Based on a recent report that analyzes data from the Civil Rights Data Collection on the 2015-2016 school year (Fink, 2018), the average national DE participation rate is 8%; the rates are higher among White (10%) and Asian (8%) students, compared with Black (5%) and Hispanic (6%) students.

DE courses in this state may be offered at both college campuses and high schools. To ensure the quality of DE experiences, the state mandates that all DE courses offered at a partnering college campus, whether they are delivered face-to-face or online,[8] be the same as those included in that college's course catalog for college-level, non-remedial courses. Courses offered at the secondary school must follow the same course syllabus; employ the same learning outcomes; and use the same textbook, materials, and assessments as the equivalent college courses delivered on the college campus. In 2016–17, 34% of DE course enrollment took place on a college campus, and among these course enrollment, more than two thirds were offered by the SCCS.

Figure 1 shows the share of college students who were dual enrolled at the public two- and four-year institutions in the state each year between 2009 and 2016. It reveals two important patterns. First, the proportion of DE students grew steadily during this period in both sectors, and the growth rate accelerated noticeably in more recent years. This is driven by a series of state policies implemented in the mid-2010s to revamp their DE program. These changes include mandating all public schools to partner with at least one college, prohibiting districts from restricting qualified student's DE participation, allowing seventh- and eighth-graders to participate in the program, and increasing the number of high school equivalent credits per college credit.[9] These policy changes can presumably increase high school students' access and participation in DE programs, especially those from less affluent school districts.

Second, since community colleges account for two thirds of all college campus DE enrollments, DE students represent a much larger percentage of community college enrollees than they do of four-year enrollees. Moreover, the proportion of DE students has increased especially quickly at two-year institutions since 2014,[10] further widening the gaps in the percentage of DE students between two-year and four-year sectors. In 2016, 18% of total community college enrollments were DE students, compared with only 4% of students in the four-year sector. These patterns suggest that for current community college enrollees in SCCS,

[8] Only a small proportion of the observations in our sample are online enrollments (15% of the sample). Yet, considering that peer effects may operate differently in a face-to-face class than in an online class, we have also run a heterogeneity analysis of DE by course delivery format. We did not find any significant interactional effects by delivery mode.
[9] Since transportation is not covered by the program, approximately 70% of all participants are still eleventh and twelfth graders, who are able to drive or take public transit to the local colleges themselves.
[10] For example, according to SCCS's annual report, the total DE enrollment grew 25% from around 54,000 to 68,000 students between the 2015–16 and 2016–17 academic years.

every five community college students include one high school student, and the proportion may be even higher in the lower division coursework that is most popular among DE students. With the state and nationwide push for DE expansion, the heavy exposure to DE peers is likely to continue or even increase in the next few years, further highlighting the importance of understanding the impact of DE peers on the academic outcomes of non-DE community college enrollees.

3.2 Data and Key Measures

We utilize administrative data from one of the largest public university systems SCCS with 20 plus community and technical colleges. Our data include approximately 386,000 students who enrolled in the system at any point between fall 2009 and summer 2017. We restrict the analyses to students enrolled in 2012 or later, as grades are missing in prior years. The dataset includes student demographic characteristics and transcript records, including grades received, course section number, delivery method (face-to-face versus online), course subject, and whether the student took the course as an undergraduate student or as a high school student through DE. Each course section has an instructor identifier, which can be further linked to a separate instructor file that includes individual-level information (such as demographic characteristics) as well as instructor-by-term-level information (such as academic rank, highest degree earned, and teaching experiences). [11]

Our analysis focuses on estimating the effect of DE peers on non-DE community college students' academic outcomes in their gateway courses. Gateway courses are a set of courses that community college students must take in order to progress toward most of the degrees and certificates. For English, Composition I and II are generally required for almost every program. Math requirements vary by major and program. Common math gateway courses include College Algebra, Trigonometry, Statistics, Precalculus, and Mathematical Foundations. Math and English gateway courses are the most popular courses for DE students. Specifically, DE participation accounted for 15% of the total enrollment in these gateway courses during the period of this study, compared with 6% in other courses. High demand in gateway courses leads to a multiplicity of sections under each course, thereby providing substantial within-course variation

[11] Our data only include teaching records between 2009 and 2017. As a result, we may underestimate teaching experiences among instructors hired prior to 2009. To address this concern, we further include a dichotomous variable that indicates whether a specific instructor teaches in 2009 in one of our robustness checks and the results remain the same.

in students' exposure to DE peers that is critical to our identification strategy. Figure 2A shows the distribution of the proportion of DE students across all course sections in gateway courses. Among the 18,512 course sections, the proportion of DE students ranged between 0% and 100%. The pronounced variations in student composition support the identification strategy used in this study, which we provide more details in Section 4. Below we describe briefly how we define our key variable of interest and outcome measures.

DE status. We use student-by-course flags to indicate an individual's DE status in a particular course. Individuals contribute to the course-level DE count only for the terms they enroll as DE students and not after they matriculate as college students. For example, a high school student may take a college gateway course through a DE program in the fall of 2013 and then matriculate at a community college in the fall of 2014. This student would serve as a source of treatment as a DE peer only during 2013. Approximately 30% of the gatekeeper course sections included in our analytical sample enrolled at least one DE student.

Outcome measures. To provide a comprehensive understanding of how exposure to DE students influences the academic outcomes of non-DE community college enrollees, we focus on student performance in the gateway courses and whether they repeated the course subsequently. The current course outcomes include the probability of passing the gateway course unconditional on persisting to the end of the course, whether a student persists to the end of the course, as well as the average end-of-course GPA among those who persisted to the end of the course. We further examine the likelihood of repeating the same course. [12]

3.3 Sample and Summary Statistics

We make three key sample restrictions to create a sample that is more representative of typical community college students. First, we exclude course sections that were offered at local high schools and thus had DE students only, which accounts for roughly 7% of all sections shown in Figure 2, Panel A. Second, another 18% of the sections had relatively high concentrations of DE students, which seem to be primarily online English classes offered at a few community colleges. To make sure that our estimates are not driven by a small set of

---

[12] Ideally, we would also like to examine students' performance in the next course after completing their gateway coursework. However, only 33% of the sample persisted to another course in the subject area, resulting in limited variation to systematically explore the association between DE peers in gateway courses and a student's subsequent performance.

specially designed classes with high concentrations of DE students, we drop these sections from our course sample.[13]

Third, approximately 2% of the students enrolled in gateway courses appeared as both DE and college enrollees in our sample. These are students who enrolled in college coursework through DE programs in high school and later officially enrolled as a community college student after high school graduation. Due to their prior DE experiences, these students may have responded to DE peers differently than other community college students who never had DE experiences. In addition, as shown in Table 1, comparisons between community college students with or without prior DE experiences suggest that those with DE experiences (column 2, referred to as "ever-DE" hereafter) were noticeably different from the majority of community college students without DE experiences (column 3, referred to as "never-DE"). For example, ever-DE college students were more likely to be female, White, in-district residents, younger, and first-time college students than their never-DE counterparts. They also had higher GPAs in the first term at SCCS and higher completion rates in associate degrees.[14] Furthermore, as shown in Figure 3, which presents the distribution of grades earned by ever- and never-DE students, ever-DE students were much more likely to attain higher grades in their gateway courses than never-DE students. In view of the noticeable differences between the small proportion of ever-DE community college students and the rest of the non-DE community college students with no DE experiences, we exclude them in our non-DE community college enrollee sample when analyzing the effects of DE peers on non-DE community college students.[15]

Our final analytical sample includes 264,716 total class enrollments from 13,897 course sections by 180,010 non-DE community college enrollees. The average proportion of DE students in these sections is 2%, with a standard deviation of 3 percentage points.

[13] We conduct a number of robustness checks with different restriction criteria (such as dropping only the top 10% instead of the top 25% of the sections with the largest proportions of DE students), and the results are fairly consistent.

[14] We merge the college administrative data with National Student Clearinghouse data that contain information about awards obtained outside of the state. Therefore, degree attainment information presented in Table 1 includes credentials earned at institutions either within or outside the state.

[15] Although these ever-DE students are excluded from our analytical sample, they still contribute to the construction of the treatment variable (i.e. proportion of DE peers in a class) when they enrolled as a DE student. In a separate robustness check, we also include the ever-DE students in our analytical sample and the results remain the same.

4. Empirical Model

Our identification strategy models current course outcomes as a function of a community college enrollee *i*'s exposure to DE students in math and English gateway courses on her course performance in section *s* of course *c* in subject *f* in term *t* at campus *k*:

$$Y_{iscftk} = \alpha + \beta\%DE_{scftk} + \delta_{cfk} + \rho_t + \sigma_i + X_{scftk} + \mu_{iscftk} \quad (1)$$

The key variable of interest, *%DE*, represents the percentage of DE peers in a specific course section, calculated as the total number of DE students in a section divided by the total enrollment in that section minus one. To make it easier to interpret, we multiply our key variable of interest by 10, which allows us to interpret the results as a 10 percentage point increase in DE peers. Given that the average class size per section in our sample is 20 students, a 10 percentage point increase is similar to adding approximately two more DE students into an average classroom of 20 students. δ_{cfk} and ρ_t control for college-course and calendar term fixed effects, respectively, allowing for comparisons among different sections of the same course at a particular college while controlling for overall fluctuations in student composition and performance over time.

Yet, although course and time fixed effects are able to address between-course and over-time variations in both peer composition and student outcomes, the identification of DE peer effects is still subject to two additional challenges. The first challenge is the well-documented selection problem in the peer effects literature, which states that peer groups are usually formed endogenously (Manski, 1993). For example, DE students might be more likely to opt into sections offered during certain days and at certain times, which may also be more popular among community college enrollees with certain characteristics that are also related to student outcomes. We directly explore the extent of student sorting by relating observable characteristics of a current college enrollee, such as gender and race, to the proportion of DE peers she is exposed to after controlling for section-level attributes as well as college-course and term fixed effects. The results presented in Table 2 suggest that the exposure to DE peers seems higher for students from certain subgroups, such as White students, older students, students who intended to receive an associate degree or certificate as their terminal degree upon initial college enrollment, students placed into remedial mathematics education and so forth, although the sizes of the correlation are generally small. To address possible selection bias due to student sorting across sections, we include student individual fixed effects (σ_i) into the model, thus controlling for any unobservable student-level characteristics that are constant across courses.

Second, in addition to student sorting, another potential threat to our identification strategy is that within a particular course at a college, instructors with certain characteristics might be more likely to teach sections that consist of a larger proportion of DE students. Similarly, sections with higher proportions of DE students may also differ from sections with lower proportions of DE students in other section-level characteristics, such as peer demographic composition, section size, and course delivery format. [16] We therefore conduct a balance test at the course-section level, where we regress the proportion of DE students on the observable section-level characteristics while controlling for college-course fixed effects and term fixed effects. Results from this exploration are presented in Appendix Table A2. The majority of the coefficients do not reach statistical significance, indicating that course sections with a higher concentration of DE students are fairly comparable to those with a lower proportion of DE students in terms of observable section-level and instructor characteristics.

Yet, in light of the handful section-level predictors that reach statistical significance (including average student age, class size, instructor's years of teaching, and whether the class is co-taught by more than one instructor), we further include a vector, denoted by X_{scftk} in Equation 1 to control for course-section-level information, which include three sets of variables: (i) overall section's demographic composition including both DE and non-DE students (e.g. the gender and racial composition of the section, etc.); (ii) instructor characteristics such as gender, age, race, highest degree earned, appointment status (part-time versus full-time), tenure status (adjunct, tenure-track, and tenured), and rank (full, associate, or assistant professor); and (iii) other section-level attributes, such as the number of total enrollments in the course section, and whether the course section is delivered online or face-to-face.[17]

---

[16] Another section-level characteristic that may influence student learning outcomes is the specific day and time of a class. For example, if DE students are more likely to opt into evening classes, our estimates would conflate the effect of evening class with that of DE peers. Unfortunately, the administrative data do not include information about the day and time of a class. To shed light on the extent of this omitted variable, we reviewed class schedules from one college's website; this college is the fourth largest community college in the state. We conducted a robustness check by comparing the results based on models with and without controlling for the day and time of a section. Due to the much smaller sample, the estimates are no longer statistically significant. However, the direction and magnitude of the *%DE* coefficient remains similar after the inclusion of the time variables.

[17] The complete list of course-section-level variables include average student age, class size, students' average credits earned in the prior term, students' average credits earned in the same subject in the prior term, and course delievery method (face-to-face or online).

Thus, Equation 1 draws on two sources of variation in estimating the key coefficient of interest β. The first is within-individual variation, in which many college students take multiple gateway courses and each gateway section may consist of a different proportion of DE peers. Among the non-DE community college enrollees in our analytical sample, 78,630 took more than one gateway course; among these students, 58% had variations in the percentage of DE peers they were exposed to in gateway courses. The second is the variation in the percentage of DE students across sections of the same course. Since the model includes college-course fixed effects, only courses with between-section variation in the proportion of DE students would contribute to the estimate of β. As shown in Figure 2, Panel A, there was substantial variation in the proportion of DE students across course sections. Specifically, approximately 55% of the courses had within-course, between-section variations in the proportion of students who were dual enrolled.[18] Figure 2, Panel B further shows the distribution of residuals after adjusting for the course and term fixed effects, which follow an approximately normal distribution. These distributions, therefore, support the use of college-course fixed effects.

5. Empirical Results

5.1 Main Findings

Table 3 presents the estimated effects of increasing the proportion of DE students in a gateway course section by 10 percentage points on non-DE community college students in terms of four outcome measures: (1) completing the gateway course with a passing grade (versus either failing or withdrawing from the course); (2) persisting to the end of the course (versus withdrawing); (3) the final course grade on a 4.0 scale, conditional on persisting to the end of the course; and (4) the probability of repeating the same course subsequently (course repetition).

Overall, within the same course at a community college, exposure to a higher proportion of DE peers in a section had a small but significant effect on non-DE enrollees in terms of all four outcome measures. Specifically, a non-DE college enrollee was 2 percentage points less likely to pass a course for every 10 percentage point increase in DE peers, which would be to add

[18] 28% of the course enrollments in our sample meet the joint requirements for within-student and within-course variations – enrollments that were from courses with between-section variations in proportions of DE students and were also taken by current community college enrollees who had within-individual variations in exposure to DE peers.

two DE students to an average class of 20 students. Given that the overall course pass rate was 68%, this 2 percentage point decline translates to a pass rate reduction of approximately 3%. The negative effect of DE peers on overall course completion is driven by both a lower likelihood of persisting to the end of the course (the course persistence rate decreased by 1 percentage point for every 10 percentage point increase in DE peers) and a lower GPA among those who persisted to the end of the course (the average GPA was 0.06 lower for every 10 percentage point increase in DE peers).

Finally, Column 4 of Table 3 examines the impacts of DE peers in gateway courses on the probability that a non-DE community college student repeats that gateway course down the road. The results indicate that a 10 percentage point increase in DE peers in a gateway course is associated with an increased probability of course repetition by 1.3 percentage points. Given that the average rate of course repetition was 12.5%, an increase of 1.3 percentage points is equivalent to a 10% increase. This is not surprising given that students exposed to more DE peers were less likely to pass the current course, and it points to specific costs accrued for non-DE community college enrollees as a result of greater exposure to DE peers.

In addition to the increased probability of course repetition, an uninspiring experience early in a student's college career (such as failing a gateway course) may also influence a student's subsequent college enrollment decisions. To explore this possibility, we conduct a student-level exploratory analysis that relates the average exposure to DE peers during a non-DE student's initial term in college to the student's probability of dropping out of college by the end of that term. We focus on the first term of enrollment given that this is the time students are least likely to systematically sort across classes based on their learned knowledge of the institution, instructors, and classes. Besides, if exposure to DE peers in the first term turns out to influence a non-DE student's probability of college persistence, estimates of DE peer effects based on subsequent terms would be biased due to sample selection.

The results are presented in Table 4, where we use three different models to address student selection to different extents: (i) an OLS model (column 1) that controls for observable student characteristics and college fixed effects; (ii) an expanded model (column 2) that includes all the variables in (i), and further controls for college-course-set fixed effects that compare the outcomes of students who take the same set of courses within the same college during their initial term of enrollment; and (iii) our preferred model (column 3) that includes all the variables in (ii), and further uses an instrumental variables approach to control for student sorting across sections within a particular course. More specifically, we exploit the term-to-term fluctuations in the headcount of DE students at a college as an instrument for a student's overall exposure to DE peers during her initial term in college. For easier interpretation, we multiply our treatment variable (proportions of DE peers averaged across the classes taken during a student's initial term in college) by 10.

Once we control for the college-course-set fixed effect, the results show a consistent positive correlation between greater exposure to DE peers during a non-DE community college student's initial term in college and her likelihood of dropping out of college right after that term. Based on the preferred instrumental variable approach in column 3, a 10 percentage-point increase in DE peers significantly increases the chances of college withdrawal by the end of that term by 5.6 percentage points. With an average first-term college withdrawal rate of 17%, a 5.6 percentage point increase is equivalent to an increased chance of college withdrawal by almost one third.

5.2 Heterogeneity by Student Prior Academic Performance

Our results so far suggest that an increase in the proportion of DE students in a particular course section negatively affects non-DE community college enrollees' current and downstream outcomes. The peer effect literature has shown evidence that peer externalities have nonlinear impacts on students with different academic capacities (e.g., Duflo et al., 2011; Hoxby & Weingarth, 2005; Lavy, Silva & Weinhardt, 2009). Therefore, we further explore whether the negative effect of DE peers on non-DE community college students varies by college students' prior academic performance. Specifically, we divide college students in our sample in half based on the median of their GPA in college-level, non-gateway courses in their first term of college. The first half includes students with a first-term GPA equal to or below 3.0, and the second half includes those with a first-term GPA higher than 3.0.[19]

Table 5 presents the estimated effects of having a greater proportion of DE peers on non-DE students' current course performance and the probability of repeating that course subsequently. The results indicate that higher exposure to DE peers affects all non-DE

[19] It is worth noting that this analysis excludes students who did not enroll in college-level, non-gateway courses in the first term or did not receive valid grades from these courses. Yet, the results from our robustness checks presented in Appendix Table A3 indicate that the estimated effect of DE peers is fairly consistent between our analytical sample and the reduced sample that excludes students without valid first-term GPA.

community college enrollees negatively regardless of their prior academic achievement. For lower-achieving students, each 10 percentage point increase in DE peers lowers the likelihood of passing the course by 1.8 percentage points, course persistence by 2.1 percentage point, and an increased probability of repeating the same course subsequently by 2.6 percentage points.
The interaction terms between prior academic achievement and exposure to DE peers are generally insignificant, suggesting, that higher achieving students are subject to similar levels of negative influence when exposure to more DE peers. The only exception is course persistence: the estimate of the interaction term is significantly positive, reducing the size of the negative influence on course persistence from 2.1 percentage points to 0.4 percentage points (-0.021+0.017 = -0.004).

5.3 Robustness Checks

This section outlines the results of sensitivity tests for various sample restriction, model specifications, and how we define the treatment variable. First, to estimate the effect of having DE peers on a typical non-DE community college student, we limit our sample to course sections in which DE students made up less than 12% of the total enrollment. We first test for the sensitivity of including course sections in which DE students made up between 12% and 56% of the total enrollment, which increases the sample to cover up to 90% of the course sections. Panel A of Table 6 shows that while the magnitude of the effect of DE students on non-DE community college students' current and downstream outcomes was much smaller with the inclusion of courses with a higher percentage of DE students, the direction and statistical significance remains the same as in Table 3 and Table 4.

Second, we have thus far limited our analytical sample to community college students without any DE experience as high school students, due to the concern that students with DE experiences might react differently to DE peers. Table 6, Panel B, shows results for an alternative sample that includes former DE students who later matriculated as community college students. The results are robust to this change.

Third, as detailed in section 4, we include every student enrolled in a section (thus both DE and non-DE students) when constructing variables to describe the demographic composition of a course section (X_{scftk} in Equation 1) This is to address the concern that higher proportions of DE peers may coincide with other section-level characteristics that also influence student outcomes, such as having a higher proportion of females or peers from certain racial groups. Yet,

Table 1 shows that DE students were more likely to be younger and female, and had higher academic achievement than non-DE community college students. These descriptive patterns suggest that controlling for the demographic characteristics of all students, including DE students in a section, may offset some of the DE peer effects, thus leading to a lower-bound estimate. Indeed, Panel C excludes DE students from constructing the section demographic composition variables, and the sizes of the coefficients generally increase. Though the coefficient for persistence to end of course lost its statistical significance, the coefficient is not statistically different from that in Table 3.

Finally, by defining the treatment variable as the proportion of DE peers in a section, we assume a linear relationship between this variable and student outcomes. In Panels D and E, we relax this parametric assumption and use alternative ways of defining our treatment variable. Panel D defines treatment as a binary variable that indicates exposure to any DE peers in a section (versus no DE peers in a section). The estimates are fairly consistent with the main findings.

In Panel E, we divide sections into tertiles according to the proportion of DE students in a section and define treatment as a set of three dummy variables indicating the tertile to which a specific section belongs. The results indicate that the negative impacts of DE peers seem to be primarily driven by sections with more than 4% of DE students; in contrast, the estimates are consistently small in size and insignificant in sections with a smaller proportion of DE peers. Given that the average enrollment size in a section at SCCS is 20, this suggests that non-DE enrollees are subject to little negative effects when there is only one DE student in a typical section of 20 students. However, when there are more than one DE students, the negative effects would start to have a significant effect.

6. Discussion and Conclusion

The rapid growth in DE in recent years has drawn much attention to the impact of these programs. In this paper, we investigate empirically whether exposure to greater proportions of DE peers in gateway math and English courses influences non-DE community college enrollees' academic achievement, as measured by both their current course outcomes and subsequent repetition of the course. To do so, we exploit the variations in the proportion of DE students across sections within a specific course and combine the course fixed effects model with individual fixed effects that control for sorting that is fixed at the course.

Summary of key findings. Our results suggest that DE peers have statistically significant and negative effects on their classmates' current course outcomes, as measured by the probability of passing the course, course persistence, and course grades. Perhaps as a result of the reduced course completion rates, non-DE enrollees exposed to a higher proportion of DE peers in their gateway coursework are more likely to repeat the course subsequently. Our additional exploration at the student-level indicates that greater exposure to DE peers during a non-DE community college student's initial term in college increases the chance that she drops out completely from college by the end of the term. These results highlight the tangible and intangible costs imposed on non-DE community college students as a result of the growing number of DE students at community colleges. Our heterogeneity analyses by student first-term academic achievement indicate that the negative effects of DE peers appear to influence non-DE community college students across the entire academic performance distribution. Finally, our nonlinearity test by the proportion of DE students in a course shows that there exists a tipping point (of about 4%) where exposure to DE peers starts to have an effect on non-DE community college students.

Connections with the existing literature. Our main results indicate that a one standard deviation increase in the proportion of DE peers leads to a decrease of 0.02 GPA points or 0.012 standard deviations in the average GPA of non-DE students. The coefficient is moderate in size and comparable to other studies that have examined changes in student composition. For example, Lavy, Paserman, & Schlosser (2011) found that a one standard deviation increase in the proportion of grade repeaters in a high school course reduced the average end-of-year test score of non-repeater classmates by 0.015 to 0.036 standard deviations. In a similar vein, Carrell et al. (2009) found the standardized effect to be an increase of 0.083 standard deviations on own GPA.

Policy implications. The results of our study have important implications for the current national discussion about dual enrollment policy. During the past two decades, surging demand from students, institutions, and policymakers has driven an increase in college coursework offerings for high school students (College Board, 2017). The main impetus behind the rapid expansion of DE appears to be the desire to increase postsecondary participation while reducing costs for students and overall time to earn a postsecondary degree (Boswell, 2001). Yet, the impacts of the expansion of DE on non-DE community college enrollees have not been systematically examined. Our results suggest that there are modest unintended costs associated with this expansion. We find that non-DE community college students start to experience negative effects if a typical classroom with 20 students on average has at least one DE student. Once that threshold is reached, non-DE community college enrollees are more likely to fail the gateway course. Though the size of the effect is only modest, course failure and repetition present not only economic costs to students (and institutions) but may also lead to less visible costs for non-DE community college students in terms of academic confidence, motivation, and self-efficacy. Indeed, our subsequent student-level exploration indicates that higher exposure to DE students discourages non-DE college students from persisting into the next term after initial term in college.

Critics of dual enrollment have noted disparities in access to and participation in DE among different subpopulations (Fink et al., 2017), further raising the concern that DE may primarily serve as a subsidy for students from more affluent backgrounds. Non-DE community college enrollees come disproportionately from disadvantaged backgrounds; if their educational opportunities are compromised as a result of sharing resources with DE students, then the expansion of dual enrollment may, in fact, exacerbate already large inequities in college success and completion by student socioeconomic backgrounds.

Nonetheless, DE students in community colleges may benefit community colleges and their non-DE students in ways that are important for future study but are beyond the scope of our analysis. As community college enrollment has fallen in the last decade, the increase in DE may potentially serve to keep the revenue stable for colleges. As a result, community colleges can support facilities, student services, and enhancements that they would otherwise not be able to afford. The boost in DE students may also allow colleges to increase the variety of course offerings and course sections with more convenient times and locations.

While DE is likely to continue to grow, in part as a result of these potential benefits, it is important for college administrators and instructors to be aware of the possible challenges that DE programs present to the learning experiences of non-DE community college enrollees. This paper is unable to test for the specific mechanisms through which DE peers influence non-DE community college enrollees. Perhaps in courses with relatively greater proportions of DE students, instructors tend to devote more attention to these high school students to help them adapt to the college environment, leaving the remaining college enrollees with less support; or perhaps in courses with greater proportions of these younger learners, interpersonal interactions and group projects are more challenging and less effective, which hurts the course performance of other students. Non-DE community college students may also get discouraged when they perceive that they are ranked lower following the addition of high-achieving DE peers. Finally, DE students may also sort into segregated social networks from the rest of the non-DE classmates, which could lead to reduced beneficial interactions between students. Future research examining peer effects in community college classrooms may wish to explore these possible channels systematically, which will provide insights on potential ways to improve student support in classes with DE students. For example, if DE peers mainly influence their non-DE community college classmates through less effective peer interactions and group projects, instructors could implement course policies and practices that would allow them to monitor student interactions more closely and detect student disengagement in a timely manner. Given the growth of DE programs nationally, it is critical to identify effective ways to ensure the quality of learning for all.

References

Allen, D., & Dadgar, M. (2012). Does dual enrollment increase students' success in college? Evidence from a quasi-experimental analysis of dual enrollment 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 impact of dual enrollment on college degree attainment: Do low-SES students benefit? *Educational Evaluation and Policy Analysis*, *35*(1), 57–75. https://doi.org/10.3102/0162373712461933

An, B. P., & Taylor, J. L. (2019). A review of empirical studies on dual enrollment: Assessing educational outcomes. In M. B. Paulsen & L. W. Perna (Eds.), *Higher education: Handbook of theory and research* (vol. 34, pp. 99–151). Springer.

Andrews, H. A., & Marshall, R. P. (1991). Challenging high school honor students with community college courses. *Community College Review*, *19*(1), 47–51. https://doi.org/10.1177/009155219101900109

Azim, S. & Sandra, W. (2019). *Dual enrollment: participation and characteristics*. Retrieved from the National Center for Education Statistics website: https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019176

Bailey, T., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review, 29*(2), 255-270. https://doi.org/10.1016/j.econedurev.2009.09.002

Betts, J. R., & Zau, A. (2004). *Peer groups and academic achievement: Panel evidence from administrative data*. Unpublished manuscript.

Booij, A. S., Leuven, E., & Oosterbeek, H. (2017). Ability peer effects in university: Evidence from a randomized experiment. *The review of economic studies*, *84*(2), 547-578. https://doi.org/10.1093/restud/rdw045

Boozer, M., & Cacciola, S. E. (2001). *Inside the 'black box' of Project STAR: Estimation of peer effects using experimental data* (Center Discussion Paper No. 832). New Haven, CT: Yale University, Economic Growth Center.

Borman, G. D., & Hewes, G. M. (2002). The long-term effects and cost-effectiveness of Success for All. *Educational Evaluation and Policy Analysis*, *24*(4), 243–266. https://doi.org/10.3102/01623737024004243

Boswell, K. (2001). State policy and postsecondary enrollment options: Creating seamless systems. *New Directions for Community Colleges*, *2001*(113), 7-14. https://doi.org/10.1002/cc.3

Brunello, G., De Paola, M., & Scoppa, V. (2010). Peer effects in higher education: Does the field of study matter? *Economic Inquiry*, *48*(3), 621-634. https://doi.org/10.1111/j.1465-7295.2009.00235.x

Burke, M. A., & Sass, T. R. (2013). Classroom peer effects and student achievement. *Journal of Labor Economics*, *31*(1), 51–82. https://doi.org/10.1086/666653

Calcagno, J. C., Crosta, P., Bailey, T., & Jenkins, D. (2007). Does age of entrance affect community college completion probabilities? Evidence from a discrete-time hazard model. *Educational Evaluation and Policy Analysis*, *29*(3), 218–235. https://doi.org/10.3102/0162373707306026

Carrell, S. E., Fullerton, R. L., & West, J. E. (2009). Does your cohort matter? Measuring peer effects in college achievement. *Journal of Labor Economics*, *27*(3), 439–464. https://doi.org/10.1086/600143

Catron, R. (2001). Dual enrollment in Virginia. *New Directions for Community Colleges*, *2001*(113), 51–58. https://doi.org/10.1002/cc.8

College Board. (2017). *College credit in high school* (Working Group Report). https://secure-media.collegeboard.org/pdf/research/college-credit-high-school-working-group-report.pdf

Conley, D. T. (2008). Rethinking college readiness. *New Directions for Higher Education*, *2008*(144), 3–13. https://doi.org/10.1002/he.321

Denning, J. T., Murphy, R., & Weinhardt, F. (2020). *Class rank and long-run outcomes* (NBER Working Paper No. 27468). Retrieved from National Bureau of Economic Research website: http://www.nber.org/papers/w27468.pdf

Duflo, E., Dupas, P., & Kremer, M. (2011). Peer effects, teacher incentives, and the impact of tracking: Evidence from a randomized evaluation in Kenya. *American Economic Review*, *101*(5), 1739–1774. https://doi.org/10.1257/aer.101.5.1739

Elsner, B., & Isphording, I. E. (2017). A big fish in a small pond: Ability rank and human capital investment. *Journal of Labor Economics*, *35*(3), 787–828. https://doi.org/10.1086/690714

Ficano, C. C. (2012). Peer effects in college academic outcomes—Gender matters! *Economics of Education Review*, *31*(6), 1102–1115. https://doi.org/10.1016/j.econedurev.2012.07.012

Fink, J. (2018, November 5). How does access to dual enrollment and Advanced Placement vary by race and gender across states? [Blog post]. Retrieved from https://ccrc.tc.columbia.edu/easyblog/access-dual-enrollment-advanced-placement-race-gender.html

Fink, J., Jenkins, D., & Yanagiura, T. (2017). *What happens to students who take community college “dual enrollment” courses in high school?* New York, NY: Columbia University, Teachers College, Community College Research Center.

Freeman, T. M., Anderman, L. H., & Jensen, J. M. (2007). Sense of belonging in college freshmen at the classroom and campus levels. *Journal of Experimental Education*, *75*(3), 203–220. https://doi.org/10.3200/JEXE.75.3.203-220

Garcia, H. A., Eicke, D., McNaughtan, J., & Harwood, Y. (2020). Understanding Dual Credit Programs: Perspectives from Faculty, Staff, and Administrators. *Community College Journal of Research and Practice*, *44*(8), 584-594. https://doi.org/10.1080/10668926.2019.1626301

Gerber, C. (1987). *High school/college brief*. Supplement to AACJC Letter, *242*, 1–4.

Giani, M., Alexander, C., & Reyes, P. (2014). Exploring variation in the impact of dual-credit coursework on postsecondary outcomes: A quasi-experimental analysis of Texas students. *High School Journal*, *97*(4), 200–218. https://doi.org/10.1353/hsj.2014.0007

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

Herzog, S. (2005). Measuring determinants of student return vs. dropout/stopout vs. transfer: A first-to-second year analysis of new freshmen. *Research in Higher Education*, *46*(8), 883–928. https://doi.org/10.1007/s11162-005-6933-7

Holmes, W. H. (1912). *School organization and the individual child: A book for school executives and teachers, being an exposition of plans that have been evolved to adapt school organization to the needs of individual children, normal, supernormal and subnormal*. Davis Press.

Horn, L., & Nevill, S. (2006). *Profile of undergraduates in U.S. postsecondary education institutions, 2003–04: With a special analysis of community college students* (NCES 2006-184). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

Hoxby, C. (2000). *Peer effects in the classroom: Learning from gender and race variation* (NBER Working Paper No. 7867). Cambridge, MA: National Bureau of Economic Research.

Hoxby, C. M., & Avery, C. (2012). *The missing "one-offs": The hidden supply of high-achieving, low income students* (NBER Working Paper No. 18586). Cambridge, MA: National Bureau of Economic Research.

Hoxby, C. M., & Weingarth, G. (2005). *Taking race out of the equation: School reassignment and the structure of peer effects*. (NBER Working Paper No. 7867). Cambridge, MA: National Bureau of Economic Research.

Hughes, K. L., & Edwards, L. (2012). Teaching and learning in the dual enrollment classroom. *New Directions for Higher Education*, *2012*(158), 29–37. https://doi.org/10.1002/he.20012

Imberman, S. A., Kugler, A. D., & Sacerdote, B. I. (2012). Katrina's children: Evidence on the structure of peer effects from hurricane evacuees. *American Economic Review*, *102*(5), 2048–2082. https://doi.org/10.1257/aer.102.5.2048

Jenkins, R. (2013, February 12). Serving our dual-enrollment students. *The Chronicle of Higher Education*. Retrieved from https://www.chronicle.com

Jones, S. J. (2014). Student participation in dual enrollment and college success. *Community College Journal of Research and Practice*, *38*(1), 24–37. https://doi.org/10.1080/10668926.2010.532449

Jordan, W. J., Cavalluzzo, L., & Corallo, C. (2006). Community college and high school reform: Lessons from five case studies. *Community College Journal of Research and Practice*, *30*(9), 729-749. https://doi.org/10.1080/01411890500207530

Karp, M. M. (2012). "I don't know, I've never been to college!" Dual enrollment as a college readiness strategy. *New Directions for Higher Education*, *2012*(158), 21–28. https://doi.org/10.1002/he.20011

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007). *The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states*. New York, NY: Columbia University, Teachers College, Community College Research Center.

Kimbrough, E. O., McGee, A. D., & Shigeoka, H. (2017). *How do peers impact learning? an experimental investigation of peer-to-peer teaching and ability tracking* (No. w23439). National Bureau of Economic Research. https://doi.org/10.3386/w23439

Kooreman, P. (2007). Time, money, peers, and parents; some data and theories on teenage behavior. *Journal of Population Economics*, *20*(1), 9-33. https://doi.org/10.1007/s00148-006-0121-8

Lavy, V., Paserman, M. D., & Schlosser, A. (2011). Inside the black box of ability peer effects: Evidence from variation in the proportion of low achievers in the classroom. *Economic Journal*, *122*(559), 208–237. https://doi.org/10.1111/j.1468-0297.2011.02463.x

Lavy, V., Silva, O., & Weinhardt, F. (2009). The good, the bad and the average: Evidence on the scale and nature of ability peer effects in schools. *Journal of Labor Economics*, *30*(2), 367–414. https://doi.org/10.1086/663592

Lefgren, L. (2004). Educational peer effects and the Chicago public schools. *Journal of Urban Economics*, *56*(2), 169–191. https://doi.org/10.1016/j.jue.2004.03.010

Lyle, D. S. (2007). Estimating and interpreting peer and role model effects from randomly assigned social groups at West Point. *Review of Economics and Statistics*, *89*(2), 289–299. https://doi.org/10.1162/rest.89.2.289

Manski, C. F. (1993). Identification of endogenous social effects: The reflection problem. *The review of economic studies*, *60*(3), 531-542. https://doi.org/10.2307/2298123

Marsh, H. W., Seaton, M., Trautwein, U., Lüdtke, O., Hau, K.-T., O'Mara, A. J., & Craven, R. G. (2008). The big-fish–little-pond-effect stands up to critical scrutiny: Implications for theory, methodology, and future research. *Educational Psychology Review*, *20*(3), 319–350. https://doi.org/10.1007/s10648-008-9075-6

Miller, T., Kosiewicz, H., Tanenbaum, C., Atchison, D., Knight, D., Ratway, B., … Levin, J. (2018). *Dual-credit education programs in Texas: Phase II*. Washington, DC: American Institutes for Research.

Mokher, C. G., & McLendon, M. K. (2009). Uniting secondary and postsecondary education: An event history analysis of state adoption of dual enrollment policies. *American Journal of Education*, *115*(2), 249–277. https://doi.org/10.1086/595668

Murphy, R., & Weinhardt, F. (2018). *Top of the class: The importance of ordinal rank* (NBER Working Paper No. 24958). Cambridge, MA: National Bureau of Economic Research.

Ost, B. (2010). The role of peers and grades in determining major persistence in the sciences. *Economics of Education Review*, *29*(6), 923–934. https://doi.org/10.1016/j.econedurev.2010.06.011

Ostrove, J. M., & Long, S. M. (2007). Social class and belonging: Implications for college adjustment. *Review of Higher Education*, *30*(4), 363–389. https://doi.org/10.1353/rhe.2007.0028

Ran, F. X., & Xu, D. (2019). Does contractual form matter? The impact of different types of non-tenure-track faculty on college students' academic outcomes. *Journal of Human Resources*, *54*(4), 1081-1120. https://doi.org/ 10.3368/jhr.54.4.0117.8505R

Reed, M. (2018, October 18). What nobody told me about dual enrollment. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/blogs/confessions-community-college-dean/what-nobody-told-me-about-dual-enrollment

Sacerdote, B. (2001). Peer effects with random assignment: Results for Dartmouth roommates. *Quarterly Journal of Economics*, *116*(2), 681–704. https://doi.org/10.1162/00335530151144131

Sacerdote, B. (2011). Peer effects in education: How might they work, how big are they and how much do we know thus far? In E. A. Hanushek, S. Manchin, & L. Woessmann (Eds.), *Handbook of the economics of education* (vol. 3, pp. 249–277). Elsevier.

Sacerdote, B. (2014). Experimental and quasi-Experimental analysis of peer effects: Two steps forward? *Annual Review of Economics*, *6*, 253–272. https://doi.org/10.1146/annurev-economics-071813-104217

Smith, A. (2017, May 31). Double-edged sword of dual enrollment. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/news/2017/05/31/dual-enrollment-provides-boost-community-colleges-may-hide-extent-enrollment

Speroni, C. (2011). *High school dual enrollment programs: Are we fast-tracking students too fast?* (NCPR Working Paper). New York, NY: National Center for Postsecondary Research.

Stinebrickner, R., & Stinebrickner, T. R. (2006). What can be learned about peer effects using college roommates? Evidence from new survey data and students from disadvantaged backgrounds. *Journal of Public Economics*, *90*(8–9), 1435–1454. https://doi.org/10.1016/j.jpubeco.2006.03.002

Strayhorn, T. (2008). Sentido de pertenencia: A hierarchical analysis predicting sense of belonging among Latino college students. *Journal of Hispanic Higher Education*, *7*(4), 301–320. https://doi.org/10.1177/1538192708320474

Strayhorn, T. L. (2018). *College students' sense of belonging: A key to educational success for all students*. Routledge.

U.S. Department of Education. (2018). Table 326.20. *Graduation rate from first institution attended within 150 percent of normal time for first-time, full-time degree/certificate-seeking students at 2-year postsecondary institutions, by race/ethnicity, sex, and control of institution: Selected cohort entry years, 2000 through 2014.* Washington, DC: National Center for Education Statistics. Retrieved from https://nces.ed.gov/programs/digest/d18/tables/dt18_326.20.asp

U.S. Government Accountability Office. (2018). *Public high schools with more students in poverty and smaller schools provide fewer academic offerings to prepare for college* (Report No. GAO-19-8). Retrieved from https://www.gao.gov/assets/700/694961.pdf

Whitmore, D. (2005). Resource and peer impacts on girls' academic achievement: Evidence from a randomized experiment. *American Economic Review*, *95*(2), 199–203. https://doi.org/10.1257/000282805774670158

Witkowsky, P., & Clayton, G. (2019). What Makes Dual Enrollment Work? High School Counselor Perspectives. *Community College Journal of Research and Practice*, 1-18. https://doi.org/10.1080/10668926.2019.1610676

Xu, D. (2019). Academic performance in community colleges: The influences of part-time and full-time instructors. *American Educational Research Journal*, *56*(2), 368–406. https://doi.org/10.3102/0002831218796131

Zimmer, R. (2003). A new twist in the educational tracking debate. *Economics of Education Review*, *22*(3), 307–315. https://doi.org/10.1016/S0272-7757(02)00055-9

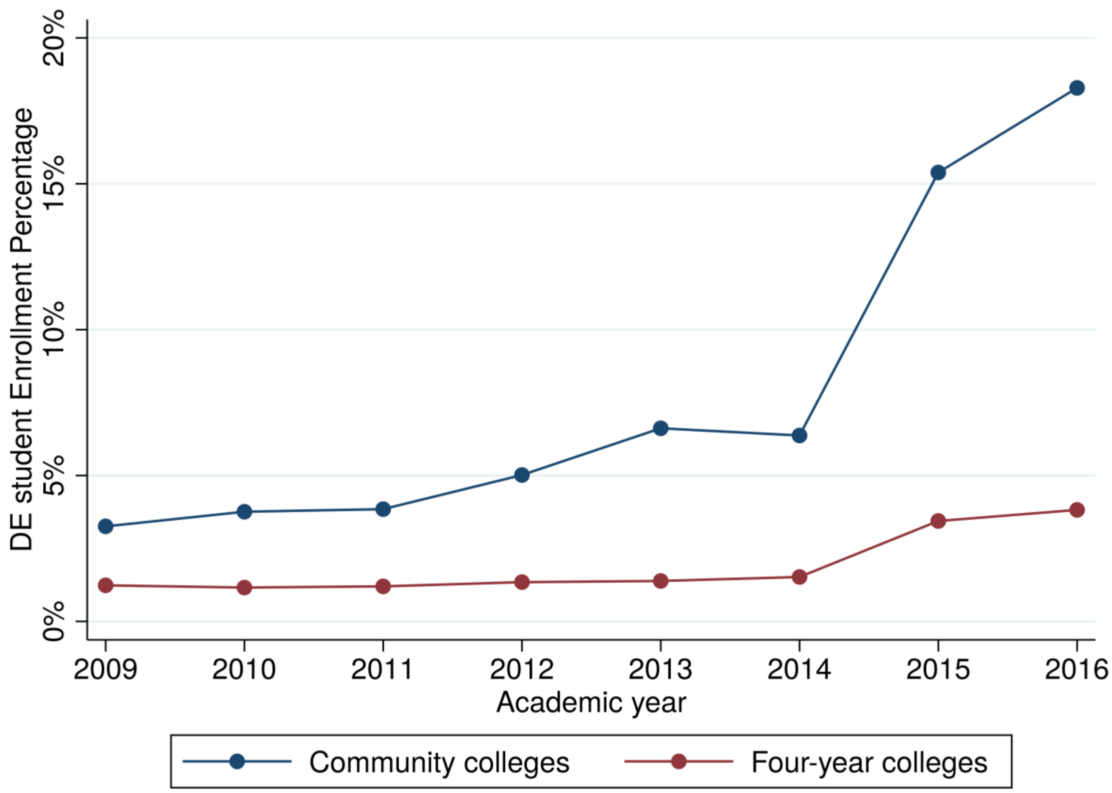
Zimmerman, D. J. (2003). Peer effects in academic outcomes: Evidence from a natural experiment. *Review of Economics and Statistics*, *85*(1), 9–23. https://doi.org/10.1162/003465303762687677

Zinth, J. (2015). State approaches to funding dual enrollment. Denver, CO: Education Commission of the States.

Zinth, J. (2016). Dual enrollment: Student eligibility requirements. Retrieved from http://ecs.force.com/mbdata/MBQuestNB2?Rep=DE1507

Zinth, J., & Barnett, E. (2018). *Rethinking dual enrollment to reach more students: Promising practices*. Denver, CO: Education Commission of the States.

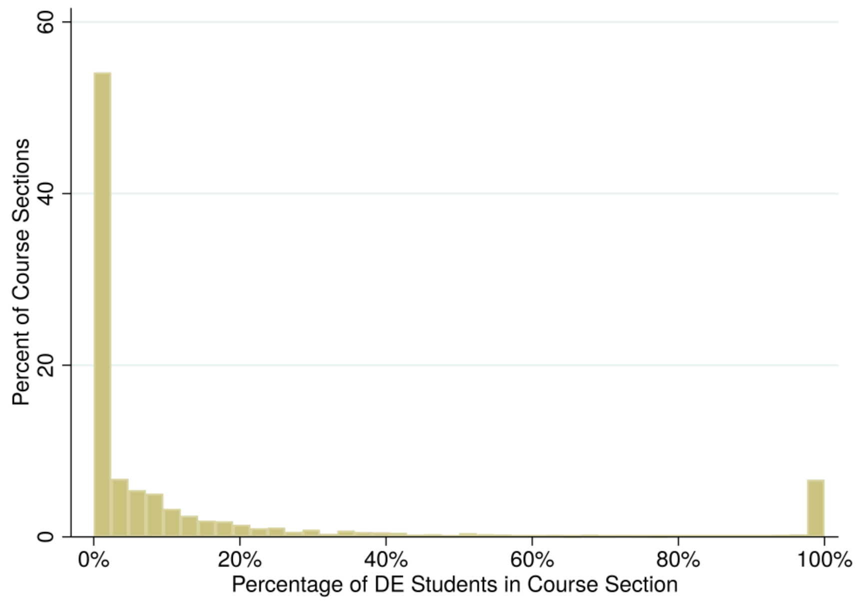
Figure 1.
Proportion of DE Students Among Two- and Four-Year Public College Students in the State



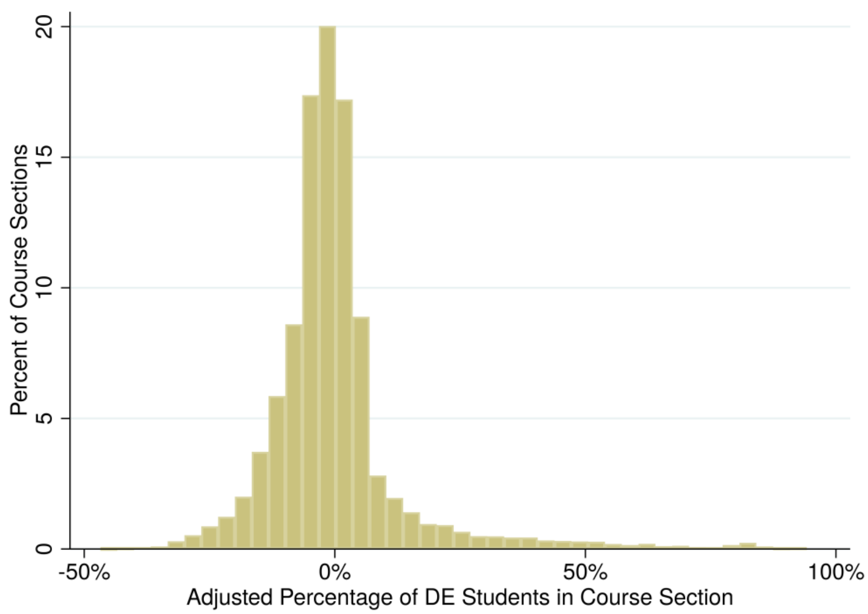
Note. Each point represents the proportion of DE students as a percentage of the total public college student count per year. The sample includes all students enrolled in the state in each academic year.

Figure 2
Raw and Adjusted Distributions of the Percentage of DE Students in Math and English Gateway Course Sections

Panel A. Raw Percentage of Dual Enrollment Students per Course Section

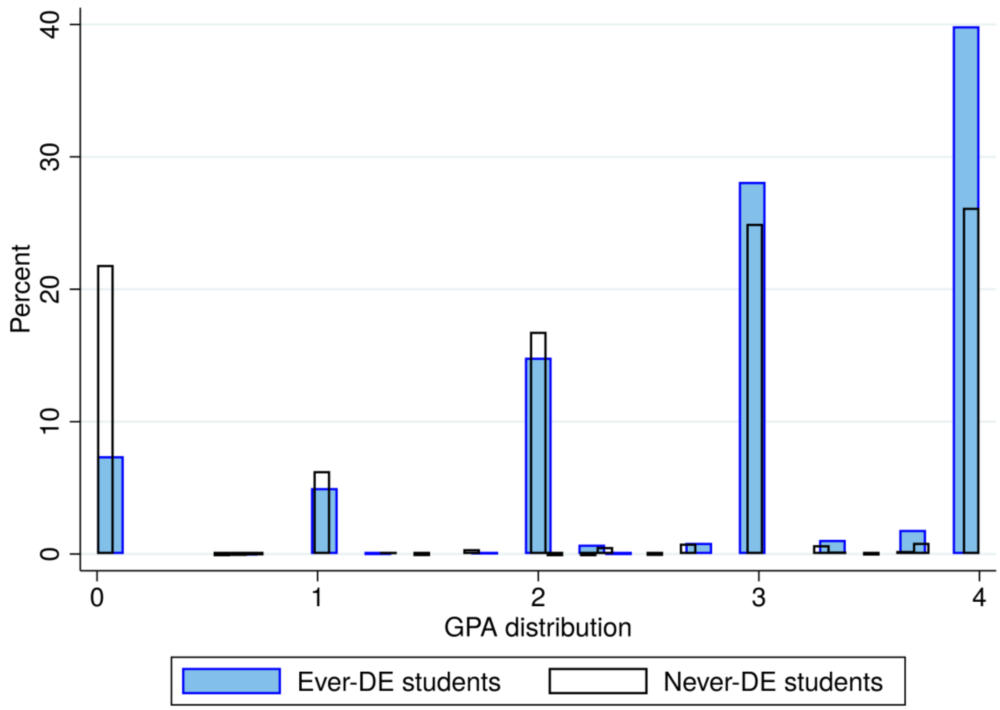


Panel B. Adjusted Percentage of Dual Enrollment Students per Course Section



Note. The sample includes all gateway courses between fall of 2012 and summer of 2017. Panel B shows the distribution of residuals after adjusting for the course and term fixed effects

Figure 3
Grade Point Average Distribution for All Gateway Courses
Among Ever-DE and Never-DE Community College Students



Note. The sample includes all gateway course grades earned between fall of 2012 and summer of 2017 in which the classroom population was 12% or less DE students.

Table 1
Summary Statistics at the Student Level (Fall 2012–Summer 2017)

	Status at Community Colleges		
	Exclusively DE	Ever DE	Never DE
Observations	4,120	3,858	180,010
Student characteristics			
Female	67%	70%	57%
White	81%	84%	69%
Black	7%	6%	17%
Hispanic	3%	4%	4%
Other races/ethnicities	13%	13%	13%
In-district resident	37%	43%	24%
In-state resident	77%	76%	80%
Disabled	5%	6%	11%
High school graduation year	2015	2014	2008
Initially enrolled in college in fall (versus spring or summer)		59%	60%
Age at college entry	19	19	24
Full-time enrollment during first term		73%	58%
First-time college students		98%	78%
Placed in remedial English		26%	20%
Placed in remedial math		37%	34%
Intention declared at college entry			
Recreation	15%	27%	5%
Skills enhancement	2%	5%	7%
Earn community college credentials	23%	43%	66%
Earn a bachelor's degree	21%	30%	23%
Missing intent	76%	63%	22%
College performance and degree outcomes			
College credits earned in Term 1	6.6	5.5	6.1
GPA in Term 1	3.16	3.05	2.95
Ever earned a certificate	30%	22%	26%
Ever earned associate degree	10%	25%	16%
Ever earned bachelor's degree	28%	18%	19%
Missing NSC data (missing coverage for out of state degree attainment)	25%	10%	14%

Note. Data include all students enrolled in any gateway course between fall of 2012 and summer of 2017 in which the classroom population was 12% or fewer DE students.

Table 2
Predictors of Exposure to Dual Enrolled Students

	Percentage of DE	
Student-level characteristics		
Female	0.002	[0.002]
Race (Base group: White)		
Black	-0.005***	[0.002]
Hispanic	-0.006	[0.004]
Other/ethnicities	-0.006***	[0.002]
In-district resident	-0.006	[0.002]
In-state resident	-0.005	[0.004]
Disabled	-0.002	[0.003]
High school graduation year	-0.000	[0.000]
Initially enrolled in college in fall (versus spring or summer)	0.001	[0.002]
Age at college entry	0.001***	[0.000]
Full-time enrollment during first term	0.001	[0.001]
First-time college students	0.000	[0.000]
Placed in remedial English	-0.002	[0.002]
Placed in remedial math	0.004***	[0.002]
Intention declared at college entry (Base group: Earn community college credentials)		
Recreation	-0.001	[0.003]
Skills enhancement	-0.005**	[0.002]
Earn a bachelor's degree	-0.003*	[0.002]
Missing intent	-0.027***	[0.005]
Term-level characteristics		
College credits enrolled this term	0.000***	[0.000]
Average age of college peers	-0.015***	[0.002]
Credits earned last term	0.000***	[0.000]
College credits earned last term	-0.000**	[0.000]
Credits earned last term in the same subject area	-0.000**	[0.000]
Observations	264,716	
R^2	0.357	

Note. Robust standard errors are in brackets and are clustered at the course-by-term and student levels. All regressions control for course section and instructor characteristics and contain college-course and term fixed effects. Singletons are included in the regressions. Results are almost identical when excluding singletons from the estimation.

**p* < .1. ***p* < .05. ****p* < .01.

Table 3
Effect of DE Peers on Non-DE Community College Students' Outcomes

Outcomes	Passed current course	Persisted to end of course	GPA	Repeated the same course
Percentage of DE peers	-0.019***	-0.010*	-0.055***	0.013**
	[0.006]	[0.005]	[0.018]	[0.005]
Sample mean	0.676	0.868	2.293	0.125
Observations	264,716	264,716	229,634	264,716
R^2	0.791	0.716	0.862	0.570

Note. Robust standard errors are in brackets and are clustered at the course-by-term and student levels. All regressions have a full set of covariates and include current college-course, student, and term fixed effects. Singletons are included in the regressions. Results are almost identical when excluding singletons from the estimation.

**p* < .1. ***p* < .05. ****p* < .01.

Table 4

Impact of DE Peers in First Semester on Non-DE Community College Students' Persistence into the Second Semester

	OLS	College-course-set FE	College-course-set FE + IV
Percentage of DE peers	-0.004***	0.004***	0.056*
	(0.0012)	(0.002)	(0.029)
Observations	501,192	501,192	501,192
R^2	0.120	0.471	0.469
Fixed effect			
Calendar term	Y	Y	Y
College	Y		
College-course-portfolio		Y	Y
F-statistics for excluded IV	-	-	1074

Note. This table estimates the impact of first-term DE exposure on non-DE college student's probability of persisting into the second term. The sample is restricted to student' first term of enrollment in any college-level course. Column 1 is the OLS model, which controls for student characteristics as well as calendar term and college fixed effects. Column 2 further includes college-course-portfolio fixed effect that compares the outcomes of students who take the same set of courses within the same college during their initial term of enrollment. Column 3 includes all the variables in Column 2 and further uses an instrumental variables approach, where we use total DE enrollment in a specific college and term as the instrumental variable for DE percentage.

**p* < .1. ***p* < .05. ****p* < .01.

Table 5
Heterogeneous Effect of Dual Enrollment Peers on
Non-DE Community College Students' Current Course Outcomes, by Prior GPA

Outcome measures	Passed current course	Persisted to end of course	GPA	Repeated same course
Percentage of DE peers	-0.018**	-0.021**	-0.046	0.026**
	[0.008]	[0.008]	[0.032]	[0.011]
Top 50 percentile GPA * % of DE peers	0.001	0.017**	-0.015	-0.016
	[0.010]	[0.008]	[0.043]	[0.013]
Observations	157,442	157,442	140,467	157,442
R^2	0.755	0.673	0.838	0.555

Note: Robust standard errors are in brackets and are clustered at the course-by-term and student levels. All regressions have a full set of covariates and include current college-course, student, and term fixed effects. Singletons are included in the regressions. Results are almost identical when excluding singletons from the estimation.

**p* < .1. ***p* < .05. ****p* < .01.

Table 6
Effects Using Different Model Specifications and Treatment Definition

	Passed current course	Persisted to end of course	GPA	Repeated same course
Panel A. Include courses with DE% < 56%				
Percentage of DE peers	-0.005**	-0.002	-0.013*	0.006**
	[0.002]	[0.002]	[0.006]	[0.002]
Observations	305,974	305,974	265,938	305,974
R^2	0.768	0.687	0.845	0.536
Panel B. Include former DE students				
Percentage of DE peers	-0.020***	-0.010*	-0.057***	0.014**
	[0.006]	[0.005]	[0.018]	[0.006]
Observations	269,635	269,635	234,109	269,635
R^2	0.792	0.716	0.863	0.571
Panel C. Exclude DE students from section-level demographic composition variables				
Percentage of DE peers	-0.022***	-0.011	-0.077***	0.014***
	[0.006]	[0.007]	[0.020]	[0.006]
Observations	264,716	264,716	229,634	264,716
R^2	0.791	0.716	0.863	0.570
Panel D. Treatment = any DE peers				
Having any DE peers	-0.011**	-0.006*	-0.030**	0.007*
	[0.004]	[0.003]	[0.013]	[0.005]
Observations	264,716	264,716	229,634	264,716
R^2	0.791	0.716	0.862	0.570
Panel E. Treatment in DE%				
0 < DE percentage ≤ 4.35%	-0.006	-0.000	-0.021	0.004
	[0.006]	[0.005]	[0.015]	[0.006]
4.35% < DE percentage ≤ 7.41%	-0.015***	-0.010*	-0.032	0.008
	[0.005]	[0.005]	[0.019]	[0.005]
DE percentage > 7.41%	-0.013*	-0.008	-0.040**	0.010
	[0.007]	[0.006]	[0.018]	[0.007]
Observations	264,716	264,716	229,634	264,716
R^2	0.791	0.716	0.862	0.570

Note. Robust standard errors are in brackets and are clustered at the course-by-term and student levels. All regressions have a full set of covariates and include current college-course, student, and term fixed effects. **p* < .1. ***p* < .05. ****p* < .01.

Appendix

Table A1 Public 2-Year Institutional Characteristics, 2012 Enrolling Cohort: National Sample VS. SCCS

	National Sample	SCCS
Panel A: Enrollment		
Full-time enrollment	2544	2168
Percent of GRS cohort[a]	29%	31%
12-month undergraduate headcount	10,159	8,918
Graduation rate (150% normal time), FTIC cohort	27%	34%
Panel B: Student Demographics & SES		
Percent of total enrollment that are		
Female	57%	59%
White, non-Hispanic	59%	80%
Black, non-Hispanic	14%	11%
Hispanic	13%	2%
Asian or Pacific Islander	4%	1%
American Indian or Alaska Native	3%	0%
Race/ethnicity unknown	6%	5%
Citizenship: non-resident alien	1%	0%
Age under 18	9%	8%
Age 18-19	22%	20%
Age 20-24	29%	28%
Age 25 and above	39%	43%
Receiving Pell grants (full-time first-time students)	60%	65%
Panel C: Institution Finance		
In-state Tuition and fees for full-time undergraduates: 2012-13	3044	3828
Expenses per FTE:		
Instruction	2691	3282
Public service	98	140
Academic support	482	497
Student services	632	446
Institutional support	930	838
Percentage of core revenues		
Tuition and fees	17%	33%
Federal appropriations	28%	31%
State appropriations	33%	24%
Local appropriations	14%	4%
Other revenue	8%	8%
Panel D: Number of and average annual salary of Instructional faculty		
Student-to-faculty ratio	19	16
Total number of instructional staff	118	118
Percentage of full-time instructor	39%	28%
Annual salary of full professors	88,000	87,981
Annual salary of associate professors	75,706	78,398
Annual salary of assistant professors	67,011	67,884
Annual salary of full-time instructors	67,414	59,009
Observations	1,049	

Note: Author derived data from the IPEDS Data Center 2012 data collection. Both samples include public degree-granting two-year institution. Number of institutions in SCCS not displayed for anonymity.

[a.] GRS cohort refers to full-time, first-time degree/ certificate-seeking students.

Table A2

Balance Test of Section-level Characteristics and Instructor Assignment

Outcome: Percentage of DE	(1) No course fixed effects		(2) With course fixed effects	
Panel A. Section-level Characteristics				
Average student age	-0.012***	[0.001]	-0.011***	[0.001]
Class size	0.003***	[0.000]	0.004***	[0.000]
Students' average credits earned last term	-0.002***	[0.000]	-0.001*	[0.000]
Average credits earned in this subject last term	0.015***	[0.002]	0.002	[0.003]
Distance learning delivery	0.021***	[0.007]	0.013*	[0.008]
Panel B. Instructor Characteristics				
Female	-0.002	[0.006]	-0.007	[0.006]
Instructor race/ethnicity				
Black	-0.023*	[0.013]	-0.024*	[0.012]
Hispanic	-0.027	[0.030]	-0.014	[0.030]
Asian	-0.025	[0.018]	-0.010	[0.018]
Missing or other	0.027*	[0.014]	0.013	[0.014]
Average age	0.000	[0.000]	0.000	[0.000]
Instructor employment status				
Part-time	-0.002	[0.011]	-0.013	[0.011]
Tenure received	-0.006	[0.012]	-0.014	[0.013]
Tenure-track, not yet received tenure	0.002	[0.014]	-0.007	[0.014]
Instructor rank				
Full professor	0.041**	[0.017]	0.011	[0.017]
Associate professor	0.026	[0.017]	0.008	[0.017]
Assistant professor	0.019	[0.015]	0.011	[0.015]
Instructor	-0.030***	[0.011]	-0.020	[0.012]
Lecturer	0.085**	[0.035]	-0.047	[0.038]
Instructor highest degree earned				
Bachelor's degree	-0.033**	[0.014]	-0.005	[0.015]
Master's degree	-0.014	[0.011]	-0.000	[0.011]
Doctoral/law degree	0.000	[0.014]	-0.001	[0.014]
Years of teaching	0.003	[0.002]	0.005**	[0.002]
Class co-taught by more than one instructor	0.027***	[0.006]	0.025***	[0.006]
Observations	13,898		13,898	
R^2	0.168		0.228	

Note. Robust standard errors are in brackets. All regressions control for section-level student characteristics and contain college-course and term fixed effects.

**p* < .1. ***p* < .05. ****p* < .01.

Table A3
Main Results with Sample Containing Prior GPA

Outcomes	Passed current course	Persisted to end of course	GPA	Repeated same course
Percentage of DE peers	-0.018**	-0.012*	-0.054**	0.016***
	[0.007]	[0.006]	[0.022]	[0.006]
Sample mean	0.741	0.893	2.467	0.118
Observations	172,465	172,465	154,054	172,465
R^2	0.753	0.670	0.838	0.554

Note. Sample includes all student college-level non-gateway course enrollments. Robust standard errors are in brackets and are clustered at the course-by-term and student levels. All regressions have a full set of covariates and include current college-course, student, and term fixed effects. Singletons are included in the regressions. Results are almost identical when excluding singletons from the estimation.

*$p < .1$. **$p < .05$. ***$p < .01$.