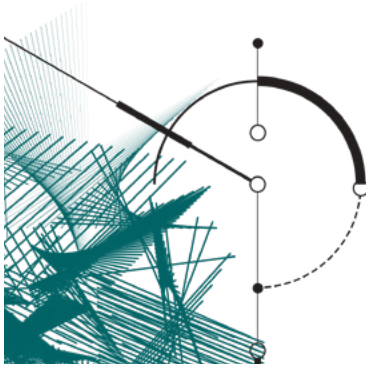
Abstract

Previous studies have found that freshmen who enter college with dual enrollment credits earned during high school have higher 6-year graduation rates. Yet, we do not know if institutional graduation rates benefit in the aggregate from their practice of accepting dual enrollment credits among incoming freshman cohorts. In this study, we used institutional panel data from the Integrated Postsecondary Education Data System and the 2006, 2007, and 2008 incoming freshman cohorts to address this policy issue. Based on regression results from generalized linear models, we found a contradictory pattern for the relationship between the institutional practice of accepting dual enrollment credits and graduation rates. Among the lesser selective institutions, those that accepted dual enrollment credits among their incoming freshmen realized higher 6-year graduation rates. But among the more selective institutions, this same practice was associated with lower 6-year graduation rates.



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Dual Enrollment Policies and Undergraduate Rates in the United States: An Institutional and Cohert Approach Using the 2006–2014 IPEDS

Graduation rates from four-year colleges in the United States have risen significantly in the past 40 years but recent data indicate that these improvements have stagnated. Indeed, 6-year graduation rates for males since 2006 have stalled at around 55-56% and those for females at about 60-62% with even lower stalled rates for racial minorities (NCES, 2016). As a result, higher education institutions are increasingly being held accountable for institutional-level graduation rates that are assessed as indicators of best practices, institutional success, and major inputs in performance funding models (Heck, Lam, & Thomas, 2014; Rabovsky, 2014).

The Integrated Postsecondary Education Data System (IPEDS) used in this research was itself developed to help institutions comply with the 1990 federal accountability policy, "Student Right-to-Know and Campus Security Act" (SRK). This act requires 2- and 4-year institutions eligible for Title IV funding to assess and report yearly graduation rates for an incoming freshman cohort, where successful graduation is defined as within 150% of normal time—three years at a 2-year institution and six years at a 4-year institution. These graduation rates are often seen as measures of institutional effectiveness. Russell (2011) argued that this assessed accountability vis-à-vis graduation rates is embedded in the "college completion agenda" promoted by stakeholders such as the College Board and the Bill and Melinda Gates and the Lumina Foundations.

These developments lead institutions to continually seek and implement best policies and practices that assessment research has shown to increase graduation rates, especially among students who are traditionally at a higher risk of incompletion. The goal of these policies is to encourage greater college preparedness and readiness that are strong predictors of college success where the activities that best achieve this are high-school students taking college-level courses and earning college credits prior to enrollment (Struhl & Vargas, 2012). Advanced Placement (AP) courses historically served this purpose, and

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college admission policies often use AP scores as a proxy for college preparation and future achievement (Jackson, 2010). More recently, higher-education institutions have partnered with high schools to offer their pre-college students the ability to earn college credit through dual enrollment (DE) courses, and when passed, these courses are accepted by some higher-education institutions as college credits. This practice is consistent with a main recommendation by Conley (2005) for improving the college readiness and success of students. Namely, there needs to be better articulation between high school and college curricula.

These institutions accept DE credits as college credits partly because it has been shown that if a DE course is well structured and provides authentic college-level learning and socializing experiences then students who take such a DE course may experience increased college preparedness and better college outcomes (Allen, 2010; Blackboard Institute, 2010; Karp, 2012). Indeed, at the individual level, research has found that students who enter college with DE credits have better college outcomes—net of selection effects—including higher GPAs, 1-year persistence rates, and, most importantly, 6-year graduation rates. Further, the effects of DE were stronger for at-risk students and those in less selective institutions (An, 2013b, 2015; Lerner & Brand, 2006).

What has not yet been assessed is whether DE credits influence graduation rates above and beyond these individual-level effects. That is, does an institution benefit as a whole when they have an admissions policy that accepts earned DE college credits among incoming freshmen?

What has not yet been assessed is whether DE credits influence graduation rates above and beyond these individual-level effects. That is, does an institution benefit as a whole when they have an admissions policy that accepts earned DE college credits among incoming freshmen? To the best of our knowledge, our research is the first to statistically assess the link between DE credit policy and graduation rates at the *institutional* level. We situate our study within the logic of Astin's Input-Environment-Output model (Astin, 1991; Astin & antonio, 2012). In this study, we focus on 4-year institutions and institutional cohort graduation rates from the incoming freshman classes of 2006 – 2008. We adopt this approach to guard against the substantial differences between 2-year and 4-year institutions (Newell, 2014) and to allow our findings to be compared to other studies who had identical selection factors and used cohort rates, as these are required by the SRK and are the only common metrics for comparing rates across the wide array of 4-year institutions in the United States (Bound, Lovenheim, & Turner, 2012; Hess, Schneider, Carey, & Kelly, 2009). Ideally, our research would also test the relative effects of DE versus those of AP policies. However, in 2006–2008 over 98% of our 4-year institutions had an admissions policy of accepting AP credits, and IPEDS does not contain any specifics about required minimum AP exam scores to receive college credit. Therefore, within a regression format we cannot assess the effects of having an AP policy as this variable is virtually a constant across our institutions.

Conceptual Approach and Research Hypotheses

Much like the AP program, the goal of a well-structured DE course is to provide high-school students with a more rigorous classroom experience, the opportunity to experience an authentic college-level course, and to earn college credits prior to enrolling in a higher-education institution. The most recent data from the 2010–11 academic year showed that 82% of public high schools had students who took DE courses, with over 1.44 million students enrolled in just over 2 million DE courses (Thomas, Marken, Gray, Lewis, & Ralph, 2013). About 16% of first-time, full-time students entered 4-year institutions in Fall 2008 with college credits from at least one DE course (Shapiro, Dundar, Yuan, Harrell, & Wakhungu, 2014).

Research has found that students who take well-structured and authentic DE courses are exposed to a potentially more rigorous, accelerated, and college-level curriculum that prepares them academically and socially for college, reduces the need for remedial courses, accelerates the earning of credits, and lowers the financial costs (Allen, 2010; An, 2013a; Bound, Lovenheim, & Turner, 2010; Karp, 2012; Lerner & Brand, 2006). Thus, DE courses provide not only an accelerated college preparation and credit but also a potentially more authentic and socializing college experience (Speroni, 2011a). A longitudinal qualitative study by Karp (2012) revealed that high-school students who take DE courses at a community college generally reported that these courses were an authentic college experience and allowed them to learn about the expectations and roles of a college student and actively practice these behavioral expectations. For these reasons, research has found that students who earned DE

credits in high school had better first-year and overall GPAs, better course sequencing, less major switching, more credits earned in the first year, and shorter times to degree completion. As a result, these students experienced greater retention and graduation rates after adjusting for a range of demographic, SES, and academic covariates (Allen, 2010; An, 2013b, 2015; Jackson, 2010; Speroni, 2011a, 2011b). The influence of DE is largely due to better college preparation, entering with college credits, the socializing and learning effects of a DE course, and greater academic motivation and engagement among these students (An, 2013a, 2015; Speroni, 2011a).

But our research seeks to answer a more macro question: do institutions benefit in the aggregate by accepting DE credits? That is, is it possible that institutions attain boosts in graduation rates from admitting students with DE credits above and beyond the summed superior outcomes among these students themselves? This institutional phenomenon would be possible if the presence of students with DE credits provides meta-individual processes and environments that benefit their fellow students without DE credits. We posit that peer effects in educational settings is the meta-individual environment and conceptual link between an institution's policy of accepting college credit for DE courses and its graduation rates. Our conceptual use of peer effects is based on Coleman et al. (1966) who found that a student with access to higher-achieving peers performed better academically, which led to the school performing better aggregately. Recent literature in higher education argues students who are exposed to higher-achieving and better-prepared peers will have enhanced academic outcomes as they have access to peer networks that provide a combination of social, human, and cultural capital resources (Booij, Leuven, & Oosterbeek, 2015; Conley, Mehta, Stinebrickner, & Stinebrickner, 2015; Estell & Perdue, 2013; Nechyba, 2006). Our review above on the relationship between DE and college behaviors and outcomes suggests that those who enter college with DE credits were more college ready, motivated, and successful than those without DE credits, and thus could fit the label of "higher-achieving peers."

The reader may link our approach to the logic of Astin's Input-Environment-Output model that is often used in educational research to organize longitudinal data and study academic outcomes (Astin & antonio, 2012). In this model, students enter college with specific Input (I) backgrounds and academic characteristics and capabilities that are partly a reflection of institutional characteristics (e.g., selectivity) given that students self-select themselves into these institutions (Tinto, 2012). Once in college, they enter into academic, social, and co-curricular Environments (E) that influence their learning and progress. Environments derive largely from institutional policies, decisions, resources, and practices that shape the educational settings and experiences in which students come into contact. The I-E-O model places an emphasis on academic and co-curricular engagements and interactions and the environmental influence of a student's peer group or "the characteristics of the student's peer group" (Astin, 1991, p. 92). At the end of this process, the Outcomes (O) or the consequences of these environments and inputs are measured, where the behavioral outcomes are usually academic progress and completion.

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For our study, students either do or do not bring with them DE credits, experiences, and DE-related benefits (i.e., inputs). Above we argued that it would be expected that institutions that accepted DE credits would also enroll more incoming freshmen with these credits. Thus, those institutions who accept DE credits may have a peer environment (E) created by these students who bring with them the benefits that stem from DE. This peer environment may also benefit students who themselves bring with them DE credits. As the I-E-O model places an emphasis on interactions in these environments, we reason that these institutions who accept DE credits would realize superior outcomes (O) in terms of 6-year graduation rates compared to their institutional counterparts who do not accept DE credits.

The IPEDS data do not collect the requisite data to directly test peer effects so our approach is heuristic. The main limitation of the IPEDS survey is that it measures with a binary variable whether the institution has a policy of accepting DE credits (yes or no). The IPEDS submission does not query the institutions beyond this binary measure, such as the percentage of students who enter the institution with DE credits. However, we do assume that schools that accept DE credits will enroll a larger percentage of freshmen with DE credits

compared to institutions that do not accept DE credits and therefore are more likely to have an environment that fosters peer effects. We make this assumption for two reasons. First, research has found that a motivating factor in taking a DE course was how college credits influence a quicker time-to-degree pace and a lower financial burden. As such, students in DE courses reported being aware of college and university policies regarding the acceptance of credits earned through DE and AP courses (Smith et al., 2007). No research exists for DE, but the College Board (2014) found over half of the AP students surveyed reported they would be less likely to apply to a college or university that did not give credit for AP exam scores. Second, the College Choice Model recognizes that parents and students make choices strongly based on the price of college and the extent to which their student will achieve success at the chosen college (Niu & Tienda, 2008). This indicates that students with DE credits may be more likely to consider a college that accepts DE credits due to the lower cost and higher utility realized from the positive effects of entering college with college credits.

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The research we cited earlier showed that incoming freshmen with DE credits were, on average, more academically and socially prepared for college, more academically motivated and engaged once in college, and more likely to graduate compared to those without DE credits. Thus, situating peer effects theory with the logic of the I-E-O model suggests that students who enter without DE credits would benefit academically from the exposure to and interaction with students with DE credits and what these students bring with them to college above and beyond college credits (e.g., socializing experiences, academic preparation, motivation, and engagement). If so, then institutional graduation rates should be higher at institutions that accept DE credits above and beyond the cumulative individual-level effects of entering college with DE credits. We propose the following hypotheses:

- Hypothesis 1: Institutions that accept DE credits will have higher 6-year graduation rates compared to those that do not accept DE credits.
- Hypothesis 2: For peer effects to be supported, we hypothesize that the graduation rates among institutions who accept DE credits will be greater than the cumulative contributions of individual-level effects.

Lastly, emerging research has found that the positive benefits of college credits earned in high school on college outcomes were often greater for those at less selective institutions (An, 2013a, 2013b, 2015). Our third hypothesis is as follows:

- Hypotheses 3: The positive effects of a DE policy on graduation rates will be greater at less selective institutions.

Methods

Data

We used institutional-level panel data from the 2006–2009 and 2012–2014 Integrated Postsecondary Education Data System (IPEDS) to track the 6-year graduation rates of the incoming 2006, 2007, and 2008 cohorts of freshmen. We chose to analyze the most recent three cohorts for which IPEDS final release graduation data were available to better reduce any biases or distinctive results that may emerge from a single cohort. IPEDS collects data from post-secondary institutions in the United States (the 50 states and the District of Columbia) and other jurisdictions, such as Puerto Rico. Participation in IPEDS is a requirement for the institutions that partake in Title IV federal student financial aid programs such as Pell Grants or Stafford Loans during the academic year.

The IPEDS definition of "cohort" refers to full-time, first-time, degree-seeking students. We followed prior studies on graduation rates by limiting our institutions to those that were eligible for Title IV funding, enrolled at least 50 full-time freshmen in 2006–2008, granted bachelor degrees, were not-for-profit, were 4-year institutions, provided graduation data in the 2012–2014 Graduation Rate Survey, had complete data on the institutional measures, and had a Barron's selectivity ranking (Bound et al., 2010; Hess et al., 2009). Our analytic sample included 1,370 institutions that met these specifications for all cohorts, which resulted in 4,110 institution observations.

Focal Study Variables

The study variables are presented in Table 1. The 6-year graduation rate was measured in 2012, 2013, and 2014 and represented the percentage of the 2006, 2007, and 2008 cohort, respectively, who earned their bachelor's degree within 150% normal time. We used the 6-year institutional rate given its inclusion in federal acts, as a common measure of institutional effectiveness, and use in past research. The focal independent variable was measured in 2006, 2007, and 2008 for the three freshman cohorts and indicated (1 = yes; 0 = no) whether the institution had a policy of granting college credit for DE courses passed while in high school. Lastly, we rated each institution's academic admissions selectivity with the Barron's Selectivity Score that ranged from 1 = noncompetitive to 6 = most competitive. This selectivity score classified the admissions competitiveness of each institution using criteria such as median SAT or composite ACT scores, GPA of the incoming freshman cohort, class rank, and acceptance rates.

Institutional Covariates

A parsimonious set of institutional covariates other than selectivity consistently predicted most of the differences in graduation rates (Hess et al., 2009; Shin, 2010). We used this set as covariates and tagged them to the entry year of each cohort. They included: (a) the 1-year retention rate for each cohort representing the percentage of incoming freshmen who returned for their second year; (b) four categories of the log of yearly institutional expenditures (in U.S. dollars) per full-time equivalent (FTE) student that tapped instructional, academic support, student service, and research; (c) the percent of undergraduate students at the institution that received federal aid, which is often used as a proxy for the extent of low-income students at the institution as Pell Grants comprise the largest share of federal aid (NCES, 2016); (d) the log of the ratio of FTE undergraduate students per full-time faculty with instructional duties; (e) control indicating whether the institution was private or public; (f) the 2005 Carnegie classification that coded the institution as doctoral, master's, or baccalaureate with doctoral institutions serving as the reference category; and (g) the log of the percent of full-time freshmen that were classified as non-White, non-Asian. The variables that were log transformed were done so to reduce issues of skewness that were identified with regression diagnostics, to allow for nonlinear relationships with graduation rates, and to make the model more efficient when estimating standard errors. These log transformations are common in studies that examine institutional covariates whose values vary considerably across institutions (Griffith & Rask, 2016; Webber & Ehrenberg, 2010). We also used the broad category of non-White, non-Asian to allow our findings to be compared to other research on graduation rates that use the IPEDS data.

Thus, situating peer effects theory with the logic of the I-E-O model suggests that students who enter without DE credits would benefit academically from the exposure to and interaction with students with DE credits and what these students bring with them to college above and beyond college credits (e.g., socializing experiences, academic preparation, motivation, and engagement).

Statistical Analyses

There were statistical concerns inherent in the data that prevented the use of ordinary least squares regression estimations. First, the White test and plots of residuals versus fitted values indicated the presence of heteroscedasticity. Second, a variety of tests including Cook's d, studentized residuals, probability plots, and DFBeta revealed several institutions to be influential observations. However, additional diagnostics using variance inflation factors and tolerance diagnostics found no multicollinearity among the independent and control variables. Furthermore, the distribution of the graduation rate measures did not violate assumptions of normality. Third, our analytic sample included 1,370 institutions across the 50 states and the District of Columbia—suggesting a nested or clustering data structure even though IPEDS does not employ any nested or cluster sampling. Pennsylvania had the most institutions included at 105 whereas Wyoming had only a single institution in the analytic sample. Therefore, it was possible that institutional rates of graduation were correlated within states given the role of states in funding and legislating higher education and the wide and growing disparities in these funding levels (Mitchell, Palacios, & Leachman, 2014). Also, since we had three measures of graduation rates for individual institutions, these outcomes were undoubtedly correlated as well.

To correct for all these issues, we estimated quasi-likelihood regression parameters with generalized linear models (GLM) and general estimating equations (GEE). We choose this

Table 1

Description of Study Variables by Cohert: IPEDS 2006–2014 (n=4,110)

Variables	Range / Coding	M	SD
6-year graduation rate	1%–99% of incoming freshmen graduating within 6 years	53.95%	18.21
Dual enrollment policy	0 = do not accept DE credits; 1 = accept DE credits	0.82	---
Selectivity	1 = noncompetitive to 6 = most competitive	3.41	1.09
Institutional Controls			
1-year retention rate	5%–100% of incoming freshmen returned in 2nd year	74.29%	11.78
Private institution	0 = no; 1 = yes	0.62	---
Doctorate (Reference)	0 = no; 1 = yes	0.20	---
Master's	0 = no; 1 = yes	0.41	---
Baccalaureate	0 = no; 1 = yes	0.39	---
% of undergraduate students that are non-White, non-Asian	0%–100% are non-White, non-Asian	19.19%	22.04
% of undergraduates receiving federal aid	1%–100% receive federal aid	31.93%	18.60
FTE student/faculty ratio	4 FTE student/faculty to 128 FTE student/faculty	16.13	7.29
Instructional expenses per FTE student	$0 per FTE student to $75,776 per FTE student	$8,435	$6,926
Research expenses per FTE student	$0 per STE student to $98,726 per FTE student	$1,627	$6,159
Academic expenses per FTE	$0 per FTE student to $54,320 per FTE student	$2,271	$2,645
Support expenses per FTE	$0 per FTE student to $47,221 per FTE student	$2,768	$2,065

approach as the GLM/GEE model assumes that the data are longitudinal and the repeated outcome measures (i.e., graduation rates) are correlated within institutions over time. To further handle the longitudinal and correlated data and the statistical issues reported above, we conducted two additional procedures. First, we adjusted all equations with an exchangeable working correlation structure among the observations due to state-level clustering and correlated outcomes, which was preferable to an autoregressive (AR-1) structure as the outcomes were measured only one year apart. Second, we calculated the standard errors with an asymptotic covariance matrix to produce robust error estimates that provided much more conservative estimates of Z- and p-values. Finally, we followed prior econometric recommendations and research and transformed our fractional response outcome of graduation rates into the log of odds ratios. This is necessary for outcomes that are bounded by 0 and 1 as untransformed variables may return regression equations that predict values less than 0 and greater than 1 (Baum, 2008).

The quasi-likelihood GLM equation was:

$$1n\left(\frac{y_{it}}{1-y_{it}}\right) = G\left(a_0 + b_1 DE_{it} + bx_{it} + u_{it}\right)$$

Where y_{it} was the 6-year graduation rate of school i as of year t for students who entered the institution as a full-time first-year student six years earlier. This outcome was then modeled as a function of the estimated coefficients for whether the institution has a policy of accepting DE credits ($b_1 DE_{it}$), a vector of institutional-level control variables (bx_{it}), and a random error term (u_{it}). G indicates that these parameters were estimated with quasi-likelihood equations.

We used this equation to estimate three regression models. The first two models attempted to capture the chronological nature of the I-E-O approach: (a) a baseline model that included only DE policy and cohort year and (b) a full model that added in all the institutional controls that measured institutional characteristics that would influence Inputs as well as the Environments encountered by students. The third model adds an interaction term crossing DE by selectivity. For GEE, the appropriate model fit statistic is QIC (quasi-likelihood under the independence model criterion) as the more common AIC is not available for GEE since it is not likelihood based (Hardin & Hilbe, 2012). When comparing QIC statistics between models a smaller value indicates which model better captures the data. We used both QIC and QICu to address model fit because QICu adds a penalty parameter for the number of variables in the model, which awards better fitting and more parsimonious models.

We did find that less selective institutions benefit the most from accepting DE credits, but the negative effects of DE at the more selective institutions directly contradicted our expectations.

Results

The figures in Table 1 show the descriptive statistics for the three cohorts of freshmen. On average, institutions had a 6-year graduation rate of about 54%, and 82% of these institutions had a policy of accepting DE credits among their incoming freshmen. We also examined whether graduation rates, DE policy, and institutional covariates differed across the three cohorts (results available upon request). They did not. For example, for the 2006, 2007, and 2008 cohorts the graduation rates were 53.6%, 54.1%, and 54.1%, respectively. For DE policies, 82% of institutions accepted DE credits for the 2006 and 2007 cohorts whereas 83% did so for the 2008 cohort. Finally, there were no significant differences in the values of the institutional covariates for the three cohorts 2006–2008. Given our focus on DE policy and institutional selectivity, we also report our descriptive statistics across these two characteristics. In Table 2, we found small-to-moderate differences between institutions that accept DE credits and those that do not. Those that did not accept DE credits have higher graduation rates, perhaps because they are more selective, private, doctoral-granting, and have more institutional resources (Tinto, 2012). We found larger differences across selectivity levels with respect to graduation rates and DE policy. Most of the institutional covariates also varied with selectivity where the quality and quantity of the covariates increased with selectivity. These results are consistent with federal data that has found selectivity to be the strongest predictor of graduation rates (NCES, 2016; Tinto, 2012). Further, variations in our set of institutional characteristics have been found to explain about 75% of institutional differences in graduation rates (Hess et al., 2009; Shin, 2010). Thus, it was important to control for these institutional covariates to conservatively test the hypotheses and minimize omitted variable bias.

A set of regression estimates are in Table 3. The baseline results in Model 1 showed that 6-year graduation rates were lower among institutions that had a policy of accepting DE credits among the incoming freshman cohorts of 2006–2008. To test the robustness of this finding, we included all the institutional covariates in Model 2 where these covariates removed the negative association between DE and graduation rates shown in Model 1. Indeed, the DE coefficient failed to retain its directional effect size and reach statistical significance in Model 2. In Model 3, we tested whether the effect of DE varied by institutional selectivity. Here we found a negative and significant interaction between DE and institutional selectivity. An examination of the QIC and QICu fit statistics across the three models indicated that Model 3 was the best fitting model. Further, in Model 3, the QICu fit value approximated the QIC fit value (within 3% of each other) suggesting that the model was correctly specified.

Table 2

Mean Values of Study Variables by DE Policy and Selectivity: IPEDS 2006–2014 (n=4.110)

	DE Policy		Selectivity by Competitiveness (1 = non to 6 = most)					
Variables	Yes	No	1	2	3	4	5	6
6-year graduation rate	52.81%	64.20%	32.22%	40.52%	49.44%	63.61%	75.16%	86.79%
Dual enrollment	---	---	0.83	0.93	0.96	0.88	0.73	0.48
Selectivity	3.31	4.15	---	---	---	---	---	---
Institutional Controls								
1-year retention rate	73.64%	80.00%	63.55%	67.49%	71.55%	79.87%	87.22%	91.01%
Private	0.60	0.79	0.50	0.49	0.55	0.68	0.76	0.86
Doctorate (Reference)	0.19	0.24	0.04	0.09	0.17	0.31	0.36	0.51
Master's	0.43	0.25	0.42	0.53	0.53	0.36	0.17	0.05
Baccalaureate	0.38	0.51	0.54	0.38	0.34	0.33	0.47	0.44
% Non-White	21.00%	21.30%	59.93%	30.66%	19.52%	13.94%	11.29%	9.80%
% Receiving federal aid	39.08%	30.10%	44.21%	40.77%	34.63%	30.52%	24.48%	20.91%
FTE student/faculty	17.84	14.33	20.09	21.22	17.62	15.35	12.61	10.89
Instructional expenses per FTE	$7,481	$10,374	$4,957	$4,044	$4,400	$6,348	$9,368	$18,383
Research expenses per FTE	$1,911	$3,575	$1,397	$1,282	$1,444	$3,303	$5,449	$8,533
Academic expenses per FTE	$5,831	$7,465	$5,111	$4,958	$6,120	$7,377	$9,083	$13,259
Support expenses per FTE	$3,035	$4,386	$2,175	$2,496	$3,669	$4,361	$5,506	$7,477

For these reasons, it is suggested to interpret the best-fitting model (Harden & Hilbe, 2012). One main assumption of a GLM/GEE approach is that the underlying correlation structure is correctly chosen. For more support of our decision to use an exchangeable structure, we reestimated Model 3 with four different types of correlation structures: exchangeable, AR-1, unstructured, and independent. The results (available upon request) showed that the QIC and QICu statistics confirmed that exchangeable was indeed the best-fitting structure to the data.

In calculating the simple slopes from Model 3 (Aiken & West, 1991), the effects of DE on graduation rates were 0.49 for noncompetitive institutions, 0.29 for less competitive institutions, 0.09 for competitive institutions, -0.11 for very competitive institutions, -0.31 for highly competitive institutions, and -0.51 for the most competitive institutions. These simple slopes were statistically significant at $p \leq .05$ except for institutions that are competitive or very competitive. Therefore, we found that the effect of DE on 6-year graduation rates were positive for the lesser selective institutions and negative for the more selective institutions.

Table 3

Generalized Linear Model Regression Coefficients for 6-Year Graduation Rates: IPEDS Cohorts of 2006, 2007, and 2008 (n=4,110)

Variables	Model 1	Model 2	Model 3
Dual enrollment	-0.61***	-0.07	0.69***
	(0.12)	(0.06)	(0.09)
Dual enrollment *x* selectivity	---	---	-0.20***
			(0.02)
Cohort	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
Selectivity	---	0.41***	0.54***
		(0.02)	(0.03)
Institutional Covariates			
1-year retention rate	---	0.05***	0.03***
		(0.00)	(0.00)
Private	---	0.31***	0.26***
		(0.06)	(0.05)
Doctorate (Reference)	---	---	---
Master's	---	-0.14***	-0.14***
		(0.04)	(0.04)
Baccalaureate	---	-0.15**	-0.17**
		(0.06)	(0.07)
% Non-White	---	-0.15***	-0.14***
		(0.04)	(0.03)
% Receiving federal aid	---	-0.01***	-0.02***
		(0.00)	(0.00)
FTE student/faculty	---	-0.11*	-0.09*
		(0.05)	(0.04)
Instructional expenses per FTE	---	0.13***	0.11***
		(0.02)	(0.02)
Research expenses per FTE	---	0.06***	0.04***
		(0.01)	(0.01)
Academic expenses per FTE	---	0.07	0.03
		(0.04)	(0.03)
Support expenses per FTE	---	0.10**	0.11**
		(0.03)	(0.03)
Intercept	0.23	-1.11	-1.89
QIC fit index (smaller is better)	4201.87	3877.23	3871.19
QICu fit index (smaller is better)	4172.00	3760.00	3754.00

Note: The 6-year graduation rates are log transformed. Robust Standard errors are in parentheses.
*p< .05. **p< .01. ***p<.001 (two-tailed)

Next, because our estimated model was nonlinear, a straight-forward interpretation of these slopes was not possible. Therefore, we calculated the marginal effect sizes for these significant interactions between DE and selectivity by following the two-step procedure in Webber & Ehrenberg (2010). First, we obtained a predicted value for 6-year retention rates for each institution. Second, we then took the difference between the averages of these predicted rates between institutions that accepted DE credits and those that did not. We found that among noncompetitive intuitions, 6-year graduation rates were 4.9 percentage points higher among those that had a policy of accepting DE credits. For less competitive institutions, accepting DE credits returned a 6-year graduation rate that was 3.5 percentage points higher than those without such a policy. Yet, for highly competitive and most competitive institutions, those that accepted DE credits had a 6-year graduation rate that was 2.8 and 4.4 percentage points lower, respectively, than similarly selective institutions without such a DE policy.

Summary

In this study, we assessed the effectiveness of the institutional practice of accepting dual enrollment (DE) credits among incoming freshman cohorts where the effectiveness outcome was measured with 6-year graduation rates. We positioned our study within the logic of Astin's I-E-O modeling where the Environment created by an institution's DE policy was theorized to be that of peer effect. We first found that institutional graduation rates were significantly lower at institutions that accept DE credits among incoming freshmen. However, our second finding was that our control variables removed the significant link between DE policies and lower graduation rates. Third, though, the best-fitting model found that the direction of the effects of DE on graduation rates depended on institutional selectivity where DE had a positive effect on these rates among the lesser selective institutions but a negative effect among the more selective institutions. Further, the positive effects were the greatest for the least selective and the negative effects are greatest for the most selective institutions.

Whether peer effects are the driving force can only be answered by future research that contains data on multiple levels (individuals and institutions) collected with multiple methods (qualitative and quantitative). Yet our findings do suggest that they may be a contributing mechanism and that research needs to more fully assess this possibility.

These results both supported and contradicted our research hypotheses. We expected that institutional policies of accepting DE credits would be associated with higher graduation rates, and we also expected that less selective institutions would benefit the most from earned college credits among their incoming freshman cohorts. We did find that less selective institutions benefit the most from accepting DE credits, but the negative effects of DE at the more selective institutions directly contradicted our expectations. There are no known studies at the institutional level between DE and institutional graduation rates. So, whereas our findings contradicted our hypotheses they did not contradict any existing research as that research does not exist. Below, we take care to offer several suggestions for our findings so that future research may untangle our results, especially research that adopts the I-E-O model and attempts to measure peer effects.

Evaluation of Hypotheses and Recommendations

The positive effects of DE among less selective institutions is consistent with research that shows DE is beneficial for individual graduation rates, especially at less selective institutions. Yet the negative effects of DE at more selective institutions are not consistent with individual-level research. For the positive effects, our hypothesis to be evaluated is whether these effects are above and beyond what we would expect from the cumulative effects of individual rates of graduation. That is, are peer effects potentially operating?

Research suggests that about 16% of incoming freshmen enter 4-year institutions with DE credit (Thomas et al., 2013). Further, An (2013b) provided the most recent national estimate of the effect of DE on graduation rates where students who entered 4-year institutions with DE credits had graduation rates that were 7 percentage points higher than those without such credits. Thus, at the institutional level, we would expect institutions who have a policy of accepting DE credits to realize an average 6-year graduation rate of 1.1 percentage points higher (7.0 x 0.16) that represents the cumulative contributions of individual-level effects. This is an average figure across all institutional types as there are no available data disaggregated across the six institutional selectivity levels.

Our positive effect sizes for 6-year graduation rates was 4.9 percentage points for noncompetitive institutions and 3.5 percentage points for less competitive institutions. These figures all exceed the expected 1.1 percentage point gain calculated above, suggesting that institutions do indeed benefit in the aggregate by having a policy of accepting DE credits. Whether peer effects are the driving force can only be answered by future research that contains data on multiple levels (individuals and institutions) collected with multiple methods (qualitative and quantitative). Yet our findings do suggest that they may be a contributing mechanism and that research needs to more fully assess this possibility. These future studies could also adopt the I-E-O approach to inform the selection of study variables.

The negative effects of DE at the more selective institutions is unanticipated as no prior research suggests such a finding. Future research will need to focus on several issues to advance our study and better inform institutions about the effects of their DE policies. First, not all DE experiences and credits are academically equal, which may influence whether DE

is an accurate proxy for the Inputs of college readiness and preparation and how it should be used as part of admissions policies. Indeed, research will need to consider two intersecting characteristics of DE programs: some high-school students take DE courses at a high school and not on a college campus, and some take DE courses with career and technical/vocational foci and not an academic focus. Research finds that the positive effects of DE credits on individual-level college outcomes is, on average, superior when high-school students take DE courses on college campuses and when these courses are academic focused (Speroni, 2011a, 2011b). Thus, future research will need to measure the DE profile of incoming freshman cohorts across institutional selectivity categories to tease out our findings. It is possible that institutions have incoming cohorts that differ in the type of and place where their DE credits were earned while in high school (i.e., Inputs), and that these differences in a cohort's DE profile across institutions could be a contributing explanation for our disparate findings.

Second, it will be important to consider the fit between the other academic and background characteristics of an incoming freshman cohort with DE credits and an institution's peer, academic, and structural characteristics (i.e., Inputs and Environments). For example, An (2015) showed that students who enter college with DE credits had lower ACT scores, came from households with lower parental education levels, and were more likely to be an underrepresented. Cowan and Goldhaber (2015) found that students who participated in DE programs in Washington State high schools are more likely to attend 2-year institutions compared to 4-year institutions and complete high school with a GED compared to their peers who did not take DE courses. While not directly measured, these findings suggest that students who earned DE credits may be less prepared academically for more selective institutions and partly explain our results. Now that more students are entering college with DE credits, institutions may be well served if they conduct institutional research assessing the academic trajectories of these students.

In this study, we attempted to account and correct for data and statistical issues that may have influenced our results. We did so by using a strong set of institutional covariates that have been shown to predict most of the differences in graduation rates between institutions, including measures of selectivity, expenditures, and proxies for stratifying student characteristics such as the percent of students receiving federal aid. We also employed regression and statistical techniques and adjustments that handled influential observations and correlated outcomes as well as produced conservative statistical tests of significance. Still, our research must be interpreted within the limitations of IPEDS.

First, it is possible that the data do not contain institutional characteristics that could further account for the effects of DE on graduation rates across institutional selectivity levels. Second, as per the SRK, we followed an institutional cohort over six years, where this cohort was comprised of first-time and full-time freshmen who stayed at the same institution. This definition covers about 25–30% of all college students in 4-year institutions, depending on the institution's characteristics, and does not take into account the academic outcomes after transferring out of the initial institution (Hess et al., 2009). Thus, our results are generalizable only to these types of students and do not capture the experiences of the other diverse set of students in higher education institutions in the United States. Lastly, future research will need to expand our binary measure of DE policy to include further information about an institution's policy, how the institution counts and applies DE credits, and the percentage of students who enter with DE credits. Saying this, our research does provide the first baseline statistical assessment on the relationships between an institution's admissions practice regarding college credit earned through DE programs and their graduation rates. This assessment provides a firm foundation for the development of future assessment research on the effects of institutional practices regarding DE credits among incoming students. Our research should also motivate institutions to analyze their DE practices and policies and to assess the academic inputs and outcomes of those students who enter college with DE credits.

This assessment provides a firm foundation for the development of future assessment research on the effects of institutional practices regarding DE credits among incoming students. Our research should also motivate institutions to analyze their DE practices and policies and to assess the academic inputs and outcomes of those students who enter college with DE credits.

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