2010

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Using detailed individual-level data from public universities in the state of Ohio, I estimate the effect of various institutional expenditures on the probability of graduating from college. Using a competing risks regression framework, I find differential impacts of expenditure categories across student characteristics. I estimate that student service expenditures have a larger impact on students with low SAT/ACT scores, while instructional expenditures are more important for high test score students and those majoring in scientific/quantitative fields. The individual-level nature of these data allows me to address measurement error and endogeneity concerns the previous literature has been unable to deal with.

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Higher Education; Education Production Function

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JEL: I2

1. Introduction

In the current economic environment, nearly all postsecondary institutions face severe financial pressures. Therefore, it is critical that these institutions make the most efficient use of every available dollar.

The literature relating graduation rates in K12 and higher education to expenditures dates back to the Coleman Report of 1966. Unfortunately, much of this research has focused on aggregate measure of expenditures, ignoring a significant amount of variation in spending across functional categories not delivering even basic policy prescriptions. Notable exceptions include Ryan (2004) and Pike et al (2006).

In one of the most comprehensive study to date, Webber and Ehrenberg (2010) used institution-level data to study the association between different expenditure categories (student services, instructional, etc.) and graduation rates at nearly 4000 4-year institutions. The study concluded that while all expenditure categories “matter”, student services had the largest marginal impact on graduation rates at schools with low median SAT scores and high student financial need (as measured by Pell Grant dollars). In contrast, instructional expenditures had the greatest effect at schools with high median SAT scores and low rates of student need.

Using restricted student-level data for each public 4-year institution in the state of Ohio[1], I am able to address several major limitations of the previous literature. First, because I know which semesters each student is enrolled, I can accurately identify which expenditures students were exposed to. Using institution-level data, the previous literature tended to use six-year graduation rates and six-year moving averages of expenditures. This implicitly assumes each student was exposed to six years of expenditures and then graduates or fails to graduate after six years of enrollment. Second, I examine subgroups of students within schools rather than examine subgroups of schools. For instance, at a high-SAT school (defined as having a median SAT in the upper half of the test score distribution) there are a number of students who will have low SAT scores. Next, I look at how the effect of expenditures differs by the student's major, which has never been studied. Finally, I am able to include institution fixed-effects to control for the many school-level unobservables which could be correlated with expenditures. Due to a small number of observations and a lack of significant variation in the expenditure variables over time, much of the previous literature was unable to include these controls.

Qualitatively, I find support for the results of Webber and Ehrenberg (2010), namely that student service expenditures are a strong determinant of the probability of graduating for students with lower test scores and instructional expenditures are more important for students with high test scores. However, the magnitudes estimated in this study are larger than suggested by Webber and Ehrenberg (2010), which I attribute to the stronger data quality in this study and my ability to better assign exposure to expenditures. Additionally, I find that instructional

1 The institutions included in this study are Akron University, Bowling Green State University, Central State University, Cleveland State University, Cincinatti University, Kent State University, Miami University, Ohio University, Northern Ohio University, Ohio State University, Toledo University, Shawnee State University and Youngstown State University.

expenditures are significant predictors of graduation for students majoring in a STEM (Science, Technology, Engineering, Math) field.

2. Model

I utilize the theoretical model of an educational production function (see Hanushek 1979 for details of the theory and estimation of these models). Specifically, I assume that graduation rates at school i in time t can be modeled as a function of institutional inputs X, institutional characteristics Y, and student characteristics Z.

(1) $G_{it} = F(X_{it}, Y_{it}, Z_{it})$

I model the probability of graduating in a competing-risks regression framework. Using the empirical methodology developed by Fine and Gray (1999), we have:

(2) $\lambda_j(t, X_{it}, Y_{it}, Z_{it})=\lambda_{j0}(t)\exp(\beta X_{it}+\gamma Y_{it}+\delta Z_{it})$,

where λ_j represents the jth cause-specific hazard function. This is distinct from the traditional Cox proportional hazard model because it allows for multiple failure types and separate subhazard functions for each type. In the context of this paper I specify two failure types: graduating or dropping out. This modeling strategy has never been employed in this literature.

The institutional inputs include student services, instructional expenditures, and academic support expenditures[2]. Student service expenditures include expenses for the admissions and registrars activities, for activities that contribute to students' emotional and physical well-being and to their intellectual, cultural and social development outside of the institution's formal instructional program. Examples here include student organizations, student health services (including psychological counseling) and supplemental instruction (such as tutoring programs).

2 Previous research has also included external research expenditures. However, among public schools in Ohio, external research funds are negligible at all but one institution.

Instructional expenditures are analogous to faculty salaries. Academic support expenditures include technology expenses which support in-class academic instruction[3].

Student-level characteristics controlled for include race, ethnicity, gender, intended major, and entrance test score[4]. Time-invariant characteristics are absorbed through institutional fixed-effects. The analysis sample covers all entering first-time freshmen in the 1998-2000 cohorts, and follows each student for six years.

3. Results

Table 1 reports summary statistics summary statistics of the analysis sample. Table 2 presents model estimates for the student service and instructional expenditure categories, along with marginal effects of a $100 per FTE student increase in the associated category[5]. All standard errors are clustered at the institution-cohort level. The first column contains estimates from the full sample of 94880 students. As was the case in Webber and Ehrenberg (2010), both variables are positive predictors of the likelihood of graduating, with Instructional expenditures having about double the impact (3.9 versus 2 percentage point increase) in this particular sample.

Breaking down the sample into high and low test score students, the same pattern observed in Webber and Ehrenberg (2010) is observed, with student service expenditures being the dominant expenditure category for those students with low ACT scores (4.1 percentage point marginal effect) and instruction mattering most for those with high test scores (6.5 percentage

3 Detailed definitions of the content of each of these categories are found in the Integrated Postsecondary Education Data System online glossary (http://nces.ed.gov/ipeds/glossary)

4 Since the ACT is the predominant test used by admission committees at these schools, those observations with only a reported SAT score were converted to an ACT equivalent using the standard crosswalk provided by the corporation which administers the ACT.

5 The model estimates for all other variables are similar in both sign and magnitude to Webber and Ehrenberg (2010). The coefficient estimates for academic support are all statistically insignificant. All results are available upon request.

point marginal effect). As discussed in Astin (1993) and Webber and Ehrenberg (2010), this may be indicative of relationship between student engagement and graduation. All else equal, students with low test scores may need more convincing (via outside the classroom activities such as a student newspaper or academically themed club) that their work inside the classroom has real-world value. Conversely, high-achieving students have always been academically engaged, and the quality of instruction is dominant factor in their academic success. Additionally, tutoring services are likely to provide a larger benefit to low achieving students.

Dividing the sample instead by whether a student's major resides in a STEM field, I find that Instructional expenditures are relatively more important than student service expenditures for STEM majors, whereas there is no relative difference among non-STEM majors.

4. Conclusion

Using detailed individual-level data from the state of Ohio and a new empirical methodology, I estimate the determinants of graduating from a postsecondary institution. I am able to deal with endogeneity and measurement error issues Webber and Ehrenberg (2010) were unable to account for. I find that student services is the strongest predictor, among expenditure categories, for students who had below median ACT scores. For those with ACT scores at or above the median I estimate that instructional expenditures is the dominant category. Finally, I conclude that instruction tends to have a larger impact on students in STEM fields rather than non-STEM fields.

Acknowledgements

I would like to thank the state of Ohio for their generosity in letting me use their restricted-access data. I would also like to thank Ron Ehrenberg, Ben Ost, and Joshua Price for insightful comments.

References

Alexander Astin, *What Matters in College: Four Critical Years Revisited* (San Francisco CA: Jossey-Bass, 1993)

James S. Coleman et. al. *Equality of Educational Opportunities* (Washington DC: U.S. Office of Education, 1966)

Jason P. Fine and Robert J. Gray "A Proportional Hazards Model for the Subdistribution of a Competing Risk" *Journal of the American Statistical Association* 94 (June 1999): 496-509

Erik A. Hanushek "Conceptual and empirical issues in the estimation of educational production functions." *Journal of Human Resources* 14 (Summer 1979):351-388.

Gary R. Pike, John C. Smart, George D. Kuh, and John C. Hayek, "Educational Expenditures and Student Engagement: When Does Money Matter?" *Research in Higher Education* 47 (November 2006):847-872

John F. Ryan, "The Relationship Between Institutional Expenditures and Degree Attainment at Baccalaureate Colleges" *Research in Higher Education* 45 (March 2004): 97-114

Douglas A. Webber and Ronald G. Ehrenberg "Do Expenditures Other than Instructional Expenditures Affect Graduation and Persistence Rates in American Higher Education" *Economics of Education Review* 29 (December 2010): 947-958

Table 1: Summary Statistics

	Mean	Std Dev
Six-Year Graduation Rate	0.36	0.48
Semesters Enrolled	8.03	3.13
Student Service Expenditures	1293	780
Instructional Expenditures	7988	2315
Academic Support	1884	516
ACT	22.3	4.3
Female	0.54	.5
Black	0.10	0.30
Hispanic	0.02	0.13
Age at entry	18.7	1.96

Table 2: Competing Risks Regression Model Estimates

	Full Sample	Low ACT	High ACT	STEM	Non-STEM
Student Services Coefficient	0.00055	0.00155**	-0.00034	-0.00049	0.00137
Std Error	0.00069	0.00063	0.00077	0.00133	0.00189
Marginal Effect	0.020	**0.041**	-0.015	-0.020	0.043
Instruction Coefficient	0.0011**	0.00086	0.00147**	0.00188*	0.000341
Std Error	0.00056	0.00058	0.00062	0.0011	0.00135
Marginal Effect	**0.039**	0.023	**0.065**	**0.077**	0.011
Observations	948080	44392	50488	43471	51409

*, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively. The low ACT sample is defined as all students below the median ACT score of 21, while high ACT is defined as all students at or above the median. Marginal effects associated with a statistically significant variable are presented in bold.