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Do Expenditures Other Than Instructional Expenditures Affect Graduation and Persistence Rates in American Higher Education

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I. Introduction

Rates of tuition increases in both private and public higher education that continually exceed inflation, coupled with the fact that the United States no longer leads the world in terms of the fraction of our young adults who have college degrees, have focused attention on why costs keep increasing in higher education and what categories of higher education expenditures have been growing the most rapidly. In a series of publications, the Delta Cost Project has shown that during the last two decades median instructional spending per full-time equivalent (FTE) student in both public and private 4-year colleges and universities in the United States grew at a slower rate than median expenditures per FTE student in many other categories of expenditures (research, public service, academic support, student services, and scholarships and fellowships).[1] Similarly, the Center for College Affordability and Productivity reports that during the same time period, managerial and support/service staff at colleges and universities grew relative to faculty.[2]

Do such changes reflect increased inefficiency and waste or do some non instructional categories of employees and expenditures contribute directly to the educational mission of American colleges and universities? In this paper, we use institutional level panel data and an educational production function approach to estimate whether various non instructional categories of expenditures directly influence graduation and persistence rates of undergraduate students in American colleges and universities. We find, not surprisingly, that the answer is several of these expenditure categories do influence students' educational outcome, but that the extent that they matter varies with

[1] Wellman et. al. (2008), Figure 18 and Wellman et. al. (2009), Figure 8
[2] Lewin (2009)

the socioeconomic backgrounds and the average test scores of the students attending the institutions.

II. Educational Production Functions

The educational production function literature has its roots in the study of the impact of school resources on educational outcomes in elementary and secondary education and goes back to the 1960s *Coleman Report.*[3] An extraordinarily large number of studies have used non experimental and experimental (most notably from the Tennessee STAR experiment) data to test whether expenditures per student or class size influence students test score gains and graduation rates.[4]

A parallel literature has developed in higher education and has used institutional level data to study the impact of higher education expenditures on persistence and graduation rates.[5] Most recently, Zhang (2009) found a modest link (0.64 percentage point increase in graduation rates for a 10 percent increase in state appropriations) between state support and student achievement after controlling for institution fixed effects.

With few exceptions, expenditures per student have not been disaggregated into different functional categories of expenditures in this research. The few studies that have separated out expenditures into functional categories, such as instruction, student services, academic support, and research, have not reached a consensus on whether expenditure categories other than instruction influence persistence and graduation rates. For example, Astin (1993) argues that student service expenditures have a strong positive effect on student retention. However, Ryan (2004) only finds evidence that instruction

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[3] Coleman et. al. (1966)
[4] A comprehensive survey and critical evaluation of this literature is found in Ehrenberg, et. al. (2001)
[5] See, for example, De Groot et. al. (1991), and Dolan and Schmidt (1994).

and academic support expenditures positively affect graduation rates and Gansemer-Topf and Schuh (2006) found that persistence rates were positively related to academic support services, but negatively related to student service expenditures. While not focusing specifically on expenditures, Pfeifer and Corneliβen (2010) find a positive link between participation in sports and educational attainment (intramural athletics is one component of student services). Finally, Pike et al (2006) proposes that student engagement is the true mechanism which determines graduation rates. The lack of consistency of these results has been attributed to methodological differences in the studies[6], including the use of different relatively small samples of institutions. This limited availability of detailed data has forced most of the studies in this small literature to rely on basic OLS regression methods, without credible fixed-effects results.

We contribute to this literature in a number of ways. First, we use panel data for a national sample of 1161 4-year colleges and universities. While most of the data we use were originally collected as part of the Integrated Postsecondary Education Data System (IPEDS), these data have been carefully compiled, edited for consistency, and then made available to researchers by the Delta Cost Project (www.deltacostproject.com). Second, we stratify the data by type of institution (baccalaureate, masters, doctoral), and, most importantly, by the test scores of entering first-year students and the average Pell Grant dollars received by FTE undergraduate students at the institution to see how the impact of

[6] Another potential reason for the difference in results is lies in the functional form chosen by the author. For instance, while papers such as Ryan (2004) and Zhang (2009) apply the log transformation to the expenditure variables, this is not universal. The evidence (discussed later) seems to support the use of such transformations for more accurate results. The same can be said for applying the logit transformation to graduation rates as a dependent variable. Both the log-transformed expenditure variables and the logit-transformed graduation rates are used in our analysis.

different expenditure categories on outcomes varies across types of students[7] and institutions. Third, we build on the work of Blose, Porter and Kokklenberg (2007), who have shown that estimation of higher educational production functions that do not control for the distribution of degrees granted at an institution across fields yield misleading estimates of the impact of measured instructional expenditures per students on graduation rates, because the cost of educating students varies widely across majors. Finally, we employ a variety of econometric methods, including unconditional quantile regression, and simulate how the reallocation of resources from instructional to other uses would influence graduation and persistence rates.

III. **Theoretical Model**

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

This strategy has several implicit assumptions which must be met for a production function to be the appropriate model. First, if productive efficiency differs across schools (different graduation rates while having the same inputs) then the causes of this inefficiency must be modeled. Second, we do not have data on the actual inputs which would go into this type of production function, we have expenditures, which are inputs multiplied by prices. If there is geographic variation in the cost of these inputs which we do not control for then our results may be biased. Third, since both the output (graduation rates) and expenditures are at the institution level, there is the potential that the levels of the various expenditure categories are endogenously determined. Finally,

[7] Previous research has shown that certain university-sponsored programs have a stronger effect on students with lower levels of academic achievement and lower family incomes (Gregerman et al. 1998)

this approach implicitly assumes that the production function which determines graduation rates is equivalent for all schools. We will attempt to deal with each of these potential problems in the empirical analysis.

IV. Descriptive Statistics and the Definitions of Expenditure Categories

Table 1 presents descriptive statistics for the institutions in our sample during the 2002-03 to 2005-06 academic years on the six-year graduation rate of entering full-time first year students, the persistence rate of full-time first year students, the median SAT scores of entering first-year students, the average Pell Grant dollars received per FTE undergraduate student, and four categories of expenditures per FTE student. The data are reported for the entire sample of 1161 institutions, for subsamples of lower and higher median SAT scores and lower and higher levels of Pell Grants per FTE, and by institutional type. The expenditure variables for each year have been adjusted to reflect the price level in 2006.

The average six-year graduation rate for the institutions in our sample was 55 percent. Graduation rates are higher at high SAT institutions than they are at low SAT institutions, and higher at institutions with lower levels of Pell Grant dollars per FTE student than they are at institutions with higher levels of Pell Grant dollars per FTE student. They also vary by institutional type and form of control and are higher at private institutions than they are at public institutions. The average persistence rate of full-time first-year students at the institutions in our sample was 77 percent and the pattern of persistence rates across the institutions mirrors the pattern of graduation rates.

The four expenditure categories that we focus on in this paper are instructional expenditures, academic support expenditures, student service expenditures, and research expenditures. 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); we summarize them only briefly here. Instructional expenditures include expenses of activities directly related to instruction including the proportion of faculty salaries going to departmental research. Researchers and policymakers who look at instructional expenditures may not be aware that departmental research, research that is not externally funded or separately budgeted by academic institutions, is included in this category; a point that we will return to shortly.

Average instructional expenditures per FTE student were $9689 for the institutions in our sample (column 1). The wide standard deviation of instructional expenditures per student ($31,352) is due to very high expenditure levels at a small number of wealthy private institutions**.** Mean instructional expenditures per FTE student are twice as high at the higher SAT score institutions in our sample ($12,966) than they are at the lower SAT score institutions ($6087) and similarly are almost twice as high at institutions with lower levels of Pell Grant expenditures per FTE student ($12,592) than they are at institutions with higher levels of Pell Grant expenditures per student ($6701). Put simply, higher test score students from higher income families attend institutions with higher instructional expenditures per student than other students do. Average instructional expenditures per student also are higher at bachelors and doctoral institutions than they are at masters institutions and higher at private institutions than they are at public institutions. However, the variability of instructional expenditures within categories is often very large.

Academic support expenditures are expenses that support the instruction, research and public service missions of the university. They include libraries, museums, academic computing (if it is not separately budgeted), media services and curriculum development. The mean level of these expenditures per FTE student was $2456 for the institutions in our sample (column 1), but again the standard deviation of this variables is very large. Academic support expenditures per student are over twice as large at both the higher SAT institutions than they are at the lower SAT institutions and at the lower Pell Grant expenditure per student institutions than they are at the higher Pell Grant expenditure per student institutions in our sample.

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, intramurals, student health services (including psychological counseling) and supplemental instruction (such as tutoring programs). These expenditures averaged $2779 per FTE student in our sample, but were higher at higher SAT institutions ($3514) than they were at lower SAT institutions($1980) and higher at institutions with lower levels of Pell Grant expenditures per FTE ($3348) than they were at institutions with higher levels of Pell Grant expenditures per FTE ($2193).

Finally research expenditures are expenses for activities that are specifically organized to produce research outcomes. Typically these include externally sponsored research and separately budgeted research centers and institutes financed out of institutional funds. Research expenditures per FTE students averaged $2682 in our sample, but there were again wide variations in this category of expenditures across institutions and institutional categories. In particular, average research expenditures per FTE student were much higher at higher SAT institutions ($4045) than they were at lower SAT institution ($704) and similar much higher at institutions with lower Pell Grant expenditure per student ($3738) than they were at institutions with higher Pell Grant expenditures per student ($1299).

Our goal is to estimate the extent to which these four different categories of expenditures influence undergraduate students' graduation rates and how these influences vary across different types of institutions. Our expectations are that instructional expenditures per student will be important for all categories of institutions, but that the importance of student services and academic support expenditures may vary across institutions. In particular, students with lower entrance test scores and those coming from families with lower economic resources may have greater need for the services that academic support and student service expenditures provide and thus that these expenditure categories should influence graduation rates more for students at lower SAT and higher Pell Grant expenditure per student institutions.

Why should research expenditures per student influence graduation rates once one control for the levels of the other expenditure categories? Here our intuition is that the institutions with high levels of funded research expenditures per student are also the institutions that have a greater share of their reported instructional expenditures in the form of departmental research. To the extent that we are correct and faculty time spent on departmental research reduces the time available for instruction, this suggests that higher levels of funded research expenditures per student may appear to have a negative effect on graduation rates, when instructional expenditures per student are held constant, because of their correlation with the unobserved (to the researcher) departmental research expenditures.[8]

V. Econometric Analyses

Our initial econometric approach involves estimating equation (2) using a panel of four years (2002-2003 to 2005-2006) data for 1161 institutions for which we have complete data on expenditures, student and institutional characteristics and graduation rates.

$$(2)\quad \ln(g_{it}/(1-g_{it}) = a_0 + a_1 STU_{it} + a_2 INS_{it} + a_3 ACA_{it} + a_4 RES_{it} + bX_{it} + cY_i + dZ_t + u_{it}$$

Here g_{it} is the 6-year graduation rate of school i as of year t for students who entered the institution as full-time first-year students 6 years earlier. STU_{it}, INS_{it}, ACA_{it}, and RES_{it} are the natural logarithms, respectively, of the average over the previous 6 years of the institution's expenditures per full-time equivalent (FTE) student on student services, instruction, academic support services and research (all values have been expressed in 2006 dollars[9]).[10] Using a six-year moving average for each of the expenditure variables is an obvious adjustment since our dependent variable is six-year

[8] We are grateful to Professor Emeritus Charles Schwartz of the Department of Physics at the University of California at Berkeley for raising with one of us the issue of whether the inclusion of departmental research in instructional costs leads researchers and administrators to overestimate the extent to which institutional resources are being devoted to undergraduate instruction; this stimulated us to provide the explanation above as to why increases in budgeted research expenditures might have a negative effect on graduation rates, when instructional expenditures were held constant.

[9] The results presented use the CPI deflator, however the results were not sensitive to the type of index used (Such as the Higher Education Price Index)

[10] In preliminary analyses we also experimented with including in the model various additional categories of expenditures per student, as well as a composite of all other expenditures per student variable. However, these variables were not consistently statistically different from zero, nor did their inclusion impact upon the coefficients of the expenditure categories that are of primary interest to us. In particular, we did not include institutional support expenditures (related to the day-to-day operations of the institution) because they were almost perfectly collinear with instructional expenditures (rho of 0.98).

graduation rates, and should alleviate some but not all endogeneity concerns[11]. The X_{it} are a vector institutional level control variables that vary over time, while the Y_i and Z_t are a vector of institutional level control variables that do not vary over time and a series of year dichotomous variables, respectively. The u_{it} is a random error term and the a, b, c, and d are coefficients to be estimated.

The dependent variable is the log odds ratio of the six-year graduation rate to constrain the predicted value to lie between 0 and 1. The logarithmic transformation of the expenditure variables is used to deal with the skewed nature of their distributions and to allow for nonlinear impacts of each variable on the graduation rate.

The institutional level control variables include characteristics of the institution and its students that might be expected to influence graduation rates. These include both the average of the 25th and 75th percentile of the SAT scores for the institution's entering first-year class and the average (over the previous six years) Pell Grant dollars per FTE received by the institution's undergraduate students.[12] Similarly, they include the percentages of the institution's undergraduate students that were male, African American, Hispanic American, Asian American, and American Indian, as well as whether the institution was a Historically Black College or University.[13]

Also included among the institutional control variables are the number and the square of the number of undergraduate and graduate students enrolled at the institution (to allow for economic of scale and to control for differing costs of undergraduate and

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[11] We were unable to obtain suitable instruments to test for the presence of endogeneity. In future work we hope to use student-level graduation data so that the outcome is not at the same decision-making level as the inputs

[12] SAT data come from the College Board's *Annual Survey of Colleges: Standard Research Tape* with a standard crosswalk used to convert ACT scores to SAT scores for the small number of institutions that reported only ACT scores

[13] Studies that have shown that African American students have higher graduation rates, ceteris paribus, at HBCUs include Constantine (1995). Ehrenberg and Rothstein (1994) and Fryer and Greenstone (2007)

graduate education) and the share of undergraduate degrees awarded by the institution in year t in each of 15 different fields.[14] These shares are included to control both for differences in the difficulty of getting a degree in different fields and differences in the institutional costs of educating students in each of the fields. Also, to account for geographic variation in the costs of institutional inputs, we tested specifications which controlled for the median house value in each institution's zip code[15][16]. Finally, dichotomous variables for the Carnegie Classification of the institution (bachelors, masters or doctoral) are included, as are year dichotomous variables (to control for macro variables such as the state of the labor market that may influence students' decisions to remain in or leave college.

Because there is very little variability within an institution in the expenditure share variables during the four years for which we have graduation rate data panel data method, such institutional fixed effects, could not be employed. Instead we initially pool our data across all years and all types of institutions and weight each observation by its undergraduate enrollment level (because larger institutions should have less random variation in their graduation rates).[17] Our estimation method also takes account of the fact that the error terms for the same institution may be correlated across years.

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[14] The degree data come from the IPEDs *Completions Survey* and the categories used are Agriculture, Architecture, Humanities, Communications, Education, Engineering, Legal, Biological Sciences, Mathematics, Military, Physical Sciences, Social Sciences, Performing Arts, Business and Health (with the omitted category being all other fields).

[15] We believe this measure will act as a proxy for salary in the local labor market. The data were obtained from the 2000 Decennial Census Summary Files.

[16] The housing value variable was statistically insignificant in every specification run (with the typical t-statistics less than 0.4), with its inclusion not affecting the coefficients of any variables of interest. We therefore conclude that potential geographic variation in the cost of inputs is not a problem in our analysis.

[17] Because we have weighted each observation by undergraduate enrollment, including undergraduate enrollment measures in our regression specification do not add any more information in a regression sense. The results both with and without a linear and quadratic undergraduate enrollment term were the same.

To test whether all of the institutions in our sample were on the production function frontier, we first estimated equation (2) using Stochastic Frontier Analysis (SFA), an econometric technique which accounts for productive inefficiency. In addition to using the SFA approach, we also tested specifications controlling for the proportion of total expenditures which are funded by tuition (which acts as a proxy for the pressure students put on colleges to provide strong educational services). The SFA analysis and alternative specifications permitted us to conclude that there was no statistical evidence[18] that productive inefficiency was present in our data[19]. Hence, OLS is suitable for us to use in estimating our models and will be used throughout unless we note otherwise.

Table 2 presents estimates of variants of equation (2) for our entire sample. The estimates presented in column (1) are for a model in which only the expenditure categories and the average level of Pell Grant expenditures per student are included. Higher Pell Grant expenditures per student are associated with lower graduation rates and higher levels of each of the expenditure categories are associated with higher graduation rates.

Columns (2) and (3) present estimates of more complete models. Other factors held constant, increases in average SAT scores and the share of students that are Asian American are associated with higher graduation rates, while increases in the share of

[18] This finding is consistent with the previous literature when using 6-year graduation rates as the dependent variable, as noted by Kokkelenberg, Sinha, Porter and Blose (2008).

[19] To say that productive inefficiency is not present is not to say that institutions are necessarily behaving efficiently in an economic sense in terms of allocating resources to different function in a way that maximizes output. which in our model we take to be the graduation rate. As Appendix Table 2 indicates, for example, for the entire sample, and for the subsamples present in table 1, there is considerable variation across institutions in the ratio of mean expenditures on student services per FTE to mean instructional expenditures per FTE. While some of this variation may be due to different institutions facing different "prices" for the two types of expenditures or having students who differentially benefit from each type of expenditures, we present evidence below that many institutions are not efficiently allocating resources in the sense that they are not maximizing graduation rates.

students that are male, African American or American Indian are associated with lower graduation rates. As the prior literature has found, other factors held constant, Historically Black Colleges and Universities have higher graduation rates. Most important, in the more complete models the only expenditure categories that have statistically significant positive impacts on graduation rates are those for instruction and student services. Moreover, as we postulated, increases in budgeted research expenditures per student adversely impact upon graduation rates.

Because the model we have estimated is nonlinear, calculation of the marginal effects of increasing expenditure levels in any expenditure category on the graduation rate depends upon the coefficients of all of the variables in the model <u>and</u> the values of all of the explanatory variables for the institution. To simulate what the impact of an increase in expenditures in any category of $100 per student would be on the graduation rate, we perform the following calculation.

1. Given the values of the explanatory variables for an institution/year observation and the estimated coefficients of the model, we obtain a predicted value of the graduation rate for the institution/year observation.
2. We add $100 per student to the institution/year observation for the particular expenditure category (e.g. student services) and redo the calculation
3. We take the difference between the predicted graduation rate in step 2 and that in step 1 and then average that over all institution/year observations in our sample

The first column of Table 3 presents the coefficient estimates for the different expenditure categories and the standard errors of these coefficient estimate that we obtained from the most general specification found in Table 3. Then the bottom panel for each expenditure category, row titled marginal effects, presents the results of the calculation described above. In the remaining columns of Table 3, we present the coefficients, standard errors of the coefficients and the marginal effects that we obtained when we re-estimated models for seven different subsamples of observations: lower and higher SAT institutions, lower and higher Pell Grant recipient institutions, bachelors, masters and doctoral institutions.

Focusing first on the overall sample results. Ceteris paribus, an increase in student services expenditures of $100 per student, on average, would increase an institution’s six-year graduation rate by 0.2 percentage points. Similar increases in instructional expenditures and academic support services expenditures would, on average, increase the graduation rate by about 0.08 percentage points, while an increase in budgeted research expenditures of the same amount would decrease the graduation rate by 0.9 percentage points; recall that we hypothesize that this latter result reflects a greater share of instructional expenditure being devoted to departmental research when budgeted research expenditures are higher.

Given the fiscal condition that our nation’s academic institutions are facing, it is probably not realistic to expect that institutions will easily be able to increase expenditures per student in any category by $100. So in the bottom row of the table that it titled “Reallocate” we perform a different simulation. Here we ask if one were to reduce an institution’s institutional expenditures per student by $100 and simultaneously increase its student services expenditure per student by the same amount, what would the impact be on the institution's graduation rate?[20] The simulation methodology is very similar to that described above. On average, our simulation suggests that this type of change would increase an institution's graduation rate by 0.13 percentage points[21].

This finding is one that neither faculty around the country worried about declining funding for faculty positions nor critics of higher education who point to the wasteful growth of expenditures on non instructional uses are likely to be happy about. But our key words are "on average". What is true on average is not necessarily true for all categories of institutions so in the remaining columns of the table we pursue our analyses further for various subsamples of the data. We run separate regressions for each subsample, thus allowing the parameters of the production function to vary.

Turning first to a comparison of lower and higher SAT institutions, the marginal effect on graduation rates of increasing student service expenditures by $100 per student is much larger at institutions whose students have lower SAT scores (0.4 percentage points) than it is at institutions whose students have higher SAT scores (0.1 percentage points) (columns 2 and 3). The marginal impact of increasing instructional expenditures per student by $100 is roughly the same at the two types of institutions; 0.08 and 0.04

[20] Budgeting at American colleges and universities tends to be primarily incremental and absent severe cuts back in funding, as many institutions faced in 2008 and 2009, institutions do not seriously consider laying off employees. So decisions on reallocations across categories are often made out of incremental funding. However, even if funding is constant or declining, reallocations across categories can occur, even in the presence of tenured faculty, because there is always some turnover of faculty and staff due to retirements and voluntary turnover. As table 1 indicates, the mean instructional expenditures per FTE of institutions in our sample was $9689. Thus a $100 reduction represents about a 1.03% reduction in instructional expenditures per student which should be easily feasible within a year or two given normal faculty turnover and retirement behavior. Of course, as table 1 indicates, mean instructional expenditures are lower at the institutions in our sample whose students have lower SAT scores and who receive more Pell Grant dollars. As we show below, these are the institutions at which a reallocation of $100 per student from instructional to student service expenditures would have the greatest impact on graduation rates. Inasmuch as a $100 reduction in instructional expenditures per student would be larger percentage reduction at these institutions, such a reduction might have to be more gradually feathered in at them.

[21] Simulations of a $250 reallocation yield an increase of .3 percentage points in the graduation rate.

percentage points, respectively. Not surprising then, when we simulate the impact of simultaneously increasing student service expenditures by $100 per student and reducing instructional expenditures by the same amount, graduation rates are estimated to increase by 0.33 percentage points at the low SAT schools, but to remain essentially unchanged at the higher SAT schools[22]. Put simply, our analyses suggest that at the margin the activities that student service expenditures fund influence graduation rates much more for students with lower entrance test scores.[23] In a production function context, the close to zero effect for our reallocation simulation at high SAT schools implies that these schools are operating at the optimal allocation of student service and instructional expenditures.

Turning next to a comparison of schools which receive lower levels and higher levels of Pell Grant expenditures per student (columns 4 and 5), the increase in the six-year graduation rate of increasing student service expenditures by $100 per student is only 0.1 percentage points at the former institutions, but 0.3 percentage points at the latter institutions. The marginal impact of an increase in instructional expenditures per student on the graduation rate is slightly smaller at the former institutions (0.03 percentage points) than it is at the latter institutions (0.08 percentage points. And, in the simulations that reallocate $100 per student from the instructional to student service expenditures, we find that the graduation rates at the higher Pell Grant institutions would increase by about 0.2 percentage points but those at the lower Pell Grant institutions would fall by a very small

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[22] Simulations of a $250 reallocation yield an increase of .77 and .12 percentage points at low SAT and high SAT schools respectively.

[23] Another way of making the same point is to say that we estimate that the proportion of our observations for which the marginal effect of student services expenditures was statistically significantly greater than zero was 0.77 for the low SAT schools and 0 for the high SAT schools. For this test, marginal effects were calculated analytically, and standard errors were obtained using the Delta Method (Casella and Berger (2001), p. 240)

amount (0.07 percentage points).[24][25] These results suggest that at the margin the activities that student service expenditures fund influence persistence rates much more for students coming from lower-income families.

The next three columns present analyses separately for bachelors, masters, and doctoral institutions. The marginal impact of an increase in student service expenditures of $100 per student is about the same at the bachelors' institutions (0.23 percentage points) as it is at masters' institutions (0..25 percentage points), which in turn is larger than it is at the doctoral institutions (0.18 percentage points). This may reflect that the students in the most need of a supportive student service expenditure environment voluntarily select to attend smaller academic institutions. Given this finding, it is not surprising that in our reallocations simulations, on average the greatest positive effect of the reallocation occurs at the bachelors' institutions.

Briefly noting two other results in this table, academic support service expenditures have a statistically significant positive impact on graduation rates only in the higher SAT, the PhD, and the private institution subsamples; in these cases the marginal effect of an increase in academic support service expenditures of $100 is about 0.1 percentage points. In contrast, increases in budgeted research expenditures per student have statistically significant negative effects on graduation rates primarily at the higher SAT level, the higher level of Pell Grant recipient, the PhD, and the public institutions in our sample.

VI. Empirical Extensions

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[24] Similar to above, we estimate that the proportion of our observations for which the marginal effect of student service expenditures was statistically significantly greater than zero was 0.56 for the high Pell Grant dollars per student schools, but 0 for the low Pell Grant dollar schools.

[25] Simulations of a $250 reallocation yield an increase of .16 and .5 percentage points at low Pell Grant and high Pell Grant schools respectively.

Two empirical extensions of our analysis warrant being briefly reported. First, another way to analyze the data is to allow the impact of the explanatory variables to vary with the current level of an institution's six-year graduation rate. We use an econometric method called *unconditional quantile regression* to do this.[26] This method allows us to illustrate how the impact of the marginal effects of changing instructional and student service expenditures per student vary at different points in the current institutional graduation rate distribution. Intuitively, we estimate a separate model for every 5th quantile (from 5 to 95), obtaining new coefficients and standard errors for each models. Estimates of the coefficients of the student services and instructional expenditure variables that we obtained when we used this method, as well as the marginal effect of increasing expenditures in each category by $100 per student, holding all other variables constant, and the marginal effect of increasing student service expenditures and decreasing instructional expenditures simultaneously by $100 per student appear in Table 4.[27]

Quite strikingly, these estimates suggest that the marginal effect of increasing student service expenditures by $100 per student on graduation rates is larger at low current graduation rate schools than it is at higher current graduation rate schools. The effect is an increase of greater than 0.6 percentage points in the graduation rate for institutions at which the graduation rate is initially 50 percent or less. It declines monotonically with the initial graduation rate after then and is less than 0.1 percentage points once the 70th percentile in the graduation rate distribution is reached. In contrast, the marginal effect of increasing instructional expenditures by $100 per student on the graduation rate is greater

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[26] See Firpo, Fortin and Lemieux (2007) for technical details. We use the second method that they propose

[27] The other variables included in the models are the same as those found in column 3 of table 2, including academic support expenditures and budgeted research expenditures per student.

than 0.2 percentage points for institutions between the 15th and 80th percentile in the graduation rate distribution, but the effect is much smaller for lower and higher initial graduation rate institutions. As a result of these two patterns of estimated effects, if one reallocated $100 per student from instructional expenditures to student service expenditures, we estimate that this would increase an institution's graduation rate by more than 0.5 percentage points if the institution was in the lowest 20 percent of institutions in terms of its graduation rate initially. For higher initial graduation rates, the effect of the reallocation would quickly approach zero or become negative. A graphical depiction of these simulations with a $500 reallocation appears in Figure 1. As mentioned before, the institutions with no effect following a reallocation can be thought of as optimally allocating their resources.

Our second extension is to re-estimate equation (2) using an institution's persistence rate, the fraction of its first-year full-time students who enroll at the institution for their second year as the dependent variables. Information on institutional persistence rates comes from the College Board's *Annual Survey of Colleges: Standard Research Tape.* Estimates of the coefficients of the student service and instructional expenditure variables derived from estimating this equation, as well as the marginal effects of simulating the impacts of $100 increases in expenditure per student for the two categories, for various subsamples of the data, appear in Table 5.[28] The sample size analyzed in this table are somewhat smaller than those reported in Table 3; the drop off in sample size is higher for low SAT institutions than it is for high SAT institutions and higher for high Pell Grant

[28] When we estimate the persistence equations only a single year's lagged value of the expenditure category and Pell Grant expenditure variables are used.

dollars per student institutions than it is for lower Pell Grant dollars per student institutions.

Similar to the graduation rate equations, the marginal effects of increasing student service expenditures by $100 per student on an institution's persistence rate is higher for lower SAT schools and higher Pell Grant dollars per student schools. But the magnitudes of these effects are much smaller than they are on the six-year graduation rates. Other factors held constant, an increase in student service expenditures of $100 per student would increase the persistence rate at the lower SAT schools by 0.2 percentage points and at the higher Pell Grant dollar schools by only 0.1 percentage points. Although these results are considerably smaller than the analogous graduation rate results, this is primarily because the average persistence rate is around 90 percent, with much less room for improvement than graduation rates.

Table 6 reports the results when we use unconditional quantile regression methods to analyze the persistence rate data. Similar to the graduation rate analyses reported in table 4, the marginal impact on persistence rates of an increase in student service expenditures of $100 per student is largest for the institutions whose initial persistence rates are in the lower half of the institutions in our sample and our reallocation simulations suggest that improvements in graduation rates would occur primarily for institutions whose initial persistence rates were below the median in the sample.

As a final robustness check on our results we adjust the model to account for the shares of expenditure variables, rather than the levels. Presented in Appendix Table 1, we control for the total dollar value of expenditures[29], as well as student service, instruction, and academic support expenditure shares (the research expenditure share is the omitted category). The share of student service expenditures is the only consistently significant share variable. These findings provide evidence that student service expenditures are important in both a relative and absolute sense, implying that our conclusions are stronger than simply "in order to raise graduation rates institutions should spend more money".

VII. Concluding Remarks

Student service expenditures influence graduation and first-year persistence rates. They matter more for students at schools with lower entrance test scores than they do at schools with higher entrance test scores and they matter more at schools that have a larger number of Pell Grant dollars per undergraduate student than they do at schools that have a smaller number of Pell Grant dollars per student. And, perhaps another way of saying the same thing, they matter more for schools that have lower graduation and persistence rates than they do for schools that have higher graduation and persistence rates.

Our simulations suggest that reallocating some funds from instructional expenditures to student service expenditures would enhance graduation and persistence rates at the former types of schools. Institutions with higher entrance test scores and lower levels of Pell Grant dollars per student would not see their graduation rates increase very much if they performed similar reallocations; put simply these institutions, which tend to be the

[29] Several different formulation of the total dollar expenditure were used, including the total of only the expenditures included in the regression and the aggregate expenditures of the university. The results were not sensitive to the measure used.

higher persistence and graduation rate institutions, probably have already achieved the correct balance of expenditures between instructional and student service expenditures.

Our finding that enhancing student service expenditures, even at the expense of reducing instructional expenditures, may enhance graduation rates at some institutions is not a call by us for institutions to make such reallocations. Institutions can also improve graduation rates by reallocating funds from other categories of expenditures that do not positively impact upon graduation rates to student services.. Furthermore, student service expenditures cover a wide range of categories and the IPEDs data that we have used in this paper do not permit us to analyze which of these subcategories of expenditures are the ones that matter. But our findings do suggest that these institutions should be sensitive to the issue and that research is needed to determine which categories of student service expenditures are the ones that matter.

Perhaps our most disturbing finding is that all other things, including instructional expenditures per student constant, higher levels of budgeted research expenditures per student appear to be associated with lower graduation rates. We have speculated, but the IPEDs data do not permit us to verify this speculation, that this relationship arises because institutions with higher levels of budgeted research may also be institutions in which a greater share of instructional expenditures are devoted to departmental research. Given the social concerns associated with the increasing costs of higher education, we would suggest that it is in the social interest for academic institutions to address what the appropriate share of departmental research should be in their instructional expenditure budgets.

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Table 1
Descriptive Statistics

	Total	Low SAT	High SAT	Low Pell	High Pell	Bachelors	Masters	PhD	Public	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Grad Rate	0.55	0.43	0.65	0.64	0.45	0.56	0.50	0.61	0.47	0.59
	(0.17))	(0.12)	(0.14)	(0.15)	(0.13)	(0.19)	(0.14)	(0.17)	(0.15)	(0.17)
Student Exp	2779	1980	3514	3348	2193	4458	1884	1686	1128	3714
	(9288)	(1282)	(12770)	(12684)	(2975)	(15167)	(1108)	(1419)	(453)	(11514)
Instruction Exp	9689	6087	12966	12592	6701	12155	6452	11943	6639	11415
	(31251)	(2827)	(42962)	(43292)	(5991)	(51052)	(2899)	(8987)	(2703)	(38951)
Academic Exp	2456	1438	3389	3320	1567	3078	1512	3280	1713	2876
	(8447)	(846)	(11602)	(11700)	(1549)	(13589)	(818)	(3908)	(973)	(10523)
Research Exp	2682	704	4045	3738	1299	1444	461	6442	2179	3318
	(8238)	(1788)	(10390)	(10534)	(2838)	(11723)	(1389)	(9017)	(3554)	(11699)
Pell Exp	779	1019	563	464	1103	873	798	579	862	732
	(454)	(470)	(311)	(150)	(434)	(513)	(390)	(400)	(439)	(456)
Median SAT	1072	973	1162	1137	1005	1077	1031	1147	1041	1090
	(122)	(61)	(92)	(115)	(89)	(136)	(85)	(123)	(101)	(129)
Persistence	0.77	0.70	0.82	0.82	0.71	0.76	0.74	0.82	0.75	0.78
	(0.10)	(0.09)	(0.08)	(0.08)	(0.09)	(0.12)	(0.09)	(0.087)	(0.09)	(0.11)
2002	0.242									
2003	0.208									
2004	0.269									
2005	0.281									
Observations	3926	1837	2044	1991	1935	1429	1667	830	1419	2507

Notes: Standard deviations are in parentheses. Grad Rate is the 6-year graduation rate of each school's freshmen class (Source: Delta Cost/IPEDS). The expenditure variables represent a 6-year moving average of per student dollars spent on student services, instruction, academic support, and research respectively (Source: Delta Cost/IPEDS). Pell Exp represents the average per student dollars received by an institution through the Pell Grant program (Source: Delta Cost/IPEDS). Median SAT is the average of the 25th and 75th percentile of SAT scores (Source: Delta Cost/IPEDS and College Board). Persistence is the proportion of full-time first year students who persist to the second year at the same institution. (Source: College Board)

Table 2:
Econometric Estimates of Graduation Rate Equations

	(1)	(2)	(3)
STUDENT	0.263***	0.163***	0.116**
	(0.0710)	(0.0532)	(0.0452)
ACADEMIC	0.151**	0.0776	0.046
	(0.0676)	(0.0494)	(0.040)
RESEARCH	0.0278*	-0.0142	-0.028**
	(0.0167)	(0.0140)	(0.013)
INSTRUCTION	0.521***	0.114	0.202***
	(0.0901)	(0.0764)	(0.068)
PELL	-0.717***	-0.297***	-0.275***
	(0.108)	(0.0745)	(0.0718)
UNDERSTUDENT			-0.00108
			(0.00506)
UNDERSTUDENT2			0
			(0)
GRADSTUDENT			0.0383
			(0.0249)
GRADSTUDENT2			-2.34e-06***
			(5.97e-7)
HBCU		1.225***	1.325***
		(0.225)	(0.173)
HISPANIC		-0.541	-0.0517
		(0.468)	(0.181)
ASIAN		0.764**	0.301
		(0.346)	(0.240)
AMINDIAN		-1.418	-2.040***
		(0.938)	(0.753)
BLACK		-0.789***	-0.897***
		(0.254)	(0.210)
MALE		-0.434***	-0.0867
		(0.165)	(0.205)
MEDIANSAT		0.00454***	0.00462***
		(0.000358)	(0.000298)
Constant	-6.068	-4.458	-1.066
	(5.395)	(5.436)	(5.351)
Year Controls	No	Yes	Yes
Carnegie Controls	No	Yes	Yes
Degree Controls	No	No	Yes
Observations	3926	3926	3926
R-squared	0.653	0.793	0.821

Notes: The SAT and expenditure variables are defined as in Table 1. UNDERSTUDENT, UNDERSTUDENT2, GRADSTUDENT, and GRADSTUDENT2 represent linear and quadratic terms for the full-time equivalent number of undergraduate and graduate students. Note that the small estimated coefficient of the undergraduate variables is due to the data having been weighted by undergraduate enrollment. HBCU is an indicator for whether an institution is a Historically Black College or University. HISPANIC ASIAN AMINDIAN BLACK and MALE represent the proportion of each demographic group in each institution. Degree controls is a collection of variables indicating the proportion of degrees obtained in each of 15 fields (Agriculture, Architecture, Biological Sciences, Business, Communications, Education, Engineering, Health, Humanities, Legal, Math, Military, Performing Arts, Physical Sciences, Social Sciences). PELL is expressed in thousands of dollars, the enrollment variables are expressed in thousands of students, and MEDIANSAT is expressed in hundreds of points. Carnegie Controls is a collection of variables controlling for the Carnegie Classification of the institution. (Source: Delta Cost/IPEDS database and College Board) Standard errors are clustered at the institution level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.

Table 3:
Econometric Estimates of Graduation Rate Equations (Subsamples)

	Total	Low SAT	High SAT	Low Pell	High Pell	Bachelors	Masters	PhD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Student Services	0.11582**	0.24589***	0.06005	0.04305	0.16605***	0.27696***	0.13014**	0.09092
Std Error	(0.04521)	(0.06719)	(0.05209)	(0.05365)	(0.05771)	(0.06715)	(0.0564)	(0.06163)
Marginal	[0.001921]	[0.004084]	[0.000918]	[0.001052]	[0.003012]	[0.0023344]	[0.002507]	[0.00179]
Instruction	0.20225***	0.19007*	0.22049***	0.17548**	0.26825***	0.0001	0.39036***	0.19663*
Std Error	(0.06805)	(0.10247)	(0.08101)	(0.08154)	(0.09331)	(0.09364)	(0.0786)	(0.10301)
Marginal	[0.00058]	[0.000755]	[0.000392]	[0.000341]	[0.000825]	[-0.0000777]	[0.001324]	[0.00043]
Academic Support	0.04553	-0.05695	0.11129**	0.06701	0.00291	0.0144	-0.00295	0.11651*
Std Error	(0.04033)	(0.05727)	(0.0499)	(0.05263)	(0.05091)	(0.05296)	(0.05408)	(0.06388)
Marginal	[0.000781]	[0.0001]	[0.001077]	[0.000799]	[0.000193]	[0.0006538]	[0.000313]	[0.001371]
Research	-0.0276**	-0.02336	-0.04246**	0.0003	-0.03744**	-0.00014	-0.00222	-0.09163***
Std Error	(0.0131)	(0.01696)	(0.01854)	(0.01949)	(0.01771)	(0.02402)	(0.01706)	(0.02947)
Marginal	[-0.00904]	[-0.012]	[-0.01036]	[-0.0005]	[-0.01248]	[0.0070357]	[-0.00029]	[-0.00333]
Reallocate	0.00133	0.003313	0.000519	0.000706	0.00217	0.002414	0.001157	0.001354
Observations	3926	1837	2044	1991	1935	1429	1667	830
R-Squared	0.8211	0.4816	0.8413	0.833	0.7248	0.8028	0.69	0.8561

Notes: Standard errors are clustered at the institution level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.
The marginal effects denotes the effect of an increase of $100 per student in the indicated expenditure category.
The Reallocate row represents the effect on graduation rates from an increase of $100 per student in student service expenditures and a decrease of $100 per student in instruction expenditures.

Table 4:
Unconditional Quantile Regression Results

	10th	20th	30th	40th	50th	60th	70th	80th	90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Student Service Exp	1.133***	1.005***	0.890***	0.760***	0.716***	0.415*	0.198	0.0873	0.268
Std Error	(0.262)	(0.190)	(0.194)	(0.201)	(0.211)	(0.224)	(0.246)	(0.267)	(0.398)
Marginal	[0.0054]	[0.0067]	[0.00647]	[0.00573]	[0.00502]	[0.00250]	[0.00091]	[0.00025]	[0.00041]
Instruction Exp	0.552	1.076***	1.464***	1.334***	0.951*	1.444***	1.430***	1.061**	0.0556
Std Error	(0.486)	(0.364)	(0.377)	(0.510)	(0.505)	(0.552)	(0.530)	(0.463)	(0.523)
Marginal	[0.00065]	[0.00179]	[0.00275]	[0.00254]	[0.00168]	[0.00218]	[0.00167]	[0.00081]	[0.00002]
Reallocate	0.004759	0.004887	0.003667	0.003135	0.003302	0.00029	-0.00078	-0.00057	0.000396

Notes: Standard errors are clustered at the institution level. We employ the logit method proposed by Firpo, Fortin and Lemieux 2007 to allow for heterogeneous response. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.
The marginal effects denotes the effect of an increase of $100 per student in the indicated expenditure category.
The Reallocate row represents the effect on graduation rates from an increase of $100 per student in student service expenditures and a decrease of $100 per student in instruction expenditures.

Table 5:
Econometric Estimates of Persistence Equations

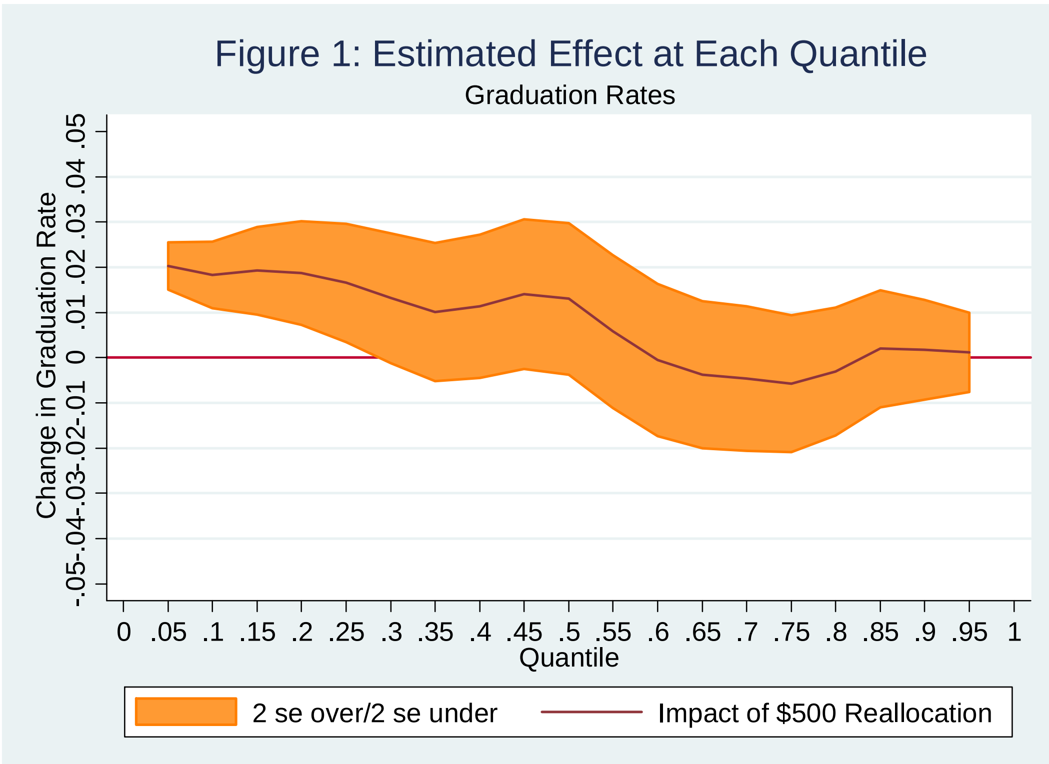
	Total (1)	Low SAT (2)	High SAT (3)	Low Poverty (4)	High Poverty (5)	Bachelors (6)	Masters (7)	PhD (8)
Student Services	0.005416	0.119**	-0.0166	-0.0255	0.0215	0.141	0.0141	-0.0366
Std Error	(0.041423)	(0.0504)	(0.0576)	(0.0575)	(0.0504)	(0.0876)	(0.0637)	(0.06)
Marginal	[0.00043]	[0.00179]	[0.00002]	[-0.000002]	[0.00111]	[0.00102]	[0.00062]	[-0.00002]
Instruction	0.144219**	0.12	0.12	0.0706	0.292***	-0.0114	0.230***	0.0989
Std Error	(0.06193)	(0.0899)	(0.0795)	(0.0792)	(0.0925)	(0.096)	(0.0822)	(0.0951)
Marginal	[0.0003]	[0.00033]	[0.00012]	[0.00011]	[0.00062]	[-0.00008]	[0.0006]	[0.00012]
Reallocate	0.00013	0.00148	-0.0001	-0.00011	0.00049	0.00107	0.00001	-0.00014
Observations	3338	1466	1835	1777	1561	1231	1375	732
R-Squared	0.9121	0.709	0.940	0.926	0.879	0.786	0.747	0.912

Notes: Standard errors are clustered at the institution level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.
The marginal effects denotes the effect of an increase of $100 per student in the indicated expenditure category.
The Reallocate row represents the effect on graduation rates from an increase of $100 per student in student service expenditures and a decrease of $100 per student in instruction expenditures.

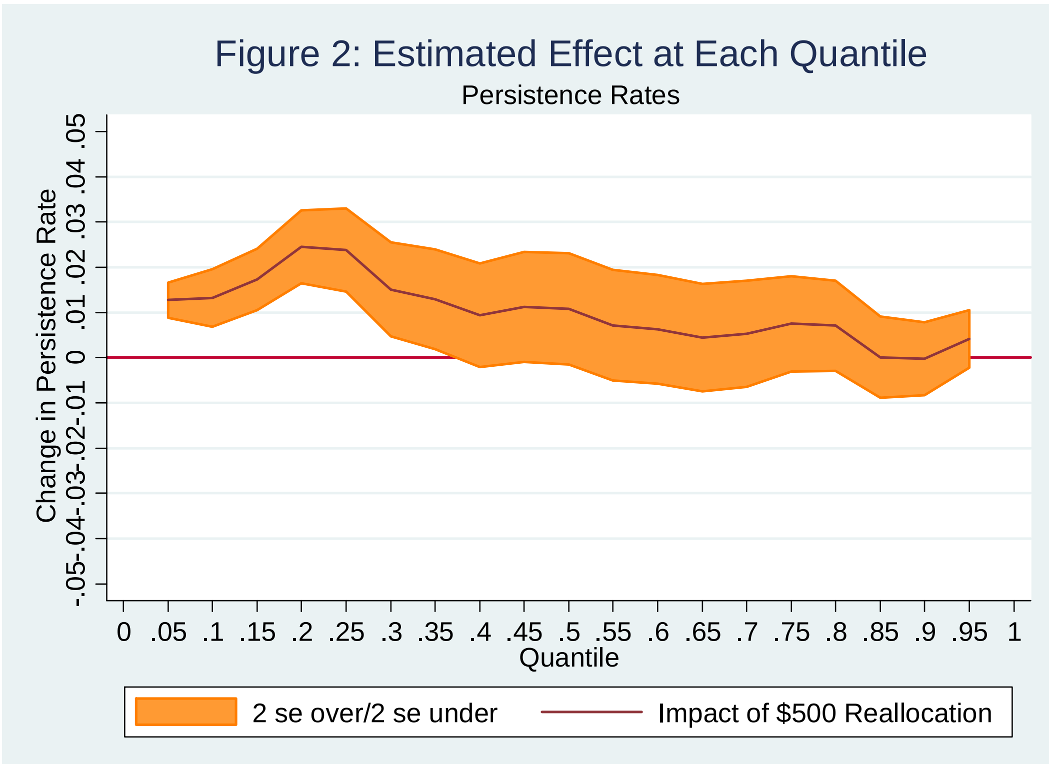
Table 6:
Unconditional Quantile Regression Results (Persistence Equations)

	10th	20th	30th	40th	50th	60th	70th	80th	90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Student Service Exp	0.933***	0.956***	0.525***	0.363**	0.304**	0.188	0.210	0.161	0.0297
Std Error	(0.276)	(0.201)	(0.168)	(0.161)	(0.150)	(0.144)	(0.144)	(0.144)	(0.162)
Marginal	[0.00318]	[0.00608]	[0.00462]	[0.00349]	[0.00313]	[0.00209]	[0.00231]	[0.00181]	[0.0004]
Instruction Exp	0.0769	0.0646	0.364	0.414	0.186	0.189	0.333	0.0662	0.180
Std Error	(0.465)	(0.367)	(0.319)	(0.317)	(0.273)	(0.222)	(0.225)	(0.220)	(0.228)
Marginal	[-0.00005]	[0.00007]	[0.00086]	[0.00107]	[0.00052]	[0.00053]	[0.0009]	[0.00016]	[0.00038]
Reallocate	0.00322	0.00601	0.00374	0.00241	0.0026	0.00156	0.0014	0.00165	0.00002

Notes: Standard Errors are clustered at the institution level. We employ the logit method proposed by Firpo, Fortin and Lemieux 2007 to allow for heterogeneous response. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.
The marginal effects denotes the effect of an increase of $100 per student in the indicated expenditure category.
The Reallocate row represents the effect on graduation rates from an increase of $100 per student in student service expenditures and a decrease of $100 per student in instruction expenditures.



Notes: The shaded region denotes a 95 percent confidence band around the estimated value.



Notes: The shaded region denotes a 95 percent confidence band around the estimated value.

Appendix Table 1:
Graduation Rate Equations Using Shares of Expenditures (Subsamples)

	Total	Low SAT	High SAT	Low Pell	High Pell	Bachelors	Masters	PhD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Expenditures ($1000)	0.000428***	0.0162***	0.000382***	0.000331**	0.00293	0.000307***	0.0237***	0.00533***
Std Error	(0.000165)	(0.00525)	(0.000126)	(0.000132)	(0.00385)	(9.81e-05)	(0.00537)	(0.00191)
Share of Student Services	1.057***	1.157***	1.124**	0.500	1.207***	1.356***	0.834*	1.418
Std Error	(0.329)	(0.432)	(0.459)	(0.486)	(0.422)	(0.442)	(0.453)	(0.916)
Share of Instruction	-0.115	-0.297	0.168	-0.165	-0.135	-0.312	0.0746	0.397
Std Error	(0.186)	(0.281)	(0.235)	(0.262)	(0.263)	(0.328)	(0.341)	(0.306)
Share of Academic Support	0.137	-0.336	0.664*	0.0792	-0.0856	0.431	-0.159	0.875
Std Error	(0.319)	(0.472)	(0.384)	(0.409)	(0.420)	(0.611)	(0.477)	(0.533)
Student Service Marginal	0.003543	0.005325	0.002358	0.001719	0.004749	0.005906	0.002756	0.001397
Observations	3926	1837	2044	1991	1935	1429	1667	830
R-Squared	0.761	0.346	0.770	0.771	0.571	0.753	0.630	0.854

Notes: Standard errors are clustered at the institution level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels respectively. The student service marginal effect denotes the effect on graduation rates from a 10% increase in the share of each institutions student service/total expenditure ratio. On average, this translates to an increase in the share of student service expenditures from about .141 to .155. Other expenditure ratios are adjusted to perform this simulation so that the sum of all ratios remains 1

Appendix Table 2:
Allocative Differences in Expenditure Ratios

	Total	Low SAT	High SAT	Low Pell	High Pell	Bachelors	Masters	PhD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Student Services/Instruction	0.312	0.338	0.290	0.289	0.337	0.426	0.294	0.153
Std Deviation	0.176	0.192	0.158	0.158	0.190	0.174	0.143	0.074

Notes: The numbers in the first row represent the mean student service expenditures per student divided by the mean instructional expenditures per student.