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Keywords

higher education, private universities, graduation rates, performance, efficiency, productivity

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It is well known that human capital is enhanced by graduation from a college or university. How efficient are such institutions in conveying this mark of human capital? Efficiency and productivity in private higher education is measured by using undergraduate graduation rates as the output, and demographic variables, the quality of the students, and the annual expenditures (adjusted for academic mission) as inputs. Tests of several models using OLS and stochastic frontier analysis confirm that private schools can increase their graduation rates by increasing focused expenditures and through more selective admissions. Estimated elasticities are reported and point toward increasing expenditures as the most responsive method. Estimate graduation efficiencies of 93.0, 91.5, and near 100% are also reported for four, five and six year graduation rates respectively. A rank correlation with the *U S News and World Report* 2008 rankings is consistent with our measure of relative efficiencies.

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INTRODUCTION

Human capital is enhanced, civic participation increased, and criminal activity is reduced by attendance and graduation from a post secondary institution (Moretti 2004). The efficiency and productivity of higher education in the U. S. in achieving these beneficent outcomes is a concern, particularly as potential regulatory pressures are placed on schools and tuition costs continue to escalate (see Getz and Siegfried, 1991; Levine , 1997; Gates and Stone, 1997; Ehrenberg 2000; Hauptman, 2000; Abbott and Doucouliagos , 2003; Salerno, 2003; Poole, 2005; Johnes, 2006; Spellings, 2006; Garibaldi, Giavazzi, Ichino and Rettore, 2007). Interest in increased efficiency, frequently focused on faculty productivity (see Fairweather, 2002; Middaugh, 2001), has been the subject of a Cornell Higher Education Research Institute (CHERI) conference (May, 2005)[5], the focus of considerable research[6], and many articles in the popular press[7].

An excellent summary of recent research on efficiency in higher education is that of Salerno, 2003.which provides a good introduction to the problem and surveys efficiency studies from six countries[8]. Studies where efficiencies are calculated by stochastic frontier methods (SF) and/or by data envelopment methods (DEA) are included. Some of these seek to measure technical efficiency, while others are concerned with scale efficiencies.

Economists describe efficiency to have three aspects; allocative efficiency which means the use of inputs in the correct proportions reflecting their marginal costs; scale efficiency which considers the optimal size of the establishment to minimize long-run costs; and technical efficiency which means that given the establishment size and the proper mix of inputs, the maximal output for given inputs under the current technology is achieved.

[5] See Ehrenberg, 2006.
[6] See St. John and Parsons (2004).
[7] See Poole, 2005.
[8] Australia, Canada, Germany, The Netherlands, United States, and United Kingdom.

Output in higher education is not unique nor solitary and a definition is often incomplete or ambiguous; Universities and colleges educate students, both undergraduate and graduate, conduct research, make discoveries, provide service to the commonweal through studies, panels, volunteers to state, local and federal governments, populate think tanks, and offer thoughts, opinions, nuances, background, and enhanced understanding on complex issues via various media. This in short means that higher education is a multi-product industry. Some earlier work recognizes this (see Ahn, Charnes and Cooper, 1988)[9].

We assume that the outputs of a college are separable and concentrate on measuring technical efficiency of institutions of private higher education in terms of undergraduate graduation rates. In what follows, we provide a brief discussion of graduation rates as a measure of higher educational output, then build a model, develop and test it using ordinary least squares. Next we use stochastic frontier analysis which allows us to estimate the overall efficiency and the efficiency of each institution in terms of graduation rates, given the mix of inputs and the size of the school. Finally, we make some policy suggestions.

GRADUATION RATES AND HIGHER EDUCATIONAL OUTPUT

Measures of efficiency of higher education in the U.S. focus on graduation rates of undergraduate students and consider these students to be the main output of schools. For example, rating services such as that published in *US News and World Report* use graduation rates to develop their overall scores[10]. Most observers recognize that such ratings are often a marketing measure, used to sell the rating firm's products, as well as the school, to prospective new undergraduates and their parents; but high graduation rates have also been viewed as a marker of institutional excellence[11].

[9] Ahn, Charnes and Cooper consider graduate Full Time Equivalent measures (FTE), Undergraduate FTE and Federal Research Grants and Contracts as the output of higher education. Similar outputs are posited by Izadi, Johnes, Oskrochi and Crouchy (2002). Stevens (2001) summarizes seven similar studies.

[10] In an attempt to find a measure of accountability in higher education, many measures have been considered. One finds relative rankings, number of graduates, job placements and job placement rates, and graduation rates suggested as measures of efficiency or of performance.

[11] College rankers often include graduation rates (e.g. *US News & World Report*) along with generic institutional data to develop their rankings. This data is obtained from a college's response to the IPEDS (Integrated Post Secondary Education Data System) surveys or other national surveys such as the College Board Annual Survey of Colleges. The typical analysis often employs a multiple regression model using graduation rate as the dependent variable and a set of institutional characteristics as the independent

The higher education community recognizes graduation rates also reflect admission standards, the academic strength of the enrolled students, and, most importantly, the resources institutions devote to instruction, to remediation, and to retention. Many possible explanations for individual student or institutional graduation rate differentials have been studied and it has been found that student experiential variables, student ability, other pre-college variables and institutional variables are all important.[12, 13]

Thus, many schools use graduation rates as a handy, and hopefully reasonable, metric of efficiency. Opponents of such a sole measure argue that graduation rates do not reflect the quality of the education of the student.[14, 15] Yet graduation rates are a measure of one of the main outputs of higher education,[16,17] and we report an investigation of that output here.

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variables. The result is used to calculate a predicted graduation rate for each college that is adjusted for any institutional characteristic included in the model. If the actual college graduation rate exceeds the predicted value, the college is assumed to be doing a good job at graduating students by the college ranking services. The idea of a traditional four-year degree program is not universal. Many engineering and architectural programs and some other programs such as three-two programs take five years and several schools have experimented with three-year programs. These details are ignored here.

[12] A good introduction to modern research on this issue together with a good bibliography is given in DesJardins, Kim and Rzonca (2002-2003). See also Braxton and Hirschy. (In press), Berger and Lyons, (in press), and Porter (2003-2004). Many of the issues are identified in Habley and McClanahan (2005). Adelman (1999) is also useful.

[13] Society has decided higher education should not be limited to those with extraordinary talent or wealth, but open to all and that creates a problem for those who hope to use the graduation and retention rates as measures of institutional performance. This is especially true in the public sector where colleges and universities are expected to provide educational opportunities to a broad spectrum of the state's population. Meeting the state's demand for higher education requires a variety of college types to accommodate the range of academic ability and personal/family resources of those wanting access to the system.

[14] The time students spend in exploring different majors and taking elective courses may better prepare them to be life long learners and better citizens. From this perspective, time-to-degree and graduation rates are not the only measures of the educational output, but the intelligence, the existence of a breadth of knowledge, understanding, and personal satisfaction of the citizenry as well as their contribution to the commonweal are. These outcomes are not tested in this paper.

[15] See also NEA January, 2004.

[16] Certification in some sub-field, employment, earnings subsequent to graduation, marriage, citizenship, and literacy are some possibilities.

Much of the literature on graduation rates and retention is descriptive and/or discusses the relationship among various student and institutional characteristics and graduation rates. Baseline studies by Tinto (1975 and 1993), Bean (1980), Pascarella and Terenzini (1991) and Astin (1992) omit the role of resources, other than student financial assistance. Kuh's (2002) research into student engagement finds most, if not all, of the educational engagement factors studied have significant financial implications for the institution.

More recently, Ryan (2004) explored the relationship between institutional funding levels and graduation rates using a methodology similar to the one used herein. Ryan found a significant and positive relationship between institutional funding for instruction and academic support, but not student services. However, his study, excluded institutions that grant degrees beyond the baccalaureate. Differences in institutional mission (undergraduate, graduate, or first professional), as well the emphasis on research and public service, varies widely in higher education.[18] Further, within each mission, colleges and universities produce education and research in a myriad of academic disciplines and each requires different inputs and bears different costs and, indeed, often engages different technologies.

STOCHASTIC FRONTIER ANALYSIS

Stochastic frontier analysis (SFA) was developed and originated by Meesuen and van der Broeck (1977) and simultaneously by Aigner, Lovell, and Schmidt (1977). Its development and history as well as its theoretical background and applications are the subject of a monograph by Kumbhakar and Lovell (2000). It has been used in the analysis of production issues in many industries, but not, to our knowledge, in the analysis of higher education graduation rates. Robst (2001) used SFA to estimate cost efficiencies for 440 public colleges and universities. Ahn, Charnes and Cooper (1988) used Data Envelopment Analysis (DEA) in the Rhodes (CCR) ratio form to analyze different aspects of production behavior of institutions of higher learning and used three outputs of graduate and undergraduate teaching, and research grants. Abbott and Doucouliagos (2003) used DEA and an output of the number of students taught in

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[17] Ivy League universities and the best liberal arts colleges have six-year graduation rates in excess of 90% and the best public institutions are not far behind. However, the average five-year baccalaureate graduation rate of all public colleges and universities is just 41.2 percent ACT (2005).

an analysis of 31 Colleges of Advanced Education in Australia. Johnes (1995) used DEA to analyze 2568 graduates from United Kingdom universities and a cost function as an alternative to more traditional approaches such as econometric-regression models. The separation of doctoral-granting universities into universities with and without medical colleges represents a departure from preceding studies and proved very important in uncovering substantial differences in behavior between the two groups.

A typical output or production function with graduation rate (G) as the output can be written as:

$$G = G(X;\tau)$$

Here X is a vector of inputs and tau the level of technology. This is typically written, when estimating this equation via a regression procedure, as:

$$G = G(X;\tau) + w,$$

where w represents a stochastic disturbance, shock or measurement error. If we rewrite this for three levels of graduation rates (four, five or six years of study) designated by j, for N establishments or schools designated by i, for T time periods designated by t, and for the h inputs, h= 1…H, we have:

$$G_{j,i,t} = G(X_{j,i,t,h};\tau_t) + w_{j,i,t}$$

In the SFA efficiency literature, this is re-written as:

$$G_{j,i,t} = G(X_{j,i,t,h};\tau_t) + (u_{j,i,t} + v_{j,i,t})$$

where

[18] Universities are increasingly training post-doctorate students-researchers but that mission's output is not included though the costs are included in the total costs below.

$$w_{j,i,t} = (u_{j,i,t} + v_{j,i,t}).$$

This compound error term, $(u_{j,i,t} + v_{j,i,t})$, consists of u, the strictly non-negative technical efficiency component, whereas v denotes the two-sided symmetrical noise component akin to the traditional stochastic error term. The one sided error term may be distributed half normal, exponential, truncated normal, or Erlang (see van Der Broeck , 1977). Our realization uses the half normal distribution.

Again, the implicit assumptions of this estimation of inefficiency is that we are estimating technical inefficiency only; that scale efficiency and allocative efficiency are assumed to be either already optimized or are additively separable.

DATA

The data consists of 753 Private Colleges and Universities in the United States for the period 1997 through 2003. Data are for the fall 1997 entering freshman cohort and follows them, at the institution level, for a period of up to six years, or spring 2003. Further details about the variables are in Appendix A.

In what follows, the assumption is that the institution's efforts devoted to increasing graduation rates can be represented by expenditures per student. This cost will include all instructional materials, faculty, support staff, student services, student counseling, athletics, libraries, computing, student health services, career advising, job placement, etc.

The output or dependent variables considered are Four, Five and Six Year Graduation Rates for Baccalaureate Students (G4), (G5), and (G6). The inputs, represented by the (N by T) by H matrix X, includes a measure of the services of capital, a measure of the flow of services from labor, and the quality of the students (the intermediate and/or raw materials of the production process); all typical production function arguments. Blose, Porter and Kokkelenberg (2006) describe the construction of a mission-weighted measure of the program costs per full time student equivalent which is used in this present study of varying graduation rates.

THE MODEL

The combined inputs of labor and capital are proxied by the Total Undergraduate Expenditures per Undergraduate FTES, adjusted and with mandatory financial transfers (AE)[19]. The quality and quantity of intermediate materials, are proxied by various demographic and ability variables.

A general form of G(.) is given by:

$$G = \beta[\overline{X}] + \lambda[\overline{v}] + u$$

Where $\overline{X'} = [1, X, X^2, X^3, ...]$ and $\overline{v} = [v, v^2, v^3, ...]$

A linear form is:

$$G_{j,i,t} = \alpha_{j,t} + X_{j,i,t}{}' \beta_{j,t} + u_{j,i,t} + v_{j,i,t}\,.$$

Here, $X_{j,i,t}{}' = [M_{j,i,t}\ , F_{j,i,t}, MIN_{j,i,t}, Math_{,ij,t}, Verbal_{j,i,t}, AE_{j,i,t}]$

Where M denotes percent male, F, percent full time, MIN, percent minority, Math the normed mathematics ability score, Verbal the normed verbal proficiency score, , and AE the adjusted expenditures per full-time equivalent undergraduate student[20].

REGRESSION RESULTS

Initially, we fitted a regression models using Ordinary Least Squares (OLS) to explore the data and the structure of the model and these results are given in Table 1. The overall fit is good (60 percent or better of the variation in graduation rates from their respective averages is explained by the model shown (see the adjusted R squared value). These results are consistent with our earlier work with public universities; males have lower graduation rates, verbal ability

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[19] See Appendix B.

[20] As an alternative to adjusted expenditures, we tested the student faculty ratio and the student staff ratio, but these results and model are not reported but available from the authors upon request.

is less important than mathematical ability as reflected in the test scores, and per student adjusted expenditures are important.

STOCHASTIC FRONTIER RESULTS

A series of SF functions were run using STATA and are shown in Table 2 A through Table 2 C. The overall fit continues to be good. Log of Likelihood ratio tests are reported in Table 3 and show that the unrestricted models, that is the ones that include the explanatory variables, are statistically better fits than the models that are restricted to an intercept only. Further, the estimated parameters are individually and jointly statistically significant (probabilities of the actual value being zero is less than 5 percent). Also, the estimated parameters are consistent with those obtained via OLS.

The efficiencies average 93.0%, 91.5%, and near 100% for four, five, and six year graduation rates respectively.

Finally, elasticities are estimated using the parameters estimated via SFA, and these are reported in Table 4. In brief, to increase graduation rates at private schools, admissions offices should favor full time women with mathematical ability, and spend monies on appropriate undergraduate departments. These results are similar to those for Public Colleges and Universities also reported in Table 4 regarding gender and expenditures; but incremental verbal ability is more important at Publics while incremental math ability seems to be more important at Private schools. This holds for all three graduation rates, four, five, and six years. Interestingly, being a full time student is more important at Publics. We have no evidence as to why we found this result.

DISCUSSION

The policy issues spring from the estimated elasticities. This study is in agreement with other studies that suggest males perform poorer than females in higher education[21]. The negative importance of maleness is largest for four year graduation rates. While the reasons for this require further analysis, preferably with substantially more data for multiple institutions,

[21] See for example Kokkelenberg, Dillon, and Christie (2007).

one policy implication for a university seems to be to give more weight to female applicants ceterus paribus. An additional implication for society may well be to better prepare males for higher education. Further policy implications suggested by these results include increasing expenditures, better mathematics preparation, and helping students concentrate full-time on their education. A comparison of the *U. S. News and World Report* 's 2008 College relative rankings, with the rankings of efficiencies we calculated for four year graduation rates, is statistically significant at the 0.005 level by a Spearman Rank Correlation test.

As Robert Eisner often related when discussing the needed improvements in the National Income and Product Accounts, drunks generally look for their lost keys under a street light as this is where they could see them regardless of where they lost them. We have looked at efficiency using the light of graduation rates, but we must expand our search to currently unlit areas if we are to truly understand the efficiency of multi-product establishments of higher education. Multiple products require multiple metrics and for that we need better, systematically collected data and a way of aggregating this data or a vector analysis. This is where future research should be profitably focused.

APPENDIX A: VARIABLES

Data were constructed for 753 Private Colleges and Universities in the United States for the period 1997 through 2003. Data are for the fall 1997 entering freshman cohort and follows them, at the institution level, for a period of up to six years, or spring 2003. The names of the institutions included in this study are available from the authors upon request. The variables are defined below and statistics and distributions follow.

<u>Four, Five and Six Year Graduation Rates for Baccalaureate Students (G4), (G5), (G6)</u>
Four, five and six-year graduation rates for the cohort of first-time full-time baccalaureate degree-seeking students entering the college in fall 1997. (Source: IPEDS AY 2003 Graduation Rate Survey).

<u>Adjusted Expenditure (AE)</u>: Total Adjusted Undergraduate Expenditure per Undergraduate Full Time Equivalent Student.
As described above, IPEDS financial statistics and enrollment by program and academic program costs, allows the decomposition of institutional expenditure by student level. The dollars are included on a per FTES (student) basis to adjust the expenditures for institutional size. (Source: IPEDS FY 2000-01 Financial Statistics Survey, IPEDS Fall 2000 Fall Enrollment Survey and IPEDS AY 2000-01 Completions Survey). Further details are given in Appendix B and also can be had from the authors upon request.

<u>Percent Male (M)</u>
The percentage of males in the institutions' cohort of baccalaureate degree-seeking students who entered the college in fall 1997.
Prior research has shown males tend to graduate at lower rates than females; also, they take longer to graduate. This may contribute to the observed differences in institutional graduation rates in higher education. (Source: College Board Annual Survey of Colleges).

<u>Percent Full-time (F)</u>
The percentage of full-time students in the institution's undergraduate cohort entering fall 1997. Institutions of higher education serve many different populations. Non-traditional populations tend to exhibit patterns of behavior that lead to higher attrition rates and longer time to degree. It is possible the greater the representation of full-time students in an institution's undergraduate class, the higher the 4, 5, and 6-year graduation rates. (Source: College Board Annual Survey of Colleges).

<u>Average SAT Score (SAT)</u>

College entrance exams are the strongest single predictor of academic success in higher education; such academically prepared students have higher retention and graduation rates. (Source: College Board Annual Survey of Colleges).

Verbal Score (VS): Normalised Average Verbal SAT or ACT score, determined by that test reported for the most students of entering cohort of fall 1997.

Math Score (MS): Normalised Average Math SAT or ACT score, determined by that test reported for the most students of entering cohort of fall 1997.

Student Faculty Ratio (SFR): Number of FTE students per FTE faculty members.

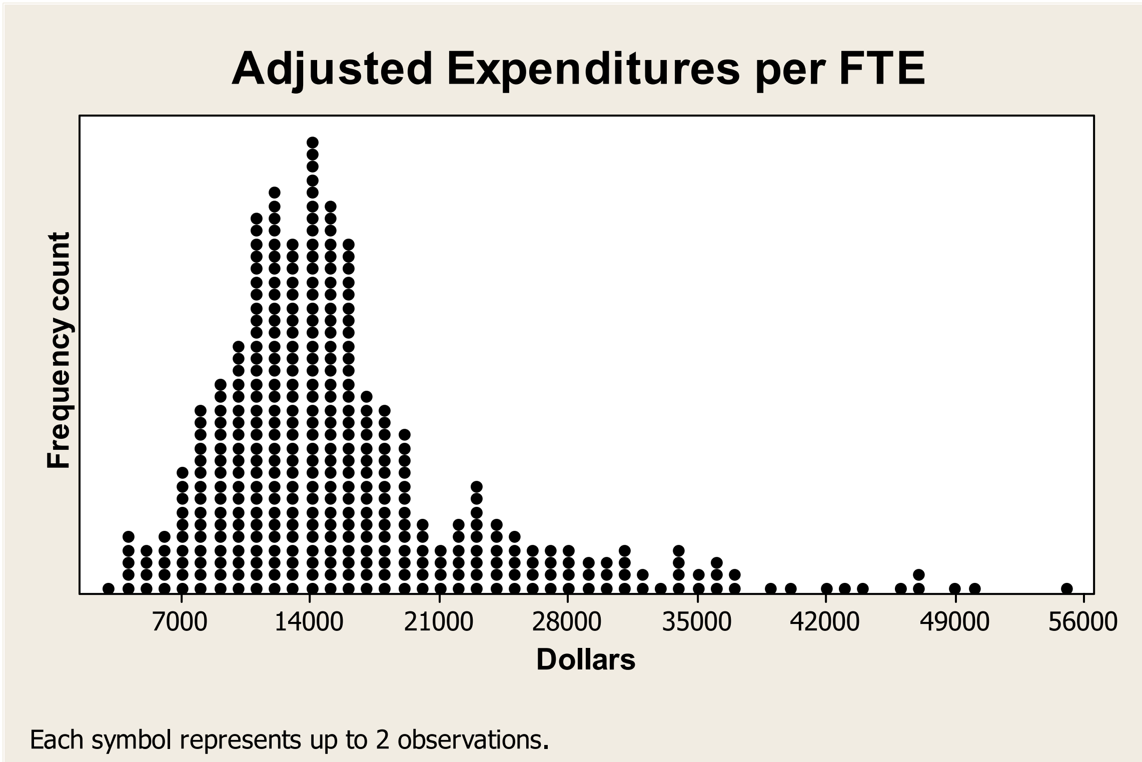
Student Staff Ratio (SSR): Number of FTE students per FTE staff members.

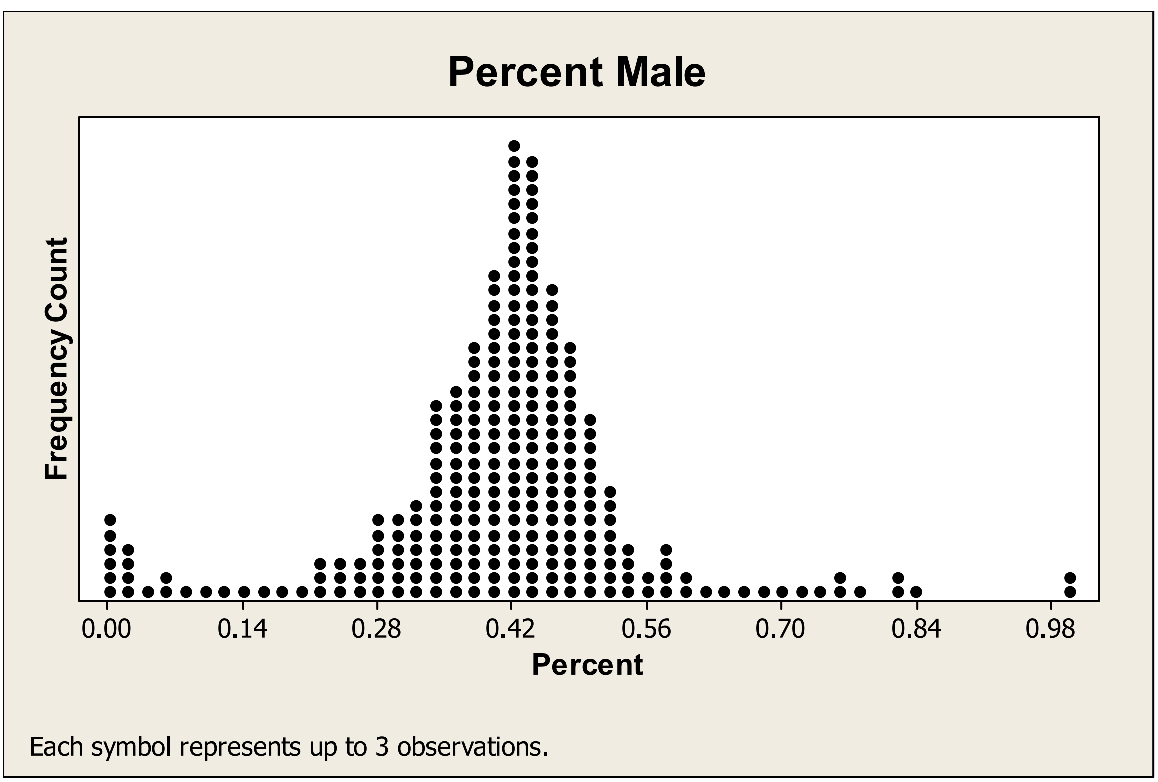
Percent Asian Pacific Islander (AP): Percentage of Asian or Pacific Islander origin students in the institution's undergraduate cohort entering fall 1997.

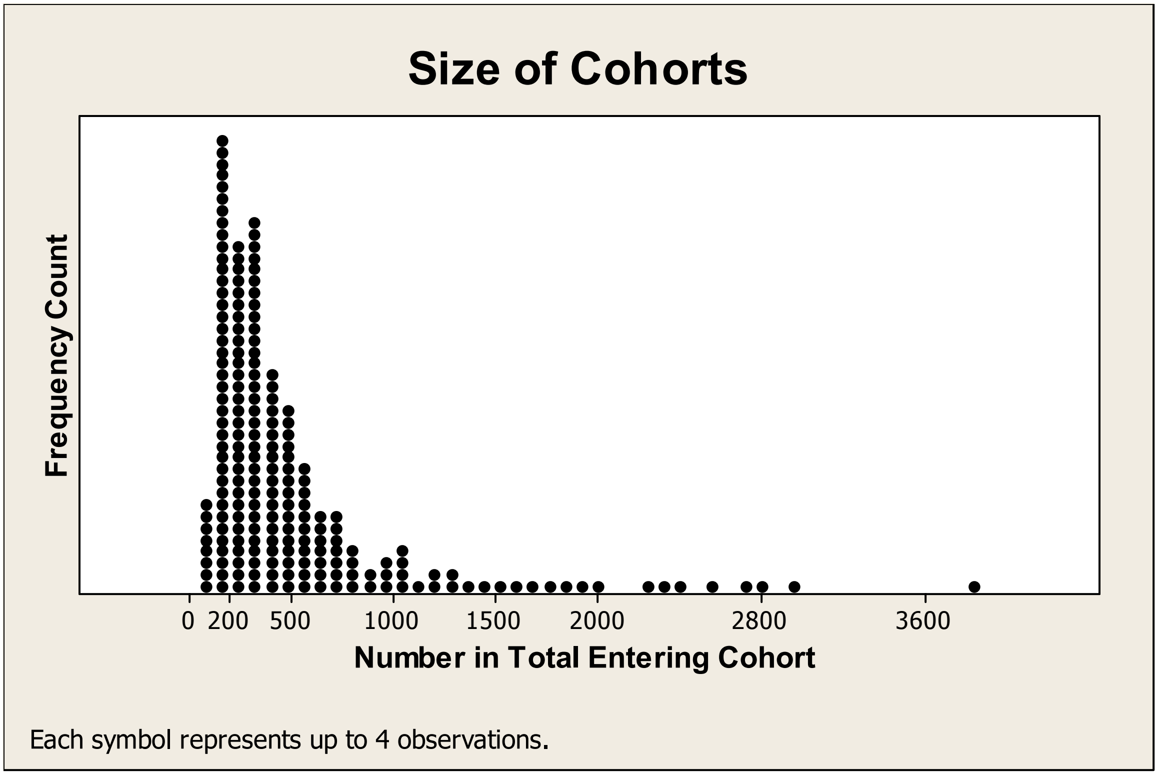
Percent White Non-Hispanic (W): Percentage of White and Non-Hispanic students in the institution's undergraduate cohort entering fall 1997.

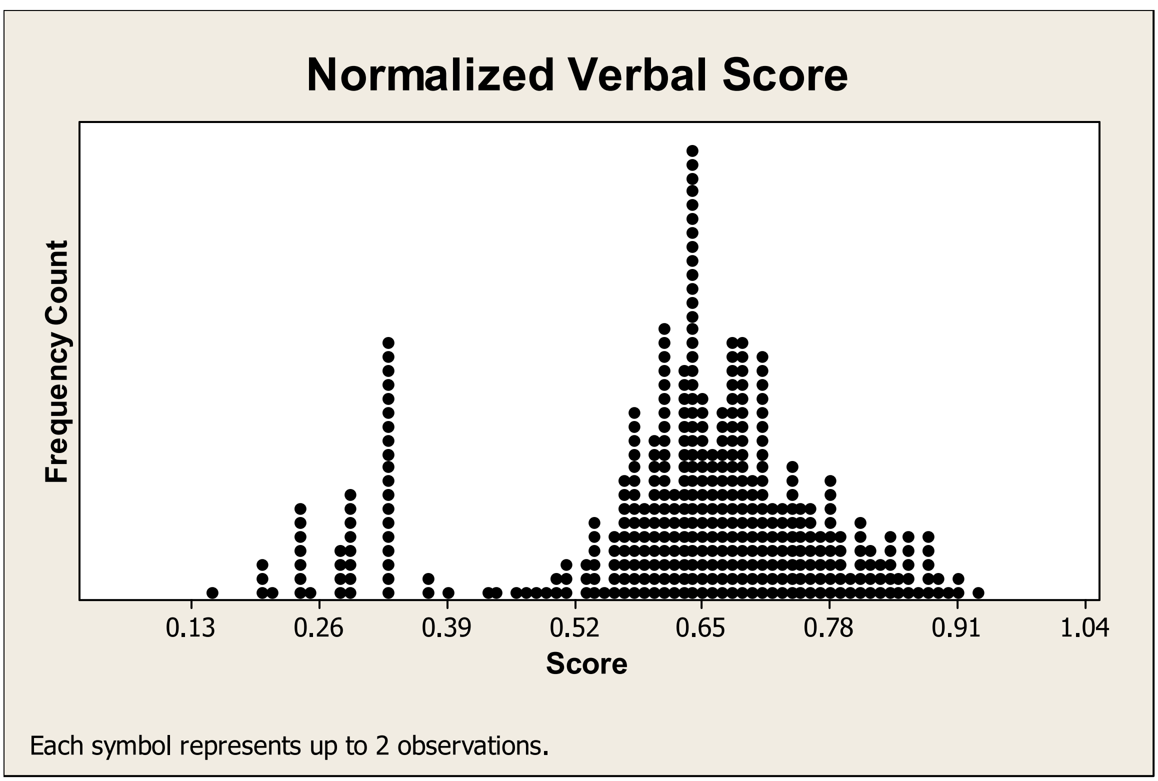
Appendix A Data

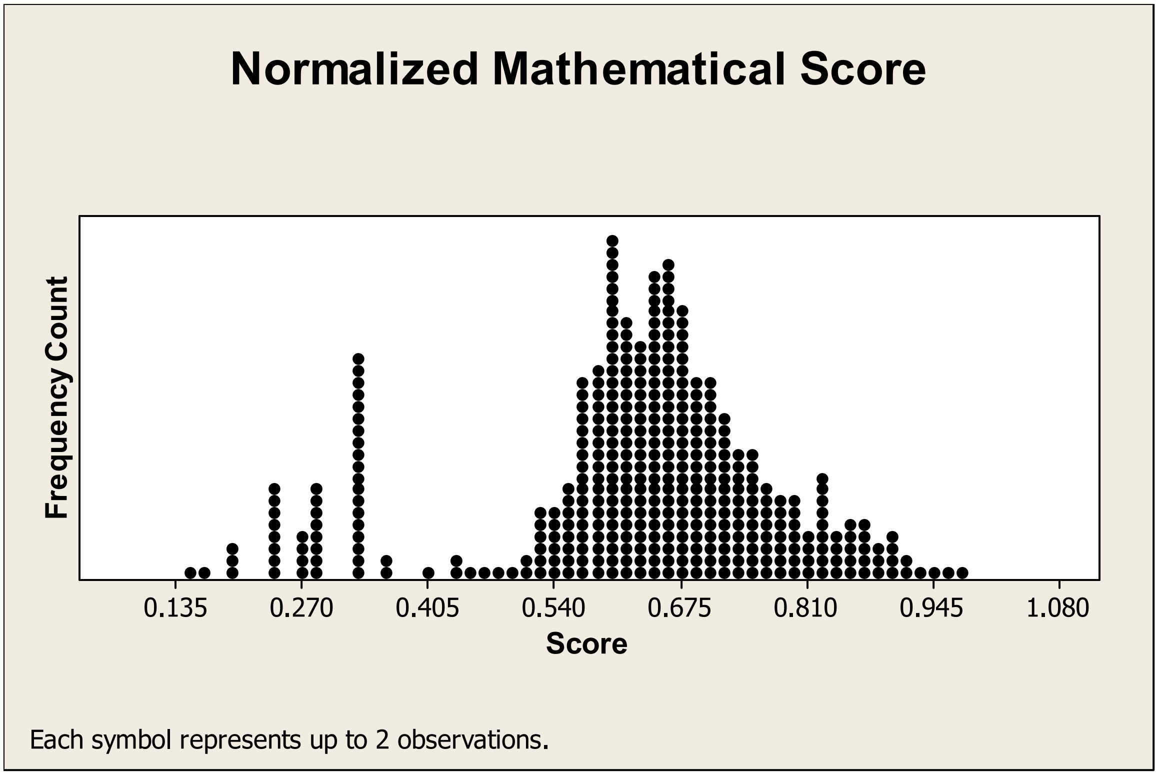
	Variable							
	G4	G5	G6	Percent Male	Percent Full-time	Adjusted Exp. / FTE	Verbal Score	Math Score
Number of Obs.	753	753	753	753	753	753	753	753
Mean	0.449	0.553	0.580	0.410	0.863	15894.19	0.632	0.627
Median	0.437	0.555	0.577	0.420	0.904	14189.65	0.652	0.642
Mode	0.273	0.500	0.500	0.000	1.000 .		0.331	0.326
Coeff. Variation	46.38	34.54	31.62	32.58	15.41	49.00	23.51	24.27
Std. Dev.	0.208	0.191	0.183	0.134	0.133	7787.52	0.148	0.152
Var.	0.043	0.036	0.034	0.018	0.018	60645503.40	0.022	0.023
Skewness	0.111	-0.205	-0.162	-0.235	-1.609	1.70	-1.060	-0.909
Kurtosis	-0.648	-0.234	-0.203	4.197	3.116	3.70	1.107	0.973
Range	0.975	0.984	0.984	1.000	0.823	51660.00	0.777	0.831
Interquartile Range	0.313	0.254	0.241	0.102	0.162	6812.00	0.119	0.125

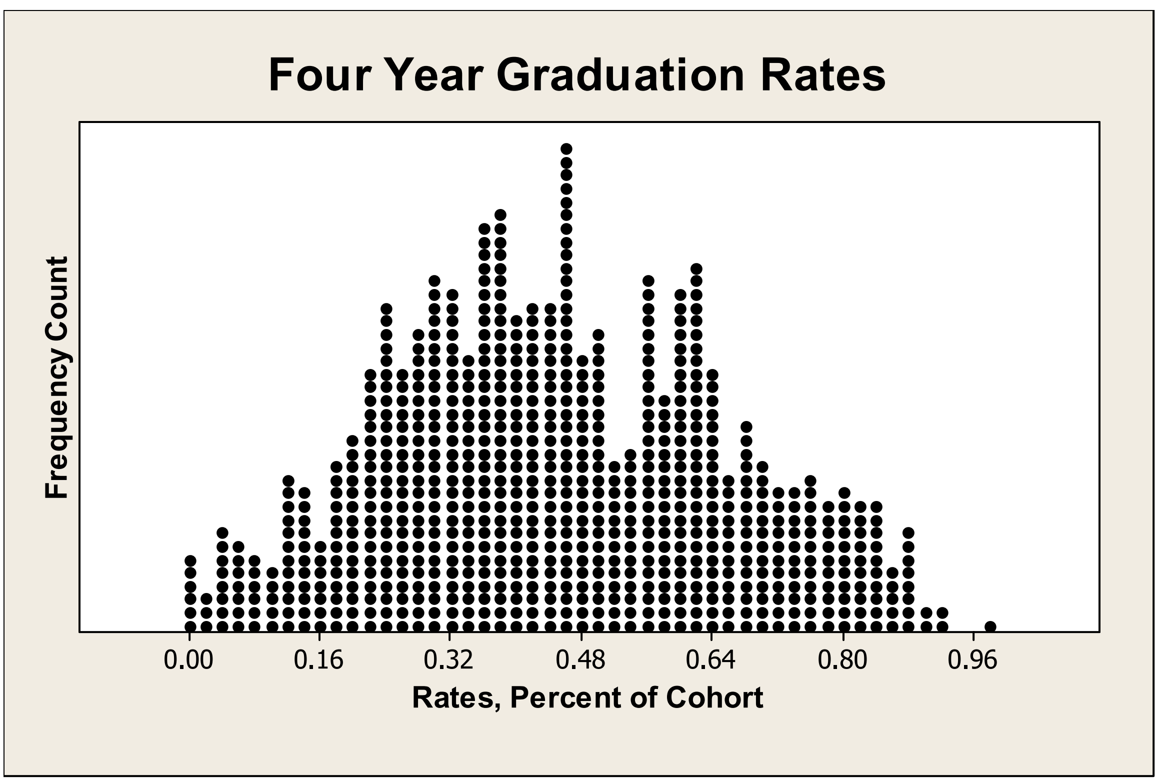

Adjusted Expenditures per FTE
Frequency count
7000
14000
21000
28000
35000
42000
49000
56000
Dollars
Each symbol represents up to 2 observations.

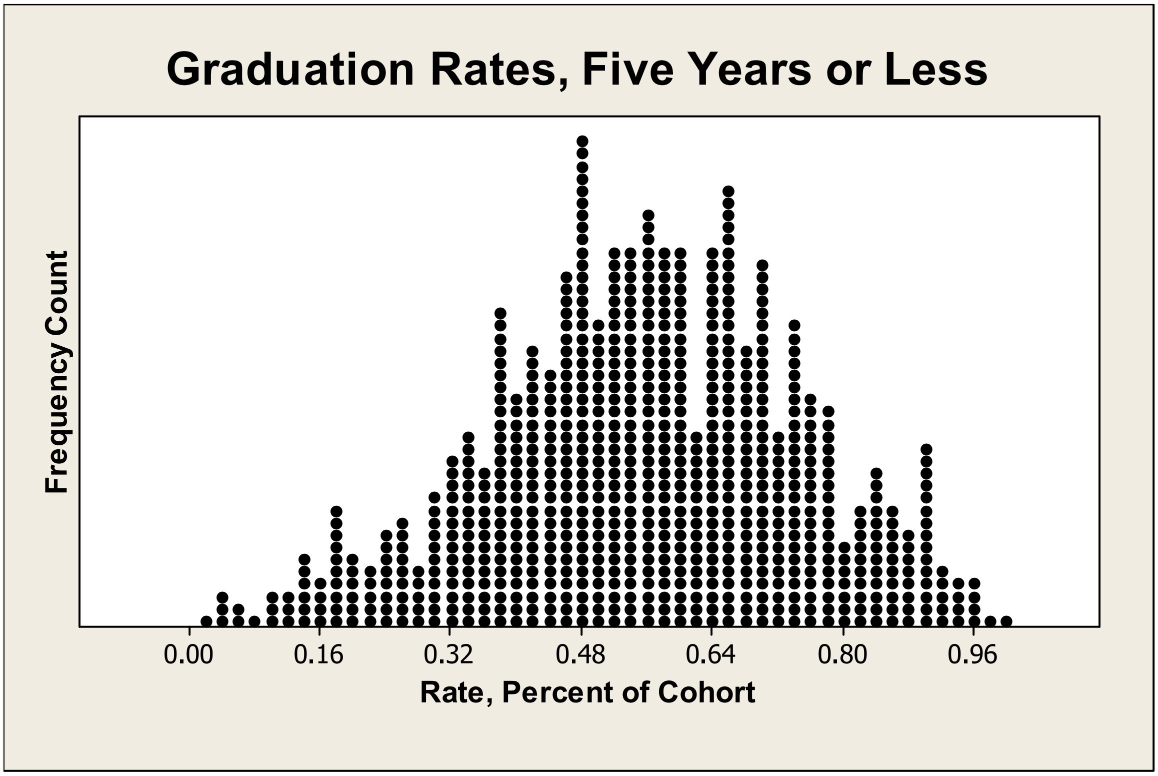

Percent Male
Frequency Count
0.00
0.14
0.28
0.42
0.56
0.70
0.84
0.98
Percent
Each symbol represents up to 3 observations.

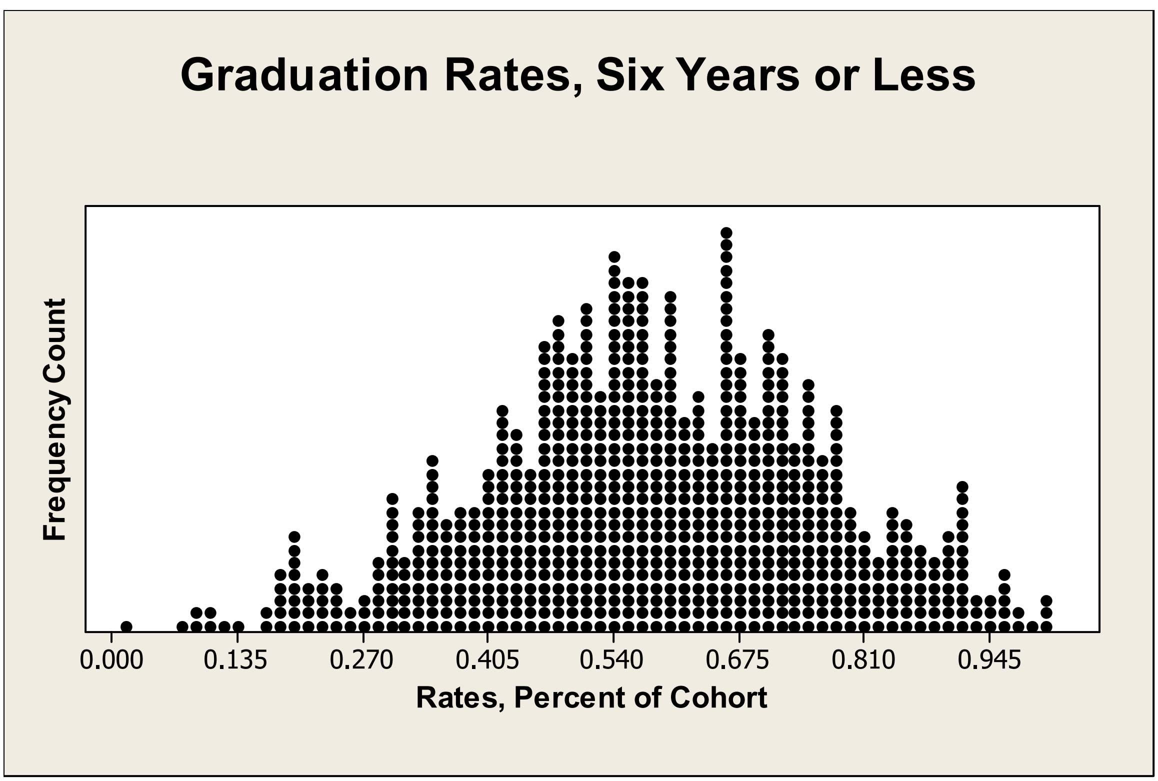

Size of Cohorts
Frequency Count
0 200 500 1000 1500 2000 2800 3600
Number in Total Entering Cohort
Each symbol represents up to 4 observations.


Normalized Verbal Score
Frequency Count
0.13 0.26 0.39 0.52 0.65 0.78 0.91 1.04
Score
Each symbol represents up to 2 observations.


Normalized Mathematical Score
Frequency Count
0.135
0.270
0.405
0.540
0.675
0.810
0.945
1.080
Score
Each symbol represents up to 2 observations.


Four Year Graduation Rates
Frequency Count
0.00
0.16
0.32
0.48
0.64
0.80
0.96
Rates, Percent of Cohort


Graduation Rates, Five Years or Less
Frequency Count
0.00
0.16
0.32
0.48
0.64
0.80
0.96
Rate, Percent of Cohort


Graduation Rates, Six Years or Less
Frequency Count
0.000
0.135
0.270
0.405
0.540
0.675
0.810
0.945
Rates, Percent of Cohort

APPENDIX B
COST METHODOLOGY

SUNY Cost Allocation Model and Methodology

Information maintained by The State University of New York (SUNY) was used to approximate the necessary costs and output variables and to address the above issues[22]. SUNY is interested in assessing the relative level of resource support for its academic programs against the funding levels of other public colleges and universities. To accomplish this SUNY calculates a “normalized” cost per FTES for a baccalaureate granting institutions. For almost thirty years, most of SUNY’s four-year colleges and universities have participated in a course and section cost allocation system. This system joins such information with financial and spatial information in arriving at a cost per credit hour for lower division, upper division, master’s and doctoral level courses. SUNY uses this information in a budget allocation model that allocates resource support for the courses taught by the institution. In the mid 1990s, SUNY estimated the academic program cost of programs offered by the twenty-eight SUNY colleges and universities participating in the course data collection system and linked actual course costs, which were derived from faculty salary and departmental support costs, to the courses taken by students during a given semester.

These costs, when aggregated by students within an academic program, yield an average program cost of all SUNY students enrolled in a particular academic program. While SUNY’s costs are not the exact costs of other institutions, this study only requires that the relative academic program costs hold across institutions.

[22] While a model based on such information measures the world through a SUNY lens, the size of SUNY (over 413,000 students) and diversity of the institutions within the System (61 colleges and universities—associate, baccalaureate, masters, doctoral and first-professional institutions—research, comprehensive and specialized institutions), suggest SUNY relative program costs may be applicable to other public institutions.

The application of the SUNY allocation model to other public institutions requires the following assumptions: 1- The relative cost differentials among SUNY academic programs are reasonable proxies for the cost differentials that exist throughout US public higher education; 2- The IPEDS Completions Survey distribution of degrees granted by academic program is a good proxy for an institution's enrollment by discipline and student level, and 3- An estimate of an institution's undergraduate Full Time Equivalent Student (FTES) load is the number of full-time undergraduate students plus one-third of the number of part-time undergraduate students.

The final methodological step is to compute an undergraduate expenditure level per FTES student. This is accomplished by dividing the adjusted full time equivalent students by the discipline-adjusted costs. Lastly, the FTES workload estimates by academic discipline are inflated or deflated based on the indexed program costs using SUNY cost data. The result is a normalized FTES workload level that adjusts for the difference in funding required by the disciplines offered by the institution. Further details of the method of adjustment are available from the authors upon request.

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TABLE 1

Ordinary Least Squares Estimation Results
Dependent Variables: Four, Five, and Six Year Graduation Rates

	Four Year		Five Year		Six Year	
Parameter	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
Intercept	0.758	0.114	0.726	0.106	0.778	0.103
Percent Male	-0.262	0.040	-0.198	0.037	-0.203	0.036
Percent Full Time	-0.826	0.268	-0.518	0.249	-0.487	0.241
Adjusted Exp. Per FTE	1.8E-05	2.4E-06	1.5E-05	2.2E-06	1.4E-05	2.1E-06
Verbal Score	-2.788	0.273	-2.714	0.253	-2.796	0.246
Math Score	1.094	0.184	1.232	0.171	1.306	0.166
Percent Full Time Sq'd	0.642	0.180	0.415	0.167	0.397	0.162
Adj. Exp. Sq'd	-3.1E-10	4.83E-11	-2.8E-10	4.78E-11	-2.4E-10	4.4E-11
Verbal Score Sq'd	2.152	0.191	1.955	0.177	1.930	0.172
R-Squared	0.617		0.610		0.600	
Adj. R-Squared	0.613		0.605		0.596	
F	149.9		145.3		139.8	
Number of Obs.	753		753		753	

TABLE 2 A
Stochastic Frontier Estimation Results
Four Year Graduation Rates

Variable	Estimate	Standard Error	T-Statistics
Intercept	0.846	0.119	7.128
Percent Male	-0.260	0.040	-6.461
Percent Full Time	-0.862	0.268	-3.217
Adjusted Exp. Per FTE	0.000	0.000	7.797
Verbal Score	-2.807	0.274	-10.252
Math Score	1.107	0.186	5.962
Percent Full Time Sq'd	0.666	0.180	3.701
Adj. Exp. Sq'd	0.000	0.000	-6.534
Verbal Score Sq'd	2.148	0.191	11.229
ln(sig2v)	-4.310	0.149	-28.993
ln(sig2u)	-4.757	0.620	-7.679
sigma_v	0.116	0.009	
sigma_u	0.093	0.029	
sigma2	0.022	0.004	
lambda	0.800	0.037	
Number of Obs	753		
chibar square	1.230		
Prob>=chibar sq	0.134		
log likelihood	475.933		

TABLE 2 B
Stochastic Frontier Estimation Results
Five Year Graduation Rates

Variable	Estimate	Standard Error	T- Statistic
Intercept	0.874	0.111	7.85
Percent Male	-0.198	0.037	-5.3
Percent Full Time	-0.576	0.247	-2.34
Adjusted Exp. Per FTE	1.51E-05	2.18E-06	6.93
Verbal Score	-2.761	0.254	-10.86
Math Score	1.198	0.173	6.94
Percent Full Time sq'd	0.458	0.166	2.76
Adj. Exp. Sq'd	-2.70E-10	4.40E-11	-6.14
Verbal Score Sq'd	1.990	0.179	11.14
Ln(sig2v)	-4.667	0.150	-31.21
Ln(sig2u)	-4.330	0.302	-14.33
sigma_v	0.097	0.007	
sigma_u	0.115	0.017	
sigma2	0.023	0.003	
lambda	1.183	0.024	
Number of Obs	753		
chibar square	6.600		
Prob>=chibar sq	0.005		
log likelihood	534.162		

TABLE 2 C
Stochastic Frontier Estimation Results
Six Year Graduation Rates

Variable	Estimate	Standard Error	T-Statistics
Intercept	0.780	0.120	6.51
Percent Male	-0.202	0.036	-5.62
Percent Full Time	-0.487	0.240	-2.03
Adjusted Exp.Per FTE	1.35E-05	2.12E-06	6.34
Verbal Score	-2.796	0.244	-11.44
Math Score	1.306	0.165	7.93
Percent Full Time Sq'd	0.397	0.161	2.46
Adj. Exp.Sq'd	-2.42E-10	4.32E-11	-5.60
Verbal Score Sq'd	1.930	0.171	11.30
Ln(sig2v)	-4.312	0.052	-82.85
Ln(sig2u)	-12.740	91.645	-0.14
sigma_v	0.116	0.003	
sigma_u	0.002	0.078	
sigma2	0.013	0.001	
lambda	0.015	0.079	
Number of Obs	753		
chibar square	0.000		
Prob>=chibar sq	1.000		
log likelihood	555.851		

Table 3
Log Likelihood Ratio Tests of Models

Model / Statistic	G4	G5	G6
Restricted Model	113.92	181.41	211.20
Un-Restricted Model	475.93	536.16	555.85
Log Likelihood Ratio	724.02	709.42	689.30
Critical Value, 0.999	26.13	26.13	26.13

Table 4
Elasticities for Three Graduation Rates
Evaluated at the Mean and the Median

with respect to	G4 Mean	G4 Median	G5 Mean	G5 Median	G6 Mean	G6 Median
753 Private Colleges and Universities						
Percent Male	-0.24	-0.25	-0.15	-0.15	-0.14	-0.15
Percent Full Time	0.55	0.71	0.33	0.41	0.29	0.36
Adjusted Exp.	0.30	0.31	0.19	0.19	0.16	0.16
Verbal score	-0.13	-0.01	-0.28	-0.19	-0.39	-0.32
Math score	1.55	1.63	1.36	1.38	1.41	1.45
480 Public Colleges and Universities						
Percent Male	-0.21	-0.24	-0.01	-0.01	0.05	0.05
Percent Full Time	1.75	2.32	1.23	1.40	0.89	0.97
Adjusted Exp.	0.29	0.34	0.14	0.15	0.09	0.10
Verbal Score	2.52	3.48	0.71	0.94	0.23	0.39
Math Score	-0.25	-0.31	0.62	0.67	0.87	0.93