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Publicly vs. Privately Controlled Higher Education Costs: Panel Data Estimates

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Abstract: More so now than ever, budgetary problems and widespread reforms are generating questions regarding higher education costs among publicly controlled compared to privately controlled colleges and universities. Past studies have offered scale and scope estimates anchored in 1995 and earlier cross sectional data that could contain omitted variable biased. In contrast, this paper employs panel data spanning the 2005 through 2009 years to estimate a multiproduct cost function and scale and scope economies separately for public and private sector colleges and universities. The two-way fixed effects results indicate the presence of significant institutional and time effects. Overall, the findings suggest private institutions have the product specific cost advantage in expanding graduate and professional school education but the economies of scope and, therefore, joint production advantages rest with public colleges and universities. Also, there is evidence that the post recessionary pace of higher education cost increases have slowed down but the permanency of that is questionable.

Keywords Higher education. Education costs. Scale and scope economies.
JEL I00, I21, I23, L32

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1. Introduction

Higher education reform that is taking a firm hold in both Europe and the U.S. continues to bring into question the cost structure of higher education and, in particular, the extent to which state owned, publicly controlled colleges and universities differ from their non-profit privately controlled counterparts. On this front, empirical evidence produced to date has relied on cross-section estimates of cost functions and the associated scale and scope economies. Those cross section results are potentially biased due to omitted, unobservable individual college and university effects and/or time effects. In addition, the most comparable studies rely on U.S. college and university data drawn from the 1995-96 academic year or earlier and, therefore, are not likely to reflect current higher education costs or structural differences between the public and private sectors.

To this line of inquiry, the present paper attempts to offer two major advances. First, instead of cross-sectional data, panel data are employed in estimating a two-way fixed effects multiproduct cost function and the resulting scale and scope economies. Second, the panel covers four years of higher education costs, including the years from 2005-06 through 2008-09. The latter is the most recent release of national data and, combined with other years allows for the control of business cycle effects, including possible effects of the financial meltdown induced recession on higher education costs.

2. Literature background

Research related to higher education has clearly recognized the multiproduct nature of colleges and universities and the replacement of unidimensional measures of economies of scale with product specific economies and economies of scope. The multiproduct lines of colleges and universities have included the usual undergraduate education, graduate education, and research outputs. While product specific economies or diseconomies relate to increases in a single output holding all others constant, measures of scope economies determine whether it is cheaper to have colleges and universities produce two or more products jointly or to have separate production in specialized colleges and universities.

The first multiproduct empirical investigation of higher education scale and scope economies was provided by Cohn, et al. (1989). Using a cross sectional sample of U.S. institutions for the 1981-82 year, they found product-specific cost advantages only in the public sector and only with regard to research and graduate education. Economies of scope in undergraduate and graduate education and research were uncovered in both public and private institutions.

Subsequent studies produced some conflicting as well as supporting evidence. All employed cross-sectional data. The most comparable research includes the use of U.S. data for the academic years 1982-83 (DeGroot et al., 1991), 1990-91 (Koshal and Koshal, 1999), and 1995-96 (Laband and Lentz, 2003 and Sav, 2004). The DeGroot et

al. (1991) study examined only research level universities but found general agreement with the Cohn et al. (1989) findings. In constrast, Koshal and Koshal (1999) excluded Ph.D. granting universities and reported economies of scope in both public and private sectors. Laband and Lentz (2003) repeat the work of Cohn et al. but provide an update using 1995-96 data. They found product-specific economies in both sectors, but diseconomies of scope in each.

Detailed comparisons across these studies are difficult at best. Each uses different cost specifications, different variables, and different survey data. However, all of them bring into question the potential omitted variable bias created from single year cross sectional estimates. Additionally, given the reforms on higher education agendas, there arises the obvious need for a more contemporary examination of education cost structures.

3. Empirical methodology

Here, panel data is used in an extension of the multiproduct cost methodology developed by Baumol et al. (1982) and employed in previous higher education research. Introducing individual college and university institutional effects α_i and controlling for time effects γ_t, the total cost C_{it} of producing all Q_j outputs is specified as a two-way fixed effects multiproduct cost function as follows:

$$C_{it} = \sum_j^J \beta_j Q_{jit} + 1/2 \sum_j \sum_k \delta_{jk} Q_{jit} Q_{kit} + \alpha_i + \gamma_t + \varepsilon_{it} \qquad (1)$$

where ε_{it} is the standard, purely random effect.

In the usual three output case, the outputs Q_j vary according to the production of research and undergraduate and graduate teaching. However, unlike previous studies, here a professional school (e.g., law and medical) teaching output will be added to account for its potentially high cost effects. Thus, (1) is expanded from a three to a four output cost function. Two additional quality type variables are appended to (1). On the input side, the percentage of students receiving low income federal government subsidies is used to proxy students potentially arriving from underfunded school districts. As a measure of quality instruction, the percentage of students that are graduated with a bachelor's degree within five years of enrollment is employed. Also, the ratio of institutional liabilities to assets is included as a possible measure of the effects of managerial quality on fiscal costs.

Multiproduct production gives rise to three measures of cost efficiency: ray economies of scale, product specific economies of scale and economies of scope. From the cost function (1), the three economies are:

$$\textit{Ray} = C_J \div \sum_j \left(C_j^{'} \times Q_j \right) \qquad \text{>1 for economies} \qquad (2)$$

$$\textit{Product Specific} = \left(C_J - C_{J-j} \right) \div \left(C_j^{'} \times Q_j \right) \qquad \text{>1 for economics} \qquad (3)$$

$$\textit{Scope} = \left(C_j + C_{J-j} - C_J \right) \div C_J \qquad \text{>0 for economies} \qquad (4)$$

where C_J is the total cost of producing all J outputs, C_j the total cost of only the j th output, and $C_j^{'}$ the marginal cost of the j th output. From a policy perspective, ray economies suggest cost advantages of expanding all university education and research.

In higher education that is an unlikely scenario: e.g., increases in undergraduate education would not carry the same increases in research or professional school output. Thus, the appropriate focus will be on product specific economies whereby the cost effect is on increasing output for a product line. Diseconomies of scale generated from values less than unity would thereby suggest product specific downsizing. Joint production cost advantages require positive values of the economies of scope measure. Negative values would lead to possible arguments for higher education systems comprised of more specialized colleges and universities.

4. Data

Data is supplied through the U.S. Department of Education, Integrated Postsecondary Education Data System (IPEDS). Frequent changes in the accounting requirements imposed upon individual colleges and universities tends to compromise the continuity of some longitudinal data. In the present study, continuity is preserved with the most recently available data for the four fiscal years 2005-06 through 2008-09. The sample excludes institutions outside of the current mainstream of post-secondary education interest; e.g., chiropractic and culinary institutes. The total panels are comprised of 2116 and 3628 observations for the public and private sectors, respectively.

Table 1 summarizes the variable definitions along with their means and standard deviations. All costs are twelve month 2009 real dollars. Undergraduate and graduate outputs are credit hours. Due to data availability, professional school education is

unduplicated enrollments. As with previous studies, it was necessary to rely on research grants received as the best proxy for institutionally aggregated research.

5. Results

Table 2 presents the total cost two-way fixed effects regression results for both the public and private sectors. The reported R-squares are reasonably strong. For each sector, individual college and university effects (α_i) are significant at the one percent level: the null hypothesis that all α_i=0 is rejected. Pooling across individual colleges and universities and employing OLS would generate biased cost estimates. In addition, the joint test that all time effects (γ_t) are zero is rejected. Thus, there is compelling support for the two-way fixed effects implementation. Moreover, a Breusch-Pagan test for each sector suggested appropriateness of random effects only at the thirty-four percent level of significance. Finally, a Chow test (28.38 significant at 1%) confirmed systematic inter-sector structural differences in costs.

For the cost factors, the majority of variables within both sectors are statistically sound at either the one, five or ten percent level of significance. The positive and significant individual time effects indicate increasing higher education costs for each year and in each sector. However, the most recent rate of increase is substantially slowed, e.g., from 2008 to 2009 compared to 2007 to 2008. While undergraduate (UGRAD) and professional (PRO) education outputs along with research (RES) prove to be statistically significant, graduate education (GRAD) falls below the 10% mark. However,

as with previous studies, the nonlinearity of cost structures pose interpretation difficulties in relying on individual coefficients. Thus, Table 3 provides marginal cost estimates at the mean outputs and confirms that the cost increment of an additional credit hour of undergraduate and graduate education is lower at public compared to private institutions. But the differential is not balanced: the undergraduate marginal cost is 9% of the private sector's while the graduate marginal cost is 40%. The marginal research cost advantage also resides with public institutions. However, an additional professional school enrollee is 40% less costly to educate in private compared to public colleges and universities.

Interestingly, the percent of federally funded lower income students has a smaller negative cost effect in the public compared to the private sector but only carries statistical significance in the former. And although not statistically significant, it is reassuring that the negative DEGREE sign suggests it could be cheaper to get students degreed in a more timely fashion that not. But if DEBT carries any managerial implications, then its cost increasing effect in both sectors could remain a long term cost issue for higher education.

Table 4 presents the economies of scale and scope results for each of the outputs. Results are provided for the overall mean of each output and for the mean outputs for 2009. Taking into account the fixed institutional effects, the estimates are generated at the median, minimum, and maximum institutional effects. As noted earlier, there is little interest in ray economies and, therefore, they are not included in the analysis of Table

4. However, at the overall means, it can be noted that ray economies were found in both the public and private sectors at values of 1.62 and 1.89, respectively. As for product specific economies, at the median evaluation only private colleges and universities producing in 2009 realize any reasonable cost advantages and that occurs in graduate and professional education outputs. At least half of the private institutions realize those scale economies. But the findings also unveil substantial variability around the median institution. That variability is almost universally larger among public compared to private colleges and universities. At the upper end of the range, the private sector shows strong product specific economies for all teaching outputs whereas the public sector has a much weaker showing on all accounts. Moreover, the public sector diseconomies tend to worsen in 2009 while the private sector shows some positive gains. However, in both sectors, the variability narrows and, therefore, there seems to be a tendency over time toward more homogeneity in cost structures within a given sector.

With respect to scope economies, quite a different picture emerges. When evaluated at the overall means, scope economies prevail at the median in both sectors and for all three teaching outputs and research. In 2009, that remains true for public colleges and universities and, in fact, becomes stronger. The same does not hold for the private sector. For the 2009 median, the scope economies degenerate into diseconomies for all outputs. But unlike the product specific economies, the tendency for the scope economies to narrow in variability is not as convincing in either sector.

6. Concluding remarks

This paper indicates that there is significant individual college and university fixed effects as well as time effects present in the underlying cost structures of public and private colleges and universities. Hence, previous cross sectional cost estimates and corresponding investigations of economies of scale and scope could have generated statistically biased results. Presently, empirical implementation of a two-way fixed cost, four output model indicates that public colleges and universities have generally exhausted product specific economies of scale in producing undergraduate, graduate, and professional education and research. Private institutions, on the other hand, appear to have cost advantages in expanding both graduate and professional school education. Yet, estimates of economies of scope give the cost advantage to the public sector, indicating from a public policy perspective that private institutions might consider moving to more specialized production whereas public colleges and universities realize lower costs of jointly producing under one roof all levels of education along with research. Incorporating fixed institutional effects, however, suggests caution in drawing industry wide conclusions. The results here indicate there exists substantial institutional variability. In addition, the time effects indicate a slowing down in the pace of cost increases occurring among both public and private colleges and universities. At this time it is not possible to determine the extent to which those cost changes are driven by budgetary problems encountered with the financial meltdown and the accompanying recession or by the implementation of widespread higher education reforms. Those answers will have to await future research as more years of data become available.

Table 1: Variables, Means and Standard Deviations

Variable	Public	Private
C, Total Cost, $	2.80E+08	1.24E+08
	(4.71E+08)	(3.88E+08)
UGRAD, Undergraduate Credit Hours	2.79E+05	0.71E+05
	(2.45E+05)	(0.85E+05)
GRAD, Graduate Credit Hours	3.96E+04	1.77E+04
	(5.55E+04)	(4.17E+04)
PRO, Professional Enrollments	2.05E+02	1.44E+02
	(5.66E+02)	(4.46E+02)
RES, Research, $	5.21E+07	1.59E+07
	(11.26E+07)	(8.01E+07)
UGRAD2, UGRAD Squared	1.38E+11	0.12E+11
	(2.77E+11)	(04.81E+11)
GRAD2, GRAD Squared	4.65E+09	2.05E+09
	(17.02E+09)	(12.16E+09)
PRO2, PRO Squared	3.62E+05	2.20E+05
	(17.22E+05)	(10.25E+05)
RES2, RES Squared	1.52E+16	0.67E+16
	(7.22E+16)	(6.03E+16)
UGRAD-GRAD, Undergraduate x Graduate	2.19E+10	0.3.5E+10
	(5.98E+10)	(1.53E+10)
UGRAD-RES, Undergraduate x Research	3.13E+13	0.38E+13
	(10.67E+13)	(2.26E+13)
GRAD-RES, Graduate x Research	7.02E+12	2.49E+12
	(29.27E+12)	(20.25E+12)
PRO-RES, Professional x Research	6.08E+10	1.93E+10
	(29.20E+10)	(12.94E+10)
WG, Faculty Average Wage, $	6.39E+04	5.87E+04
	(1.34E+04)	(1.83E+04)
WG2, WG Squared	4.26E+09	3.78E+09
	(1.76E+09)	(2.53E+09)
UGRAD-WG, Undergraduate x Wage	1.95E+10	0.49E+10
	(2.02E+10)	(0.77E+10)
GRAD-WG, Graduate x Wage	2.94E+09	1.40E+09
	(4.79E+09)	(4.08E+09)
PRO-WG, Professional x Wage	1.63E+07	1.22E+07
	(4.77E+07)	(4.14E+07)

Table 1: (continued) Variable	**Public**	**Private**
RES-WG, Research x Wage	4.08E+12	1.60E+12
	(9.91E+12)	(8.99E+12)
FED, Percent Students on Federal Grants	32.21	31.43
	(16.37)	(19.26)
DEGREE, Percent Students Degreed in 6 Years	42.89	56.33
	(17.66)	(19.84)
UGRAD-DEGREE, Undergraduate x Degree	1.40E+07	0.45E+07
	(1.65E+07)	(0.65E+07)
FED-DEGREE, Undergraduate x FED	1.26E+03	1.57E+03
	(0.55E+03)	(0.86E+03)
DEBT, Liability to Asset	0.38	0.34
	(0.22)	(0.17)
N	2116	3626

Table 2: Public vs Private Total Cost Regression Results

Variable	Public	Private
Constant	48.63E+07***	7.85E+07***
	(9.20E+07)	(1.58E+07)
UGRAD	-7.59E+02***	-1.85E+02*
	(1.82E+02)	(0.9.5E+02)
GRAD	-3.58E+02	2.99E+02
	(6.31E+02)	(2.19E+02)
PRO	-17.52E+04*	8.49E+04**
	(9.41E+04)	(3.52E+04)
RES	2.04E-01*	5.04E-01**
	(1.21E-01)	(2.47E-01)
UGRAD2	1.02E-04	-2.04E-04
	(0.83E-04)	(1.32E-04)
GRAD2	-1.93E-03*	-7.10E-03***
	(1.13E-03)	(0.64E-03)
PRO2	3.56E+01	-6.25E+01***
	(2.72E+01)	(1.48E+01)
RES2	2.59E-09***	-2.25E-09***
	(3.74E-10)	(1.40E-10)
UGRAD-GRAD	1.50E-03***	1.71E-03***
	(4.62E-04)	(4.33E-04)
UGRAD-RES	-6.86E-07**	-38.03E-07***
	(3.39E-07)	(3.72E-07)
GRAD-RES	-1.15E-06*	6.84E-06***
	(6.83E-07)	(4.51E-07)
PRO-RES	-6.30E-04***	14.60E-04***
	(8.80E-05)	(8.64E-05)
WG	-8.67E+03***	-1.13E+03***
	(22.70E+02)	(2.45E+02)
WG2	2.84E-02*	0.78E-02***
	(15.1E-03)	(2.14E-03)
UGRAD-WG	8.22E-03	6.92E-03***
	(1.56E-03)	(1.10E-03)
GRAD-WG	6.69E-03	6.73E-03***
	(9.07E-03)	(2.41E-03)
PRO-WG	52.76E-01***	-5.47E-01**
	(6.98E-01)	(2.47E-01)
RES-WG	1.17E-05	2.83E-05***
	(0.40E-05)	(0.12E-05)

Table 2: (continued) Variable	**Public**	**Private**
FED	-0.38E+05***	-1.33E+05
	(4.26E+05)	(1.00E+05)
DEGREE	-1.61E+05	-1.62E+05
	(4.96E+05)	(1.01E+05)
UGRAD-DEGREE	3.93E+00***	0.12E+00
	(1.38E+00)	(0.69E+00)
FED-DEGREE	-5.35E+03	3.57E+03**
	(10.42E+03)	(1.79E+03)
DEBT	2.71E+07*	1.49E+07*
	(1.59E+07)	(0.82E+07)
2007	2.07E+07***	0.36E+07***
	(0.42E+07)	(0.11E+07)
2008	5.28E+07***	0.63E+07***
	(0.65E+07) ***	(0.14E+07)
2009	6.06E+07***	0.90E+07***
	(0.74E+07)	(0.15E+07)
F	99.96***	396.18***
R^2 (within/between/overall)	0.63/0.84/0.83	0.79/0.88/0.88
All α_i=0 (rejected)	32.37***	87.59***
All γ_t=0 (rejected)	24.76***	10.76***
N	2116	3626

Note: Significant at the 10% (*), 5% (**), and 1% level (***) or better, two-tailed.

Table 3: Intersector Marginal Cost Estimates ($)

	Undergraduate	Graduate	Professional	Research
Public	15.24	275.44	413,349.89	0.86
Private	169.36	673.176	58,041.83	2.16

Table 4: Product Specific and Scope Minimums, Medians and Maximums

	Public			Private		
	Min	Median	Max	Min	Median	Max
Product Economies at the overall means						
Undergraduate	-4.171	0.478	2.931	-1.096	0.392	1.222
Graduate	-1.542	0.268	1.224	-1.092	0.483	1.236
Professional	-0.569	0.135	0.457	-1.564	0.626	1.757
Research	-0.421	0.211	0.255	-0.378	0.185	0.434
Scope Economies at the overall means						
Undergraduate	-0.698	0.452	1.454	-0.227	0.136	0.220
Graduate	-0.656	0.888	1.498	-0.238	0.252	0.227
Professional	-0.591	1.534	1.563	-0.223	0.467	0.224
Research	-0.058	1.683	1.578	-0.226	0.225	0.221
Product Economies at the 2009 means						
Undergraduate	-1.274	0.139	0.886	0.036	0.936	1.063
Graduate	-1.351	0.222	1.053	0.462	1.063	1.121
Professional	-0.511	0.087	0.404	0.642	1.593	1.770
Research	-0.409	0.161	0.241	0.179	0.386	0.388
Scope Economies at the 2009 means						
Undergraduate	-0.613	0.615	1.338	-0.203	-0.098	0.156
Graduate	-0.571	1.041	1.381	-0.202	-0.868	0.273
Professional	-0.510	1.641	1.441	-0.200	-0.671	0.471
Research	-0.496	1.783	1.455	-0.202	-0.904	0.237

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