MANAGING PUBLIC HIGHER EDUCATION RESTRUCTURING: UNDERSTANDING COLLEGE AND UNIVERSITY COST STRUCTURES

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This paper focuses on understanding college and university costs as a prerequisite for successfully managing ongoing issues associated with restructuring publicly provided higher education. Restructuring is well underway as a result of globalization, the European led Bologna Declaration, and U.S. nationally competitive forces. It potentially affects the mix and level of products that colleges and universities produce. To capture the possible cost implications of those changes, multi-product cost functions are empirically estimated for four levels of U.S. public colleges and universities: doctoral, master, bachelor, and associate degree granting institutions. Scale and scope estimates are derived for research and three teaching outputs, including undergraduate, graduate, and professional education. Findings regarding product specific economies of scale suggest that government reforms to place enrollment growth at lower level associate colleges may increase the costs of providing public higher education. In contrast, reforms that create more specialized institutional missions could generate cost savings. While the empirical estimates pertain to U.S. colleges and universities, the lessons of experience in one country can be valuable to others.

1. INTRODUCTION

In U.S. publicly controlled higher education, a growing restructuring movement is underway that is driven in part by the European reform launched by the Bologna Declaration and in part by nationally, as well as other internationally, competitive forces. Successfully managing such restructuring in the U.S. and abroad requires a firm understanding of the cost structures embedded in the multiproduct structure of the higher education delivery system. Those products include teaching, research, and service and vary in intensity

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according to college and university missions. Any restructuring that alters the mix of products carries important implications for the differential effects on higher education costs. For example, if increased costs are the result of reforms that decrease research relative to teaching output , then those costs are borne by higher education consumers; taxpayers, students, and, in the aggregate, all of society.

The extent to which restructuring developments in the U.S. are applicable to European reforms has been explored elsewhere (for example, see the Institute for Higher Education Policy, 2008). However, while part of the thrust of the Bologna Declaration is to create greater inter-country compatibility in higher education, some of the U.S. reforms being undertaken are designed around the need to create greater intra-country compatibility. The difference lies in name only, being that publicly controlled higher education in the U.S. comes under the separate auspices of state governments. There are 50 different and competing public higher education systems and the compatibility issue arises from U.S. national competition.

Like the Bologna Declaration, increased globalization drives each of these systems to institute reforms so as to maintain or create greater international competitiveness. In the present context, that is especially true given the presence of U.S. colleges and universities in Europe and the American style curriculum and accreditation degree programs that they offer in host countries. The largest segment of that market has been the mark of privately controlled colleges and universities. Publicly controlled colleges and universities are the relatively new but real players in expanding their offerings in Europe, not to mention Southeast Asia and China.

The need for expansion of educational markets came in the post September 11 attack on the U.S. and the subsequent forced decline in foreign student enrollment in U.S. higher education, especially graduate degree programs. World-wide, the U.S. still attracts more international students in total, but ranks modestly on a per capita basis (Wauters, 2006); that is, measures of foreign students as a proportion of all students enrolled in higher education per country. The increasing internationalization of higher education will continue to affect that distribution. The resulting convergence of curricular requirements will alter the concept of the "international university" (Wende, 2007), lower the cost of education outside the native country, and alter the market concentration among universities and countries.

Among the restructuring issues in the U.S. is a call for three–year baccalaureate degree programs to match those being implemented in some European countries (for example, see Helguero-Balcells, 2007). In addition, there are advocates of institutional mergers, alliances, and strategies to develop more specialized colleges and universities (see for example, Patterson, 2000). In other cases, the state government political machinery has mandated restructuring. States, such as Ohio, have mandated a system-wide restructuring of academic calendars and shifts in educational missions for its 14 public universities and 23 two-year colleges (Ohio Board of Regents, 2008). The state of Virginia is extending additional autonomy to its public universities, but with tie-ins in the form of state-wide government oversight of selected goals (Restructured Higher Education Financial and Administrative Operations Act, 2005). In contrast, many other states are not as transparent in implementing reforms. However, external accrediting bodies such as the Association to Advance Collegiate Schools of Business are continuously requiring curricular changes for undergraduate and graduate study, both nationally and internationally. Therefore, changes in the European business curriculum (for example, see Jurse and Tominc, 2008) are critical to that Association's oversight.

How restructuring possibly impacts higher education costs depends upon the quantity and the mix of producing higher education products, including teaching, research, and service. Those are the usual three legs of the stool measure of outputs. However, when empirical measurement is needed, outputs and inputs tend to become entwined. As developed in the seminal work by Rothschild and White (1995), colleges and universities produce human capital and students are inputs but are also recipients of human capital outputs. In Cohn and Cooper (2004), colleges and universities produce "knowledge creation" and "knowledge dissemination", along with social critique and entertainment. The difficulty, however, is that human capital and knowledge do not have directly observable market prices. As Rothschild and White (1995) point out, that leads to college and university pricing linked to student enrollments. The latter are readily observable and are bookkeeping entries in institutional accounting records. The fact that the "true outputs" do not carry market prices and are not easily quantified leads to the reliance on accounting data for model building and empirical tests associated with college and university costs (Belfield, 2000).

Understanding college and university costs requires a clear differentiation between single and multiproduct cost measures. If a college or university is very specialized in teaching and, in fact, teaching at a particular level such that

undergraduate education is the sole product produced, then it would be appropriate to employ the usual economies of scale measure to examine quantity effects on costs. For example, it could be a matter of determining whether the average cost decreases or increases with changes in a size proxy like student enrollments. Economies of scale are present if average costs decline with increased enrollments, and therefore, bigger would be better from a purely cost standpoint. However, for two decades, it has been recognized (for example, since Cohn, et al., 1989) that the multiproduct nature of higher education creates a more complex cost structure and requires additional measures of economies of scope whereby the focus is on the cost of producing one product simultaneously in conjunction with another product at the same institution. In this multiproduct context, the question that arises centers on the cost comparison of producing both education products at the same college or university versus producing them separately at different colleges or universities. If it is less costly to offer, that is produce, undergraduate and graduate program education within the same university compared to producing them separately in two specialized colleges or universities, then it is said that are economies of scope. Also, the magnitude matters. The greater that differential is, the stronger the scope economies and a cost based argument for joint production of the two products; undergraduate and graduate education produced in the same university setting.

Diseconomies of scope prevail when it is more costly to create higher education systems whereby individual universities attempt to be everything to everybody and produce to satisfy multiple constituencies. Perhaps that could be a university that engages in undergraduate and graduate education along with medical, law, and other professional school education and a mandated research output. Here again, the size of diseconomies carries importance for public policy implications and can lead to the justifiable rise of specialized stand-alone institutions such as medical schools. Overall, economies of scope measures are preferred multi dimensional cost measures. They are consistent with the goals set forth in the implementation of performance management as applied to the public sector (Fryer, et al., 2009) and, therefore, better position managers and public policy decision-makers to determine the cost consequences of changes brought about through restructuring policies.

Managerial positioning on a cost basis is a basic prerequisite to formulating and evaluating policies pertaining to higher education funding reform. That partly derives from the Bologna Process as an intergovernmental higher education commitment and partly from the European Union's Lisbon Strategy as a wider platform extending beyond but including higher education (Keeling,

2006). In the U.S., it is scattered about the 50 different states and created by fiscal problems in funding, increasing demands for public goods expenditures with decreasing tax revenues. Those fiscal problems, of course, have also plagued European nations and sparked the same funding problems for more than a decade (Eicher, 1998). Combined with ever-increasing globalization and recognition of the tangible benefits derived from a knowledge economy, decision makers are pressured to better link funding to performance measures, while simultaneously calling upon individual colleges and universities to seek more diversified and market based sources of funding, including greater private sponsorship and market based tuition fee structures (Alexander, 2003 and Pavicic, et al., 2009). As colleges and universities advance to more market based and perhaps greater for-profit orientation, regulatory oversight can begin to replace government ownership while achieving the same social welfare objective (e.g., Shleifer, 1998).

Although higher education is only sector specific in the more wide spread public management reform (Pollitt, 2000), the transformation of public higher education in a way that places more binding market forces on behavior and outcomes makes for an easier sell, given that for comparative purposes it has both private non-profit and private for-profit college and university counterparts. That differs substantially between the U.S. and Europe. In the former, the government tax effort in support of public higher education varies among the 50 different states from 88% to 183% of per capita income (Alexander, 2003). On average, publicly controlled colleges and universities offering a bachelor degree or above receive only 18% of their revenue from student tuition charges. That is in comparison to 36% for privately controlled non-profit institutions, and 88% for the for-profit colleges and universities (U.S. Department of Education, 2010).

However, due to variations in institutional accounting procedures, it is difficult to unmask student payment allotments and, therefore, the dependence on student tuition charges, especially given that more than 70% of students receive government subsidies and other financial assistance. Thus, comparing the funding composition across 50 different U.S. systems of higher education to nationally operated European systems that have normally been associated with free tuition is at this time difficult at best. Using a composite indicator, private investment as a percent of gross domestic product is four times greater in the U.S. than in the European Union (Council of the European Union, 2004). As the Bologna Accord takes greater foothold and globalization continues to heat up the world-wide competition in higher education, both U.S. and European

higher education will likely emerge as yet more tuition dependent, less governmentally owned and operated, and, therefore, more market oriented.

As those processes continue to unfold, understanding the complexity of educational delivery costs becomes increasingly more central to successful public policy decision making and college and university management. Therein is the purpose of the present paper. A multi-product total cost function and the associated economies of scale and scope are estimated for public higher education. The country of focus is the U.S., but the lessons of experience in one country can be valuable to others. Unlike the thrust of previous works, the estimates better capture differential and present day higher education production and costs through several means. First, along with research output, an expansion of teaching outputs is undertaken to include that of professional schools in addition to undergraduate and graduate education. That leads to a total of four instead of the more limited three outputs. Previous research that employed only three outputs ignored professional education production and, therefore, likely overestimated the cost of undergraduate and graduate education. Second, in contrast to aggregate estimates, cost, scale, and scope measures are disaggregated and provided separately for four Carnegie classification levels, including doctoral, master, bachelor, and two-year associate degree granting universities and colleges. That produces a major contribution over other research that aggregates cost estimates by bundling all public universities and colleges together and, therefore, fails to account for structural differences arising from product differentiation across institutional levels. Finally, previous research has generated cost estimates based on the 1995-96 academic year educational data, while the present study employs the most recent final data for the 2006-07 year. That is important in understanding the more current costs of public higher education. Moreover, it captures the post 2001 recessionary adjustments and the September 11 managerial responses to federal and state policies guiding public higher education.

The next section presents a brief background of the cost literature and is followed by a section on methodology. Then provided is an explanation of the data, the empirical results, and a summary with concluding remarks.

2. COST BACKGROUND

Research focused on managerial implications derived from higher education costs has a rich history. Early research culminated with the extensive review provided by Brinkman and Leslie (1986). However, since then, another 20 years has passed. Much of that beginning research tends to be a simplified

cataloging of university expenditures from an accounting framework as related to different university operations. In the context of the overall managerial and operational functions of colleges and universities, Hoenack (1990) and Brinkman (1990) funnel attention away from accounting costs to economic costs and the issue of economies of scale.

The major weakness in early economies of scale approaches to build models of higher education costs resides in the assumption that colleges and universities produce a single output. That output was usually taken to be undergraduate enrollments (for example, Southwick (1969) and Maynard (1971)). Even the early research clearly admitted that student enrollments were education inputs, not outputs. However, in that research and as pointed out in the introduction herein, enrollments are easily obtainable accounting measures that have become empirical substitutes for true outputs. That issue aside, the remaining problem with early work was that it hinged on the assumption that colleges and universities were single output entities.

It was not until the multiproduct contributions of Baumol et al. (1982) eventually found the way to higher education research that led to advances in our understanding of college and university cost structures. On that front, the work of Cohn et al. (1989) put forth the first substantial multiproduct cost model for the higher education industry. Using the 1981-82 academic data for U.S. colleges and universities, their work turned attention away from economies of scale to the more appropriate economies of scope in producing three rather than one higher education product; graduate as well as undergraduate education and research. Within the public sector, cost and scope estimates were generated for 1,195 institutions in the aggregate. Those aggregate estimates failed to account for cost differences across institutional levels, e.g., doctoral vs. master degree granting universities versus two-year technical colleges. As Cohn and Cooper (2004) suggest, outputs are likely to be more homogeneous within a given level of institutions, such as doctoral granting universities or within two-year colleges and ignoring those differences is likely to lead to corrupted cost estimates.

De Groot et al. (1991) followed suite with the multiproduct specification and using the 1982-83 data focused in a much more limited research capacity on only 147 U.S. universities. At an even more micro level, Dunbar and Lewis (1995) selected 18 U.S. public universities and explored the 1985-86 cost structures for specific disciplines (social and physical sciences and engineering). Additional research focused on U.S. higher education includes the Koshal and Koshal (1999) examination of 171 public colleges using the 1990-91 data and

the Laband and Lentz (2003) repeat of the industry-wide work of Cohn et al. (1989), but with cost estimates for the 1995-96 academic year.

All of these studies, with the exception of the De Groot et al. (1991) employ a three output multiproduct quadratic cost function. Outputs include research, undergraduate education, and graduate education. De Groot et al (1991) extend that to four outputs by separately including master level teaching. Sav (2004) also uses a four output model by including professional school education and, like Laband and Lentz (2003), provides an update to the 1995-96 academic year. Each of the studies relies on some measure of student enrollments and institutional expenditures to measure inputs and outputs. Beyond that, there is little general consensus on the specific inputs and outputs to use and how to measure them. In addition, there are intractable differences in sample selections. Each study uses different surveys and samples and invokes different twists on the empirical implementation of the cost function, e.g., including interaction terms and dummy variables.

With the lack of research uniformity in empirical techniques and input and output measures, it is nearly impossible to derive definitive cost conclusions from the various empirical results. It is only clear that economies of scale and scope vary across educational products and depend upon college and university size. Cohn et al. (1989) revealed diseconomies of scope at small outputs – possibly of the associate level variety, but that remains uncertain given their aggregate estimates. De Groot et al. (1991) more limited sample generated scope economies with respect to their measures of teaching outputs. Dunbar and Lewis (1995) find both scale and scope economies in the physical sciences and engineering disciplines. Unlike Cohn et al. (1989), Koshal and Koshal (1999) find economies of scope at nearly all output ranges. Laband and Lentz (2003) conclude that public institution scale and scope economies exist everywhere except in undergraduate teaching.

Nearly all these studies conclude in one way or another that continued independent verification of results is required to ensure that a bias is not built into a specific year. Moreover, it is emphasized that there is a need to implement better control for varying degrees of institutional specialization across colleges and universities within a given sector and year. In view of the public sector restructuring mandates and movements currently underway and on the horizon, there is now even more importance in determining the policy implications associated with college and university production costs. The remainder of this paper proceeds to do both by using institutional data disaggregated by Carnegie specialization to investigate cost structures for four

publicly provided higher education levels, including doctoral, master, bachelor, and associate degree granting colleges and universities.

3. METHODOLOGY

The cost methodology employs the flexibility of the multi-product quadratic total cost techniques applied to the higher education industry. The total cost (*TC*) of producing all *N* products at a public higher education institution is specified as:

$$TC_N = \alpha_0 + \sum_i \beta_i Output_i + 1/2 \sum_i \sum_j \delta_{ij} Output_i Output_j + \xi\ Medical + \gamma\ Wage + \varepsilon \quad (1)$$

where α_0 is a fixed cost and the output ($Output_i$) mix includes four products: undergraduate, graduate, and professional education, and research production. To capture the differential costs associated with those institutions that produce high cost medical education, a medical school (*Medical*) dummy variable is appended. The wage (*Wage*) variable is based on instructional costs and is included as a factor price. In addition, the cost function allows for the interaction between outputs *i* and *j*, e.g., graduate education and research. Specific measurements pertaining to the cost variables are explained in the data section to follow.

Not all public universities and colleges produce the same mix of outputs. The mix varies across institutional levels and those levels are best defined by the Carnegie Classification Code. For the cost specification here, four institutional levels will be used: doctoral, master, bachelor, and associate degree granting institutions. As expected and as bourn out in our empirical work, the number of products in the output mix declines from four at doctoral level institutions to two outputs at associate degree granting level institutions.

Of particular interest in our inquiry are the economies of scale and scope that exist in producing higher education. That includes ray (or overall) economies of scale associated with the proportional expansion of all *N* products (i.e., all three education outputs and research output), product specific economies of scale associated with the increased output of one product *i* while all other *N-i* are unchanged (e.g., increased professional school education, but all other education and research unchanged), and possible economies of scope arising from the cost advantages of producing the *ith* product jointly with all other *N-i* products (e.g., producing professional school education jointly with all other education and research or producing it separately in specialized universities). The working definitions of these measures have been well

established even as early as Baumol et al. (1982). Using the above notation and denoting MC_i as the marginal cost of producing the *ith* product, ray economies are defined as follows - Ray Economies of Scale:

$$TC_N / [\sum_i MC_i \times Output_i] \qquad (2)$$

Numerical values greater than one indicate the existence of ray economies of scale and, therefore, proportional increases in all outputs would lead to decreasing average costs. Values less than one are associated with increasing average costs.

Measuring product specific economies of scale requires the following - Product Specific Economies of Scale:

$$[TC_N - TC_{N-i})] / [MC_i \times Output_i] \qquad (3)$$

Here again, numerical values greater than one (less than one) result in economies (diseconomies) and declining (increasing) average costs, but result from an increase in the production level of only one product while maintaining all other production at existing levels. In contrast, economies of scope measures are not related to average costs but rather are determined by the following - Economies of Scope:

$$[TC_i + TC_{N-i} - TC_N] / TC_N \qquad (4)$$

Positive numerical values indicate the presence of scope economies and the notion that it is cheaper to produce multiple products jointly in the same university or college rather than in specialized single product institutions. Negative values generate diseconomies of scope in production and give rise to the economic based conclusion that it is less costly to have higher education systems that are comprised of more specialized colleges and universities.

4. DATA

The data for individual public universities and colleges are obtained from the U.S. Department of Education, National Center for Education Statistics and Integrated Postsecondary Education Data System (IPEDS). The most recently available data is for the academic year 2006-07 and it is used here. Financial, institutional characteristics, and enrollment surveys from IPEDS are combined to produce a useable data set of 1,242 public universities and colleges. That data is taken and subset by official Carnegie classified doctoral degree granting universities (151), master level degree granting colleges and universities (251),

bachelor degree granting colleges (55), and two-year associate degree granting colleges (785). Although the bachelor level sample size is relatively small, it was decided to retain it for reporting purposes with appropriately noted caution.

From IPEDS, a total cost measure is derived using the institution's 12-month educational and general expenditure. Accounting procedures do not permit separating out medical school costs, hence the inclusion of the medical school dummy in the total cost function. For the undergraduate and graduate education outputs, a total 12-month production of student credit hours is calculated from the IPEDS data. Employing student credit hours rather than student enrollments, as done in previous research, more closely aligns production with costs and the potential presence of government control in the managerial decisions of individual colleges and universities: the latter being due to the fact that government provided funding is directly determined by college and university credit hour production. Also, using credit hours as opposed to student enrollments accounts for that teaching difference, whereby 50 students enrolled in one class for four credit hours differs from the same number enrolled in a three credit hour class. That distinction is particularly important for inter-institutional controls as some colleges and universities operate under a three credit hour curriculum and teaching base, while others have elected to adopt a four or five credit hour base. For professional school education, credit hours are not available in the IPEDS data base and, therefore, it is required to use the full-time equivalent student enrollment as a substitute. This should not present a problem, given the relatively smaller presence of professional school production in the total output mix at the vast majority of institutions.

The inherent problem that does remain in relying on either student credit hours as herein or enrollments as with previous research is the absence of teaching quality. One could argue that perhaps conferred degrees would better measure outputs and partially account for instructional quality. However, such measures could inappropriately bestow higher quality ratings upon so-called "diploma mills" or, more generally, institutions with lower grading or curriculum expectation standards. Time to graduation could also be preferred over enrollment based measures if it were possible to account for the quality differences among longer versus shorter duration students. That could require a differentiation between part-time and full-time students as well as possible part-full-time student quality differences. The mass media generated rankings of various measures such as those created by *U.S. News and World Reports* or the *Times Higher Education* have not been fully accepted in academic circles. In reality, even at the very micro departmental level, measures of teaching quality, especially for interpersonal faculty and course comparisons, remain elusive.

Unfortunately, at the IPEDS national data collection level, there is not an institutional-wide measure of teaching quality that is available. The credit hour measure implemented here is at least expected to serve as an improvement over previous dependencies on enrollments.

With respect to the need to capture a measure of institutional research output, one would ideally have a research output index that aggregates all scholarly research output produced across all disciplines and units within a university. That could also be subject to considerable controversy. On a small scale, research output measures have been attempted and resulted in numerous discipline and departmental rankings, including for example, economics departments for the U.S. (for example, the seminal work of Hirsch, et al., 1984) and recently for the world (Kalaitzidakis, et al., 2003). There may also be some research type rankings acceptable for the internationally elite group of universities such as the Harvard's and Oxford's. However, university-wide measures of research productivity are nonexistent across the large heterogeneous population of institutions in the present undertaking. Other similar inquiries have adopted the Cohn et al. (1989) reliance on external research grant monies awarded to and received by the institution as a proxy for research output. Although it is recognized to be an input, the acceptance of it as an output proxy has been based on the notion that external funding support should correlate highly with college and university research output. That assumption has not been subjected to rigorous empirical scrutiny, nor has it been outright rejected on lesser grounds. Since it is the only available output measure that can be extracted from the IPEDS national data base, it will be employed in the present cost formulation.

The dominate factor price as defined by the wage variable is the institution's average faculty salaries. Separate wage measures could not be constructed for non-faculty employees, nor was it possible to determine the proportion of faculty salaries parceled out to part-time adjunct or non-tenure track faculty. In addition, universities and colleges offering graduate programs and employing graduate teaching assistants can have differential effects on the instructional wage. Differences could also arise across institutions based on financial accounting methods that are unrelated to the IPEDS reporting methodology and, therefore, uncontrollable for the present cost estimations.

Table 1 presents the means for all the variables and interactions separated by college and university degree granting level. As indicated, the product mix varies across levels with undergraduate education and research being produced everywhere but graduate education absent from the product mix for lower level

two-year associate colleges. Similarly, professional school education is not a product of either bachelor or associate level institutions. As expected, higher level degree granting institutions incur greater total costs of delivering the complete package of educational products. Of course, there is more produced of any given product. Furthermore, it is not surprising that the instructional wage is lower at doctoral universities with their ability to employ an abundance of doctoral and master level graduate teaching assistants for classroom instruction.

*Table 1. Variable means by institutional level: 2006 fiscal year**

VARIABLE	Doctoral	Master	Bachelor	Associate
Total Cost	710.76	119.07	46.16	44.25
Undergraduate	506.45	216.38	90.08	139.42
Graduate	93.81	23.96	1.75	-
Professional	6.69	0.27	-	-
Research	113.70	2.88	0.66	0.0002
Undergraduate^2	329.97	67.44	12.84	39.37
Graduate^2	13.52	1.10	0.01	-
Professional^2	12.15	0.02	-	-
Research^2	30.46	0.03	0.0002	0.0***
Undergraduate-Graduate	62.62	7.48	0.19	-
Undergraduate-Research	809.00	7.89	0.59	0.02
Grad-Profess-Research	3057.30	0.58	0.0001**	-
Medical	0.40	-	-	-
Wage	25.05	30.89	28.34	33.43
N	151	251	55	785

* Undergraduate and graduate measured in 1,000's of 12 month credit hours; professional in 100's of full-time equivalent enrollments, research in $1,000,000, squared terms denoted by "^" and measured in 1,000, and interaction terms measured in 100's.

** For bachelor level, the interaction is only Grad-Research.

*** Value is less than 0.00001.

5. EMPIRICAL RESULTS

The total cost regression results are presented in Table 2. They are the ordinary least squares regressions with White's robust variance-covariance matrix used to generate the standard errors and correct for the presence of cross sectional heteroskedasticity in the sample data (see for example, Greene, 1993).

Overall, the explanatory ability of the cost function is quite powerful across all four college and university levels. Based on the R squared, slightly better results are obtained for the master level and doctoral level institutions, with 90% and 87 % of the cost variability being captured across the 251 and 151 colleges and universities, respectively.

Table 2. Total cost regression results

VARIABLE	Doctoral	Master	Bachelor	Associate
Intercept	497.901** (99.543)	42.354* (11.050)	29.240** (12.713)	5.684* (0.811)
Undergraduate	0.064*** (0.033)	0.482* (0.122)	0.442* (0.137)	0.340** (0.056)
Graduate	2.823*** (1.657)	0.853* (0.212)	2.66 (3.451)	-
Professional	30.130** (13.634)	2.764** (1.250)	-	-
Research	1.694** (0.771)	2.110*** (1.110)	4.773 (6.331)	40.950*** (23.400)
Undergraduate^2	-0.0001 (0.0009)	-0.0004 (0.0017)	-0.0004 (0.0090)	-0.0001** (0.00003)
Graduate^2	-0.014 (0.009)	-0.011 (0.112)	-0.263 (0.015)	-
Professional^2	-0.884** (0.366)	0.004 (0.006)	-	-
Research^2	0.00002 (0.00004)	0.011 (0.018)	-1.453** (0.732)	-33.454 (41.811)
Undergraduate-Graduate	0.003 (0.016)	0.003** (0.001)	0.024 (0.233)	-
Undergraduate-Research	0.005 (0.006)	0.0004 (0.017)	0.124 (0.318)	0.071 (0.059)
Grad-Profess-Research	0.0002 (0.0003)	-0.002 (0.016)	-2.421 (2.206)	-
Medical	61.511** (25.635)	-	-	-
Wage	-0.0023** (0.0011)	-0.0001* (0.00002)	-0.0001* (0.00002)	-0.00001** (0.000001)
N	151	251	55	785
F	81.442*	181.264*	23.181*	698.004*
R^2	0.87	0.90	0.80	0.84

Note: Asterisks denote significance at the 1% level (*), 5% level (**), and 10% level (***), two tailed test. Standard errors are in parenthesis and are the White heteroskedasticity-consistent standard errors.

Within those two segments of U.S. public higher education, institutions tend to be more homogeneous with regard to missions, size, and program offerings than the lower level bachelor and associate degree granting colleges. The greater variability among the latter creates greater difficulty in accurately modeling the cost structures and is evident in the lower R squared for each segment with 84% of the cost variability being explained for the associate level colleges and 80% for the smaller group of bachelor level colleges. For all four levels of colleges and universities, the F statistic is beyond the one percent level of significance.

Examining the cost variables, the majority are statistically sound at reasonable levels of significance, including one, five and 10 percent. Extension to 10% should be acceptable given the interest in the institutionally-wide cost measures developed here and not at the specific program or discipline level. A microeconomic focus of the latter would have to account for differential program costs such as the higher cost performing arts programs compared to lower cost economics programs. The results here show undergraduate education is less costly to produce at the margin for doctoral universities compared to any other public level institution. This is quite likely to be attributed to the fore mentioned effect of using graduate teaching assistants in undergraduate student instruction and the fact that those assistants are more plentiful as a source of teaching labor at doctoral granting universities. Compared to master and bachelor level institutions, undergraduate education is cheaper to produce at the lower tier two-year degree granting colleges. That lower instructional cost can be due to what is traditionally true in the U.S. education labor market and that is the employment of relatively more non-Ph.D. faculty and part-time adjunct faculty in the two-year degree granting colleges compared to the higher level degree institutions. It is noted that in the empirical results of the cost function, some of the interaction terms are dropped and some are combined. In practice, professional schools such as law and dentistry have little to no interaction with undergraduate education and are quite separated from Ph.D. graduate program education. Thus, the interactions between undergraduate and professional education and between graduate program and professional program education are excluded. Also, as is standard practice, since wages enter as a factor price, not an output, the wage-output interactions are not included.

The results indicate that graduate education is more costly at doctoral compared to master level institutions. While doctoral programs are expensive undertakings, many universities run master and doctoral programs side-by-side with the former students attending the same classes, up to some level, as doctoral students. At those universities, the IPEDS data does not allow for the

distinction between master and doctoral level produced student credit hours. Thus, it is possible that it is less expensive to educate a master level student at a doctoral granting university than in a non-doctoral granting college or university. The data constraint precludes that determination.

Research costs rise somewhat slowly as the institutional level declines and then there occurs a dramatic cost increase at the two-year associate level colleges. Here again, given the data limitations involving the research proxy, it is not possible to determine the underlying cause of that cost upswing. In U.S. higher education, much of the two-year college level research is vocational or technical oriented; for example, involving tool and die or automotive research. At higher level institutions, research is more academically focused. However, the data requires us to rely on a single research measure across all institutional levels. Thus, from a public policy perspective, it would be unfounded in using the cost results to conclude that these lower level publicly funded colleges should drop that high cost research product line. Finally, the negative sign on all the quadratic teaching variables (except professional education at the master level institutions) indicates declining marginal costs of education. Student enrollment increases can be funded with additional and declining tax supported dollars. Yet, there are increasing marginal research costs at both doctoral and master level universities and colleges.

Turning to the main thrust of interest, Table 3 presents the economies of scale and scope results. The estimates are generated at the sample means. Except for bachelor level colleges, ray or overall economies of scale are everywhere present and suggest that publicly produced higher education costs per unit could decline as universities and colleges undertake proportional increases in their product mix. Diseconomies of scale are found at the public bachelor level institutions, but in number, they only comprise 4% of the public higher education market.

As for product specific economies of scale, the results lead us to conclude that doctoral, master, and bachelor degree granting universities and colleges experience economies of scale with respect to undergraduate education. Associate degree granting colleges are headed into undergraduate diseconomies and might require some internal or publicly mandated enrollment management. The same is true for both doctoral and master level institutions that are well into the graduate education diseconomies range. Add to that the professional education diseconomies generated at the doctoral universities. For the latter, some taxpayer cost savings could be realized in shifting at least part of the professional school education away from doctoral toward master level colleges

where economies of scale still persist. On the matter of research, of the four institutional levels, only doctoral and master level universities and colleges experience economies of scale.

Table 3. Economies of scale and scope by institutional level

	Doctoral	Master	Bachelor	Associate
Ray Economies of Scale	1.99	1.15	0.95	1.02
Product Economies of Scale				
Undergraduate	2.16	1.20	1.05	0.99
Graduate	-1.58	0.51	2.68	-
Professional	0.77	1.01	-	-
Research	1.34	1.03	0.71	0.79
Economies of Scope				
Undergraduate	-0.17	-0.19	-0.18	0.03
Graduate	-0.12	-0.18	0.46	-
Professional	-0.12	-0.18	-	-
Research	-0.005	0.02	-0.04	0.03

In considering the extent to which educational products should be jointly or separately produced in different institutions, Table 3 presents the economies of scope results. At both doctoral and master level universities and colleges, diseconomies of scope (negative values) exist for nearly all products. Based on those results, we would believe that these institutions should not attempt to be everything to everyone and that public higher education could perhaps benefit from a restructuring where there are more specialized institutions and not institutions that run the gamut of production from undergraduate to graduate to professional and on up to medical education. That is not the conclusion reached at the two-year associate level colleges where there are economies of scope. There are only two products being produced, but that alone is important; that is, unlike their higher level public sisters, those institutions have not ventured into diseconomies derived from the three and four educational product line.

6. CONCLUDING REMARKS

The aim of this paper has been to provide critical insight into understanding the cost structure of public higher education and its possible use in managerial and public policy reform and restructuring. Indeed, that was necessary given (1) recent political and bureaucratic interest in restructuring the public provision of higher education and (2) the weaknesses associated with relying on available cost studies that are more than a decade old and do not account for cost differences that arise from different organizational forms,

missions or product differentiation across institutional levels. To that end, the paper provides public higher education cost and economies of scale and scope estimates for the 2006-07 academic year, the most recent final data releases available from the U.S. Department of Education. Using the Carnegie Classification Code, those estimates are generated separately for doctoral, master, bachelor, and associate degree level colleges and universities and are expanded to include professional school teaching outputs.

The empirical results lead us to conclude that ray economies of scale are generally present in producing U.S. public higher education. The exception is the existence of diseconomies in bachelor degree offering institutions. However, in that multi-product industry, policy uses of that cost efficiency measure require proportional changes in all that is produced. That is not a likely scenario for universities and colleges. That is, for example, a 2% increase in undergraduate education is not likely to be accompanied by a simultaneous 2% increase in graduate and professional school education along with a 2% increase in research output. More relevant is the finding that product specific economies of scale with respect to undergraduate education exist at all levels except associate degree granting colleges. That does not bode well for higher education costs given that the latter institutions are receiving the bulk of undergraduate enrollment growth. Moreover, some state-wide government restructuring plans include diverting enrollment away from the higher level universities and into the associate level two-year degree granting institutions. That will only place a greater cost burden on taxpayers. At the same time, the professional school education diseconomies being incurred at doctoral universities suggest shifting some of its education to master level institutions. Regarding joint production, the diseconomies of scope findings at doctoral and master level institutions suggest a cost benefit to be realized from trimming their product lines.

In sum, if public higher education restructuring discussions continue to evolve, then the single most likely conclusion to be derived presently is that there is possible support for cost savings in a reorganization that is comprised of more specialized universities and colleges and, in some instances, possibly abandoning plans to shift student enrollments toward lower level, two-year associate degree colleges. However, to what extent European reforms being implemented through the Bologna Declaration and potential increased international competition will force U.S. colleges and universities in new restructuring directions is yet to be determined. The costs of any major restructuring should only proceed with a firm understanding of the multiproduct nature and associated costs of public higher education as outlined in this paper.

An equal amount of caution though is due in relying on aggregate cost measures for the purpose of uniformly imposing higher education policy reforms. While this paper has offered a much needed more contemporary understanding of higher education costs in addition to methodological improvements, several caveats are in order. They primarily rest with the quality of data collected at the national level.

First and foremost is the fact that we are absent measures of true educational outputs and the associated quality of those outputs. Here, at least, the sub-setting of colleges and universities into four product groups as determined and used by the Carnegie Commission on Higher Education has hopefully made some contribution to the control of quality. Better and more accurate quality measures are likely to only come with more micro based analyses that could be limiting in drawing up important system-wide policy conclusions. Secondly, how one measures institutional level research output and makes that possible across a broad spectrum of colleges and universities for meaningful inter-institutional comparisons has not been accomplished for the purpose of the present cost analyses or for previous research. The use of research grants is not a comprehensive measure of scholarly work and hinges on the untested assumption that the ability to successfully compete in a national grant market correlates with scholarly productivity. That should be put to bed with empirical testing or compared to the development of alternative output measures. Also, further development needs to be undertaken with regard to the factor price measure that presently is constrained to the use of faculty salaries and neglects the possible marginal contributions of non-faculty employees to teaching and research. Those employees, either separately or along with faculty, may also produce that third leg of the higher education stool, namely service, including such community and professional service provided by faculty in business schools, law schools, psychology and art programs, etc. Metropolitan compared to rurally located colleges and universities tend to be more service conscious and productive. That would be interesting to explore in relation to cost differences. However, for the purposes of measuring scale and scope economies here and elsewhere, it has not and may not be possible to disentangle service from teaching and research.

With these empirical faults understood, it is clear that scale and, more importantly, scope economies provide essential insights into the costs of public higher education provision and act as a basic prerequisite for successful managerial and public policy decision-making. That higher education is now and will continue to be increasingly competitive on a global scale is not debatable; nor, therefore, is the fact that to compete effectively in that

environment it is now, compared to decades past, critical that one recognizes how costs will come under the scrutiny of performance management. However, with higher education funding reforms pushing colleges and universities both in Europe and in the U.S. to more market oriented dependence, it is obvious that the focus cannot remain on a cost basis alone. Much needs to be done in the way of determining the economic and social effects of reduced government financial support and greater privatization of public higher education. What may be good for one segment of higher education may not fare well for another. College and university niches may need to rule, but individual segments and institutions will have to get positioned to compete in the global market place. The industry-wide restructuring movements and funding reforms well underway and more continuing to be placed on the table for consideration in both Europe and the U.S. need careful evaluation as to the potential differential effects on public higher education outcomes. Successful reform requires a balancing of cost reform with funding reform and a formulation of a societal optimal mix of governmentally tax-based support and market driven performance criteria.

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UPRAVLJANJE RESTRUKTURIRANJEM JAVNOG VISOKOG OBRAZOVANJA: RAZUMIJEVANJE TROŠKOVNE STRUKTURE VISOKIH UČILIŠTA I SVEUČILIŠTA

Sažetak

Ovaj se rad koncentrira na razumijevanje troškova djelovanja visokih učilišta i sveučilišta, kao preduvjeta za uspješno upravljanje tekućim pitanjima restrukturiranja javnog visokog obrazovanja. Samo je restrukturiranje u tijeku kao rezultat globalizacije, europske bolonjske deklaracije i nacionalne konkurencije unutar SAD, a koje potencijalno utječe na prirodu i razinu proizvoda visokih učilišta i sveučilišta. Da bi se obuhvatile moguće implikacije troškova na prethodno navedene promjene, empirijski se predviđaju troškovne funkcije četiriju razina javnih visokih učilišta i sveučilišta u SAD, i to za institucije koje provode doktorske, magistarske (diplomske), preddiplomske i programe pridruženih akademskih naslova niže razine. Procjene razine i obuhvata aktivnosti se izvode za istraživačke rezultate te tri vrste nastavnih rezultata (u preddiplomskom, diplomskom i profesionalnom obrazovanju). Rezultati koji se odnose na ekonomiju obujma pojedinih proizvoda visokog obrazovanja ukazuju da bi vladine reforme, usmjerene na povećanje broja financiranih studenata na visokim učilištima niže razine, mogla povećati troškove javnog visokog obrazovanja. S druge strane, reforme usmjerene na kreiranje institucija više razine specijalizacije bi mogla generirati dodatnu uštedu troškova. Iako se rezultati ovog rada temelje na podacima za američka visoka učilišta i sveučilišta, lekcije stečene na iskustvu jedne zemlje mogu biti od koristi i za druge.