Scientific Papers (www.scientificpapers.org)
Journal of Knowledge Management, Economics and Information Technology

Vol. VI, Issue 2
April 2016

Differential Recessionary Impacts on U.S. Research Relative to Comprehensive University Efficiencies and Productivities: 2004-2014 Panel Data Estimates

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Using data envelopment analysis and Malmquist index decompositions this paper focuses on the impacts of the Great Recession on the efficiency and productivity changes of U.S. publicly funded prestigious research universities in comparison to their lower level comprehensive university counterparts. Do elite research relative to comprehensive universities have more political clout and resources to better ward off the financial impacts and production demands of the? Results, based on ten academic years from 2004-05 through 2013-14, are somewhat mixed, but indicate that research universities have a technological edge that acts as the primary advantage driver to total productivity gains over their counterparts. However, comprehensive universities outperform research universities in both managerial and scale gains. Overall, there is significant variability among both groups of universities in their adjustments to the dramatic recessionary forces imposed upon them. While the paper greatly improves upon three previous studies, there remains the question of how publicly funded and managed U.S. universities will continue future adjustments to the some of the lingering and more permanent effects of the recession.

Keywords: *recession, productivity, efficiency, universities, DEA, data envelopment, Malmquist.*

Introduction

Publicly funded, non-profit, universities in the United States have had to adjust to a set of diverse forces inflicted upon them as a result of the financial crisis and the subsequently imposed Great Recession. While private, for-profit, sectors could not escape those forces and adjusted accordingly through internal managerial decision making, public universities differ in that external political decisions control portions of what they can and cannot do. Among other things, the political process controls portions of public university revenues through the state subsidy mechanism. December 2007 to June 2009 officially marks the dates of the Recession but from the academic year 2008 to 2013 state funding support for public universities was cut from 32% to 23%. Concomitantly, high unemployment rates created by the recession, subjected public universities to unforeseen large increases in student enrollments. Enrollments increased 1.5% from 2004 to 2006 and 12% from 2007 to 2010, thereafter leveling off as economy wide conditions began to improve and unemployment rates followed suit.

However, those forces may carry different implications in the U.S. for the more prestigious Carnegie classified doctoral granting, research universities compared to the lower level comprehensive classified universities that primarily engage in master level programs as the highest degree offering. Of particular interest is the extent to which those recessionary forces produced differential impacts on the operating efficiencies and productivity gains among those more elite universities compared to their lower level counterparts. Employing data envelopment analysis (DEA), that task was somewhat addressed by Sav (2012a) using 2005-06 through 2008-09 academic year data for U.S. comprehensive universities. The findings suggest that there were positive efficiency gains but productivity losses over the four academic years. In two parallel studies, Sav (2012b and 2012c) finds that the more elite U.S. research universities experienced productivity regress over the same academic years. However, the three studies use different methodologies and, subsequently, different efficiency measures, thereby rendering it problematic, at best, in comparing the impacts of recessionary forces across those universities. Moreover, ending with the 2008-09 academic year, those studies fall short of capturing the more enduring effects of the financial crisis.

The present paper proposes to correct for those deficiencies by using panel data encompassing ten academic years, 2004-05 through 2013-14, for both research and comprehensive universities. DEA efficiencies and Malmquist decompositions of productivities are estimated for both research and comprehensive universities with the analysis presented in relative comparisons. The advantages offered are twofold. First, the ten year panel captures the ability to evaluate the more dynamic implications regarding efficiency and productivity changes of universities prior to, into, and out of the recession. Second, the relative comparisons allow an evaluation of differential managerial adjustments among research compared to comprehensive universities. That is of particular interest given that the former Ph.D. granting and heavily focused research institutions are the more flagship public universities that carry greater managerial autonomy and political leverage relative to their lower level comprehensive counterparts. However, while they have more resources at their disposal, they are overall larger universities with more hierarchical managerial levels that may carry different implications for adjustment responses to external shocks relative to smaller publicly managed comprehensive universities.

The paper proceeds as follows: the next section presents the efficiency and productivity methodology followed by the DEA efficiency results and then the Malmquist productivity results. A final section provides a summary and concluding remark. A literature review revealed that there has not been any comparable study of U.S. research and comprehensive public universities produced since the three studies cited herein. Therefore, the extensive literature reviews provided in the previous studies by Sav (2012a, b, and c) are more than sufficient for reference and, therefore, unnecessary to duplicate in the present paper.

Efficiency and Productivity Methodology

A DEA output oriented model is adopted based on the assumption that universities need to meet specified levels of production with fixed resources. That is in accord with previous panel data studies evaluating higher education efficiencies, including the output oriented works of Worthington and Lee (2008), Agasisti and Johnes (2009), and Sav (2012a). The basic model evaluates university production efficiencies under the more restrictive assumption of constant returns to scale, CRS (Charnes, et al., 1978), and the

greater flexibility offered by variable returns to scale, VRS (Banker, et al. (1984). Estimation of both CRS and VRS technical efficiencies thereby allows for the determination of how universities are efficient with respect to the scale of production, i.e., scale efficiency (SE) is determined by the technical efficiency under CRS relative to the technical efficiency under VRS.

Using standard notation (e.g., Cooper, et al. 2004 and Cook and Zhu, 2008), for the *ith* university producing *Q* outputs with *R* inputs, the variable returns to scale (VRS) DEA can be expressed as follows:

$$\max_{\phi_i, \lambda_j} \phi_i \qquad (1)$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{qj} - \phi_i y q_{qi} - s_q = 0 \quad q = 1, \ldots, Q \text{ outputs} \qquad (2)$$

$$\sum_{j=1}^{n} \lambda_j x_{rj} + s_r = x_{ri} \qquad r = 1, \ldots R \text{ inputs} \qquad (3)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \quad j = 1, \ldots, N \text{ universities} \quad (4)$$

$$\lambda_j \geq 0, s_r \geq 0, \text{ and } s_k \geq 0 \qquad (5)$$

Here, *s* represents output (*q*) and input (*r*) slacks, respectively. The comparative production output for an individual university is captured in the value of *theta*, whereby a fully efficient university that operates on its production frontier obtains a *theta*=1. Distance from the frontier is inefficient and produces a *theta* >1. Thus, technical efficiency varies among universities in the range of 0 to 1 as determined by 1/ *theta* or real production output compared to DEA achievable output.

Under CRS, constraint (4) is relaxed, thereby allowing an evaluation of the degree to which universities are operating with respect to their scale level of efficiency as determined by the CRS relative to the VRS technical efficiency. Again, fully scale efficient universities would be at a scale efficiency equal to a value of one.

Advantages inherent in panel data produce the ability to evaluate changes in university efficiencies over academic years. That is, efficiency improvements obtained by advancements toward the efficient frontier or inefficiency increases produced by movements away from the frontier. While those changes can be rooted in administrative and managerial actions or input productivities, simultaneously, year to year frontier shifts created by technological changes can alter distances from the frontier, thereby impacting university efficiencies. Panel data affords the ability to calculate

indices of changes over time using the Malmquist index (Malmquist, 1953). The combined effect of these changes on university productivity is captured by the Malmquist index (Malmquist, 1953). The output productivity index (Fare et al., 1994) computed over two academic years, say t and t+1, can be specified as follows (e.g., Cooper, et al., 2004 and Cook and Zhu, 2008):

$$M_0(r^{t+1}, q^{t+1}, r^t, q^t) = \frac{D_0^{t+1}(r^{t+1}, q^{t+1})}{D_0^t(r^t, q^t)} \left[\left(\frac{D_0^t(r^{t+1}, q^{t+1})}{D_0^{t+1}(r^{t+1}, q^{t+1})} \right) \left(\frac{D_0^t(r^t, q^t)}{D_0^{t+1}(r^t, q^t)} \right) \right]^{\frac{1}{2}}$$

(6)

where, as in the DEA above, the r and q are inputs and outputs, respectively, being relevant to academic years t and t+1. Changes in university efficiency, i.e., technical efficiency, between two academic years are represented by the first term in equation (6). It is common to take full advantage of this approach and decompose changes in technical efficiency into that which is due to changes in scale efficiency and changes in pure technical or managerial efficiency. The bracketed second term in (6) measures the frontier shifts attributed to technological changes as referred to above. Overall, the Malmquist index can assume values $M \geq 0$. Universities realizing productivity gains would generate an index $M > 1$. Productivity regress would, therefore, be represented by an index $M < 1$.

To summarize, in the empirical analysis of university productivity changes, the Malmquist indices will be determined for

- Technological changes
- Technical efficiency changes further decomposed into
    - Management (or pure technical) changes
    - Scale changes
- Total Productivity changes (technical x technological)

Preceding, that analysis, of course, the DEA results will be determined under both the CRS and VRS models, thereby enabling the scale efficiency changes to be presented.

University Panel Data

A panel data of publicly owned and operated universities were obtained from the U.S. Department of Education, Center for Education Statistics,

based on the annual surveys available in the Integrated Postsecondary Data System (IPEDS). The panel spans the ten academic years 2004-05 through 2013-14 and includes universities that offer both undergraduate and graduate programs, engage in research, and are classified as research universities and comprehensive universities. The former being the more so-called prestigious American universities that engage in high levels of research and offer premier Ph.D. programs, while the latter tend to not be on the cutting-edge of research and primarily offer master level programs. Due to the fact that some universities fail to report complete survey information and the fact that IPEDS reporting requirements and collection data alter over time, some universities could not be included in the 10 year panel. The full panel consists of 139 research universities and 195 comprehensive universities over 10 years for a complete panel of 1,390 and 1,950 observations, respectively.

Based on the available IPEDS data, four university output variables were constructed. They include (1) undergraduate credit hour production (Und CrHr), (2) graduate credit hour production (Grd CrHr), (3) graduation success rate (Grad Rate), and (4) research (Research). The first two outputs are based on the fact that public universities have traditionally been and continue to be partially funded through the state subsidy mechanism via their credit hour production. More recently, however, state funding decision makers have brought greater pressure to bear on universities to improve graduation success rates (Grad Rate, herein) and have, to some extent, begun to tie funding to that success, i.e., a measure of university output. Research, of course, is included as an obvious measure of university production, but as with the bulk of other studies, limited data require it to proxied by annual research expenditures.

There are eight input variables. Undergraduate student enrollment (Und Enroll) and the graduate student enrollment (Grd Enroll) serve as inputs to the production of credit hours, with the latter also potentially contributed to research. Labor inputs are subset into the number of (1) faculty employed with tenure (Fac Tenured), (2) faculty employed in tenure track positions (Fac Track), (3) faculty employed in non-tenure track positions (Fac No Track) that can include combinations of instructors, lectures, and adjuncts, and (3) university non-faculty, staff (Staff). The two remaining inputs include land and land improvements (Land) and infrastructure and capital (Capital). The available data constrains those to be

measured in dollars but provide useful measures of university size and infrastructure that can impact production.

Table 1 summarizes the variables, presenting the 2004-05 academic year means for both research and comprehensive universities and, thereafter, followed by annual percentage changes for selected years. The years selected offer a focus on the some of the more dramatic changes that occur following the financial crisis and the subsequent Great Recession officially dated as December 2007 to June 2009. However, the annual unemployment rate stood at 4.6% in 2007, 5.8% in 2008, 9.3% in 2009 and peaked at 9.6% in 2010, declining thereafter to 7.4% in 2013. The academic years presented in Table 1 capture the lag in impacts on universities resulting from those rates and the economy wide performance that they reflect. Most notably, are the 2008 through 2010 academic year large increases in graduate enrollments, Grd Enroll, and graduate credit hour production, Grd CrHr, at research universities and the smaller, but still significant, increases experienced among comprehensive universities in the 2009 and 2010 academic years. Undergraduate enrollments and credit hours show much less sensitivity to the external economic conditions, but, nevertheless, are present, especially in the 2010 academic year for both levels of universities. With economy wide improvements, the anti-cyclical nature of higher education is equally present in the 2012 and 2013 academic years as both levels of universities experienced large decreases in graduate and undergraduate enrollments and, as a result, credit hour production. The large increases in research for the 2010 academic year are partly due to federal grant increases, but are also due to increases in institutional research for infrastructure and capital improvements. The need to rely on research expenditures as a proxy for research output is, of course, problematic but has equally plagued past studies.

Equally evident are the administrative and managerial university decisions making responses to the recessionary effects. Beginning in 2009 and carried though the 2013 academic year, tenured track faculty, Fac Track, employment declines among both research and comprehensive universities (with the exception of a 0% change in 2013 among research universities). In part, of course, that results from tenure track faculty moving to tenure status, but, in part, it is also attributed to administrative decisions in not replacing tenure track lines of employment. And among comprehensive universities, even with tenure track promotions to tenure status, the annual

increases in tenured faculty declined from 2.2% in 2010, to 1.8% in 2011, and then 1.2% in 2012. Parallel to the declines in tenure track employment are the annual increases in non-tenure track faculty employment, Fac No Track, for both research and comprehensive universities (the odd exception being the 2012 decline of 4.3% among the latter universities). That trend has nationally persisted for well more than the decade presently under consideration, i.e., administrative decisions in substituting non-tenure track employment of instructors, lecturers, and adjuncts for tenure track and tenured faculty.

Table 1: DEA Variables and Percentage Changes for Selected Years

Variable	2004	2006	2008	2009	2010	2012	2013
Research Universities							
Und CrHr	471840	1.3%	2.2%	1.6%	3.0%	1.4%	-2.0%
Grd CrHr	88020	1.4%	7.6%	6.4%	14.0%	-20.5%	-4.2%
Grad Rate	53	1.4%	1.1%	1.5%	0.8%	1.5%	1.1%
Research	9.1E+07	3.0%	9.5%	7.4%	13.8%	1.4%	2.5%
Und Enroll	19258	0.9%	1.6%	1.5%	2.4%	1.8%	-0.5%
Grd Enroll	6260	-0.2%	4.3%	3.0%	7.2%	-1.4%	-2.5%
Fac Tenured	575	0.7%	1.2%	1.1%	0.4%	0.7%	0.6%
Fac Track	211	1.7%	2.3%	-3.3%	-4.9%	-1.1%	0.0%
Fac No Track	609	-0.8%	3.4%	1.9%	2.1%	8.6%	2.3%
Staff	2933	1.6%	2.5%	-0.2%	0.2%	-1.8%	0.9%
Land	2.8E+07	7.1%	6.8%	6.7%	7.8%	7.8%	7.3%

Capital N=139	5.2E+08	8.3%	8.2%	9.0%	9.1%	7.2%	7.2%
Comprehensive Universities							
Und CrHr	214004	1.8%	1.4%	2.0%	3.0%	0.6%	-0.6%
Grd CrHr	21352	0.0%	-2.0%	4.7%	6.6%	-7.8%	-2.8%
Grad Rate	42	1.6%	0.0%	1.0%	0.7%	0.7%	1.1%
Research	3.1E+06	3.1%	7.7%	5.7%	20.2%	0.8%	-3.5%
Und Enroll	9307	1.5%	1.0%	1.8%	2.2%	1.0%	-0.5%
Grd Enroll	2176	-1.0%	1.3%	1.7%	2.5%	-4.2%	-3.4%
Fac Tenured	196	1.4%	0.8%	2.1%	2.2%	1.8%	1.2%
Fac Track	94	1.4%	2.1%	-2.2%	-4.2%	-3.1%	-0.2%
Fac No Track	253	5.3%	3.2%	2.3%	3.7%	-4.3%	0.9%
Staff	684	2.6%	2.1%	0.7%	-0.6%	5.3%	-0.8%
Land	7.9E+06	21.4%	8.9%	6.2%	11.6%	7.3%	9.1%
Capital N=195	1.3E+08	17.5%	8.3%	8.3%	10.0%	7.2%	6.1%

Following the 2008 academic year, it is also apparent that administrative hiring decisions affected university staff employment, Staff, but not with the equivalent impact as witnessed on tenure track faculty. That is, compared to four years of declines in tenure track faculty, decreases in Staff occurs in only two of the four years following 2008. And among comprehensive universities, Staff employment increased 5.3% in 2012 and

could be somewhat associated with the odd 4.3% decline in non-tenure track faculty employment as administrators move internal budgets to staff positions and out of teaching, especially with the declines in graduate enrollment.

DEA Efficiency Results

The DEA results for CRS, VRS, and scale are presented in Table 2 for each of the ten academic years, 2004 through 2013. First, mean efficiencies and standard deviations are presented for research universities. Second, to simplify the comparative evaluations between research and comprehensive university, research university efficiency means are evaluated as a percentage difference from comprehensive university efficiency means (Res as % of Comp). Thus, negative (positive) percentages show the percentage by which research university efficiencies fall below (are above) comprehensive university efficiencies for a given academic year. Third and presented in the last two columns of the Table are (1) the percentage of the 139 research universities that are found to operate fully efficient (Full Efficiency=1) and (2) the percentage difference in full efficiency of research compared to comprehensive universities (Res-Comp).

Results under the CRS estimates show research university efficiencies dropped to a low of 0.866 in 2007, indicating that universities fall approximately 14% below full efficiency with the given the level of inputs. During and following the potential recessionary effects imposed upon public higher education, the CRS efficiencies show efficiency gains realized among research universities, but the real gains appear in the 2013 academic year with the highest ten year efficiency of 0.908 or 9.2% below full efficiency. It is also interestingly to note that accompanying the recession and the lagging impact, the variability (StdDev) in efficiencies increased beginning with the 2007 academic year and remained relatively high through 2010 and then bottomed out at is ten year low in 2013. To what extent the 2013 efficiency gain and decreased efficiency variability could be attributed to post-recessionary managerial adjustments and possible collaborative efforts among universities is surely of interest but cannot be determined based on present results of efficiency estimates.

The VRS estimates mirror the CRS results, but the research university efficiencies are larger due to the absence of scale inefficiencies

included in the former. That is, as with the CRS efficiencies, operating efficiencies drop in the 2007 academic year and thereafter begin to rebound with the highest ten year efficiency being produced at 0.938 in 2013. The same basic pattern of efficiency variability exists and declines to a ten year low in 2013.

Only a slightly different pattern emerges with respect to the scale results. Scale efficiency decreases among research universities mainly occur in the 2006 and 2007 academic years with the exception of the decline in 2011. But again, the largest efficiency gain and lowest efficiency variability rests with the 2013 academic year.

Comparing comprehensive university operating efficiencies to those of research universities, as indicated (Res as % of Comp), on nearly all accounts comprehensive universities are more efficient than their research counterparts. That is, under the CRS, VRS, and scale estimates, comprehensive universities show efficiency superiority over research universities – the only exception being the 2013 CRS and 2013 scale results. And although the negative values of "Res as % of Comp" are indicative of the efficiency differences, tests of the statistical significance between the actual efficiency means are noted by the asterisks (*). Based on those tests, it can be generally concluded that the 2011 and 2012 academic years are most important in representing the significant years in which comprehensive universities out performed research universities in efficiency gains under both the CRS and VRS estimates.

Table 2: DEA Results: Research (Res) Relative to Comprehensive (Comp)

	Research		Res as % of Comp		Full Efficiency=1	
CRS	Mean	StdDev	%		Res	Res – Comp
2004	0.886	0.117	-2.2%		36%	-10%
2005	0.892	0.112	-1.4%		36%	-8%
2006	0.879	0.115	-2.5%	***	35%	-9%
2007	0.866	0.122	-0.8%		29%	-2%

2008	0.872	0.122	-2.6%	***	32%	-6%
2009	0.870	0.124	-2.1%		32%	-6%
2010	0.872	0.123	-2.1%		29%	-10%
2011	0.870	0.118	-4.0%	*	29%	-13%
2012	0.870	0.120	-3.7%	*	35%	-10%
2013	0.908	0.090	1.0%		35%	-9%
VRS						
2004	0.928	0.092	-1.4%		46%	-11%
2005	0.933	0.087	-0.3%		46%	-9%
2006	0.923	0.093	-1.1%		42%	-12%
2007	0.917	0.096	-0.7%		39%	-6%
2008	0.918	0.103	-1.8%		44%	-8%
2009	0.921	0.101	-1.2%		47%	-3%
2010	0.923	0.100	-2.7%	**	45%	-7%
2011	0.925	0.093	-2.5%	**	43%	-13%
2012	0.919	0.100	-3.1%	*	45%	-14%
2013	0.938	0.082	-0.6%		47%	-10%
Scale						
2004	0.953	0.062	-0.9%		38%	-10%

						-6%
2005	0.955	0.062	-1.1%		39%	
						-10%
2006	0.951	0.065	-1.4%	***	36%	
						-1%
2007	0.943	0.069	-0.2%		32%	
						-8%
2008	0.949	0.068	-0.8%		33%	
						-8%
2009	0.944	0.071	-1.0%		33%	
						-12%
2010	0.943	0.067	-0.6%		30%	
						-13%
2011	0.940	0.069	-1.6%	**	29%	
						-8%
2012	0.946	0.065	-0.6%		36%	
						-8%
2013	0.968	0.048	1.8%	**	37%	

Note: Means test, significant at 1% (*), 5% (**), and 10% (***).

In the final two columns of Table 2 are the percentages of research universities that are estimated to operate at full efficiency (=1) and the research compared to the comprehensive university differentials. As indicated, under the CRS estimates, research universities fall from a high of 36% in the outset of the 2004 academic year to a low of 29% in 2007 and then exhibit increases and decreases thereafter but eventually rise to 35% in 2013. For the most part, the same pattern of changes exists under the VRS and scale results. Throughout every academic year, however, a larger percentage of comprehensive universities operate at full efficiency as indicated by the "Res-Comp" percentage differences across all CRS, VRS, and scale measures.

Malmquist Productivity Results

University Malmquist total productivity changes along with the decompositions are produced in Table 3 for each academic year and the ten year mean.

Table 3: Malmquist Decomposition Results

Year	Technology	Efficiency	Management	Scale	Total Productivity
Research Universities					
2005	0.968	1.011	1.008	1.002	0.979
2006	1.009	0.986	0.990	0.997	0.995
2007	1.022	0.986	0.994	0.992	1.007
2008	0.979	1.009	1.001	1.008	0.988
2009	1.007	1.001	1.005	0.995	1.008
2010	1.026	1.005	1.005	1.000	1.032
2011	1.014	1.003	1.006	0.997	1.017
2012	0.962	1.005	0.996	1.008	0.968
2013	0.929	1.051	1.025	1.026	0.974
Mean	0.987	1.003	1.001	1.002	0.990
Research Universities as a % of Comprehensive Universities					
2005	-7.0%	0.9%	1.0%	-0.1%	-6.7%
2006	5.8%	-1.5%	-1.1%	-0.3%	4.0%
2007	-0.8%	1.8%	0.4%	1.4%	1.0%
2008	2.1%	-2.1%	-1.3%	-0.8%	0.2%
2009	0.0%	0.6%	0.7%	-0.2%	0.7%

2010	1.5%	0.1%	-0.4%	0.6%	1.7%
2011	3.3%	-1.9%	-0.7%	-1.2%	1.4%
2012	-4.0%	0.5%	-0.6%	1.0%	-3.8%
2013	-6.9%	5.6%	2.9%	2.6%	-2.0%
Mean	-0.5%	0.4%	0.1%	0.3%	-0.1%

Total productivity is decomposed into technological changes or shifts in the production frontier and efficiency changes or advancements toward or away from the frontier. The latter is further decomposed into management and scale efficiency changes. The upper panel of Table 3 presents the results for research universities, while the bottom panel, for comparative evaluations, consists of the research university results as a percentage of the comprehensive university results. Thus, in the bottom panel, positive (negative) percentage changes represent the percentage by which research university productivities are greater (less) than comprehensive university productivity changes.

For research universities, there occurs total productivity regress in the pre-recession academic years of 2005 and 2006, productivity gain of 0.7% in 2007 and followed by a 1.2% decline in 2008. However, from the 2009 through 2011 research universities realized total productivity gains, but those gains were apparently not sustainable as regress reappears in each of the 2012 and 2013 academic years. On the comprehensive university front, from 2006 through 2011 the positive percentage differences reveal that research universities out performed comprehensive universities on the order of 0.2% to 4% in total productivity gains. That advance, however, vanished in the 2012 and 2013 academic years as comprehensive university total productivity gains exceeded those of their counterparts by 3.8% in 2012 and 2% in 2013.

Examining the decomposition of total productivity changes into technological and efficiency changes, it is evident that the 2012 and 2013 research university total productivity regress can be attributed to the declines in technological progress, i.e., 0.962 or about 4% in 2012 and 0.929 or about 7% in 2013. Counter to those decreases but unable to offset them,

are the efficiency gains of 0.5% in 2012 and a large 5.1% in 2013. In contrast, comprehensive universities well out performed research universities with respect to technological progress in both of those 2012 (research universities 4% below comprehensives) and 2013 (research universities 6.9% below comprehensives) academic years. The comprehensive university efficiency gains, while lower than that of research universities in both 2012 (0.5%) and 2013 (5.6%), are not significant enough to offset the technological gains and, therefore produce the superior total productivity gains of 3.8% and 2% in 2012 and 2013, respectively.

Decomposing efficiency gains into that which is due to management and scale gains is somewhat more blurred in terms of separating their individual contributions. However, it is apparent that research universities generated managerial gains, albeit small (0.1% to 0.6%) throughout the 2008 through 2011 academic years. The slight decline to an index of 0.996 or 0.4 % in 2012 is over shadowed by the 1.025 or 2.5% gain in 2013. Results with respect to gains in scale efficiency among research universities vary considerably throughout all pre-2012 academic years, but admirably so they realized gains in both 2012 at 0.8% and 2.6% in 2013. In both management and scale gains over the ten academic years, research universities outperform comprehensive universities in five of the ten years and, therefore, comprehensive universities perform better in another five of the ten years.

For the ten year Malmquist means, research universities are estimated to have experienced a 1% total productivity regress (0.990). That is 0.1% below that of comprehensive universities. On other accounts, research universities have produced gains in efficiency, management, and scale, but in total unable to offset the decline in technological progress. Relative to research universities, comprehensive universities managed to produce a slightly better average total productivity gain of 0.1%. While on average, comprehensive universities did not perform as well with respect to efficiency, management, and scale progress, the superior gains in technological progress acted to offset that disadvantage relative to research universities.

Malmquist index averages presented in Table 3 are geometric means. To sort out the ten year mean productivity increases (>1) and declines (<1), Table 4 summarizes those changes for both research and comprehensive universities across all Malmquist decompositions.

Table 4: Ten Year Mean Changes: Research vs Comprehensive Universities

Change	Technology	Efficiency	Management	Scale	Total Productivity
Research					
<1	66%	37%	23%	35%	59%
=1	1%	33%	48%	39%	1%
>1	33%	29%	30%	26%	39%
Comprehensive					
<1	75%	31%	28%	29%	68%
=1	3%	25%	36%	32%	1%
>1	22%	44%	36%	40%	30%
Research Minus Comprehensive					
<1	-9%	7%	-5%	7%	-9%
=1	-2%	8%	12%	7%	0%
>1	11%	-15%	-6%	-14%	9%

The bottom panel produces the research minus comprehensive university results. With respect to productivity regress, 7% more research universities performed worse than comprehensive universities on both efficiency and scale measures. On technology, management, and total productivity, more than 5% to 9% of comprehensive universities experienced regress (<1). Yet, comprehensive universities realized productivity gains (>1) relative to research universities with more than 15%, 6%, and 14% gains in efficiency, management, and scale. In the end,

however, more than 9% of research universities out weighted comprehensive universities with regard to total productivity gains.

Conclusions

The purpose of this paper was to estimate the potential differential effects of the recessionary forces on the operating efficiencies and productivity gains of U.S. publicly owned, financed, and managed research universities compared to their lower lever comprehensive university counterparts. The thrust of the paper was to determine the possibility that the more prestigious research universities that carry more political clout were able to ward off the recessionary effects better than their less positioned comprehensive universities. The paper offered significant advantages over three earlier studies in that it better (1) captures efficiency and productivity changes over a ten year period, 2004-05 to 2013-14, compared to a four year period, 2005-06 through 2008-09, and (2) evaluated those changes among research relative to comprehensive universities by employing a consistent methodology as opposed to separate estimates that rendered comparative evaluations problematic, at best.

Overall, the data envelopment results, including the CRS, VRS estimates and Scale efficiencies, reveal that both research and comprehensive universities struggled in attempting to maintain production efficiency and productivity gains as a result of the forces imposed upon them as a result of the financial crisis and the continuing impacts of the Great Recession. Indeed, the CRS and VRS estimates indicate that the variability in efficiencies among both sectors of universities increased as a result of external forces imposed upon them. Yet, under all estimates, comprehensive universities were found to outperform their more elite counterparts, but the 2011 and 2012 academic years showed the most significant relative advantages. However, research universities had greater production scale efficiency improvements in the 2013 academic year. When evaluated at full operating efficiency, a larger percentage of comprehensive universities achieved that level relative to research universities in every of the ten academic years.

With respect to the estimates of productivity gains based on the Malmquist index estimates, research universities out performed comprehensive universities on the order of 0.2% to 4% in total productivity

gains throughout the 2006 through 2011 academic years. Thereafter, however, comprehensive universities productivity gains were superior in each of the 2012 and 2013 academic years by at least a 3.8% margin. Upon decomposing efficiency gains into management and scale gains, research universities were found to produce management gains from 2008 through 2011, a small decline in 2012, and a large managerial improvement of 2.5% in 2013. The latter was also accompanied by a large 2.6% scale improvement. Yet, over the ten academic years, while research university management and scale gains exceed those of comprehensive universities in five of the ten years, the reverse holds in the other five of ten years with comprehensive universities doing better.

Over the full ten academic years, research universities experienced productivity regress on the order of 1% and comprehensive universities did only slightly better with a 0.1% gain above that regress. The ten year averages reveal that research universities out did outperform comprehensive universities in technology gains and total productivity gains. The strength of comprehensive universities over research universities stood with better performances in efficiency gains and both components of management and scale gains.

In summary, the results indicate that research universities hold an edge over comprehensive universities with respect to their ability to advance in technological gains and that creates a significant advantage in leading to overall total productivity gains. On the other hand, the smaller and perhaps more manageable comprehensive universities perform better with respect to management and scale gains, thereby producing better in overall efficiency gains. However, the results also make it clear that there was significant variability in how both research and comprehensive universities responded to the forces imposed upon them via the Great Recession and subsequent changes in enrollment demands and government funding. The results presented herein, suggest that research universities may have a political clout advantage over comprehensive universities in warding off some political and economy wide effects, but equally apparent is the notion that future adjustments in among both levels of universities are yet to continue. How it all plays out, however, will require additional academic years of observations on the U.S. public higher education system.

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