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

Issue 8
February 2012

Is The Production of Religious Knowledge Efficient? Managing Faith Related Postsecondary Institutions

Author: **G. Thomas SAV,** Department of Economics, Raj Soin College of Business, Wright State University, Dayton, Ohio 45435 U.S.A., tom.sav@wright.edu

The focus of this paper is on the efficiency of producing and managing religion based knowledge in postsecondary institutions. Panel data is used to estimate a stochastic cost frontier and associated inefficiencies for a panel of 222 U.S. bible colleges, theological seminaries, and other faith based higher education institutions over the 2005-09 academic years. Results indicate that institutions offering undergraduate only education are on average less inefficient than graduate only or combined undergraduate-graduate education institutions. Government provided student loans and private philanthropy are efficiency improving, while institutional debt acts to increase inefficiency. Time varying inefficiencies show efficiency gains over the last two of the four academic years. However, additional observations will be required to determine whether that is a managerial reaction to the global financial crisis and if it is sustainable in future academic years.

Keywords: *Cost inefficiency, Stochastic cost frontier, Religion, Postsecondary*

Introduction

In this paper, the question of whether religion is efficient is empirically explored in the context of knowledge production and the managerial operating cost efficiencies within faith related postsecondary institutions. That includes bible colleges, theological seminaries, and other faith based accredited postsecondary institutions using the United States as the sample base. From four years of panel data, cost inefficiencies are estimated using stochastic frontier analysis. The results reveal the extent to which operating inefficiencies depend upon different educational offerings and other faith related institutional characteristics. After an exhaustive literature search, this appears to be the first research to provide stochastic efficiency estimates for religious based higher education institutions.

In what is believed to be a fairly comprehensive literature review, these institutions have escaped much of the empirical scrutiny embedded in investigations of higher education institutions as multi-product entities. The lone exception appears to be the Koshal, et al. (2001) empirical estimates of scale and scope economies for what they label as bible colleges, but includes seminaries and other faith based institutions. Their findings indicate that these institutions exhibit both scale and scope economies. The results are generally supportive of other scale and scope studies of (e.g., Cohn, 1989, Sav, 2004, and Lenton, 2008). However, scale and scope estimates fall short of providing an overall measure of institutional cost efficiency. In contrast, stochastic frontier analysis provides a parametric methodology for estimating cost efficiencies or inefficiencies for industries, sectors, and individual institutions. The analysis is used to compare cost performance to a potential minimum cost. The deviation can be attributed to cost inefficiency due to institutional characteristics, environmental factors, or managerial decision-making.

In this paper, stochastic cost analysis is used to estimate operating inefficiencies for a panel of 222 U.S. faiths based postsecondary institutions. The panel covers the 2005-09 academic years. The cost structure is specified as Cobb-Douglas with an inefficiency component defined by institutional specific characteristics. Operating cost inefficiencies are reported for three institutional groups defined by those institutions engaged in undergraduate only education, graduate only education, and both undergraduate and graduate education. In addition, the dynamics of the time variant inefficiencies are investigated and institutional efficiency gains or losses are examined by academic year.

The managerial efficiency of these institutions should be of importance from several perspectives. First, faith based postsecondary enrollments in the U.S. have been on the upswing for more than a decade.

Some have experienced sixty percent enrollment growth (Chronicle, 2005). Second, the proportion of high school seniors and, therefore potential future postsecondary enrollees, who attend weekly religious services and who feel religion is important in their lives has shown a turnaround since its 1980's decline. Third, religious colleges generally charge lower tuitions relative to other non-profit private institutions and are said to offer a haven from what is perceived to be cultural and moral problems existing at larger secular public universities (Chronicle, 1999). And last, like nearly all of higher education, these institutions did not escape the financial difficulties imposed by the global financial crisis. Like their counterparts, the changed financial landscape dictates that managerial decisions will have to be made to improve the cost efficiency with which these institutions produce knowledge. Understanding the extent of inefficiency and some of the root causes of it are the first steps in moving to that improvement.

The paper proceeds with the next section providing an overview of applied stochastic analysis, followed by a section explaining the empirical specification for the present inquiry and then sections related to data sources, statistical results, and conclusions.

Literature Overview

The foundations of stochastic frontier analysis are due to the seminal works of Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broech (1977). Many methodological developments immediately followed and include the econometric interest in panel data brought forth in the contributions of Kumbhakar (1991), Battese and Coelli (1992), and Battese and Coelli (1995). These and other systematically provided refinements have been comprehensively documented in Kumbhakar and Lovell (2003), Coelli, et al. (2005), and Fried, et al. (2008).

The empirical application of frontier analysis to postsecondary education is fairly new. Initially appearing in 2002, there are only five such studies that were uncovered at the outset of this research. Due to the multiproduct nature of higher education institutions, each study employs a cost frontier rather than production frontier. Izadi, et al. (2002) applies a constant elasticity of substitution cost function to a 1994-95 cross section of 99 British higher education institutions. Stevens (2005) uses a 1995-99 panel of 80 English and Welsh universities in conjunction with a translog cost function. McMillan and Chan (2006) estimate a linear cost function for a 1992-93, cross section of 45 Canadian universities. Johnes and Johnes (2009) use a quadratic function and a 2000-03 panel data of 121 English institutions, while Abbott and Doucouliagos (2009) estimate a translog cost frontier for 36 Australia (1995-2002) universities and 7 New Zealand (1997-2003) universities.

Each of these studies uses some measure of academic year or calendar year total university expenditures to represent the total cost. In addition, all employ various measures of undergraduate education, graduate education, and research as university outputs. Full time equivalent enrollment is the most common use for the education outputs. Combined research grants and contracts normally enter as the proxy for institutional research output. Stevens (2005) and McMillan and Chan (2006) also include a form of faculty salary as an input price. Including interaction terms and dummy variables, the number of independent variables devoted to the cost frontier vary from a total of 4 in the Izadi, et al. (2002) study to 36 in Stevens' (2005) study.

Each of these studies differs in cost and inefficiency modeling structures. However, three of them do use some variation of the inefficiency model introduced by Battese and Coelli (1995). But the method by which university efficiency or inefficiency is determined renders comparisons among the empirical results difficult at best. For example, McMillan and Chan (2006) and Abbott and Doucouliagos (2009) report technical efficiency scores, maximum output from available inputs, varying from approximately 0.6 to 1.0. In contrast, Stevens (2005) estimates cost inefficiencies, costs above the minimum obtainable, and reports scores ranging from 1.007 to 2.011. Although these scores are generated from the same inefficiency model genre, there remains unrecoverable differences in the specific data leading to the results and, consequently, an inability to reformulate the inefficiency scores and place them on an equivalent scale. Across all studies, matters are also complicated by the vast differences in the specification of the cost frontiers, the use of cross sectional time invariant vs. panel data inefficiency structures, and the number of variables and their definitions used in the studies.

Empirical Specification

Among all stochastic frontier studies, the Cobb-Douglas and Trans log functions are the most widely used specifications. Although the Trans log is the more flexible functional form, in preliminary maximum likelihood tests on the present data, it did not cooperate in producing convergence and, therefore, had to be abandoned in favor of the nested Cobb-Douglas. Here it is applied to panel data under the Battese and Coelli (1995) inefficiency model.

Total cost (*TC*) for each institution (*i*) in each academic year (*t*) is formulated as follows:

$$TC_{it} = \alpha_0 + \alpha_U U_{it} + \alpha_G G_{it} + \alpha_w w_{it} + \alpha_k k_{it} + d_G D_{G,it} + d_{UG} D_{UG,it} + (u_{it} + v_{it}) \quad (1)$$

Where: U=undergraduate full time equivalent (FTE) enrollment,
G=graduate full time equivalent (FTE) enrollment,
w=faculty wage measured by average salary,
k=capital value measured by year ending value of buildings,
DG=1 if only graduate education is produced, 0 otherwise,
DUG=1 if both undergraduate and graduate education are produced, 0 otherwise, and all non-dummy variables are in natural logs.

The specification includes the usual two educational outputs but is absent of a research output typical of cost studies pertaining to secular universities. Bible colleges and theological seminaries do not typically produce scholarship in the same vein as found at research and doctoral or comprehensive universities. For inclusion of an input price, the often used average faculty salary is employed as a measure of the faculty wage. In addition, the institution's year ending value of buildings is used as a proxy for the capital input price. A modified Cobb-Douglas is presented via dummy variables to account for the differences across institutions as a result of the three educational level offerings. Thus, effects are relative to institutions offering only undergraduate programs.

In this specification, the error term is comprised of two components: usual measurement error v_{it} along with a measure of cost inefficiency u_{it}. The former is noise that is assumed to be independent and identically distributed as a normal distribution with zero mean and variance Φ_v^2. Cost inefficiency is assumed to be independently distributed with a truncated at zero normal distribution, variance Φ_u^2, and is dependent on institutional inefficiency determinants such that

$$u_{it} = \beta_0 + \beta_I I_{it} + \beta_F F_{it} + \beta_B B_{it} + z_{it} \qquad (2)$$

Where: z is the random error and inefficiency determinants in natural logs are

I=the percentage of enrolled students receiving government grants,

F=the percentage of university revenues received from private giving,

B=institution debt measured as liabilities to assets expressed as a percentage.

Basic cost principles suggest that the outputs and input prices are expected to carry positive effects in the cost structure of institutions. Too little is known of these institutions to offer speculation regarding the effects of different educational level offerings.

With regard to the inefficiency effects, matters are somewhat more complicated. Student funding derived from externally provided government grants could lessen student financial complications, increase retention rates and possibly improve institutional efficiency. However, to the extent that such grants impose additional administrative burdens on institutions, they could generate inefficiencies. Similarly, greater proportions of revenue derived from private giving could produce different inefficiency effects.

Private giving rich institutions can be less dependent upon market driven tuition charges and revenue and, in that sense, be better insulated from market forces. As some would argue, while market forces might be efficiency promoting in for-profit industries, they have no place in the non-profit higher education sector. Others can argue that the production of education is inefficient and, e.g., in the publicly owned sector, that inefficiency derives from it insulation from market forces. Yet, greater donor support can also have tie-ins in bringing greater donor control over internal decision-making. Overall, there is little in the way of strong a priori expectations on the inefficiency effects of either student grants or private giving. On the other hand, it is expected that the institutional debt variable does represent some measure of managerial skills and, therefore, larger debt would produce greater inefficiency.

The model parameters are estimated simultaneous using the method of maximum likelihood. The Battese and Corra (1977) parameterization of $\sigma^2=\sigma_v^2+\sigma_u^2$ is used and a resulting estimate of ($=\sigma_u^2/\sigma^2$ is produced. The value of provides a route to test the significance of inefficiency in university costs. The measure of cost inefficiency is exp (u_{it}) and varies from one to infinity, with the score farther above one being greater institutional and managerial inefficiency.

Data Source

Data pertaining to postsecondary education in the U.S. is maintained through a system of surveys conducted annually by the U.S. Department of Education, National Center for Education Statistics. Data are housed in the Integrated Postsecondary Education Data System (IPEDS). Bible colleges, theological seminaries, and other faith related institutions are uniquely identified in IPEDS under a single designated classification.

Using the most recent survey releases, it was possible to assemble a consistent set variables and institutions over the academic years 2005-09. Omitting institutions that failed to report costs or enrollments resulted in a panel of 222 institutions for a total of 888 observations over the four academic years. Table 1 presents a summary of the cost and inefficiency variables along with the means and standard deviations for the complete panel of institutions.

Estimation Results

Maximum likelihood estimates are presented in Table 2. Based on the statistical significance of individual coefficients, the model performs extremely well with all of the coefficients being significant at the ten percent and better level. Both education outputs and input prices carry the expected positive cost effects. For the Cobb-Douglas specification, the estimated coefficients are elasticity. Undergraduate cost elasticity is nearly twice that of the graduate cost elasticity, but the faculty wage elasticity outstrips both. The dummy variables indicate that, compared to undergraduate only institutions, it is relatively more costly to separately produce faith related graduate education. However, the negative D_{UG} coefficient suggests that there is a cost advantage in adding graduate education to the undergraduate program offerings and producing both at same institution.

Table 1: Variables, Means and Standard Deviations

	All Institutions		Institutional Means by Level[a]		
Variable	Mean	S.D.	U	G	UG
Total Costs, TC ($)	6.96E+06	8.10E+06	3.80E+06	8.61E+06	7.81E+06
Undergraduate Enrollment, U	159	274	213	0	308
Graduate Enrollment, G	117	301	0	179	146
Faculty Wage, w ($)	43623	15788	35417	54260	37878
Capital Price (Building), k ($)	1.16E+07	1.57E+07	5643153	1.63E+07	1.11E+07
Percent Student Grants, I (%)	25.70	28.63	49.46	1.00	34.73
Percent Private Gifts, F (%)	45.13	86.55	31.54	59.34	39.87
Percent Debt, B (%)	23.36	22.08	32.13	13.79	27.26
Graduate Only Degree, D_G (=1,0)	0.39	0.49	-	-	-
Both Undergrad-Grad Degrees, D_{UG} (=1,0)	0.32	0.47	-	-	-

Note: a. U=undergraduate only, G=graduate only, UG=both undergraduate and graduate.

Table 2: Cost Frontier and Inefficiency Estimates

Variable (Coefficient)	Estimate	S.D.	t Value
Cost			
Constant ($\forall_o$)	2.762	0.445	*6.21
Undergraduate Enrollment, U ($\forall_U$)	0.299	0.020	*15.00
Graduate Enrollment, G ($\forall_G$)	0.155	0.014	*10.84
Faculty Wage, w ($\forall_w$)	0.490	0.045	*10.85
Capital Price, k ($\forall_k$)	0.351	0.015	*23.28
Graduate Only Degree, D_G (d_G)	1.013	0.143	*7.11
Both Undergrad-Grad Degrees, D_{UG} (d_o)	-0.317	0.066	*-4.79
Inefficiency	-5.274	2.774	*-1.90
Constant ($\exists_o$)	-0.389	0.175	*-2.23
Percent Student Grants, I ($\exists_I$)	-0.223	0.111	*-2.01
Percent Private Gifts, F ($\exists_F$)	0.653	0.345	*1.89
Percent Debt, B ($\exists_B$)	-5.274	2.774	*-1.90
Sigma Squared (Φ^2)	1.422	0.578	*2.46
Gamma ()	0.904	0.043	*21.24
Log Likelihood	-516.942		
Likelihood Ratio	*22.311		
Observations (N)	888		

Note: * denotes statistical significance at 10% and better level.

As for the frontier specification, the statistically significant likelihood ratio indicates that the approach does offer superiority over ordinary least squares. Moreover, inefficiency plays a significant role in the operating costs of faith related postsecondary educational institutions. Based on the estimate of gamma, the share of inefficiency in the comprised error is approximately 0.90. All three individual inefficiency effects are statistically significant. Interestingly, increases in the proportions of students supported by government loans and increases in private giving act to decrease inefficiency, i.e., improve efficiency.

One could either interpret the latter as efficiency improvements resulting from a lessening of pressures from market forces or a possible improvement in institutional decision-making imposed from external donor influence. However, the two efficiency improving effects are countered by the inefficiency increases associated with higher levels of debt. If institutional debt is a measure of internal management, then institutions that are not as managerially skilled, thereby suffering greater debt, are more inefficient according to the present estimates.

Table 3 presents a summary of the calculated inefficiencies and their variation across academic years. Inefficiency scores are shown for the full sample of 888 institutions and a decomposition of institutions by educational program offerings, i.e., institutions offerings undergraduate only, graduate only, and both undergraduate and graduate programs.

Table 3: Inefficiency Scores and Variations

	All Institutions	Undergraduate (U)	Graduate (G)	Undergraduate Graduate
Mean	1.310	1.261	1.317	1.346
Median	1.238	1.219	1.249	1.236
Minimum	1.081	1.081	1.088	1.092
Maximum	6.166	1.856	3.220	6.166
S.D.	0.298	0.140	0.231	0.441

2005-06	1.291	1.266	1.307	1.297
2006-07 (% change)	1.313 (1.64)	1.259 (-0.56)	1.329 (1.74)	1.342 (3.48)
2007-08 (% change)	1.318 (0.43)	1.260 (0.11)	1.330 (0.03)	1.355 (1.00)
2008-09 (% change)	1.318 (-0.01)	1.259 (-0.07)	1.304 (-1.91)	1.387 (2.30)
Observations	888	257	350	281

The mean inefficiency for the full sample in Table 3 is 1.31, indicating that on average the sample of postsecondary institutions of faith are operating around 31% above the minimum frontier cost. But the median indicates that fifty percent of the institutions are below the 1.238 inefficiency levels, hence some substantial positive skeins. When examined across educational levels, the results show that institutions engaged in undergraduate only education are the most efficient on average. That is followed by graduate only institutions and then the most inefficient group of institutions offering both undergraduate and graduate education. However, when viewed from the perspective of both the median inefficiency scores, we would have to be comfortable in concluding that there is no difference in the operating inefficiency across different groups of institutions.

When inefficiencies are examined by academic year, Table 3 reveals that the aggregate of institutions did not encounter any significant inefficiency increases over the four year period. In fact, the 0.43% increase in 2007-08 can be viewed as an inefficiency slowdown or efficiency improvement when compared to the 1.64% increase experienced in the previous 2006-07 academic year. Of course, the inefficiency decrease of -0.01% in 2008-09, although nearly undetectable, is still a notable efficiency improvement when viewed in context of the full four years. An examination across the different institutional levels shows that the undergraduate only and graduate only institutions are the contributors to overall annual efficiency gains. The relatively greater academic year inefficiency increases borne by those institutions offering both undergrad-grad programs represent offsets to those efficiency gains.

Conclusions

Results indicate that the cost inefficiency of knowledge producing religions higher educational institutions varies depending upon the degree level offerings and other institutional characteristics. Efficiency improvements occur in the presence of increased government provided student loans and external institutional financial support in the form of private philanthropy. Those improvements tend to be offset by inefficiency increases brought about by increased increases in institutional debt that might be attributed to poorer managerial skills. Findings also indicate that institutions offering only undergraduate education exhibit lower mean inefficiencies relative to graduate only institutions and institutions offering both undergraduate and graduate education. There is evidence that efficiency improvements have occurred over the 2007-08 and 2008-09 academic years.

That could possibly be a positive managerial adjustment undertaken in response to the financial difficulties induced by the global financial crisis, although the sustainability of that will have to wait for confirmation derived from future years of observation related to the management of faith based educational institutions.

References

[1] M. Abbott and C. Doucouliagos, "*Competition and efficiency: overseas students and technical efficiency in Australian and New Zealand universities.*" *Education Economics*, vol. 17, pp. 31-57, 2009

[2] D. J Aigner, C. A. K. Lowell and P. Schmidt. "*Formulation and estimation of stochastic frontier production function models.*" *Journal of Econometrics,* vol. 6, pp. 21-37, 1977

[3] G. E. Battese and T. J. Coelli, "*Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India.*" *Journal of Productivity Analysis,* vol. 3, pp. 153-169, 1992

[4] G. E. Battese and T. J. Coelli, *"A model for technical inefficiency effects in a stochastic frontier production function for panel data." Empirical Economics* , vol. 20, pp. 325-332, 1995
[5] G. E. Battese and G. S. Corra, "*Estimation of a production frontier model: With application to the pastoral zone of eastern Australia." Australian Journal of Agricultural Economics*, vol. 21, pp. 169–179, 1977
[6] The Chroncile of Higher Education, "*Enrollments Surge at Christian Colleges.*" March 5, 1999
[7] The Chroncile of Higher Education, "*Enrollments Surge at Christian Colleges."* March 18, 2005
[8] T. Coelli, J.D.S.Rao Prasada, C.J. O'Donnell, and G.E. Battese, "*An Introduction to Efficiency and Productivity Analysis. (*2nd ed.)" Springer, New York, 2005
[9] H.K. Fried, K. Lovell, and S. Schmidt, "*The Measurement of Productivity and Productive Growth."* Oxford University Press, New York, 2008
[10] E. Cohn, S.L. Rhine, W. Rhine and M. C. Santos, "*Institutions of higher education as multi-product firms: Economies of scale and scope" Review of Economics and Statistics*, vol. 71, pp. 284-290, 1989
[11] H. Izadi, G. Johnes, R. Oskrochi and R. Crouchley, "*Stochastic frontier estimation of a CES cost function: The case of higher education in Britain" Economics of Education Review,* vol. 21, pp. 63-71, 2002
[12] G. Johnes and J. Johnes, "*Higher education institutions' cost and efficiency: taking the decomposition a further step" Economics of Education Review,* vol. 28, pp. 107-113, 2009