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The cost efficiency of state universities and colleges in the Philippines[1]

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As part of its effort to combat poverty and improve the country's competitiveness through education, the Philippine government provides financial support to hundreds of thousands of students coursed through subsidized state universities and colleges (SUCs), which today number 110 all over the archipelago. The effectiveness with which these institutions use taxpayers' money is under constant public scrutiny. We explore the cost efficiency of SUCs, taking into consideration their ability to produce graduates and board passers given the budget allocation they receive annually, for the period 2006–2010. Universities are analysed separately from colleges owing to the inherent differences in their operative structures. State universities are found to be more cost efficient than state colleges, a fact attributable in part to their larger scale and scope of operation. Calculations show that state universities are characterized by economies of scale and scope, while state colleges are not. This has significant implications for their educational function.

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1. Introduction

Higher education institutions play an essential role in improving the country's competitiveness owing to their part in developing human resources and providing a path out of poverty. This provides the motivation for reforms in Philippine public higher-education institutions such as state universities and colleges (SUCs). Public higher-education institutions were created to make education more accessible to the poor and disadvantaged. The "Roadmap for public higher education report" [CHED 2012a] outlines the vision and directions of the Higher Education Reform Agenda for 2011–2016. Its aims in summary form are to (1) rationalize higher education, (2) improve quality and standards of higher education, and (3) expand access to quality higher education.

This study examines SUCs in the Philippines in terms of their performance and seeks answers to the following questions: (1) How cost effective and efficient is the provision of SUC programs in the Philippines? (2) How significant are improvements in outcomes for students of SUCs, as measured by the number of graduates and board passers? Previous studies on higher education institutions (specifically Conchada [2008]) have inquired into the efficiency of SUCs using a methodology similar to that used in this paper but these have treated the data for both state universities and colleges as one data set. It has been found that state universities and colleges are not cost effective since they exhibit diseconomies of scale. The present study however takes a different direction by analysing state universities and state colleges separately, since these have inherent differences in their operative structures. Moreover, this study involves larger panel data series accounting for five school years (SY), from 2006–2007 until 2010–2011.

2. Review of related literature

2.1. State universities and colleges in the Philippines

As of 2011, there were 110 state universities and colleges (main campuses) across the Philippines [CHED 2012a]. The number of SUCs has increased over the past two decades, as new institutions were added or existing ones were converted by law from secondary or postsecondary institutions. Among the issues faced by SUCs is the lack of financial resources. The General Appropriations Act (GAA) shows more than two-thirds of budget for SUCs is allotted to personnel services, while the rest is shared between maintenance and other operating expenses (MOOE) and capital outlays. A consequence of this budget allocation is the very small amount devoted to facilities and materials used, as compared to the salaries of the teaching and nonteaching staff. The low budget for MOOE affects the quality of instruction given to students, which may be reflected in the quality of graduates and their productivity in the labor market in the future [Conchada 2008].

SUCs and private higher-education institutions differ in the type of degree programs offered. According to data from the Commission on Higher Education (CHED) COE-COD database, most Philippine state universities and colleges offer undergraduate or graduate degree programs in teacher education, agriculture, forestry, veterinary medicine, industrial technology, and even engineering. Private higher-education institutions, on the other hand, tend to offer degree programs in business and management, engineering and architecture, health profession education (i.e., medicine and nursing), humanities, science and mathematics, social sciences, and teacher education.

CHED's list of Centers of Excellence (COEs) and Centers of Development (CODs) shows SUCs in general excelling in the fields of teacher education, agriculture, fishery, and veterinary medicine. Private higher-education institutions, on the other hand, excel in business management, computer science, architecture, the humanities, and the arts. This characterization excludes the University of the Philippines, which is one state university that excels equally in the sciences, the arts, as well as teacher education [Conchada 2008].

2.2. Role of SUCs in national development

Because of the high social value attached to it, higher education has been the subject of close public scrutiny even as it has been plagued by various issues [Cuenca 2011]. Indeed owing to the peculiar place it holds in Philippines society, higher education has been the most extensively studied social sector [Orbeta 2002].

While education is supposed to train Filipinos to become more productive workers and patriotic and responsible citizens [Castano and Cabanda 2007], the government recognizes the difficulty of ensuring equitable access to quality education because of economic constraints or cultural factors. Various programs and institutions have therefore been put in place to augment the process of educating the youth and enhancing their capacity to work and earn.

In 1994, the Higher Education Development Fund (HEDF) was established under the Commission of Higher Education to help strengthen the Philippine education HEDF by granting additional funds to higher education institutions (HEIs). The HEDF was created specifically for staff development, the upgrade of facilities and research capacity, and scholarships. In addition, the Higher Education Development Project was begun in 2003, also with the aim of improving higher-education programs.

State universities and colleges are education institutions whose operations are either partly or fully subsidized by the government. Government spending on higher education, as exemplified by the budget allocated to the 110 SUCs [GAA 2011], improves access by students, which enhances their earnings ability [Manasan, Cuenca, and Villanueva-Ruiz 2008]. The provision of such programs and institutions as SUCs is a significant factor in Filipino households' decision to send their children to school and pursue higher education [Orbeta 2002].

2.3. Cost efficiency of SUCs

Because SUCs are subsidized by the national government, public interest attaches to determining whether and how well they are able to efficiently utilize such funds. Castano and Cabanda [2007] predict that efficiency analyses of education institutions will be more common as funders and education administrators increasingly demand accountability from these institutions. Indeed, Cuenca [2011] concurs that the need to analyse the efficiency of SUCs cannot be overemphasized as public budget constraints grow ever tighter. Efficiency is a primary concern of government, whose spending must be justified by two principles: promoting efficiency (e.g., in economic terms) and equity (e.g., social welfare) [Manasan, Cuenca, and Villanueva-Ruiz 2008].

Current discussions however has less to do with the existence of inefficiency per se (as discussed by Preddey and Nuqui [2001] and Tan [2011]) than with measuring such inefficiencies [Cuenca 2011]. The efficiency of SUCs has been measured in papers employing data envelopment analysis (DEA) and/or stochastic frontier analysis (SFA) (see Abon et al. [2006]; Ampit and Tan-Cruz [2007]; Castano and Cabanda [2007]; Cuenca [2011]).

2.3.1. Economies of scale

Alinsonorin, Jala, and Lara [1996] were the first to conduct a study on the economies of scale that may arise from the operation of SUCs in the Philippines. They emphasize that an analysis of economies of scale is not simply one of reduction of per unit (student) cost, which is almost certain to provoke violent reactions about the quality of education; rather, it is the analysis of mixes of costs and educational outputs, and determination of whether these are efficient. This cost-benefit analysis will determine a plethora of essential features of the educational system: "overall size of the educational budget, the broad allocation of the budget between major educational sectors, as well as more detailed choices relating to curricula, class sizes, teaching methods, etc." [Alinsonorin, Jala, and Lara 1996].

The presence of economies of scale in SUCs is supported by the studies of Alinsonorin, Jala, and Lara [1996] and Manasan [2012]. Manasan [2012] points out that this finding supports proposals of amalgamation of SUCs, as it is most likely to be more cost efficient.

Economies of scale in the education sector refer to the cost efficiency of an institution in providing education as its student population grows. This is demonstrated when more students are able to access and utilize educational facilities even as the latter maintain or even improve student performance. The demonstration of economies of scale among Philippine SUCs is the source of various economic and political implications and major subject of discussions owing to its effects on the amount of financial and political support an SUC gets. Manasan [2012], for example, recommends that an SUC demonstrating economies of scale should reduce its dependence on national government funding, since it is already efficient; government therefore ought to focus its resources on other SUCs not yet experiencing cost efficiencies.

2.3.2. Economies of scope

Economies of scope refer to the decline in average cost per student as the scope of the programs offered in the SUC is enlarged. This aspect of efficiency is most especially important in the Philippine context because of the presence of state colleges that specialize in the fields of agriculture, fisheries, and pig husbandry. Manasan [2012] finds that the multiplicity of programs offered in Philippine SUCs drives the cost per student upward.

2.4. Research gap

To date, however, we have found no analysis of the differences between state universities and state colleges, whether in the Philippines and overseas. Differences in how they operate and utilize their funds make for a particularly important distinction that ultimately has significant repercussions on how the national government should run and fund these institutions. Inherently distinct characteristics of state universities and colleges such as size and programs offered could suggest differential treatment, rather than the prevalent amalgamation of the two in the status quo and in the literature. A distinction in how the state develops these institutions could be a significant stride toward increased efficiency.

The methodology used in the literature to analyse the efficiency of SUCs and HEIs has currently been limited to data envelopment analysis (DEA) and/or stochastic frontier analysis (SFA). This has had the effect of merely replicating studies done in the past. A new methodology must be employed to confirm the robustness of the results of previous studies.

Furthermore, while economies of scale are a well-researched topic in addressing the question of efficiency, economies of scope (i.e., decreasing cost with increase in programs offered) of SUCs have been barely touched in the literature. In the Philippine context, this may pose an equally important challenge to efficiency, since there are questions on whether specialization in certain fields offered in many colleges in the country—including agriculture, fishing, and animal husbandry, or information technology, engineering, business—is indeed cost efficient.

Finally, the discovery of economies of scale and economies of scope in SUCs is a rich ground for policy recommendations that has not been fully explored.

3. Theoretical framework

3.1. Cost functions

For a more detailed discussion of cost functions in higher education, the reader is referred to Conchada [2008]. Here we consider a higher education institution (HEI) that produces graduates, research, and extension services. To produce these outputs, HEIs can combine inputs in various ways. Each input combination produces a different level of cost, and is associated with a function that is not well defined. It is therefore essential to establish assumptions regarding types of HEI, recognizing that the cost of production depends on an HEI's objectives and constraints, the most typical of which is the budget and factor prices of inputs.

A major assumption to be made is that an HEI is really a multiple-output firm whose objective is to minimize the cost of producing given levels of output. This is seen in the fact that private and public colleges and universities offer various degree programs to society.

3.1.1. Transcendental logarithmic variable cost function

Various functional forms have been employed in the literature to estimate the relationship between outputs and costs. Only a few are truly suitable for use in the context of multiproduct organizations. Linear specifications, for instance, are not appropriate because they prevent the possibility that there might exist economies of scope. Likewise, other common functional forms (i.e., Cobb-Douglas) may be ruled out since they generate spurious results.

Flexible functional forms can locally approximate any differentiable function [Alba 1995], and this is one way to avoid the risk of misspecifying the form of the regression equation. On the other hand, one disadvantage, is that since they are local expansions, flexible functional forms yield estimation results that are not valid globally but only in the neighborhood of the expansion points.

The transcendental logarithmic (translog) variable cost function is the most widely used flexible functional form because it requires the estimation of the least number of parameters. It is a second-order Taylor series expansion of the natural logarithm of a normalized variable cost function about the point ($\ln w^*$, $\ln q^*$, $\ln k^*$) = (0, 0, 0) where $w^* = (w^{*1},\ldots,w^{*I})$, $q^* = (q^{*1}, \ldots , q^{*N})$, and $k^* = (k^{*1}, \ldots , k^{*T})$ are respectively vectors of input prices, outputs, and fixed factors about which the expansion is performed [Alba 1995].

3.2. Operational framework

3.2.1. Estimated cost function of HEIs in the Philippines

With a positive-economics[2] view of the issues we focus on the estimation of the cost function, specifically the cost associated with scholarships, which takes the following general form:

$$C = C(q_n, w_{i,}, V) \quad (1)$$

where w_i are factor prices, consisting of wages or personal services and maintenance and other operating expenses, q_n are the outputs produced by HEIs, which in this study consist of graduates and board takers, and V is a vector of characteristics. From the estimated cost function, it then becomes possible to determine the existence of economies of scope and economies of scale [Conchada 2008].

The following definitions may provide clearer understanding of the terms used in this study:

Board takers. Refers to the number of students who took the board examination in various fields from SY 2006–2007 until SY 2010–2011. Board examinations, administered by the Philippine Professional Regulation Commission, are a way to regulate and license practitioners of various professions and occupations under the commission's jurisdiction. Various fields have different professional regulatory boards that exercise administrative control over their respective professions. Note that not all fields of study in colleges and universities require licensure examinations.

Board passers. Refers to the number of students who passed the board examination in various fields based on a cutoff score determined by the professional regulatory board from SY 2006–2007 until SY 2010–2011.

Center of Excellence. A designation developed by the CHED to spearhead the nation's development thrust. It refers to higher-education institutions, public or private, that demonstrate the highest standards in instruction, research, and extension, as well as exhibiting excellent qualities in producing professionals (CHED).

Center of Development. Developed by the CHED, this designation refers to higher-education institutions that have the potential to become a Center of

[2] That is, positive economics, in the sense of an analysis of facts and behavior in an economy, or "the way things are" [Samuelson 2001].

Excellence in the future. The Center of Excellence and Center of Development designation is based on a set of criteria that include instructional quality, research and publication, extension and linkages, and institutional qualifications. The CHED grants this status to improve the quality of programs in colleges and universities.

3.2.2. The translog cost function model

In the estimation of the cost function for HEIs, the study utilizes the transcendental logarithmic specification—the most widely used flexible function form since it requires the estimation of the least number of parameters [Alba 1995]. The estimation of the translog model is derived from the work of Alba and the group of Pulley and Braunstein [1992].

This study will estimate a translog cost function given by

$$
\begin{aligned}
\ln c^{v^*} = {} & \alpha_0 + \sum_{i=1}^{I} \alpha_i \ln w_i^* + \sum_{n=1}^{N} \beta_n \ln q_n^* \sum_{t=1}^{T} \gamma_n \ln k_t^* \\
& + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j=1}^{I} \alpha_{ij} \ln w_i^* \ln w_j^* + \tfrac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{N} \beta_{nm} \ln q_n^* \ln q_m^* \\
& + \tfrac{1}{2} \sum_{t=1}^{T} \sum_{s=1}^{T} \gamma_{ts} \ln k_t^* \ln k_s^* + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{n=1}^{N} \rho_{in} \ln w_i^* \ln q_n^* \\
& \sum_{i=1}^{I} \sum_{t=1}^{T} \delta_{it} \ln w_i^* \ln k_t^* + \sum_{n=1}^{N} \sum_{t=1}^{T} \theta_{nt} \ln k_t^* + D_2 + D_3 + \varepsilon
\end{aligned} \tag{2}
$$

where ln c, ln w_i for $i = 1, \ldots, I$, ln q_n for $n = 1, \ldots, N$, and k_t for $t = 1,\ldots,T$ are, respectively, the natural logarithms of mean-scaled values of total cost, input prices, output levels, and fixed inputs of HEIs in the Philippines. The input prices are weighted average monthly wages of faculty members and value of educational supplies and materials (annual average per student). Output levels, on the other hand, include the following: number of board takers, number of board passers, number of graduates for the undergraduate level, and number of graduates for the graduate level. Dummy variables are included to account for the regional location of the HEIs.

The translog cost function is a second-order Taylor series approximation of the true but unknown multiproduct cost function around a point of expansion given by $q_i = w_i (i_, j = 1,2)$. This cost function is commonly used because of its flexibility in representing cost and production technologies of varying complexities.

For equation (2) to be a proper cost function, it must possess certain characteristics such as the following: it must be linearly homogeneous and concave in input prices, convex in output levels, and nondecreasing and continuous in both output levels and input prices. Moreover, it should be monotonic in both outputs and input prices. To ensure continuity in factor prices and output levels, the following symmetric restrictions were imposed:

$$\alpha_{ij} = \alpha_{ji} \text{ for all } i \text{ and } j \text{ and } \beta_{nm} = \beta_{mni} \text{ for all } n \text{ and } m$$

The table below summarizes the characteristics of an estimated translog cost function that should be obtained for it to qualify as a proper cost function.

TABLE 1. Characteristics of translog cost function

CHARACTERISTICS	DESCRIPTION
1. linearly homogeneous	Input prices = 1; second order terms of combination of inputs = 0; second order terms of combination of inputs and outputs = 0
2. concave in input prices	The matrix of inputs must be negative semi-definite
3. convex in output levels	The matrix of outputs must be positive semi-definite
4. monotonic in both outputs and inputs	Coefficients of the outputs and input prices should be positive semi-definite

The first characteristic of the translog cost function implies that if any of the input prices doubles, assuming that output is held constant, the total cost of HEIs also doubles. The second characteristic denotes a positive relationship between input prices and total cost. The third characteristic allows for economies of scale—that is, that outputs, such as graduates and board takers, may have a negative relationship with total cost. Some state universities and colleges find it less costly to offer several undergraduate and graduate programs compared to offering only a few.

3.2.3. Economies of scale

Inferences about the structure of costs and production of HEIs can be derived from the analysis of economies of scale, which will help address issues on how unit costs are affected by changes in operations in HEIs. The most commonly used concept of economies of scale for multiple output firms [Alba 1995] is the ray, or overall economies of scale. It measures the relative increase in total costs of increasing all outputs of the institution by the same proportion. Once the evaluation is done on the translog cost function for HEIs, the index of ray scale is expressed as

$$\varepsilon = \frac{1 - (\hat{\gamma}_1 + \hat{\gamma}_{11} \ln k_1')}{\beta_1 + \beta_2} \tag{3}$$

where the numerator contains the coefficient estimates of the fixed input while the denominator comprises the coefficient estimates of the outputs in the translog cost function. Economies of scale exist if the absolute value of ε is greater than 1 while diseconomies of scale exist if the absolute value of ε is less than 1.

4. Methodology

The data used were taken mostly from the CHED and included (1) programs and enrollment for each SUC, (2) total number of graduates for each SUC, (3) number of board takers and passers for each SUC, and (4) other information pertinent to each SUC. Data on budget expenditures allotted to each SUC were taken from the GAA of the Department of Budget and Management. All data were based on SY 2006–2007 until SY 2010–2011 since these were the most complete and available. The variables for board takers and board passers pertain only to certain fields in colleges and universities that require licensure examinations, such as engineering, teacher education, accountancy, and medicine, among others. The data include the total number of board takers and passers for various fields and for each college and university. The data however fail to specify the field for each higher education institution. The indicator of quality used is simply the difference between the board takers and passers.

The translog cost function model represents the relationship of input prices, outputs, fixed inputs, interaction terms, and dummy variables to the total cost of the SUC. The empirical model is as follows:

$$\begin{aligned} \ln TC = {} & \alpha_0 + \alpha_1 \ln w_i + \alpha_2 \ln w_2 + \beta_1 \ln q_1 + \beta_2 \ln q_2 + \gamma_1 \ln k_1 \\ & + ½\, \alpha_{11} (\ln w_1)^2 + ½\, \alpha_{22} (\ln w_2)^2 + ½\, \alpha_{11} \ln w_1 \ln w_2 \\ & + ½\, \beta_{11} (\ln q_l)^2 + ½\, \beta_{22} (\ln q_2)^2 + \beta_{12} \ln q_1 \ln q_2 \\ & + ½\, \gamma_{11} (\ln k_1)^2 + \rho_{11} \ln w_1 \ln q_1 + \rho_{21} \ln w_2 \ln q_1 \\ & + \rho_{12} \ln w_1 \ln q_2 + \rho_{22} \ln w_2 \ln q_2 + \delta_{11} \ln w_1 \ln k_1 \\ & + \delta_{21} \ln w_2 \ln k_1 + \theta_{11} \ln q_1 \ln k_1 + \theta_{21} \ln q_2 \ln k_1 + D_2 + D_3 + \varepsilon \end{aligned} \quad (4)$$

where the w_is are input prices, the q_js are the SUC outputs, and k is the fixed input. The left-hand side of the translog cost function is the total cost or expenditures. Dummy variables were included to account for the differences in regional location of the state universities and colleges. The first dummy variable assigns a value of 1 for SUCs located in the Visayas region and 0 otherwise. The second dummy variable takes a value of 1 for SUCs located in the Mindanao region and is 0 otherwise. Interaction variables between inputs, outputs, and fixed input were also included.

The translog cost function is estimated using the seemingly unrelated regression (SUR) in the statistical software Stata. SUR is a system-estimation method that deals with the cost function and its share equations. Also known as Zellner's method, SUR estimates the parameters of the system, taking into account heteroskedasticity and contemporaneous correlation in the errors across equations.

The data set covers 37 universities and 30 colleges across SY 2006–2007 through SY 2010–2011. All dependent and independent variables across the universities and colleges for the aforementioned school years formed the pooled time-series data. Translog cost functions were estimated separately for colleges and universities, bringing the total number of observations down to 100 and 144, respectively, due to observations that were dropped because of incomplete information.

5. Presentation and analysis of data

5.1. Data set and variables

The variables considered were input prices, outputs, fixed input, dummy variables, and total cost related to SUCs. Input prices included weighted wage of the teaching staff per SUC, and value of educational materials, which is the MOOE divided by the total number of enrollees. Output variables included board takers, board passers, graduates in the undergraduate level, and graduates in the master's and doctoral levels. Fixed inputs refer to the number of classrooms. Since data on this were unavailable, this variable was indirectly estimated by dividing the total number of classes taught by all the faculty members (for a certain SUC) into the average number of classes held on a regular school day.(It was assumed that a regular school day has an average of eight classes each lasting 1.5 hours and that class-hour slots are fully utilized.) Total cost is the current operating expenditures of state universities and colleges for SY 2006–2007 to SY 2010–2011; all of the values are in current market prices. It includes personal services (PS), MOOE, and capital outlays (CO). The descriptive statistics are given in the table below.

TABLE 2. Descriptive statistics for SUCs, SY 2006–2007 to SY 2010–2011

VARIABLES	DESCRIPTION	MEAN	STANDARD DEVIATION	MIN.	MAX.
Total cost	Total cost of operating expenses of state universities and colleges for SY 2006–2007 to SY 2010–2011	2.04e+08	7.13e+08	1.31e+07	7.06e+09
Fixed input	Average number of classrooms for each SUC (based on teaching load)	72	45.48	6	307
Wage of part-time and full-time faculty	Average monthly wage of part-time and full-time faculty members	20,149.89	4,977.13	0	42,514.86

VARIABLES	DESCRIPTION	MEAN	STANDARD DEVIATION	MIN.	MAX.
Value of educational supplies and materials	Part of MOOE that is devoted to higher, advanced and research services divided by student population for SY 2006–2007 to SY 2010–2011	3,216.81	4,216.98	406.39	35,058.02
Board takers	Total number of students who took the board exam in various fields in SY 2006–2007 to SY 2010–2011	886	785.05	52	4,660
Board passers	Total number of students who passed the board exam in various fields in SY 2006–2007 to SY 2010–2011	322	376.62	8	2,165
Graduates (Undergraduate level)	Total number of graduates for the undergraduate level for SY 2006–2007 to SY 2010–2011	900	905.58	0	6,382
Graduates (Graduate level)	Total number of graduates for the graduate level for SY 2006–2007 to SY 2010–2011	42	141.60	0	1,345
Visayas	1 if located in Visayas; 0 otherwise	.33	.47	0	1
Mindanao	1 if located in Mindanao; 0 otherwise	.18	.38	0	1
	Number of observations = 244				

From a total of 335 observations across four school years, the total number of observations was reduced to 244, since SUCs with incomplete data were dropped. In terms of location, most SUCs are located in Luzon followed by the Visayas, with 32.8 percent, and Mindanao with only 17.9 percent. For the fixed input, which is represented by the number of classrooms, the average 72 is very low compared to the SUC that has the largest number of classrooms. This implies that SUCs in general have a limited number of classrooms. With regard to the inputs of the SUCs, the wage of teaching staff is ₱20,150 on average. On the other hand, the average value of educational materials is ₱3,217 per student. This is very low especially for courses that are highly technical, such as engineering, computer science, and science. The average number of board takers (resp. passers) is 886 (resp. 322). Lastly, the average number of graduates with a bachelor's degree is 900 and 42 for master's/doctor's degrees.

5.2. Regression results and analysis

Table 3 contains the estimated translog cost function for state universities, while Table 4 does the same for state colleges. In the case of state universities, most variables are significant in explaining changes in total cost. Variables with double and single asterisks represent a 10 percent and 5 percent significance level, respectively. Independent variables that are highly significant are *value of educational supplies*, *board takers*, *board passers*, *graduates at the undergraduate level*, dummy variables for state universities in *Visayas* and *Mindanao*, *number of classrooms*, and several interaction variables.

TABLE 3. Translog cost function for state universities

VARIABLES	COEFFICIENT ESTIMATES	p-value	
Constant	-29.34754	0.617	
Dummy			
Visayas	-.2828794	0.000	***
Mindanao	-.201815	0.016	***
input prices			
ln(wage of faculty)	-2.764765	0.779	
ln(value educational supplies and materials)	11.71794	0.000	***
Outputs			
ln(graduates – undergraduate level)	-10.16749	0.014	***
ln(graduates – graduate level)	.117318	0.944	
ln(board takers)	21.14276	0.000	***
ln(board passers)	-13.08674	0.002	***
fixed input			
ln(number of classrooms)	6.065735	0.080	***
[ln(wage of faculty)]2	.7643776	0.384	
[ln(value of educational supplies and materials)]2	-.5607697	0.000	***
ln(wage of faculty) x ln(value educational supplies and materials)			
[ln(graduates – undergraduate level)]2	.1144448	0.538	
[ln(graduates – graduate level)]2	-.0096324	0.705	
[ln(board takers)]2	-.5868214	0.010	***
[ln(board passers)]2	.0477492	0.728	
ln(graduate – undergraduate level) x ln(graduate – graduate level)	.3524006	0.000	***
[ln(number of classrooms)]2	.4251373	0.010	***
ln(board takers) x ln(board passers)	1.88e-07	0.000	***
ln(wage of faculty) x ln(graduate – undergraduate level)	.8738807	0.025	***
ln(wage of faculty) x ln(graduate – graduate level)	-.277187	0.085	***

VARIABLES	COEFFICIENT ESTIMATES	p-value	
ln(value of educational supplies and mat.) x ln(graduate – graduate level)	.1660128	0.000	***
ln(wage of faculty) x ln(board takers)	-1.585363	0.002	***
ln(wage of faculty) x ln(board passers)	1.278163	0.002	***
ln(value of educational supplies and mat.) x ln(board takers)	-.3701928	0.022	***
ln(value of educational supplies and mat.) x ln(board passers)	.2947288	0.014	***
ln(board takers) x ln(graduate – undergraduate level)	.2978117	0.148	
ln(board takers) x ln(graduate – graduate level)	-.0531277	0.542	
ln(board passers) x ln(graduate – undergraduate level)	-.2607286	0.166	
ln(board passers) x ln(graduate – graduate level)	-.2018712	0.002	***
ln(wage of faculty) x ln(number of classrooms)	-.5405179	0.088	***
ln(value of educational supplies and mat.) x ln(number of classrooms)	-.23359	0.033	***
ln(graduates – undergraduate level) x ln(number of classrooms)	-.1527844	0.279	
ln(graduates – graduate level) x ln(number of classrooms)	.098202	0.146	
number of observations = 144 R^2 = 0.9494			

*** significant at 95 percent

**significant at 90 percent

The independent variable *board takers* has the most significant effect on total cost of the state universities. Total cost increases by 21.1 percent as the number of board takers increases. However, the total cost decreases by 13.1 percent with more board passers. This indicates that though the SUC may have to incur a cost in producing graduates who take the board exam, their cost eventually decreases if the number of board passers increases. These board passers in various fields, especially in the sciences and engineering, contribute to the efficiency and quality of a state university. One indicator is when CHED grants the SUC the status of a Center of Development or Center of Excellence. Another highly significant variable is the value of educational supplies, which positively affects total cost of the SUC. Total cost increases by 11.7 percent as the value of educational supplies increases, since this input depends on the number of students. The total cost is based on the PS, MOOE, and CO. The dummy variable that accounts for location is also highly significant. Total cost decreases by 0.28 percent and 0.20 percent if the state university is located in Visayas and Mindanao, respectively. This could be attributed to the lower cost of living in these provinces compared to Luzon.

This implies that it would be more cost efficient if the state university or college is located in the Visayas and Mindanao.

The robustness of the translog cost function was determined by seeing whether it fulfilled the inequality restrictions. Wald's test[3] was conducted to determine whether the input prices are equal to one, the second-order terms of combination of inputs are equal to zero, and the second-order terms of combination of inputs and outputs are equal to zero also. Since the *p*-values of the Wald's test are greater than .05 (5 percent significance level), the null hypothesis should be accepted, and the null hypothesis states the linear homogeneity conditions exists. This implies that the translog cost function is robust and can be used to infer results. The details of this test are shown in Appendix 1.

Computing for the index of ray scale economies should show whether average total costs would decline, increase, or keep pace with outputs if SUCs were to expand the scale of their operations. Using the formula given in (3) and substituting the relevant values for each variable yields:

$$\varepsilon = \frac{1 - (6.065735 + .4251373 \ln 81)}{-10.16749 + .117318} = 0.6934$$

The computed value of the index is 0.6934, which may be rounded off to 1, suggesting the existence of economies of scale. This implies that average total cost would decrease if state universities were to expand in terms of offering more courses, hiring more teaching and nonteaching staff, and accepting more students.

State universities also display economies of scope. Economies of scope means that an institution would be more cost effective if it offered various programs—in this case, undergraduate and graduate programs. The resultng *p*-value of 0.0196 is significantly less than .05, leading us to reject the null hypothesis that state universities do not experience economies of scope.

The next regression result and analysis focuses on state colleges. The difference between state universities and state colleges lies mainly in the number of programs offered and the number of students. State colleges offer a limited number of programs in the undergraduate and graduate levels. Because of this, the number of students is also small. Below is a summary of the regression results for state colleges.

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[3] Wald's test is used to test for certain conditions such as linear equality restrictions [Danao 2002].

TABLE 4. Translog cost function for state colleges

VARIABLES	COEFFICIENT ESTIMATES	P-value	
Constant	63.70577	0.870	
Dummy			
Visayas	.161721	0.160	**
Mindanao	.0813247	0.544	
input prices			
ln(wage of faculty)	16.16075	0.831	
ln(value educational supplies and materials)	-29.73595	0.039	***
Outputs			
ln(graduates – undergraduate level)	-17.02189	0.265	
ln(graduates – graduate level)	.2490025	0.968	
ln(board takers)			
ln(board passers)	20.51201	0.206	
fixed input			
ln(number of classrooms)	.9356391	0.900	
[ln(wage of faculty)]2	-4.541538	0.552	
[ln(value of educational supplies and materials)]2	.1752775	0.595	
ln(wage of faculty) x ln(value educational supplies and materials)			
[ln(graduates – undergraduate level)]2	.0853217	0.665	
[ln(graduates – graduate level)]2	-.0547939	0.572	
[ln(board takers)]2	-.2238111	0.513	
[ln(board passers)]2	-.3478943	0.337	
ln(graduate – undergraduate level) x ln(graduate – graduate level)			
[ln(number of classrooms)]2	.123328	0.521	
ln(board takers) x ln(board passers)			
ln(wage of faculty) x ln(graduate – undergraduate level)	1.765676	0.252	
ln(wage of faculty) x ln(graduate – graduate level)	-.2943916	0.630	
ln(value of educational supplies and mat.) x ln(graduate – graduate level)	.3251159	0.026	***
ln(wage of faculty) x ln(board takers)	.9600083	0.516	

VARIABLES	COEFFICIENT ESTIMATES	P-value	
ln(wage of faculty) x ln(board passers)	-2.141001	0.177	**
ln(value of educational supplies and mat.) x ln(board takers)	-.1810358	0.586	
ln(value of educational supplies and mat.) x ln(board passers)	-.0000321	1.000	
ln(board takers) x ln(graduate – undergraduate level)	-.4105986	0.106	
ln(board takers) x ln(graduate – graduate level)	.329319	0.039	***
ln(board passers) x ln(graduate – undergraduate level)	.4958742	0.050	***
ln(board passers) x ln(graduate – graduate level)	-.3130996	0.047	***
ln(wage of faculty) x ln(number of classrooms)	.0085091	0.991	
ln(value of educational supplies and mat.) x ln(number of classrooms)	-.0127578	0.960	
ln(graduates – undergraduate level) x ln(number of classrooms)	-.1653031	0.150	**
ln(graduates – graduate level) x ln(number of classrooms)	-.0603913	0.573	
number of observations = 100 R^2 = 0.7517			

*** significant at 95 percent

**significant at 90 percent

A total of 30 state colleges were included in the translog cost function for SY 2005–2006 until SY 2010–2011. The results of the regression using SUR in Stata yielded a relatively high R^2, which implies that 75 percent of the changes in *total cost* is explained by the independent variables.

The only highly significant variable among inputs and outputs is the *value of educational supplies*. However, the sign is counterintuitive, which means that an increase in *value of educational supplies* leads to lower total cost. This could only be true if the state college experiences economies of scale, but results below show that they do not. There could be other variables to explain changes in total cost that were not captured in the data, thus most of the independent variables were not significant.

The robustness of the translog cost function for state colleges was determined if the cost function fulfilled the inequality restrictions. Since the p-values of the Wald's test are greater than .05 (5 percent significance level), the null hypothesis should be accepted; and the null hypothesis states that the linear homogeneity conditions exist. This implies that the translog cost function is robust and could be used to infer results.

To determine if state colleges exhibit economies of scale, the formula used for state universities was deployed. The computed value of ray scale economies is 0.025, which is less than 1, and which means that state colleges do not exhibit economies of scale. It would be costly for state colleges to increase the number of students or offer more degree programs. This can be attributed to the fact that state colleges have a limited number of teaching and nonteaching staff compared to state universities.

In terms of determining whether it would be more economical for state colleges to offer only undergraduate programs, the methodology for economies of scope was utilized. The result yielded a p-value of 0.3308, which is greater than .05, leading us to accept the null hypothesis that state colleges do not experience economies of scope. It would be better for state colleges to concentrate on offering a specific program based on the expertise of its teaching staff.

State universities and colleges in the Philippines are chartered institutions established by law [CHED 2012b]. There is not much difference between universities and colleges except for their size and course offerings. Colleges have limited course offerings, thus resulting in smaller student and faculty populations. The conversion of a college into a university involves an accreditation process. For instance, the Accrediting Agency of Chartered Colleges and Universities of the Philippines (AACCUP) requires a level 3 accreditation status for a college to be converted into a university [Ruiz and Junio-Sabio 2012]. The criteria for accreditation include quality of instruction, program, and facilities.

6. Conclusion and recommendations

The first objective of this research was to determine whether SUCs are cost effective in delivering its programs to students. A panel data of SUCs across SY 2005–2006 until SY 2010–2011 was used to estimate the translog cost function that included total cost as its dependent variable, and inputs, outputs, fixed input, and dummy variables as independent variables. Separate translog cost functions were estimated for state universities and state colleges since these two institutions differ in terms of enrollment size and programs offered.

6.1. State universities

The estimated translog cost function for state universities yielded a relatively high R^2 (0.9494), and most of the variables were found to be significant based on a 90 percent confidence level. This means that changes in the dependent variable are explained 94 percent by the independent variables. Among the parameters, one input price (value of educational supplies) and several outputs (board takers, board passers, and graduates at the undergraduate level) were found to be significant. The fact that the estimated function conforms with the theoretical requirements of a translog cost function makes it robust and increases the confidence in using it as a basis of decision making.

Nonsignificant variables for state universities were wages of faculty and graduates at the graduate level. This implies that these variables are not significant factors in total cost; hence, if state universities were to decide on cutting costs, they could manipulate these variables. Increasing wages and other monetary benefits, for instance, would not necessarily lead to average higher cost but could instead improve the quality of students in terms of performance in board exams. Investing in good teachers, in turn, would result in improvements in the university.

State universities exhibited economies of scale—meaning, average total cost would not increase if they were to decide to expand their operations. They also exhibited economies of scope, which implies that it would be more efficient for universities to offer various programs at the undergraduate and graduate levels, if they also invested in quality faculty through a more attractive compensation package. Universities in the Philippines should offer programs in line with their strengths. For instance, a university with good research and teaching in agriculture, combined with appropriate facilities, should offer more programs in that area.

6.2. State colleges

State colleges have smaller student and faculty populations compared to universities. They also offer fewer programs at the undergraduate and graduate level. The results of the translog cost function for state universities yield a relatively high R^2 (.7517), and most of the variables were found to be significant based on a 90 percent confidence level. This means that changes in the dependent variable, which is total expenditures/costs of a state university, are explained 75 percent by the independent variables. Among the parameters, one input price (value of educational supplies) and dummy variable for Visayas were found to be significant.

It is interesting that the sign of the coefficient of the value of educational materials is negative, implying that as this variable increases, total cost of the college would decrease. If state colleges invested their budget in educational materials such as books, journals, computer equipment, and other educational materials, total cost would decrease in the long run since these are considered capital that creates investment. The other variables were not significant, which could be due to the fact that there could be other variables not captured in the regression.

Unlike state universities, state colleges did not exhibit economies of scale or scope. State colleges have limitations in terms of expanding their enrollment size because of limited resources. For instance, adding more classrooms to accommodate more students could lead to higher total cost. Moreover, state colleges could offer limited programs and degrees at the undergraduate and graduate levels due to limited human resources. More colleges offer courses in their areas of specialization—for instance, nursing—simply because they are in demand in the labor market.

The second objective of the study was to determine whether school outcomes improved. The regression result for state universities shows that most outputs were significant in explaining total cost. In fact, board passers negatively affect the total cost of a state university. As the number of board passers increases, total cost decreases. This indicates that a state university with a high passing rate would most likely have a Center of Development and/or Center of Excellence status, which is awarded by the CHED to high-performing SUCs.

The study points to the need to further improve the quality of higher education institutions in general. The quality of the programs, faculty and instruction, and facilities needs to be monitored and evaluated. Although there is an accreditation system in place, it is voluntary and the CHED simply encourages and assists interested institutions. There may be a need to require HEIs to go through an accreditation process to ensure their quality and performance in producing skilled and employable graduates and to ensure the cost-efficient use of resources.

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ANNEX 1. Wald test for linear homogeneity (cost function for state universities)

Null hypothesis:	[lntotalcost]lnwage + [lntotalcost]lneducsupplies = 1		
Chi-square	0.60	Probability	0.4388

Null hypothesis:	[lntotalcost]wagex2 + [lntotalcost]educsuppliesx2 + [lntotalcost]output19 = 0		
Chi-square	0.15	Probability	0.6968

Null hypothesis:	[lntotalcost]output9 + [lntotalcost]output10 + [lntotalcost]output11 + [lntotalcost]output12 + [lntotalcost]output13 + [lntotalcost]output14 + [lntotalcost]output15 + [lntotalcost]output16 = 0		
Chi-square	1.68	Probability	0.1947

ANNEX 2: Wald test for linear homogeneity (cost function for state colleges).

Null hypothesis:	[lntotalcost]lnwage + [lntotalcost]lneducsupplies = 1		
Chi-square	0.03	Probability	0.8525

Null hypothesis:	[lntotalcost]wagex2 + [lntotalcost]educsuppliesx2 + [lntotalcost]output19 = 0		
Chi-square	0.03	Probability	0.8547

Null hypothesis:	[lntotalcost]output9 + [lntotalcost]output10 + [lntotalcost]output11 + [lntotalcost]output12 + [lntotalcost]output13 + [lntotalcost]output14 + [lntotalcost]output15 + [lntotalcost]output16 = 0		
Chi-square	0.21	Probability	0.6476