Expert Systems With Applications 48 (2016) 89–99

Contents lists available at ScienceDirect

Expert Systems With Applications

journal homepage: www.elsevier.com/locate/eswa

A three-stage DEA model to evaluate learning-teaching technical efficiency: Key performance indicators and contextual variables

Ramón Fuentes[1], Begoña Fuster[2], Adelaida Lillo-Bañuls*

Faculty of Economics, Department of Applied Economic Analysis, University of Alicante, P.O. Box 99, E-03080, Spain

ARTICLE INFO

Keywords:
Learning-teaching technical efficiency
Key performance indicators
Contextual variables
Data Envelopment Analysis (DEA)
Super efficiency

ABSTRACT

This study evaluates the technical efficiency of the learning-teaching process in higher education using a three-stage procedure that offers advances in comparison to previous studies and improves the quality of the results. First, it utilizes a multiple stage Data Envelopment Analysis (DEA) with contextual variables. Second, the levels of super efficiency are calculated in order to prioritize the efficiency units. And finally, through sensitivity analysis, the contribution of each key performance indicator (KPI) is established with respect to the efficiency levels without omission of variables. The analytical data was collected from a survey completed by 633 tourism students during the 2011/12, 2012/13 and 2013/14 academic course years. The results suggest that level of satisfaction with the course, diversity of materials and satisfaction with the teacher were the most important factors affecting teaching performance. Furthermore, the effect of the contextual variables was found to be significant.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The efficiency of university higher education is crucial to the development and growth of countries. Specifically, the production of human capital and the creation of new knowledge are fundamental factors for national economies that must compete at an international level. Therefore, studies such as this one, determining which aspects of higher education should be improved in order to achieve greater efficiency, are quite useful.

Over recent years, the growing importance of undergraduate and post graduate degree studies in tourism in Spain has justified the analysis of teaching efficiency in tourism studies (considering the fact that between the academic course years of 1988/89 and 2008/09, two and a half times the students pursued tourism degrees during a period in which, overall, diploma and degree studies decreased by approximately 25%, National Institute of Statistics [INE, in Spanish], 2010). This work focuses specifically on the tourism degree of the University of Alicante (Spain) during the 2011/12, 2012/13 and 2013/14 academic course years.

The aim of this work is first, to evaluate the efficiency of the learning-teaching process in higher education, specifically in the tourism degree and second, to select the correct indicators that permit an adequate evaluation of the performance and efficiency of education. The identification and subsequent study of the variables used to monitor the progress and success of the teaching process (Key Performance Indicators, KPIs) is a fundamental issue. According to the expert systems perspective, the methodology used in this study facilitates and improves the identification and quantification of potential improvements in terms of reduction of resources and/or improvement in academic results.

Since the work of Charnes, Cooper, and Rhodes (1978), Data Envelopment Analysis (DEA) has been widely used to analyze efficiency in diverse areas, specifically, in higher education. It is ideal for analyzing activities in sectors that require multiple resources in their production process in order to generate different types of products. Thus, DEA has become one of the most frequently used methods for determining which variables contribute to improving higher education performance (Agasisti & Dal Bianco, 2009; Johnes, 2006a; Joumady & Risk, 2005). DEA has enabled the assessment of the relative efficiency of the units in higher education institutions and has permitted the determination of which inputs and outputs contribute to the achievement of optimum performance.

The methodology selected for this study was implemented in three stages. First, the DEA method developed by Fried and Lovell (1996) and subsequently modified by Muñiz (2002) was applied. This method considers the contextual variables that affect the teaching process; second, super efficiency was analyzed, leading to the prioritization of the efficient units; and, finally, a sensitivity analysis was conducted to determine the contribution of each variable in terms of the efficiency level without the need to omit any variables.

* Corresponding author. Tel.: +34 965 90 34 00; fax: +349965909322.
E-mail addresses: rfuentes@ua.es (R. Fuentes), bfuster@ua.es (B. Fuster), alillo@ua.es (A. Lillo-Bañuls).
[1] Tel./fax: +34 965 90 97 11.
[2] Tel.: +34 965 90 34 00x2712.

http://dx.doi.org/10.1016/j.eswa.2015.11.022
0957-4174/© 2015 Elsevier Ltd. All rights reserved.

A significant theoretical contribution of this study is that it improves the manner in which the key variables were selected in previous studies on teaching efficiency using DEA, such as those by Montoneri, Lee, Lin, and Huang (2011, 2012), since it takes advantage of the information provided by contextual variables, super efficiency and the influence of variables (KPIs) on technical efficiency.

This study has been organized as follows: Section 2 presents a literature review in order to support the selection of the analysis model and variables. Section 3 presents the methodological model to be justified and described. The data from the study is presented in Section 4 and the results of the same are presented and discussed in Section 5. Finally, Section 6 offers our conclusions and suggests the main ideas that may be implemented in order to improve the learning-teaching efficiency analysis.

2. Literature review on efficiency in higher education

Assessing the efficiency of higher education institutions is not a simple task given that these are complex organizations having multiple inputs and outputs (Abd Aziz, Janor, & Mahadi, 2013; Johnes, 2006b). Although efficiency in higher education has also been analyzed using parametric and OLS (Ordinary Least Square) regression methods (Johnes & Taylor, 1990; Zoghbi, Rocha, & Mattos, 2013), ever since Johnes and Johnes (1993) the most widely used methodology have been frontier methods such as Data Envelopment Analysis (DEA).

The principal empirical works existing on efficiency in higher education using non-parametric methods, specifically, the DEA method, have been analyzed below. These studies use higher education institutions, universities, faculties, university departments or programs, among others, as units of evaluation. These works analyze efficiency in the field, both in terms of teaching alone (aside from other activities) and teaching and research jointly (Table 1). Although several works in the literature have analyzed efficiency solely from a research perspective (normally measured with the production and output of published articles and research projects) these are not the subject of this study (Agasisti, Dal Bianco, Landoni, Sala, & Salerno, 2011; Athanassopoulos & Shale, 1997; Castrodeza & Peña, 2002; Johnes & Johnes, 1993; Johnes & Yu, 2008; Ng & Li, 2000).

Studies analyzing the efficiency of higher education, in terms of teaching, have considered this subject from a variety of perspectives. Some studies simply analyze the relative effectiveness of higher education institutions in a specific country (Glass, Mccallion, Mckillop, Rasaratmen, & Stringer, 2006 and Johnes, 2006b in UK; Agasisti & Dal Bianco, 2006, 2009 in Italy; Abbot & Doucouliagos, 2003 and Avrikan, 2001 in Australia; and García Aracil, López Iñiesta & Palomares, 2009 in Spain). Other studies have made comparisons on an international level, considering higher education systems in different countries (Agasisti & Johnes, 2009; St. Aubyn, Pina, García, & Pais, 2009; Joumady & Ris, 2005). Furthermore, a number of works analyze the efficiency of higher education at the departmental, faculty or university program levels. These studies have been classified into two categories: those evaluating the relative efficiency of the various units assessed at the same university, such as Kao and Hungb (2008) and Abd Aziz et al. (2013) and those analyzing the efficiency of departments or faculties of the same discipline at different universities in the same country, such as Besley (1995), Chang, Chung, and Hsu (2012), Colbert, Levary, and Shaner (2000), Flégl and Vltavská (2013) and Avilés, Güemes, Cook, and Cantú (2015).

Clearly, these studies consider the efficiency of higher education from a broad perspective, yet only Chang et al. (2012) has considered efficiency in higher education in the tourism department. Our study, however, has a more specific purpose, as it attempts to analyze the teaching-learning process, an area that has only been considered by a few researchers. Specifically, Montoneri et al. (2011), Montoneri, Lee, Lin, & Huang, 2012 use the DEA method to examine teaching efficiency in written English at the University of Taiwan. Methodologically speaking, our study offers a number of advances, as described in Section 3.

In order to evaluate teaching performance in higher education, indicators (inputs and outputs) must be selected with care. Therefore, Chalmers (2008) offers an overview of the context in which teaching performance indicators have been used in higher education, providing information on the level of compliance with quality objectives in the teaching learning process and permitting comparisons to be made.

In the aforementioned works, it is clear that when assessing the efficiency of higher education institutions and providing guidance on educational policy, the most widely used variables for teaching outputs have been the number of undergraduate and postgraduate degrees awarded (Abbot & Doucouliagos, 2003; Johnes, 2006b), the number of equivalent full time students (Abbot & Doucouliagos, 2003; Avrikan, 2001; Besley, 1995), the number of graduates (Abd Aziz et al., 2013; Agasisti & Dal Bianco, 2006, 2009; Agasisti & Johnes, 2009; Besley, 1995; St. Aubyn et al., 2009; Flégl & Vltavská, 2013); García Aracil et al. 2009, the percentage of students that gain employment (Avilés et al., 2015) and students´ learning performance (Montoneri et al., 2011, 2012).

As for inputs, the most frequently used teaching variables found in the literature were personnel, students and facilities and equipment. Regarding personnel, although most works distinguish between academic and nonacademic personnel (Abbot & Doucouliagos, 2003; Abd Aziz et al., 2013; Avrikan, 2001; García Aracil, López Iñesta, & Palomares, 2009; Glass et al., 2006), some studies only consider academic staff, measured by the number of equivalent full time personnel (Agasisti & Dal Bianco, 2006, 2009; St. Aubyn et al., 2009; Flégl & Vltavská, 2013); Johnes, 2006b, although personnel may also be measured in terms of salary costs, as in Besley (1995) and Flégl and Vltavská (2013). Montoneri et al. (2011), looked at teaching skills**.** Another commonly used teaching input is the number of full time students (Agasisti & Dal Bianco, 2006, 2009; Agasisti & Johnes, 2009; St. Aubyn et al., 2009; Johnes, 2006b). In the case of students, their entrance characteristics are also taken into account with respect to the qualifications obtained (Avilés et al., 2015; Johnes, 2006a; Joumady & Ris, 2005). Colbert et al. (2000) look at the teacher/student ratio. Another commonly used indicator is that of facilities and equipment, normally in terms of cost (Agasisti & Dal Bianco, 2009; Besley, 1995; Glass et al., 2006; Johnes, 2006b). Montoneri et al. (2012) examined the diversity of multiple teaching channels accessed and the diversity of teaching materials used.

A review of all of these works was necessary in order to determine the statistical model and variables to be used in our analysis, applied to higher education. A recapitulation of the aforementioned studies, methodology and indicators, is shown in Table 1.

3. Method

Based on the reviewed studies, this section presents the methodology used in our analysis, the inputs and outputs used and an outline of our reasons for selecting them.

The literature revealed that Data Envelopment Analysis (DEA) was the most frequently used method for analyzing efficiency in the context of higher education, although other methods such as the Stochastic Frontier Analysis (SFA) have also been used. DEA offers a number of advantages that make it ideal for analyzing efficiency in higher education in general, and in teaching, specifically. First, it is ideal for the analysis of activities in sectors that require multiple resources in their production process in order to generate different types of products. Furthermore, this method does not require any type of information on the variable prices and therefore, it is ideal for situations where it is impossible to calculate these prices, or when computing them correctly would be difficult, as is the case with public

Download English Version:

https://daneshyari.com/en/article/384092

Download Persian Version:

https://daneshyari.com/article/384092

Daneshyari.com