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Benchmarking and target setting with expert preferences: An application to the evaluation of educational performance of Spanish universities

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ABSTRACT

Benchmarking and target setting should identify best practices that are not only technically achievable but also desirable in the light of prior knowledge and expert opinion. It should also be considered the possibility of finding targets by minimizing the gap between actual and efficient performances, so that the units under evaluation can achieve these targets with less effort. We extend here the DEA models that provide closest targets for use when expert preferences are incorporated into the analysis. This approach is illustrated by applying the model proposed to the evaluation of educational performance of public Spanish universities.

1. Introduction

In management, organizations use benchmarking for the evaluation of their processes in comparison to best practices of others within a peer group of firms in an industry or sector. In the best practice benchmarking process the identification of the best firms enables the setting of targets, which allows these organizations to learn from others and develop plans for improving some aspects of their own performance.

Data Envelopment Analysis (DEA) (Charnes, Cooper, & Rhodes, 1978), which is a methodology that evaluates the relative efficiency of decision making units (DMUs) involved in a production process, has been widely used for benchmarking purposes. In DEA, an empirical production possibility set is constructed from the observations by making some technological assumptions. The envelopment of such technology determines an efficient frontier formed by the efficient units, which is used as reference for assessment of the remaining DMUs. As stated in Cook, Tone, and Zhu, (2014), *In the circumstance of benchmarking, the efficient DMUs, as defined by DEA, may not necessarily form a "production frontier", but rather lead to a "best-practice frontier*". Specifically, the points on the best practice frontier are potential benchmarks for the inefficient units, while the targets are actually the coordinates of these benchmarks and represent levels of operation for the inefficient DMUs that would make them perform efficiently. For some recent references on DEA and benchmarking see Adler, Liebert, and Yazhemsky (2013), Andrejić, Bojović, and Kilibarda (2013), Costa (2012), Dai and Kuosmanen (2014), Hung, Lu, and Wang (2010) and Zanella, Camanho, and Dias (2013).

In this paper, we propose a model for performance benchmarking as an extension of the classical DEA models. This new model has two main features: (1) it allows us to find the closest benchmarks for the DMU that is being evaluated. The standard DEA models yield targets that are usually determined by the "furthest" efficient projection to the assessed unit. However, the distance to this efficient projection should be minimized, so that the resulting targets are as similar as possible to the inputs and outputs of the assessed unit. The idea behind this reasoning is that closer targets suggest directions of improvement for the inefficient units that may lead them to the efficiency with less effort. The problem of finding closest targets with DEA has been addressed in Aparicio, Ruiz, and Sirvent (2007), Portela, Borges, and Thanassoulis (2003) and Tone (2010) (see also Estrada, Song, Kim, Namn, & Kang, 2009; Lozano & Villa, 2005) for a couple of related approaches based on sequential steps to setting targets). And (2) the new model allows us to incorporate into the analysis the expert opinions regarding the relative importance of the different inputs and outputs, so the selection of benchmarks and the setting of targets reflect their accepted views. In general, benchmarking and target setting should include value judgments from group management in order to identify what is desirable in addition to what is technically achievable. In order to do so, we add some weight restrictions to the DEA formulation and set targets by using the optimal solutions of the resulting model. Traditionally, weight restrictions are used as a way to incorporate value judgments and avoid unreasonable results, in particular to prevent inappropriate selections of benchmarks (see Cooper, Ruiz, & Sirvent, 2011 for a discussion on choices and uses of

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DEA weights). Alternative approaches to incorporate preference information in efficiency analyses and target setting with DEA include the use of hypothetical DMUs (Golany, 1995), the DEA-benchmarking models in Cook, Seiford, and Zhu (2004), the specification of preference weights in weighted non-radial models in Zhu (1996) or the combination of DEA and interactive MOLP techniques (Yang, Wong, Xu, & Stewart, 2009). The proposed approach therefore makes a contribution both to the area of benchmarking in DEA, because the incorporation of expert preferences had not been investigated in the context of the models that yield closest targets, and to that of the DEA models with weight restrictions, because the setting of targets with the existing models does not ensure minimization of the gap between actual and efficient performances.

This paper was initially motivated by a real-world application to the evaluation of educational performance of Spanish universities. The incorporation of the Spanish universities into the European Space for Higher Education (ESHE) after the Bologna Declaration has been a very important challenge for these institutions. The convergence with the ESHE has entailed changes not only in the structures of the university system, with a new framework of degrees at undergraduate and postgraduate levels, but also in the processes of teaching and learning, with new (or renewed) methodologies which promote the role of the students. In fact, the existing regulatory framework in Spain emphasizes the importance of undergraduate education as a key issue in the performance of the universities, in line with the higher education policies and practices in Europe. This regulation also raises the need to design mechanisms for the evaluation of the universities' teaching performance, independently from their performance in other areas, such as those of research or knowledge transfer. To be specific, the Royal Order (RD) 1393/2007 (amended in the RD 861/2010), which regulates the organization of official university studies, together with the verification program (VERIFICA) of the National Agency for Quality Assessment and Accreditation (ANECA), require the new degrees to have a quality assurance system available for their verification (in a first step) and their subsequent accreditation (6 years after their establishment). These quality assurance systems must include procedures for the evaluation and improvement of the quality of teaching and of the academic staff.

The present paper evaluates educational performance in Spanish higher education institutions (HEIs) by means of an efficiency analysis of the public universities. From the perspective of university managers and policy makers, it is important not only the achievement of results but also the availability of resources of the universities to that end. For this reason, we evaluate here the efficiency of the universities as the result of an assessment of their educational performance in a process in which several inputs are used to produce several outputs. From a methodological point of view, DEA is the most commonly used methodology in efficiency analyses, due precisely to the multi-factor nature of educational production. See, for example, Abbott and Doucouliagos (2003), Flegg and Allen (2007), Johnes (2006), and Johnes (2008). Nevertheless, it should be noted that stochastic frontier analysis (SFA) has also been used (see Izadi, Johnes, Oskrochi, & Crouchley, 2002; Johnes & Johnes, 2009; Kuo & Ho, 2008), and even DEA and SFA in conjunction with each other (Bayraktar, Tatoglu, & Zaim, 2013).

The analysis of efficiency undertaken here focuses specifically on benchmarking and target setting, and is carried out with the new DEA model we propose. The practice of benchmarking is growing among universities, which see comparisons with their peers as an opportunity to analyze their own strengths and weaknesses and to establish directions for improving their performance. DEA is a suitable methodology for benchmarking, which has been used in particular for the evaluation of performance of HEIs. As Cook and Zhu (2007) state, the appropriate setting to which the DEA models apply is one wherein the DMUs are assumed to be comparable, yet with each having its own unique circumstances. Specifically, each DMU is permitted to choose, probably within bounds (as is the case in the present paper where expert preferences are incorporated into the analysis), its own set of multipliers for its output/input bundle. Thus, through a choice of DEA weights which are DMU-specific the circumstances under which the different DMUs operate can be taken into consideration in the analysis. In terms of the setting of targets, this means that DEA makes a selection of DMU-specific benchmarks in a piece-wise linear frontier. This is one of the key features in the evaluation of relative efficiency with DEA models. As a result, in the efficiency analysis of Spanish HEIs, DEA allows each of the universities to identify specific best practices (in line with the views of experts), which they may learn from. Therefore, managerial implications of the DEA analysis may offer suggestions for the universities to consider in order to orient their policies toward the achievement of educational performance improvements, specifically setting university-specific targets.

Universities are institutions with different missions, which can be generally categorized into teaching, research and service. Many of the existing studies on the efficiency of universities analyze the overall performance in producing research and teaching (see, for example, Thanassoulis, Kortelainen, Johnes, & Johnes, 2011; Worthington & Lee, 2008). Our study, which deals specifically with educational performance, is more akin to the analyses made in Avkiran (2001), Archibald and Feldman (2008), Agasisti and Dal Bianco (2009) and Breu and Raab (1994). As stated in Avkiran (2001), designing different efficiency models generates insight into the performance of universities on various dimensions, thus guiding managerial action. The model used here, which is similar to the one concerned with the delivery of educational services in that paper, is focused on analyzing how successfully the universities manage their resources in delivering educational services that contribute to the graduation, retention and progress of students. In the current context of the HEIs in Spain, which started with the reforms motivated by the convergence with the ESHE mentioned above, different studies have evaluated universities' performance providing disaggregated information for teaching, research, innovation and technological development. See, for example, the one carried out by the BBVA[1] Foundation and the IVIE[2] and that of the Foundation FCyD.[3] The present study can complement those reports with a different view of the educational performance of HEIs in Spain.

The paper is organized as follows: Section 2 includes the theoretical developments that lead to the model for performance benchmarking that allows to incorporating expert preferences. In Section 3 we carry out an application to the assessment of educational performance of Spanish universities. The last section concludes.

2. Theory

In this section we develop a model for performance benchmarking that seeks to find closest efficient targets while taking into account the expert opinion, which is incorporated into the analysis by adding weight restrictions to the DEA formulation. Methodologically, we follow an approach which is in the same vein of the models used in Aparicio et al. (2007) to find closest targets. The resulting model is used in the next section for an application to the assessment of educational performance of the public Spanish universities.

Consider that we have n DMUs which use m inputs to produce s outputs. These are denoted by (X_j, Y_j), $j = 1, \ldots, n$. It is assumed that $X_j = (x_{1j}, \ldots, x_{mj})' \geq 0, X_j \neq 0$, $j = 1, \ldots, n$, and $Y_j = (y_{1j}, \ldots, y_{sj})' \geq 0$, $Y_j \neq 0$, $j = 1, \ldots, n$. The relative efficiency of each DMU_0 in the sample is assessed with reference to the boundary of the so-called production possibility set (PPS) $T = \{(X, Y)/X \text{ can produce } Y\}$, which is

[1] Bilbao Vizcaya Argentaria Bank.
[2] It could be translated as Valencian Institute for Research in Economics.
[3] It could be translated as Foundation for the Knowledge and Development.