

New data envelopment analysis models for assessing sustainability Part 1: A dynamic data envelopment analysis approach

1 | INTRODUCTION

Sustainability implies business resilience over time through robust economic, social and environmental systems. Sustainable business practices lead to the creation of economic value, healthy ecosystems and strong communities. Sustainable business practices are fostered through engagement with stakeholders, effective environmental management systems and good governance, all underpinned by effective measurement and evaluation (Shabanpour, Yousefi, & Farzipoor Saen, 2017).

Data envelopment analysis (DEA) is a technique which helps decision makers to assess the efficiency of decision making units (DMUs) (Ahmady, Azadi, Sadeghi, & Farzipoor Saen, 2013; Charnes, Cooper, & Rhodes, 1978). Recently, new DEA models have been developed to assess sustainability issues. However, DEA research into sustainability is sparse and there is a need for greater focus on this important topic. In this special issue, ground-breaking research into new DEA models to assess sustainability of DMUs is presented. Such research will assist decision makers to manage organizations with a focus on sustainability.

The special issue also provides an opportunity for practitioners to develop and increase understanding of DEA models in sustainability evaluation. For maximum utility, authors should not only develop new DEA models but also show efficacy of real-world applications. The responses to the call for new DEA models and applications are presented in the following six accepted articles published in Part 1 of this special edition. In the next section, we summarize the main contributions of these articles.

2 | CONTENTS OF THE SPECIAL ISSUE

The first article entitled "Analysis of the environmental efficiency in China based on the DEA cross efficiency approach under different policy objectives" by Chen, Wu, Wang, and Li (2019) proposes a cross-efficiency approach with undesirable outputs to evaluate environmental efficiency. The model incorporates three new evaluation strategies: economic development strategy, environmental protection strategy and a win-win strategy, all of which are designed to reflect the needs of decision makers under different policy objectives. Combining the meta-frontier DEA approach and DEA window analysis leads to a new cross-efficiency analytical framework. The framework is applied to analyse the environmental efficiency of China's economic development during 2006–2015.

In the second article entitled "Sustainability assessment of Iranian petrochemical companies in stock exchange: A data envelopment analysis-based approach" Fallah and Hosseinzadeh Lotfi (2019) evaluate petrochemical companies to calculate the relative efficiency of a set of decision making units with network structures. The authors analyse seven petro-chemical companies listed on the Iranian stock exchange in terms of financial performance and sustainable development during 2015–2016. The outputs showed that only one company was efficient in all areas while four of the companies were efficient in financial terms. A ranking of the best performing three companies is provided.

The third article entitled "How does environmental regulation affect environmental performance? A case study of China's regional energy efficiency" is by Wu, Yang, and Zhou (2019) who discuss the impact of environmental regulation on environmental performance, both directly, and indirectly through environmental innovation. The authors develop a productivity index to measure the environmental performance of 30 Chinese provinces during the period 2010–2015. The index is constructed using the Malmquist-Luenberger productivity index together with DEA. Application of the model shows that environment regulation and environmental innovation have positive direct effects on environmental performance. Market-based environmental regulation is also shown to have a positive indirect effect on environmental performance by increasing environmental innovation.

The fourth article "Sustainability of Chinese airlines: A modified slack-based measure model for CO₂ emissions" by Hadi-Vencheh, Wanke, Jamshidi, and Chen (2019) identifies sustainability as an essential factor in the long-term success of airlines, particularly in respect of CO₂ emissions. A modified slacks-based measure model is proposed to evaluate emissions. The model uses the efficiency assessment of 13 major Chinese airlines for the period 2008–2015 to account for CO₂ emissions. Contextual variables such as length of operation, fleet, network span,

governance, ownership type and previous ownership are tested. Findings suggest that Chinese airlines' operations depend on a range of factors including learning curve, economies of scale, technology type and network management. The policy implications for Chinese airlines are presented.

The fifth article "Sustainability assessment in the presence of undesirable factors over time: A case on gas companies" proposes a DEA-based model to assess the sustainability of business systems. In this article Amirteimoori, Amirteimoori, and Amirteimoori (2019) present a DEA-based approach to assess the sustainability of systems when undesirable outputs are present in the process. Sustainability is assessed in each period and overall. The study considers socio-economic, socio-environmental and eco-environmental factors in addition to economic, social and environmental aspects. The model is illustrated through its application to Iranian gas companies.

The sixth article "Dynamic efficiency evaluation of state-level business incubators in China by using a slacks-based measure approach" by Sun, Cheng, Lu, and Hu (2019) evaluates the efficiency of business incubators with a focus on business improvement. Using a dynamic slacks-based measure model the efficiency of China's state level business incubators during 2010–2012 is evaluated. The results identify that neglecting new entrants and the typical carry-over variable, based on the number of incubating enterprises, may underestimate the incubation system's efficiency. The operational efficiency of business incubators in China is relatively low due mainly to lower pure technical efficiency. Policy suggestions are presented.

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