Chapter 20

Data Envelopment Analysis Development in Banking Sector

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ABSTRACT

Data Envelopment Analysis is a non-linear programming model introduced by Charnes, Cooper and Rhodes in 1978. It is used widely in literature to measure the relative performance of units in several various fields including the banking. The fascinating real life cases and problems needed to be solved, the nature of data and the types of indicators in the banking field makes it one the most popular fields for DEA researchers theoretically and empirically. DEA and its applications have been the subject of several reviews. However, in this paper the authors specifically review the classic and new DEA models and the applications of them in the banking field.

INTRODUCTION

Banks play an important role in the financial system and the economy. As a key component of the financial system, banks allocate funds from savers to borrowers. In recent decades, many new products and financial instruments have been created, as well as new financial institutions. Although banks create no wealth but their essential activities facilitate the process of production, exchange, and distribution of wealth. In this way, they become the effective partners in the process of economic development and growth. Thus, measuring the performance of banks has been always an important subject for policymakers, regulators, investors and customers.

Performance measurement is an essential tool for performance improvement. However, performance measurement can be observed from two different angles. Firstly, the accounting-based perspective, which is widely used in the literature, measures the performance of a bank by using comprehensive information from financial statements, financial indexes like return on assets (ROA), return on Equity (ROE), return on investment (ROI) and return on sales. Secondly, the economic-based perspective which concentrates...
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on the efficiency. The efficiency could be measured by nonparametric techniques such as well-known Data Envelopment Analysis (DEA) that estimates efficiency as the distance away from some ideal frontier measured relative to the lowest cost or highest profit bank in the sample or parametric techniques including stochastic frontier approach (SFA) and distribution free approach (DFA) which impose cost, production, or profit functions (Olson & Zoubi 2011).

DEA is a linear-programming-based method for assessing the performance of homogeneous decision-making units (DMUs). The traditional form of DEA is first introduced by Charnes, Cooper and Rhodes in 1978, who proposed a novel method that combines and transforms multiple inputs and outputs into a single efficiency index. After three decades still, DEA and its developments are being used to real world applications in several fields (banking, education, health care, transportation). DEA has successfully been applied in banking field both at branch-level, and country-level.

Efforts have been made over the last three decades to review the applications of DEA in the banking industry. For instance, Berger and Humphrey (1997) review 130 studied on the application of frontier efficiency to financial institutions in 21 countries, Thanassoulis (1999) discussed the application of DEA in the banking industry. Emrouznejad and Yang (2017) show that banking was the second application fields of DEA methodology in 2015 and 2016. At branch-level Paradi and Zhu (2013) reviewed DEA applications in 80 studies. Liu et al. (2013) surveyed different applications of DEA and stated that banking field is the first major application of DEA. Most recently, Kaffash and Marra (2016) reviewed 620 DEA papers in financial service.

BACKGROUND

Efficiency measurement originates from the definition of efficiency of DMU by Koopmans (1951) and Debreu (1951). They stated that DMU is efficient when producing one more unit of any output results in using more of some inputs or producing less of some outputs. For measuring the radial distance of DMU from the frontier, Debreu (1951) introduced output-expanding direction distance function while Shepherd (1956) introduced input-conserving direction distance function. Farrell (1957) presented efficiency measure as the product of allocated efficiency and technical efficiency. Using his idea, frontier approaches have been developed in two groups; parametric and non-parametric approaches. Based on these two approaches numerous models with different applications to a variety of industries were developed. Depending on the availability of data and the reason for efficiency measurement, scholars choose different models for their research. Table 1 illustrates the methods developed according to these two approaches.

Table 1. Production frontier approaches

<table>
<thead>
<tr>
<th>Parametric Frontier</th>
<th>Non-Parametric Frontier</th>
</tr>
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<tbody>
<tr>
<td>Deterministic</td>
<td>Stochastic</td>
</tr>
<tr>
<td>OLS, COLS, MOLS</td>
<td>SFA, TFA, DFA</td>
</tr>
<tr>
<td></td>
<td>Stochastic Frontier</td>
</tr>
</tbody>
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Emrouznejad and Witte, 2010.