Full Length Article

Efficiency in the Brazilian banking system using data envelopment analysis☆

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ABSTRACT

The objective of this paper is to evaluate bank efficiency in the period from 2012 to 2016 by applying Data Envelopment Analysis (DEA) in a dataset of 37 Brazilian banks provided by the Brazilian Central Bank. We have explored three gaps in research conducted with Brazilian banks by using the intermediation approach to select variables, by analysing the main causes of bank inefficiency and by identifying how inefficient banks in scale can improve their efficiency. Brazilian banks presented an average efficiency of 51.4% for the Charnes, Cooper and Rhodes (CCR) model and 69.8% for the Banker, Charnes and Cooper (BCC) model. The largest banks have performed well in regards to Pure Technical Efficiency (PTE), but failure to operate at the optimal scale level has impaired Technical efficiency (TE), jeopardizing the position of these banks in the efficiency ranking. These banks, in the majority, presented decreasing returns to scale, while the smaller banks had increasing returns to scale. Inefficiency of Brazilian banks is slightly more related to technical and administrative issues than to the scale of operations, although the banks have many opportunities for improvement in this second aspect, especially the larger banks. Ribeirão Preto Bank was the most efficient bank in the group, followed by Cooperativa Sicredi Bank and Alfa Bank. All three banks can be considered small banks. The results indicate that the largest banks are not necessarily the most efficient ones. The efficiency of the sector could be increased if policies were adopted to increase the participation of the smallest banks in the sector, which is currently highly concentrated in the largest ten banks. Government could encourage a dilution in market share of larger banks either through fiscal stimuli among small banks or by fostering mergers and acquisitions.

1. Introduction

Banks are key elements in a country's economy. According to Tsolas and Charles (2015, p. 3491), the banking sector plays a central role in the development of the economy; therefore, problems in this segment are the focus of various studies. Svitalkova (2014, p. 664) states that it is important for countries to have a consolidated and advanced banking system, since the better its financial environment, the more competitive a nation will be.

Considering the relevance of financial institutions, many studies have sought to evaluate the performance of banks in different countries (Schure et al., 2004; Řepková, 2014; Lin et al., 2009; Liu, 2010; Wanke et al., 2016a; Sokic, 2015; Barros & Wanke, 2014; Kamarudin et al., 2017). Among the methods to evaluate the performance of banks, efficiency frontier techniques stand out. Berger and Humphrey (1997, p. 11), for example, examined 130 studies that investigated 21 different countries to measure bank efficiency through parametric and non-parametric methods, which evidences the importance of studies on efficiency in this sector.

Svitalkova (2014, p. 645) points out that non-parametric techniques are more adequate than parametric models to rank the efficiency of banking institutions. In this context, according to Wanke et al. (2016a), Data Envelopment Analysis (DEA) is the main non-parametric technique currently used for efficiency assessment. This empirical mechanism, developed by Charnes et al. (1978), is based on a mathematical technique of measuring the efficiency of a homogeneous group of decision-making units (*DMUs*) that use the same inputs and outputs. By transforming a programming problem with infinite solutions into a linear programming approach, DEA identifies the most efficient *DMUs* and indicates what inefficient units must do to become efficient. In other words, DEA allows best practices to be identified from an efficiency frontier (Charnes et al., 1994, pp. 7–8).

The first study to apply DEA to financial institutions was Sherman and Gold (1985), which aimed to evaluate 14 branches of a bank. These authors verified that traditional techniques for measuring performance such as profitability and transaction costs were not so appropriate because they did not take into account the complexity of the operations of each branch and did not consider the multiple outputs generated by multiple inputs. After this research, the banking sector became one of the main areas of interest for the application of DEA, as depicted in studies by Assaf et al. (2011); Kwon and Lee (2015); Holod and Lewis (2011); Gulati and Kumar (2017); Sufian (2015); Pasiouras (2008).

Among studies on efficiency, Luo (2003) highlights that an important issue in the literature related to financial institutions is the evaluation of which type of return to scale (RTS) banks' experience. Banks can present increasing return to scale (IRS), constant return to scale (CRS) or decreasing return to scale (DRS). To verify what type of RTS a bank has, it is necessary to decompose the overall efficiency indexes. We use both Charnes, Cooper and Rhodes (CCR) and Banker, Cooper and Rhodes (BCC) model, since the first model will measure Technical Efficiency (TE), also called global efficiency, while the second model identifies Pure Technical Efficiency (PTE) related only to administrative and managerial capabilities. Scale Efficiency (SE), which is linked to the operating scale level, is then calculated by the ratio of TE to PTE. By using both the CCR and the BCC models, we achieve a better understanding of the causes of inefficiencies of the banks under analysis. Is the bank inefficient because of its administrative and managerial skills or because of its operating scale level? The application of the two models allows to answer such question, as discussed by Řepková (2014) and Yilmaz and Güneş (2015).

In spite of the high popularity of DEA in studies that aim to measure bank efficiency either by only measuring efficiency indices or by bringing a more in-depth discussion of TE, PTE, SE and RTS types of efficiency, Wanke and Barros (2014) argue that the vast majority of studies focus on the United States and the European Union. Among the research carried out in Brazil, we can cite Périco et al. (2008); Ceretta and Niederauer (2001); Souza and Macedo (2009) and Wanke and Barros (2014).

Périco et al. (2008) sought to verify whether the largest banks were the most efficient by applying the BCC model. Ceretta and Niederauer (2001) evaluated the profitability and efficiency of 144 financial conglomerates using a two-stage model. Souza and Macedo (2009) applied DEA to measure the performance of the 100 largest banks in activity in Brazil, from 2001 to 2005, using a composite boundary model. Wanke and Barros (2014) also measured the efficiency of Brazilian banks using a two-stage DEA model.

As Wanke and Barros (2014) have pointed out, the amount of research in the context of the Brazilian banking sector is very limited. To the best of our knowledge, none of the studies with Brazilian banks have decomposed efficiency, measuring PTE, SE, and TE, which in turn would allow a deeper understanding of the efficiency of the sector, and also have not identified what kind of return to scale banks would be presenting. These two aspects are of great relevance because, when addressed, it would be possible to suggest managers' procedures that should be taken to make the bank more efficient, i.e., indicating the cause of inefficiency (administrative issues or operating scale level). Additionally, by identifying the bank's return to scale, it would be possible to deepen the discussion about potential scale inefficiencies of the banks. By verifying whether the bank presents increasing, constant or decreasing returns, scale inefficiency can be reversed by adequately changing the scale of operations.

Finally, analysing the research in the Brazilian context, as discussed in depth in Section 2, only two studies (Staub et al., 2010; Wanke and Barros, 2014) followed the intermediation approach in the selection of the variables. This procedure, proposed by Sealey and Lindley (1977), has received great attention by researchers and is currently the predominant approach in bank efficiency studies (Fethi and Pasiouras, 2010, p. 191)[1]. This perspective is based on the bank's primary function of collecting funds and converting them into loans and other profitable assets, using physical capital and labour. In this approach, the bank is seen as a financial intermediary between agents with surplus and agents with deficit of financial resources. Although the intermediation approach is widely used in the literature, few studies have applied that approach to select variables in Latin America, as evidenced in Table 1.

This research, therefore, addresses three gaps in the literature on bank efficiency not only in the Brazilian context but also in Latin America and also provides policy implications for Brazilian banks by following the intermediation approach for the selection of variables, by measuring TE, SE and PTE and, finally, by verifying the RTS of the banks.

In this context, the aim of this study is to verify which Brazilian banks were most efficient in their role as financial intermediary institutions. By analysing from 2012 to 2016, we study whether the largest banks in terms of total assets were the most efficient and what the main causes of inefficiency of the banks were. We use the database entitled "The Fifty Largest Banks", made available by the

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[1] Fethi and Pasiouras (2010) reviewed 196 studies that applied operations research techniques in the banking sector. In their review, 151 studies used the DEA, most of them following the intermediation approach.