



## Two-stage evaluation of bank branch efficiency using data envelopment analysis

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### ABSTRACT

There are two key motivations for this paper: (1) the need to respond to the often observed rejections of efficiency studies' results by management as they claim that a single-perspective evaluation cannot fully reflect the operating units' multi-function nature; and (2) a detailed bank branch performance assessment that is acceptable to both line managers and senior executives is still needed. In this context, a two-stage Data Envelopment Analysis approach is developed for simultaneously benchmarking the performance of operating units along different dimensions (for line managers) and a modified Slacks-Based Measure model is applied for the first time to aggregate the obtained efficiency scores from stage one and generate a composite performance index for each unit. This approach is illustrated by using the data from a major Canadian bank with 816 branches operating across the nation. Three important branch performance dimensions are evaluated: Production, Profitability, and Intermediation. This approach improves the reality of the performance assessment method and enables branch managers to clearly identify the strengths and weaknesses in their operations. Branch scale efficiency and the impacts of geographic location and market size on branch performance are also investigated. This multi-dimensional performance evaluation approach may improve management acceptance of the practical applications of DEA in real businesses.

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### 1. Introduction

Banking is one of the most complex industries in the world—and a major contributor to a country's wealth (in the UK 25% of the GDP is produced by its financial services sector). Today's banks offer a wide range of products and services ranging from simple checking accounts to retirement plans, mutual funds, home mortgages, consumer loans, and many others. The conduit through which banks handle these transactions is the branch network that serves as the main contact with and existing as well as potential clients. Notwithstanding the rapid rise in the use of the Internet in banking and numerous other available transaction channels, it is through a branch that customers do a large percentage of their more value added banking activities, including mortgages, loans, investment accounts, securities brokerage, to name just a few. A recent Canadian study found that 61% of bank customers still visited their bank branches in person and on average made four trips per month [1]. However, branches are one of the largest operational expenses for a bank. With

increasing foreign and alternative channel entrants in the Canadian banking industry, there is a significant need for improving branch performance in order to remain competitive.

Bank branch performance measurement is a very difficult task. Branches come in a variety of sizes, offering different services to different customers while operating in different economic regions. Such performance evaluation, both within a country and globally, remains an important area for research and is a subject of continual investigations. There are numerous techniques used to measure bank branch operational efficiency, such as ratios [2], indices [3,4], and regression analyses [5–7]. While effective in many circumstances (used to measure just about every aspect or to compare similar branches), traditional techniques have a number of inherent limitations making them unsuitable for fully reflecting the increasingly complex nature of branch banking. For example, traditional financial ratio analysis does not allow for objectively combining independent evaluations into a single performance score and it is difficult to use for comparative purposes. A branch might have strong results for some ratios but show poorly in others making it difficult to judge whether the branch is, on average or on some other basis, efficient or not. Simply aggregating these results together can give a misleading indicator of performance or worse, hide under-performing business components within the overall

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numbers. Although, some more complex ratios can take the form of index numbers, determining the weights to be used (as they are often not known) and discovering under-performing activities due to aggregated numbers are just two of the difficulties using indices. Another way to measure efficiency is regression analysis (RA), a parametric method that requires a general production model to be specified. Moreover, RA is a central tendency method and is only suitable to model single input-multiple outputs or multiple inputs-single output systems.

In recent years, academic research on the performance of financial institutions has increasingly focused on the efficient production frontier based models which estimate how well a firm performs relative to the best firms if they are doing business under the same operating conditions. The main advantage of such a method over other approaches is that it removes the effects of differences in prices and other exogenous market factors and produces an objectively determined quantitative measure [8]. Berger and Humphrey [9] concluded that the frontier approach could offer an objective numerical efficiency score and a ranking of firms together with the economic optimization mechanism in complex operational environments. Two competing frontier efficiency approaches are: the Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA). The primary differences between these are the assumptions imposed on the specifications of the efficient frontier, the existence of random error, and the distribution of the inefficiencies and random error [9]. SFA is a regression-based approach and basically, assumes a particular functional form (e.g. Cobb–Douglas) for the production or cost function [10]. A review of the SFA applications in the banking industry can be found in Kumbhakar and Lovell (2000) [11]. SFA can deal with the presence of noise in the data and allow statistical inference but with the risks of imposing improper functional forms or distribution assumptions [12–16]. Ruggiero in 2007 [17] showed that the SFA model did not produce better results than DEA. Another drawback of SFA is that until recently it only allowed a single output, or multiple outputs with using a cost function if price data are available [18].

As one of non-parametric frontier approaches, DEA is recognized as an excellent and robust efficiency analysis tool with a broad range of applications. DEA was introduced by Charnes et al., [19] based on the work of Farrell [20]. This watershed paper [19] described a mathematical programming approach assuming constant returns to scale (named after the authors as CCR) for the construction of a practically efficient frontier, which was formed as the piecewise linear combination that connects the set of the best practice observations. A DEA efficient frontier is not determined by some specific functional form, but by the actual data from the evaluated production units referred to as Decision Making Units (DMUs)—a rather fortuitous choice of a name as DEA is about measuring performance that is based on human decisions. Therefore, the DEA efficiency score for a specific DMU is not defined by an absolute standard, but is measured with respect to the empirically constructed efficient frontier defined by the best performing DMUs.

The capability of dealing with multi-input/multi-output settings without requiring explicit specifications of the relationships between the inputs and outputs provides DEA an edge over other analytical tools. Since 1978, DEA has been applied to problems in many areas, both for profit and not-for-profit industries, and numerous theoretical additions have been made. The most notable one is the BCC model proposed by Banker et al., 1984 [21], which permits variable returns to scale (VRS) and measures an operating unit's pure technical efficiency. Other theoretical and applied extensions include the additive model and Slacks-Based Measure model to consider both input- and output-orientations simultaneously; models with weight restrictions; models that

incorporate exogenous factors which are treated as categorical or non-discretionary variables; window analyses and Malmquist indices to examine the efficiency changes over time and many others. Färe and Grosskopf [22] and Tone and Tsutsui [23] proposed the concept of the dynamic DEA model to incorporate carry-over activities between consecutive time periods into the model. For a comprehensive treatment of DEA refer to the textbook by Cooper et al. [24].

Aside from any theoretical developments in the DEA literature, this research is designed to address the serious problem of management's rejection of suggested improvements from DEA studies because they find the process not only difficult to understand, but more importantly, psychologically unacceptable as they see the process as unfair and inequitable because, as they see it, it does not consider their "unique" environment. To make matters worse, many studies actually rank the branches from 1 to whatever the size of the branch network according to a single-aspect measure [25,26]. This paper is aimed to establish a new DEA approach to explore bank branch performance in different dimensions and identify the best-practice branches in all aspects simultaneously.

The remainder of this paper is organized as follows: Section 2 briefly reviews the literature on DEA used in bank efficiency analysis; Section 3 discusses the motivation for applying multi-dimensional DMU performance evaluation; Section 4 focuses on the methodology and data used for this study; Section 5 reports on the main results of the empirical tests; and the main conclusions are revealed in Section 6.

## 2. DEA in bank branch efficiency analysis

DEA has been demonstrated to be effective for benchmarking in many service industries involving complex input–output relationships (Cooper et al. [24]; Zhu [27]). In the last two decades, there have been numerous published applications of DEA to measure the efficiency of banks and branch systems, which have further motivated the development and improvement of DEA techniques (such as, [28–33]). However, due to the much easier availability of corporate data (typically from the regulator), the majority of the studies focusing on bank efficiency measurements are at the institutional level, rather than at the branch level. To the authors' knowledge, since 1997 there are 65 published papers on bank branches using DEA for efficiency measurements compared to 163 papers on bank efficiency analysis. The first published paper on a DEA application in a bank branch setting was by Sherman and Gold [34] examining a small sample of fourteen branches of a US bank. Since then many other DEA studies have been completed around the world, for instance, Vassiloglou and Giokas [35] on bank branches in Greece; Oral and Yolalan [36] in Turkey; Giokas [37] in Greece; Al-Faraj et al. [38] in Saudi Arabia; Tulkens [39] in Belgium; Drake and Howcroft [40,41] in the UK; Lovell and Pastor [42] in Spain; Golany and Storbeck [43] in the US; Kantor and Maital [44] in Israel; Porembski [45] in Germany; Camanho and Dyson [46] and Portela and Thanassoulis [47] in Portugal; Das et al. [48] in India, Avkiran [49] in United Arab Emirates, and there are others.

There are some published papers about DEA applications on Canadian bank branches. Parkan [50] evaluated a small sampling (35 branches) of a large Canadian bank in Calgary for operational efficiency using a CCR model. In particular, he included space quality and marketing activity ranking as inputs, and number of error corrections as outputs. In 1997, Schaffnit et al. [51] examined 291 branches from a major Canadian bank operating in the province of Ontario. They developed a variable returns to scale production efficiency model using five types of personnel as

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