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TECHNICAL EFFICIENCY ANALYSIS OF BURUNDIAN BANKING SYSTEM USING DATA ENVELOPMENT ANALYSIS

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Abstract

The purpose of this study is analyzing technical efficiency (TE) of Burundian banking sector using Data Envelopment Analysis (DEA). It also examines pure technical efficiency (PTE) and scale efficiency (SE). Finally the study identifies the type of returns-to-scale (RTS) within Burundian banking system. Quantitative data related to social capital (SC), retained on earnings (RE), credit (C), and profit (P) for 2019 fiscal year were collected and analyzed using DEA. Constant returns-to-scale (CRS) and variable returns-to-scale (VRS) with input oriented model were performed using R programing environment. SC and RE were used as inputs while C and P were used as outputs. The findings of this study show that Burundian Banking system has more inefficient banks than efficient ones. Additionally, this study shows that under CRS and VRS model, only BANCOBU, CRDB, BCB, and FPHU are technically efficient. However, the same model shows that BGF could have produced the same level of C and P with only 84% of the SC and RE actually used, IBB 58%, BNDE 65%, BBCI 49%, FinBank 61% and Ecobank 22%. These banks are technically inefficient. Their combination of inputs and outputs is not scale-efficient. Moreover, most of inefficiency is due to pure technical inefficiency (wasting input) and scale inefficiency (operating at non-constant returns to scale).For all inefficient banks and financial institution, it was recommended to increase output using the actual level of input. Moreover, management should improve their managerial inefficiency and optimize the output.

Keywords: *Technical efficiency, scale effiency, pure technical efficiency, Data emvelopment analysis.*

INTRODUCTION

To produce goods or services, organizations combine human and capital (financial and equipment) resources. The ways available resources are combined differentiate efficient and non-efficient organizations. In banking sector, the concept of efficiency has got much attention from academics, professionals, and policymakers due to its practical implications. Assessing efficiency can constitute an early warning or benchmark of current performance and it can help defining future improvements in numerous areas such as decision-making, and technology or socio-economic (Othman, Zamil, Rasid, Vakilbashi and Mokhber 2016). These authors considered efficiency as the capability of an organization to produce output with minimal resources or inputs, or with the smallest ratio of outputs over inputs. Therefore, an organization is considered efficient if it is able to produce more output using less resource or input. There are two hypotheses regarding the relationship between bank size and bank efficiency. The first one predicts efficiency when a bank is big. The second hypothesis is that enlarged bank size beyond certain thresholds leads to diseconomies of scale that in turn generate inefficiency (Asongu and Odhiambo 2019).

Baking efficiency got much attention all over the World particularly in Africa. There is existing literature related to analyzing bank efficiency whether in Africa or in East African Community (EAC). For instance, Kablan (2010) evaluated the determinants of banking system efficiency in sub-Saharan Africa (SSA) using stochastic frontier analysis (SFA) and concluded that banks operating in SSA were cost-efficient; nevertheless nonperforming loans destabilize their efficiency. The study conducted by Raphael (2013) evaluated relative efficiency of selected 58 commercial banks operating within the EAC, specifically Tanzania, Kenya, Uganda, Rwanda and Burundi for the period from 2008 to 2011using Data Envelopment analysis (DEA). He concluded that under variable returns to scale (BCC) and constant returns to scale (CCR) model the number of efficient commercial banks which had in their four years with the score 1, were Tanzania (42), Kenya (66), Uganda (61), Rwanda (11) and Burundi (21). Additionally, he concluded that most commercial banks in east Africa were operating under a decreasing return to scale. Which means, increasing of inputs lead to less increase in output. The bank efficiency is indispensable for bank stability as indicated by Dutta and Saha (2021).

Other studies analyzing bank efficiency were conducted using DEA in some African countries like Ethiopia (Alemu 2016). Erasmus and Makina (2014) evaluated efficiency of the major banks operating in South Africa.

Bank efficiency was also analyzed in other countries beyond Africa. For instance, Hafsa, Suvvari and Durai (2021) evaluated the nexus between non-performing assets and Indian bank efficiency. Chowdhury and Haron (2021) used DEA technique and the Malmquist productivity index to evaluate 31 Islamic banks' efficiency in the Southeast Asia Region. Jiang and He (2018) used DEA and Malmquist index to assess efficiency of Chinese listed banks. Palecková (2017) applied the DEA and Malmquist index approaches to calculate the efficiency change of Czech commercial banks.

Prior studies mostly focused on community/regional banks' efficiency without analyzing the level of efficiency in the individual country. Prior studies did not consider country specific factor/environment related to each country. Conclusions drawn based on the panel data may be misleading as there is great difference in banking environment in each country that may affect bank efficiency. The level of technologies is not the same for each country. Business environment in all countries also is different. The report of the World Bank on ease of doing business 2020 ranked Burundi 166 at ease of doing business while its neighbor Rwanda is ranked 38, Kenya 56, Uganda 116, and Tanzania 141(World Bank 2020). Chang, Jang, Li, and Kim (2017) showed that the efficiency of banks is estimated to vary depending on regional economic differences.

When countries are classified based on their per capita gross national income Tanzania, Burundi, Rwanda and Uganda are in the group of low-income economies, while Kenya is in low middle-income economies (United Nations 2020). A population with low-income will not be able to borrow or to save. This situation will affect banks in terms of credit distribution or in terms of resource gathering (banks collect customer resource as deposit or savings and transform it in credit). It will also be difficult to reimburse received credit increasing nonperforming loans which affect bank efficiency.

Additionally, with population low revenue, it will increase the risk of no reimbursement of received credit for borrowers. When credit risk is high, banks tend reducing credit distribution, which may affect their technical efficiency. With regards to this situation, bank efficiency may be affected at all levels. Any study analyzing bank efficiency by combining banks operating under unequal business, regulatory, economic, and technological environments will necessary produce biased results. Finally, level of bank efficiency may be influenced by both internal factors such nature of activities, characteristics and business activities of the bank and external factors like the levels of competition and economic conditions (Ruslan, Pahlevi, Alam, and Nohong 2018).

Since 2008, Burundian banking system has registered banks from EAC (DTB,CRDB,KCB). However little is known on the technical efficiency of Burundian banks. To fill the knowledge gap regarding Burundian bank technical efficiency, this study aims to measure the technical efficiency of Burundian banking sector using DEA technique. In the light of the limitations of the existing literature on bank efficiency analysis in east Africa community, the problematic of this study to be addressed can be stated as follows: "What was the relative technical efficiency of Burundian banking system?" To the best of our knowledge, no study has been conducted to evaluate technical efficiency of Burundian banking system. This paper contributes to the literature by providing a deep investigation of the relative efficiency of Burundian banking sector.

The novelty of this research is bringing understanding of the current technical efficiency of Burundian banking system. From the appraisal of previous literature, this paper is the first investigating Burundian bank system efficiency using DEA. Furthermore, this research contributes to the academic literature in the field of bank efficiency by concentrating on one country avoiding the influence of country specific factors.

The main objective of this study is examining Burundian banking system efficiency. Specifically, the study evaluated technical efficiency, scale efficiency, return –to- scale for each bank analyzed and made super efficiency analysis. This research addressed the following research questions: what was the technical efficiency of Burundian banking system? What was the scale efficiency of Burundian banking system? What was the return-to-scale of Burundian banking system? What was the super efficiency of Burundian banking system? This study offers an empirical contribution to the concept of the bank efficiency analysis. Moreover, the research contributes to the academic literature on the field of technical efficiency analysis using DEA.

This study is organized in six sections. The first section presents the introduction, the purpose of the study, and the research questions. The second section is related to the analysis of the literature review. The third section presents the methods, the fourth section presents the result, the fifth discusses the result, and sixth section concludes the study by indicating practical implication, limitation and recommendation for future research. The following section analyses the literature review.

LITERATURE REVIEW

This section first presents theories related to bank efficiency. It also indicates the types of bank efficiency. Methods generally used in bank efficiency analysis are developed. A summary of studies demonstrating the lack of consensus on the variables included in bank efficiency analysis as input or output is given. Finally, this section presents findings on determinant of bank efficiency.

Regarding bank efficiency theories, Aguenaou, Lahrech, and Bounakaya (2017) identified two main theories explaining differences in bank efficiency: Market power theory and efficient-structure theory. Market power theory believes that banks' performance is determines by market structure. Two hypotheses are underlying this theory. Structure-conduct performance referring to the connection between a firm and the concentration level of the industry in which it is working stating that as the cost of barriers to entry rises, firms can improve or at least maintain their profitability. The relative market power indicates that a firm's financial performance is a function of its market share and its differentiation strategy. The second theory is efficient-structure theory which explains why some banks make more profits. According to this theory, some banks are more efficient than others, and to realize this efficiency; there are two main hypotheses under this theory: the X-efficiency and scale-efficiency. The X-efficiency hypothesis denotes the firms' ability to create more profit through dropping costs thanks to their management practices efficiency, which allows them to gain larger market shares. On the other side, the scale-efficiency hypothesis indicates that some banks are more efficient than others thanks to their capacity to achieve economies of scales which permits them to have lower costs and make higher profits.

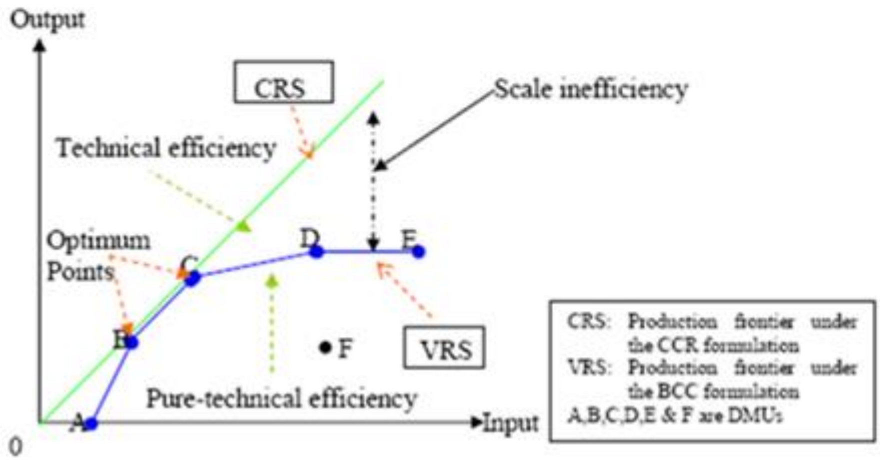
Regarding the types of efficiency, Siudek (2008) identified three types of bank efficiency including organizational, financial, and cost efficiency. Organizational efficiency is related to organizational goals, its resources, internal and external environment and business performance over time. Financial efficiency deals with items which are financial in nature such as bank financial statement analysis using ratios. Cost efficiency which identified how nearby bank's costs lie to the efficient cost frontier for given inputs and their ratio. The author added that researches evaluating bank efficiency have absorbed technical efficiency and scale and scope efficiency. In addition, Othman, Zamil, Rasid, Vakilbashi and Mokhber (2016) classified efficiency in four types including technical efficiency, scale efficiency, price efficiency, and allocative efficiency. Accordingly, technical efficiency or global efficiency estimates the ability of banks to produce actual outputs with fewer inputs, or less resources. Scale efficiency is the optimal activity volume level whereby inefficiency may occur if goods or services are produced above or below optimal level that resulted in added fixed cost. Price efficiency refers to increasing efficiency by purchasing required inputs (human capital and material) at lower price without losing the quality. Allocative efficiency estimates the optimal combination of several inputs in order to produce products or services, such as banks incorporate automatic teller machines (ATM) and internet banking for capital labour tradeoffs to increase efficiency. Tan (2016 indicated that theories of technical efficiency, cost efficiency, revenue efficiency and profit efficiency have been developed to assess bank efficiency. The technical efficiency theory refers to technical efficiency as the ability of decision making units (DMUs), such as insurance firms, banks, firms, universities, faculties, hospitals, and other kinds of production units to obtain the maximum amount of output using a given volume of inputs (output oriented models), or indicates the minimum needed input to produce a given volume of the output (input oriented models) (Horvatova 2018). Cost efficiency theory assesses the ability of DMU to produce current outputs at minimal cost (Belas, Kocisova and Gavurova 2019). Profit efficiency theory evaluates the distance between the current profit of a firm and the efficient profit frontier. Profit efficiency denotes a firm's ability to manage its resources and produces outputs with greater economic value (Arbelo, Arbelo-Pérez, Pérez-Gómez 2021). Additionally, Profit efficiency indicates the proportion of the maximum profit that a DMU gets, and it includes both cost efficiency and revenue efficiency.

Concerning the underlying concepts of DEA, Gitto (2008) identified two main concepts that are used in DEA. The first one is productivity which refers to the ratio of inputs to its outputs. Regarding efficiency, the concept requires to a comparison of the firm to optimal value. According to Gitto, inefficiency can be due to differences in production technology, differences in the scale of operation, difference in operating efficiency and differences in the operating environment in which production occurs.

Regarding the use of DEA, Chang, Jang, Li, and Kim (2017) indicated that DEA was established for the relative efficiency calculation of DMUs with multiple inputs and outputs. According to these authors, linear programming is used in DEA to define an "efficient frontier" indicating of a collection of DMUs that show the best performance in terms of efficiency. Then, the efficiency scores of the other DMUs considered less efficient are determined by the distance to the DMUs on the frontier. Regarding model used in DEA, the authors indicated two main models. Those models are constant returns-to-scale (CRS) model and variable returns-to-scale (VRS) model. The first one is also named as CCR model after the name of three authors Charnes, Cooper, and Rhodes who developed this model. The assumption under CCR model is that the ratio of output to input is constant over any interval. In other words, the proportion of the variation in input is the same as in output. For instance, when inputs increase by two times, the output will increase by two times. Under the VRS model the ratio of output to input varies with size, and is also called as BCC after the first letters of three authors of Banker, Charnes, and Cooper who developed it (Saraçli, Kiliç, Do˘gan, and Gazelo˘glu1 2013). Explicitly, when inputs increase by two times, the variation of outputs will be greater or less than two times. DEA computes the relative efficiency of each DMU in relation to all the other DMUs by means of the actual experimental values for the inputs and outputs of each DMU. It similarly identifies, for inefficient DMUs, the causes and level of inefficiency for each of the inputs and outputs (Řepková 2015). Jelena, Jelena, and Nataļja (2014) explained that CRS can be applied only for the companies which operate at an optimal scale. However, they indicated that imperfect competition, government regulations, may cause the deviation from an optimal scale in many industries.

Banks technical efficiency can be estimated by using either stochastic frontier analysis (SFA), or data envelopment analysis. SFA allows the specification of a composed error that can be decomposed in two parts: a one-sided error that measures the non-negative inefficiency effects and a classical random error. However, the DEA does not allow for the presence of a random error term to calculate the error. Consequently, any deviation from the efficiency frontier is related to inefficiency (Niţoi and Spulbar 2015). SFA needs a specific functional form that assumes the shape of the cost efficiency frontier and assumes a specific probability distribution for the efficiency level. Furthermore, if the assumptions are incorrectly specified, the projected cost efficiency will have errors. Nevertheless, DEA avoids this type of specification error since it does not require a priori assumptions about the analytical form of the cost function or an assumed probability distribution for efficiency. Though, DEA has one major disadvantage of not allowing for random errors in the optimization problem and all deviations from the cost efficiency frontier are considered as inefficiency (Belas, Kocisova and Gavurova 2019).

Fundamentally data envelopment application can be classified into input and output-oriented. On the one hand, input-oriented model reduce the inputs for a desired level of output to be achieved. On the other hand, output-oriented model maximize the outputs while keeping input at constant level. Input-oriented model carefully focuses on operational and managerial issues while output -oriented model is more related with planning and strategy (Rajasekar and Deo 2014). These authors indicated super efficiency model is a ranking method developed by Anderson and Peterson in the year 1993. Super efficiency model finds both the efficient and inefficient observations. The efficient DMUs may obtain higher value whereas for inefficient DMUs the measure of efficiency score does not change. While comparing the efficiency result based on input-oriented approach and output-oriented approach, these authors found no efficiency difference among the results. In other words, input-oriented model or output oriented model have no difference in efficiency identification of DMUs when used on the same DEA model (CRS or VRS). However, in the interpretation of the result, there is a great difference. When analyzing DEA using input oriented, the difference between the best performing DMU (efficient at 100%) and the least performing efficiency DMU (for instance efficient at 60%) indicates the excess resources that are being misused (100%-60%= 40%) at the actual level out of the nonperforming DMU. It means that the least performing DMU should reduce the resource used by (40%) to be on the efficiency frontier. On the other hand, when using output oriented, 40% represents the level of output the least efficiency DMU has to increase to be on the efficiency frontier. Input-oriented tends at reducing the input amounts by as much as possible at a given level of output, and the output-oriented method maximizes output levels at a given input level (Singh and Fida 2015). Horvatova(2018) indicted that DEA provides indication on what should be done with inputs such as the amount of decreasing inputs. While output oriented models provides indication on what should be done with the output like the amount of increasing output by given inputs.



Source : Coelli, Rao, O'Donnell and Battese (1998); Seelanatha (2007)
Figure 1:Technical efficiency, pure technical efficiency, and scale efficiency.

There is still no consensus among researchers about what to include as input or output in bank efficiency measurement (Rahim 2017). The choice of orientation (input/output) is based on the variables which are under control by decision makers (Huguenin 2013). The choice can also depend on the purpose of the organization costs minimization (input orientation), production maximization (output orientation). As indicated by Horvatova (2018) under CRS assumption the input-oriented and output-oriented approaches always provide the same values, nonetheless values are different when VRS is assumed. Novickytė and Droždz (2018) indicated that input-oriented model is the most regularly used in determining banking efficiency because the bank managers have a higher control over inputs (labor, expenses, and etc.) rather than outputs (loans, income, and etc.)

To evaluate bank efficiency, it is crucial to identify which bank indicators to use as inputs and outputs. The choice make may impact the result of the analysis. Radojicic, Savic and Jeremic (2018) indicated that there is no agreement between researchers on which indicators should be used. These authors gave an example of most controversies regarding whether deposit can be used as input or out in DEA analysis. As indicated by these authors, the choice depends on the approach the research considers in the analysis. The users of intermediation approach consider deposits as input and the users of production approach take deposit as output. On one hand, the production approach considers banks as production units which use labor and capital to create loans and deposit account services. Therefore, banks try to minimize the use of resources in providing products and services. On the other hand, the intermediation approach considers banks as a mediator between savers and investors. Banks help to translate deposits into loans. As result, bank's main purpose is to raise funds (deposits) to sell (loans) in order to maximize profit.

Table 1: Types of input and output used in previous studies

Paper	Inputs	Outputs
(Ferrier & Hirschberg, 1997)	number of employees, capital, consumer deposit accounts, commercial deposit accounts, industrial deposit accounts	loans (consumer, commercial and industrial), deposits at other financial institutions, investments, number of branches
(Kuosmanen & Post, 2001)	equity capital, debt capital, operational costs	total earning assets
(Isik & Hassan, 2002)	labor, capital, funds	short-term loans, long-term loans, risk-adjusted off-balance sheet items, other earning assets
(Fukuyama &Weber, 2002)	labor, capital, funds	loans, other investments
(Mukherjee, Nath, & Nath Pal, 2002)	net worth, borrowings, operating expenses, number of employees, number of branches	deposit, net profit, advances, noninterest income, interest spread
(Kao & Liu, 2004)	total deposits, interest expenses, non-interest expenses	total loans, interest income, noninterest income
(Casu, Girardone, & Molyneux, 2004)	the average cost of labor, deposits, capital	total loans, securities, the nominal value of banks' off-balance sheet items
(Paul & Kourouche, 2008)	interest expense, non-interest expense	net interest income, noninterest income
(Tortosa-Ausina, Grifell-Tatjé, Armero, & Conesa, 2008)	labor, capital, purchased funds	loans, core deposits, noninterest income and income from securities
(Sahoo & Tone, 2009)	fixed assets, borrowed funds, labor	investments, performing loan assets, non-interest income
(Avkiran, 2009)	interest expense, non-interest expense	interest income, non-interest income
(Thoraneenitiyan & Avkiran, 2009)	deposits, labor capital, physical capita	amount of loans, investments and other earning assets, fee income, off-balance sheet items
(Staub et al., 2010)	labor, capital, other assets	deposit, loans, investment
(Savic et al., 2012)	number of employees, fixed assets and intangible investments, capital deposits	granted loans and deposits, noninterest income
(Jayaraman, Srinivasan, & Jeremic, 2013)	equity, borrowed funds, number of employees, number of branches	deployed funds, non-interest income
(Puri & Yadav, 2013)	labor, fixed assets, total expenses	interest income, other income
(Moradi-Motlagh & Saleh, 2014)	interest expense, non-interest expense	interest income, non-interest income
(Hou et al., 2014)	deposits, fixed assets, number of employees	the total net loan, other earning asset
(Řepková, 2014)	labor, deposits	loans, net interest income
(Kao & Liu, 2014)	labor, physical capital, purchased funds	demand deposits, short-term loans, medium-and-longterm loans

Table 1: Types of input and output used in previous studies

Paper	Inputs	Outputs
(Johnes, Izzeldin, & Pappas, 2014)	deposits and short-term funding, fixed assets, general and administrative expenses, equity	total loans, other earning assets
(D. Tandon, K. Tandon, & Malhotra, 2014)	deposits, assets	interest income, non-interest income
(C. R. Chiu, Y. H. Chiu, Fang, & Pang, 2014)	number of employees, assets, equity	operating profit, non-performing loans
(Marković et al., 2015)	assets, equity, number of employees	earnings before tax, total revenue
(Avkiran, 2015)	interest expenses on customer deposit, other interest expenses, personnel expenses, other operating expenses	interest income on loans, other interest income, bet fees and commissions, other operating income
(Kao & Liu, 2016)	labor, physical capital, purchased funds	demand deposits, short-term loans, medium-and-longterm loans
(Fukuyama & Matousek, 2017)	number of employees, capital	loans, securities
(Tanna, Luo, & De Vita, 2017)	fixed assets, deposit and short-term funding, personnel expenses	loans, other earning assets, non-interest income
(Simper, Hall, Liu, Zelenyuk, & Zhou, 2017)	general admin and other expenses, fee and trading expenditure, loan loss provisions, equity	loans, net interest revenue, other operating revenue
(Fukuyama & Webber, 2017)	labor, physical capital, equity capital	performing loans, securities investments
(Kevork et al., 2017)	total assets, the total number of employees, total deposits	net loans, securities investments
(Silva et al., 2017)	total interest expenses, total non-interest expenses	deposits, loans, liquid assets

Source: Reproduced from Radojicic, Savic and Jeremic (2018, pp. 5-7)

Kablan (2010) evaluated the determinants of banking system efficiency in sub-Saharan Africa (SSA) using stochastic frontier analysis (SFA). To identify the outputs and inputs to include in the analysis, he followed the intermediation approach and the value-added principle. According to intermediation approach, banks are supposed simultaneously to deliver liquid deposits without risk and to make loans, which are risky assets and less liquid. While the value-added principle specifies that the elements that contribute to produce added-value are viewed as outputs. Therefore, he used deposits, loans and securities as outputs, and labor, physical capital, and financial capital as inputs. Raphael (2013) calculated the relative efficiency of 58 commercial banks located in the East African Community, including Tanzania, Kenya, Uganda, Rwanda and Burundi. He considered deposit, interest expenses, operating expenses as inputs and loan, investment, interest income and noninterest income as outputs.The Table 2 presents Burundian banks and financial institutions.

Tableau 2: Burundian banking system April 2021

Commercial Bank		Date of registering	Social capital in Burundian Francs
1.	BANCOBU	13/06/1960	33 196 996 000
2.	BCB	25/07/1964	15 500 000 000
3.	BBCI	01/09/1988	17 645 000 000
4.	BGF	08/02/1996	13 563 400 000
5.	FINBANK	18/04/2002	10 813 005 000
6.	IBB	24/09/1992	20 484 800 000
7.	ECOBANK	03/09/2002	10 500 187 632
8.	DTB	26/12/2008	11 000 000 000
9.	KCB	18/04/2012	15 692 000 000

10.	CRDB	16/08/2012	19 625 000 000
11.	BCAB	21/04/2020	10 000 000 000
12.	BIJE	17/03/2020	10 000 000 000
Financial Institutions		Date of registering	Social capital in (BIF)
1.	FPHU	11/12/1989	6 325 052 442
2.	BNDE	04/04/1967	6 190 100 000

Source : Burundi Central Bank (https://brb.bi/en/content/financial-institutions)

FPHU became a commercial bank since April 29, 2021 under the name "Banque de l'Habitat Urbain (BHB)". As it can be seen Burundi has 13 commercial banks and one financial institution. As the study is dealing with 2019 financial year, the sample seize becomes ten commercial bank and two financial institutions that were operating at the end of 2019. BCAB and BIJE were registered during 2020.

The determinants of bank efficiency were analyzed in previous studies. Alrafadi (2020) examined efficiency determinant in 17 Libyan banks using data covering 2004 to 2010. His results indicated positive correlation between bank efficiency, and return on investment, risk and size of operation. Tesfay(2016) investigated determinants of Ethiopian commercial banks efficiency using a sample of eight banks. The results of data envelopment analysis showed that deposit and liquidity had significant positive relationship with Ethiopian commercial banks efficiency. Tossa (2016) analyzed the technical efficiency of 21 banks operating between 2009 and 2013 in Ghana. He concluded that there were more technically inefficient banks in the country than there were technically efficient ones. Variables that are negatively related to bank efficiency were gross domestic product per capita, inflation, credit risk, size and operating cost. While market concentration had a positive influence on bank efficiency in Ghana. Řepková (2015) studied determinants of efficiency in the Czech banking sector using data for 2001-2012 periods. He concluded that the level of capitalization, liquidity risk and riskiness of portfolio had a positive impact on banking efficiency. However, ROA, interest rate and gross domestic product had a negative impact on efficiency in constant returns-to-scale model. In Variable returns-to-scale model, the liquidity risk and riskiness of portfolio had a positive impact on efficiency and gross domestic product had a negative impact on efficiency. Adusei (2016) evaluated determinant of technical efficiency of rural and community banks in Ghana. He concluded that only 20 rural and community banks were found technically efficient. Factors like bank size, profitability, and bank funding quality were significant determinants of technical efficiency in the rural banking industry in Ghana. Moreover, he found that increasing in the size and funding quality of a rural bank resulted in a decreasing technical efficiency, increasing in the profitability of a rural bank improved its technical efficiency. Lema (2017) studied the determinants of the technical efficiency of commercial banks in Ethiopia over the period from 2011 to 2014. The result from Tobit model indicated that level of capitalization, liquidity risk, return on asset and market share had positive and significant effect on the bank technical efficiency score.

METHODS/EXPERIMENTAL

To estimate Burundian banking system efficiency, data related to financial year 2019 were collected for the study sample. The sample of commercial bank is made by BANCOBU, BCB, BBCI, BGF, FINBANK, IBB, ECOBANK and CRDB. We didn't get data for DTB and KCB.The sample represents 80% of commercial bank that were operating at the end of 2019. Regarding financial institution, the study included both FPHU and BNDE. Data were retried on bank web site and in published financial statement in "le Renouveau du Burundi".

The methods used in this study follow the procedure proposed by Bielik and Rajčániová (2004). This paper used Data Envelopment Analysis (DEA) to evaluate Burundian banking system. The distance to this efficiency frontier indicates technical inefficiency. To find technical efficiency (TE) under the constant returns to scale (CRS), the model suggested by Charnes, Cooper and Rhodes in 1978 was used working under the assumption of constant returns to scale (CRS). The model developed by Banker, Charnes and Cooper during 1984 also was used assuming variable return- to- scale (VRS). Under CRS, the total technical efficiency can be further decomposed into pure technical efficiency (PTE) and scale efficiency (SE). PTE refers to the ability of the management to save the input for making a certain amount of output or to produce more output with a given level of input (Taib, Ashraf and Razimi 2018). To evaluate PTE, the production technology is assumed to display variable returns to scale. Therefore, PTE is technical efficiency of BCC model measuring inefficiencies due to only managerial underperformance (Hassen, Marwa, Hanen, and Amira 2017). SE is then the residual between the total and pure technical efficiency. Calculation of SE itself assumes the calculation of TE measures under both CRS and VRS. If any difference between the scores of technical efficiency under CRS and VRS for a given DMU, the difference specifies that a DMU is scale-inefficient. The TE under CRS assumption signifies overall technical efficiency which evaluates inefficiencies due to the input/output configuration and as well as the size of operations (Hassen, Marwa, Hanen and Amira 2017).Scale efficiency measure can be estimated by dividing the total technical efficiency by pure technical efficiency:

SE = (TE CRS)/(TE VRS) (1)
If SE = 1, then a farm is scale-efficient, its combination of inputs and outputs is efficient both under CRS and VRS
If SE < 1, then the combination of inputs and outputs is not scale-efficient.
Banks can be evaluated whether they are operating under increasing returns to scale (IRS) or decreasing returns to scale (DRS) by using the DEA model under the non-increasing returns to scale (NIRS).

SE NIRS = (TE CRS)/(TE NIRS) (2)
If the result equals to one, the bank works under increasing returns to scale (IRS). If the result is less than one, the bank works under decreasing returns to scale.
Input-oriented model carefully focuses on operational and managerial issues while output -oriented model is more related with planning and strategy (Rajasekar and Deo 2014). These authors indicated super efficiency model is a ranking method developed by Anderson and Peterson in the year 1993. Super efficiency model finds both the efficient and inefficient observations. The efficient DMUs may obtain higher value whereas for inefficient DMUs the measure of efficiency score does not change.
The DEA analysis developed by Charnes et al. (Saraçli, Kiliç, Do˘gan, and Gazelo˘glu1 2013) is based on mathematical programming model that incorporates several inputs and outputs. This model adopts n decision-making units (DMUs), with m inputs and p outputs, where the efficiency evaluation model of jth DMU can be defined as the equation 3. Its constraints are given in the equation 4. Variables included in this study as input are social capital and retained on earnings. Variables used as output are credits and profit. The choice of these variables is based on prior studies as indicated in Table 1. The figure one shows the mathematical equation of efficiency function. The choice of orientation (input/output) is based on the variables which are under control by decision makers (Huguenin 2013). In this study, social capital and retained on earning are under control of banks' managers, that why they were used as input.

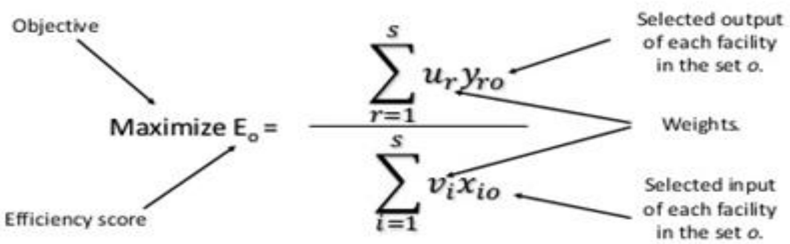


Figure 2: General equation for DEA programming
The previous model can be written as follows:
Max efficiency $=\frac{u1y1o+u2y2o+\cdots+usyso}{v1x1o+v2x2o+\cdots+vmxso}$ (3), subject to : $\frac{u1y1j+.....+usysj}{v1x1j+\cdots+vmxmj} \leq 1(j=1,\ldots n)(4)$
$v_1, v_2, \ldots, v_m \geq 0$,
$u_1, u_2, \ldots u_s \geq 0$, u and v are weights for output and inputs.
Y refers to output and x refers to input.

Using our data, we can write the following mathematical equation. To calculate the efficiency of BANCOBU, we define the objective function as:

MaxEfficiency= $(261800864\, u_1 + 48852202 u_2)/(33196996\, v_1 + 19711597 v_2)$ (5)

Subject to constraints: efficiency of other banks are under or equal to on (≤ 1) (6)
Efficiency of CRDB = $(73834642\, u_1 + 5095440\, u_2)/(19625000\, v_1 + 225410 V_2) \leq 1$ (7)
Efficiency of BGF = $(85695144\, u_1 + 8463174\, u_2)/(13563400\, v_1 + 4899359\, v_2) \leq 1$ (8)
Efficiency of IBB =$(107374340\, u_1 + 15225396\, u_2)/(20484800\, v_1 + 19087627\, v_2) \leq 1$ (9)
Efficiency of BNDE = $(38257567\, u_1 + 2928296\, u_2)/(10453146\, v_1 + 1674936\, v_2) \leq 1$ (10)
Efficiency of BCB = $(174938001 u_1 + 17017001 u_2)/(15500000\, v_1 + 30671001\, v_2) \leq 1$ (11)
Efficiency of FPHU = $(146543841 u_1 + 4527612 u_2)/(14104201\, v_1 + 5614853\, v_2) \leq 1$ (12)
Efficiency of BBCI = $(39097758 u_1 + 3055472 u_2)/(17645000\, v_1 + 1380399\, v_2) \leq 1$ (13)
Efficiency of FinBank = $(52579493 u_1 + 3318855 u_2)/(10813005\, v_1 + 3389139\, v_2) \leq 1$ (14)
Efficiency of DTB = $(20005771 u_1 + 2435992 u_2)/(11000000\, v_1 + 9144709\, v_2) \leq 1$ (15)
Where u_1 and u_2 are weights of outputs, and v1 and v2 are weights of inputs. Moreover v and u ≥ 0.

On numerator, the first number is social capital, the second number is the retained on earning. On denominator, the first number is total credit for each bank, the second number is net profit for 2019 financial ended year for each bank.
Input orientation was used running DEA model under both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) assumptions, technical efficiency and pure technical efficiency scores were obtained which was used to compute scale efficiency by dividing technical efficiency by pure technical efficiency as indicated in equation 1. The table 3 presents descriptive statistics of variables used in this study, the values are in millions of Burundian Francs. To compute the analyses, R programing environment 4.0.2 was used. To calculated technical efficiency, deaR package developed by Coll-Serrano, Bolos, Suarez (2021) was used. Moreover, benchmarking package developed by Bogetoft and Otto (2020) also was used.

RESULTS AND DISCUSSION

This section presents the results of our analysis. Descriptive statistics of the collected data are in Table 3. Mean, median, standard deviation, minimum, maximum value, skewness, and kurtosis are presented. As can be seen in Table 3 there is a great difference between the mean and median value for all variables. The skewness also is greater than zero. We can conclude that the data under investigation are not normally distributed. There is a great different in social capital (SC) Retained on earnings (RE), credit (C) and Profit (P) in Burundian Banking system. The lack of data normality justifies the use of non-parametric approach DEA as this does not make any assumption on error distribution (Belas, Kocisova and Gavurova 2019). Stochastic Frontier model with distributional assumes that efficiency effects can be separated from stochastic elements in the model and for this aim a distributional assumption has to be made. Stochastic Frontier analysis uses a composed error model in which inefficiencies are assumed to follow an asymmetric distribution, usually the half-normal, while random errors are assumed to follow a symmetric distribution, usually the standard normal (Baten and Hossain 2014).

Tableau 3: Descriptive statistics

	Social capital	Retained on Earnings	Credits	Profit
Mean	16588.574	9686.486	100425.565	11017.416
Median	14802.101	5257.106	79764.893	4811.526
Standard deviation	6879.390	10172.666	74854.631	14313.810
Skewness	1.696	1.150	1.215	2.446
Kurtosis	3.498	0.370	1.099	6.440
Minimum	10453.146	225.410	24134.005	1690.713
Maximum	33196.996	30671.001	261800.864	48852.202

The technical efficiency of the Burundian banking sector was estimated using DEA technique. It was further divided into pure technical and scale efficiency. The results are presented in Table 4. TE_{CRS} refers to technical efficiency (total efficiency) under constant returns-to-scale (CRS model). TE_{VRS} refers to technical efficiency under variable returns-to-scale (VRS model). SE refers to scale efficiency. SE refers to scale efficiency. TE_{NIRS} refers to technical efficiency under non-increasing returns-to-scale. The column (I) shows technical relative efficiency. Column (II) presents pure technical efficiency. Column (III) presents scale efficiency. Column (IV) presents technical efficiency under non increasing returns to scale. Column (V) indicates the result of the equation two. The result of this column indicates the scale efficiency under non- increasing returns to scale.

Banks can be evaluated whether they are operating under increasing returns to scale (IRS) or decreasing returns to scale (DRS) by using the DEA model under the non-increasing returns to scale (NIRS). The column (VI) indicates the types of returns-to-scale (RTS) under which banks were operating.

Tableau 4: Result of technical efficiency, scale efficiency and returns-to-scale

Banks	TE_{CRS} (I)	TE_{VRS} (II)	SE = TE_{CRS}/ TE_{VRS} (III)	TE_{NIRS} (IV)	TE_{CRS}/ TE_{NIRS} (V)	RTS(VI)
BANCOBU	1	1	1	1	1	IRS
CRDB	1	1	1	1	1	IRS
BGF	0.84	1	0.84	0.84	1	IRS
IBB	0.58	0.77	0.75	0.58	1	IRS
BNDE	0.66	1	0.66	0.66	1	IRS
BCB	1	1	1	1	1	IRS
FPHU	1	1	1	1	1	IRS
BBCI	0.49	0.8	0.62	0.49	1	IRS

FinBank	0.61	1	0.61	0.61	1	IRS
Ecobank	0.22	0.995	0.22	0.22	1	IRS

Source: Author's computation

The Table 5 presents the results of super efficiency analysis. The analysis allows identifying the most efficient banks. The results of the Table 4 do not indicate how efficiency is varying among banks analyzed as all performing banks are on efficiency frontier with score one. In this analysis efficient DMUs obtain higher value whereas for inefficient DMUs the measure of efficiency score does not change. This analysis allows raking and comparing efficient banks. The column (I) presents the super efficiency analysis under CRS model. The column (III) presents the results of super efficiency analysis under VRS.

Table 5: Super efficiency analysis

Banks	Super efficiency (CRS) (I)	Super efficiency (VRS) (II)
BANCOBU	1.40418	2.33295
CRDB	10.84672	6.30896
BGF	1	1.00537
IBB	1	1
BNDE	1	1.24559
BCB	1.12943	1.12437
FPHU	1.22547	1.23147
BBCI	1	1
FinBank	1	1.00599
Ecobank	1	1

Source: Author's computation

The technical efficiency of the Burundian Banking system was assessed using DEA technique. Technical efficiency was additional decomposed into pure technical and scale efficiency. The Table 4 presents the results of our analysis related to technical efficiency, scale efficiency and return –to- scale for each bank analyzed. The Table 5 presents the results of the super efficiency analysis of Burundian banking sector. Technical efficiency scores and super efficiency were evaluated on constant returns-to- scale and variable returns-to-scale. The average technical efficiency scores of Burundian banking system were ranged from 0.22 to 1. It is worthwhile to note that the technical efficiency scores of three commercial banks and one financial institution is one.

The Table 4 shows that there is a great possibility for the inefficient commercial bank and financial institution to increase their credit and profit if they decide to operate at the same effective level of the most efficient banks and financial institution in the sample of the study. The most efficient commercial banks and financial institution are: BANCOBU,CRDB,BCB and FPHU. These banks are efficient under both models (CRT and VRT). The least technical efficient bank is Ecobank with 0.22 score. BGF,IBB,BNDE,BBCI,Finbank,Ecobank were found to be technically inefficient. A deep analysis of the relative technical efficiency allows identifying the source of inefficiency. The Table 6 identifies the source of inefficiency for technically inefficient commercial banks and financial institution.

Tableau 6: Source of technical inefficiency

Banks	Global technical efficiency	Pure Technical efficiency (PTE)	Scale efficiency (SE)	Source of inefficiency
BGF	0.84	1	0.84	SE
IBB	0.58	0.77	0.75	PTE &SE
BNDE	0.66	1	0.66	SE
BBCI	0.49	0.8	0.62	PTE &SE
FinBank	0.61	1	0.61	SE
Ecobank	0.22	0.995	0.22	PTE &SE

Source: Author's computation

As it can be seen on Table 6, the source of inefficiency is not common for all these banks. The source of inefficiency for BGF,BNDE, and FinBank is scale inefficiency. Managers of these scale inefficient banks should improve their management practices by increasing credit and profit using the actual level of social capital and retained on earnings.

The source of inefficiency for IBB, BBCI and Ecobank is both pure technical inefficiency and scale inefficiency. For these pure technical and scale inefficient banks, their managers were not able to use efficiently social capital and retained on earnings available to increase credit and make enough profit during 2019 year. These managers also should find optimal size for their banks to be able of producing at the most productive scale.

It can be noticed that BGF is 16% scale inefficient, IBB 25% scale inefficient, BNDE 34% scale inefficient, BBCI 38% scale inefficient, Finbank 39 % scale inefficient, Ecobank 78% scale inefficient. The pure technical inefficiency is a result of inefficient management practices since credit and profit can be increased by 16%, 42%, 34%, 51%, 39% and 78% respectively. Therefore, these banks can increase their credit and profit efficiency through increasing their input use.

Regarding returns-to-scale of Burundian banking system, the result of the ratio following equation (2) indicates that for both banks is one. This indicates that Burundian banking system is operating under increasing returns to scale. In other words, in increasing reurns-to-scale, the proportional increase of input will cause a greater proportional increase in output.

The super efficiency analysis from Table 5 allows ranking and comparing bank efficiency. Under constant and variable returns –to- scale, CRDB is super-efficient, followed by BANCOBU, FPHU and BCB. Other banks remain with score one under CRS model indicating that they are less efficient. CRDB is a Tanzanian bank which opened its branch in Burundi during 2012.

CONCLUSION

This study investigated Burundian banking system efficiency. Specifically, it evaluated technical efficiency, scale efficiency, return –to- scale for each bank analyzed and made super efficiency analysis. The technical efficiency was conducted under variable returns to scale (BCC model) and constant returns to scale (CCR model). The models were conducted under input orientation to identify efficiency frontier. The findings reveal that the most efficient commercial banks and financial institution are: BANCOBU,CRDB,BCB and FPHU. These banks are efficient under both models (CRT and VRT) and have efficient score one. The least technical efficient bank is Ecobank with 0.22 score. BGF,IBB,BNDE,BBCI,Finbank,Ecobank were found to be technically inefficient. BANCOBU, CRDB, BGF, BNDE, BNDE, FPHU and FinBank are pure technical efficient. IBB,BBCI and Ecobank were pure technical inefficient. BANCOBU,CRDB,BCB,FPHU were scale efficient. BGF, IBB,BNDE,BBCI,Finbank and Ecobank are scale-inefficient. In other words, these banks did not reach their optimal activity volume level. All those banks and financial institutions are operating under increasing return to scale. This finding is inconsistent with the findings by Raphael (2013) who concluded that most commercial banks in east Africa were operating under a decreasing return to scale.

PRACTICAL IMPLICATION

Our model indicated that social capital and retained on earning needed to produce actual level of credit and profit is 84%. This means that 16% of capital and retained is not optimized. BGF should increase credit and profit by 16% (100%-84%) using the actual level of social capital and retained on earning.

Regarding IBB, social capital and retained on earning needed to produce actual level of credit and profit is 58%. This means that 42% of capital and retained is not optimized. IBB should increase credit and profit by 42% (100%-58%) using the actual level of social capital and retained on earning.

Concerning BNDE, social capital and retained on earning needed to produce actual level of credit and profit is 66%. This means that 34% of capital and retained is not optimized. BNDE should increase credit and profit by 34% (100%-66%) using the actual level of social capital and retained on earning.

Concerning BBCI, social capital and retained on earning needed to produce actual level of credit and profit is 49%. This means that 51% of capital and retained is not optimized. BBCI should increase credit and profit by 51% (100%-49%) using the actual level of social capital and retained on earning.

Relating to Finbank, social capital and retained on earning needed to produce actual level of credit and profit is 61%. This means that 39% of capital and retained is not optimized. Finbank should increase credit and profit by 39% (100%-61%) using the actual level of social capital and retained on earning.

Relating to Ecobank, social capital and retained on earning needed to produce actual level of credit and profit is 22%. This means that 78% of capital and retained is not optimized. Ecobank should increase credit and profit by 78% (100%-22%) using the actual level of social capital and retained on earning.

Burundian banking system should increase their capital and retained on earnings to increase distributed credit and profit. This would support economic growth of Burundi and contribute to poverty alleviation as Burundi is ranked as least developed country with small gross domestic per capita.

LIMITATION AND RECOMMENDATION FOR FUTURE STUDY

The Table 1 has shown that various variables were used as input or output to assess bank technical efficiency. This study did not test other variables to evaluate whether the result of DEA remains the same. This analysis would help exploring to what extent different input/output specifications may affect the comparability or congruence of technical efficiency scores in Burundian banking system. Boďa and Piklová (2020) found that the choice of the input-output set is a critical hypercritical input to efficiency measurement meanwhile there is vast diversity in efficiency scores of input-output sets coming from different approaches, but also for input-output sets associated with the same approach. Further research should be conducted using different set of input and output. The number of available information on Burundian Banking system also may constitute a limitation. However, there is a conflict on the number of DMUs to include in the model based on the number of input and the number of output. Boussofiane A, Dyson RG,Thanassoulis (1991) specified that to get good discriminatory power out of the CCR and BCC models the lower bound on the number of DMUs should be the multiple of the number of inputs and the number of outputs. This study is consistent with this approach as it has two inputs, two outputs and ten banks. On the other hand, Novickytė and Droždz (2018) indicated that the number of DMUs should be at least three times the total number of inputs plus outputs used in the models. Further study should be conducted increasing the number of DMUs based on this approach to validate the study's findings.

ABBREVIATIONS

DEA: Data Envelopment Analysis
DMU: Decision Making Unit
SC: social capital
RE: Retained on earnings,
C: Credit
P: Profit
CRS: Constant returns-to-scale
VRS: Variable returns-to-scale
CCR: Charnes, Cooper and Rhodes
BCC: Banker, Charnes dan Cooper

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