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DEA INPUTS/OUTPUTS: EFFICIENCY OF LEBANESE BANKS

The main goal of this paper is to discuss the importance for selecting the best set of input and output variables to perform an efficiency study for banks using DEA model, it will also introduce the techniques that have been used previously to decide the number of analyzed units (DMUs) and how this number affects the number of inputs and outputs, in addition, it will discuss the difference between input and output oriented models, and the criteria used to classify an indicator as input or output. This paper will also discuss the specific factors that affect the selection for the input and output variables that will used be to perform an efficiency measurement for the Lebanese banks using DEA. To perform the goals of this paper, a secondary data was reviewed from previous studies to examine the techniques used to deal with all aspects associated with DEA's inputs and outputs. Also, A review of the Lebanese banks' annual reports and other international journals was conducted to decide which bank indicators should be selected as inputs or outputs to perform an efficiency measurement for Lebanese banks using DEA. This paper shows that the input-output selection for DEA models is essential and difficult task, that must be performed properly, to achieve an effective DEA study. This paper also sets up the basic elements to perform the efficiency measurement for the Lebanese banks; the study will use BCC DEA input-oriented model, it will cover 18 Lebanese banks that constitutes 95,3 % of Lebanese banks' total assets, its will be performed over the period 2004–2018, the three inputs selected are 'Interest Expenses', 'Cash & Deposits with Central Bank', and 'Total Assets', and the two outputs selected are 'Non-Interest Income', and 'Loans & Advances to Customers'.

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ВХОДНЫЕ И ВЫХОДНЫЕ ПАРАМЕТРЫ МОДЕЛИ АСФ: ИЗМЕРЕНИЕ ЭФФЕКТИВНОСТИ ЛИВАНСКИХ БАНКОВ

Основная цель данной статьи состоит в обсуждении важности выбора наилучшего набора входных и выходных переменных для исследования эффективности функционирования банков с использованием модели анализа среды функционирования (АСФ). В статье также представлена использованная ранее методика выбора числа входных и выходных переменных, обсуждаются критерии для отнесения показателей к числу входных либо выходных индикаторов, а также рассматриваются факторы, влияющие на выбор входных и выходных переменных для измерения эффективности ливанских банков с использованием АСФ. Для достижения указанных целей проанализирована вторичная информация из работ, посвященных исследованию методов, связанных с различными аспектами входных и выходных параметров для АСФ. Кроме того, осуществлен обзор годовых отчетов ливанских банков и международных журналов для определения, какие именно показатели должны быть отобраны в качестве входных и выходных для оценки эффективности функционирования ливанских банков на основе АСФ. В статье показана важность и сложность задачи выбора входных и выходных параметров для АСФ, поскольку от нее зависит качество получаемых результатов и выводов. В статье обоснован выбор основных методов оценки эффективности ливанских банков; исследование будет основано на модели АСФ, ориентированной на входные параметры, будут исследованы 18 ливанских банков, что составляет 95,3 % суммарных активов ливанских банков за период с 2004 по 2018 г.; в качестве входных выбрано три показателя: расходы по процентам, наличность и депозиты центрального банка, суммарные активы, в качестве выходных выбрано 2 показателя: непроцентный доход и займы и ссуды клиентам.

Ключевые слова: *ливанские банки; государственные облигации; анализ среды функционирования; входные и выходные показатели; измерение эффективности; суммарные активы; коррелированные переменные; регрессионный анализ; ориентированная на входные параметры модель АСФ; посреднический подход.*

Introduction. The 2008 financial crisis has affected the banking sector all over the world, and over both the short and the long terms. The tightening of the legislation rules internationally such as Basel III requirements, and the Dodd-Frank Wall Street Reform and Consumer Protection Act in the United States, forced banks to restructure their risk management activities and strategies to survive. To cope with the competitive environment and to sustain profitable trend, banks are forced to diversify their portfolios and to perform more innovative duties for their clients. Banks traditionally act as intermediaries between savers and borrowers to provide the needed liquidity for the economy to grow, however, banks start to play advisory and brokering duties; they act as information channels, risk managers, and drivers of innovations.

To avoid unpredictable financial crisis and their undesirable outcomes, banks start to search for more accurate efficiency measurement and credit scoring models, to assess precisely the creditworthiness of their counterparties, the models should accurately detect the ability of these banks to meet the capital adequacy requirements while facing severe economic and financial conditions. In addition, the performance measurement concept for banks covers also wider range of challenges such as competition, concentration, efficiency, productivity, and profitability. However, there is no consensus among researchers regarding the most appropriate method to measure banks' efficiency. Yang (2009) mentioned that due

to the complex operational environment of banks, ratio analysis provides relatively insignificant amount of information when considering other factors such as the economies of scale, the benchmarking criteria, and the total performance measurement [1]. While ratio analysis technique examines only few activities for an organization, Data Envelopment Analysis (DEA) method is used increasingly by banks across the world to examine their total efficiency, DEA technique is based on the frontier approach that incorporates multiple inputs and outputs into the study.

In banking industry, DEA could be used to evaluate the specific bank branches efficiencies, or to compare the efficiency of different banks [2]. Production and intermediation are the two main approaches used to measure the banks' efficiency. Production approach emphasized at the service part that banks play in the form of transactions, in this sense banks are seen as producers of loans and deposits using the main production factors (capital, land, and labor). The intermediation approach used to evaluate the efficiency of banks from the perspective of collecting funds then transform them into loans and other investment assets, that is banks are seen as an intermediary between savers and borrowers. DEA models are classified as either input-oriented or output-oriented, the input-oriented model uses linear programming equations to determine how to use efficiently the firm-inputs in order to achieve the same level of output. In contrast, the output-oriented model configures the linear programming equations to determine the optimal level of output that a firm could achieve using the same inputs, and if this firm operates efficiently along the best practice frontier.

Despite the successful long history of the banking sector in Lebanon, there are limited measurement performance studies about the Lebanese banks, and there are no studies that examine the effect of their high exposure to the Lebanese government bonds on their performance over the long term. This paper will introduce the required elements to perform an efficiency measurement study for the Lebanese banks using Data Envelopment Analysis; a list of banks that will be covered by this study, the DEA model approach that will be followed, and the inputs and outputs that will be selected for this study. The methods that will be used to determine the required DEA aspects for this study will be based on previous techniques followed by other researchers, taking into consideration the specific factors associated to Lebanese banks.

Methodology. The aim of this paper is to describe the importance and the different techniques used to select the inputs and outputs for DEA models, that will be used to measure the banks' efficiency. In addition, this paper will discuss the techniques used to select the best combination of inputs and outputs to perform an efficiency measurement for the Lebanese banks, associated to their exposure to the Lebanese public debt, and using the input-oriented BCC DEA model [2]. The methodology used to achieve the goals of this paper is based on secondary data collected from previous studies, journals, and annual reports. First, a review of the literature will be conducted, to examine the main inputs and outputs used by previous efficiency measurement studies for banks, this review will include studies for both production and intermediation approaches, this review will be used to select the best combination of inputs and outputs for the efficiency measurement of the Lebanese banks. In addition, secondary data will be collected from the annual reports of the Lebanese banks over the years 2014–2018, this data will cover selected asset accounts, liability accounts, interest and mon-interest revenues and expenses, and financial and capital adequacy ratios. After collecting the required data for the Lebanese banks, an analysis will be performed to select three inputs and two outputs, this selection represents an essential step to perform an efficiency measurement for Lebanese banks, the analysis will also discuss the research objectives and the approach used for this efficiency measurement.

To select the banks and the inputs and outputs that will be used to measure the efficiency of Lebanese banks associated to their exposure to the Lebanese government bonds, the following objectives have been identified for the purpose of this research paper.

1. A review of previous studies about the techniques used to select the DMUs, and the input and output variables that are needed to perform an efficiency measurement analysis for banks using DEA.

2. Set up the number of banks and select the inputs and outputs for the DEA model that will be used to measure the efficiency of Lebanese banks.

Review of Literature. Many studies have been conducted using DEA to measure the efficiency and the capacity of firms in different sectors. This review will focus on efficiency measurement studies about banks using Data Envelopment Analysis, this will help to examine the main techniques used to select the inputs and outputs for DEA models. Kumar and Singh analyzed ten Indian commercial banks using CCR DEA model over the period 2006−2010 [3]. They considered three inputs; deposits, number of employees, and operating expenses, and three outputs; investments, other income, and advances [3]. Al-Faraj et al. used DEA to study the relative efficiency of 15 branches of the biggest bank in Saudi Arabia, using data for only one year with eight inputs, and seven outputs [4]. Grmanova and Ivanova assessed the efficiency of 13 Slovakian banks using BCC DEA for the year 2009 [5]. They used 2 inputs; liabilities to banks and customers, and operating cost, and 2 outputs; loans and advances to banks and customers, and non-interest income [5].

Jeremic and Vujicic used both CCR and BCC models to analyze the efficiency of 39 Croatian commercial banks for the period 1995−2000 [6]. For the operating efficiency they selected four inputs; Interest and related costs, Commissions for services and related costs, Labor related administrative costs, and Capital related administrative costs, and two outputs; interest and related revenues, and non-interest revenues. For the intermediation approach they selected three inputs; fixed assets, number of employees, and total deposits, and for the outputs; total loans extended and short-term securities issued by official sectors [6]. Casu and Molyneux employed the DEA approach to investigate the efficiency of 750 European banks between 1993 and 1997 including five countries: France, Spain, UK, Italy, and Germany. Two inputs were included; total costs and short-term funding, and two outputs were considered; total loans and other earning assets [7]. Ibrahim H Osman, et al. implemented a Data Envelopment Analysis (DEA) method, over the period 1997−2004, to measure the relative performance of Lebanese banks, they selected five inputs; interest expenses, general expenses, total deposits, Number of employees, and number of branches, and three outputs; interest income, non-interest income, and total loans [8].

Inputs-Outputs for DEA Models. The ability to incorporate multiple inputs and outputs, using DEA model, represents the main reason for the its success over other traditional efficiency models. In DEA models, the indicators for the DMUs should be classified as either inputs or outputs, however, there are no clear criteria to perform this classification. In addition, with DEA, there is no standardized guideline for setting the number of variables (Inputs/Outputs) associated to particular study, therefore, researchers need to create their own criteria to decide the number of input and output variables, and to classify an indicator as input or output.

The usage of all variable for a particular study faces several constraints, first, according to Cooper et al. the number of DMUs (n) selected should be greater than 3 times the sum of the number of inputs (m) and that of outputs (r); $n \geq \max(m.r, 3(m + r))$ [9], since the availability of data for all DMUs is not possible, this limits the number or DMUs selected, therefore, reduces the number of inputs and outputs used. Second, the number of variables used affect the discriminating power between efficient and inefficient DMU's, for this purpose, an excessive number of inputs and outputs would inflate the number of efficient DMUs. On the other hand, the omission of relevant inputs and/or the inclusion of irrelevant variables, affects largely the technical efficiency measurement result, and leads to misspecification of the DEA model, this will affect significantly the DEA efficiency scores. Therefore, to achieve precise measurements, there is a need to select the most appropriate variables as inputs and outputs.

Several methods have been developed to select the input and output variables; Ruiz et al. selected the relevant variables based on their associated contribution to efficiency [10]. Jenkins et al. proposed a multivariate statistical approach for reducing the number of variables using partial correlation, which showed that removing highly correlated variables, will certainly affect the efficiency scores heavily [11]. Ruggiero used regression analysis as a technique for identifying relevant variables wherein variables are selected if statistically significant [12]. Morita and Haba designed a method based on experimental criteria and selected the optimal variables using 2-level orthogonal layout experiment [13]. Edirisinghe and Zhang created a maximizing principle based on the correlation between the external performance index and the DEA scores, then they proposed a generalized DEA approach to select inputs and outputs [14]. Morita and Avkiran used external evolution to propose a selection method, and to find the best combination of inputs and outputs they implement a 3-level orthogonal layout design [15].

Inputs-Outputs for Lebanese DEA Model. Over the last 50 years the number of Lebanese banks varied between 60 to 92 banks. There are 65 Lebanese banks operating in 2018 classified as follows, 50 commercial banks and 15 investment banks. Lebanese banks are divided into four groups according to the size of customer deposits; Alpha Group with customer deposits above USD 2 billion, Beta Groups with customer deposits between USD 500 million and USD 2 billion, Gamma with customer deposits between USD 200 million and USD 500 million, and Delta Group with customer deposits below USD 200 million. The following chart summarizes the distribution of Lebanese banks according to their size (fig. 1).
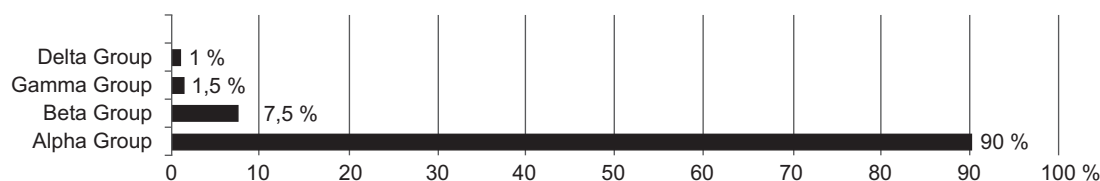

Fig. 1. Group distribution of Lebanese commercial banks in 2018

S o u r c e: compiled by the author on the basis of data from the association of Banks in Lebanon ABL, Banque de Liban BDL.

In order to determine precisely the inputs and outputs for the DEA model, that will be used to measure the Lebanese banks' efficiency, there is a need to discuss the main risks facing the Lebanese banks. The increasing exposure of Lebanese banks to the Lebanese government bonds is a major source of credit risks for Lebanese banks and is expected to weaken their balance sheet' strength, according to analysts and rating agencies. Lebanese banks including the Lebanese central bank hold about 65 per cent of the nation's public debt. The reason why Lebanese banks are highly exposed to government bonds is associated to the few growth opportunities for Lebanese banks within the country's thin market. The total assets for Lebanese banks are about 5 times the countries' Gross Domestic Product (GDP), this situation leaves the 65 banks compete, at a country with population around 6 million, for less than required private investments. The following chart compares the Lebanese GDP to the Lebanese banks' total assets over the period 2014–1019 (fig. 2).

The major criticism raised by ratings agencies about Lebanese banks is their willingness to lend the government over the private sector. The high yield from investing in government securities compared with lower private credit investments, and the lack of alternative investment opportunities, forced the Lebanese banks to hold high percentage of the government debt without considering the additional risk of such strategic decision. This was very
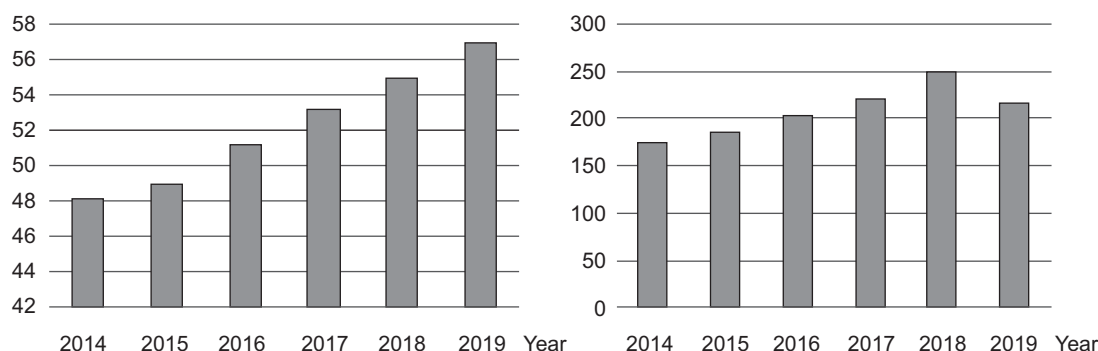
Fig. 2. Lebanese Gross Domestic Product GDP versus Total Assets of Lebanese Banks, USD Billion

S o u r c e: compiled by the author on the basis of data from Banque de Liban BDL, Ministry of Finance MOF.

attractive source of short-term profitability for banks, but also long-term structural weakness because of the government's low sovereign rating.

The efficiency analysis for the Lebanese banks aims to discuss the effect of their high exposure to the government bonds on their performance in the future, therefore, the selection criteria for the input/output variables should take into consideration this fact. The main reason why Lebanese banks have invested largely in the government bonds is the lack of investment opportunities at Lebanon, with banks' total assets is almost five times the Lebanese' gross domestic product GDP, the excess cash with the Lebanese banks have been invested in financial securities issued by the Lebanese central bank BDL, the BDL in its turn used these funds to buy government bonds which were issued to cover its large budget deficit (approximately 5 to 6 USD billion each year over around 25 years). To overcome this dilemma, banks should reduce their total assets, if they are not able to invest the excess funds efficiently, without reducing their loans and advances to customers, this will reduce their 'cash and deposits with the central bank' that exceeds the legal required reserve, therefore, they will decrease their exposure to the government debt. In addition, banks should focus more on services that increases their non-interest revenues because the role of banks is changing rapidly all over the globe, Lebanese banks should play big part to promote the country's economic growth and make profits from financing sustainable investments in the country's infrastructures rather than playing only an intermediary role by collecting money from people and lend them to the government to finance the corruption of the politicians. After detailed review of previous studies and detailed analysis of the current situation of the Lebanese banks, the efficiency measurement study about the Lebanese banks will be performed using an input-oriented BCC DEA model, it will cover a representative sample of 18 Lebanese banks whose accumulated total assets in 2018 is almost 95,4 % of the total assets of all Lebanese banks, and over the period 2014–2018, this period is also representative since Lebanon faced over the selected 5 years an alternate economic and political situations that changed from bad into good. Three inputs and two outputs will be selected to perform the study. The three inputs selected are; 'Interest Expenses', 'Cash & Deposits with Central Bank', and 'Total Assets', and the two outputs selected are; 'Non-Interest Income', and 'Loans & Advances to Customers'.

The following table lists the 18 Lebanese banks that will constitute the DMUs for the efficiency analysis of Lebanese banks, and their associated total assets.

Efficiency analysis of Lebanese banks and their associated total assets, USD Billion

Bank	Total Assets for the Year 2018	Bank	Total Assets for the Year 2018
Audi	47,2	Cedrus	1,96
BBAC	8,086	Credit Bank	4,242
BEMO	2,024	Credit Libanais	12,45
BLC	5,058	FB	23,609
BLF	15,085	Fenicia Bank	1,85
BLOM	36,74	FNB	5,196
BML	2,055	IBL	7,82
BOB	18,3	MEAB	2,214
Byblos	25,01	MED	19,03
Total Assets of Selected Banks	237,929	Total Assets of Lebanese Banks in 2018	249,48

S o u r c e: compiled by the author on the basis of the Annual Reports of Lebanese banks.

Conclusion. This paper provides a comprehensive investigation of the empirical literature to gather information about the best criteria to select the inputs and outputs needed to analyze the efficiency of banks using DEA. The conclusion was that there are no clear criteria to classify an indicator as input or output, in addition, there is no standardized guideline for setting the number of variables (Inputs/Outputs) associated to particular study, therefore, researchers need to create their own criteria to decide the number of input and output variables depending on the number of DMUs, and to classify an indicator as input or output. The selection of the inputs and outputs is essential for assessing the efficiency of the decision-making-units because the DEA is seen to be a system that is likely to reach higher performance level without large increase in inputs. After detailed analysis of the risks facing the Lebanese banks and detailed review of previous studies, the efficiency measurement study about the Lebanese banks will be performed using an input-oriented BCC DEA model, it will cover 18 Lebanese banks over the period 2014-2018, three inputs and two outputs will be selected to perform the study, the inputs are 'Interest Expenses', 'Cash & Deposits with Central Bank', and 'Total Assets', and the outputs are 'Non-Interest Income', and 'Loans & Advances to Customers'.

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BEHAVIORAL APPROACH TO FINANCIAL SERVICES: DECISION MAKING ERRORS AND BIASES

The article provides an overview of various theories of behavioral finance and some of the best-studied mistakes that often manifest themselves in the financial market. Behavioral finance, a sub-field of behavioral economics, argues that the financial practices of investors and financial professionals are influenced by psychological illusions and prejudices. In addition, cognitive biases and prejudices may be used to describe all forms of market anomalies and, especially, stock market anomalies, such as extreme increases or declines in stock prices. Studying decision making errors and biases in the financial market is very important for understanding how financial markets work in reality. Based on author's experience as an employee of the banking sector, observations were made about the manifestation of such errors in the financial market of Lebanon.

Keywords: *behavioral finance; cognitive biases; financial market; stock market; behavioral economics; banking sector; investment; Lebanon.*

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ПОВЕДЕНЧЕСКИЙ ПОДХОД К ФИНАНСОВЫМ УСЛУГАМ: ОШИБКИ И ПРЕДУБЕЖДЕНИЯ В ПРИНЯТИИ РЕШЕНИЙ

В статье представлен обзор различных теорий поведенческих финансов и некоторые из наиболее частых ошибок на финансовом рынке. Поведенческие финансы как подраздел поведенческой эко-