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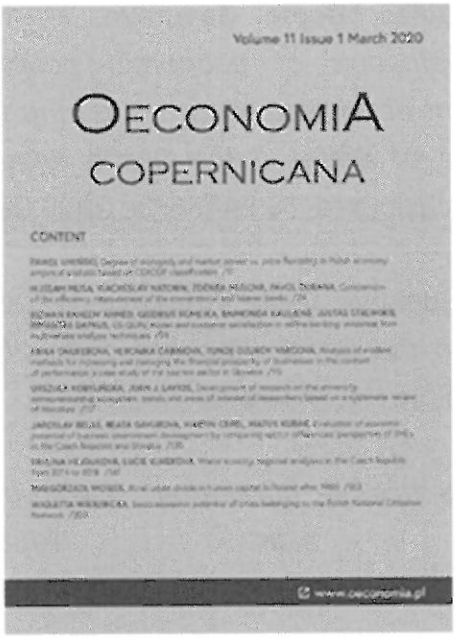

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Comparison of the efficiency measurement of the conventional and Islamic banks

JEL Classification: *G2; G21; F37*

Keywords: *Islamic banks; conventional banks; efficiency; DEA*

Abstract

Research background: Islamic banks appeared on the world scene as active players over two decades ago. Many of the principles upon which Islamic banking is based have been commonly accepted all over the world. Financial institutions driven by Islamic principles acquire new clientele without excessive marketing, due to preservation of conservative values. Contrary to the conventional investment banks, their value is based on real money, and not on virtual activities from swap and derivative assets. Competition between conventional (or traditional) and Islamic banks is increasing every day, moreover, Islamic financial institutions are more resistant to the crisis. Our study contains analysis and comparison of economic efficiency of the conventional and Islamic banks. Besides the fact that traditional and Islamic banks apply inputs differently, the reason of better efficiency of Islamic banks may be connected with different approach to the risk management and control of the banking operations by the Sharia commission.
Purpose of the article: The main aim of the article is to compare the economic efficiency of the conventional and Islamic banks in Europe.
Methods: To achieve the aim of the paper, firstly the selected financial indicators of traditional and Islamic banks in Europe were compared. The second, the analysis of the economic efficiency of the selected 1460 conventional and Islamic financial institutions using DEA methods was conducted.
Findings & Value added: Research results indicated methodological differences in the economic efficiency measuring in the Islamic banks. At the same time, the higher economic efficiency of Islamic banks was confirmed. The results are motivating for the follow-up investigation into the causes of higher efficiency of Islamic banks compared to traditional banks.

Introduction

Banking is considered to be one of the main components of the financial system, as it has a broad impact on the overall financial stability and the strength of the economy. It connects economic agents with the financial market. Banking plays a major role in financial intermediation and helps to create wealth through multiple economic relationships. Interest is regarded as a basic source of income for banks. As a result, financial markets and institutions are very sensitive to changes of interest rates because of their crucial role in generating revenues and profits. Any change of the interest rate has an impact on the banking and financial sectors. Therefore, banks are actively involved in the interest rate risk management.

Islamic banking has evolved from a little-known financial experiment to a major player in world finance, both in terms of asset size and activity. Especially after the outbreak of the global financial crisis, Islamic banking has emerged as a viable alternative to conventional models of banking. The research often mentions the customers' increasing awareness of Islamic banking products and services and the financial crisis, which induced the need for alternative havens as the triggering factor behind the growth of Islamic finance (Aysan *et al.*, 2018, pp. 1–19).

Islamic banking differs from conventional banking by several important principles. An essential feature of Islamic banking is absence of interest payments. Shares-compatible financial institutions do not deal with interest. In Islam, interest is considered to be a form of exploitation, thus there is only a fee for using money. However, this requires the development of modern mechanisms to replace interest income with cash flows from productive sources, such as income from investment and wealth-generating operations (profits from trading real assets and cash flows from the transfer of the right to use assets (leasing)). Tackling the specific risks of Islamic

banking requires adequate capital and reserves, appropriate pricing and risk control, certain rules and data control procedures (prescribed division of items in the financial statements), accounting and auditing rules, as well as infrastructure that allows liquidity management. Whether Islamic banks are more or less stable than conventional banks depend on relative views on the effects mentioned above and may fundamentally vary from country to country and even from bank to bank (Musa & Musova, 2010, pp. 269–276).

Nowadays, the Islamic financial system emerges as an alternative to traditional banks in many parts of the world. The market share of Islamic banking is still small in the global financial sector; however, it is growing fast in many countries, especially in the Middle East and Asian region (Doumpos *et al.*, 2017, pp. 513–523). The total assets of Sharia-compliant financial industry have reached the total of US$ 2.05 trillion in 2017. The development of this sector can be explained by several factors including (i) the oil revenues of the Gulf countries, and (ii) the desire of the Muslim world to extend Sharia laws to all economic activities. The global growth of the Islamic banking industry experienced a 4.3% expansion mainly located in Iran, Saudi Arabia, UAE, and Malaysia. In addition, the Islamic banking market share has increased above 20% in several countries, reflecting its role as a promising new player along with conventional banks (Bitar *et al.*, 2019).

It also attracts conventional investors who want to engage in new investment opportunities. For example, HSBC Amanah, a segregated division of HSBC, provides a range of Sharia-compliant financial services, such as Amanah's bank account and Amanah's domestic services to meet the needs of the Muslim community in the UK. Barclays Capital has a leading position in the Islamic Sukuk bond market. Ahli United Bank (UK) has introduced Manzil 'real estate purchase plans' to help clients in buying real estate property in accordance with their religious regulations. Arab Banking Corporation (ABC), through its London-based subsidiary ABC International Bank plc (ABCIB), brings "alburaq" to offer real estate financing (mortgage) in the UK. The Islamic Investment Bank (CIIB), a subsidiary of Citicorp Banking Corporation, continues to play pioneering and innovative role in the industry through Islamic funding windows within the City of London. Lloyds TSB has developed a set of sharia approved products. Last, but not least, the Royal Bank of Scotland (RBS) provides clients with the consumer and commercial products based on decreasing musharaka and murabaha.

Due to the different behavior of Islamic and conventional banks, the long-term sustainability of Islamic banks has always been discussed with a view to linking them to their efficiency. The efficiency of conventional

banks has been widely studied in the literature to assess banks' experience in achieving their goals. Efficiency is defined as a measure of performance indicating how cautious a bank applies its resources, which produces output. This means better profitability, prices and quality of services for consumers, and a greater number of financial mediations (Berger *et al.*, 1993, pp. 317–347).

The literature on Islamic bank performance is very popular. Within this banking literature, there are several variants of studies (Narayan & Phan, 2019, p. 485). Beck *et al.* (2013, pp. 433–447) use data from 22 countries and show that Islamic banks are less cost-effective compared to conventional banks but have a higher intermediation ratio, higher asset quality and are better capitalized. Kabir *et al.* (2015, pp. 327–353) explore credit risk in Islamic and non-Islamic banks and find, expectedly, that Islamic banks have significantly lower credit risk compared to conventional banks. Sorwar *et al.* (2016, pp. 113–126), using a sample of 65 Islamic and 65 conventional banks, find no difference in risk between Islamic and non-Islamic banks. Bank efficiency has been a topic of considerable interest in the literature in the last two decades. Over the last decade, a number of studies have compared the efficiency of Islamic banks with their conventional counterparts (Safiullah & Shamsuddin, 2019, pp. 105–140).

In the outlined context, our article focuses on the possibilities and specifics of measuring the efficiency of bank institution using DEA method, especially of Islamic banks. The main aim of the article is to compare the economic efficiency of the conventional and Islamic bank in Europe.

The authors have chosen the following logical structure of the article. In the Introduction the fundamentals of the topic (basic principles of Islamic financial system), intentions and goals of the authors are briefly outlined. The "Literature review" section presents the relevant theoretical background and secondary data analysis. The next section contains research methodology. The fourth chapter, "Results", presents the detailed procedure of the research and the calculation and comparing of the economic efficiency of the selected conventional and Islamic banks using the DEA methods. Discussion and Conclusion are focused on the presentation of the most important findings compared with other studies and recommendations for further research.

Literature review

In practice, different approaches are applied to measuring the efficiency of banks, either towards banks in the financial sector (inter-banking compari-

son) or towards branches within the bank (intra-bank comparison). Prior studies overlooked the difference in efficient frontiers under which Islamic and conventional bank groups operate, and the potential trade-off between risk and efficiency for these bank groups (Safiullah & Shamsuddin, 2019, pp. 105–140). Assaf *et al.* (2017) argue that cost efficiency during normal times helps reduce bank failure and risk during subsequent financial crisis which leads banks to grow further.

Data Envelopment Analysis (DEA) is a widely used general method of efficiency analysis. The literature about the application of DEA contains a great deal of empirical researches, such as Casu and Molyneux (2003, pp. 1865–1876). They, using the DEA, measured the efficiency of European banks for the period from 1993 up to 1997. The sample included the 150 largest banks, whose share in the European banking sector is the most significant. Scientists used the intermediary approach to define inputs and outputs and DEA model of CCR-type. The input variables thus included the total cost (the amount of interest and non-interest costs) and the amount of short-term deposits and as for output — the amount of loans granted and other long-term profitable assets.

Grira *et al.* (2016, pp. 152–168) analyze deposit insurance premiums of Islamic banks vis-a-vis conventional banks. Based on a sample of 352 Islamic banks and over 30,000 conventional banks covering 213 countries they find that premiums for publicly listed Islamic banks are 28% lower than corresponding conventional banks.

Baele *et al.* (2014, pp. 141–159) compare default rates on conventional and Islamic loans using data from Pakistan. Their main conclusion is that default rate of Isalmic loans is less than half the default rate of conventional loans.

Cook *et al.* (2000, pp. 455–475) measured the impact of financial liberalization programs on the efficiency of Tunisian banks in 1992–1997 by comparing the efficiency estimations of banks with a DEA method. In this work, the intermediary approach was used, in which the interest and non-interest costs were input and the bank's net profit was the output. The sample included only banks in Tunisia (10 in 1992, 13 in 1997). The researchers used a DEA model of CCR-type.

Narayan and Phan (2019, pp. 484–496) present several studies, which explore the efficiency of Islamic banks with many comparing their efficiency with conventional banks (f. e. Abdul-Majid *et al.*, 2011, pp. 2033–2054; Ahmad & Luo, 2011, pp. 361–389; Johnes *et al.*, 2014, pp. S93–S107; Rosman *et al.*, 2014, pp. 76–90).

Vujcis and Jemric (2001) accomplished the study evaluating Croatian banks from 1995 up to 2000 years. Scientists decided to evaluate the technical and scale efficiency of banks using two of the most common models, DEA — CCR (constant returns to scale) and BCC (variable returns to scale). Croatian scientists determined the technical or operational efficiency of the bank in terms of cost-and-revenue comparison. In order to measure technical efficiency, the input variables included interest costs, fees, personnel costs, capital expenditures, while the output variables were interest and non-interest income. In the intermediary approach of assessing efficiency, Vujcis & Jemric regarded each bank as a business unit that uses labor and capital to convert deposits into loans and securities. In the case of intermediary approach, fixed assets and software, number of employees, and total deposits were among the input variables. As for output ones, the following variables were included: total loans and short-term government securities.

Fiorentino *et al.* (2006), using DEA and SFA (Stochastic Frontier Analysis), measured the intermediary efficiency of German banks from 1993 up to 2004. Scientists considered fixed assets, number of employees, borrowed funds (deposits and bonds) as input variables. Output variables included interbank and consumer loans, investment in stocks and bonds. The classical CCR model was used for measurement.

Staub *et al.* (2009, pp. 204–213) measured Brazilian banks' allocation efficiency (resource allocation) for the period 2000–2007. Inputs and outputs were determined by the intermediary approach, within which the Bank's efficiency is identified by its ability to allocate funds between depositors and debtors. Under this approach, the main inputs are cash and interest costs; operational and labor costs are additional. As outputs, scientists accepted deposits, issued loans and investments in securities. The researchers used the CCR model to assess efficiency.

Tahir *et al.* (2009, pp. 96–106) evaluated the intermediary efficiency of commercial banks in Malaysia in 2000–2007. The sample included 9 domestic and 13 foreign banks assessed according to the CCR model. One variable was chosen as an output — the sum of all bank assets generating revenue and two input variables — total deposits and total costs.

Hoque and Rayhan (2012, pp. 17–21) examined 24 commercial banks in Bangladesh in 2010 using the two most widely applied models — CCR and BCC. The purpose of this study was to measure the technical efficiency of domestic banks. The input variables included operating income, deposits, total assets and operating expenses. In his work, Hoque recorded only one output variable — operating profit.

Measurement of the operational efficiency of Taiwanese banks in 2013 was carried out by a group of researchers led by Ming-Miin Yu (Yu *et al.*, 2013). The sample included 22 Taiwanese banks in the period 1999–2011,

on the basis of which the CCR model was constructed. Input variables included labor costs, fixed assets and operating costs. The output variables were deposits, loans and investments in securities. The authors of this research also applied the intermediary approach to assess the efficiency of the banks.

The efficiency of Czech commercial banks from 2003 up to 2012 was reviewed by Repkova (2014, pp. 587–596) with using of the CCR model. The researcher chose the intermediary approach for her work, which expresses the main function of banks as financial intermediaries — the transformation of liabilities (deposits) into assets (loans). In this approach, it is assumed that the bank uses its human resources and deposits to generate loans, so that the volume of deposits and labor costs are two input variables and loans with net interest income are outputs.

The production approach in measuring the technical efficiency of banks in the Slovak banking sector was mainly applied by authors: Boda (2015, pp. 1847–1858), Boda and Zimkova (2014, pp. 7–25), Boda and Zimkova (2015, pp. 434–451), who used input and output variables, which are typical for production approach (inputs — operating costs, fixed assets; and outputs — loans, net interest income, deposits). According to Zimkova (2015, p. 49), the production approach is mainly used in assessing the technical efficiency of commercial bank branches, as opposed to the intermediary approach applied in assessing the technical efficiency of banks. To measure technical efficiency and super efficiency, Zimkova (2014, pp. 780–787) used deposits, fixed assets, average number of employees as inputs and earning assets as outputs.

From the "academic" point of view, despite the considerable development of the DEA method in the banking sector, there is still a little amount of studies that examine the efficiency of Islamic banks. Previous studies focused primarily on the conceptual issues of Islamic banking. The main purpose of this research is mainly to fill this gap in the literature. Our primary contribution to literature is to conduct a first empirical analysis of the efficiency of traditional European banks in comparison with the Islamic banks, including Islamic banks in Europe. We compare the results of the DEA analysis with the results of the analysis of classical financial indicators ROAA, ROAE, CIR, CAR, NIM, NPLs, LCR, LR.

Research methodology

The aim of this study is to compare the economic efficiency of the conventional and Islamic banks in Europe. We measure efficiency using the DEA

method and also by calculating financial indicators. We will compare the results of the analysis of traditional banking with the results of the analysis of Islamic ones.

Moody's Analytics Bank Focus and Thomson Reuters databases were used in this study. The data come from 46 European countries and 34 Middle East countries, which consist of 217 Islamic banks and 1961 conventional banks for the period 2013–2017.

For the analysis the following financial indicators were chosen:

$$ROAA = Net\ Income/Total\ Average\ Assets\ (\%) \quad (1)$$

$$ROAE = Net\ Income/Stockholders\ Equity\ (\%) \quad (2)$$

$$ROC = Profit\ /\ Total\ costs\ (\%) \quad (3)$$

$$CIR = Operating\ Expenses/Operating\ Income\ (\%) \quad (4)$$

$$Ropv^{1} = \frac{Other\ operating\ income}{Total\ assets}\ (\%) \quad (5)$$

$$Rp^{2} = Net\ income\ /\ Staff\ costs\ (\%) \quad (6)$$

$$LCR = total\ volume\ of\ high\ liquid\ assets/Total\ assets\ (\%) \quad (7)$$

$$LR = Total\ loans/Total\ deposits\ (\%) \quad (8)$$

$$FEXP = New\ loan\ /\ Total\ assets\ (\%) \quad (9)$$

$$NPLs = Amount\ of\ defaulted\ loans/Total\ loans\ (\%) \quad (10)$$

$$LR = Total\ capital\ paid/Total\ loans\ (\%) \quad (11)$$

$$NIM = \frac{Investment\ Income - Interest\ expens}{Average\ Earning\ Assets}\ (\%) \quad (12)$$

Descriptive statistics were analyzed in Eviews 10 and DEA analysis was performed using MaxDEA 7.

We will present the methodology on the example of model with the constant returns to scale. We assume that we have a set of homogeneous units (branches of banks) U1, U2, ... Un. When measuring the efficiency of

[1] *Ropv* – return on other operating income
[2] *Rp* – profitability of personal expenses

these banks, we consider r outputs and m inputs. We define input matrix as X and output matrix as Y.

$$X=\begin{bmatrix} x_{11} & x_{12} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & \cdots & x_{mn} \end{bmatrix} \quad Y=\begin{bmatrix} y_{11} & y_{12} & \cdots & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & \cdots & y_{2n} \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ y_{r1} & y_{r2} & \cdots & \cdots & y_{rn} \end{bmatrix} \tag{13}$$

Then, the efficiency ratio of the unit Uq can generally be expressed as:

$$U_q=\frac{weighted\ outputs}{weighted\ inputs}=\frac{u_1y_{1q}+u_2y_{2q}+....+u_ry_{rq}}{v_1x_{1q}+v_2x_{2q}+....+v_mx_{mq}}=\frac{\sum_{i=1}^{r}u_iy_{iq}}{\sum_{j=1}^{m}v_jx_{jq}} \tag{14}$$

The DEA models maximize the measurement of efficiency of the estimated unit Uq, expressed as the ratio of weighted outputs to weighted inputs (14), under condition that the efficiency measurements of all other units are less than or equal to one.

Basic models include CCR DEA models, sometimes referred to as constant returns to scale (CRS) models, and BCC DEA models. The difference between these models is that the CCR DEA model assumes constant returns to scale, while the BCC DEA model, which is essentially a modification of it, considers variable returns. The BCC DEA model can be defined in three alternatives:

1. VRS – variable returns to scale;
2. NIRS – non-decreasing returns to scale;
3. NDRS – non-increasing returns to scale.

All models can be computationally oriented as either input-oriented or output oriented ones. For input-oriented models, we determine the efficiency of banks on the basis of input variables (total assets, number of clients served in the bank, operating costs, number of employees, etc.). Those banks whose optimum value of the assigned function is equal to one work within the observed group of banks effectively, and those banks whose optimum value of the assigned function is less than one work inefficiently. This value shows the need for a proportional reduction (improvement) of inputs, so that the inefficient working enterprise (bank branch) becomes effective. With the DEA models, we can determine not only the efficiency of banks, but first of all we will get information on how banks should "improve" their activities to become effective. Conversely, for output-oriented models, we determine the efficiency of banks based on output variables (sales, number of loans granted, production volume, etc.). Those companies whose optimum value of the target function equals to one work effectively within the observed group of banks, and those banks, whose optimum value of the target function is greater than one work inefficiently. In output-oriented models, an increase in some or all of the output variables will be considered as an "improvement" in the activity of inefficient banks.

CCR DEA input-oriented models

A. The primary CCR input-oriented data envelopment model

The CCR DEA model maximizes the efficiency measurement of the estimated business unit Uq, which is expressed as a ratio of weighted outputs to weighted inputs, under the condition that the efficiency measurements of all other units are less than or equal to one. The model for the bank Uq can be formulated as a task of linear angular programming as follows:

$$\begin{aligned} &\text{maximize} && z=\frac{\sum_{i=1}^{r}u_iy_{iq}}{\sum_{j=1}^{m}v_jx_{jq}}, \\ &\text{under conditions} && \frac{\sum_{i=1}^{r}u_iy_{iq}}{\sum_{j=1}^{m}v_jx_{jq}}\le 1, \qquad k=1,2,3,\ldots,n, \\ & && u_i\ge\varepsilon, \qquad i=1,2,3,\ldots,r, \\ & && v_j\ge\varepsilon, \qquad j=1,2,3,\ldots,m, \end{aligned} \tag{15}$$

where z is the measure of efficiency of the unit Uq, ε is an infinitesimal constant by which the model ensures that all weights of inputs and outputs will be positive and then included at least to a minimum rate in the models. This infinitesimal constant is generally chosen as a very small number, order 10^{-8}.

The task (15) is converted by the Charnes-Cooper transformation to the standard linear programming task.

$$\text{maximize} \qquad z = \sum_{i=1}^{r} u_i y_{iq}$$

$$\text{under conditions} \qquad \sum_{i=1}^{r} u_i y_{ik} \le \sum_{j=1}^{m} v_k x_{jk}, \qquad k = 1,2,3,\ldots,n,$$
$$\sum_{j=1}^{m} v_j x_{jq} = 1, \qquad (16)$$
$$u_i \ge \varepsilon, \qquad i = 1,2,3,\ldots,m,$$
$$v_j \ge \varepsilon, \qquad j = 1,2,3,\ldots,n,$$

The rated bank Uq lies at the CCR effective limit and it is considered as CCR effective if the optimum efficiency ratio calculated by model (16) is equal to one i.e. z*=1. The optimal value of the efficiency of inefficient banks will be less than one. Model (16) is called the primary input-oriented CCR model.

B. Dual CCR input-oriented data envelopment model.

From an interpretative point of view, it is preferable and especially practical to work with a model which is dual-model to model (17). This model is called the dual input-oriented CCR model and it has the following form:

$$\text{minimize} \qquad z = \theta_q$$

$$\text{under conditions} \qquad \sum_{i=1}^{n} x_{ij}\lambda_i \le \theta_q x_{iq}, \qquad i = 1,2,3,\ldots..,m,$$
$$\sum_{i=1}^{n} y_{ij}\lambda_i \ge y_{rq}, \qquad r = 1,2,3,\ldots..,s, \qquad (17)$$
$$\lambda_i \ge 0, \qquad j = 1,2,3,\ldots..,n,$$

where λ = (λ1, λ2, λ3,..... λn), λ ≥ 0, is a vector of weights, which are assigned to individual banks. θq is the measure of efficiency of the rated bank Uq. The variable θq can also be interpreted as a necessary measure of input reduction to reach the effective limit and its value will be less than or equal to one.

The rated bank Uq is effective if the following conditions are met:

- The optimal value θ*q is equal to one.
- The optimal values of all additional variables si+* and si-* are equal to zero.

All effective DMUs have a value of θ*q equal to 1 and DMUs inefficiently have a value of θ*q less than 1. This value indicates the degree of inefficiency of the unit and the need for proportional reduction of inputs so that the DMU Uq becomes effective, i.e. how the behavior of the rated unit should be improved so that it becomes effective. We calculate this proportional input reduction ratio by:

$$x_q' = X\lambda^* \quad \text{or} \quad x_q' = \theta^*_q x_q - s_i^{-*} \qquad (18)$$

CCR DEA output-oriented models

The procedure for constructing output-oriented CCR DEA models is almost analogous to input-oriented models.

A. The primary CCR output-oriented data envelopment model

$$\text{minimize} \qquad g = \sum_{j=1}^{m} v_k x_{jq}$$

$$\text{under conditions} \qquad \sum_{i=1}^{r} u_i y_{ik} \le \sum_{j=1}^{m} v_k x_{jk}, \qquad k = 1,2,3,\ldots,n,$$
$$\sum_{i=1}^{r} u_i y_{iq} = 1, \qquad (19)$$
$$u_i \ge \varepsilon, \qquad i = 1,2,3,\ldots,m,$$
$$v_j \ge \varepsilon, \qquad j = 1,2,3,\ldots,n,$$

B. Dual CCR output-oriented data envelopment model

$$\text{maximize} \qquad g = \Phi_q$$

$$\text{under conditions} \qquad \sum_{i=1}^{n} x_{ij}\lambda_i \le x_{iq}, \qquad i = 1,2,3,\ldots..,m,$$
$$\sum_{i=1}^{n} y_{ij}\lambda_i \ge \Phi_q y_{rq}, \qquad r = 1,2,3,\ldots..,s, \qquad (20)$$
$$\lambda_i \ge 0, \qquad j = 1,2,3,\ldots..,n,$$

Interpretation of model results (20) is similar to input-oriented CCR model (17). The bank Uq is effective if the optimum value of the assigned function g * is equal to one. If this value is greater than one, then the bank is not operating efficiently and the optimal value Φq * indicates the need

for a proportional increase of the bank's output. After their increase, the bank will work effectively. We calculate this measure of proportional increase of output according to the relation:

$$yq' = Y\lambda^{*} or\ yq' = \Phi^{*} q\ yq + si+^{*} \quad (21)$$

For an optimal solution of input and output oriented CCR models, their efficiency rates i.e. the values of their target functions, are inverted values. This relationship may not be applied for the BCC group of models (Kliestik, 2009, pp. 133–145).

Basic CCR models can be converted to all three BCC DEA models by simple transformation (see Table 1).

Results

The assessment of the efficiency of Islamic and traditional banks starts from the ROAA, ROAE, CIR, ROC, Ropv, Rp indicators. The total number of observed objects is 2539, including 254 Islamic banks and 2,285 traditional banks. Descriptive statistics of financial indicators are presented below in Table 2 and Table 3. We will mainly compare the median, maximal and minimal values of indicators.

The median of return on assets in Islamic banking is 0.35% higher than in the traditional one. The median of return on equity in Islamic banking is higher by 3.21%. The operating cost-to-income ratio is lower by 6.95% in Islamic banking, suggesting a greater efficiency of Islamic banks in asset management. The ratio of other operating income (Ropv) is higher in Islamic banking by 1.1%, indicating a reasonable diversification of the charged services in the Islamic banking. The ROC shows that $1 of operating expenses generates $0.43 of post-tax profit in Islamic banking and $0.21 of post-tax profit in traditional one. Similarly, Rp shows that $1 of staff expenditure generates $0.92 of profit after tax in Islamic banking and $0.43 of profit after tax in traditional ones.

LCR, NIM, FEXP, NPLs, CAR will be used for deeper financial analysis.

Descriptive statistics of the LCR, NIM, FEXP, NPLs, CAR financial indicators for Islamic and traditional banking are shown below in Table 4 and Table 5.

Capital adequacy is sufficient for both banking systems (> 8%). The median of capital adequacy ratio in Islamic banking is lower 0.85% than for traditional banking. The growth of new investment instruments is much

more vivid in the Islamic banking, i.e. 11.55% versus 3.29%. The level of highly liquid assets is 0.57% higher in Islamic banking. Interest margin is 0.67% lower in Islamic banking. It is remarkable that with the higher level of financial expansion, Islamic banks have twice as less defaulted loans. During crises and defaults, the bank balance sheet is at an unstable position, which poses a significant risk to the bank. The bank loses the client's trust and, as a result, clients starts to take their deposits out the accounts in bulk, which further distorts the bank's balance sheet and may result in bank failure or bankruptcy. This is the reason why the regulating government controls banks and their businesses with the huge attention (Musa, 2011). Credit risk is one of the three fundamental risks and bank or any other regulated financial institution has to face it, while operating on the market (Musa *et al.*, 2015, pp. 451–456). It is also noteworthy that none of the Islamic banks went bankrupt during the financial crisis, and our analysis of classical financial indicators shows higher profitability of the Islamic banks.

We continue to analyze the efficiency of the sample of commercial banks using the DEA method with the constructed output-oriented BCC model with the variable returns to scale. The variable-returns-to-scale BCC model is more suitable for the group of banks with a relatively different volume of assets. During the first measurement, we do not divide the file into target groups according to the volume of assets, because at this stage it is a selection of a suitable approach and variables. In order to justify the chosen intermediary approach, we also analyze the sample using the production approach.

According to Boda and Zimkova (2015, pp. 434–451), we apply the production approach and the following variables: operating costs, fixed assets (inputs) and loans, net interest income, deposits (outputs). According to the selected variables, the analyzed group contains 1460 banks. We created CCR-O and BCC-O models for comparison. The results of the comparison are shown in Table 5. We can see that the results of the CCR-O model are not transparent because 96.78% of the analyzed banks were included in the efficiency interval [0; 0.25). The results of BCC-O are more transparent, as the effect of the variable ratio of income needs to be taken into account in the analysis of banks' efficiency (see Table 6).

We will evaluate the efficiency intervals as follows:

- [0 – 0,25) – very low efficiency;
- [0,25 – 0,5) – low efficiency;
- [0,5 – 0,75) – medium efficiency;
- [0,75 – 1) – high efficiency;
- 1 – very high efficiency.

Figure 1 shows distribution of Islamic banks (IB) and traditional banks (TB) according to the model BCC-O. The proportion of Islamic banks in the very low-efficiency group is less than the proportion of traditional banks and, vice versa, it is higher in the low- and medium-efficiency groups.

The most important obstacle in applying the DEA analysis to Islamic banking is the use of net interest income as output. Interest income affects the efficiency of Islamic banks less than the efficiency of traditional ones. Income of Islamic banks is mostly generated from other operating income, fees, etc. We consider that it is appropriate to the use of total revenues in combination with other traditional variables as output, in order to measure the efficiency of Islamic and traditional banks. We will expand the number of variables similarly to the Abu-Alkheil (2012) research.

As mentioned above, the net interest income variable used in the analysis of traditional banks should be replaced by total operating income for at least two reasons:

- Net interest income does not reflect the overall profitability of Islamic banks, which is based on other accounting items;
- MaxDEA 7 program is not limited by the number of researched units, as it cannot handle negative numbers, and it is limited by the number of available DEA models and the possibility of using the Malmquist index.

From the sample, a certain number of banks have negative net interest income, so we will compare the total volume of operating income that the bank has, using a certain amount of inputs. We will replace the production approach with the intermediary one and will use the new Abu-Alkheil (2012) variables. The inputs include total labor costs, deposits, operating costs and outputs include loans, operating income. The results of the analysis are summarized in Table 7. The share of low-efficiency banks in Islamic banking is two times smaller than in traditional banking, while the share of high-efficiency banks is three times greater. The share of Islamic banks with the efficiency equal to one is 13.56% versus 1.83% of traditional banks.

Our research is focused on European Islamic banks and there are some with the total assets under $2 billion, thus we narrowed the target group of estimated banks according to asset volume. The sample was reduced to 1,454 banks (89 Islamic and 1,365 traditional banks). In the group with assets below $2 billion is 9 Islamic banks located in Europe. Table 8 summarizes the results of the efficiency measurement of the target group.

In the group with assets below $2 billion, we see that the share of Islamic banks with high and very high efficiency is much greater than traditional banks have. The results of the efficiency measurements are presented in the following Table 9 and graphed (Figure 2).

We can see that none of the Islamic banks in the research sample, according to the data presented above, has the efficiency of less than 0.2.

Four banks have high efficiency, one bank has medium efficiency, the other four have low efficiency, but closer to the middle interval. The lowest efficiency is with KT Bank Ag from Germany, which is justified by its recent establishment, but every year KT Bank Ag increases its efficiency.

Discussion

The achieved results are important for banking practice, especially for the traditional banking. From the point of view of a traditional commercial bank, when there is a different type of running business, a different approach to clients and to making money, such an approach must be explored, and elements that increase competitiveness, resistance to crisis, financial stability should be applied in the traditional banks. The dissemination of knowledge regarding Islamic banking can be considered to be the theoretical contribution of research, but more important is the practical benefit, because the efficiency estimation of Islamic and traditional banks has clearly shown that there are elements in Islamic banking that condition lower credit defaults, higher capital adequacy, higher efficiency of running business. We will be able to find out what factors are decisive in Islamic banking or there are set of such factors, like the Sharia Commission control of banking activities, the principle of profit and loss sharing and / or other risk management approaches. In any case, the application of these elements should contribute to the development of traditional banking.

To date, the majority of researchers have focused more on cost and profit efficiency in banking sectors and only a few have looked on revenue efficiency. Furthermore, most of these studies are carried out on the conventional banking sectors, while empirical evidence on the Islamic banking sectors is relatively scarce (Kamarudin *et al.*, 2014, pp. 1–24).

With regard to size, the prescription for conventional banks is just the reverse of Islamic banks. Conventional banks are suffering from diseconomies of scale due to their overcapacity (Miah & Uddin, 2017, pp. 172–185).

A comparison of the efficiency of the traditional and Islamic banks are also performed by Abu-Alkheil (2012). The author examines 50 Islamic

banks, including 7 Islamic banks in the UK and 158 traditional UK banks. Our research is different in its focus on European banks, both Islamic and traditional (total 1460). In addition to ROA and ROE, other financial indicators were used to assess the efficiency of banks.

Omar *et al.* (2007, pp. 1–18) investigate the efficiency and productivity performance of the national private banks in Indonesia during the time frame from 2002 to 2004. The data involved 21 national private banks, including 2 Islamic banks. Productivity is measured by the Malmquist Index using the DEA technique. The article identifies that the efficiency of two Islamic banks is above the average efficiency of the national private banks. Batir *et al.* (2017, pp. 86–96) confirm this conclusion that average Islam bank efficiency is higher than the average conventional bank efficiency for each year. They evaluate the technical, allocative, and cost efficiency of conventional and Islamic banks in Turkey with DEA method. The beginning year of the study is 2005 and the ending year is 2013 for 49 banks in the Turkish banking system: 4 Islamic banks, 32 commercial banks and 13 investment and development banks. On the contrary, Hassan *et al.* (2009, pp. 46–65) assess 40 banks in 11 Organization of Islamic Conference countries during the time period 1990–2005 using DEA nonparametric efficiency. Their results show no significant differences between the overall efficiency of conventional and Islamic banks. But, Erfani and Vasigh (2018, p. 66) use the sample of 8 Islamic banks and 11 commercial banks to find out the impact of the global financial crisis on efficiency and profitability of the banking covered the period from 2006 to 2013. Their conclusions mark that over the analyzed period, Islamic banks managed to maintain their efficiency, while most commercial banks suffered a loss in their efficiency. Furthermore, they highlight that the financial crisis did not have a significant impact on the profitability of Islamic banks.

Ismail *et al.* (2013, pp. 92–107) examine cost efficiencies of the selected Islamic and conventional commercial banks over the period of 2006 to 2009 in Malaysia. They select 8 domestic Islamic commercial banks and 9 domestic conventional commercial banks. DEA discloses technical efficiency as the main contributor of cost efficiency for conventional commercial banks and allocative efficiency as the core contributor for cost efficiency of Islamic commercial banks. This means conventional commercial banks have been efficient in utilizing information technology and electronics. On the other hand, Islamic commercial banks have been efficient in allocating and utilizing their resources. In addition, scale efficiency is found to be the core source of technical efficiency for both Islamic and conventional commercial banks, denoting that size is important in improving bank efficiency. Abdul-Wahab and Haron (2017, pp. 298–318) detect

the efficiency of the banking sector in Qatar. Their study utilizes 15 banks, comprising Islamic, conventional and foreign banks for the period of 2007 to 2011. DEA technique as well as Malmquist productivity index are run to compute technical efficiency, pure technical efficiency and scale efficiency. The conclusions indicate that conventional banks are the most efficient in Qatar in the condition of technical and pure technical efficiencies, Islamic banks are most efficient in the conditions of scale efficiency. Besides these facts, pure technical inefficiency dominated scale inefficiency in the Qatari banking sector. Shawtari *et al.* (2018, pp. 1681–1705) collect data of all banks operating in Yemen for the 1996–2011 (16 conventional banks to 4 Islamic banks). The results of DEA indicate that the pure technical efficiency is higher for conventional banks compared to Islamic banks. However, the Islamic banks are more scale efficient than their conventional counterpart.

Kamarudin *et al.* (2013, pp. 215–236) and Kamarudin *et al.* (2014, pp. 1–24) examine the price efficiency consist of cost, revenue and profit efficiency and returns to scale on 74 banks (47 conventional and 27 Islamic banks) in Gulf Cooperative Council countries over the periods 2007 to 2011. They argue (applying DEA), that revenue efficiency means the core factor leading to the lower or higher profit efficiency levels only on Islamic banks. The paper presents that statistically significant differences on cost, revenue and profit efficiency between Islamic and conventional banks in GCC countries exist. Furth more, Kamarudin *et al.* (2017, pp. 33–46) test 29 banks from Malaysia, Indonesia and Brunei over the period of 2006–2014. The findings of DEA imply that the domestic Islamic banks have higher efficiency levels compared to their foreign bank competitors.

Conclusions

When measuring technical efficiency in banking, the intention is to assess how commercial banks are capable of producing banking services or to assess how banks perform their macroeconomic function as financial intermediaries. In the first case, the assessment of technical efficiency is interesting for commercial banks themselves, in the latter case — for regulatory authorities.

As the banking sector is highly competitive, it is essential that banks measure their efficiency and assess it, comparing with the competing commercial banks. Both parametric and non-parametric methods are used to measure technical efficiency. Our research responds to selected methodological problems that arise in measuring of the technical efficiency of Is-

lamic banks, with an emphasis on the methodological choices needed to use non-parametric data analysis. Regarding the specification of the theoretical approach of banking production, it appears that the banking production process is associated with hardly definable inputs and outputs. This problem is linked to a discussion of what the essence of banking business is and how to understand the position of deposits, which are an important part of the production process of banks. These considerations refer to two different theoretical approaches to banking production, a production approach and an intermediary approach. We used both approaches and two combinations of variables to measure the technical efficiency of Islamic and traditional banks. The analysis showed that the production and intermediary approach differ from each other, but in both cases Islamic banks showed higher results.

The obtained results of measuring the efficiency of Islamic and traditional banks by DEA analysis allow us to claim that the Islamic banks are more efficient than the traditional ones. To the group of banks with assets below 2 billion. $, which includes 1,454 banks, we have also added 9 European Islamic banks, and, as a result, we can see that 14.61% of Islamic banks have the highest efficiency compared to 1.47% of traditional banks. The results of the DEA analysis confirm the results of the financial analysis of the balance sheet data and we can say that the bank's profile affects its efficiency.

The DEA analysis was performed using MaxDEA 7 program, which is limited by the number of DEA models provided. Also, this program does not contain the Malmquist index and it does not allow to work with negative figures. As some banks' net profit was negative for calculations, the total return variable was used.

Furthermore, the portion of traditional and Islamic banks are not in the balance, but this disproportion is caused by the real economic phenomenon of occurrence these types of banks. The creation of forced equivalence may lead to distortion of results. The imbalance in the portion of banks is also highlighted in the part of discussion when other studies are compared to this issue. The discussed investigations use as well as apply not proportional sample to avoid the decreasing of comprehensive in provided studies.

The results of the study will serve as a starting point for further investigation into the causes of higher efficiency of Islamic banks compared to traditional ones. We believe that this is influenced by the different approaches to risk management and additional control of the Sharia commission.

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Annex

Table 1. Transformation of DEA models

Returns to scale	Primary model	Dual model
CRS	$\mu = 0$	$eT\lambda$ - free
VRS	μ - free	$eT\lambda = 1$
NIRS	$\mu \leq 0$	$eT\lambda < 0$
NDRS	$\mu \geq 0$	$eT\lambda \geq 0$

Source: Jablonsky and Dlouhy (2004). Models of efficiency evaluation of the production units.

Table 2. Results of the financial indicators calculations in the Islamic banks (1)

	ROAA	ROAE	CIR	Ropv	ROC	Rp
Mean	0.74	7.99	67.69	2.32	0.55	2.31
Median	0.85	8.42	57.68	1.54	0.44	0.92
Maximum	7.83	55.08	325.10	18.42	5.33	32.72
Minimum	-14.04	-43.21	12.95	-5.58	-4.69	-9.76
Std. Dev.	2.10	10.81	43.31	2.56	0.93	5.22
Skewness	-2.41	0.26	3.15	2.86	0.88	3.70
Kurtosis	18.47	8.95	16.25	15.69	12.16	18.47
Observations	254	254	254	254	254	254

Source: own processing based on the statements of Islamic banks 2015-2017, BankFocus.

Table 3. Results of the financial indicators calculations in the traditional banks (1)

	ROAA	ROAE	CIR	Ropv	ROC	Rp
Mean	0.32	2.55	68.95	0.94	0.22	0.46
Median	0.51	5.22	64.64	0.43	0.22	0.43
Maximum	14.42	280.04	518.73	127.58	7.19	36.94
Minimum	-32.78	-299.42	7.60	-1.16	-6.76	-25.82
Std. Dev.	2.55	22.24	31.54	4.13	0.71	2.12
Skewness	-3.86	-3.24	4.59	24.29	0.99	2.83
Kurtosis	39.89	55.48	49.30	688.20	22.01	83.97
Observations	2285	2285	2285	2285	2285	2285

Source: own processing based on the statements of traditional banks 2015–2017, BankFocus.

Table 4. Results of the financial indicators calculations in the Islamic banks (2)

	CAR	FXEP	LCR	NIM	NPLs
Mean	21.73	21.45	24.23	2.66	7.41
Median	16.67	11.55	21.17	2.41	3.01
Maximum	455.00	576.23	91.15	11.94	77.52
Minimum	-108.49	-73.34	4.90	-4.68	0.00
Std. Dev.	38.17	59.93	15.82	2.56	12.79
Skewness	7.59	5.81	2.08	0.88	3.54
Kurtosis	84.29	44.43	8.33	4.94	16.73
Observations	249	249	249	249	249

Source: own processing based on the statements of Islamic banks 2015–2017, BankFocus.

Table 5. Results of the financial indicators calculations in the traditional banks (2)

	CAR	FXEP	LCR	NIM	NPLs
Mean	22.48	5.46	24.93	4.30	13.33
Median	17.52	3.29	20.60	3.08	6.85
Maximum	837.00	652.40	97.30	64.74	146.60
Minimum	-20.27	-99.99	0.09	-1.25	0.00
Std. Dev.	24.46	28.61	17.73	4.25	18.44
Skewness	18.57	6.35	1.24	3.77	2.87
Kurtosis	555.16	125.99	4.67	30.94	12.86
Observations	2306	2306	2306	2306	2306

Source: own processing based on the statements of traditional banks 2015–2017, BankFocus.

Table 6. The DEA results — Boda and Zimkova's production approach

CCR-O										
1	%	[0.75 - 1)	%	[0.5 - 0.75)	%	[0.25 -0.5)	%	[0 – 0.25)	%	**Total observations**
1	0.75	0	0.00	0	0.00	2	1.50	130	97.74	**133**
9	0.68	1	0.08	4	0.30	30	2.26	1283	96.68	**1,327**
10	0.68	1	0.07	4	0.27	32	2.19	1413	96.78	**1,460**
BCC- O										
1	%	[0.75 - 1)	%	[0.5 - 0.75)	%	[0.25 -0.5)	%	[0 – 0.25)	%	**Total observations**
2	1.50	0	0.00	10	7.52	31	23.31	90	67.67	**133**
31	2.34	24	1.81	63	4.75	157	11.83	1052	79.28	**1,327**
33	2.26	24	1.64	73	5.00	188	12.88	1142	78.22	**1,460**

Table 7. The DEA results — Abu-Alkheil intermediary approach

BCC- O										
1	%	[0.75 - 1)	%	[0.5 – 0.75)	%	[0.25 – 0.5)	%	[0 – 0.25)	%	**Total observations**
24	13.56	36	20.34	58	32.77	54	30.51	5	2.82	**177**
29	1.83	102	6.42	452	28.46	989	62.28	16	1.01	**1,588**
53	3.00	138	7.82	510	28.90	1043	59.09	21	1.19	**1,765**

Table 8. The DEA results — intermediary approach in the group of banks with assets under 2 billion. $

BCC- O										
1	%	[0.75 - 1)	%	[0.5 – 0.75)	%	[0.25 – 0.5)	%	[0 – 0.25)	%	**Total observations**
13	14.61	16	17.98	26	29.21	31	34.83	3	3.37	**89**
20	1.47	112	8.21	566	41.47	653	47.84	14	1.03	**1,365**
33	2.27	128	8.80	592	40.72	684	47.04	17	1.17	**1,454**

Table 9. DEA results — Islamic banks located in Europe (with assets under 2 billion. $)

Name	Country	Efficiency
Kibris Faisal Islam Bankasi	Cyprus	0.345903
KT Bank Ag	Germany	0.247279
Gatehouse Bank Plc	United Kingdom	0.394157
QIB (UK) Plc	United Kingdom	0.869905
BLME Holdings PLC	United Kingdom	0.613426
Vakif Katilim Bankasi Anonim Sirketi	Turkey	0.771715
Al Rayan Bank Plc	United Kingdom	0.967954
Bank of London and The Middle East Plc-BLME	United Kingdom	0.853687
Turkiye Finans Katilim Bankasi AS	Turkey	0.394157

Figure 1. Distribution of IB and TB according to efficiency, BCC-O

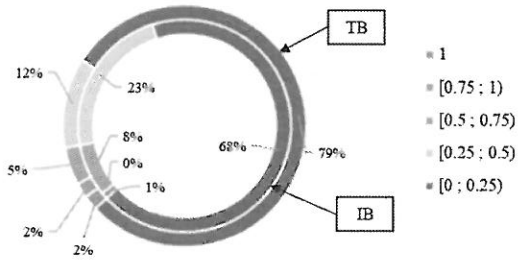

Figure 2. Efficiency of Islamic banks in Europe in 2017