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## EFFICIENCY OF BANKING SECTORS OF THE EUROPEAN UNION. A COMPARATIVE BENCHMARKING ANALYSIS BEFORE AND DURING THE COVID-19 PANDEMIC

Iwona Dorota Czechowska<sup>1</sup>, Tomasz Florczak<sup>2</sup>

<sup>1,2</sup> *Institute of Finance, Faculty of Economics and Sociology, University of Lodz, ul. Rewolucji 19055 r. No 39, 90-214 Lodz, Poland*

E-mails: [dorota.czechowska@uni.lodz.pl](mailto:dorota.czechowska@uni.lodz.pl); [tomasz.florczak@uni.lodz.pl](mailto:tomasz.florczak@uni.lodz.pl)

*Received 15 September 2022; accepted 11 November 2022; published 30 December 2022*

**Abstract.** The banking industry is a crucial sector for any country's economic growth. Therefore, it is essential to study factors that affect bank performance as the findings of this research help regulators and managers make better decisions. Thus, the paper will aim to determine the efficiency level of the banking sectors of the 27 EU countries before and during the COVID-19 pandemic. The article applies the non-parametric Data Envelopment Analysis (DEA) method to measure the performance and efficiency of banking sectors belonging to 27 EU countries. The operationalisation of the objective/methodology will be done by using data from the Eurostat database. The authors will verify the research hypothesis that the number of efficient banking sectors in the EU during the COVID-19 pandemic is lower than before the pandemic. The research period covers years between 2008-2020. The hypothesis was verified negatively because the number of efficient banking sectors during the COVID-19 pandemic was higher than previously. The number of effective banking sectors in the research period wasn't constant. Six effective banking sectors operated in 2020 (the first year of the COVID-19 pandemic), one even more effectively than in 2019. Those effective ones in the entire study period were banking sectors from Cyprus, Luxembourg and Romania.

**Keywords:** banking sector; Data Envelopment Analysis; Non-Parametric Approach; efficiency

**Reference** to this paper should be made as follows: Czechowska, I.D., Florczak, T. 2022. Efficiency of banking sectors of the European Union. A comparative benchmarking analysis before and during the COVID-19 pandemic. *Entrepreneurship and Sustainability Issues*, 10(2), 319-332. [http://doi.org/10.9770/jesi.2022.10.2\(19\)](http://doi.org/10.9770/jesi.2022.10.2(19))

**JEL Classifications:** G20, G21, C14

### 1. Introduction

The banking sector in most economies is seen as the bloodstream of the economy, an essential part of the financial system, which plays a vital role in achieving economic growth and expansion thanks to the fact that it is the primary source of funds for long-term investments and the foundation of economic growth (Schumpeter, 1934). The banking sector is also very often referred to as the backbone of the financial system. Therefore, as Levine (1998) points out, an efficient banking sector and the financial system affect, on the one hand, economic growth and, on the other, bank (financial intermediation) insolvencies could result in systemic crises and consequently negative implications on the economy (Kamarudin et al., 2016). An analysis of the content of the

Top 100 Scopus articles identifies five basic themes related to profitability, productivity and efficiency of the banking sector: efficiency determinants, methodology, ownership form, financial crises and economies of scale (Ahmad, Naveed, Ahmad, and Butt, 2020). The authors of this study follow this trend by analysing most of the aspects of effectiveness mentioned above. It has been assumed that banks are exposed to various types of risk that affect their effectiveness. In previous studies, the links between risk and effectiveness were most often observed while focusing on periods of financial crises (Amild, Zhu, 2016).

A new research issue is assessing the level of banks' effectiveness during the COVID-19 pandemic. In order to examine the results and efficiency of banking sectors in individual countries, this study uses the non-parametric Data Envelopment Analysis (DEA) method. Many empirical studies have determined the effectiveness of banks in various countries (Bhatia et al., 2018, Sickles, Zelenyuk, 2019). As indicated (Ahmad, Naveed, Ahmad, Butt, 2020), the most frequently cited article on the topic of bank efficiency is "Problem loans and cost-effectiveness in commercial banks" by Berger and DeYoung (1997). The efficiency of banks has been described in European countries (Ayadi et al., 2015, Mirzaei, Moore, 2019, Al.-Gasaymeh, Samarah, 2020). The countries from Eastern and Central Europe were also studied (Pancurova, Lycosa, 2013, Grmanová, Ivanová, 2018). Lozano-Vivas et al. (2002) examine ten EU countries, Bergendahl (1998) focuses on Nordic countries, while Pasiouras (2008a) examines an international dataset. However, the research concerned only some of the banking sectors of the EU countries. To a minimal extent (Casu, Molyneux, 2003), hardly any studies assessed the overall efficiency and effectiveness of banking sectors in the EU-27. A study covering the banking sectors of all EU countries is necessary to establish a comprehensive assessment of the effectiveness of banking sectors in the EU, both before and during the pandemic. In order to fill this gap, this study aims to determine the level of effectiveness of the banking sectors of the 27 EU countries before and during the COVID-19 pandemic. Determining the classification of banking sectors according to efficiency and effectiveness will guide troubled banking sectors, the banking sectors of the countries that are the most efficient. The authors will verify the research hypothesis that the number of efficient banking sectors in the EU during the COVID-19 pandemic is lower than before the pandemic.

The individual chapters are organised as follows. Chapter 2 and chapter 3 contain the literature review, while chapter 2 discusses bank efficiency, and chapter 3 is a dedicated DEA description. Chapter 4 summarises the data and methodology used in this study. Chapter 5 presents the research results, and there is a brief discussion about the results of our research and other research in the literature on the subject. The last one, chapter 6, summarises the article.

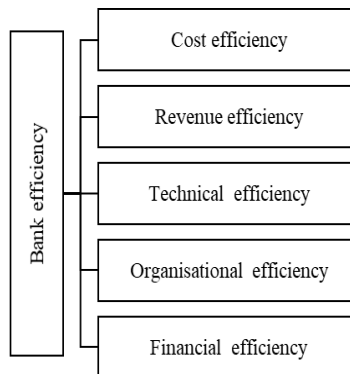
## **2. Efficiency of banks - theoretical background**

Before embarking on the empirical assessment of banking sector efficiency, it is worth looking at this issue in the theoretical context and from the perspective of the condition of the banking sector. Determining the essence of efficiency, as well as indicating and selecting the best methods of its measurement, depends on the context in which the concept of efficiency is applied. This term has numerous definitions and applications in the scientific literature; it is present, for example, in the theory of organization and economics. In the case of the theory of organization, there is the concept of the degree of achievement of goals and effectiveness (Shaw, 2009; Henri, 2004). Within the framework of economic theory, in the classical approach, the efficiency criterion was related to the relationship between effects/outputs and inputs/resources and was called resource allocation optimization. Economic efficiency is measured through cost analysis (Giokas, 2008). The efficiency criterion allows for assessing how well the market allocates resources. In this approach, the allocation was better when the production costs (inputs) were lower (Camanho, Dyson 2005).

The banking sector is one of the most complex sectors of the economy and one of the main sectors contributing to national well-being ([taxtracker.eu/bank-profiles](http://taxtracker.eu/bank-profiles)). As researchers point out, this sector plays a growing role in developing the financial system (Henriques et al., 2020). The assessment of financial institutions, which are

banks, is critical to support the decision-making process, not only from the microeconomic perspective but also from the macroeconomic perspective (Fethi, Pasiouras, 2010). The concept of banks' effectiveness or the effectiveness of the banking system has been described in many ways. The efficiency of banks is determined by factors related to the macro-environment - e.g. fiscal policy, interest rates, and regulatory requirements (Brissimis et al., 2008). In a narrow sense, the effectiveness of banks depends on the adopted operating policy, e.g. granting loans on the bank's pricing policy, dividend policy, asset structure and quality (Casu, Molyneux, 2003).

Based on the financial literature on the issue of examining bank efficiency, a distinction is made (Perek, 2014): cost efficiency (which assesses how efficiently a bank manages its costs, to what extent a given bank's costs are close to those of the most efficient bank (Giokas, 2008a, Noulas et al., 2008); profit efficiency (which concerns the assessment of profit maximisation at specific prices and a certain amount of inputs and outputs, assessing how close a given bank's profit is to the highest profit generator with the same resources) (Coelli et al., 2005); technical efficiency (which is a relative measure, referring to other objects of the group under study (Coelli et al., 2005), assessing how effectively a bank manages costs). In other words, technical inefficiency is the excessive use of inputs to produce a given volume of output, i.e. according to Farrell it is the relationship between the productivity of a given object and the limit of its actual production capacity (1957); organisational efficiency (which assesses the degree to which objectives are achieved) (Shaw, 2009); financial efficiency (assessment of financial performance on the basis of financial statements and a set of indicators). Its determinants include capital, assets, profit (e.g. Haralayya, Aithal, 2021). These types are presented in diagram 1.



**Diagram 1.** Types of bank efficiency

*Source:* based on Perek, 2014

In economic practice, depending on the type of effectiveness, various methods are used to evaluate it: based on indicator analysis, parametric and non-parametric methods (Coelli et al., 2005). Parametric methods used to measure efficiency involve solving an optimisation problem. Econometric approaches use stochastic frontier models (functions). The problem in applying these methods is the identification of the inputs and outputs of banking institutions. Using the Sealey and Lindley approach, it was considered that the factors of production are human capital, financial capital and physical capital. On the other hand, the final effects of activities are those services with a higher value than the inputs incurred, i.e. loans and credits (Sealey, Lindley, 1977). The group of parametric methods includes the Thick Frontier Approach (TFA) and the Distribution-Free Approach (DFA). Parametric methods also include the Stochastic Frontier Approach (SFA). This method needs a specific functional form that assumes the shape of the efficient frontier and presupposes a specific efficiency distribution level. A significant limitation of this approach is that measured efficiency will be incorrect if assumptions are misspecified (Bauer et al., 1998). Parametric methods are used for cost and revenue efficiency analysis. In parametric methods, assumptions about the relationship between inputs and outputs are made. On the other hand, in non-parametric methods, a production function is defined and set against the best banks in a given period. In the next step, the

relative remoteness of the remaining banks from the predetermined benchmark is assessed. In this case, the distance is a measure of the inefficiency of a given bank vis-à-vis the leader banks. DEA - Data Envelopment Analysis is often indicated among the non-parametric methods used to study the technical efficiency of banks. DEA is a benchmarking method that compares the studied entity's efficiency to the benchmark efficiency (Cook, Seiford, 2009).

### **3. DEA: a brief description**

DEA is a non-parametric linear programming technique proposed by Charnes, Cooper, and Rhodes (1978). A mathematical programming technique DEA, aims to evaluate the efficiency with which a given decision-making unit converts its inputs into outputs. This method allows several inputs and outputs to be compared simultaneously. With the DEA method, it is possible to identify the efficient units in a given sample by limiting their productive capacity. The DEA method has several limitations. It is prone to measurement error and depends on the choice of variables representing inputs and outputs (Fethi, Pasiouras, 2010). Technical efficiency can be estimated under an input-oriented or output-oriented approach, but most studies use efficiency assessment under the input-oriented approach (Coelli et al., 2005). The analysis of the level of technical efficiency depends on the adopted inputs and outputs; with no strictly defined inputs and outputs in the literature, their choice depends on the purpose of the analysis (Kopinski, Porębski, 2018). The concept of the bank as an intermediary and producer is the most commonly used for this purpose. In these models, deposits have a dual character and can appear as inputs and effects of banking activities (Berger, Humphrey, 1997).

In the literature, there are between two and five approaches to the technology of modelling bank activities and the application of Best Practice Frontier theory concepts, with different perspectives and different choices for inputs and outputs (effects). Banks' perspectives are distinguished: production, intermediation, value-added, assets, and user costs (Berger, Humphrey, 1997). From the production perspective, a bank is likened to an industrial enterprise, to a Decision Making Unit (DMU) using physical and financial capital and labour for production. This approach is often used to analyse the efficiency of individual banks and often prevents sectoral analysis (Kenjegalieva, Simper, Weyman-Jones, 2009). The intermediation perspective assumes that banks as intermediaries convert savings into investments, i.e. they make cash available to customers for development. In this arrangement, inputs are deposits and other funds, together with labour or tangible assets, while outputs/products are loans and credits (Barth et al., 2013). From the value-added perspective, the bank is treated as an institution, a provider of financial services, generating income from the difference between the income from the products sold and the cost of producing those goods. In this case, inputs and outputs are determined by the bank's share of profits. From the asset perspective, as in the intermediation perspective, banks offer various types of deposits and investments, using deposits, labour and fixed assets. On the other hand, from the user cost perspective, outlays and effects are determined by their nature (Czechowska et al., 2022).

The DEA method, introduced to banking more than 40 years ago, has gained importance and becomes more popular (Yang, 2016). The DEA method applied to banks allows us to assess which banks were efficient, how their efficiency evolved in the analysed period, and also to develop benchmarking of the banks under study and identify the occurrence of differentiation. The strengths of DEA include the versatility of application vis-à-vis parametric methods, efficiency in dealing with complex production processes (Schaffnit et al., 1997), the possibility of evaluation with different inputs and different effects (Svitalkova, 2014), the possibility of individual analysis of each DMU and comparison with other DMUs, as well as the identification of inefficient units by indicating benchmarks (Aggelopoulos, Georgopoulos, 2017). Despite the incredible popularity of this method, its traditional approach is criticised for not considering the environment, in which the bank operates (Henriques et al., 2020). It can be considered that it is still a method in its formative stages. The current state of knowledge concerning the application of the DEA method is being extended to solve various problems, e.g. the lack of a uniform approach to the selection of variables that affect the assessment of efficiency, the analysis of the impact

of changes in regulation or the market environment on bank efficiency, especially during the financial crisis or the COVID-19 pandemic. There are many unresolved issues in the literature concerning the application of this method as a measure of banking sector efficiency, e.g. the problem of qualifying deposits as inputs or outputs. There is a view in the literature that the DEA method can be used to complement the traditional methods of efficiency assessment while keeping in mind both the problems of input-effect selection and the drawbacks of this method (Iqbal, Lerme, 1997).

Assessing the efficiency of the banking system generates various problems. One is the link between the various regulatory burdens and their impact on efficiency. It is noteworthy that supervision and the number of different types of regulations applied to the banking system are increasing to improve the efficiency and resilience of the global financial system to a potential increase in risk. The issue of excessive regulation of the financial market, including banking, and its impact on the efficiency of the banking sector is not definitively resolved (Andries, Capraru, 2013, Roy, Kemme, 2020; Mukherjee et al., 2021). Summing up, the considerations on efficiency presented above, it can be claimed that the banking sector is very dynamic. It operates in a rapidly changing environment, which means that to assess its condition or efficiency, which is the basis for strategic decision-making, tools and instruments will be used, which are also subject to transformations and modifications.

#### **4. Research objective and methodology**

The health crisis caused by COVID-19 resulted in an economic crisis. The development of the pandemic had a significant impact on the maintenance of financial stability. The pandemic and the associated restrictions on the virus's spread have negatively affected banking customers' finances. A source of risk to the economic situation and the financial system's health was the uncertainty associated with the global economic situation. The pandemic led to many companies having to scale down and suspend their operations. Restrictions were put in place, consisting of a total lockdown. The outbreak caused a decline in activity, mainly in the service sector. Customers in the banking sector lost their jobs. The reduction in society's income during the pandemic increased concerns about household financial security. Among the public, the factors that built security were savings and the low scale of over-indebtedness. Customers without savings buffers were at a disadvantage. Measures directed at saving the economy were needed (Solarz, Waliszewski, 2020). Therefore, public anti-crisis support was directed at companies and borrowers (e.g. Report, 2020). The pandemic resulted in a significant increase in debt risk. After a major credit market collapse shortly after the outbreak of the pandemic, also due to the risk of deterioration of industries particularly vulnerable to the pandemic, the situation began to improve. Gradually, banks became optimistic about the credit market situation and eased credit requirements (Czechowska et al., 2020).

Due to the assumption of the completeness of the group researched with the DEA method, 27 banking sectors of EU countries were included in the study. Considering that during the last few years, there have been two significant events (the financial crisis of 2007 and COVID-19) affecting the economies of most countries, the years 2008-2020 were assumed for the research period. Therefore, the paper aims to determine the efficiency level of the banking sectors of the 27 countries at the time before and during the pandemic. The obtained results are significantly influenced by the adopted DEA model and the variables used in the study as inputs and outputs. There is a two-level division of DEA Models in the literature on the subject. The first criterion is the orientation of the model to inputs or outputs. The second level of model breakdown involves the approach to the effects of scale (Kosmaczewska, 2011). The basic approach (radial) to efficiency involves identifying proportional changes in all inputs or outputs (Guzik, 2009). The literature distinguishes non-radial efficiency (Russell efficiency), which consists in calculating unit efficiency indicators (for each input or effect, we obtain an efficiency index). Because of that, it is possible to indicate changes in individual inputs or outputs that should be introduced for the DMU to be effective in terms of a given input or output. The efficiency index for DMU is the average of the effectiveness indicators of individual inputs (or outputs) (Russell, 1985).

In the study of the efficiency of banking sectors of the EU countries, an input-oriented non-radial DEA model with variable effects of the scale was used. Determining the efficiency of banking sectors required the selection of variables representing inputs and outputs. The research used data from Eurostat for monetary financial institutions other than the central bank (ESA 2010). The authors used the bank's approach as a producer and initially assumed:

1. Equity - equity determines the size of the bank's operations. An example of such dependence is that the amount of equity depends on the possibility of increasing specific components of the balance sheet, i.e. loans granted (Galbarczyk, 2009).
2. Value of debt securities issued by entities from the banking sector - the issue of securities constitutes a stable source of bank financing. It gives the issuer flexibility in determining the amount and term of the loan. The value of debt securities also affects the bank's lending activity and is a source of financing its operations (Węgrzyn, 2020).

The outputs are the value of the primary products offered by the banking sector:

1. The value of deposits placed in the banking sector - obtaining funds in the form of deposits enables the creation of credit money (Stola, 2013). On the one hand, the value of deposits can be described as the primary method of obtaining funds by the bank; on the other hand, it is the result of the bank's activities. For this reason, if the bank's role as a producer is adopted, the value of deposits is considered an effect.
2. Value of loans granted by entities from the banking sector - loans are an asset item in the balance sheet of banks and generate the highest profit among assets. The value of the loans granted is the primary effect of the bank's operations (Wiatrzyk, 2018).

The data adopted for the efficiency of banking sectors study carried out with the DEA method should meet several criteria. One is the low correlation between the inputs and the low correlation between the outputs. In order to determine the correlation between the adopted variables, the linear Pearson correlation was used. Based on the results obtained for the individual years of the 2008-2020 research period, the authors decided to exclude the variable covering the value of loans and advances granted to entities from the banking sector from the study.

The analysis of the results obtained from the applied model was carried out in two stages:

1. indication of effective and ineffective objects;
2. determination of the effectiveness concerning each input.

## 5. Results and discussion

### Results

The study included the determination of the efficiency of the banking sectors of the EU countries in the period 2008-2020. The measure of relative technical effectiveness in DEA method is (Baran, 2007):

$$e_j = \frac{\sum_{r=1}^R \mu_r Y_{rj}}{\sum_{p=1}^P v_p X_{pj}}$$

where:

$e_j$ —effectiveness of object  $j$ ;

$\mu_r$ —weight of the effect  $r$ ;

$v_p$ —weight of the input  $p$ .

**The first stage** of the research was to determine which banking sectors were effective. Efficient banking sectors have an index value of 1 in the input-oriented DEA model. Any banking sector with an index below 1 is ineffective. Table 1 shows the value of the average efficiency ratio for the banking sectors of the 27 surveyed countries. It should be noted that the results in the table below show the efficiency ratio at the end of a given year. The conducted analysis is not an analysis of the dynamics of changes in efficiency.

**Table 1.** Efficiency indicators of the banking sectors of EU countries in period 2008-2020

Country of the banking sector	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	0,432	0,375	0,206	0,106	0,269	0,281	0,292	0,264	0,250	0,262	0,186	0,350	0,341
Belgium	1,000	1,000	0,422	0,299	0,563	0,479	0,457	0,473	0,349	0,280	0,221	0,350	0,356
Bulgaria	1,000	1,000	0,975	0,699	0,575	0,688	0,618	0,560	0,405	0,510	0,376	0,418	0,420
Croatia	0,496	1,000	1,000	0,701	1,000	0,781	0,749	0,770	0,418	0,670	0,403	0,358	0,416
Cyprus	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Czechia	0,572	0,642	0,491	0,329	0,545	0,480	0,452	0,431	0,309	0,363	0,276	0,395	0,343
Denmark	1,000	1,000	1,000	0,461	0,558	1,000	1,000	0,426	0,417	0,335	1,000	1,000	1,000
Estonia	0,417	1,000	1,000	1,000	0,500	0,500	0,500	0,500	1,000	0,468	0,278	0,250	0,243
Finland	0,423	0,419	0,321	0,160	0,516	0,511	0,533	0,445	0,280	0,476	0,129	0,242	0,234
France	0,685	0,497	0,352	0,195	0,500	0,459	0,478	0,472	0,330	0,295	0,305	0,489	1,000
Germany	0,569	0,553	0,360	0,157	0,465	0,502	0,467	1,000	0,425	0,388	0,281	0,462	0,374
Greece	1,000	1,000	1,000	1,000	0,714	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Hungary	0,494	0,425	0,399	0,256	0,476	0,433	0,534	0,440	0,290	0,271	0,268	0,232	0,268
Ireland	0,691	0,479	0,301	0,165	0,202	0,163	0,166	0,224	0,150	0,173	0,149	0,216	0,221
Italy	0,885	0,597	1,000	0,510	1,000	1,000	1,000	0,453	0,493	0,405	0,405	0,497	0,519
Latvia	1,000	1,000	0,699	0,465	0,580	0,514	0,522	0,521	0,324	0,363	0,374	0,369	0,351
Lithuania	1,000	0,782	0,529	0,420	0,553	0,799	1,000	1,000	0,500	0,500	0,500	0,500	0,500
Luxembourg	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Malta	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,500	0,500	0,500
Netherlands	0,950	1,000	1,000	0,335	0,527	0,634	1,000	0,501	0,438	0,322	0,214	0,363	0,279
Poland	0,408	0,401	0,405	0,359	0,382	0,333	0,382	0,438	0,312	0,293	0,322	0,434	0,576
Portugal	0,891	0,824	0,711	0,375	0,571	0,592	0,483	0,508	0,407	0,328	0,282	0,407	0,401
Romania	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Slovakia	1,000	1,000	1,000	0,444	1,000	1,000	1,000	0,475	0,341	0,390	0,359	0,454	0,428
Slovenia	0,639	0,599	0,429	0,217	0,828	0,496	0,446	0,474	0,323	0,387	0,387	0,378	0,403
Spain	1,000	0,659	0,673	0,314	0,554	0,443	0,347	0,405	0,314	0,257	0,235	0,402	0,485
Sweden	0,557	0,372	0,236	0,121	0,275	0,223	0,219	0,211	0,153	0,153	0,181	0,373	0,386
<b>Number of effective banking sectors</b>	<b>12</b>	<b>13</b>	<b>11</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>10</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>6</b>

Source: own study based on data from Eurostat (2022) database

According to the information from the table 1, most banking sectors were effective in 2008-2010. The banking sectors in Cyprus, Denmark, Greece, Luxembourg, Malta, Romania and Slovakia were effective in each of these years. In period 2011-2013, fewer banking sectors were effective (less than nine effective banking sectors). Probably at that time, the financial crisis had a negative effect on the efficiency of banking sectors. The banking sectors in Cyprus, Luxembourg, Malta and Romania were effective in each of these three years. In 2014, ten banking sectors were effective, which could have been related to the lower impact of the crisis on the situation in the banking sector. However, in each of the following years the number of effective banking sectors decreased: seven effective banking sectors in 2015; six effective banking sectors in 2016; five effective banking sectors each in period from 2017 to 2019. This could be related to an attempt to limit the effects of the crisis and to prevent

further crises. In the EU, in the years following the onset of the financial crisis, legal acts were introduced to limit the uncontrolled growth of the financial sector and its impact on the economy. A smaller number of effective banking sectors after 2014 may be associated with the introduction of new legislative packages. Taking into account the onset of the pandemic, in 2020 (the latest available data), there was one more efficient banking sector than in 2017-2019. This means that the initial phase of the pandemic did not significantly affect the efficiency of the banking sectors of the EU countries. To sum up, three banking sectors (Cyprus, Luxembourg and Romania) were effective in each of the analyzed years. In Cyprus and Luxembourg, the banking sectors play an essential role and are the most important sectors of the economies of these countries. An interesting case is the banking sector in Romania, the effectiveness of which may result from the ability of Romanian credit institutions to absorb losses resulting from unforeseen market events, i.e. the financial crisis (Cichy, Puszer, 2016).

**The second stage** of the study is to indicate the effectiveness of banking sectors in terms of individual expenditures. A greater number of banking sectors achieved efficiency in terms of the value of equity in individual years than in the case of the average efficiency ratio. In the period 2008-2014, less than 12 analyzed banking sectors were effective only in 2011. From 2015, the number of effective banking sectors was equal to or less than ten. However, it should be noted that, as in the case of the average efficiency ratio, the number of effective banking sectors in the first year of the pandemic (nine effective banking sectors in 2020) was higher than in the previous year (seven effective banking sectors in 2019). This means that the pandemic has not influenced into fewer efficient banking sectors. In each of the analyzed years 2008-2020, four banking sectors were effective: those operating in Cyprus, Luxembourg, Romania and Malta.

The efficiency in terms of the value of issued debt securities in 2008-2020 was demonstrated for the same number of banking sectors as in the case of the average efficiency ratio. This means that the value of this input contributed to ineffectiveness of some banking sectors and a lower number of effective banking sectors. Due to this expenditure, as in the case of the average efficiency ratio, three banking sectors (the banking sector in Cyprus, Luxembourg and Romania) were effective. The greater number of efficient banking sectors in 2008-2010 may have been due to the lower value of issued securities. This could have been caused by the financial crisis and the decline in confidence in banking institutions. The performance of the banking sectors in the period 2015-2019 leading up to the pandemic may indicate an increase in the value of securities issued by banks. There could be several reasons for this. One of them is adapting to the legal acts defined by the EU to reduce the impact of the financial sector on the economy and reduce the likelihood of another financial crisis. On the other hand, during the pandemic, the value of securities issued by banks may have decreased due to the lower value of free cash at the disposal of other institutions (e.g. non-financial companies). At the same time, in 2020, compared to the previous year, there was one more efficient sector. This was because most enterprises and households decreased their propensity to take out loans. Enterprises were uncertain about their activities in the short term. Therefore, they were not willing to finance themselves with debt. On the other hand, they probably used free funds to finance current operations. This means that the lower value of securities issued by the banking sector (in this study of the input) took place with a simultaneous decline in lending (the value of loans is an output in this study). For this reason, only one more banking sector was effective than in 2019.

### **Discussion**

The performance of banks and banking sectors has been the subject of many studies. In the source literature, the DEA method is often used to test effectiveness. Some authors compare the results obtained with the use of individual different DEA models, e.g. comparing the results from the CCR model with results from the BCC model (Chpradit et al., 2021). Others check how the variables adopted for the study affect the obtained results (Učkar, Petrović, 2021; Novickyte, Drożdż, 2018). The literature includes studies covering the banking sectors of various countries (Doan Tuan, 2020) or selected banks operating in a given country (Hosszù, Dancsik, 2018; Akhtar et al., 2021). Research into the performance of banking sectors or banks covers a different period. Some



cover the period after the 2007 financial crisis and before the pandemic ( Cvetkoska et al., 2021), and others focus on a single year (San-Jose, 2018).

The research described in this article included the determination of the efficiency of banking sectors of the EU countries before and during the pandemic. The authors used the non-radial BCC input-oriented model. Moreover, the application of non-radial efficiency made it possible to indicate which outlays contributed to the achievement of efficiency or a lower / greater ineffectiveness of the banking sectors of the EU countries. An interesting approach to the issue of bank efficiency was adopted by Titko, Stankevičienė and Lāce (Titko et al., 2014). They studied Latvian banks efficiency using 14 alternative models with various combinations of inputs and outputs. As a result, they defined a set of inputs and outputs that best reflect the specificity of the Latvian banking sector and the effectiveness of its banks. The authors of this study focused on determining a set of variables that best describe the efficiency of Latvian banks using the output-oriented BCC model. In turn, Da Silva Fernandes F., Stasinakis Ch. and Bardarowa V. (Da Silva Fernandes et al., 2018) focused on examining changes in the efficiency of banks operating in GIIPS countries (Greece, Ireland, Italy, Portugal, Spain) in a period 2007-2014 using the Malmquist index. The selected decomposition of this index made it possible to indicate potential reasons for efficiency changes. The study was supplemented with Double Bootstrapped Truncated Regression, which allowed to determine whether changes in the financial situation of banks in the surveyed countries affect the level of their effectiveness in different ways. There are also studies similar in terms of the time range to that carried out in this article, e.g. study by Belas J. et al. (2019) was to determine the cost-effectiveness of the banking sectors of the EU Member States in the period 2008-2017. The authors also attempted to identify macroeconomic variables and variables describing the banking sector that affect cost effectiveness. It is difficult to compare the results presented by other authors with the results of this study. Each study differs in the research scope (other countries are taken into account, or the time trial does not cover the onset of COVID-19). Based on research made by other authors, the study of banking sector efficiency can be extended to include the determination of variables that best reflect the specificity of banking sectors in EU countries. It would also be possible to compare the results obtained from different DEA models. Studying the dynamics of changes in efficiency would also broaden the interpretation of the results. Especially taking into account the changes in efficiency resulting from external factors in 2020, they could indicate an indirect impact of the pandemic on the efficiency of the banking sectors under study.

## **6. Conclusions**

The efficiency of banking sectors or banks is an important issue discussed in the literature. Both parametric and non-parametric methods are used to test their efficiency. Some authors focus on choosing the appropriate approach to understanding the functioning of the bank (producer or intermediary), or the variables that describe the inputs and outputs of banking sectors. Others focus on different types of effectiveness (e.g. cost-effectiveness) or extend the research to apply further research methods. This study attempts to examine the efficiency of the banking sectors of the EU countries before and during the pandemic. Due to data availability, the research period covered the period between 2008-2020. The study was conducted with the use of the non-radial BCC input-oriented model. The bank-as-producer approach was used in determining the inputs and outputs. Ultimately, the study used outputs in the form of the value of equity and the value of debt securities issued by banking institutions. On the other hand, the outputs were the value of deposits placed with banking institutions and the value of loans granted by these institutions. The research results show that most banking sectors were effective at the beginning of the financial crisis. From 2011, a maximum of eight banking sectors were efficient (except in 2014). In each of 2017-2019, five banking sectors were efficient. Interestingly, in the first year of the COVID-19 pandemic, six banking sectors were efficient. This means that the pandemic and restrictions did not significantly affect the number of effective banking sectors. Based on the obtained results, it should be concluded that the hypothesis that the number of efficient banking sectors in the EU during the COVID-19 pandemic is lower than before the pandemic has been verified negatively. In each of years 2008-2020, the banking sectors in three countries (Cyprus, Luxembourg, Romania) were effective. The efficiency of each input in non-radial efficiency

makes it possible to indicate which inputs influenced a smaller number of effective banking sectors. In the case of this study, the effectiveness of the value of issued debt securities meant that the effectiveness reached a smaller number among the analyzed banking sectors. It should be remembered that the interpretation covers the number of effective banking sectors because the efficiency indicators should not be compared because the DEA method includes determining the effectiveness at a given moment.

The results obtained using the DEA method depend on many factors. The inputs and outputs adopted for the study are the most important ones. Variables were adopted in the study due to the role of the bank as a producer. Subsequent research should focus on finding a set of variables that reflect the specificity of the banking sectors of EU countries in different approaches to the role of the bank. What proves to be important is also the model adopted for the research. In this study, the BCC model was used, i.e. a model with variable scale effects. In future research, models can indicate the direction of changes in the effects of scale. It is worth supplementing the analysis of the effectiveness of researched banking sectors for the entire period of 2008-2020 with the determination of the dynamics of efficiency changes in these sectors. This would make it possible to indicate how the efficiency of banking sectors has changed from year to year. Moreover, each of the methods used can be developed through the use of other parametric and non-parametric methods, which would increase the interpretative possibilities of results.

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**Author Contributions:** Conceptualization, methodology, data analysis, writing—original draft preparation, writing review and editing, visualization: Iwona D. Czechowska, Tomasz Florczak. The authors have read and agreed to the published version of the manuscript.

**Iwona Dorota CZECHOWSKA, professor**, head of the Department of Central Banking and Financial Intermediation at the Faculty of Economics and Sociology of the University of Lodz. Lecturer of subjects in the field of finance, banking, monetary policy and consumer protection in the financial market. Editor-in-chief of the scientific journal Finance and Financial Law. Author of many articles and seven books in the field of finance, banking, consumer transformations as well as security in the financial system, monetary policy and ethics in finance.

ORCID ID: <https://orcid.org/0000-0002-8051-5324>

**Tomasz Florczak - Ph.D.**, lecturer in Department of Central Banking and Financial Intermediation at the Faculty of Economics and Sociology of the University of Lodz. Lecturer of subjects in the field Financialization with particular emphasis on the banking sector, deposit guarantee schemes and the use of statistical and non-parametric methods in research related to the above-mentioned topics. Legal and Organisational Issues Editor of Journal of Finance and Financial Law.

ORCID ID: <https://orcid.org/0000-0002-9111-3400>

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