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Cost efficiency in commercial banking in Poland. Linear ordering approach

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Abstract

Motivation: Previous research has primarily focused on the impact of operational efficiency on bank profitability. An in-depth review of the literature indicates that there is a lack of studies aimed at identifying the characteristics of banks with similar levels of cost efficiency.

Aim: The aim of the article is to identify clusters of banks with similar profiles, given the level of operating costs relative to the scale and profitability of operations.

Results: Operational efficiency is positively related to bank profitability, and economies of scale manifest themselves in the form of relatively higher cost efficiency of large credit institutions. The results confirm the validity of the management strategy of the abrupt reduction of operating costs in commercial banks and create premises for supervisory authorities to



prepare the expected (optimal) scenario of banking sector structure evolution and adjust to it the regulatory policy.

Keywords: commercial bank; cost effectiveness; linear ordering; cost-income; profitability

JEL: G20; g21

1. Introduction

In studies devoted to the CIR as an independent or dependent variable, this ratio is considered not only as a measure of efficiency (e.g. Ayinuola and Gumel, 2023; Xu et al., 2019 and Metadata glossary in the DataBank of the World Bank), but also of profitability indicator (e.g. Statista, 2023), although the latter perspective appears relatively seldom in the literature and in various types of reports by consulting firms.

The question arises as to why the analysis of the dynamics and determinants of CIR, as well as the consequences of changes in CIR, is important. Firstly, fierce competition in the banking sector makes cost efficiency one of the key determinants of bank profitability (Assaf et al., 2019; Hassan et al., 2024). The results revealed that the impact of CIR on return on assets (ROA) is negative and significant, reflecting the detrimental effect of high CIR on bank performance. In turn, profitability is an important factor in building a bank's capital (Gropp and Heider, 2007). The resilience, survival during a crisis, and potential for credit are determined by the bank's own funds. Secondly, the CIR is one of the most important multipliers used in bank valuation (Gounder and Nair, 2023). Thirdly, the CIR, through peer group comparison, is an indicator of a bank's potential to reduce its operating costs and the direction of its growth.

Previous research has primarily focused on the impact of operational efficiency on bank profitability (Hess and Francis, 2004; Almazari, 2012, Xu et al., 2019), the effect of cost efficiency on bank risk (Assaf et al., 2019), influence of the bank specific characteristics (inter alia cost efficiency) on its valuation (Gounder and Nair, 2023) or the relationship between the quality of a bank's credit portfolios or balance sheet structure with cost efficiency (Srivastava and Kumar, 2021). Relatively few studies have been devoted to the determinants of banks' cost efficiency and to establishing sets of characteristics of banks with similar levels of efficiency. Among these few, a study by Klepczarek (2019), who proves the impact of selected corporate governance mechanisms on the cost efficiency of banks listed on the WSE, stands out. In particular, this author, using linear regression model (pool), as well as models with fixed and random time effects and group effects (fixed effects, FE and random effects, RE), concludes that there is a negative correlation between the independence of a bank's board and its cost efficiency. An in-



depth review of the literature indicates that there is a lack of studies aimed at identifying the characteristics of banks with similar levels of cost efficiency, including those using a methodology other than the linear regression model. The research gap identified above becomes the rationale for the formulation of the research objective. The purpose of the study is to identify clusters of banks with a similar profile, given the level of operating costs relative to the profitability and scale of the bank's operations. The paper focuses on operating expenses, which primarily include wages, marketing costs, real estate and vehicle fleet maintenance costs, amortisation and utility consumption opex. Based on the characteristics of banks belonging to specific groups, similarities in terms of their business model are established. The study is based on a sample consisting of 17 commercial banks registered in Poland (banks in the form of joint stock companies excluding mortgage banks and those operating for less than 5 years), which together account for more than 78.6% of the assets of the Polish banking sector as of the end of 2022.

The article is the first analysis aimed at identifying similarities among banks belonging to clusters created on the basis of the operating cost management model under the strong impact of extraordinary events. In this context, it fills a research gap. The results indicate that a bank's operational efficiency, as approximated by the ranking determined by its 5 measures, is positively correlated with the size of the institution and its profitability. We also show that between 2018 and 2022, the vast majority of Polish banks have improved or stabilised at a high level their cost efficiency.

The remainder of this article is structured as follows. Section 1 reviews the most significant literature. The next one describes the data and methodology employed in the empirical research. Section 3 presents results and their discussion. The last part of the manuscript summarises and presents the main conclusions.

2. Literature review and hypotheses development

Searching for characteristics of banks with similar levels of cost efficiency, two strands of research come to the fore. The first concerns the relationship between cost efficiency and bank profitability. Here, the question most often asked is whether banks with relatively better cost efficiency produce a higher return on equity or assets. The second strand centres around economies of scale theory, with bank size usually considered from the perspective of a bank's total assets or revenues. In addition to the above-mentioned main research areas, one can also point to analyses aimed at determining the impact of a bank's shareholding structure, board of directors and CEO characteristics on the CIR (Klepczarek, 2019), also the relationship between the CIR and the cost of equity (Bochmann et al., 2023) or impact of cost efficiency on

bank stability (Kozak, 2010). The CIR is also used in the benchmarking when reviewing bank's operational efficiency (Hess and Francis, 2004). Burger and Moormann (2008) indicate the following factors affecting the CIR: business model, regional focus, cyclic improvements of income, non-recurring effects, risk affinity and balance sheet management. Endri et al. (2022) evaluate the efficiency of Islamic Rural Banks in Indonesia in the period between 2013 and 2021. They conclude that ROA, growth rate, inflation and CIR contribute to the improvement of bank's efficiency while Capital at Risk, NPL and Loans/Deposits ratios are destimulants.

2.1. Cost efficiency and profitability

The results of studies devoted to the relationship between cost efficiency and bank profitability are ambiguous. The results are highly dependent on market power and the ability of banks to pass on operating costs to their customers and other stakeholders. If banks have this ability, which happens in less competitive markets, the correlation between the CIR and bank profitability is positive (Flamini et al., 2009). Most studies point to a negative impact of the CIR on the bank performance. Ayinuola and Gumel (2023) document significant and negative effect of the CIR on ROA. These authors state however that interacting the CIR with capital adequacy and bank size exerts positive and negative effects on the profitability. Xu et al. (2019) also confirm positive impact of operating efficiency on bank profitability measured by ROAA, ROAE and risk-adjusted returns. They also suggest that the greatest improvements in efficiency following the global financial crisis are recorded by GSIBs and US banks. Analysing the profitability of banking systems in the Central European countries Uralov (2020) proves negative correlation between the CIR and banking sector performance. The process of improving cost efficiency goes hand in hand with the implementation of capital regulations. It can be argued that there is a kind of substitution of operating costs for the additional cost of capital (Ben Naceur and Kandil, 2009). Sufian and Chong (2008) find negative impact of savings related to management salaries on profitability. Inadequate management of operating costs, resulting in an increase in the CIR, reduces bank profitability, as indicated by Hess and Francis (2004), Almazari (2012), Al-Sharkas and Al-Sharkas (2022) and Hassan et al. (2024). Also the results provided by Bywalec et al. (2020) and referring to the cost effectiveness for the 15 leading banks in Ukraine in 2013–2018 indicate negative correlation between cost-to-income ratio and profitability. Assuming that the direction of the correlation between CIR and profitability is a function of market competition, and that competition is intensifying in the banking sector (Alimbekovich et al., 2023), we have formulated the following hypothesis:

H1: Cost efficient banks are characterized by higher profitability.



2.2. Cost efficiency and bank size

One of the rationales for mergers and acquisitions is to achieve economies of scale and cost synergies. Thus, increasing the scale of operations should be accompanied by improvements in cost efficiency (Umashankar et al., 2022), however Soyemi et al. (2013) prove that banks suffer from diseconomy of scale resulting from cost inefficiencies specific for large complex organizations. Srivastava and Kumar (2021) note that the wage CIR is negatively correlated with total assets while the relation between non-wage CIR and bank's assets is positive. Kovner, Vickery, and Zhou (2014) find a robust negative relationship between bank size and normalized measures of noninterest expense. Ayinuola and Gumel (2023), focusing on the influence of CIR bank profitability, conclude that the inclusion of bank size in the model moderates the negative influence of the CIR on return on assets. Hossain and Saif (2019) prove that firm size positively affects its profitability. Also, the regression model built by Klepczarek (2019) implies a negative effect of bank size, approximated by \ln of total assets, on the CIR. Hussain (2014) finds that size and ownership characteristics have strong impact on the cost efficiency of banks operating in India. Taking the above into account and the negative correlation between CIR and profitability, it is expected that:

H2: The size of a bank is positively correlated with its cost efficiency.

3. Data and methods

The sample consists of 17 largest commercial banks operating in the Polish banking sector (Table 1).

The analysis is conducted on a sample of banks whose total assets represent 78.60% of the assets of domestic commercial banks as of 31/12/2022.

The analysis of banks was carried out using linear ordering methods, classified into Multiple-Criteria Decision Making (MCDM) group, which lead to a ranking of banks from the point of view of the adopted ordering criterion. For this purpose, the Hellwig method (1968) and the TOPSIS method (1981) are used – model methods of aggregation of variables, which consist in determining the distance of individual objects from a certain defined model object (Table 2).

In the first step of the multivariate comparative analysis, diagnostic characteristics were selected (Table 3).

Linear ordering methods require the determination of quantitative weights for individual variables (Ma et al. (1999), Choo and Wedley (1985), Schoemaker and Waid (1982)). In the study conducted, two criteria were used to select variables:



system w1 – equal weights were assumed for all variables, i.e.:

$$w_k = \frac{1}{m}, \text{ where: } k - \text{number of the indicator } (k = 1, 2, \dots, m);$$

system w2 – weights were determined based on the expert method – the highest weights were assigned to Z1 – 0.50, the remaining features – 0.125. In the next step, the structural diversity of the banks considered is analysed using cluster analysis, which involves grouping objects into relatively homogeneous classes. For this purpose, Ward's (1963) method, which uses a variance analysis approach, is applied. This method is considered effective when the number of objects is not large (Stanisz, 2007, 122). The distance between objects was calculated using the Euclidean norm:

$$d_{i,j} = \left\{ \sum_{k=1}^m (x_{ik} - x_{jk})^2 \right\}^{1/2} \quad \text{for } i \neq j \quad (1)$$

where:

x_{ik} – value of the k variable in the i -th object,

x_{jk} – value of the k variable in the j -th object,

k – number of characteristics examined,

m – number of diagnostic variables.

The distances between the study sites are calculated on the basis of standardised diagnostic variables:

$$d_{i,j} = \left\{ \sum_{k=1}^m (z_{ik} - z_{jk})^2 \right\}^{1/2}, \quad \text{for } i \neq j \quad (2)$$

where:

z_{ik} – the standardised value of the k -th variable in the i -th object,

z_{jk} – the standardised value of the k -th variable in the j -th object, whereby:

$$z_{ik} = \frac{x_{ik} - \bar{x}}{s_k} \quad (3)$$

where:

\bar{x} – the arithmetic mean of the k -th variable,

s_k – standard deviation of the k -th variable.

4. Results and discussion

In order to evaluate the management of banks' operating cost levels, the values of each bank's relative proximity to the ideal solution were determined, and bank rankings were constructed using the Hellwig and TOPSIS meth-



ods, taking into account two weight construction procedures. In this way, 20 rankings were obtained (Tables 4a–4e).

Next, the final ranking of banks obtained from the subsequent ranking of banks in order from best to worst using TOPSI and Hellwig's method and adopting w1 weights was carried out, using the banks' places in the 20 rankings in 2018–2022 as the ranking criterion (Table 5).

The correlations between the ranking obtained and the value of assets and revenues are statistically significant at the significance level of $\alpha = 0.05$. The results clearly indicate that the relatively larger banks (the first 8 banks in Tables 4a–4e defined on the basis of asset value) managed the level of operating expenses much better. As the value of assets and revenues increases, the bank's ranking increases which allows confirming H2. In contrast, the correlation of the obtained ranking with AROA and AROE although is negative however not strong (Table 6). Due to the relatively small study sample, the statistical significance tests of the correlation coefficients between ranking and AROA as well as between the ranking and AROE are on the borderline of statistical significance, but the repetition of the results from one year to the next allows the observation of certain trends occurring during the years of the Covid crisis and the war in Ukraine. This is also confirmed by the test of significance without dividing by years, where a Pearson correlation coefficient of -0.3 turns out to be statistically significant.

These results are confirmed using hierarchical methods for cluster analysis of the banks analysed (Scheme 1).

As at the end of 2022, with the exception of three banks, all institutions managed to achieve the CIR below 60%, and the three most efficient entities even below 40%. During the period studied (between 2018 and 2022), most of the banks analysed stabilised or reduced their CIRs (Chart 1).

Our results indicate that large and medium-sized banks, irrespective of their ownership structure, affected inter alia by sovereign creditworthiness (Korzeb et al., 2023), are characterised by the highest cost efficiency, which warrants positive verification of H1. They also prove the possibility of improving or stabilising at a low level operational efficiency. Our findings confirm the conclusions of economies of scale theory (Stigler, 1958) and what is suggested in empirical studies (Al-Sharkas and Al-Sharkas; 2022, Hassan et al., 2024; Umashankar et al., 2022, Srivastava and Kumar, 2021). The results may encourage further consolidation of the Polish banking sector, given at least three arguments. Firstly, there are the synergy effects currently no longer associated with the liquidation of branches in the same locations, but with the reduction of fixed costs per unit of income/revenues, such as IT, marketing and compliance costs, for example. Secondly, the Polish banking sector is still one of the European sectors with the lowest concentration. Thirdly, in the near future, significant costs will have to be reckoned with in relation to the implementation of supervisory regulations, financial and non-financial reporting, as well as the need for expenditure on cyber-security and IT solutions aimed

at process automation. Consolidation allows for the marginal costs of these expenses to be minimised. At the same time, it should be noted that improving efficiency, as measured e.g. by CIR, is not a monotonous and systematic process. This is due to the fact that certain measures that will bring about a reduction in operating costs in the future often require significant expenditure in the current period (e.g. redundancy costs, training costs, maintenance, etc.). Our CIR analysis for the period we studied confirms the phenomenon outlined above. However, consolidation of the banking sector threatens to materialise Too-Big-To-Fail (TBTF) or Too-Complex-To-Fail (TCTF) risks and augmentation of systemic risk (Xiao, 2023). Supervisory policy aimed at mitigating the impact of TBTF institutions on systemic risk implies intensifying supervision of these entities and tightening quantitative standards for banks that are not systemically important (Morrison, 2012). Thus, if a bank does not further optimise its operating costs after consolidation, it will face additional expenses due to the additional regulatory requirements. However, this is usually not the case, which allows us to confirm the hypothesis formulated by Ben Naceur and Kandil (2009) about the substitutability of increasing funding costs (in an absolute sense) by diminishing operating expenses. At the same time, our results do not indicate the existence of the diseconomies of scale reported by Soyemi et al. (2013).

At the same time, except in one case, we do not observe the effect indicated by Sufian and Chong (2008) in identifying banks in case of which improved cost efficiency (decrease in CIR) is not be associated with improved profitability (increase in AROE or AROA), which allows confirming H2. However, such an effect can be expected in the case of banking sector consolidation when lower margins and commissions are sufficient to cover operating costs and owners' expected profit (Yuanita, 2019). Such a phenomenon will occur when consolidation is not accompanied by a decrease in competition in the banking sector. This conclusion is supported by the results of a study conducted by Montgomery et al. (2014). The aforementioned authors, analysing the consolidation of the Japanese banking sector, conclude that this process is accompanied by an improvement in cost efficiency, which, however, does not translate into an increase in profitability. If consolidation results in a weakening of competition, an increase in banks' profitability is expected (Muratovic, 2023).

5. Conclusion

The positive correlation between cost efficiency and scale of operations, as well as between a bank's efficiency and profitability, is important information from the point of view of bank managers. It confirms the validity of their strategy of systematic reduction of operating costs. This is because the



study does not show the existence of a limit of cost reduction, beyond which this action would negatively affect profitability. This would happen if, for example, excessive reduction of personnel costs and diminishing of employee competence or insufficient IT expenditures would result in de facto avoidable losses. However, with regard to the current structure of the commercial bank sector in Poland, one should expect to reach the limit of cost efficiency improvement. A further enhancement of efficiency will be possible through consolidation, and the prerequisites for this will probably come with a reduction in legal risk, which currently weighs most heavily on the valuation of Polish banks. Supervisory authorities should be prepared for consolidation processes. On the one hand, account should be taken of the scenario in which an improvement in cost efficiency is accompanied by an erosion of profitability, negatively affecting bank capital accumulation. On the other hand, consolidation resulting in a sharp increase in concentration shall improve profitability, but at the expense of an escalation of systemic risk. Conclusions of our study provide information on the stage of development of the Polish banking sector (on the eve of consolidation) and create premises for supervisory authorities to prepare the expected (optimal) scenario of market structure evolution. At the same time, it should be noted that the changing fiscal, regulatory and technological environment may revise the conclusions formulated in this study. New determinants of cost efficiency may also emerge. The phenomena indicated above create space for the development of research in the area of banks' cost efficiency.

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Appendix

Table 1. List of commercial banks included in the study

Alior Bank S.A.
Bank Handlowy w Warszawie S.A.
Bank Millennium S.A.
Bank Ochrony Środowiska S.A.
Bank Pocztowy S.A.
Bank Polska Kasa Opieki S.A.
BNP Paribas Bank Polska S.A.
Credit Agricole Bank Polska S.A.
Deutsche Bank Polska S.A.
DnB Nord Polska SA
ING Bank Śląski S.A.
mBank S.A.
Nest Bank SA
Powszechna Kasa Oszczędności Bank Polski S.A.
Santander Bank Polska SA
Santander Consumer Bank S.A.
Toyota Bank Polska S.A.

Source: Own preparation.

Table 2. Hellwig and TOPSIS synthetic measures

Method	Standardisation	Coordinates of the pattern	Distances of objects from the pattern	Value of the aggregate variable
Hellwig	$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}$	$z_j^+ = \max_i \{z_{ij}\}$	$d_i^+ = \sqrt{\sum_{j=1}^m (z_{ij} - z_j^+)^2}$	$q_i = 1 - \frac{d_i^+}{d_o^+}$, whereby: typically $q_i \in [0; 1]$; $\max\{q_i\}$ – the best object; $\min\{q_i\}$ – the worst object; $d_0 = \bar{d}_0 + 2S_d$; $d_0 = \frac{\sum_{i=1}^n d_i^+}{n}$; $S_d = \sqrt{\frac{\sum_{i=1}^n (d_i^+ - \bar{d})^2}{n}}$.



Method	Standardisation	Coordinates of the pattern	Distances of objects from the pattern	Value of the aggregate variable
TOPSIS	$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}$	$z_j^+ = \max_i \{z_{ij}\}$	$d_i^+ = \sqrt{\sum_{j=1}^m (z_{ij} - z_j^+)^2}$	$q_i = 1 - \frac{d_i^+}{d_0}$, whereby: typically $q_i \in [0; 1]$; $\max_i \{q_i\}$ – the best object; $\min_i \{q_i\}$ – the worst object; $d_0 = \bar{d}_0 + 2S_d$; $d_0 = \frac{\sum_{i=1}^n d_i^+}{n}$; $S_d = \sqrt{\frac{\sum_{i=1}^n (d_i^+ - \bar{d})^2}{n}}$.

Source: Own preparation based On: Hellwig (1968), Hwang and Yoon (1981), and Kukuła and Luty (2018).

Table 3. Selected diagnostic variables

Symbol	Specification	Stimulant/Destimulant
Z1	CIR (Cost-Income Ratio)	D – destimulant
Z2	salaries and other employee benefits / total assets	D – destimulant
Z3	(other administrative costs + amortisation) / total assets	D – destimulant
Z4	salaries and other employee benefits / total revenues	D – destimulant
Z5	(other administrative costs + amortisation) / total revenues	D – destimulant

Source: Own preparation.

Table 4a. Bank rankings obtained using TOPSIS and Hellwig method for 2018

RANKING	2018							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Alior	0,708	5	0,821	5	0,592	5	0,784	5
BNP	0,668	8	0,675	10	0,527	7	0,600	9
ING BSK	0,800	3	0,865	3	0,715	3	0,835	3
mBank	0,840	1	0,890	1	0,770	1	0,866	1
Millennium	0,813	2	0,850	4	0,746	2	0,820	4
Pekao	0,668	9	0,791	7	0,509	9	0,734	7
PKO BP	0,707	6	0,814	6	0,557	6	0,762	6
Santander	0,797	4	0,866	2	0,715	4	0,838	2
BH	0,564	13	0,675	9	0,290	13	0,568	10
BOŚ	0,683	7	0,646	11	0,519	8	0,555	11
Bank Pocztowy	0,474	15	0,500	13	0,192	14	0,368	13



RANKING	2018							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Credit Agricole	0,402	17	0,459	15	0,022	17	0,302	15
Deutsche Bank	0,462	16	0,330	16	0,140	15	0,077	16
DnB Nord	0,666	11	0,570	12	0,396	12	0,427	12
Nest Bank	0,478	14	0,276	17	0,113	16	-0,101	17
Santander Consumer	0,631	12	0,779	8	0,403	11	0,706	8
Toyota Bank	0,666	10	0,477	14	0,470	10	0,307	14

*) S – Scores, R – Rank

Source: Own preparation.

Table 4b. Bank rankings obtained using TOPSIS and Hellwig method for 2019

RANKING	2019							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Alior	0,713	4	0,846	4	0,564	4	0,767	4
BNP	0,539	13	0,721	10	0,272	12	0,572	10
ING BSK	0,750	2	0,866	2	0,616	1	0,795	1
mBank	0,757	1	0,868	1	0,614	2	0,794	2
Millennium	0,700	5	0,823	6	0,537	5	0,734	6
Pekao	0,615	10	0,789	8	0,387	10	0,668	8
PKO BP	0,737	3	0,862	3	0,607	3	0,790	3
Santander	0,690	6	0,824	5	0,520	6	0,734	5
BH	0,545	12	0,724	9	0,241	13	0,564	11
BOŚ	0,628	9	0,715	11	0,415	9	0,580	9
Bank Pocztowy	0,490	14	0,619	13	0,200	15	0,436	13
Credit Agricole	0,431	16	0,571	14	0,077	16	0,356	15
Deutsche Bank	0,471	15	0,482	16	0,233	14	0,267	16
DnB Nord	0,636	8	0,673	12	0,511	7	0,552	12
Nest Bank	0,413	17	0,233	17	-0,060	17	-0,318	17
Santander Consumer	0,667	7	0,815	7	0,473	8	0,718	7
Toyota Bank	0,602	11	0,529	15	0,374	11	0,311	14

*) S – Scores, R – Rank

Source: Own preparation.



Table 4c. Bank rankings obtained using TOPSIS and Hellwig method for 2020

RANKING	2020							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Alior	0,818	7	0,903	5	0,643	9	0,794	7
BNP	0,792	10	0,878	8	0,628	10	0,765	9
ING BSK	0,856	4	0,929	3	0,748	4	0,857	3
mBank	0,928	1	0,966	1	0,867	1	0,926	1
Millennium	0,843	5	0,910	4	0,715	6	0,824	4
Pekao	0,811	8	0,901	6	0,672	8	0,807	6
PKO BP	0,882	3	0,944	2	0,778	3	0,877	2
Santander	0,840	6	0,898	7	0,715	5	0,810	5
BH	0,739	12	0,835	12	0,593	11	0,714	11
BOŚ	0,802	9	0,840	11	0,676	7	0,728	10
Bank Pocztowy	0,696	13	0,754	15	0,492	13	0,578	14
Credit Agricole	0,628	16	0,732	16	0,267	15	0,489	16
Deutsche Bank	0,140	17	0,069	17	-0,283	17	-0,567	17
DnB Nord	0,898	2	0,860	10	0,867	2	0,779	8
Nest Bank	0,634	15	0,794	13	0,171	16	0,524	15
Santander Consumer	0,764	11	0,872	9	0,494	12	0,711	12
Toyota Bank	0,687	14	0,767	14	0,453	14	0,586	13

*) S – Scores, R – Rank

Source: Own preparation.

Table 4d. Bank rankings obtained using TOPSIS and Hellwig method for 2021

RANKING	2021							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Alior	0,858	5	0,934	5	0,720	5	0,848	5
BNP	0,805	8	0,899	8	0,646	8	0,795	8
ING BSK	0,879	3	0,945	3	0,793	3	0,888	3
mBank	0,907	1	0,958	1	0,850	1	0,919	1
Millennium	0,868	4	0,936	4	0,771	4	0,872	4
Pekao	0,810	7	0,910	7	0,654	7	0,809	7



RANKING	2021							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
PKO BP	0,881	2	0,947	2	0,794	2	0,889	2
Santander	0,758	10	0,866	10	0,519	10	0,717	10
BH	0,729	11	0,869	9	0,464	12	0,705	11
BOŚ	0,771	9	0,858	11	0,579	9	0,730	9
Bank Pocztowy	0,727	12	0,814	12	0,493	11	0,654	12
Credit Agricole	0,665	13	0,784	13	0,351	13	0,579	14
Deutsche Bank	0,493	17	0,247	17	-0,047	17	-0,478	17
DnB Nord	0,603	15	0,571	16	0,277	14	0,286	16
Nest Bank	0,660	14	0,832	14	0,248	15	0,586	13
Santander Consumer	0,829	6	0,923	6	0,681	6	0,829	6
Toyota Bank	0,511	16	0,739	15	0,036	16	0,473	15

*) S – Scores, R – Rank

Source: Own preparation.

Table 4e. Bank rankings obtained using TOPSIS and Hellwig method for 2022

RANKING	2022							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Alior	0,700	8	0,849	8	0,548	8	0,733	8
BNP	0,667	9	0,792	11	0,520	9	0,670	11
ING BSK	0,725	5	0,854	7	0,599	5	0,754	7
mBank	0,764	2	0,883	3	0,652	2	0,798	2
Millennium	0,719	7	0,872	5	0,582	6	0,764	6
Pekao	0,647	11	0,828	9	0,469	11	0,692	9
PKO BP	0,745	4	0,869	6	0,631	4	0,778	4
Santander	0,754	3	0,887	2	0,637	3	0,796	3
BH	0,721	6	0,875	4	0,582	7	0,765	5
BOŚ	0,666	10	0,810	10	0,510	10	0,685	10
Bank Pocztowy	0,579	13	0,781	12	0,343	13	0,603	13
Credit Agricole	0,460	16	0,630	15	0,194	14	0,412	15
Deutsche Bank	0,535	14	0,265	17	0,134	15	-0,291	17
DnB Nord	0,282	17	0,321	16	-0,107	17	-0,010	16



RANKING	2022							
	TOPSIS				HELLWIG			
	W1		W2		W1		W2	
	S	R	S	R	S	R	S	R
Nest Bank	0,491	15	0,733	14	0,116	16	0,480	14
Santander Consumer	0,644	12	0,760	13	0,463	12	0,619	12
Toyota Bank	0,792	1	0,901	1	0,694	1	0,825	1

*) S – Scores, R – Rank

Source: Own preparation.

Table 5. The final ranking of banks

RANKING	W1	
	Hellwig	TOPSIS
Alior	5	6
BNP Paribas	8	9
ING BSK	2	2
mBank	1	1
Millennium	4	4
Pekao	7	7
PKO BP	3	3
Santander Bank	6	5
BH	11	11
BOŚ	9	10
Bank Pocztowy	14	14
Credit Agricole	15	15
Deutsche Bank	17	17
DnB Nord	13	13
Nest Bank	16	16
Santander Consumer	10	8

Source: Own preparation.

Table 6. Pearson's correlation

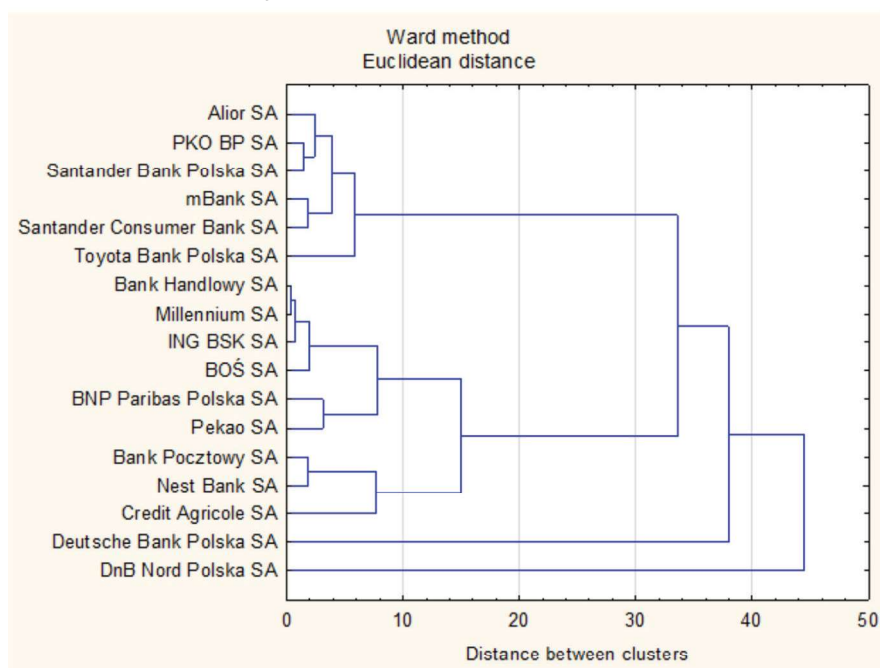
Ranking	Assets	Revenues	AROA	AROE
2018	-0,668118	-0,640696	-0,434672	-0,684290
2019	-0,685911	-0,681612	0,036383	-0,028991
2020	-0,707015	-0,696644	-0,361690	-0,407513



Ranking	Assets	Revenues	AROA	AROE
2021	-0,674907	-0,695327	-0,269246	-0,262452
2022	-0,548431	-0,555691	-0,403912	-0,268357

Source: Own preparation.

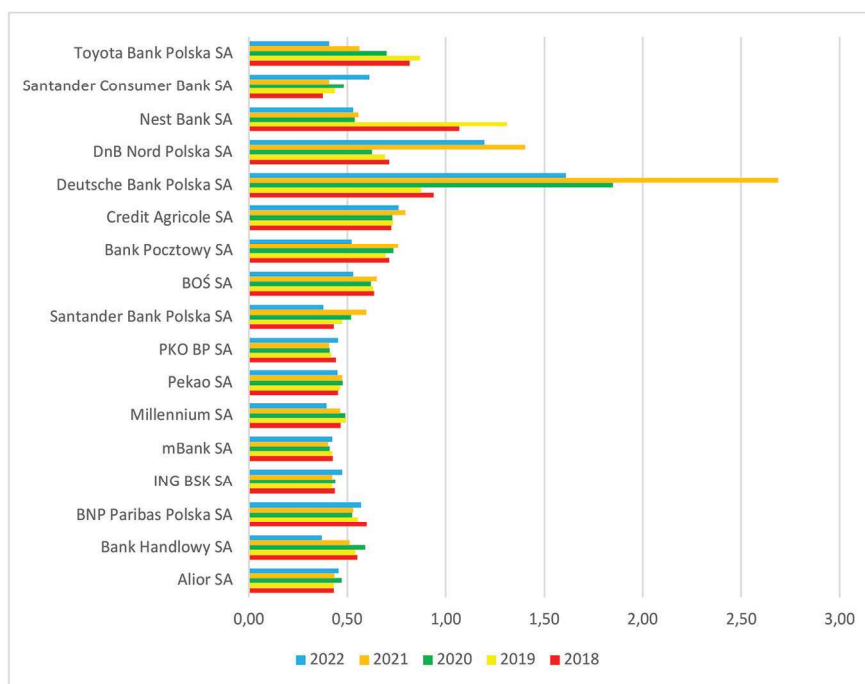
Scheme 1. Ward's dendrogram for 2022



Source: Own preparation.



Chart 1. The CIR of Polish banks in years 2018–2022



Source: Own preparation.