chapter

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CLUSTERING AND INVESTIGATION OF CHANGES THE PERFORMANCE OF DEPOSIT BANKS BY PROVINCES: COVID-19 PANDEMIC PERIOD

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INTRODUCTION

The banking sector is vital in the financial system. Banks play an intermediary role in the supply and demand transactions of funds in an economy. While banks perform their intermediary roles, they reliably fulfill the transactions of demanders and suppliers. These transactions contribute to the growth and development of the economy and to the reliable and most efficient use of the collected funds.

The COVID-19 pandemic, which deeply affected the economies of all countries on a global scale, showed itself in 2020. The wide-ranging and forced changes in social life created by the epidemic have put the economy and the general banking industry at great risk. The regulations made under the name of government restriction policies in order to prevent the possible risks of the COVID-19 pandemic have also closely concerned the banking sector. The restrictions have negatively affected institutions, businesses and the public socially, culturally and economically. Practices and regulations have been introduced in many areas, In order to minimize the negative effects of mandatory restrictions. It is aimed to prevent possible problems that may arise in company and bank balance sheets and to maintain the credit channel in a healthy way, with the arrangements made for the banking sector with the COVID-19 pandemic (Yetiz, 2021: 110). In addition, some banks operating in the Turkish banking sector have prepared holiday support loans, advantageous housing loans, vehicle loans, coronavirus disease insurance packages and similar loan support packages within the scope of the controlled normalization process. Tax and credit debts of companies have been postponed due to government policies In order to minimize the negative effects that may arise in the banking sector. In addition, many different economic and financial services such as providing liquidity and support packages to SMEs were provided by central banks (Yetiz, 2021:111).

Banks went through a difficult period and made great efforts to maintain their sustainability in their operations during the COVID-19 epidemic. Banks are trying to overcome the pandemic process with the least damage with their applications, along with the normalization process. Looking at the basic indicators in the ongoing process of the pandemic, the balance sheet size has reached 6.7 trillion TL according to the data of July 2021 in the Turkish banking sector. The loans extended reached TL 3.9 trillion as of August 2021 (Çakar, 2021: 2).

The aim of this study is to group the performances of deposit banks operating before and during the pandemic on a provincial basis in the Turkish banking sector. Deposit banks are grouped as "public deposit banks" and "private capital deposit banks" in the Turkish banking system since 3/9/2022. While three banks operate as public deposit banks, eight

banks operate in private deposit banks (Türkiye Bankalar Birliği (TBB), www.tbb.org.tr).

Operating before and during the pandemic will be analyzed using data from deposit banks changes in the groups of deposit banks. The effects of the recent COVID-19 pandemic, which has a negative impact on the global scale, will be investigated in this context. Clustering method will be used for analysis. The next stages of the study consist of literature review, method, application and conclusion parts, respectively.

LITERATURE REVIEW

It is known that during the COVID-19 pandemic, countries are adversely affected in economic, social, cultural and many areas. Many measures have been taken to minimize these negative effects and to overcome the pandemic process in the best way possible. The effects of these measures can be revealed by these studies. The studies carried out by the researchers in this process contribute to eliminating the unknowns with the pandemic and to have a preliminary idea for the measures that can be taken. Some of the studies on banks during the pandemic process are given below.

Ersoy et al., (2020) examined the Turkish Banking sector during the COVID-19 pandemic period. For the analysis, they used a 10-week time frame covering the pre-pandemic and the pandemic process. For analysis, they examined the changes in banks' loans, non-performing loans, securities, deposits, and foreign currency positions. As a result, it was determined that loans, securities and deposits increased; In terms of non-performing loans, a relative decrease was recorded in domestic banks. In addition to this, no clear effect could be revealed for the foreign currency position.

Beybur (2021) Banks in the Turkish banking system examined the changes in profitability levels before and during the pandemic. Evaluated bank groups are public deposit banks, domestic deposit banks, foreign deposit banks and participation banks. As a result of the analysis, when compared to other banks, it was seen that interest expenses and other expenses other than interest increased. At the same time, it was observed that the net profit levels, return on assets, return on equity ratios and net interest margins of public banks compared to other banks decreased.

Işık and Aydoğan (2021) analyzed the situation of public, private and foreign-capital deposit banks operating in the Turkish banking sector during the COVID-19 pandemic period.

Operating incomes of banks were analyzed using profitability, net interest margin, loan/deposit, liquidity ratios and cash flow tables. Compared to

the pre-pandemic period, decreased profitability in banks, decline in banking main activities and liquidity holding tendencies were observed.

Arslantürk Çöllü (2021) comparatively examined the financial performances of participation banks and traditional banks during the COVID-19 pandemic. When the findings obtained in the analysis are examined, it is observed that there is no change in the selected ratios between participation banks and traditional banks. As a result of the measures taken, it was stated that the impact of the COVID-19 pandemic on banks in the Turkish banking sector remained at a limited level.

Koche and Siddiqui (2021) examined the Indian banking sector. They investigated the relationship between non-performing loans and profitability of Indian banks operating during the Covid-19 pandemic process. When the findings are examined, it is observed that there is a strong relationship between the problematic assets of the banks and the profitability of the bank. It has been stated that problematic bank assets, which increased during the COVID-19 pandemic period, had a negative impact on bank profitability.

Bicil (2021) examined the lending and profitability of deposit banks during the COVID-19 pandemic. Efficiency measurement was made with the data obtained. Considering the results of the analysis, the findings are that the factor productivity of deposit banks decreased significantly in the 09.2019 03.2020 and 09.2020-03.2021 periods. In terms of efficiency decrease, it has been determined that the performances of public banks are better than those of foreign and private banks.

Koç et al., (2021) examined the effects of the number of COVID-19 cases on banking indicators by examining the period of 2020 March-2021 May. For the analysis, the variables of the ratio of non-performing loans, total loans and consumer loans to total loans and the number of cases were used. According to the findings, it has been determined that there is a positive relationship between the number of cases, the volume of individual loans and the total loan volume. At the same time, it was observed that the increase in the number of cases affected the asset quality negatively. However, it has been observed that there has been an increase in all risk items in the banking system due to the epidemic. It has been determined that the precautionary measures taken to prevent the liquidity squeeze in the system have partially relaxing effects.

Ulusoy and Demirel (2021) examined the factors affecting bank profitability in the Turkish banking system. They also discussed the impact of the COVID-19 pandemic process as a term. Considering the factors examined before and during the pandemic, it was determined that the capital adequacy ratio, equity and total assets had an impact on profitability in the pre-COVID-19 pandemic period. In the pandemic period, it was observed that the effect of the capital adequacy ratio on the

profitability of the banking system continued. However, the impact of equity and total assets on profitability before the pandemic was left to the balance sheet structure, asset quality and liquidity during the pandemic period.

Armağan et al., (2021) evaluated the financial performances of 12 banks operating in Borsa Istanbul during the COVID-19 pandemic. As a result of the analysis, the performance ranking of 12 banks was made within the framework of the determined criteria. With this study, they revealed the financial impact of the pandemic among banks.

Çalış and Sakarya (2022), examined the effect of the COVID-19 pandemic on the liquidity and profitability of deposit banks in the BIST Banking Index. The analyzes were evaluated on a yearly basis. In 2017, a significant relationship was observed between the liquidity of deposit banks and the COVID-19 pandemic process. In 2018 and 2019, no significant relationship was found between the pandemic process and liquidity. While a statistically significant relationship was observed between profitability and the pandemic process in 2017 and 2018, no significant relationship was found with 2019. As a result, it has been observed that the pandemic has affected the profitability of deposit banks.

Some of the studies on banks during the pandemic period are included. In this study, banks were evaluated from a different perspective, and banks were grouped on the basis of provinces before and during the pandemic. For the purpose of the study, the grouping of the provinces was analyzed by the clustering method. Clustering method is used in many fields. It is seen that researchers prefer clustering method in many different fields. Some of those; classification of provinces according to their cultural structures (Çakmak et al., 2015), grouping of countries according to health indicators (Ersöz, 2009), clustering of airports (Yalçın and Ayyıldız, 2018), clustering analysis on psychology research (Henry et al., 2005), countries' specific characteristics. clustering (Sarıman, 2011) and establishment location selection (Barreto, 2007).

CLUSTER ANALYSIS

Clustering analysis, which provides summary information to the researcher by grouping ungrouped data in terms of similar characteristics, is frequently used in data mining. Cluster analysis is also one of the multivariate statistical methods (Kalaycı, 2009: 349).

It is necessary to determine the similarities and differences of objects in a cluster in order to apply cluster analysis. Cluster analysis is the most basic method used to estimate similarities. Cluster analysis applications are found in almost all professions. Some practices aid science, while others aid planning and management. For example, an archaeologist might use

cluster analysis to piece together evidence of how prehistoric Indian culture lived, while a historian might use it to show that ancient Greek sculptors were influenced by the style of Egyptian sculptors. An industrial engineer can use cluster analysis to find the best arrangement for a factory's machinery (Romesburg, 1984: 9).

Cluster analysis distinguishes groups called clusters in the analyzed data set. These groups are discrete subsets of the dataset. Data from different clusters differ much more than data from the same cluster. Therefore, the role of cluster analysis is to reveal a certain kind of natural structure in the data set. The tools to accomplish this task usually consist of a certain measure of similarity or difference. Cluster analysis is not only an important cognitive tool, but also an important method to reduce large data sets (Wierzchon and Klopotek, 2018: 9).

Determining the most appropriate number of clusters in cluster analysis is one of the most important issues faced by researchers. Cluster analysis contains a large number of different clustering techniques. There have been many studies on which clustering technique is more successful and how to determine the most appropriate number of clusters. Cluster analysis is usually calculated with the following six-step process. The steps of the process are as follows (Dardac and Boiton, 2009: 111):

- Determining the purpose of the analysis, selecting the assumption to be tested and the most important variables,
- Processing of numeric values,
- Choosing a clustering method,
- Choosing an appropriate method for data collection,
- Algorithm selection,
- Interpreting the dendogram and determining the optimal number of clusters.

In this study, algorithms using numerical data were subjected to cluster analysis and it was seen that the EM algorithm gave the most consistent and appropriate solutions. Therefore, the EM algorithm is given in detail below.

EM (Expectation - Maximization) Algorithm

The Expectation Maximization (EM) algorithm was first introduced as an iterative procedure that produces maximum likelihood parameter estimates under certain conditions in the statistical literature (Georghiades and Han, 1997: 300).

The EM algorithm iteratively estimates the parameters of a model, starting from some initial estimates (Neal and Hinton, 1998: 2).

The method follows the sequence of the two steps. The features of these steps are as follows (Wierzchon and Klopotek, 2018: 97):

- **Step E (Expectation):** The known property values of the objects, together with the predicted model parameters, are used to calculate the expected values of the unknowns for these objects.
- **Step M (Maximization):** Both known (observed) and predicted (unobserved) property values of objects are used to estimate model parameters using a given likelihood maximization.

The utility measure that forms the basis of the algorithm is the expected log-likelihood function. The basic idea underlying the algorithm is to iterate through the expectation and maximization steps until convergence is reached. The expectation involves updating the probabilities of missing data using the latest available parameter estimates. The model parameters are recalculated to maximize the expected value of the probability of incomplete data in the maximization stage (Luo and Hancock, 2001: 1124).

The EM algorithm is applied in fields such as genetics, medical imaging and neural networks, as well as various general statistical problems such as the resolution of mixtures, versatile probability tables, variance components estimation, factor analysis (McLachlan et al., 2004: 3).

APPLICATION OF THE CLUSTERING METHOD

In this study, the provinces in Turkey were divided into clusters based on the credit and deposit information of the banks in each province. Only deposit banks were included in the study. In the study, in which the pre-COVID-19 and COVID-19 periods were taken into account, it was observed how the provinces in the clusters underwent a change in the pre COVID-19 period and during the COVID-19 period. In other words, it is aimed to examine the changes between the grouping of provinces made before the pandemic and the groupings made during the pandemic process.

The data obtained from the Banking Regulation and Supervision Agency was used in the study (https://www.bddk.org.tr/BultenFinTurk)

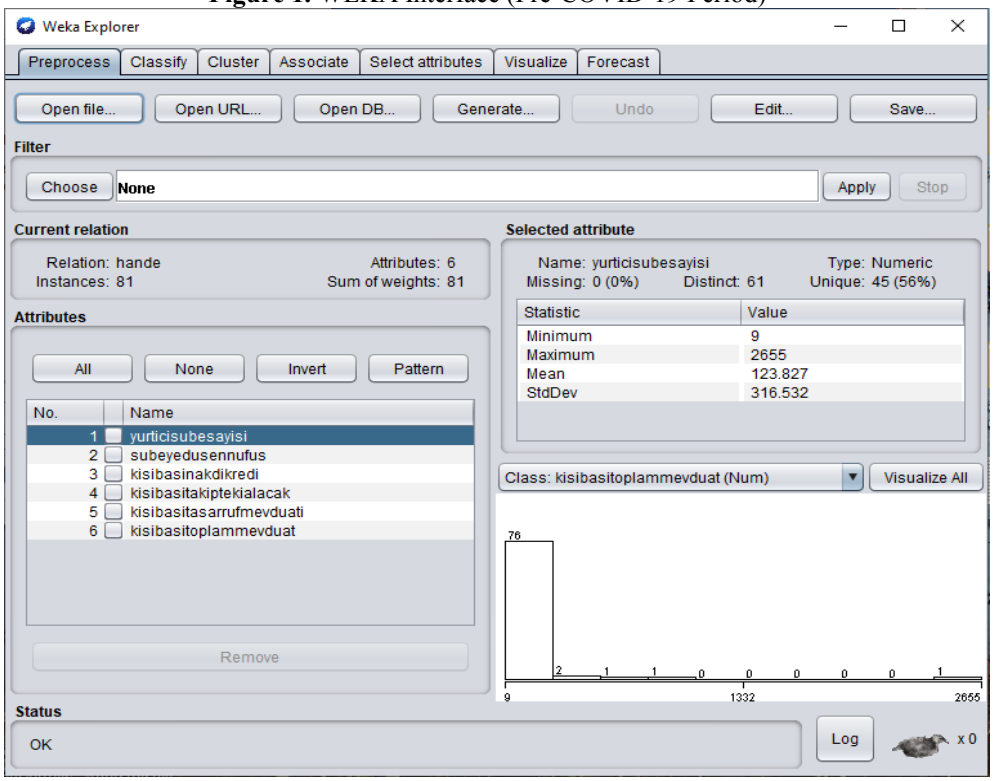
In the study, a decision matrix was created by using 6 criteria (number of domestic branches, population per branch, cash loans per capita, NPL per capita, savings deposits per capita and total deposits per capita) and 81 alternatives (provinces). In the study, decision matrices of both pre-COVID-19 and COVID-19 processes were prepared. After the decision matrices were created, the data obtained were analyzed in the WEKA program. Algorithms such as Canopy and EM, in which numeric data can be calculated, have been tried in the program. In the clustering of 81

provinces, the EM algorithm gave the most consistent and ideal results in both periods.

In the literature, the number of clusters is usually calculated with the help of the equation $k=(n/2)^{1/2}$ (Everitt, 1974: 122). This formulation was also used in this study and the number of clusters was calculated as 6.

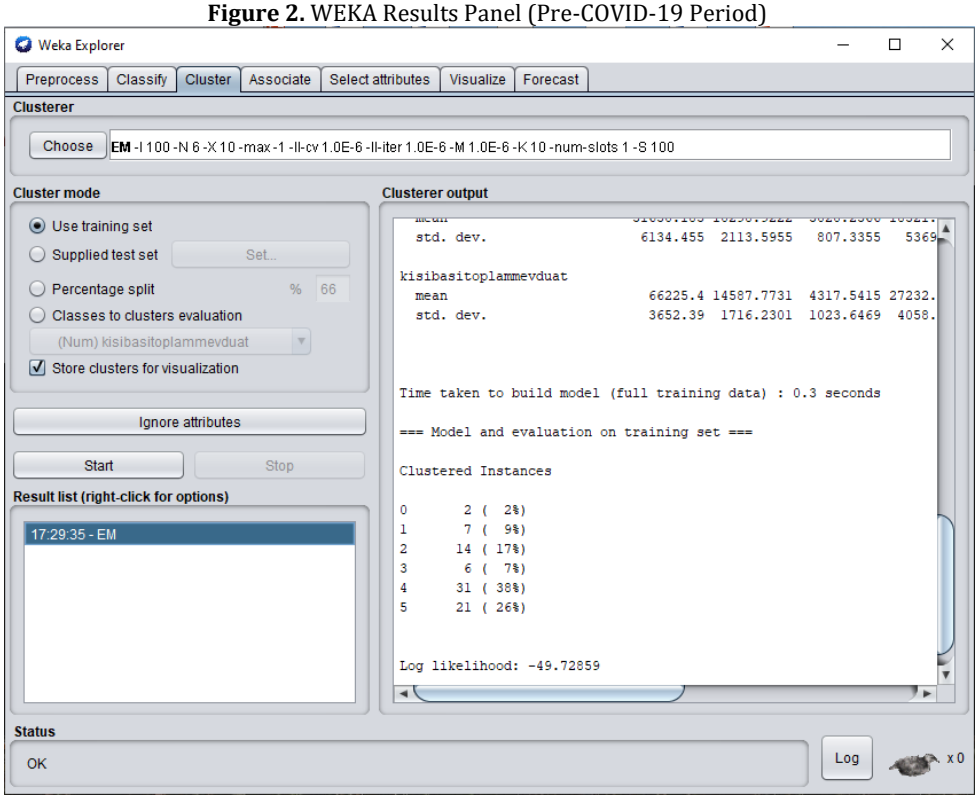
The following interface was obtained by analyzing the data in the decision matrix in the WEKA program. Since there are similar interfaces in the study, the WEKA interface obtained for the pre-COVID-19 period is included as an example.

Figure 1. WEKA Interface (Pre-COVID-19 Period)



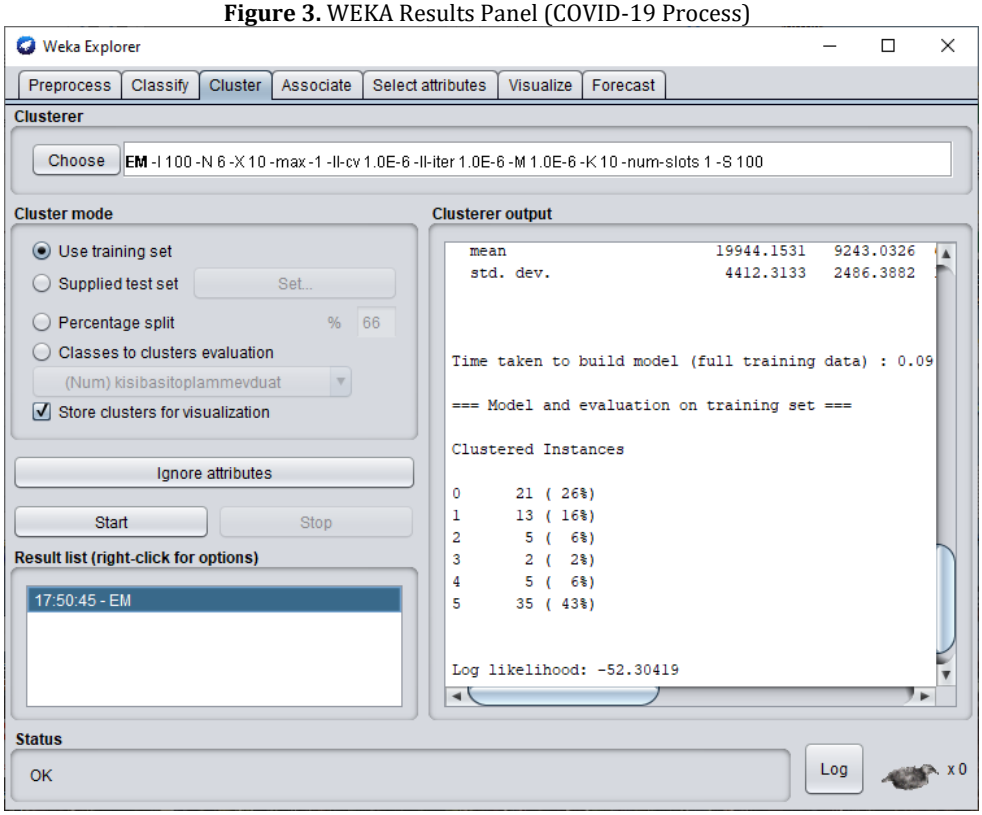
In the Weka interface, there are values such as the number of alternatives and criteria, the benefit and cost values of the data belonging to the criteria, frequency distribution, standard deviation and mean.

Figure 2. WEKA Results Panel (Pre-COVID-19 Period)



In the analysis performed with the EM algorithm for the pre-COVID-19 period, 81 provinces divided into 6 clusters, 2 of them to Cluster 0, 7 of them to Cluster 1, 14 of them to Cluster 2, 6 of them to Cluster 3, 31 of them to Cluster 4. and 21 have been assigned to Cluster 5.

Figure 3. WEKA Results Panel (COVID-19 Process)



In the analysis performed with the EM algorithm for the COVID-19 process, 21 of the 81 provinces divided into 6 clusters were assigned to Cluster 0, 13 to Cluster 1, 5 to Cluster 2, 2 to Cluster 3, 5 to Cluster 4 and Another 35 are assigned to Cluster 5.

Table 1 and Table 2 show the clustering results of 81 provinces in Turkey for the pre-COVID-19 period and the COVID-19 process.

Table 1. Clustering Results of Provinces (Pre-COVID-19 Period)

Clusters	İller
Cluster 0	Ankara, İstanbul
Cluster 1	Adana, Gaziantep, Hatay, Kayseri, Konya, Manisa, Mersin
Cluster 2	Adıyaman, Ağrı, Batman, Bingöl, Bitlis, Diyarbakır, Hakkari, Kilis, Mardin, Muş, Siirt, Şanlıurfa, Şırnak, Van
Cluster 3	Antalya, Bursa, Denizli, İzmir, Kocaeli, Muğla
Cluster 4	Afyon, Artvin, Aydın, Balıkesir, Bartın, Bilecik, Bolu, Burdur, Çanakkale, Çankırı, Çorum, Edirne, Eskişehir, Giresun, Isparta, Karabük, Karaman, Kastamonu, Kırklareli, Kırşehir, Nevşehir, Rize, Sakarya, Samsun, Sinop, Tekirdağ, Trabzon, Tunceli, Uşak, Yalova, Zonguldak
Cluster 5	Aksaray, Amasya, Ardahan, Bayburt, Düzce, Elazığ, Erzincan, Erzurum, Gümüşhane, Iğdır, Kahramanmaraş, Kars, Kırıkkale, Kütahya, Malatya, Niğde, Ordu, Osmaniye, Sivas, Tokat, Yozgat

Table 2. Clustering Results of Provinces (COVID-19 Process)

Clusters	İller
Cluster 0	Adıyaman, Amasya, Ardahan, Bayburt, Çankırı, Düzce, Elazığ, Erzincan, Erzurum, Gümüşhane, Iğdır, Kahramanmaraş, Kars, Kırıkkale, Kütahya, Malatya, Niğde, Ordu, Osmaniye, Sivas, Tokat
Cluster 1	Ağrı, Batman, Bingöl, Bitlis, Diyarbakır, Hakkari, Kilis, Mardin, Muş, Siirt, Şanlıurfa, Şırnak, Van
Cluster 2	Antalya, Bursa, Denizli, İzmir, Muğla
Cluster 3	Ankara, İstanbul
Cluster 4	Adana, Gaziantep, Hatay, Kocaeli, Konya
Cluster 5	Afyon, Aksaray, Artvin, Aydın, Balıkesir, Bartın, Bilecik, Bolu, Burdur, Çanakkale, Çorum, Edirne, Eskişehir, Giresun, Isparta, Karabük, Karaman, Kastamonu, Kayseri, Kırklareli, Kırşehir, Manisa, Mersin, Nevşehir, Rize, Sakarya, Samsun, Sinop, Tekirdağ, Trabzon, Tunceli, Uşak, Yalova, Yozgat, Zonguldak

CONCLUSION AND EVALUATION

One of the most important sectors forming the institutional structure of the financial market is the banking sector. Due to its sensitive nature, it stands out as a sector that has been exposed to sectoral fluctuations for many years and has become the focus of intense discussions.

In the study, a clustering analysis was carried out based on the loan and deposit information of deposit banks in the provinces of Turkey. The data of 81 provinces were subjected to cluster analysis with the help of WEKA program and divided into 6 clusters. Several algorithms in which numerical data can be calculated have been tried and it has been seen that the EM algorithm gives the most significant results.

Table 1 shows that Ankara and Istanbul are included in Cluster 0. When the current criteria are examined, it is seen that the provinces in this cluster rank at the top in terms of the number of domestic branches, cash loans per capita, non-performing loans per capita, savings deposits per capita and total deposits per capita. Ankara and Istanbul provinces took the last place in the population per branch criterion. This shows that the deposit banks operating in the provinces in the cluster are at a very good level in terms of loan and deposit indicators. In addition, these provinces are the ones at the best level in terms of development, industry and welfare in Turkey.

It has been observed that provinces such as Adana, Gaziantep and Hatay are in the same cluster in Cluster 1. When the criteria are examined, these provinces in the cluster are generally in the middle and upper ranks in all criteria. In addition, all of these provinces are provinces with metropolitan status.

Cluster 2 includes provinces in the eastern region such as Adıyaman, Ağrı, Batman, Bingöl and Bitlis. When the criteria are examined, it is seen that the provinces in this cluster are in the lowest ranks in terms of the number

of domestic branches, cash loans per capita, non-performing loans per capita, savings deposits per capita and total deposits per capita. These provinces in the cluster rank high in the population per branch criterion. Depending on this result, it can be said that deposit banks operating in these provinces should make some improvements in terms of loan and deposit indicators. For example, since the number of population per branch is high, the number of deposit bank branches can be increased in these provinces.

Cluster 3 includes the provinces of Antalya, Bursa, Denizli, İzmir, Kocaeli and Muğla. The provinces in this cluster are industrially advanced, developed and have metropolitan status. When the criteria are examined, it is seen that these provinces are in good condition in other criteria, except for the population per branch criterion. This shows that the deposit banks operating in the provinces in the cluster are at a good level in terms of loan and deposit indicators.

Cluster 4 includes provinces such as Afyon, Artvin, Aydın, and Balıkesir. These provinces are in the middle and good level in terms of development. When evaluated according to the criteria, it can be commented that these provinces are generally at the middle level.

Cluster 5 includes provinces such as Aksaray, Amasya, Ardahan, Bayburt and Düzce. When evaluated over the criteria, it was seen that these provinces were in the middle and lower ranks in general. In addition, this cluster consists of provinces that do not have metropolitan status, except for Erzurum, Kahramanmaraş, Malatya and Ordu provinces.

Similar comments can be made about clusters in general for the COVID-19 process in Table 2. The provinces that changed their places in the cluster during the COVID-19 process are Adıyaman, Çankırı, Kocaeli, Aksaray, Kayseri, Manisa, Mersin and Yozgat.

It can be said that the displacement of these provinces within the cluster does not have a great effect. It was seen that the clusters did not change much before and during the COVID-19 period. As a result of this, it can be said that the banks in the provinces implemented the COVID-19 measures well and survived this process in the most effective way.

This shows that the Turkish banking system is strong and can be resistant to possible risks. Arslantürk Çöllü (2021), emphasized that the effect of the pandemic remained at a limited level as a result of the measures taken by the banks in the Turkish banking sector during the pandemic process. Although the pandemic process adversely affected the activities of the banks, it was observed that the banks recovered very quickly thanks to the measures taken. The results of this study support this situation.

With this study, deposit banks operating in the same clusters were determined. By looking at the common similarities of these banks, the

deficiencies in the provinces can be seen more clearly. It will be easier for the banking sector to carry out possible improvement studies in these provinces. The study is expected to be a preliminary idea to researchers working in this field. In future studies, the reliability of the study can be increased by using one or more numerical methods in addition to cluster analysis. Banks of different categories can be analyzed as well as deposit banks. In addition, comparisons can be made by using different statistical programs other than WEKA.

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