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A Big Data Analysis with Machine Learning techniques in Accounting dataset from the Greek banking system

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Abstract

The effects of the 2008 financial crisis undoubtedly caused problems not only to the banking sector but also to the real economy of the developed and the developing countries in almost all around the globe. Besides, as is widely known, every banking crisis entails the corresponding cost to the economy of each country affected by it, which results from the shakeout and the restructuring of its financial system. The purpose of this research is to investigate the consequences of the financial crisis and the COVID-19 health crisis and how these affected the course of the four systemic banks (Eurobank, Alpha Bank, National Bank, Piraeus Bank) through the analysis of ratios for the period of 2015-2020.

Keywords: Ratios, Financial Crisis, Covid-19, Big Data, Accounting Data

1 INTRODUCTION

The topicality of this paper lies in the necessity of the international community to seek and identify the impact of the banking crisis on the sectors of the economy and how it affects the natural and legal persons of a country, whose purpose is to save money in order to ensure an adequate standard of living, since the absence of the welfare state has been particularly noticeable and this is evident from the limitation that exists in the funds given for the payment of the state regarding expenditure on health, education, etc. On the other hand, their purpose is to secure the necessary funding from the banking institutions, in order to make productive investments, which will create new jobs, contributing in this way to the growth of the country's GDP and of the incomes (Thanasas et al., 2017)

A series of events, such as the global financial crisis, which also profoundly affected the Greek banking system, resulted in 2010 an external financial assistance being requested, in order to avoid the bankruptcy of Greece and to correct the newly created macroeconomic imbalances (Kousenidis et al., 2013). Thus, a number of initiatives have been taken to strengthen the banking system, such as the resolution and recapitalization of banks. The starting point for the resolution of banking institutions in Greece was the Law 3601/2007. This was followed by its amendment in October 2011 by the Law 4021/2011 which referred to the adoption of specific measures regarding supervision and resolution, while the Law 4261/2014 incorporated the provisions of Directive 2013/36/EU (Capital Requirements Directive - CRD IV) which included all articles on the prudential supervision of credit institutions and businesses. Unfortunately, the measures implemented were not adequate enough. A second programme was launched in 2012 but again there was a derailment. The solution was provided with a third program, in the summer of 2015 which was successfully completed in 2018.

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In order to achieve this goal, the following research objectives of the project were defined:

- The way in which the banking sector operates in Greece will be analyzed.
- The factors affecting the internal and external environment of the Greek financial institutions will be analyzed.
- A comparative analysis of the four systemic banks (Eurobank, AlphaBank, National Bank of Greece, Piraeus Bank) will be carried out.

The subject of the research is the theoretical aspects related to the study of the main financial ratios, which has been flourishing in the last decade in Western Macedonia and as well as the prospects for its development.

2 LITERATURE REVIEW

The financial system in Greece

The role of the financial system is multidimensional and multifaceted. Initially through it, all cash flows are carried out and by operating in an effective manner and in accordance with the laws and rules of the economic science; it can bear huge benefits to a financial entity. Thus, the flow generated in a closed economy begins with the creation of income by households and businesses, where it can be absorbed by the following different fields: a) it can be used to pay the costs of meeting needs or even taxes, b) either not to be spent at all and the remaining amount to be converted into savings. These cash flows will then be channeled to the entities, which are deficient and for them to be able to function, the capital is crucial (Smaraidos, et. al 2014 Bellas, et al, 2010).

However, many times there is also the possibility that the desires and behaviors of the surplus entities may not find them in accordance with the way the funds are handled (such as the duration of the contract, the size and the legal character, etc). This gap is filled by the financial system, where it plays its role as a financial intermediary, with a view to convert the financial funds which are products of the surplus entities, in the form of financial instruments that will be eventually used to cover the costs of the deficit entities. (Antonopoulou., et. al 2022). Thus, it turns them into "securities" that can take the form of deposits, bonds, shares, etc. However, these financial instruments have varying degrees of return, risk and duration between the assumption of the commitment and their repayment (Georgiadis, 2002)

The Greek Financial System in the period of 2015-2020

In the last 13 years or so, since the financial crisis broke out, the Greek banking sector has been facing new challenges and problems. This led to the formation of a new landscape, having as its main feature the fact that financial stability is constantly at risk. The fact that the quality of the assets of financial institutions deteriorated and the liquidity plummeted, led to restrictions on transactions between the international capital and money markets and along with the restrictions on the capital movement regime, composed the most important issues that were called to overcome by the governments of all member states that were in the € zone including the leadership of the Bank of Greece, the European and the international institutions (Kalantonis et al., 2021). The problems in the Eurozone before the crisis were initially found in delays and inefficiencies, particularly in preventing and remedying budgetary divergences. Secondarily, to inadequacies of the institutional framework, in the area that we now call macro-prudential supervision of the financial system and in the multilateral supervision of macroeconomic policies, as well as flaws in the architecture of monetary union with the lack of an institutional framework for crisis management (Kontogeorga et al.,2010).

3 METHODOLOGY

The data set has been pre-processed with big data analysis tools such Apache Spark due to their complexity and volume but also for cleaning the database from duplicate and damaged records. Also Machine learning techniques such as Random Forest and Naive Bayes have been applied to help us ensure proper accuracy through automated processes. In the following table is presented the accuracy with each algorithm.

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Table 1. Accuracy of each Algorithm

Algorithm	Accuracy
Naive Bayes	81.75%
Random Forest	76.23%

Apache Spark is open source software designed specifically for bulk data analysis and uses the Python programming language. It has been built in such a way that it can support distributed general-purpose systems, based on high-volume data processing, with a high degree of efficiency and speed.(Dritsas, et.al 2018) In terms of speed, the Spark app supports Map Reduce as an extension to support more types of processing, such as interactive queries and data processing. In the following figure is presented the Number of data points in Apache Spark vs Map Reduce. (Karanikolas, et al 2018)

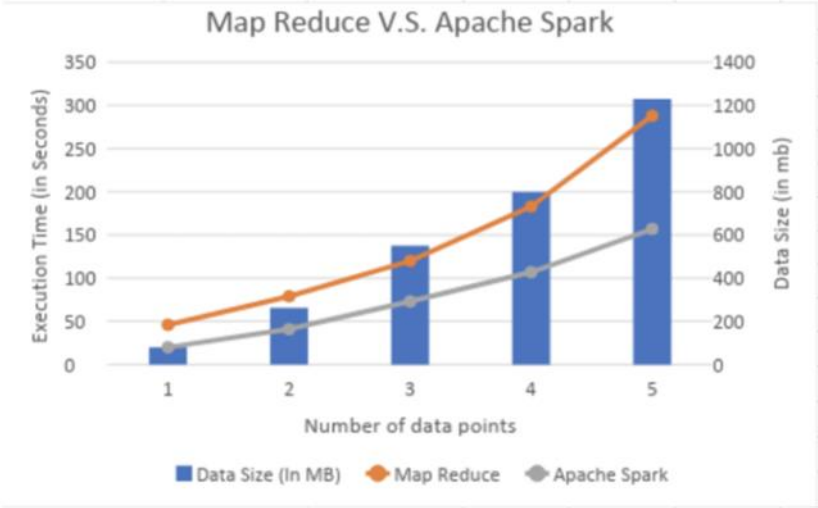

Figure 1. Number of Data Points

Liquidity Ratios

The ratios of this category measure the Bank's ability to meet its current financial obligations, related to the short-term accounting period, the coverage of which requires the holding of liquid assets / cash / reserves or directly liquid / realizable assets (Dervishi, et al., 2016). The ratios used in this research which belong to this category are the following:

Cash To Loans Ratio
Regarding the liquid assets of banks, these are elements that are used by the financial institutions on the one hand as one of the most important tools to deal with the phenomena of mass capital flight, and on the other hand in cases when the demand for borrowed funds is particularly high, ensuring for the financial institution the stability it seeks when there is a bank panic

The ratio is calculated by dividing the Cash and the Reserve Assets of the Central Banks by the total loans granted. So by this way, is extracted the percentage of the loans which is covered by the available money and are available immediately in cases of flight of deposits. Thus, the higher the value of the ratio, the more liquidity the Bank has and the more the consequences of a potential liquidity risk, are limited. It should be noted, however, that in cases where the ratio is at high levels, there are funds that remain unallocated and which each financial institution could possibly use in order to generate more revenue.

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$$Cash\ To\ Loans\ = \frac{\text{Cash} + \text{ Reserves In Central Banks}}{Loans\ Granted}$$

Loans Granted To Deposits Ratio

When it comes to this ratio, it is calculated by dividing the total loans granted by the financial institution by the total deposits that it has received from the different natural and legal persons. It expresses the percentage of deposits that it has lent to the various borrowers.

Essentially, it is a ratio that highlights the degree of dependence that a financial institution has on the inter-bank market. Thus, if the ratio exceeds the unit, that essentially means that, the loans granted cannot be adequately financed by the deposits. As a result, there is a need to cover this difference through the inter-bank market (Christopoulos & Dokas, 2012).

$$Loans\ To\ Deposits\ = \frac{Loans\ Granted}{Deposits}$$

Thus, when this ratio is at a high level, the higher the percentage of deposits is. The higher percentage of deposits provided to natural and legal persons, results in an increase in net interest income for the financial institution. At the same time, the financial institution is accepting the increased liquidity risk. Now when the ratio is at a low level, this means that the revenues are moving at low levels too. This results in low profits. On the other hand the higher ratios may provide more revenue for the bank, but they also involve more risk.

4. RESULTS

Liquidity Ratios

Cash To Loans Ratio
The results for the cash-to-loans ratio are shown in the table and diagram below:

Table 2. Cash To Loans Ratio

Cash To Loans Ratio						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
ALPHA BANK	7,20%	6,18%	3,24%	6,47%	8,55%	22,47%
EUROBANK	3,75%	3,41%	3,68%	4,79%	5,17%	18,96%
NATIONAL BANK	4,87%	3,60%	4,69%	17,05%	12,04%	34,23%
PIRAEUS BANK	4,51%	3,78%	4,11%	5,31%	9,84%	17,73%
Mean (Average)	5,08%	4,24%	3,93%	8,41%	8,90%	23,35%

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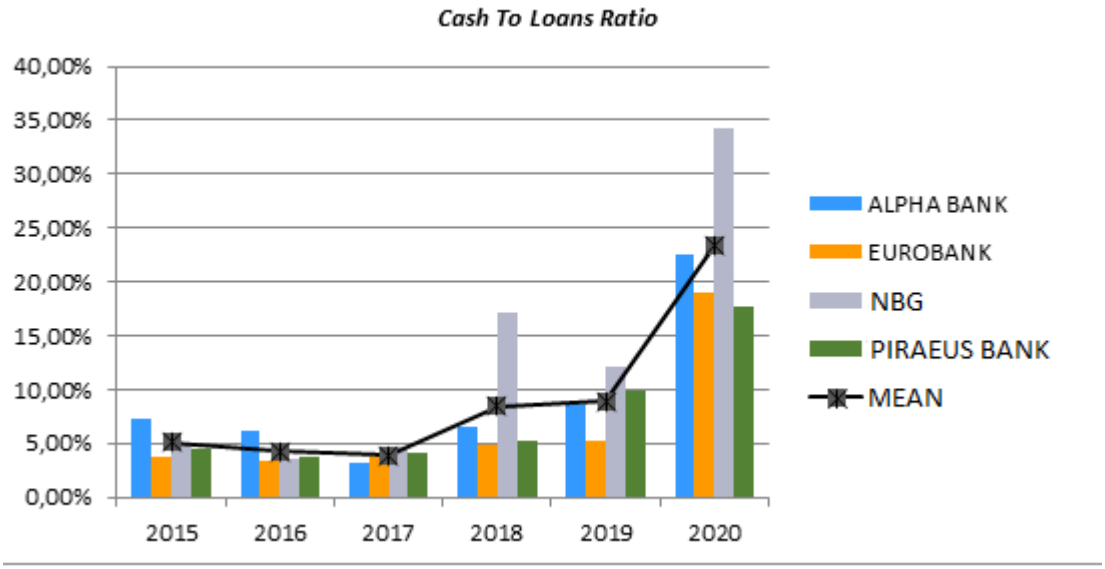

Figure 2. Cash To Loans Ratio

As it can be observed from the study of this ratio, throughout the period under review, it fluctuates continuously in all four systemic banks. The massive flight deposits due to the imposition of Capital Control in both households and legal entities in 2015, resulted in, the four financial institutions being studied, recording significant decreases in the following year. The downward trend of the ratio continued in 2017. The exception is the indices of NBG and Alpha bank, which recorded an increase, and were the ones that raised the overall average. More specifically, NBG's ratio recorded a fairly significant increase, rising from 3.60% to 4.69% surpassing the average of the ratio for that year. Accordingly, Eurobank's ratio rose from 3.78% to 4.11%. This is due to the fact that they managed to take advantage in the most efficient way of the existing economic conditions, where they increased their cash reserves and correspondingly reduced the loans and receivables granted to their customers. Over the next three years 2018-2020, the results were encouraging for all four systemic banks as the ratio followed an upward trend. Especially NBG's ratio managed from 4.69%, to more than double reaching 17.05% and this is because there was an increase of its cash reserves to € 3.5 billion and at the same time there was a decrease of loans granted to natural and legal persons by € 7 billion. The fact that there is a differentiation in the ratios between the four systemic banks examined, indicates that there are differences in the way the bank's managements manage their cash reserves, but also in the way that they grant their loans. This is due to the fragile economic environment in which they operate.

Loans Granted To Deposits Ratio

Table 3: Loans Granted To Deposits Ratio

Loans Granted To Deposits Ratio						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
ALPHA BANK	129,88%	138,78%	127,32%	106,44%	98,07%	89,24%
EUROBANK	146,93%	134,76%	123,39%	100,75%	90,84%	84,94%
NATIONAL BANK	105,62%	102,25%	93,30%	68,88%	65,52%	53,56%
PIRAEUS BANK	126,86%	122,59%	108,89%	90,29%	83,66%	79,83%
Mean (Average)	127,32%	124,60%	113,23%	91,59%	84,52%	76,89%

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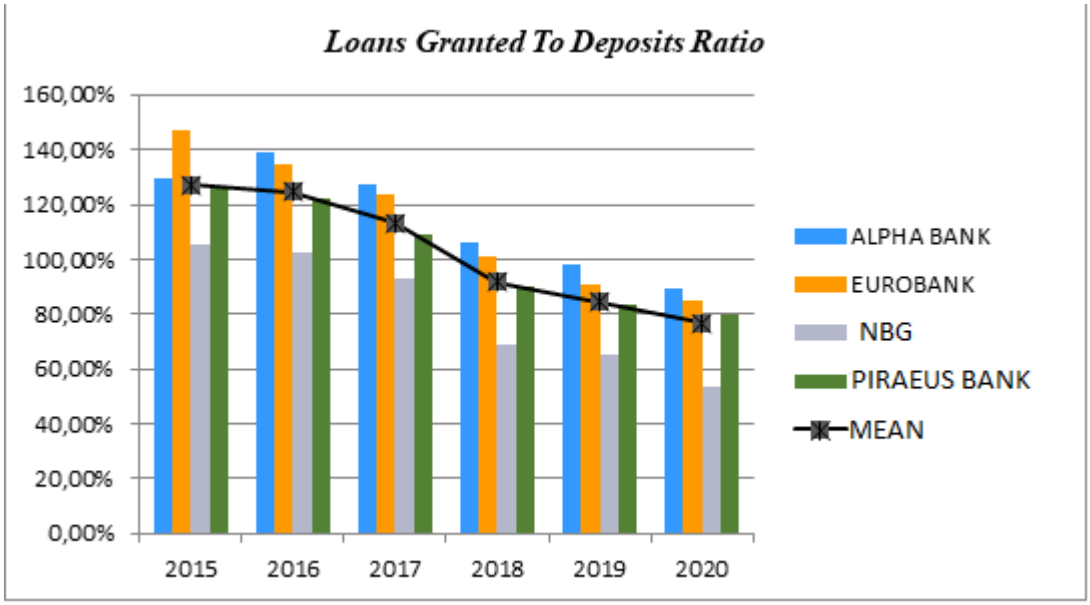

Figure 3: Loans Granted To Deposits Ratio

Regarding the evolution of the Loans Granted To Deposits Ratio, as evidenced by the present study, it shows continuous diminutions, reflecting a particularly significant improvement in the liquidity level of the four systemic banks. This results in positive prospects for granting loans to natural and legal persons, which essentially means stimulating the real economy, with the various funding given to them.

The fact that the number of the ratio shows a downward trend is a very positive signal for their subsequent course, since it reveals that the financing of borrowers does not come from their deposits, but from other sources of financing such as the Central Banks, the issuance of new bonds, etc.

As can be seen from the figure 4.2.2 above, NBG is clearly in a better position than other financial institutions, as it managed from 105.62% in 2015 to fall to 53.56% in 2020. This proves the trust that NBG enjoys from its depositors, as well as the high level of solvency it holds. Of course, the other banking institutions also moved on a downward trajectory, showing that the conditions in the banking sector are slowly beginning to improve more and more.

More specifically, in the next best position is Eurobank where its ratio fell from 126.86% in 2015 to 79.83% in 2020, followed by Alpha Bank and Piraeus Bank, where for the same years their ratios decreased respectively from 146.93% to 84.94% and from 129.88% to 89.24%.

5. CONCLUSIONS

The paper provided the opportunity to formulate the conclusions that not only are characterized by the scientific documentation, but they also have theoretical-methodological, scientific and practical significance:

• It was found that NBG managed in the most efficient way, the mass flight of deposits by limiting the consequences of the existence of liquidity risk, since its ratio in 2018 climbed to 17.05%. This was noted, due to the increase of its cash reserves to € 3.5 billion and at the same time due to the reduction of loans granted to natural and legal persons by € 7 billion.

• It was found that in all financial institutions examined, the number of the ratio shows a downward trend, since it reveals that the financing of borrowers does not come from their deposits, but from other sources of funding such as the Central Banks, the issuance of new bonds, etc. NBG is clearly in a better position than any other financial institution, as it managed from the 105.62% in 2015 to fall to 53.56% in 2020.

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6. FUTURE RESEARCH

At a later stage the research will be extended to the ROE and ROA ratios using the same data analysis methods in order to check the degree of correlations if any. Also with the results we will evaluate how effectively is a company's management team of managing the capital entrusted to it.

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