Al-Farabi International Journal of Social Sciences
Cilt 10/Sayı 2 (2025), 327-354 | Araştırma Makalesi

ECONOMETRIC ANALYSIS OF THE FACTORS AFFECTING THE CAPITAL ADEQUACY RATIO IN THE TURKISH BANKING SYSTEM

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Abstract

Financial market crises have adversely affected many sectors, in particular banks. This has increased the need for effective supervisory and prudential mechanisms to reduce the spillover effects of crises, ensure financial stability and balance bank balance sheets. In response to these needs, the Basel Committee was established in 1974. The Basel Committee has implemented many regulations and published the Basel Criteria to ensure financial stability and create a strong foundation in the banking sector. The aim of this study is to examine the factors that may affect the capital adequacy ratio, which is an important component of the Basel I, Basel II, Basel III and Basel IV Criteria, using the Turkish banking sector as a model. In this context, the relationship between the capital adequacy ratio and the profitability of deposit-taking banks in the Turkish banking sector has been the main starting point of the study. As important as this relationship is for the banking sector, it is also very important for the proper functioning of the financial system. The proper functioning of the financial system is essential for the financial structure. In this study, panel data regression analysis was performed using quarterly data on capital adequacy ratio and the variables that may affect it such as equity, deposits and return on assets for the period 2007Q1-2021Q4 in the Turkish banking sector. After checking whether our data have seasonal effects or not, unit root analysis is performed and differencing is performed for variables with unit root. Following the cointegration analysis, after determining that it would be correct to use Granger causality analysis for causality analysis, causality analysis, impulse response analysis, and variance decomposition tests were performed with all necessary conditions for VAR analysis. After the analyses, the results are interpreted.

Keywords: Turkish Banking Sector, Risk Concept, Basel Criteria, VAR Analysis, Granger Causality Analysis.

Citation

Avine Öztürk, Hülya. & Polat, Mehmet Ali (2025). "Econometrıc Analysıs Of The Factors Affectıng The Capıtal Adequacy Ratıo In The Turkısh Bankıng System". *Al-Farabi International Journal Of Social Sciences, 10 (2)*, s. 327-354.

https://doi.org/10.5281/zenodo.18056267

Date of Submission	27.07.2025
Date of Acceptance	07.09.2025
Date of Publication	31.12.2025
Author Contribution	%70 - %30
Peer-Review	Double anonymized - Two External
Ethical Statement	This article is extracted from my doctorate dissertation entitled "Salih Bin Celaleddin'in Tarih-i Mısır'ı (Dil İncelemesi-Metin Dizin", supervised by Prof. Dr. Turgut TOK (Ph.D. Dissertation, Pamukkale University, Denizli, 2018). It is hereby declared that scientific and ethical principles were followed during the preparation of this study, and all referenced works have been cited in the bibliography
Ethics Committee Permission	Ethics committee approval is not required
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	Contact.alfarabi@iksad.org.tr
Grant Support	The author(s) acknowledge that they received no external funding in support of this research.
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TÜRK BANKACILIK SİSTEMİNDE SERMAYE YETERLİLİK ORANINI ETKİLEYEN FAKTÖRLERİN EKONOMETRİK ANALİZİ

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Öz

Finansal piyasa krizleri birçok sektörü, özellikle bankaları olumsuz etkilemiştir. Bu durum, krizlerin yayılma etkilerini azaltmak, finansal istikrarı sağlamak ve banka bilançolarını dengelemek için etkili denetim ve ihtiyatlı mekanizmalara olan ihtiyacı artırmıştır. Bu ihtiyaçlara yanıt olarak, 1974 yılında Basel Komitesi kurulmuştur. Basel Komitesi, finansal istikrarı sağlamak ve bankacılık sektöründe güçlü bir temel oluşturmak için birçok düzenleme uygulamış ve Basel Kriterlerini yayınlamıştır. Bu çalışmanın amacı, Türk bankacılık sektörünü model alarak, Basel I, Basel II, Basel III ve Basel IV Kriterlerinin önemli bir bileşeni olan sermaye yeterlilik oranını etkileyebilecek faktörleri incelemektir. Bu bağlamda, Türk bankacılık sektöründe mevduat kabul eden bankaların sermaye yeterlilik oranı ile kârlılığı arasındaki ilişki, çalışmanın ana başlangıç noktası olmuştur. Bu ilişki bankacılık sektörü için ne kadar önemliyse, finansal sistemin düzgün işleyişi için de o kadar önemlidir. Finansal sistemin düzgün işleyişi, finansal yapı için hayati önem taşımaktadır. Bu çalışmada, Türk bankacılık sektöründe 2007Q1-2021Q4 dönemi için sermaye yeterlilik oranı ve bunu etkileyebilecek özkaynak, mevduat ve aktif kârlılığı gibi değişkenlere ilişkin üç aylık veriler kullanılarak panel veri regresyon analizi yapılmıştır. Verilerimizin mevsimsel etkiler içerip içermediğini kontrol ettikten sonra, birim kök analizi yapılmış ve birim kök içeren değişkenler için farklama işlemi gerçekleştirilmiştir. Eşbütünleşme analizinin ardından, nedensellik analizi için Granger nedensellik analizinin kullanılmasının doğru olacağına karar verildikten sonra, VAR analizi için gerekli tüm koşullar sağlanarak nedensellik analizi, dürtü tepki analizi ve varyans ayrıştırma testleri yapılmıştır. Analizlerin ardından sonuçlar yorumlanmıştır.

Anahtar Kelimeler: Türk Bankacılık Sektörü, Risk Kavramı, Basel Kriterleri, VAR Analizi, Granger Nedensellik Analizi.

Atıf Bilgisi

Avine Öztürk, Hülya. & Polat, Mehmet Ali (2025) "Türk Bankacılık Sisteminde Sermaye Yeterlilik Oranını Etkileyen Faktörlerin Ekonometrik Analizi". *Al Farabi Uluslararası Sosyal Bilimler Dergisi*, 10 (2), s. 327-354.

https://doi.org/10.5281/zenodo.18056267

Geliş Tarihi	27.07.2025
Kabul Tarihi	07.09.2025
Yayım Tarihi	31.12.2025
Yazar Katkı Oranı	%70 - %30
Değerlendirme	İki Dış Hakem / Çift Taraflı Körleme
Etik Beyan	Bu çalışma Prof. Dr. Turgut TOK danışmanlığında 12.11.2018 tarihinde sunduğumuz "Salih Bin Celaleddin'in Tarih-i Mısır'ı (Dil İncelemesi-Metin Dizin" başlıklı doktora tezi esas alınarak hazırlanmıştır. Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur
Etik Kurul İzni	Etik kurul izni gerektirmemektedir
Benzerlik Taraması	Yapıldı – Turnitin
Etik Bildirim	Contact.alfarabi@iksad.org.tr
Çıkar Çatışması	Çıkar çatışması beyan edilmemiştir.
Finansman	Bu araştırmayı desteklemek için dış fon kullanılmamıştır.
Telif Hakkı & Lisans	Yazarlar dergide yayınlanan çalışmalarının telif hakkına sahiptirler ve çalışmaları **CC BY- 4.0** lisansı altında yayımlanmaktadır.

1. Introduction

The fluctuations in the financial system, the deterioration of banks' balance sheets, the complexity of the system, the crises experienced and the negative developments in the Bretton Woods system called for new regulations. The Basel Committee was set up in 1974 to find solutions to all these problems. With the aim of strengthening the financial system and minimising adversities, the Committee published the Basel Criteria. Agreements on the Criteria have been made in parallel with developments in the international market. The Committee first published the Basel I Criteria in 1975. Basel I focused on capital adequacy requirements. The aim was to establish a common capital ratio for international banks. It categorised the risks to which banks were exposed and attempted to determine the amount of capital they should hold against these risks. The crises of the 1990s and the shortcomings of the previous consensus led to Basel II. One of the major themes of Basel II, which is more comprehensive in structure, was to move away from the rule of applying the same standards to all banks. Another concept was to increase risk sensitivity. Transparency was to be increased and the OECD country rule was abolished. Basel II highlighted three important blocks. The first block, the minimum capital requirement, aims to ensure that banks hold more risk-sensitive minimum capital. The first block also added the concept of operational risk to the calculation of the capital adequacy ratio. The second block, the supervisory review process, aims to ensure that risk factors are addressed by supervisors. The third structural block focused on market discipline. Turkey enacted the Banking Law No. 5411 to comply with the Basel II Criteria. With this law, it is aimed to establish a more transparent structure, harmonisation with international banks, and an effective internal audit and risk management system in the Turkish banking sector. Basel II, which aims for a strong financial sector, shows that the Turkish Banking Sector is successful in internal control and risk management, has a sound capital and uses up-to-date techniques. The capital adequacy ratio in Turkey has remained above both the 8% set by the committee and the 12% set by the Banking Regulation and Supervision Agency (BDDK). The BDDK's setting of the ratio at 12% ensured that banks in Turkey did not face capital problems during the crisis period. When the structural blocks, which are important issues of Basel II, are analysed from the perspective of Turkey, it is seen that the BDDK attaches importance to this issue. Within the scope of Pillar I, it is observed that the method based on internal ratings is mostly used in Turkey. In addition, banks have also attached importance to factors such as infrastructure and system during measurement. As a result of the studies, harmonisation has been achieved between the banks in Turkey and the first structural block. The second structural block, which emphasises supervision and audit against the risks that banks may face, has also been an important issue for Turkey. The majority of banks in Turkey have harmonised on this issue by focusing on an effective supervision and audit mechanism. In terms of the third structural block, which focuses on market discipline, Turkey has achieved a great deal of harmonisation. As a result of the weaknesses of Basel III, a new regulation text came to the agenda and was named Basel IV. The consensus, which is in constant change and development, aims to eliminate the complex structure of the capital adequacy ratio.

The new text, which aims to achieve simplicity, transparency, comparability, consistency and sensitivity, has introduced a number of innovations. These innovations are; New Standardised Approach for Credit Risk, Future of Credit Risk Internal Ratings Based Approaches - BCBS, New Standardised Approach for Operational Risk, Market and Interest Rate Risk Regulations. When considering Basel IV in relation to the Turkish banking sector, "Good Practice Guidelines" have been announced in order to comply with the process in Turkey. The BDDK sent a notification to the banks for the implementation of the Risk Management Guide. Within the framework of the Consensus, a number of positive and negative effects are foreseen in Turkey. Within the framework of Basel III, a positive impact is expected in Turkey in the form of an 85% risk weight for SMEs instead of a 100% risk weight. On the other hand, negative effects are also expected, such as the increase of conversion ratios in off-balance sheet transactions, the elimination of "tranching" in loans whose mortgages are linked to commercial real estate, the application of 100-150% risk weights to specialised loans instead of the risk weight previously applied to corporate exposures, and the application of 150% risk weight to the unsecured portions of defaulted loans. Following a review of the literature, the study conducts an empirical analysis of the relationship between the capital adequacy ratio, which is important for the Basel Criteria, and the variables that may influence it, such as equity, deposits and return on assets. The period considered is 2007-2021, using quarterly data. After checking whether or not our data have seasonal effects, unit root analyses were carried out and differencing was performed for variables with unit roots. After the cointegration analysis, and having established that it would be correct to use Granger causality analysis for the causality analysis, causality analysis, impulse response analysis and variance decomposition tests were carried out, providing all the necessary conditions for VAR analysis. Finally, the results of the empirical analysis are interpreted. In this study, it is considered important to identify the financial ratios that affect the capital adequacy ratio, and analyses using financial ratios and capital adequacy ratio in different periods are presented as a suggestion to valuable researchers, institutions and sector stakeholders.

2. Literature Review

There are several studies in the literature on the factors affecting the capital adequacy ratio, which is one of the strongest financial indicators and is considered to be a risk indicator for banks. These studies cover different years and financial ratios and analyses have been carried out using different methodologies. Some of the academic studies are mentioned below.

Okuyan (2013), in his study to determine the factors affecting the capital adequacy ratios of Turkish banks, analysed the quarterly data obtained from the financial statements of 23 banks between 2002:Q04 - 2012Q1 using the panel data method. The results showed that there is a negative relationship between capital adequacy ratio and risk, size, deposit ratio and loan ratio, and a positive relationship between economic growth and return on assets. Among the independent variables, only return on equity was found to be insignificant.

Reis and Kötüoğlu (2016) used regression analysis to determine the factors affecting the capital adequacy ratio. As a result of their study, they found that the non-performing loan ratio, liquidity ratio and profitability ratio variables positively affect the capital adequacy ratio, while the asset size variable does not affect the capital adequacy ratio.

In his study, Dizgil (2017) analysed the effect of financial structure of banks operating in the BIST financial sector on financial performance. For this purpose, the variables of return on assets ratio, total loans to assets ratio, equity to assets ratio, deposits to assets ratio and asset size ratio of 10 banks for the period 2009:03-2019:09 were analysed using quarterly data. In the study, panel regression method was applied to determine the relationship between financial performance and financial structures of banks. According to the results of the analysis, the ratio of total loans to assets has a negative effect on return on assets at 1% significance level. The effect of the ratio of equity to assets on return on assets is positive. The ratio of deposits to assets has a positive effect on return on assets. The size of assets also has a positive effect on return on assets. Analysing the results of the study as a whole, it can be concluded that banks with a strong equity and deposit structure are more important in terms of profitability in explaining bank performance; similarly, banks with a high asset size may also have a high return on assets.

In his study, Topaloğlu (2018) aimed to identify the micro factors that affect the financial fragility of commercial banks operating continuously in the Turkish banking sector between 2002Q2-2015Q4. Financial fragility is represented by non-performing loan ratio and capital adequacy ratio, while micro factors are represented by return on assets, return on equity, liquidity ratio, bank size, financial leverage and net interest margin. Two separate models were constructed to identify the factors affecting financial fragility. These models were analysed using panel data techniques. As a result of the analysis, in Model 1 a significant and negative relationship was found between the NPL ratio and bank size, while a significant and positive relationship was found with the liquidity ratio. In model 2, a significant and positive relationship was found between capital adequacy ratio and net interest margin and return on assets, while a significant and negative relationship was found between financial leverage and return on equity.

In the study by Afşar and Karaçayır (2018), the determinants of capital adequacy ratio in the Turkish banking sector were tested using the panel data method for the period 2002Q4-2017Q1. The results of the study showed that loan-to-value ratio, deposit and asset size variables negatively affect the capital adequacy ratio, while return on assets positively affects it.

Aydın (2019) aimed to investigate the factors affecting the capital structure of 22 deposit-taking banks operating in the Turkish banking sector during the period 2006:Q1-2016:Q3. According to the results of the study's fixed-effect panel data estimation, bank-specific variables such as bank size, return on assets, credit risk, liquidity risk and deposit level are factors affecting banks' capital adequacy ratio. Therefore, the capital adequacy ratio of banks is positively related to return on assets and non-performing loans, while it is negatively related to bank size, liquidity risk and deposit level.

Özdemir (2019) analysed the effect of capital structure on bank performance in the Turkish banking sector. The study used quarterly data from 2005Q4-2017Q3, and the return on assets (ROA) variable was used as the performance indicator. As a result of the study, empirical evidence was obtained that there is a negative relationship between capital structure and ROA in the Turkish banking sector and that there is a differentiation between development and investment banks and deposit-taking banks in terms of the effect of capital structure on performance.

Şit and Hacıevliyagıl (2019) conducted a study to determine the effect of capital adequacy ratio on bank profitability. In the study, 10 banks with the largest asset size were sampled and panel data analysis was conducted using quarterly data from 2011Q1-2016Q4. As a result of their study, it was concluded that banks' capital adequacy has an impact on banks' profitability. However, capital adequacy did not differ between equity and conventional banks. In other words, when analysing the effect of capital adequacy on banks' profitability, participation banks and conventional banks did not differ significantly. Albaraka Türk participation bank was the most affected by the capital adequacy ratio, while Halk Bank was the least affected.

Çıtak and Kandil Göker (2020) conducted a study to determine the factors that are effective in determining the capital adequacy ratio. The study, which was conducted on deposit-taking banks operating in Turkey and whose financial data are continuously available, used data for the period 2002Q1-2017Q3 and applied panel data analysis. According to the results, there is a significant relationship between the capital adequacy ratio and banks' total assets, the ratio of deposits to total assets, the ratio of loans to total assets, the interest margin and the ratio of non-performing loans to total loans.

Temelli, Özbay and Tekin (2022) conducted a study to determine the determinants of the capital adequacy ratio of participation banks operating in Turkey. In this study, the determinants of the capital adequacy ratio of participation banks in Turkey were investigated using panel data analysis for the period 2010Q1-2018Q3. In this direction, the analyses were conducted using the data of Albaraka Türk, Kuveyt Türk and Türkiye Finans participation banks operating in Turkey. The results of the analyses show that return on equity and the ratio of loans to assets (loan-to-value ratio) have a negative effect on the capital adequacy ratio, while return on assets and total assets have a positive effect on the capital adequacy ratio. The non-performing loans/total loans ratio is found to have a statistically insignificant effect on the capital adequacy ratio.

Medetoğlu (2023) based his study on the 10 banks with the highest asset size in 2021. The data used covers the years 2011Q1-2021Q2. In the study, the capital adequacy ratio was determined as the dependent variable, and the following independent variables were determined: equity/total assets, total deposits/total assets, loans received/total assets, total loans/total deposits, non-performing loans/total loans, liquid assets/total assets, and return on average equity. As a result of the study, it is concluded that there is a statistically significant relationship between the capital adequacy ratio and all the financial ratios.

3. Econometric Analysis

3.1. Data Set

In this study, capital adequacy ratio, return on assets, total equity/total assets, total deposits/total assets variables were used in the Turkish banking sector. In order to test the hypotheses of the research, the data obtained from the website of the Banking Association of Turkey were used as the main data source. The research covers the period 2007Q1-2021Q4. Some information about the variables used in the research is given in table 1.

Table 1: Information on the Data Set Used in the Study

Variable Name	*Abbreviation*	*Year*	*Source*
Capital Adequacy Ratio	CAR	2007-2021	TBB
Return on Assets	RA	2007-2021	TBB
Total Equity / Total Assets	TETA	2007-2021	TBB
Total Deposits / Total Assets	TDTA	2007-2021	TBB

In determining the independent variables in the study, care was taken to use variables that could have a high impact on the capital adequacy ratio. As equity is effective in the capital adequacy formula, it is included in the analysis. The ratio of total equity to total assets shows how much of banks' assets are covered by equity. It is therefore important in measuring a bank's risk of default and is expected to have a positive relationship with the capital adequacy ratio. In addition, as deposits have an impact on banks' profitability and profitability supports capital, the return on assets effect is analysed.

3.2. Econometric Method

In order to examine the relationship between the capital adequacy ratio and return on assets, total equity/total assets, total deposits/total assets variables in the Turkish banking sector, a time series analysis was conducted and the period between 2007 and 2021 was considered. Quarterly data were used for the period under consideration. In order to minimise the possible volatility during the time series analysis, the logarithms of the series were taken and the problem of changing variance was avoided. The econometric method used is the Vector Autoregressive (VAR) model and Granger causality analysis. Prior to the analysis, unit root tests are used to check whether the series to be used have unit roots and to what degree they are stationary, and cointegration tests are used to check whether there is a long run relationship between the variables. VAR analysis and Granger causality tests are then carried out by determining the appropriate lag length. Finally, the variables were subjected to impulse response analysis and variance decomposition and the results were evaluated.

3.2.1. Unit root tests

In econometric analysis, the stationarity of the series is very important in order to obtain a meaningful relationship between the variables. This is because temporary or permanent shocks in the economy can cause trend effects or seasonal fluctuations in the series. This causes the series to be non-stationary. The results of the studies in which the series are non-stationary appear as "spurious regressions". Therefore, unit root tests are used in econometric analysis (Hassler and Wolters, 2005: 1).

3.2.1.1. ADF (Augmented Dickey Fuller) Unit Root Test

The Extended Dickey Fuller test is one of the methods used to determine the existence and stationarity of unit roots in time series. Three models are used: with trend with constant, without trend with constant and without trend without constant. In the presence of a unit root, the series is non-stationary. In the absence of a unit root, the series is stationary (Oltulular, 2015: 122). The ADF unit root test is designed to detect the presence of a single unit root. Therefore, when it is applied to time series with more than one unit root, model-building errors often occur and the reliability of the test results decreases (Küreş, 2019: 29).

During interpretation, the test statistic is compared with the critical values at the 1%, 5% and 10% levels. If the test statistic is greater than the critical values as a result of the unit root analysis, the H1 hypothesis is accepted. This indicates that the series is stationary, i.e. there is no unit root in the series. If the test statistic is less than the critical value, the H0 hypothesis is accepted. This indicates that there is a unit root in the series. Following the result of the ADF unit root test, the unit root test is continued by taking the difference of the series until the H0 hypothesis is rejected.

3.2.1.2. Phillips ve Perron (PP) Unit Root Test

The PP unit root test was introduced to overcome the shortcomings of the Augmented Dickey Fuller (ADF) unit root test. ADF tests assume that error terms are independent and have equal variance. When time series are analysed, it is found that most of them are weakly dependent and heterogeneously distributed. In 1988, Phillips and Perron developed a new unit root test based on the possibility of autocorrelation among error terms (Boğa, 2020: 494).

In the interpretation of the PP unit root test, the test statistic is compared with the critical values at 1%, 5% and 10% levels. As a result of the unit root analysis, if the test statistic is greater than the critical values, the H1 hypothesis is accepted. This indicates that the series is stationary, i.e. there is no unit root in the series. If the test statistic is less than the critical value, the H0 hypothesis is accepted. This indicates that there is a unit root in the series. Following the result of the PP unit root test, the unit root test is continued by taking the difference of the series until the H0 hypothesis is rejected.

3.2.1.3. KPSS (Kwiatkowski-Phillips-Schmidt-Shin) Unit Root Test

The KPSS unit root test was introduced by Kwiatkowski, Phillips, Schmidt and Shin. The hypotheses in the ADF and PP unit root tests are that there is a unit root in the series, i.e. there is no stationarity. In the KPSS test, on the other hand, this situation indicates that the series is stationary. The KPSS test examines the stationarity of the series without testing for the presence of a unit root. For this reason, the KPSS test is referred to as a stationarity test rather than a unit root test (Çil Yavuz, 241).

Here, our test statistic is compared with the critical values at 1%, 5% and 10% levels; if our KPSS test statistic is greater than the critical values, the H1 hypothesis is accepted. In this case, the series is not stationary. If our KPSS test statistic is less than the critical value, the H0 hypothesis is accepted and the series is stationary.

3.2.2. VAR (Vector Autoregression Model) Analysis

The complexity of economic relationships has brought simultaneous equation models, rather than single equation models, to the fore in explaining economic events. The interaction of macroeconomic variables has made it difficult to classify data as endogenous or exogenous. For this reason, the VAR (Vector Autoregression) model has been proposed to overcome problems such as the distinction between endogenous and exogenous variables in simultaneous equation models (Tarı and Bozkurt, 2006: 4). VAR analysis attempts to identify the relationship between two or more variables. While the other analyses in the literature refer to a unidirectional relationship, VAR analysis focuses on the bidirectional relationship between variables. Therefore, variables used in VAR analysis should be stationary. Therefore, unit root tests of the variables should be carried out first. In case of non-stationarity, first order differences should be taken and the tests should be repeated. The second step is to check for co-variance and autocorrelation between the variables. These conditions are an obstacle in the construction of the VAR model. The third step is to find the optimal lag length. At this point, information criteria such as 1Schwarz (SC) and Akaike (AIC) are used. Üçüncü aşamada ise en uygun gecikme uzunluğu bulunur. Bu noktada, 1Schwarz (SC) ve Akaike (AIC) gibi bilgi kriterleri kullanılmaktadır. Once the appropriate lag length has been found, the VAR model is reconstructed. The coefficients of the VAR model are interpreted (Serezli, 2022: 141-142).

3.2.3. Granger Causality Analysis

The Granger causality test is based on testing the significance of the lagged values of the independent variable in the regression equation. Granger causality analysis is defined as the use of past values of one variable to increase the predictive power of the other variable (Akyüz, 2018: 185).

It is used in econometric studies to test the existence of a causal relationship between two variables. It also determines the direction of the causal relationship. Since it is an easily applicable econometric method, it is widely used. The mutual relationship between the variables used in the VAR analysis is examined by the Granger causality test. It defines a bivariate VAR model with an appropriate lag length. However, the equation set up for the analysis is not a structural econometric model. This model does not aim to predict the future, but to test the causality relationship. Granger causality analysis is used to determine whether one variable has a stable effect on another variable in the model. Granger causality is defined as "X is the Granger cause of Y if the prediction of Y is more successful when past values of X are used than when past values of X are not used" (Bakır Yiğitbaş, 2012: 120).

In Granger causality analysis, instant causality cannot be mentioned due to the time difference between independent movements, there is no simultaneous causality due to the lack of instant causality, and the future is not the cause of the present (Akyüz, 2018: 185).

3.3. Econometric Findings

Before analysing the vector autoregression model, the seasonal effects of the variables in the model were examined and it was found that there was no seasonal effect in the variables used. Fixed effects and trend effects in the series were then analysed. ADF, PP and KPSS unit root tests were carried out on the series. In this way, the stationarity of the series belonging to the variables in the model and whether they contain unit roots were determined.

3.3.1. Results of Unit Root Tests

Table 2: ADF Unit Root Test Results

ADF Unit Root Test								
	Fixed Term				*Constant Term and Trend*			
Variables	%1	%5	t ist	prob	%1	%5	t ist	prob
	Level							
CAR	-3.546	-2.911	-3.236	0.022	-4.121	-3.487	-2.872	0.178
RA	-3.552	-2.914	-1.574	0.489	-4.124	-3.489	-3.350	0.068
TETA	-3.557	-2.916	-0.311	0.915	-4.137	-3.495	-2.500	0.326
TDTA	-3.555	-2.915	-1.607	0.472	-4.133	-3.493	-0.501	0.980
	1. Difference							
CAR	-3.548	-2.912	-8.389	0.000	-4.127	-3.490	-6.201	0.000
RA	-3.552	-2.914	-4.060	0.002	-4.130	-3.492	-4.031	0.013
TETA	-3.557	-2.916	-4.815	0.000	-4.140	-3.496	-4.784	0.001
TDTA	-3.555	-2.915	-3.630	0.008	-4.133	-3.493	-4.023	0.013

The results of the ADF unit root test are presented in table 2. In the model, the Akaike Information Criterion (AIC) is used and the maximum lag length is taken as 5 since the series are quarterly. When analysing the ADF unit root test results, according to the constant term model, the test statistic is less than the calculated value at 1% significance level. Furthermore, according to the constant term model, the test statistics of RA, TETA and TDTA variables are smaller than the calculated values at 1% and 5% significance levels. According to the constant term and trend model, the test statistics for all variables are smaller than the calculated values at 1% and 5% significance levels. Also, the prob. values of all variables are greater than 0.05. In this case the hypothesis H0 is accepted. This indicates that there is a unit root in the series. Therefore, it is concluded that the series are non-stationary at I (0) level and first order differences of all variables are taken to make the series stationary. As can be seen in the table, at the I (1) level, the test statistics of the series are greater than the calculated values and the prob values are less than 0.05. Therefore, the series are stationarised by removing the unit root and adding it to the model.

The results of the Phillips Perron unit root test are presented in table 3. Standard (Bartlett Kernel) and Newey-West Bandwidth were used as estimation methods in the model.

Table 3: PP Unit Root Test Results

PP Unit Root Test								
	Fixed Term				*Fixed Term and Trend*			
Variables	%1	%5	t ist	prob	%1	%5	t ist	prob
	Level							
CAR	-3.546	-2.911	-3.266	0.021	-4.121	-3.487	-2.915	0.165
RA	-3.546	-2.911	-1.311	0.618	-4.121	-3.487	-2.457	0.347
TETA	-3.546	-2.911	-1.940	0.312	-4.121	-3.487	-3.481	0.051
TDTA	-3.546	-2.911	-1.614	0.468	-4.121	-3.487	-0.766	0.962
	1st Difference							
CAR	-3.548	-2.912	-9.172	0.000	-4.124	-3.489	-9.358	0.000
RA	-3.548	-2.912	-4.199	0.001	-4.124	-3.489	-4.283	0.006
TETA	-3.548	-2.912	-10.773	0.000	-4.124	-3.489	-11.928	0.000
TDTA	-3.548	-2.912	-6.494	0.000	-4.124	-3.489	-6.638	0.000

When analysing the results of the Phillips Perron unit root test, according to the constant term model, the test statistic is smaller than the calculated value at 1% significance level for our variable CAR. Furthermore, according to the constant term model, the test statistics of RA, TETA and TDTA variables are smaller than the calculated values at 1% and 5% significance levels. According to the constant term and trend model, the test statistics for all variables are smaller than the calculated values at 1% and 5% significance levels. Also, the prob. values of all variables are greater than 0.05. This indicates that there is a unit root in the series. The first order differences of all variables are taken and the series are stationary at I (1) level by removing the unit root and adding it to the model.

KPSS unit root test results are presented in table 4. Default (Bartlett Kernel) and Newey-West Bandwidth were used as estimation methods in the model.

Table 4: KPSS Unit Root Test Results

KPSS Unit Root Test						
Variables	*Fixed Term*			*Fixed Term and Trend*		
	%1	%5	t statistics	%1	%5	t statistics
	Level					
CAR	0.739	0.463	0.337	0.216	0.146	0.225
RA	0.739	0.463	0.848	0.216	0.146	0.099
TETA	0.739	0.463	0.673	0.216	0.146	0.225
TDTA	0.739	0.463	0.665	0.216	0.146	0.210
	1st Difference					
CAR	0.739	0.463	0.263	0.216	0.146	0.046
RA	0.739	0.463	0.068	0.216	0.146	0.057
TETA	0.739	0.463	0.212	0.216	0.146	0.132
TDTA	0.739	0.463	0.309	0.216	0.146	0.093

Notes: If the KPSS test statistic is > the critical value, the null hypothesis H1 is accepted. In this case, the series is not stationary. If the KPSS test statistic is < the critical value, the null hypothesis H0 is accepted. The series is stationary.

Looking at the results of the KPSS unit root test, first order differences were used to make our series stationary.

Consequently, all variables were subjected to unit root tests after taking their logarithms. Non-stationary series were made stationary by taking their first order differences. Before proceeding to the causality test, Johansen cointegration test was carried out. The dependent variable of the study is the capital adequacy ratio, while the independent variables are total equity/total assets, total deposits/total assets and return on assets. The linear estimating equations to be used in the econometric analysis are as follows:

$$\text{MODEL: } CAR = \beta 0 + \beta 1 TETA + \beta 2 TDTA + \beta 3 RA + ut$$

3.3.2. Co-integration - Cointegration Test Results

After satisfying the stability condition, the non-autocorrelation condition and the non-variance condition, the co-integration test was carried out on the variables. Due to the risk of loss of information, we continued our study at the I (0) level in our cointegration test, although our series are stationary at the I (1) level. Trace and maximum eigenvalue statistics were used to test for cointegration between variables.

In cointegration analysis, r indicates the number of cointegrated vectors. If we conclude that r is 0, there is no long run relationship between the variables. The rule for both cointegration and eigenvalue statistics is that the calculated value should be less than the critical value. This gives us the acceptance result of H0 and the analysis should continue until H0 is accepted. Table 5 shows the results of the trace and max eigenvalue statistics.

Table 5: Trace and Max-Eigen Statistic Results

Unbounded Cointegration Sequence Test (Trace)				
Number of Cointegrations	Eigen Value	Trace Statistics	0.05 Critical Value	Prob.**
No	0.302130	44.40388	54.07904	0.2720
Maximum 1	0.164052	23.89968	35.19275	0.4692
Maximum 2	0.122948	13.68589	20.26184	0.3116
Maximum 3	0.103192	6.208093	9.164546	0.1752
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Number of Cointegration	Eigen Value	Trace Statistics	0.05 Kritik Value	Prob.**
No	0.302130	20.50420	28.58808	0.3746
Maximum 1	0.164052	10.21379	22.29962	0.8181
Maximum 2	0.122948	7.477798	15.89210	0.6110
Maximum 3	0.103192	6.208093	9.164546	0.1752

Note: If the trace statistic < critical value, the H0 hypothesis is accepted.

When analysing Table 5, it is observed that the statistics opposite to none in both trace and max-eigen results are less than the critical values and H0 is accepted. Therefore, the trace and max Eigen tests indicate that there is no cointegration at the 0.05 level and the null hypothesis is rejected. Since there is no cointegrated relationship between the variables, Granger causality analysis is used for causality analysis. Therefore, VAR analysis has been applied.

3.3.3. VAR Model Results

Since our series are stationary at level I (1), the VAR analysis continues at level I (1). The order of the VAR is TDTA, TETA, RA and CAR from the most exogenous to the most endogenous. While our dependent variable in the model is CAR, our independent variables are chosen as RA, TETA, TDTA. Before analysing the vector autoregression models, the appropriate number of lags for an accurate estimation was determined. Considering the lag lengths in Table 6 for the VAR model, the most appropriate lag length is 1 according to the LR, FPE, AIC, SC and HQ information criteria. Therefore, the appropriate lag length is accepted as 1.

Table 6: Determination of the Optimum Lag Length

ag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
	377.7536	NA	1.14e-11	-13.84273	-13.69539	-13.78591
	411.1107	60.53685*	6.03e-12*	-14.48558*	-13.74892*	-14.20148*
	421.9880	18.12894	7.36e-12	-14.29585	-12.96986	-13.78447
	436.4596	21.97543	8.00e-12	-14.23925	-12.32393	-13.50058
	449.9976	18.55197	9.21e-12	-14.14806	-11.64341	-13.18211
	467.2293	21.06099	9.57e-12	-14.19368	-11.09970	-13.00045

Since the stability condition, the autocorrelation condition and the variance changing condition are satisfied with a lag of 1 for the VAR model, the analysis is continued with a lag length of 1.

3.3.3.1 Stability Condition

Figure 1 shows that the distribution of the inverse roots of the characteristic polynomial in the VAR model is inside the circle.

Figure 1: Inverse Roots of AR Characteristic Polynomial

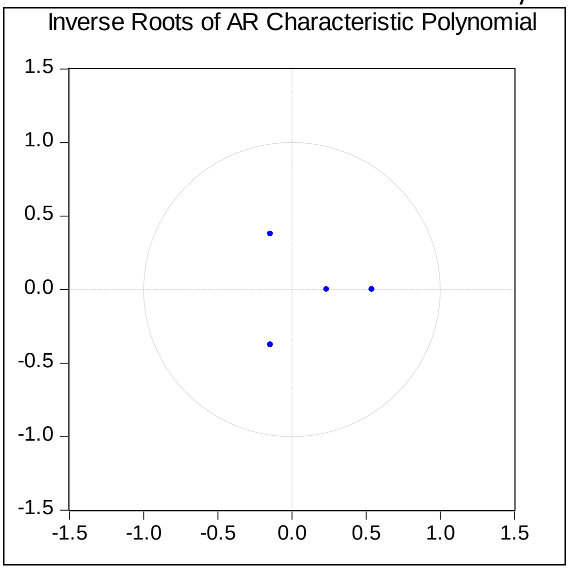


Table 7: Stationarity of Characteristic Polynomials

Root	*Modulus*
0.540636	0.540636
-0.143467 - 0.377058i	0.403430
-0.143467 + 0.377058i	0.403430

0.235360	0.235360
No root lies outside the unit circle.	

In table 7, all values are less than 1 and there is no root outside the unit circle. This shows that the VAR model is stationary and stable. Therefore, the VAR model satisfies the stability condition for our model.

3.3.3.2. Autocorrelation Condition

Autocorrelation implies the existence of a periodic relationship between observations. It is very important for VAR analysis that observations do not influence each other between periods. When analysing the results of the autocorrelation LM test in Table 8, it is observed that all the prob. values are greater than 0.05. This tells us that H0 is accepted and that there is no autocorrelation problem in our model.

Table 8: Autocorrelation LM Test Results

Lags	LM-Stat	Prob
1	19.25500	0.2557
2	19.30158	0.2533
3	19.14275	0.2613
4	21.73452	0.1520
5	22.95800	0.1149

3.3.3.3. No Variance Condition (White Test)

To avoid problems in our models, there should be no problem of varying variance in the error terms. The White Heteroskedasticity (No Cross Terms) test was performed to detect the problem of varying variance in the error terms. Looking at the results in Table 9, it is observed that the prob. value is greater than 0.05. Therefore, the H0 hypothesis is accepted and it is accepted that there is no problem of varying variance.

Table 9: White Variance Test Results

Chi-sq	*df*	*Prob.*
85.72963	80	0.3103

3.3.4. Granger Causality Analysis Results

Once the 3 conditions required for the VAR model were met, the Granger causality test was started. The causality test attempted to determine the correct order between the variables. The dependent variable in our model is the capital adequacy ratio, while the independent variables are total equity/total assets, total deposits/total assets and return on assets. Table 10 shows the results of the Granger causality test.

Table 10: Granger Causality Test Results

Dependent variable: DLCAR			
Excluded	Chi-sq	df	Prob.
DLTETA	4.596978	1	0.0320
DLTDTA	0.129640	1	0.7188
DLRA	0.323773	1	0.5693
All	4.994053	3	0.1722
Dependent variable: DLTETA			
Excluded	Chi-sq	df	Prob.
DLCAR	0.199875	1	0.6548
DLTDTA	8.454764	1	0.0036
DLRA	0.451914	1	0.5014
All	9.082721	3	0.0282
Dependent variable: DLTDTA			
Excluded	Chi-sq	df	Prob.
DLCAR	6.337707	1	0.0118
DLTETA	9.844569	1	0.0017
DLRA	0.354150	1	0.5518
All	20.38586	3	0.0001
Dependent variable: DLRA			
Excluded	Chi-sq	df	Prob.
DLCAR	5.759818	1	0.0164
DLTETA	0.291342	1	0.5894
DLTDTA	2.619708	1	0.1055
All	8.684533	3	0.0338

When the dependent variable is the capital adequacy ratio, the probabilities of the return on assets and total deposits / total assets variables are greater than 0.05. Therefore, there is no causality from the return on assets and total deposits / total assets variables to the capital adequacy ratio. The prob. values of the total capital / total assets variables are less than 0.05. Therefore, there is a causality from the total equity / total assets variable to the capital adequacy ratio over the period considered in Turkey. In summary, return on assets and total deposits / total assets do not cause the capital adequacy ratio. On the other hand, total equity / total assets is the cause of the capital adequacy ratio. Looking at whether all independent variables together are the cause of the capital adequacy ratio, we find that there is no Granger causality as the value of 0.172 is greater than 0.05.

When the dependent variable is total equity/total assets, the probabilities of the variables capital adequacy ratio and return on assets are greater than 0.05 and H0 is accepted. Therefore, there is no causality from capital adequacy ratio and return on assets to total equity / total assets. The probable value of the variable total deposits / total assets is 0.003 and less than 0.05. Therefore, there is a causality from the variable total deposits / total assets to the variable total equity / total assets. When we consider whether all the independent variables together are the cause of the total equity / total assets variable, we find that they are Granger-caused together, as the value of 0.0282 is less than 0.05.

When the dependent variable is total deposits / total assets, the probabilities of return on assets are greater than 0.05 and H0 is accepted. Therefore, there is no causality from return on average assets to the ratio of total deposits / total assets. The prob. value of capital adequacy ratio is 0.011 and the prob. value of total equity / total assets is 0.001. Since the probabilities of both variables are less than 0.05, there is causality from these two variables to the variable total deposits / total assets. The variables CAR and TETA are the cause of TDTA. In addition, if we look at whether all the independent variables together are the cause of the total deposits / total assets variable, we find that they are Granger-caused together, since the value of 0.0001 is less than 0.05.

When the dependent variable is return on assets, the probabilities of total equity / total assets and total deposits / total assets are greater than 0.05 and H0 is accepted. Therefore, there is no causality from total equity / total assets and total deposits / total assets to return on assets. The prob. value of the capital adequacy ratio is 0.016. Therefore, it is less than 0.05 and there is causality from the capital adequacy ratio to the return on assets. CAR is the cause of RA.

3.3.5. Results of The Impulse-Response Analysis

In the impulse - response function graph, the horizontal axis shows the time elapsed after the shock, while the vertical axis shows the direction and magnitude of the response of the other variable to a shock of one standard deviation. Below are the graphs showing the impulse response functions of the variables.

Figure 2: SYR's Response to Equity

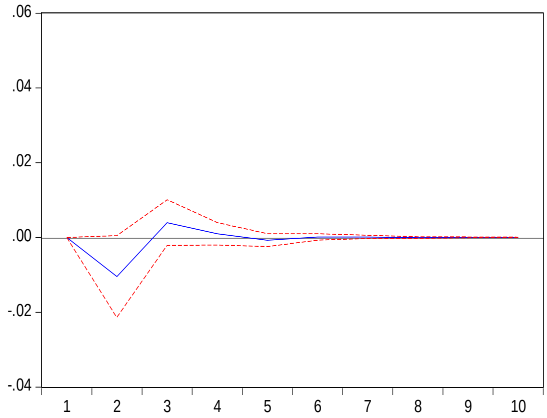
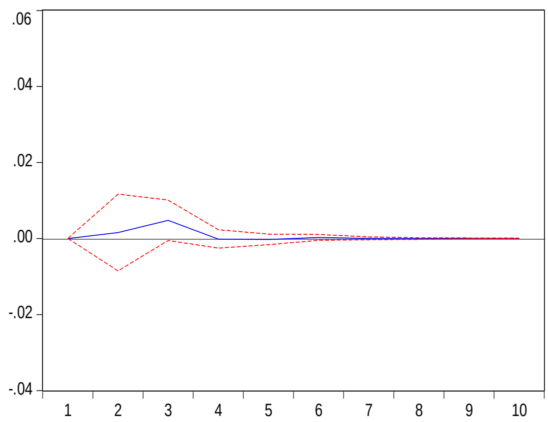


Figure 3: SYR's Response to TMTA



Source: Figures created by author using Eviews software.

The first impulse response graph in figure 2 shows the response of the capital adequacy ratio to a one-unit shock to equity. With a one-unit increase in equity, the capital adequacy ratio falls in the early periods and then rises to reach equilibrium in the medium and long run. Therefore, while the effect of equity on capital adequacy was effective in the early period of our study, i.e. in the short run, this effect stabilised in the medium and long run (Figure 2). The impulse response graph in figure 3 shows the response of the capital adequacy ratio to a one-unit shock in total deposits. When total deposits increase by one standard unit, the capital adequacy ratio increases in the first period and then stabilises in the medium and long run (Figure 3).

Figure 4: Response of CAR to RA

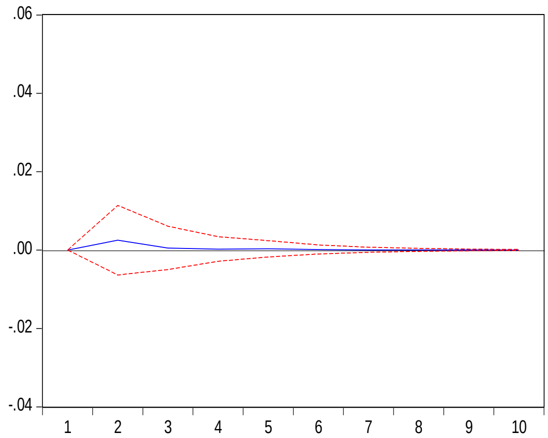
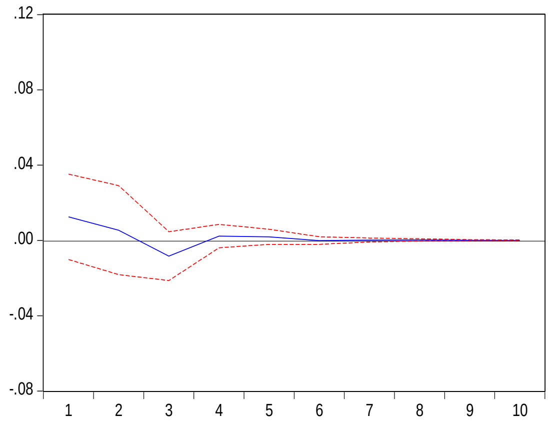


Figure 5: Equity Response to CAR



Source: Figures created by author using Eviews software.

The impulse response graph in figure 4 shows the response of the capital adequacy ratio to a one-unit shock in the return on assets. A one-unit increase in the return on assets causes the capital adequacy ratio to rise in the early periods and then to stabilise in the medium and long term (Figure 4). The impulse response graph in figure 5 shows the response of equity to a one-unit shock in the capital adequacy ratio. For a one-unit increase in the capital adequacy ratio, equity increases in the initial periods and then stabilises in the medium to long run with declines and increases (Figure 5).

Figure 6: TDTA Response to CAR

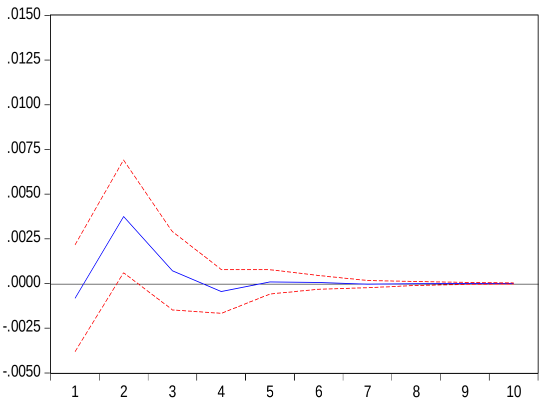
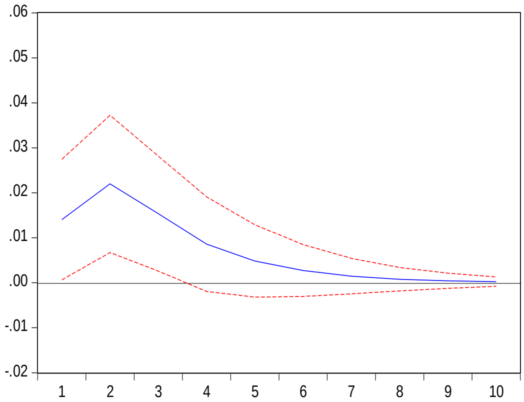


Figure 7: RA Response to CAR



Source: Figures created by author using Eviews software.

The impulse response graph in figure 6 shows the response of deposits to a one-unit shock in the capital adequacy ratio. For a one-unit increase in the capital adequacy ratio, deposits initially fall and then stabilise in the medium to long term, rising and falling (Figure 6). The impulse response graph in figure 7 shows the response of the return on assets to a one-unit shock in the capital adequacy ratio. When the capital adequacy ratio is increased by one unit, the return on assets increases continuously for a certain period and stabilises in the long run (Figure 7).

3.3.6. Variance Decomposition Results

Finally, the variance decomposition test is carried out. The variance decomposition, which is another important tool obtained from the VAR model, is obtained from the moving average part of the model. The variance decomposition expresses in percentage terms the sources of shocks in the variables themselves and in other variables. This test determines how much of the change in the variance of a variable is caused by itself and how much is caused by the change in the variances of other variables. In this study, variance decomposition tests were applied and ten-period results were obtained for the four variables used in the empirical application. Table 11 shows the results of the variance decomposition tests.

Table 11: Variance Decomposition Results

Capital Adequacy Ratio Variance Decomposition					
Period	*S.E.*	*CAR*	*TETA*	*TDTA*	*RA*
1	0.042308	100.0000	0.000000	0.000000	0.000000
2	0.043698	93.85095	5.685689	0.130315	0.333043
3	0.044155	91.98191	6.379928	1.297540	0.340623
4	0.044216	91.95092	6.411680	1.294814	0.342588
5	0.044224	91.91926	6.436124	1.297331	0.347284
6	0.044225	91.91352	6.436915	1.301443	0.348121
7	0.044226	91.91261	6.437610	1.301520	0.348256
8	0.044226	91.91249	6.437645	1.301529	0.348336
9	0.044226	91.91245	6.437642	1.301548	0.348359
10	0.044226	91.91244	6.437649	1.301552	0.348364
TETA Variance Decomposition					
Period	*S.E.*	*CAR*	*TETA*	*TDTA*	*RA*
1	0.086887	2.092911	97.90709	0.000000	0.000000
2	0.095705	2.048127	87.59220	9.950933	0.408741
3	0.096373	2.772874	86.71522	9.957045	0.554861
4	0.096686	2.811056	86.61106	10.02149	0.556392
5	0.096717	2.848357	86.55913	10.03216	0.560354
6	0.096720	2.848229	86.55748	10.03157	0.562719
7	0.096722	2.848581	86.55577	10.03263	0.563018
8	0.096722	2.849137	86.55519	10.03256	0.563112
9	0.096722	2.849164	86.55513	10.03255	0.563156
10	0.096723	2.849172	86.55510	10.03256	0.563166
TDTA Variance Decomposition					
Period	*S.E.*	*CAR*	*TETA*	*TDTA*	*RA*
1	0.011394	0.530340	2.534480	96.93518	0.000000
2	0.013009	8.706539	14.40125	76.59409	0.298122
3	0.013175	8.778744	15.40043	75.52939	0.291435
4	0.013190	8.874739	15.41694	75.41617	0.292154
5	0.013195	8.871440	15.46770	75.36792	0.292943
6	0.013196	8.872742	15.46793	75.36639	0.292941
7	0.013196	8.873188	15.46867	75.36520	0.292943
8	0.013196	8.873162	15.46883	75.36506	0.292947
9	0.013196	8.873171	15.46883	75.36505	0.292947
10	0.013196	8.873172	15.46883	75.36505	0.292947
RA Variance Decomposition					

Period	*S.E.*	*CAR*	*TETA*	*TDTA*	*RA*
1	0.052014	7.279939	4.752242	0.616497	87.35132
2	0.063192	17.02299	6.209335	1.936974	74.83070
3	0.066765	20.53385	6.113356	2.307328	71.04547
4	0.067827	21.49298	6.046015	2.480825	69.98018
5	0.068160	21.78764	6.040339	2.550313	69.62170
6	0.068260	21.88199	6.037427	2.568191	69.51239
7	0.068288	21.90888	6.035959	2.573443	69.48172
8	0.068297	21.91665	6.035662	2.575168	69.47252
9	0.068299	21.91899	6.035582	2.575652	69.46978
10	0.068300	21.91967	6.035550	2.575788	69.46899
Cholesky Sorting: CAR TETA TDTA RA					

Analysing Table 11, according to the variance decomposition results, which measure the explanatory power of the variables on each other, 100% of the forecast error variance of the CAR variable in period 1 is explained by the variable itself. This result shows that CAR is the most exogenous variable. As the period increases, this ratio decreases and in the 10th period it is seen that the rate of self-explanation of the variable is 91.91%. Furthermore, when analysing the explanatory power of the other variables on the CAR variable, it can be seen that TETA is in first place with a share of 6.43%, TDTA is in second place with a share of 1.30% and RA is in third place with 0.34%. Therefore, 91.91% of a change in the CAR variable is caused by itself, 6.43% by the TETA variable, 1.30% by the TDTA variable and 0.34% by the RA variable. The variables TETA, TDTA and RA appear to have the largest share in explaining the variance of the forecast error variance. When analysing the explanatory power of the other variables, it can be seen that the variation in TETA is explained by the TDTA variable and then by the CAR and RA variables, while the variation in TDTA is explained by the TETA variable and then by the CAR and RA variables.

The variables TETA, TDTA and RA appear to have the largest share in explaining the variance of the forecast error variance. When analysing the explanatory power of the other variables, it can be seen that the variation in TETA is explained by the TDTA variable and then by the CAR and RA variables, while the variation in TDTA is explained by the TETA variable and then by the CAR and RA variables.

Conclusion

A healthy financial system makes for a strong economy. The banking sector plays an important role in the functioning of the financial system. The banking sector, which has evolved with the development of technology, has begun to operate in new and risky areas. This development has led to complexity, competition and negativity in the banking sector. Some regulations have been prepared to eliminate these problems, to increase confidence in the banking sector and to eliminate differences in practices in the sector. To this end, the Basel Committee was established in 1974 within the Bank for International Settlements (BIS). The Committee first published the Basel I Criteria in 1988. These criteria placed particular emphasis on credit and market risk. In the 1990s, the increasing impact of global crises brought the issue of capital adequacy to the fore. In 2004, the Basel II Criteria were published to address these issues where Basel I was deficient. In the Basel II Criteria, the risk factors that banks may face are addressed more comprehensively. The concept of operational risk was emphasised and different methods of calculating risk were applied. In 2008, the Basel III Criteria were published to solve the liquidity problem caused by the global crisis, to overcome the shortcomings of Basel II, to strengthen the financial system, to make banks risk resistant and to create a transparent banking system. In this context, practices such as capital increases, capital adequacy and liquidity requirements were implemented to achieve the objectives set. Subsequently, the Basel IV criteria were published to remodulate international capital and address the shortcomings of Basel III. The Basel IV framework focuses on credit risk, market risk, operational risk, the output floor and the leverage ratio component. The Accord includes significant changes to the treatment of operational risk and credit capital. Emphasis is placed on the definition of the leverage ratio and its application to globally significant banks. In addition, provisions have been made to restore the credibility of the capital ratio. The Committee's main objective was to restore reliability in the calculation of risk-weighted assets and to improve the comparability of banks' capital ratios.

In this study, an empirical study has been conducted to analyse the capital adequacy ratio, which is an important component of the Basel criteria, and the variables that may affect the capital adequacy ratio. In this direction, the main starting point of the study is the relationship between the capital adequacy ratio and the profitability of banks in the banking sector. This relationship is as important for the banking sector as it is for the financial system. The proper functioning of the financial system is essential for the financial structure. First, the seasonal effects of the series were analysed. After taking the logarithms of our series that do not have seasonal effects, whether they are stationary or not is determined by ADF, PP and KPSS unit root tests. As a result of the tests, all our variables are stationary in their first differences. Then, the Johansen cointegration test was carried out to determine the long run relationship between our variables. As a result of the analysis, it is found that our series are not cointegrated. Then, Granger causality analysis was carried out to determine the causality relationship between the variables. According to the results of this analysis, it is concluded that return on assets and deposits are not the cause of the capital adequacy ratio, while equity is the cause of the capital adequacy ratio. Therefore, there is a unidirectional causality from equity to capital adequacy ratio. This result indicates that a strong equity structure contributes to the capital adequacy ratio. It is also concluded that the capital adequacy ratio is the cause of return on assets. A unidirectional causality was found from the capital adequacy ratio to the return on assets. The bidirectional causality between the variables was found in the variables TETA and TDTA. That is, deposits affect capital and capital affects deposits. Finally, impulse response analysis and variance decomposition were applied to the variables. A number of conclusions can be drawn from the impulse response analysis. These are: 1) While the effect of the equity shock on the capital adequacy ratio is quite rapid in the short run, it stabilises in the medium and long run. 2) While the effect of deposits on the capital adequacy ratio was small in the first period, it increased thereafter and stabilised in the long run. A similar situation is observed for the effect of return on assets on the capital adequacy ratio. 3) Equity responded significantly to the capital adequacy shock in the short run, and then this effect stabilised in the medium and long run. 4) Deposits initially decreased in response to the capital adequacy shock and stabilised in the medium to long term. 5) The effect of the capital adequacy ratio on return on assets increased continuously over a certain period and stabilised in the long run. The relationship between the two variables persisted. Finally, the variance decomposition test shows that 21.91% of the variation in ROA is explained by CAR, indicating that there is a strong relationship between banks' ROA and CAR. The results of the impulse response analysis also show that RA is affected by a shock in CAR. In this context, the results obtained by variance decomposition and the results obtained by impulse response analysis are mutually supportive. According to all our results, the capital adequacy ratio is effective on banks' return on assets.

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