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Does Digitalisation Have an Impact on Profitability? Evidence from the Turkish Banking Sector

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ABSTRACT

Purpose – Developments and innovations in information technologies have seriously affected the banking sector as they have affected all sectors. Thus, significant gains have been achieved in terms of transaction speed and costs have been significantly reduced. This study aims to investigate the impact of the digitalisation process in the banking sector on the profitability of the sector.

Design/methodology/approach – In the study, quarterly data set for the period 2010/Q4-2024/Q1 is used. Time series analyses are used to examine the relationship between variables. Time series analysis was utilized in the study. Phillip Perron (PP) unit root test was used to determine the stationarity levels of the variables used in the study. ARDL (Autoregressive Distributed Lag Bound Test) bounds test approach was utilized to reveal the long-run relationship between the series. Toda-Yamamoto test was used to test the causality relationship between the variables.

Findings – According to the findings obtained as a result of the analyses, it is determined that there is a cointegration relationship between the return on assets of the Turkish banking system and the volume and number of digital banking transactions. According to the results of Toda-Yamamoto causality tests, it was concluded that there is a unidirectional Granger causality relationship between return on assets and digital banking transaction volume, while no causality relationship was found between return on assets and the number of digital banking transactions. It is concluded that digital banking applications have a positive effect on the return on assets of the Turkish Banking sector.

Discussion – It is important for banks to increase their service quality by focusing more on digitalisation efforts, to equip their personnel with digital technologies and to aim to increase the use of digital banking applications by making detailed introductions to their customers.

1. INTRODUCTION

The banking sector, which is characterised as the locomotive of the financial system, has entered a significant change and transformation process with the developments in financial technology, especially since the 2000s. Since the finance and banking sector is an information-intensive and technology-oriented field, the range of activities of banks has started to grow with the development of financial technology (Zhao et al., 2022). With the developments in information and communication technologies, significant transformations are taking place in the banking sector. Due to the innovations in internet technology, the banking sector has become obliged to change and improve its services day by day. Digital banking services, which can be listed as internet banking services, ATM banking services, telephone banking services, POS (point of sale) services, mobile banking services, television banking services, home and office banking services, are replacing traditional banking services today (Ojeka & Ikpefan, 2011).

Financial Technology (FinTech), which is a combination of the concepts of finance and technology as an indicator of digitalisation and associated with the terms advanced-competitive, refers to innovative business models, new technology applications and business processes that promote financial innovation through

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technical means. Digital transformation through financial technology can significantly affect financial institutions and services, especially financial markets. This impact is particularly evident in the digitalisation of financial services, increasing the efficiency of banking services and reducing costs (Mbama & Ezepue, 2018).

The potential strategic advantages of banks in the face of these developments are related to the regulatory structure of the banking system and the resulting customer trust, data security, specialised banking products and services. On the other hand, the potential strategic advantages of FinTech institutions are to provide versatile platform-based services, to provide a variety of products and services in accordance with the needs thanks to data storage and information processing, and to facilitate access to finance. Although banks and FinTech institutions have basically two options, such as competing or cooperating over these advantages, there is a tendency towards cooperation.

Digital banking is a tool that enables financial consumers to perform banking transactions through the bank distribution networks of banks. Many transactions such as balance control, money transfer, bill, tax, etc. payments, credit card and loan applications, limit changes, investment transactions, etc. can be performed through this application. This banking method provides financial consumers with the opportunity to make fast transactions at a lower cost, at the time and place of their choice. For banks, digital banking is a very effective application in terms of providing a sustainable customer potential (Khan, 2019).

The banking sector is one of the sectors that adapt to the rapid changes in technology the fastest. The number of customers using digital banking is increasing exponentially. The profitability of banks can be affected by many factors. Examples such as increasing loan and deposit volume, technological innovations, revenues from alternative distribution channels of banks, and revenues from banking services can be given. Today, it would not be wrong to call banking as digital banking. The increasing use of digital banking should be thoroughly evaluated by banks.

Today, the competitive environment in the banking sector is intensifying on the axis of digital banking. In the digitalised competitive environment, banks need to develop digital banking systems by recognising their customer profiles well. For this purpose, it is seen that digital banking with technological infrastructure has become more prominent with technological developments in recent years. Since the ultimate goal of digital banking is to make a profit, the impact of digitalisation on profitability in banks is an issue worth examining.

The Covid-19 crisis has made consumers of all generations even more eager to use digital banking channels. Banks' "self-service" capabilities are not limited to common activities such as transferring money and checking account balances online. With the help of the latest banking technologies, consumers can perform advanced digital self-service tasks such as self-registration, remote account opening, loan origination, and insurance purchase. Self-service banking solutions offer users a fast, simple and transparent banking experience anytime, anywhere (Ulusoy, 2022).

Research on digital banking in Türkiye is generally aimed at revealing the approach of consumers to this service and the factors affecting the use of these services. Among the studies conducted globally, there is a limited number of studies on the effect of internet banking on the performance of banks. In this sense, it is thought that our study will contribute to the literature. In the study, the impact of the digitalisation process in the banking sector on the profitability of the banking sector was investigated. For this purpose, the changes that may occur in the number of internet and mobile banking customers and transaction volume are discussed, the literature on the subject is evaluated and the effect of digitalisation on profitability in the banking sector is analysed based on the data. In this context, firstly, domestic and foreign literature on the subject has been researched. Then, the data set of the study and the methodology used in the study are explained. The study is concluded with findings and discussions in the last section.

2. LITERATURE REVIEW

Since digital banking is a widely used application by both corporate and retail customers, there are many studies on digital banking in the literature. While some of these studies are related to technical infrastructures and security, the other part is generally about the adoption of internet banking by customers (Lin, Wang & Hung, 2020; Rahi, Ghani & Ngah, 2020; Teka, 2017; Yurttadur & Süzen, 2016; Hanafizadeh, Behboudi, Koshksaray & Tabar, 2014; Safeena, Date, Kammani & Hundewale, 2012; Cheng, Lam & Yeung, 2006; Furst, Lang & Nolle, 2002). Apart from this, issues such as bank profitability and its effects on management (Roy,

2018; Felix, 2014; Driga & Isac, 2014; Siam, 2006; Daniel & Storey, 1997), customer satisfaction (John & Rotimi, 2014; Uzundağ, 2013) have been investigated. In addition, there are studies on job security problems experienced by bank employees due to internet banking or other electronic banking channels (Khattab, Ahmed & Al-Magli, 2020; Ahmed & Rahman, 2020; Adelani, 2019).

Studies examining the relationship between banking sector profitability and digital banking services have been increasing with the increase in technological developments. While some of the studies have obtained findings showing a positive relationship between digital banking applications and bank profitability, some of them have obtained contrary results. In addition, there are also studies that have found that digitalisation does not affect bank profitability. Digitalisation enables banking activities to continue especially for a long time, to be used outside working hours and to spread innovative electronic services. In this context, the results to be obtained from the analysis of the study are expected to contribute to the literature.

Malhotra and Singh (2009) investigated how the provision of internet banking services by banks in India affects the profitability and risk profile of banks. As a result of the research, they found that there is no significant relationship between internet banking and profitability, on the other hand, internet banking has a significant and negative relationship with the risk profile of banks.

Ciciretti et al. (2009) analysed the effect of internet banking activities on bank performance by considering two separate periods as before and after the banks in Italy started to use internet banking services. They found that the use of Internet technology and innovative banking products positively affected bank returns. In the period after the introduction of Internet banking services, they found a weak positive relationship between risk and bank performance.

Abaenewe et al. (2013) investigated the effects of digital banking on bank performance. They preferred ratios such as equity and profitability as performance factors. In the study, the returns of both periods were compared using the data before and after the digital banking activities and it was determined that the return on equity was positively affected by the introduction of digital banking transactions. It was stated that a significant change was detected in the return on assets.

Kathuo et al. (2015) examined the profitability of forty-two banks serving in the banking sector within the framework of mobile banking. According to the research findings, it was stated that the significant increase in the number of transactions in the last 5 years when mobile banking was used had a positive effect on performance.

Akhisar et al. (2015) examined the impact of electronic banking services on bank performance in twenty-three developed and developing countries. They used return on assets and return on equity as indicators of bank performance. As a result of the research, they found that bank profitability of developed and developing countries is positively affected by the number of debit cards, credit cards and POS. On the other hand, it is negatively affected by the ratio of the number of branches to the number of ATMs and the number of customers utilising internet banking services. The different electronic banking infrastructures of the countries examined, the effect of socio-cultural differences on customer behaviour, high infrastructure and advertising costs in developing countries are stated as factors that reduce profitability.

Mahboub (2018) analysed the relationship between banks' investments in IT technologies and their performance in Lebanon. As a result of the research, it was observed that telephone banking services, internet banking services, ATMs and POS (Point of Sale System) terminals do not significantly affect bank performance, but mobile banking services and offering credit cards to customers significantly and directly affect the performance of banks.

Owusu Kwateng et al. (2020) examined the relationship between the adoption of internet banking services and bank performance in the Ghanaian banking sector. They observed that the independent implementation of internet banking as a strategy to improve performance did not lead to higher returns due to the low level of internet service usage by bank customers. As a result of the study, they concluded that the integration of internet banking into traditional banking methods improves bank performance.

Ulusoy and Demirel (2022) examined the impact of digitalization on banks' return on assets. The results of their study using multiple regression analysis reveal the existence of a positive relationship between

digitalization and profitability. Moreover, the study indicates that internet banking and mobile banking transaction volume and number of transactions have a positive relationship with the banking sector's return on assets (ROA). In addition, it is concluded that digital banking transaction volumes are the most important factor affecting the banking sector's return on assets.

In his study, Deniz (2023) examined the effect of internet banking and mobile banking usage, which are among digital banking services, on bank performance. In the study, regression analysis method was used. In his study, the author found a positive and significant relationship between mobile banking services and bank performance. On the other hand, he concluded that the impact of average financial transaction volume on banking sector performance is higher than the impact of financial transaction volume.

Ergün (2023), on the other hand, used the ARDL bounds test approach to determine the long-run interaction between digitalization in the Turkish banking sector and total net profitability of the banking sector. As a result of the analysis, it was found that there is a long-run relationship between digitalization indicators and total net profitability of the banking sector and that digitalization and profitability move together. In other words, it is concluded that the development in digitalization in the banking sector positively affects banking profitability.

According to the data of all these studies, digital banking transaction volume and the number of active users are increasing day by day and this increase has a positive effect on bank profitability ratios. These findings are similar to the findings of our study.

3. METHODOLOGY AND DATA SET

This study aims to investigate the impact of the digitalization process in the banking sector on the profitability of the sector. For this purpose, in line with the studies in the literature (Abaenewe et al. 2013; Ulusoy and Demirel, 2022; Deniz, 2023), the number of internet and mobile banking customers, transaction volume and return on assets figures of the Turkish banking sector are considered. While determining the number of digital banking customers, the number of customers who have "logged in at least once" in terms of mobile banking and internet banking is taken into account. A quarterly data set for the period 2010/Q4-2024/Q1 is used. The reason for starting the period in 2010 is that the Banks Association of Türkiye (BAT) started to publish the amount of payments made via mobile banking, mobile banking transaction volume and the number of mobile banking active customers, which are digital banking indicators, in its database for the first time. The data set of variables covering a total of 14 years and 54 quarterly periods is obtained from the websites of the "Banking Regulation and Supervision Agency (BRSA)" and UMT. Before starting the analysis, the natural logarithm of the variables was taken to minimize the variance, which is a common problem in time series analysis. The abbreviations, explanations and information on where these data were obtained are shown in Table 1 for the variables included in the study.

Table 1. Data Set

Variables	Explanations of Variables	Time Interval	Data Period	Source
logDBV	Digital Banking Transaction Volume	2010Q1- 2024Q1	3 Aylık	BRSA, BAT
logDBN	Number of Digital Banking Transactions			
logROA	Banking Sector Return on Assets			

Return on assets ratio (ROA) is the most important ratio that shows how much profit banks generate with their existing assets and how effectively they can use these assets. For this reason, it is used extensively in the literature as an indicator of banks' profitability.

3.1. Methodology

In time series analyses, it is first necessary to determine whether the variables used in the study contain unit roots, that is, it is an important issue to determine whether the series are stationary (Gujarati, 1999). For the stated reason, Phillips-Perron (PP) test, one of the unit root tests, was applied first.

ARDL bounds test approach was utilised to determine the long-run and significant relationship between the variables. This method is used to test the concept of 'cointegration', which states that there is a stationary combination of at least two non-stationary variables (Tarı, 2014). Therefore, the ARDL method serves to identify a stationary combination of variables with different levels of stationarity. This approach is more flexible than traditional cointegration tests such as Engle and Granger (1987), Johansen and Juselius (1990), Phillips and Hansen (1990). The ARDL method does not require all variables to be integrated to the same degree. It provides consistent empirical evidence for models with small samples (Pesaran, Shin & Smith, 2001).

In order to determine whether there is a cointegration relationship between the series using the bounds test approach, an unrestricted error correction model is first constructed. The ARDL Boundary Test equation, which is created to reveal the cointegration relationship between the two variables, is as shown below:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{i=1}^{m} \beta_{2i} X_{t-i} + \beta_{3i} Y_{t-1} + \beta_4 X_{t-1} + \varepsilon_t \quad (1)$$

ΔY_t is the dependent variable, X_t is the independent variable, ε_t is the error term, and m is the optimum lag length, where m is the smallest value of the information criteria. The hypotheses regarding the existence of cointegration in the ARDL bounds test model are as follows:

H_0: $\beta_3=\beta_4=0$ (There is no cointegration)

H_1: $\exists \delta_i < 0, i = 3,4$ (There is cointegration)

In order to test the above equation, which includes both constant and trend, the appropriate lag length should be determined first. Information criteria such as Akaike (AIC), Schwarz (SBC), Hannan-Quin (HQ) are used to determine the appropriate lag length. The lag length with the smallest value from these information criteria is used in the model. The model should not have autocorrelation problem at the relevant lag length. After determining the lag length, F statistics are used to determine the existence of cointegration relationship between the series. In the ARDL bounds test method, F statistics are determined according to the lower and upper values in Pesaran et al (2001). If the value obtained from the analysis is less than the lower critical value of the calculated F statistic, it can be said that there is no cointegration relationship between the series, and if it is greater than the upper critical value, it can be said that there is a cointegration relationship. However, if the value is between the lower and upper critical values, then no decision can be made about cointegration. The equation for the long-run relationship is as follows:

$$Y_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{i=0}^{n} \beta_{2i} X_{t-i} + \varepsilon_t \quad (2)$$

Y_t is the dependent variable, X_t is the independent variable, β_0 is the constant term, ε_t is the error term, and n and m are the optimal lag lengths.

In traditional causality tests, the series should be stationary. In Toda-Yamamoto (1995), there is no such requirement in causality analysis. The Toda-Yamamoto approach is preferred because it allows the use of series with unit roots and contains more information. In order to apply this test, firstly, the optimum lag length (p) should be determined with the help of VAR model. Then, the highest degree of integration (d_{max}) is added to the lag length (p). The equations of the Toda-Yamamoto causality test are shown in Equations 1 and 2 (Toda &Yamamoto, 1995).

$$Y_t = \omega + \sum_{t-1}^{m} a_{1i} x_{t-i} + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{j=m+1}^{dmax} \delta_{1i} X_{t-i} + \sum_{j=m+1}^{dmax} \theta_{1i} Y_{t-i} + \varepsilon_{1t} \quad (3)$$

$$X_t = \varphi + \sum_{i=1}^{m} a_{2i} X_{t-i} + \sum_{i=1}^{m} \beta_{2i} Y_{t-i} + \sum_{j=m+1}^{dmax} \delta_{2i} X_{t-i} + \sum_{j=m+1}^{dmax} \theta_{2i} Y_{t-i} + \varepsilon_{2t} \quad (4)$$

The appropriate lag length (m) can be determined with the help of information criteria and the maximum degree of integration (d_{max}) can be determined by unit root tests. If the calculated MWALD (Modified Wald)

test statistic value is greater than the X^2 table value with k degrees of freedom, the above mentioned hypotheses are rejected. (Toda &Yamamoto, 1995). The main hypotheses of the equation are as follows:

The hypotheses of the equation are as follows:

H_0: There is no causality from Y to X.

H_1: There is a causal relationship from Y to X.

4. FINDING OF THE STUDY

This section of the study presents the results of the tests and the findings obtained in order to reveal the relationship between the return on assets ratio, the dependent variable of the Turkish banking system, and the volume and number of digital banking transactions.

4.1. Unit Root Test Results

Before ARDL cointegration and Toda-Yamamoto causality analysis, it should be checked whether the variables are stationary or not. Therefore, firstly, PP unit root test was applied to the series. The results of PP unit root test are shown in Table 2.

Table 2. PP Unit Root Test Results

			PP		
			logROA	***log***DBV	***log***DBN
LEVEL	With Constant	Test Statistic	-2,0052	-4,8033	8,0673
		Probability	0,2838	0,0002	1,0000
			-	***	-
	With Constant & Trend	Test Statistic	-2,5273	-4,6480	1,2960
		Probability	0,3143	0,0024	1,0000
			-	*	-
	Without Constant & Trend	Test Statistic	0,8502	-4,2211	16,5375
		Probability	0,3428	0,0001	1,0000
			-	***	-
1. DIFFERENCE	With Constant	Test Statistic	-13,9213	-	-6,0578
		Probability	0,0000	-	0,0000
			***	-	***
	With Constant & Trend	Test Statistic	-16,2965	-	-9,8326
		Probability	0,0000	-	0,0000
			***	-	***
	Without Constant & Trend	Test Statistic	-13,6510	-	-3,0610
		Probability	0,0000	-	0,0029
			***	-	***
Significance Level	1%	-2,6110			
	5%	-1,9473			
	10%	-1,6127			

Note: (*) indicates that the null hypothesis of unit root in the series is rejected at 10%, (**) 5% and (***) 1% significance level.

According to the PP unit root test results, it is observed that some of the series, which are non-stationary at the level value, become stationary after the first differences are taken.

4.2. ARDL Border Test Results

In order to perform the ARDL test, the maximum lag lengths of the stationary series must first be determined. SC (Schwarz Criterion), AIC (Akaike Information Criterion) and HQ (Hannan-Quinn Criterion) are frequently used criteria for determining lag lengths in time series. The results of this test are as shown in Table 3.

Table 3. Maximum Lag Lengths

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-529.3083	NA	11352161	24.75852	24.88140	24.80384
1	-384.5368	262.6087	20569.40	18.44357	18.93507*	18.62482
2	-370.2077	23.99290	16168.90	18.19571	19.05583	18.51289
3	-360.7204	14.56198	16081.32	18.17304	19.40178	18.62616
4	-346.5029	19.83838	13033.05	17.93037	19.52773	18.51943
5	-318.8870	34.68036	5787.323	17.06451	19.03050	17.78951
6	-315.9971	3.225907	8359.486	17.34870	19.68332	18.20964
7	-310.4564	5.411928	11112.15	17.50960	20.21284	18.50647
8	-292.0189	15.43600	8570.249	17.07065	20.14251	18.20345
9	-264.8810	18.93340*	4770.978	16.22703	19.66751	17.49577
10	-243.6061	11.87439	**3922.011***	**15.65610***	19.46520	**17.06078***

As a result of setting the maximum lag length as 10, the results of the ARDL Border Test applied to logROA and logIH and logIA series are as follows:

Table 4. ARDL Border Test Results

Model	K	M	F Statistic	Significance Level	Lower Bound	Upper Bound
				1%	4,13	5,00
ARDL (4,2,2)	12	4	7,313361	5%	3,10	3,87
				10%	2,63	3,35

Note: Critical values for lower and upper bounds are taken from Table CI(ii) in (Pesaran et al., 2001: 300).

As can be seen in Table 4, the F-statistic value is above the upper bound at the 5% level. According to this result, there is a cointegration relationship between the return on assets of the Turkish banking system and the DBV and DBN series. Since there is a cointegration relationship between the series, it is appropriate to use the ARDL model for long and short-run estimations.

Table 5. ARDL(4,2,2) Model Long Run Coefficient Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
logDBV	3.97941	2.733530	4.016570	0.0003
logDBN	0.02104	6.121505	3.330617	0.0020
C	-0.97666	0.251146	-3.888837	0.0004

As can be seen in Table 5, DBV and DBN data are statistically significant in the long run. The data is significant at the 5% level. The coefficient of digital banking transaction volume is 3.97. Accordingly, a 1% increase in transaction volume results in a 3.97% increase in return on assets. Therefore, there is a positive and strong long-run relationship between return on assets and digital banking transaction volume. Similarly, the coefficient of the number of digital banking transactions is 0.021 and there is a positive and long-run relationship between return on assets and the number of digital banking transactions. A 1% increase in the number of transactions increases return on assets by 0.021%.

Table 6. ARDL Error Correction Model

Variables	Coefficient	Std. Error	t-Statistic	Prob.
D(ROA(-1))	-0.839348	0.136783	-6.136331	0.0000
D(ROA(-2))	-0.716567	0.171330	-4.182380	0.0002
D(ROA(-3))	-0.736646	0.161437	-4.563065	0.0001
D(IA)	0.000204	6.12E-05	3.330617	0.0020
D(IA(-1))	0.000198	7.16E-05	2.766701	0.0089
D(LOG_H)	2.132263	1.014877	2.101006	0.0427
D(LOG_H(-1))	-5.991710	2.052980	-2.918543	0.0060
D(LOG_H(-2))	-5.159522	1.614882	-3.194984	0.0029
D(LOG_H(-3))	-1.755539	1.111185	-1.579879	0.1229
CointEq(-1)*	-0.008993	0.001598	-5.629497	0.0000
R-squared	0.746985	Mean dependent var		0.068163
Adjusted R-squared	0.688597	S.D. dependent var		1.104717
S.E. of regression	0.616470	Akaike info criterion		2.050291
Sum squared resid	14.82138	Schwarz criterion		2.436377
Log likelihood	-40.23212	Hannan-Quinn criter.		2.196771
Durbin-Watson stat	1.490031			

The existence of a short-run relationship between the variables should be determined by the coefficient of the error correction model (ECT). For this model to work, the ECT coefficient must be between 0 and -1 and statistically significant. The results of Table 6 show the short-run data and error correction model for the ARDL (4,2,2) model. When the short-run estimation results are analyzed, the coefficient of the error correction term "Y1" corresponds to "CointEq(-1)" in this table. This coefficient is expected to be negative (-) and the probability value is expected to be less than 0.05. As can be seen in Table 6, the coefficient of the error correction term is -0.008993 and the probability value is 0.0000. The fact that the coefficient of the error correction term is negative and statistically significant provides additional evidence that the model is cointegrated. A probability value less than 0.05 indicates that this coefficient is significant, while a negative (-) coefficient means that an imbalance in the model will be corrected. The data show that in the short run, digital banking transaction volume and number of transactions affect ROA ratios.

While determining the causality between the series, the lag length (k) of the series was found according to the "Schwarz (SC) criterion" and the maximum degree of integration (dmax) was found according to the PP unit root test. Then, the "Wald Statistic" was applied to the (k) lagged values of this model and it was mutually determined whether there is a causality relationship between the two dependent variables and the independent variables. Table 7 and Table 8 show the results of the Toda-Yamamoto Causality test.

Table 7. Toda-Yamamoto Causality Test Results-1

Dependent Variable	Independent Variable	d_{max}	k	Chi-Square Test Statistics	Chi-Square P - Value	Relationship and Direction
ROA	log DBV	4	4	9.719456	0.0454	**There is a relationship**
	log DBN	4	4	0.239952	0.3745	No relationship

Note: Statistically significant at the 5% level. The optimal lag length is determined according to the Akaike (AIC) criterion.

DBV ⟶ ROA

Table 7 shows the results of the Toda-Yamamoto causality test with ROA as the dependent variable and DBV and DBN as independent variables. According to the test results, H_0 hypothesis is rejected and H_1 hypothesis is accepted in the hypotheses established between ROA and DBV at 5% significance level. In other words, it is

concluded that there is a Granger causality relationship between ROA and DBV as of the analyzed periods. On the other hand, no econometric causality relationship was found between ROA and DBN.

Table 8. Toda-Yamamoto Causality Test Results-2

Dependent Variable	Independent Variable	d_{max}	k	Chi-Square Test Statistics	Chi-Square P - Value	Relationship and Direction
log DBV	ROA	4	4	7.627598	0.1062	No relationship
log DBN		4	4	13.89024	0.0077	**There is a relationship**

Note: Statistically significant at the 5% level. The optimal lag length is determined according to the Akaike (AIC) criterion.

ROA ⟶ **DBN**

Table 8 also shows the results of the Toda-Yamamoto causality test where the dependent variable is DBV and DBN and the independent variable is ROA. According to the test results, H_0 hypothesis is rejected and H_1 hypothesis is accepted in the hypotheses established between DBV and ROA at 5% significance level. In other words, it is concluded that there is a Granger causality relationship between DBV and ROA as of the analyzed periods. On the other hand, no econometric causality relationship was found between DBV and ROA.

5. CONCLUSION

The increasing use of digital technology in the world has had a significant impact on the banking sector as in all sectors. Within the scope of digitalization, the banking sector has aimed to diversify the services and products it offers to its customers and to increase the quality of these services and products. The biggest step taken by banks in the context of digital banking has been internet banking applications and mobile banking applications.

The acceleration of technological innovations along with globalization has led to an increase in relations between states and made it necessary for banks, which are among the financial sector actors, to develop their services in this direction. On the other hand, the increase in the costs of banks with developing markets and increasing transaction volume has led them to different channels with cost-reducing effects such as digital banking. In this sense, digital banking activities provide social and economic advantages to both consumers and banks. The Turkish banking sector has also followed these developments and has installed ATMs even in the most rural areas of Türkiye, and offered telephone banking, internet and mobile banking services that consumers can access at any time of the day.

The relationship between digitalisation and profitability in the banking sector has emerged as a focus of contemporary research, particularly in light of rapid technological developments and changes in consumer behaviour. Findings from various studies suggest that while digitalisation offers significant opportunities to improve profitability, the relationship is complex and influenced by multiple factors, including the timing of technology adoption, the nature of digital investments and operational adjustments made by banks.

This study aims to investigate the impact of the digitalization process in the banking sector on the profitability of the sector. For this purpose, in line with the studies in the literature, the number of internet and mobile banking customers, transaction volume and return on assets of the Turkish banking sector are analyzed. Quarterly data set for the period 2010/Q4-2024/Q1 is used in the study. Time series analysis is used to examine the relationship between variables. PP unit root tests unit root tests were applied to determine the stationarity levels of the variables. Since the series became stationary at different levels, ARDL (Autoregressive Distributed Lag Bound Test) test, one of the cointegration tests, was applied. Afterwards, Toda-Yamamoto tests were utilized to determine whether there is causality between the variables and if there is a causality relationship, to determine its directions.

According to the results of the analyses, there is a cointegration relationship between the return on assets and the volume and number of digital banking transactions in the Turkish banking system. According to the results of Toda-Yamamoto causality tests, it is concluded that there is a unidirectional Granger causality relationship

between return on assets and digital banking transaction volume at 5% significance level, while no causality relationship is found between return on assets and the number of digital banking transactions. In conclusion, digital banking practices have a positive impact on the return on assets of the Turkish banking sector. These results are consistent with the results of Çetiner and Karaman (2021), Ulusoy and Demirel (2022), İslamoğlu and Bayrak (2022), Deniz (2023) and Ergün (2023). In this context, it is important for banks to increase their service quality by focusing more on digitalization efforts, to better equip their staff with digital technologies, and to aim to increase the use of digital banking applications by making detailed introductions to their customers. In this context, banks should increase their activities with an innovative and change-oriented approach. In this way, millions of customers will be served with minimum staff, office and workload. Although the new generation banking model has not fully completed its development phase, the fact that it is developing very rapidly can be understood by the increase in the number of users of existing financial institutions.

The relationship between digitalisation and profitability in the banking sector is multifaceted and influenced by numerous factors. While digital transformation offers significant opportunities to increase profitability through improved efficiency, customer engagement and operational cost reductions, it also requires a strategic approach that includes employee training and adapting to technological advancements. As banks continue to navigate the evolving landscape of digital finance, those that effectively utilise digital tools in addressing the associated challenges are likely to experience sustained profitability and competitive advantage in the marketplace.

A limitation of this study is that participation banking is not included in the analysis. On the other hand, published digital banking reports do not include bank-specific data, but only aggregated data for the entire sector. With the expectation that the use of digital banking will continue to increase in the coming years, more detailed analyses can be made if digital banking data specific to each bank is published.

In conclusion, with the development of information technology, a radical change and transformation is taking place with digitalization in the financial sector in which banks, insurance companies and other financial institutions operate. Factors such as the reflections of digitalization on banking activity and financial performance, cheaper service supply, reduction in the number of bank branches and cost savings are among the main factors that push banks to digitalization. The acceleration of technological advances can be seen as an important opportunity to develop strategies and targets for innovative financial products and services. In addition, with digitalization, banks can be better prepared for unexpected events in the future, have stronger financial performances and be at the forefront of the competitive race.

REFERENCES

Abaenewe, Z. C., Ogbulu, O. M., & Ndugbu, M. O. (2013). Electronic banking and bank performance in Nigeria. *West African Journal of Industrial and Academic Research*, 6(1), 171-187.

Adelani, T. (2019). Electronic banking and employees' job security in Lafia Nasarawa State, Nigeria. *Lafia Journal of Economics and Management Sciences*, 4(2), 89-107.

Ahmed, O., & Rahman, B. (2020). Employees of commercial banks learning to unlearn: a case study on the impact of electronic banking in the commercial banks of Bangladesh. *International Journal of Business and Technopreneurship,* 10(1), 31-50.

Akhisar, İ., Tunay, K.B., & Tunay N. (2015). Interaction between ınternet banking and bank performance: the case of Europe. *Procedia-Social and Behavioral Sciences*, 195, 363-368.

Cheng, T., Lam, D., & Yeung, A. (2006). Adoption of internet banking: an empirical study in Hong Kong. *Decision Support Systems*, (42), 1558-1572.

Ciciretti, R., Hasan, I., & Zazzara, C. (2009). Do ınternet activities add value? evidence from the traditional banks. *Journal of Financial Services Research*, 35, 81-98.

Çetiner, M. & Karaman, A.C. (2021). Türk bankacılık sektöründe internet bankacılığının banka karlılığı üzerindeki etkisinin irdelenmesi. *International Social Sciences Studies Journal*, 7(92), 5776-5786.

Daniel, E., & Storey, C. (1997). On-line banking: strategic and management challenges. *Long Range Planning*, 30(6), 890-898.

Deniz, F., (2023). Dijital bankacılık hizmetlerinin banka performansına etkisi. *Üçüncü Sektör Sosyal Ekonomi Dergisi, 58*(3), 2654-2669.

Driga, I., &Isac, C. (2014). E-banking services – features, challenges and benefits. *Annals of The University of Petroşani, Economics,* 14(1), 49-58.

Engle, R. F. & Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation and testing. *Econometrica,* 55(2), 251-276.

Ergün, T. (2023). Dijitalleşme ile bankacılık kârlılığı arasındaki etkileşim: ARDL sınır testi yaklaşımı. *Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 34, 206-227.

Felix, P. (2014). Prospects and challenges of electronic banking in Ghana: the case of Zenith Bank, Sunyani. International Journal of Advances in Management. *Economics and Entrepreneurship*, (1), 6-14.

Furst, K., Lang, W., & Nolle, D. (2002). Internet banking. *Journal of Financial Services Research*, 22(1/2), 95-117.

Gujarati, D.N. (1999). *Basic econometrics*. McGraw Hill, (3rd Edition), New York.

Hanafizadeh, P., Behboudi, M., Koshksaray, A., & Tabar, M. (2014). Mobile-Banking adoption by Iranian bank clients. *Telematics and Informatics*, 31, 62-78.

İslamoğlu, M., & Bayrak, M. (2022). Dijital bankacılık ürünlerinin sektörün büyüme performansı üzerindeki etkileri. *Finans Ekonomi ve Sosyal Araştırmalar Dergisi*, 7(3), 403-416.

Johansen, S. (1988). Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control,* 12(2-3), 231-254.

John, O. & Rotimi, O. (2014). Analysis of electronic banking and customer satisfaction in Nigeria. *European Journal of Business and Social Sciences*, 3(3), 14-27.

Kathuo, S., Rotich, G., & Anyango, W. (2015). Effect of mobile banking on the financial performance of banking institutions in Kenya. *The Strategic Journal of Business & Change Management*, 2(98), 1440-1457.

Khan, Y.M. (2019). An essential review of ınternet banking services in developing countries. *e-Finanse*, 15, s. 74.

Khattab, I., Ahmed, A., & Al-Magli, O. (2020). The implications of e-banking channels on job security and personal development. *Banking & Financial Studies*, (35), 9-39.

Lin, W.-R., Wang, Y.H., & Hung, Y.M. (2020). Analyzing the factors influencing adoption intention of internet banking: applying dematel-anp-sem approach. *Plos One*, 15(2), 1-25.

Mahboub, R. M. (2018). The ımpact of ınformation and communication technology ınvestments on the performance of lebanese banks. *European Research Studies*, 21(4), 435-458.

Malhotra, P., & Singh, B. (2009). The Impact of Internet Banking on Bank Performance and Risk: The Indian Experience. *Eurasian Journal of Business and Economics*, 2(4), 43-62.

Mbama, C. I., & Ezepue, P. O. (2018). Digital banking, customer experience and bank financial performance UK customers' perceptions. *International Journal of Bank Marketing*, 36(2), 230-255.

Ojeka, S.A., & Ikpefan, O.A. (2011). Electronic commerce, automationand online banking in Nigeria: challenges and benefits. *School of Doctoral Studies (EuropeanUnion) Journal*, 1, 39-50.

Owusu Kwateng, K., Osei-Wusu, E.E., & Amanor, K. (2020). Exploring the effect of online banking on bank performance using data envelopment analysis. *Benchmarking: An International Journal*, 27 (1), 137-165.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationship. *Journal of Applied Econometrics,* 16(3), 289-326

Phillips, P. C. B., & Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. *Econometrica,* 58(1), 165-193.

Rahi, S., Ghani, M., &Ngah, A. (2020). Factors propelling the adoption of internet banking: the role of e-customer service, website design, brand image and customer satisfaction. *International Journal of Business Information Systems*, 33(4), 549-569.

Roy, A. (2018). Business impacts of electronic banking technologies. *Int. J. Electronic Banking*, 1(2), 113-128.

Safeena, R., Date, H., Kammani, A., & Hundewale, N. (2012). Technology adoption and Indian consumers: study on mobile banking. *International Journal of Computer Theory and Engineering*, 4(6), 1020-1024.

Siam, A. (2006). Role of the electronic banking services on the profits of Jordanian banks. *American Journal of Applied Sciences*, 3(9), 1999-2004.

Tarı, R. (2014). *Ekonometri.* (14.Baskı).Umuttepe Yayınları.

Teka, B. (2017). Assessment of the practices and challenges of electronic banking adoption in Ethiopia. *International Journal of Research in It and Management*, 7(3), 82-94.

Toda, H.Y., & Yamamoto, T. (1995). statistical ınference in vector autoregressions with possibly ıntegrated processes. *Journal of Econometrics*, 66(1), 225-250.

Ulusoy, A., Demirel, S. (2022). Türk bankacılık sisteminde dijitalleşme-kârlılık etkileşimi. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 40* (1), 184-200

Uzundağ, Ş. (2013). Türkiye'de internet bankacılığının gelişimi ve internet bankacılığına ilişkin tüketici davranışları analizi. *Yayımlanmamış Yüksek Lisans Tezi*, Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü İşletme Anabilim Dalı, Aydın.

Yavuz, N. Ç. (2006). Türkiye'de turizm gelirlerinin ekonomik büyümeye etkisinin testi: Yapısal kırılma ve nedensellik analizi. *Doğuş Üniversitesi Dergisi*, 7(2), 162-171.

Yurttadur, M., & Süzen, E. (2016). Türkiye'de banka müşterilerinin internet bankacılığına yaklaşımlarının incelenmesi üzerine bir uygulama. *Tüketici ve Tüketim Araştırmaları Dergisi*, 8(1), 93-120.

Zhao, J., Li, X., Yu, C. H., Chen, S., & Lee, C. C. (2022). Riding the FinTech innovation wawe: FinTech, patents bank performance. *Journal of International Money and Finance*, 122, 102552. https://doi.org/10.1016/j.jimonfin.2021.102552