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The Symmetric and Asymmetric Relationship Between the Ratio of Non-Performing Loans and the Return on Equity: Evidence from Borsa İstanbul

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Abstract

The Non-Performing Loans (NPL) ratio is an important indicator of banks' success in credit management in the banking industry. With the increase in this ratio, banks' profitability is adversely affected. This study investigates the short and long-term asymmetric relationship between NPLs and the Return On Equity (ROE) of banks listed on the Borsa Istanbul (BIST) using quarterly data from 2008:Q1-2017:Q4. We have formulated four different models for each bank with Autoregressive Distributed Lag (ARDL), and Non-Linear Autoregressive Distributed Lag (NARDL) to evaluate the relationship between the selected variables. After our evaluation, the empirical results show a long-term asymmetric relationship between ROE and NPLs for most banks in BIST.

Key words: Non-Performing Loans (NPLs), Return on Equity (ROE), ARDL, NARDL

JEL Code: G10, G21, G32, L25

1. Introduction

A well-functioning banking sector plays a vital role in the acceleration of economic growth in a country. However, the banking system involves multiple risks, including liquidity risk, interest rate risk, currency risk, operational risk, and credit risk. Credit risk is the potential of a borrower's failure to return the acquired

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loan from a bank within due time, which causes increased NPLs in banks (Şahbaz and İnkaya, 2014, p 69-70). A non-performing loan is defined as the non-repayment of credits in a period exceeding 90 days (Tanınmış-Yücemiş and Sözer, 2011, p. 44). Without an efficient risk management strategy, NPLs will increase consistently, negatively affecting the balance sheets, asset quality, profitability, and capital adequacy ratios. Therefore, inadequate credit risk management is considered one of the leading causes of bank crises.

In recent years, the NPL ratio has become a significant reason for bank solvency in almost all world countries. The high NPL ratio is considered an indicator of its failure, which adversely affects banks' performance and triggers the stagnation of a country's economy. NPLs in the financial sector cause in-debt companies to fall into financial difficulties and decrease their profitability. Therefore, it is necessary to minimize the NPLs to increase economic growth (Hatipoğlu et al. 2015, p.76). A high NPL ratio can lead to a bank's loss of income, an increase in loan loss provisions, a deficit in capital, and, eventually, a complete financial crisis. Each of these dimensions can also affect each other. The high-risk premium in financial markets and the increase in credit pricing cost can cause a decrease in the investment level and slow down economic growth, which further increases unemployment. Therefore, a higher NPL ratio causes negative consequences that affect the entire economy, starting with the financial market crisis.

The present study aims to analyze the relationship between the NPL ratio and profitability indicator (ROE) for 12 deposit banks of Türkiye by employing Autoregressive (AR) models for the period 2008:Q1-2017:Q4. AR models are found useful in determining a process's behavior in time-series data by linking the current observation of the process with an earlier period. Besides, autoregressive modeling is also qualified to solve issues like determining the noisy feedback systems in time series data analysis. The current research used linear and nonlinear autoregressive distributed lag models to examine the relationship between selected variables. The study's findings provide useful insights into understanding the complicated relationship between NPL ratios and bank-specific variables of profitability. Besides, the results will have policy implications for better management of credit risks involved in Türkiye's banking system.

We have reviewed several research studies examining the relationship between NPL ratio and profitability indicators. Most of these previous studies have used linear investigation methods such as Ordinary Least Squares, ARDL, etc. to determine the relationship between the above-mentioned variables, ignoring nonlinearity. It is argued that symmetrical models may not depict the true extent of the relationship among different variables of interest and yield misleading results. Therefore, it is crucial to test the asymmetry for a more detailed understanding of this relationship.

The rest of this article is organized as follows. After the introduction section, you will find a literature review of relevant studies. The third section describes the data, methodology, and empirical model used for the research. The fourth section of this study includes empirical results and a detailed discussion of the findings. The final part presents the conclusion of the study.

2. Literature Review

The global financial crisis of 2007-08 has significantly increased the ratio of NPL in many countries and regions of the world. However, large disparities among different groups of countries are observed regarding growth in NPLs during and after the crisis, posing questions about their determinants. A growing number of empirical studies from other countries examine the determinants of NPLs (Wood and Skinner 2018; Kartikasary et al. 2020; Kjosevski and Petkovski 2021). Most of the studies have focused on multiple explanatory variables to determine the factors affecting the ratio of NPL, which can be placed in two broader categories macroeconomic and bank-specific factors. The variables categorized as macroeconomic determinants include gross domestic product (GDP) growth, unemployment, exchange rate, interest rate, and inflation. Among the bank-specific variables, the size of the bank, equity to total assets ratio, return on assets (ROA) or ROE, and growth of gross loans are essential determinants of the NPL ratio. ROA is considered an essential measure of financial performance through the bank's base of assets. It is useful in determining the bank's management of assets and usually preferred by small size banks. On the other hand, ROE depicts a bank's profitability by looking at the bank's effective use of shareholder capital. The higher ratio of ROE means the expected higher performance of banks in the future. Therefore, ROA and ROE are considered important indicators of bank performance and profitability while determining the factors affecting the ratio of NPL.

Many studies in literature have examined the determinants of banks' NPLs in different areas of the world. These studies have analyzed the relationship of various bank-specific and macroeconomic factors to the NPLs.

Espinoza and Prasad (2010) investigated the macroeconomic effects of NPLs on the banking system of member countries of the Gulf Cooperative Council (GCC) using the dynamic panel method for 1995-2008. The study found that weak economic growth and increased interest rates had exacerbated effects on NPLs. The cumulative impact of macroeconomic shocks was seen quite large on non-performing loans for three years in the study. Besides, short-lived adverse feedback effects of the financial losses of banks' balance sheets on economic activity were also determined by employing the VAR approach. In a study conducted in Italy, Bofondi and Ropele (2011) analyzed the macroeconomic determinants of NPLs for households and firms for the period 1990:Q1-2010:Q2. They found that the quality of household and firm loans could be explained by the economy's general state, borrowing cost, and debt burden, while changes in macroeconomic conditions generally affected NPLs with a delay.

In assessing the determinants of NPLs in the Eastern Caribbean Currency Union (ECCU), Beaton et al. (2016) examined the impact of the deterioration of asset quality in negative feedback from the banking system's economic activities. The study employed a panel data approach on the data for the period 1996:Q1-2015:Q4. The results revealed that macroeconomic and bank-specific factors influence the deterioration of asset quality. Besides, it was also determined that the low-level credit allocation policy for the household and construction sectors by the banks with high profitability was effective in lower NPLs. Also, the NPL ratio of foreign banks was found to decrease than that of domestic banks.

Saba et al. (2012) examined the factors affecting the NPL ratio of the US banking system. The study determined that real GDP per capita, inflation, and total loans had a significant effect on the ratio of NPL. Still, the coefficient value of the independent variables was not very high. In a study on the determinants of NPLs in the Greek banking sector, Louzis et al. (2012) analyzed consumer loans, commercial loans, and mortgage loans employing dynamic panel data methods. It was found that NPL were explained by the variables of GDP, unemployment, interest rates, public debt, and management quality.

Messai and Jouini (2013) conducted empirical research to examine the determinants of NPLs in 85 banks in Italy, Greece, and Spain for 2004-2008. The growth rate of GDP, unemployment rate, and real interest rate are used as macroeconomic variables. In contrast, return on assets, change in loans, and change in NPLs were used as variables specific to the bank. A negative relationship between the NPL ratio and GDP growth rate was found in the study. On the other hand, it was determined that there was a positive relationship between the NPL ratio and return on assets, the unemployment rate, the percentage of loan provisions to total loans, and the real interest rate.

Abid et al. (2014) analyzed 16 Tunisian banks' data for 2003-2012 using the dynamic panel data method. The study investigated the potential effect of GDP, inflation, interest rate, and bank-specific variables on the ratio of non-performing household loans. It was found that the NPL ratio of households could not be explained by the variables of GDP, inflation, and interest rates, but low management quality.

Beck et al. (2015) examined the determinants of NPL in 75 countries. NPL ratio, real GDP growth, stock price, exchange rate, and lending rate were used as variables of interest in the research model. They found that the exchange rate effect depended on the scope of foreign currency loans while the impact of stock prices on GDP was more significant in countries with stock exchanges of large transaction volumes.

Rajha (2017) analyzed the determinants of the NPL ratio in the Jordanian banking sector for the period 2007-2012 by using macroeconomic and bank-

specific variables. It was observed that the NPL ratio and the loan-to-assets ratio variable, which were among the bank-specific variables, had a positive effect on the NPL ratio. Besides, it was also determined that big banks did not pay much attention to examining their loan customers well, unlike small banks. Again, it was found that economic growth and inflation, which were among the macroeconomic factors, harmed NPLs. The study also determined that the global financial crisis caused an increase in the ratio of NPL.

In a study on the banking system of Nepal, Koju et al. (2018), analyzed macroeconomic and bank-specific determinants of NPLs using both static and dynamic panel estimation approaches. They used seven bank-specific and five macroeconomic variables of 30 Nepalese commercial banks from 2003 to 2015. The findings showed that the ratio of NPL had a significant positive relationship with export/import ratio, inefficiency, and asset size, and a negative association with GDP growth rate, capital adequacy, and inflation rate.

Bayar (2019) examined macroeconomic, institutional, and bank-specific factors affecting the NPL ratio using the GMM dynamic panel data estimator for 2000-2013 period data in emerging market economies. The dynamic panel regression analysis results depicted the ratio of economic growth, inflation, financial freedom (corporate development), return on assets and equity, regulatory capital to risk-weighted assets, and the ratio of non-interest income to total income negatively affected NPLs. On the other hand, unemployment, public debt, loan growth, lagged values, income/cost ratio, and financial crises positively affected NPLs.

Morakinyo and Sibanda (2016) examined the relationship between NPLs and economic variables in Nigeria using the ARDL model on quarterly data from 1998-2014. The variables in the research model were found statistically significant in the long run. The results showed that the NPL harmed economic growth, but bank loans had a direct impact on economic growth. The impact of NPLs on profitability in the Turkish banking sector was estimated by Kılınç et al. (2018) using Panel Data Models for the period 2003:Q1-2015:Q4. As a result of the analysis, it was seen that NPLs decreased the level of ROE.

Škarıca (2014) conducted a study on the banking sector of 7 Central and Eastern European Countries in 2007:Q3-2012:Q3 by employing the panel data analysis method. He found that the economy entered a slowdown process with the increase in the NPL ratio. In contrast, the ratio of NPL had a statistically significant effect on national income, unemployment, and inflation. In a study on Central, Eastern, and Southwestern European Countries (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Hungary, Lithuania, Montenegro, Macedonia, Romania, Serbia, and Slovenia) Tanasković and Jandrić (2015) analyzed the determinant factors of NPLs for the data for a period 2006-2013 employing the static panel model approach. The study determined that there was a negative relationship between the increases in GDP and the NPL ratio. It was found that there was a positive relationship between the GDP and the ratio of foreign currency loans, the exchange

rate level, and the NPL ratio. On the other hand, the effect of the inflation rate on NPL was found to be statistically insignificant.

In a comparative study, Polat (2018) examined the impact of NPL on Türkiye and Saudi Arabia's financial stability from 2000 to 2016. He found a positive relationship between the rate of NPL and GDP, market capitalization, and Türkiye's inflation rate. However, for Saudi Arabia, the study determined a positive relationship between the ratio of NPL and inflation rate, debt, market capitalization, and the money supply, and a negative relationship between the ratio of NPL and the unemployment rate and the transparency variable. Salvi et al. (2018) analyzed the effect of bank-specific determinants and macroeconomic indicators on the ratio of NPL in 2,816 European bank samples for the period 2011-2015 using the panel data method. They found that the high return on assets might be related to the bank's NPL ratio. Besides, the results further revealed that the unfavorable conditions stemming from low GDP growth and high unemployment rate caused an increase in NPL ratio.

Macit and Keçeli (2012) analyzed the macroeconomic and micro factors that determine the NPL ratio for Turkish "participation banks" for 2005-2011. The findings revealed that banks with a high rate of loans to total assets had a lower NPL ratio, thus confirming that asset size negatively affected the NPL ratio. Also, it was determined that the decline in GDP growth increased the NPL ratio both in the lagged and same period, while the exchange rate and inflation rate did not have a significant effect on the NPL ratio. On the other hand, it was determined that the increase in the unemployment rate significantly increased NPLs.

Regarding Turkish banking, Tanınmış-Yücememiş and Sözer (2010) evaluated the rate of NPL during the economic crises of 2001 and 2008 using a comparative approach. They found a minimum increase in NPLs during 2008 in Türkiye compared to 2001 in contrast to many EU countries. Such a lower rate of NPL in 2008 was attributed to Türkiye's reforms after 2001. Another study conducted in Türkiye by Abdioğlu and Aytekin (2016), determined the factors affecting banks' NPL ratios after the 2001 local financial crisis for the period of 2002-2014 employing System GMM and Difference GMM methods. The study revealed that net interest margin, capital adequacy, and solvency ratio negatively affected NPL. On the other hand, a positive relationship was found between interest on loans, loan/deposit ratio, inefficiency and operating efficiency variables, and NPL.

Based on the panel data method, Isik and Bolat (2016) analyzed the data from 20 banks in determining the NPL ratio of commercial banks in Türkiye for the period 2006-2012. The findings showed that greater profitability and income diversification significantly decreased the ratio of NPL. In contrast, more considerable capital and loan provision losses significantly increased the proportion of NPL. They found only one macroeconomic variable of economic growth to be

negatively related to the ratio of NPL. It was also observed that the NPL ratio of banks increased during the last global financial crisis.

Us (2016) examined the determinants of NPLs in the Turkish banking sector before and after the global economic crisis of 2008. The study used the variables of continuity, capital adequacy, profitability, loan supply, inefficiency, and bank size as bank-specific determinants. At the same time, growth, inflation, exchange rate, and policy rate were macroeconomic variables. The results showed that the bank-specific variables predominantly determined the NPLs in the pre-crisis period. The effects of these variables diminished in the post-crisis period.

Tekşen and Çelik (2018) examined the relationship between loan types and NPL ratio by using the panel data analysis of 10 Turkish banks of deposit for the period 2006-2016. The study demonstrated a negative relationship between housing and commercial vehicle loans and the ratio of NPLs. Moreover, a positive relationship between vehicle loans and NPLs also determined. It was also determined that variables of inflation, NPL ratio in the previous period, and asset size had a significant and positive effect. In contrast, the crisis variable had a significant and negative impact on the NPL ratio.

The relationship between macroeconomic factors and bank-specific factors and the NPL ratio was analyzed by Vatansever and Hepşen (2013) using the data for the period between January 2007 and March 2013. Linear regression models and cointegration analysis methods were performed in the empirical analysis. It was found that there was no effect of variables of borrowing ratio, loans/asset ratio, real sector confidence index, consumer price index, EURO rate, USD rate, change in money supply, interest rate, change in national income, change in national income of the Euro Zone and Standard & Poor's 500 stock market index on NPLs. On the other hand, the variables of the industrial production index, BIST-100 Index, and banks' inefficiency rate harmed the rate of NPL. It was also determined that the variables of the unemployment rate, return on equity, and capital adequacy ratio had a positive impact on NPLs.

Genç and Şaşmaz (2016) estimated the determining macroeconomic factors of the ratio of non-performing commercial loans in Turkish banking and the direction and degree of influence of these factors on non-performing commercial loans by employing the Hatemi-J (2008) cointegration test for a period 2005:Q4-2015:Q2. The results of their study revealed that the macroeconomic factors that determined the non-performing commercial loans were GDP, BIST-100 index, commercial loan interest rates, and real exchange rate. It was also determined that the BIST-100 index harmed non-performing commercial loan rates, while the real exchange rate had a positive impact.

In a study in Türkiye, Yuksel (2016) analyzed the data of bank-specific and macroeconomic variables for the period 1988-2014 by employing the MARS method. He found that the increase in the USD exchange rate increased the banks'

NPL ratio, and the increase in the banks' interest income and the country's growth rate had a decreasing effect on the NPL ratio.

To identify factors that influence the NPL rate of Türkiye's banking sector, Çetinkaya (2019), examined the quarterly data of the first three banks with an enormous volume from 2014 to 2017. He found that the variables of ROA, bank size, net interest margin, financing gap, and ROE were statistically significant at a 99% confidence level. There was a statistically significant difference between the GDP ratio, the capital adequacy ratio variable, and the ratio of NPL at a 90% confidence level.

Erdaş (2019) tested the existence of the relationship between the NPL ratio and macroeconomic variables for the monthly data of the Turkish banking sector for the period January 2005-August 2018 by employing Johansen cointegration, VECM Granger causality, and Hatemi-J asymmetric causality tests. The Johansen cointegration test results revealed the existence of significant cointegration relationships in the long run between variables. The Granger Causality Test Based on VECM confirmed a one-way causality relationship between the ratio of NPL and market capitalization, exchange rate, industrial production index, and foreign trade deficit. It was found that the causality relationship was towards the ratio of NPL among other macroeconomic variables except for market capitalization. According to the Hatami-J asymmetric causality test, it was observed that there was an asymmetric causality relationship between the ratio of NPL, excluding the consumer price index, and other macroeconomic variables.

Koyuncu and Saka (2011) investigated the impacts of NPLs on the private sector and private investments in Türkiye, employing multiple regression methods to analyze data for 1986-2008. They found that NPLs decreased domestic loans and assets provided to the private sector. Another study from Türkiye conducted by Tanınmış-Yücememiş and Sözer (2011), proposes a model for the monthly estimation of the NPL ratio for the Turkish banking sector. The model estimated that the increase in NPLs would remain relatively limited, even if the economic conditions would deteriorate in future periods with the excellent management of NPLs.

The literature review reveals numerous research on the determinants of NPL using various other methods. However, very few studies employed linear and nonlinear autoregressive distributed lag model to explain the determinants of the NPLs. In the case of Türkiye, according to the best knowledge of the authors, there is no previous study conducted to determine the determinants of NPLs employing symmetrical and asymmetrical linear methods. Therefore, the present study aims to fill the literature gap by analyzing the determinants of NPLs utilizing linear and nonlinear ARDL modeling. The study results are expected to provide useful insights for policy improvements regarding bank performance in Türkiye.

3. Data and Methodology

In this study, the symmetrical and asymmetrical relationship between the ratio of NPL and the ROE is investigated. Data from 12 Turkish Deposit Banks traded on Borsa Istanbul were obtained from the Banks Association of Türkiye website (www.tbb.org.tr). Türkiye's unemployment data was obtained from the Turkish Statistical Institute (www.tuik.gov.tr). The research data covers the period 2008:Q1-2017:Q4 quarterly. Following the literature, the present study has used the NPL ratio as the dependent variable, while ROE and Unemployment Rate (UR) were used as independent variables.

The not restricted model in the long run could be written as:

$$\mathrm{NPL}_t = \alpha_0 + \alpha_1 \mathrm{UR}_t + \alpha_2 \mathrm{ROE}_t + \varepsilon_t \quad (1)$$

In this Equation, NPL, UR, and ROE denote non-performing loan ratio, unemployment rate, and return on equity, respectively. The ordinary error correction model (ECM) can be written as follows:

$$\mathrm{NPL}_t = \beta_0 + \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{NPL}_{t-j} + \sum_{j=0}^{q} \beta_{2j} \Delta \mathrm{UR}_{t-j} + \sum_{j=0}^{m} \beta_{3j} \Delta \mathrm{ROE}_{t-j} + \varphi t + \theta \epsilon_{t-1} + e_t \quad (2)$$

Δ represents the first differences of the selected variables in Equation 2, while the error-correction term ε depicts the OLS residual derived from long-run cointegrating regression in Equation (1). We can produce an ECM equation by combining both equations (1) and (2) in the following linear model:

$$\Delta \mathrm{NPL}_t = \psi + \eta_0 \mathrm{NPL}_{t-1} + \eta_1 \mathrm{UR}_{t-1} + \eta_2 \mathrm{ROE}_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{NPL}_{t-j} + \sum_{j=0}^{q} \beta_{2j} \Delta \mathrm{UR}_{t-j} + \sum_{j=0}^{m} \beta_{3j} \Delta \mathrm{ROE}_{t-j} + \varphi t + e_t \quad (3)$$

The linear model showing symmetry in both the short-run and long-run can be designated as the SS model.

In the above model, $\psi = \beta_0 - \theta\alpha_0$, $\eta_0 = \theta$, $\eta_1 = -\theta\alpha_1$, $\eta_2 = -\theta\alpha_2$. Also, $\alpha_1 = -\frac{\eta_1}{\theta}$ and $\alpha_2 = -\frac{\eta_2}{\theta}$ are the long-run coefficients of UR and ROE variables, while β_1, β_2 and β_3 are the short-run coefficients of the variables.

In a standard cointegration model, only a linear relationship of selected variables is realized. However, there are possibilities of nonlinearities in relationships which might not be revealed in a linear model. An analysis based on a linear relationship ignoring nonlinearities may yield misleading results. Therefore, the calculation of the nonlinear relationship is of great importance in providing more robust results. The present study has employed the NARDL approach to estimate the asymmetric effect of ROE and UR on the NPL ratio. In

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the current analysis, we use the NARDL estimation method developed by Shin et al. (2014) as an extension of Pesaran et al. (2001) ARDL model. In an asymmetric ARDL model, the nonlinear long-run relationship is combined with the nonlinear error correction using partial sum decompositions. The asymmetric long-run relationship employed in the present study is described as follows:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t \quad (4)$$

In the above Equation, x_t is a k × 1 vector of regressors, which is further disintegrated as $x_t = x_0 + x_t^+ + x_t^-$ where x^+ and x^- represent partial sum processes of positive and negative variations in x_t.

The current study has adopted the econometric approach established by Schorderet (2002, 2003) and Shin et al. (2014) to find out the asymmetric relationship of ROE and UR rate on the ratio of NPL. According to this approach, it is necessary to decompose all the variables into positive and negative shocks. In the present NARDL model, ROE + and ROE – show the partial sums of positive and negative variations in the ROE variable. These are calculated as follows:

$$\text{ROE}_t^+ = \sum_{i=1}^{t} \Delta\text{ROE}_i^+ = \sum_{i=1}^{t} max(\Delta\text{ROE}_i, 0) \; ; \; \text{ROE}_t^- = \sum_{i=1}^{t} \Delta\text{ROE}_i^- = \sum_{i=1}^{t} min(\Delta\text{ROE}_i, 0) \quad (5)$$

We can rewrite the long-run relationship presented in Equation (4) as follows:

$$\text{NPL}_t = \alpha_0 + \alpha_1 \text{UR}_t + \alpha_2^+ \text{ROE}_t^+ + \alpha_2^- \text{ROE}_t^- + \epsilon_t \quad (6)$$

After determining the long-run and short-run asymmetric relationship, Equation (1) can be rewritten as follows:

$$\text{NPL}_t = \psi + \eta_0 \text{NPL}_{t-1} + \eta_1 \text{UR}_{t-1} + \eta_2^+ \text{ROE}_{t-1}^+ + \eta_2^- \text{ROE}_{t-1}^- + \sum_{j=1}^{p} \beta_{1j} \Delta\text{NPL}_{t-j} + \sum_{j=0}^{q} \beta_{2j} \Delta\text{UR}_{t-j} + \sum_{j=0}^{m} \left(\beta_{3j}^+ \Delta\text{ROE}_{t-j}^+ + \beta_{3j}^- \Delta\text{ROE}_{t-j}^-\right) + \varphi t + e_t \quad (7)$$

Equation (7) represents the asymmetry in both the short-run and long-run. We can denote this as the AA model in our analysis. We can further extend Equation (3) to describe the models with long-run asymmetry and short-run symmetry (AS) or long-run symmetry and short-run asymmetry (SA) by following Shin et al. (2014).

$$\Delta\text{NPL}_t = \psi + \eta_0 \text{NPL}_{t-1} + \eta_1 \text{UR}_{t-1} + \eta_2 \text{ROE}_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta\text{NPL}_{t-j} + \sum_{j=0}^{q} \beta_{2j} \Delta\text{UR}_{t-j} + \sum_{j=0}^{m} \left(\beta_{3j}^+ \Delta\text{ROE}_{t-j}^+ + \beta_{3j}^- \Delta\text{ROE}_{t-j}^-\right) + \varphi t + e_t \quad (8)$$

Equation (8) depicts the model showing asymmetry in the short run only. Therefore, this Equation can be our AS model.

$$\Delta \mathrm{NPL}_t = \psi + \eta_0 \mathrm{NPL}_{t-1} + \eta_1 \mathrm{UR}_{t-1} + \eta_2^{+} \mathrm{ROE}_{t-1}^{+} + \eta_2^{-} \mathrm{ROE}_{t-1}^{-} + \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{NPL}_{t-j} + \sum_{j=0}^{q} \beta_{2j} \Delta \mathrm{UR}_{t-j} + \sum_{j=0}^{m} \beta_{3j} \Delta \mathrm{ROE}_{t-j} + \varphi t + e_t \quad (9)$$

Equation (9) describes the model with asymmetry in the long run only. We denote the model as SA in our analysis.

The current study employed the bound test following Shin et al. (2014) to determine the long-run asymmetric cointegration among the selected variables. The long-run cointegration among the variables is determined by evaluating t-statistics and F-statistics proposed by Banerjee et al. (1998) and Pesaran et al. (2001). The F statistics approach is meant to test the null hypothesis, which is defined as $H_0: \eta_0 = \eta_1 = \eta_2 = 0$ against the alternative hypothesis $\eta_0 \neq 0$ or $\eta_1 \neq 0$ or $\eta_2 \neq 0$. If the long-run asymmetry is presented in the analysis, the null hypothesis would be rejected.

Meanwhile, we test the presence of the long-run symmetry in the relationships among variables using the Wald test of the null hypothesis $H_0: \eta_0 = \eta^{-}{}_1 = \eta^{+}{}_1 = \eta_2 = 0$ of $H_0: \alpha_1^{+} = \alpha_1^{-} = \alpha_1$. In the Wald test, it is necessary to compare the calculated Wald-F with the tabulated F values as determined by Pesaran et al. (2001). The null hypothesis, $H_0: \sum_{i=0}^{q} \beta_{2i}^{+} = \sum_{i=0}^{q} \beta_{2i}^{-}$, is used to test the presence of short-run symmetry. The asymmetric relationships are confirmed if the null hypothesis of the existence of symmetry is rejected. As a result, the asymmetric dynamic multiplier of change of $ROE^{+}$and ROE^{-}could respectively be found.

4. Empirical Results

In the present analysis, all asymmetric models presented in equations (3), (7), (8), and (9) are estimated through the Akaike Info Criterion (AIC) with a maximum lag of four. The results of the cointegration tests are provided in Table 1. After the cointegration test, we conduct Wald tests to analyze the short-run and long-run asymmetry to select the best-suited model.

The cointegration test results in Table 1 describe very contrasting and even conflicting results for all coefficients in the long run. In general, it is found that an increase in the NPL ratio is associated with a reduction in ROE over time. However, we can't claim that an increase in the NPL ratio always reduces ROE. The estimation of long-run asymmetry between ROE_P, ROE_N, and NPL of commercial banks shows that ROE_P of AKBNK, GARAN, and TIB significantly causes a decrease in their NPL ratios. In contrast, there is no statistically significant relationship for the remaining nine banks between the ROE_P and NPL ratios.

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Similarly, the ROE_N of AKBNK and YKBNK significantly causes an increase in their NPL ratios in contrast to the ROE_N of TEB and SKBNK, which have a significant but negative impact on their NPL ratios. The findings related to the banks that operate on a large scale such as AKBNK, GARAN, TIB, and YKBNK (ranked among the top ten banks in terms of asset and loan size), are consistent and promising. The statistically significant relation for large-scale banks is associated with more accurate reporting of financial statements data than relatively medium and small-sized banks.

The long-run and short-run asymmetry between ROE_P, ROE_N, and NPL ratios differs from the previous one. For ROE_P, we obtained statistically significant results for five banks, but two of them are not consistent with our estimations. ROE_P of AKBNK, GARAN, and YKBNK resulted in a reduction in their NPL ratios, but ROE_P of ALNTF and TEB surprisingly showed a rise in their NPL ratios. Here, another conflicting result is observed for ROE_N of YKBNK. As previously indicated, according to our estimations, ROE_P of YKBNK significantly causes a reduction in its NPL ratio. However, the ROE_N of YKBNK also decreases in its NPL ratio, which is contrary to our estimates. ROE_N of AKBNK and DENIZ have a statistically significant impact on their NPL ratios as well. But unlike YKBNK, ROE_N of AKBNK and DENIZ increase their NPL ratios consistent with our estimations.

The diagnostic statistics for all four models are presented in Table (2). The Wald test enables us to find the most suitable model for each bank in the context of symmetry or asymmetry in the short run or the long run. The results of Bound F statistics verify asymmetric cointegration among the variables for almost all the banks involved in the analysis except for SKBNK. For Equation 9, Bound F Statistics show cointegration among the banks except for SKBNK and ICBCT. When we examine the banks individually, we can find consistent results for almost all the equations involved in the analysis except for ICBCT and SKBNK.

The Wald test is used to detect long and short-run asymmetries. The null hypothesis (long-run symmetry) is tested against the alternative hypothesis (long-run asymmetry). According to Karamelikli et al.(2019) and Karimi et al. (2019), we should test the AA model showing both long and short-run asymmetry should be considered to depict any nonlinearity in the relationships of the variables. The Wald test results revealed that AKBNK, TEB, and YKBNK have shown asymmetry in both the long and short run while the rest of the banks have shown different patterns of relationship. The results in Table 2 have revealed that only SKBNK bank has shown short-run asymmetry and long-run symmetry.

Table 1: Normalized estimates of the long-run coefficient

	UR				ROE_P	
	AA	**AS**	**SA**	**SS**	**AA**	**SA**
AKBNK	0.0015 *	0.0022 *	0.0017 *	0.0024 *	-0.0993 *	-0.0866 *
ALNTF	0.0036 **	0.0054 *	0.0041 *	0.0052 *	0.1576 ***	0.0579
DENIZ	0.0001	0.0038 *	0.0023	0.0021 *	0.0211	0.0029
TEB	0.0019 *	0.0018	0.0028 *	0.0025 *	0.2368 *	0.0187
GARAN	-0.0002	0.0019 *	0.0003	0.0019 *	-0.0699 ***	-0.0750 **
HALKB	0.0021 *	0.0021 *	0.0020 *	0.0021 *	-0.0189	-0.0197
ICBCT	0.0029	-0.0032 ***	-0.0025	-0.0029	-0.3494	0.1513
TIB	0.0005	0.0014	-0.0001	0.0054	-0.1167	-0.1178 *
QNBFB	-0.0017	-0.0011	-0.0018	-0.001	-0.0272	-0.0359
SKBNK	0.0034 ***	0.0015	0.0025	0.0023	0.1524	-0.1319
VAKBN	0.0012	0.0014 ***	0.0013 **	0.0013 *	0.0714	0.0699
YKBNK	0.0048 *	0.0031 *	0.0026 *	0.0029 **	-0.6610 *	-0.0118

	ROE_N		ROE	
	AA	**SA**	**AS**	**SS**
AKBNK	0.0508 *	0.0366 **	0.0365	-0.0283
ALNTF	0.0201	-0.0273	0.0323	-0.0153
DENIZ	0.1412 **	-0.002	0.0989	0.0008
TEB	0.0542	-0.0540 ***	0.035	-0.0319
GARAN	0.0448	0.0093	0.0019	-0.0262
HALKB	-0.0184	-0.018	-0.0184	-0.018
ICBCT	0.3195	0.2094	0.091	0.1892
TIB	-0.025	0.0385	-0.3527 ***	-6.1514 *
QNBFB	0.0208	0.0233	0.008	0.0068
SKBNK	0.0264	-0.1478 ***	-0.1234	-0.1471 ***
VAKBN	0.1036	0.0815	0.0834 **	0.0737 **
YKBNK	-0.4490 *	0.0273 ***	0.0121	0.0241

Notes: *,**, (***) show the significance at 1%, 5%, and 10% respectively. The critical values of standard t-distribution, i.e., 2.73, 2.03, and 1.69 are used to arrive at *, **, and ***, respectively.

Source: Authors' calculations

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Table 2: Diagnostic statistics associated with linear and nonlinear ARDL models

	Bound F				Adjusted R^2			
	SS	**SA**	**AS**	**AA**	**SS**	**SA**	**AS**	**AA**
AKBNK	9.51 *	6.76 *	3.33	12.13 *	0.49	0.63	0.42	0.67
ALNTF	6.38 **	6.36 **	6.29 **	7.92 *	0.34	0.43	0.41	0.49
DENIZ	11.60 *	8.35 *	7.17 **	8.85 *	0.59	0.58	0.66	0.73
TEB	10.52 *	10.38 *	3.92	10.85 *	0.56	0.62	0.59	0.87
GARAN	8.15 *	6.51 *	6.60 **	6.21 **	0.53	0.56	0.51	0.53
HALKB	6.69 **	4.85 ***	5.07 ***	4.70 ***	0.48	0.46	0.47	0.45
ICBCT	3.09	2.22	5.04	4.87 ***	0.40	0.38	0.6	0.61
TIB	11.24 *	4.80 ***	8.33 *	8.17 *	0.58	0.67	0.75	0.74
QNBFB	9.27 *	6.95 *	7.16 **	6.54 *	0.53	0.52	0.51	0.50
SKBNK	5.51 ***	4.00	2.78	3.43	0.43	0.41	0.46	0.43
VAKBN	8.72 *	6.23 **	6.54 **	4.93 ***	0.55	0.52	0.44	0.4
YKBNK	5.00	10.39 *	7.83 *	7.85 *	0.48	0.55	0.47	0.55

	WALD_LR		WALD_SR	
	SA	**AA**	**AS**	**AA**
AKBNK	20.47 *	22.78 *	6.36 **	7.55 **
ALNTF	3.31 ***	3.43 ***	0.32	2.66
DENIZ	0.02	6.15 **	3.25 ***	1.39
TEB	5.20 **	56.30 *	0.15	21.49 *
GARAN	2.99 ***	3.40 ***	0.05	2.05
HALKB	0.02	0.00	0.28	0.26
ICBCT	0.01	1.41	0.03	0.77
TIB	13.19 *	3.00	0.02	0.01
QNBFB	0.52	0.27	0.29	0.07
SKBNK	0.04	2.39	1.85	5.42 **
VAKBN	0.03	0.07	0.00	0.01
YKBNK	6.45 **	19.13 *	0.96	20.26 *

Notes: The F following Pesaran et al. (2001) is denoted by FPSS.

Source: Authors' calculations

The bounds test approach is used to test the null hypothesis of no cointegration against the alternative hypothesis of cointegration). At the 1%, 5%, and 10% significance level when there are three exogenous variables (k=3), its critical value is 6.36, 5.07, and 4.45. In the case of only two exogenous variables (k=2), its critical value is 7.52, 5.85, and 5.06, respectively, according to Pesaran et al. (2001, p. 301). The Wald symmetry test is distributed as $\chi 2$ with one degree

of freedom (first-order). Its critical value at 1%, 5%, and 10% levels is 6.63, 3.84 and 2.71 respectively.

Table 3: Long run and short run coefficient estimate of ROE

	ROE	**Lags on *ΔROE***				**ROE_P**	**Lags on *ΔROE_P***			
		0	1	2	3		0	1	2	3
AKBNK		0.01				-0.09*				
ALNTF		0.02				0.06				
DENIZ	0.0008	-0.004*								
TEB						0.24*	0.04***	-0.13*	-0.15*	-0.13*
GARAN		0.01	0.01***			-0.07**				
HALKB	-0.02	0.003								
ICBCT	0.19	-0.002*	-0.02	-0.08***						
TIB	-6.15*	-0.03*	0.03*							
QNBFB	0.01	-0.02***								
SKBNK	-0.15***	-0.01								
VAKBN	0.07**	0.006	-0.06**	-0.02	-0.04**					
YKBNK						-0.66*	-0.02	0.53*	0.41*	0.19*

	ROE_N	**Lags on *ΔROE_N***			
		0	1	2	3
AKBNK	0.04**				
ALNTF	-0.03				
DENIZ					
TEB	0.05	0.01	-0.05**	0.01	0.02
GARAN	0.01				
HALKB					
ICBCT					
TIB					
QNBFB					
SKBNK					
VAKBN					
YKBNK	-0.45*	-0.10*	0.10**	-0.01	-0.04**

Notes: Long-run coefficients are normalized. *,**, (***) show the significance at the 1%, 5% and 10% respectively. The critical values of standard t-distribution, i.e., 2.73, 2.03, and 1.69 are used to arrive at *, **, and ***, respectively.

Source: Authors' calculations

According to Table 3, TIB and SKBNK banks have negative and significant coefficients while, and VAKBN bank has positive and significant coefficients. It means an increase in the ROE, in the long run, decreases the NPL ratio in TIB and SKBNK banks while it will increase the NPL ratio for VAKBN bank. On the other hand, in the short run, DENIZ, GARAN, ICBCT, TIB, QNBFB, and VAKBN have significant coefficients. Here, DENIZ, ICBCT, QNBFB, and VAKBN have significant negative coefficients, while GARAN and TIB have significant positive coefficients. It means a decrease in the ROE will increase the NPL ratio in the

DENIZ, ICBCT, QNBFB, and VAKBN banks in the short run. Simultaneously, a reduction in ROE will decrease the NPL ratio in GARAN and TIB banks.

In the context of nonlinearity, AKBNK, TEB, GARAN, and YKBNK have significant coefficients in the long run. YKBNK has negative coefficients for ROE_P and ROE-N, which means that an increase/decrease in ROE will decrease /increase the NPL ratio in the long run in different intensities. On the other hand, TEB and GARAN have only significant coefficients for ROE_P. This means that while the ROE increase will affect the NPL ratio, the decrease in the ROE will not be very significant. An increase in ROE will increase the NPL ratio for TEB bank, while it will decrease it for GARAN bank. In the short run, TEB and YKBNK have significant coefficients towards any change in ROE.

5. Conclusions

In the present study, we examined the short and long-run asymmetry between the ROE and NPL ratio of 12 Turkish Deposit Banks. We employed data from 2008:Q1 to 2017:Q4 and utilized ARDL and NARDL methods for estimating four different models. We assessed each bank's models individually to test for cointegration (Bound F statistics) among selected variables. The results revealed that almost all the banks except for SKBNK and ICBCT are found to be cointegrated. On the other hand, short and long-run asymmetries are tested using the Wald Test. We obtained significant results for long-run asymmetry, even for most of the banks involved in the analysis. However, only AKBNK, DENIZ, TEB, SKBNK, and YKBNK are found significant for short-run asymmetry. There is a significant short and long-run asymmetry in the relationship between NPL ratio and ROE for only AKBNK, DENIZ, TEB, and YKBNK. These banks are ranked among the top ten banks in asset and loan size, which is common among them. As they operate on a large scale, they are more devoted to accuracy in reporting financial statement data than relatively medium and small-sized banks. The remaining eight banks are insignificant for both short and long-run asymmetries. Other variables other than ROE significantly impact NPL ratios such as exchange rate, interest rate, excessive credit expansion (Reinhart and Rogoff, 2011), etc. Therefore, the present study suggests further research to examine all the factors to decide.

Appendix

	Stock Code	Bank Name
1	AKBNK	AKBANK
2	ALNTF	ALTERNATİFBANK
3	DENIZ	DENİZBANK
4	TEB	TÜRK EKONOMİ BANKASI
5	GARAN	GARANTİ BANKASI
6	HALKB	HALK BANKASI
7	ICBCT	ICBC TÜRKİYE BANK
8	TIB	TÜRKİYE İŞ BANKASI
9	QNBFB	QNB FİNANSBANK
10	SKBNK	ŞEKERBANK
11	VAKBN	VAKIFBANK
12	YKBNK	YAPI KREDİ BANKASI

Source: BAT (2019). www.tbb.org.tr

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