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Economic Determinants of Nonperforming Loans in Turkey: Quantile ARDL Results

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Abstract In the banking sector, problems in repaying customers' credits can increase credit risk and fragility. Therefore, it is of great importance for banks to monitor the status of non-performing loans (NPLs) closely. This study analyzes the macroeconomic factors affecting NLPs in the Turkish banking sector. It used ARDL and QARDL approaches and data for 2011M5-2024M9 in the study. According to the long-run estimation results of the ARDL model, inflation and industrial production affect the NLPs in the opposite direction. In contrast, unemployment, the exchange rate, and interest rates affect it in the same direction. The estimation results are consistent with economic theory and the literature. The QARDL estimation results show that lnCPI (τ=0.2 to τ=0.8) has negative and significant coefficients in most quantiles (τ). The coefficients for lnPMI are generally negative and statistically insignificant. The lnUNE variable has positive and significant coefficients at most levels τ (τ=0.1 to τ=0.8). The estimation results for lnEXC show that the overall effect of the variable on NPL is positive and significant. The coefficients of interest rates are generally positive and significant. For the increase in the NLPs to remain at an acceptable threshold level for the banking sector and the Turkish economy, it is critical that the credit risk assessment system at the banking level works effectively and efficiently on the one hand and that macroeconomic indicators in the Turkish economy are supportive of the credit repayment conditions of economic agents on the other.

Keywords Non-performing loans · Turkish banking sector · Credit risk

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Economic Determinants of Nonperforming Loans in Turkey: Quantile ARDL Results

In the Turkish economy, the close monitoring of non-performing loans in the banking sector is crucial for ensuring the stability of the financial sector. An increase in the rate of NLPs can heighten the fragility of the financial sector, potentially leading to a financial crisis. This, in turn, may trigger an economic crisis. Considering this, banks and banking regulators should proactively manage credit risk. This includes assessing both the banks' lending practices and the creditworthiness of their customers, while closely monitoring the overall level of credit extended to customers.

There may be several factors specific to banks, the banking sector and macroeconomic conditions that affect the NLPs. This study analyzes the macroeconomic factors affecting NLPs in the banking sector in the Turkish economy. In this study, the economic factors affecting NLPs are analysed using ARDL and QARDL approaches using the data for the period 2011M5-2024M9. The unique contribution of the study to the literature is that it contributes both to the literature and to the policy design of decision makers by revealing the factors affecting NLPs by using ARDL and QARDL approaches together with current data.

Literature

Many studies have investigated the factors affecting NLPs in the Turkish banking sector. These studies have different results depending on the variables used in the research, the research period, and the econometric methodology used. The results of the prominent studies in the literature are summarised below.

Yalçın (2001) analysed the relationship between the non-performing consumer loan ratio and macroeconomic variables. According to the results of the study, there is a positive long-run relationship between the exchange rate and the consumer loan interest rate and the non-performing consumer loan ratio, and a negative long-run relationship between the policy interest rate and the inflation rate and the non-performing consumer loan ratio.

In their study, Yücememiş and Sözer (2011) proposed a model that produces efficient results for forecasting the NLPs in the Turkish banking sector. According to the analysis results, the model indicated that NLPs have a significant stock problem.

Koyuncu and Saka (2011) analyse the impact of NLPs on credits to the private sector and investments in Turkey. According to the results of the analysis, NLPs have a dampening effect on domestic credits and investments provided to the private sector.

Hatipoğlu, Şaşmaz and Ertürk (2015) found that in the banking sector, failure to repay loans in due time has negative effects on banks in terms of profitability and other aspects.

Yağcılar and Demir (2015) analysed the macroeconomic and bank-level determinants of NLPs. The analysis found that NLPs have a negative relationship with bank scale, loan/deposit ratio, stock exchange listing, liquidity, and return on assets variables, while growth, interest rates, foreign banks, and capital adequacy variables have a positive relationship.

Abdioğlu and Aytekin (2016) investigated the factors affecting banks' NLPs. As a result of the analysis, it is found that the previous period's non-performing loan ratio, net interest margin, capital adequacy and solvency ratio have an adverse effect on NLPs, while the interest rate applied to loans, loan/deposit ratio, inefficiency and operating efficiency variables have the same effect.

Genç & Şaşmaz, M. Ü. (2016) analysed the macroeconomic factors determining NLPs. According to the results of the study, the BIST-100 index has a negative effect on NLPs, while the real exchange rate has a positive effect.

Yüksel (2016) analysed the determinants of banks' NLPs in Turkey. According to the results of the model, the dollar exchange rate affects NLPs in the same direction, while the increase in banks' interest income and the country's growth rate affect NLPs in the opposite direction.

We (2016) analysed the determinants of NLPs in the Turkish banking sector. According to the results of the analysis, it was determined that bank-specific variables had a high impact on NLPs in the pre-crisis period, while their impact decreased after the crisis.

Telek & Şit (2017) analysed the relationship between NLPs and Turkey's risk premium. According to the analysis results, a causal relationship was found between CDS premiums and NLPs in Turkey.

Tekşen & Çelik (2018) analysed the impact of loan preferences on the NPL ratio. According to the results of the analysis, mortgage and commercial vehicle loans have a negative effect on NLPs, while vehicle loans, inflation, prior period NLPs and asset size have the same effect in the same direction.

In their study, Kara and Baş (2019) analysed the relationship between banking sector loan growth and NLPs. According to the results of the analysis, it is determined that in the long run, when the banking sector loan volume increases, NLPs also increase, the banking sector's total loan volume is effective on NLPs in the short run on the other hand.

Poyraz & Arlı (2019) analyse the effect of foreign currencies on NLPs. The analysis's results determine that USD affects NLPs eventually.

Erdaş (2019) analysed the macroeconomic determinants of NLPs. The results show a unidirectional causality relationship between NLPs, the industrial production index, the exchange rate, market capitalisation, and the foreign trade deficit.

In their study, Özel & Sayılgan (2021) analysed the determinants of the NLPs in the banking sector for the period 2003-2019. According to the results of the analysis, it is determined that NLPs have many macroeconomic and bank-specific reasons and have negative effects on the general economy and the banking system.

Sevinç (2021) analysed the impact of macroeconomic factors on the non-performing loan ratio. The analysis determined that economic growth and inflation decreased the ratio, while unemployment and the exchange rate increased it.

Arlı & Bayrakdaroğlu (2021) analysed the relationship between changes in sectoral costs and NLPs. According to the results of the study, it was found that construction sector costs and NLPs of the construction sector are cointegrate both in the short and long run, and according to Granger causality results, sectoral costs and NLPs have mutual causality.

Tunçay (2021) analysed the relationship between the economic discomfort index calculated in the Turkish economy and the NLP ratio. The analysis determined that changes in the economic discomfort index and changes in NLPs mutually affect each other.

Ayaydın, Pilatin & Barut (2021) analysed the determinants of NLPs. According to the analysis results, the compromise on the lending variable has a negative effect on NLPs , while the capitalisation variable has a positive impact.

In his study, Özel (2022) analysed determinants of the NLPs. Based on the analysis results, it is determined that the industrial production index affects NLPs in the opposite direction. In contrast, weighted average interest rates, average exchange rates and changes in performing loans affect NLPs in the same direction.

Sarıay (2022) analysed the effect of financial openness on Turkey's banking sector NPL ratio. The analysis concluded that financial openness has a positive effect on the NPL ratio eventually while having a negative effect in the short run. Capital adequacy has a positive effect on the NPL ratio in the long run and varies in the short run, while profitability and the liquidity ratio decrease the NPL ratio in the long run and increase it at low rates in the short run.

In his study, Varlık (2023) analysed the macro-financial linkages in the Turkish economy and the role of asset prices. The analysis found that asset price movements have an important effect on the emergence of macro-financial linkages.

Erdoğan (2024) analysed the factors affecting commercial banks' NLPs. The study's results showed a positive relationship between banks' NLPs and the capital adequacy ratio and loan loss provisions/total assets.

İlhan and Gökçe (2024) analysed the effect of the change in NLPs on lending behaviour. According to the results of the analysis, a negative relationship exists between the increase in the number of NLPs and the willingness to lend in Turkey.

Tunay & Tunay, N. (2024) analyse the relationship between non-performing bank loans and recession probabilities in Turkey. According to the results of the analysis, there is a strong interaction between NLPs and economic activity.

Data and Methods

In this study, the economic factors affecting NLPs are analysed using ARDL and QARDL approaches. Compared to the traditional co-integration tests, the ARDL method has many advantages. Among these advantages are that (independent) variables can be I(0) and I(1), it provides reliable results in small samples, and long- and short-run dynamics can be determined. Cho et al. (2015) introduced the QARDL approach by extending the ARDL approach within the quantile regression framework. The foundations of this approach are well-established (Koenker & Bassett, 1978; Pesaran & Shin, 1998; Pesaran et al., 2001; Koenker, R., & Hallock, K., 2001; Koenker, R. Xiao, Z., 2002; Koenker, R. & Xiao, Z., 2006). The QARDL approach offers a different perspective from traditional approaches by modelling the effect of changes in regressors on the quantiles of the dependent variable. The flexible nature of the method provides a more detailed econometric framework as it accounts for heterogeneity across quantiles in short- and long-run (cointegration) linkages. Moreover, relaxing the normality assumption produces more robust results when the non-normality of the variables in the model is ignored (Shahzad et al., 2020:3575).

The data used in the study covers the period 2011M5 - 2024M9, and the explanations regarding the data are presented in Table 1. The consumer price index, industrial production index, Number of unemployed, and exchange rate variables are included in the model logarithmically. The dependent variables non-performing loan and Weighted Average Interest Rates are included in the model at their level values since they are proportional variables.

Table 1

Data Description

Variables	Symbol	Unit
Non-performing loan	*NPL*	Ratio
Consumer price index	*CPI*	2003=100
Industrial production index	*PMI*	2021=100
Number of unemployed	*UNE*	Thousand People

Variables	Symbol	Unit
Exchange rates	*EXC*	USD/TL
Weighted Average Interest Rates	*INT*	Rate

Source: Data from the Central Bank of the Republic of Türkiye

The ratio of NLPs (NPL) to total loans is chosen as the dependent variable, a common indicator for measuring credit risk in the banking sector. The independent variables consist of macroeconomic and financial indicators such as inflation (CPI), industrial production index, number of unemployed, exchange rate and interest rate (weighted average cost of funding). These variables are frequently used determinants of credit risk and the macroeconomic context in the literature. The functional form of the relationship is given in Equation 1:

$$NPL_t = f(CPI, PMI, UNE, EXC, INT) \tag{1}$$

The unrestricted error correction model (UECM) in Equation 2 was first developed to analyse the long-run relationship with the approach proposed by Pesaran et al. (2001).

$$\begin{aligned}\Delta NPL_t = \mu &+ \sum_{i=1}^{p}\theta_i \Delta NPL_{t-i} + \sum_{i=0}^{p}\delta_i \Delta lnCPI_{t-i} + \sum_{i=0}^{p}\psi_i \Delta lnPMI_{t-i} \\ &+ \sum_{i=0}^{p}\lambda_i \Delta lnUNE_{t-i} + \sum_{i=0}^{p}\phi_i \Delta lnEXC_{t-i} + \sum_{i=0}^{p}\omega_i \Delta INT_{t-i} \\ &+ a_1 NPL_{t-1} + a_2 \ln CPI_{t-1} + a_3 \ln PMI_{t-1} + a_4 lnUNE_{t-1} \\ &+ a_5 lnEXC_{t-1} + a_6 INT_{t-1} + \varepsilon_t\end{aligned} \tag{2}$$

After selecting the appropriate lag length using the VAR model and information criteria (AIC, SIC and HQ), the model was tested for autocorrelation. Then, the F test () is used to test whether there is a co-integration relationship. Once it is found that the linear relationship between the variables is not spurious, the parameters of the long-run relationship can be estimated using the ARDL procedure (Pesaran, 2015:527). Equation 3 is obtained by adapting the QARDL model to this study:

$$\begin{aligned}NPL_t = \mu(\tau) &+ \sum_{i=1}^{p}\theta_i(\tau) \Delta NPL_{t-i} + \sum_{i=0}^{q_1}\delta_i(\tau) \Delta lnCPI_{t-i} + \sum_{i=0}^{q_2}\psi_i(\tau) \Delta lnPMI_{t-i} \\ &+ \sum_{i=0}^{q_3}\lambda_i(\tau) \Delta lnUNE_{t-i} + \sum_{i=0}^{q_4}\phi_i(\tau) \Delta lnEXC_{t-i} \\ &+ \sum_{i=0}^{q_5}\omega_i(\tau) \Delta INT_{t-i} + a_1(\tau) NPL_{t-1} + a_2(\tau) \ln CPI_{t-1} \\ &+ a_3(\tau) \ln PMI_{t-1} + a_4(\tau) lnUNE_{t-1} + a_5(\tau) lnEXC_{t-1} \\ &+ a_6(\tau) INT_{t-1} + U_t(\tau)\end{aligned} \tag{3}$$

In Equation 3, $\tau \in (0, 1)$denotes the quantile. In this study, the relevant quantiles are taken as {0.1, 0.2, ... , 0.9}. The QARDL parameters can be affected by the $U_t(\tau)$ innovations introduced in each period and hence may differ across quantiles. Therefore, (dynamic) conditioning variables not only change the location but also the scale and shape of the conditional distribution of the dependent variable (Cho, 2015:283). It is, therefore, convenient to write the QARDL process in the error correction form:

$$\begin{aligned}\Delta NPL_t = \mu(\tau) &+ \rho(\tau)(NPL_{t-1} + \beta_1(\tau)\ln CPI_{t-1} + \beta_2(\tau)\ln PMI_{t-1} \\ &+ \beta_3(\tau)lnUNE_{t-1} + \beta_4(\tau)lnEXC_{t-1} + \beta_5(\tau)INT_{t-1}) \\ &+ \sum_{i=1}^{p}\theta_i(\tau)\Delta NPL_{t-i} + \sum_{i=0}^{q_1}\delta_i(\tau)\Delta lnCPI_{t-i} \\ &+ \sum_{i=0}^{q_2}\psi_i(\tau)\Delta lnPMI_{t-i} + \sum_{i=0}^{q_3}\lambda_i(\tau)\Delta lnUNE_{t-i} \\ &+ \sum_{i=0}^{q_4}\phi_i(\tau)\Delta lnEXC_{t-i} + \sum_{i=0}^{q_5}\omega_i(\tau)\Delta INT_{t-i} + \varepsilon_t(\tau)\end{aligned} \tag{4}$$

Cho et al. (2015) suggested that to make the quantile forecasting results comparable to the baseline conditional mean model, it would be appropriate to use common lag lengths across quantiles chosen by the BIC applied to the conditional mean model.

Empirical Results

According to the ADF test, the NPL, lnCPI, lnUNE and lnEXC variables have unit root at levels. The null hypothesis of the unit root is rejected at the 10% level for the INT variable and at the 1% level for the lnPMI variable. According to the PP test, only the lnPMI variable is stationary at the level. It is observed that all variables become stationary in the first differences. The fact that the variables are found at I(0) and I(1) levels indicates that the ARDL model is appropriate. Table 3 summarises the ARDL bound test findings. Panel A shows the F test statistic and the upper and lower bounds for the long-run relationship. Panel B presents the estimation of the long-run coefficients and Panel C presents the error correction term (ect) obtained from the error correction model along with graphs for the autocorrelation, heteroscedasticity, and dynamic stability of the coefficients. As shown in Panel B of Table 3, the explanatory variables used to estimate NLPs are statistically significant at the 5% significance level. The signs of the independent variables are also consistent with economic theory and the literature.

Table 2

Unit root test results

Variables	ADF		PP	
	Level	Δ	Level	Δ
NPL	-0.939	-7.558*	-1.119	-7.744*
lnCPI	1.125	-7.178*	1.788	-7.096*
lnPMI	-5.137*	-14.737*	-5.109*	-24.458*
lnUNE	-1.384	-3.318***	-2.424	-13.011*
lnEXC	-1.515	-9.578*	-1.191	-9.183*
INT	-3.228***	-4.787*	-1.348	-9.321*

Note: *, ** and *** denote statistical significance at the 1%, 5% and 10% levels, respectively. ADF: Augmented Dickey Fuller, PP: Phillips-Perron. For all variables, the model structure with constant and trend is considered.

Table 3

ARDL Bounds Test and Long Run Coefficients

Panel A								
k	$\mathbf{F_{PSS}}$	**I(0)**			**I(1)**			
5	4.901	%10	%5	%1	%10	%5	%1	
		2.080	2.390	3.060	3.00	3.380	4.150	

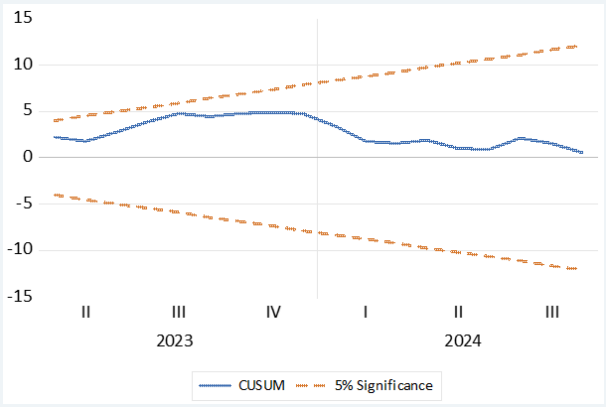
Panel B			
Variables	**Coefficient**	**Std. Error**	**t- stat [prob.]**
lnCPI	-3.799	1.417	-2.682 [0.008]
lnPMI	-2.982	1.494	-1.996 [0.048]
lnUNE	2.106	0.770	2.735 [0.007]
lnEXC	2.541	1.199	2.120 [0.036]
INT	0.048	0.018	2.695 [0.008]
c	17.239	13.042	1.322 [0.188]

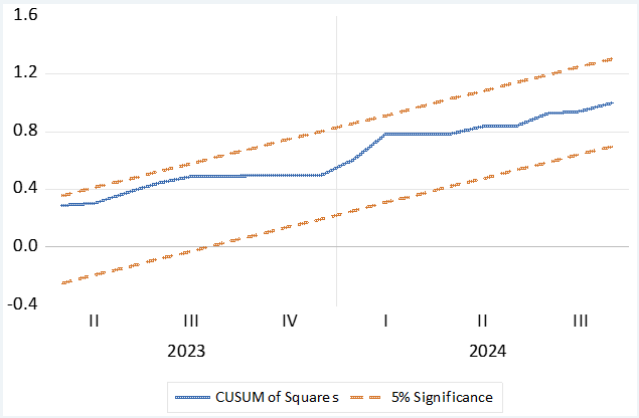
Panel C

$\chi^2_{LM(1)} = 0.137\ [0.711]$ $\chi^2_{BPG} = 15.412\ [0.696]$

$\chi^2_{LM(12)} = 12.141\ [0.434]$ $\chi^2_{JB} = 0.681\ [0.711]$

$ect = -0.056\ [0.000]$





Note: Dummy variables are included exogenously in the model for the detected breaks in 2018m06, 2018m08, 2018m09, 2019m05, 2019m09 and 2023m3.

When the test statistic value calculated in Panel A is compared with the table values given by Pesaran et al. (2001) (Table CI(ii) Case II), it is observed that it is above the upper bound value. Therefore, the null hypothesis of no long-run relationship is rejected. The long-run coefficients in Panel B are statistically significant. According to the LM autocorrelation test results in Panel C, there is no 1st and 12th order autocorrelation. In addition, according to the Breusch-Pagan-Godfrey (BPG) heteroskedasticity test, there is no heteroskedasticity problem. According to the Jarque- Bera normality test, the residuals are normally distributed. The Cusum and Cusum-Sq plots show that the estimated coefficients are dynamically stable. The error correction term obtained from the error correction model estimated to detect short-run dynamics is statistically significant. The error correction term indicates a slow correction towards equilibrium. Table 4 presents the estimated long-run coefficients of the QARDL model.

Table 4

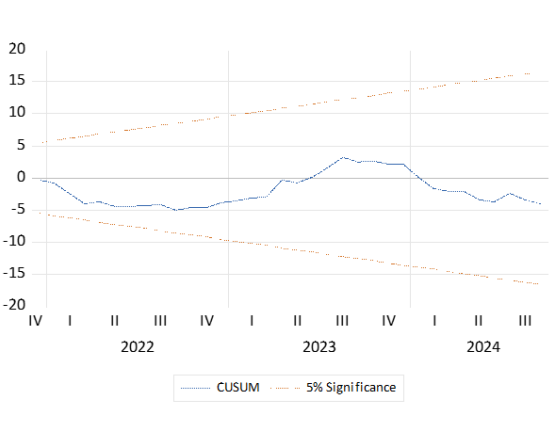
QARDL Estimation Results

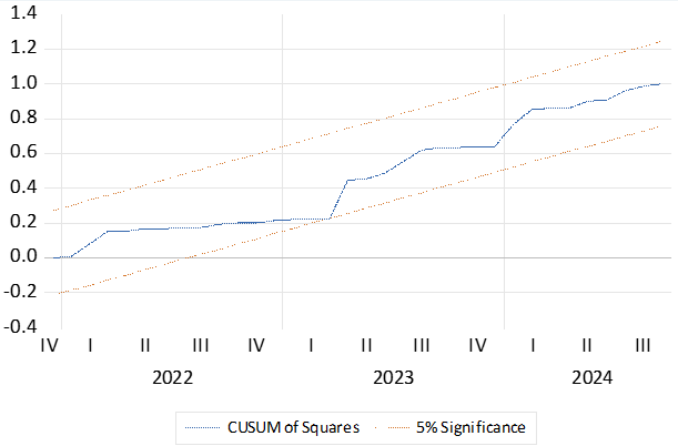
(τ)	$\rho(\tau)$	$\beta_{lnCPI}(\tau)$	$\beta_{lnPMI}(\tau)$	$\beta_{lnUNE}(\tau)$	$\beta_{lnEXC}(\tau)$	$\beta_{INT}(\tau)$
0.1	-0.054	-2.057	-1.553	1.741	1.158	0.038*
0.2	-0.066	-3.185*	-1.475	2.515*	1.600	0.050*
0.3	-0.067	-4.595*	-2.581	2.233*	3.027*	0.056*
0.4	-0.072	-5.097*	-4.576*	2.419*	3.674*	0.053*
0.5	-0.061	-5.808*	-5.302*	2.962*	4.185*	0.064*

(τ)	$\rho(\tau)$	$\beta_{lnCPI}(\tau)$	$\beta_{lnPMI}(\tau)$	$\beta_{lnUNE}(\tau)$	$\beta_{lnEXC}(\tau)$	$\beta_{INT}(\tau)$
0.6	−0.058	−5.802*	−5.243*	2.860*	4.144*	0.077*
0.7	−0.057	−4.116*	−5.937*	3.765*	2.732*	0.095*
0.8	−0.036	−5.031*	−8.599*	4.840*	3.519	0.138*
0.9	0.003	9.008	63.707	−22.142	−6.157	−1.194

$\chi^2_{LM(1)} = 5.153\ [0.025]$
$\chi^2_{LM(2)} = 2.600\ [0.077]$

$\chi^2_{White} = 8.427\ [0.815]$
$\chi^2_{JB} = 4.727\ [0.094]$





Note: Coefficient estimates with* are statistically significant at the 5% level.

Table 4 shows that lnCPI (τ=0.2 to τ=0.8) has negative and significant coefficients at many quantiles (τ), suggesting that the NPL ratios decrease when the inflation rate (CPI) increases. This is quite expected in a high-inflation environment as higher nominal incomes may facilitate debt repayments. The positive and very high coefficient of τ=0.9 may indicate an extreme case. This may indicate that inflation is a factor that increases NPL ratios at very high levels or that the estimate at this level suffers from stability problems. The coefficients for lnPMI are generally negative and statistically insignificant. This may indicate that the impact of increased economic activity (PMI) on NPL ratios is weak or that there is no systematic relationship. Statistically significant coefficients at τ=0.4 and τ=0.5 may indicate that a moderate deterioration in economic activity creates more problems in debt repayment. The lnUNE variable has positive and significant coefficients at most τ levels (τ=0.1 to τ=0.8), suggesting that an increase in the unemployment rate increases the NPL ratios. An increase in unemployment may be directly linked to the inability of individuals and businesses to repay their debts. However, the dramatic negative coefficient at τ=0.9 (and the high absolute value) indicates an extreme case, where lenders may turn to different strategies (e.g. credit restructuring) when unemployment rises to very high levels. The estimation results for lnEXC show that the overall effect of the variable on NPL is positive and significant. An increase in exchange rates may increase the repayment cost and raise NPL ratios, especially for individuals and firms with foreign currency debt. However, the negative coefficient of the exchange rate at τ=0.9 suggests that different economic or systematic dynamics may come into play at higher quantiles (e.g., lenders hedging FX risk or managing debt in different ways). The coefficients of interest rates are generally positive and significant. This implies that when interest rates increase, NPL ratios rise as borrowing costs also increase. This may indicate that interest rate increases have a negative impact on the ability to repay debt.

Conclusion

This study analyzes the macroeconomic factors affecting NLPs in the Turkish banking sector. It uses ARDL and QARDL approaches and data for 2011M5-2024M9. According to the long-run estimation results of the ARDL model, inflation and industrial production affect the NLPs in the opposite direction, while unemployment, exchange rate, and interest rates affect it in the same direction. The estimation results are consistent with economic theory and the literature.

The QARDL estimation results show that lnCPI (τ=0.2 to τ=0.8) has negative and significant coefficients in most quantiles (τ). The coefficients for lnPMI are generally negative and statistically insignificant. This may indicate that the impact of increased economic activity (PMI) on NPL ratios is weak or that there is no systematic relationship. Statistically significant coefficients at τ=0.4 and τ=0.5 may indicate that a moderate deterioration in economic activity creates more problems with debt repayment. The lnUNE variable has positive and significant coefficients at most levels τ (τ=0.1 to τ=0.8), suggesting that an increase in the unemployment rate increases NPL rates. The estimation results for lnEXC show that the overall effect of the variable on NPL is positive and significant. An increase in exchange rates can increase the repayment cost and raise NPL ratios, especially for individuals and firms with foreign currency debt. The coefficients of interest rates are generally positive and significant.

For the increase in the NLPs to remain at an acceptable threshold level for the banking sector and the Turkish economy, it is critical that the credit risk assessment system at the banking level works effectively and efficiently on the one hand and that macroeconomic indicators in the Turkish economy are supportive of the credit repayment conditions of economic agents on the other. It is important to protect financial and economic stability by ensuring that decision makers closely monitor credit risk indicators both at the banking level and at the economy-wide level and pursue policies that support the credit repayment conditions of economic agents.

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