



Araştırma Makalesi / Research Article

EXPLORING THE DETERMINANTS OF NON-PERFORMING LOANS IN E-7 ECONOMIES: MACROECONOMIC, BANKING SECTOR, AND INSTITUTIONAL DIMENSIONS

Mümin Atalay ÇETİN¹

Abstract

In emerging market economies, non-performing loans (NPLs) are recognized as a crucial element not only for maintaining financial stability but also for advancing sustainable economic development. This study aims to explore the potential drivers of NPLs in E-7 countries by examining them through three key lenses: macroeconomic conditions, banking sector characteristics, and institutional factors. The analysis is based on data spanning the years 2000 to 2020 and utilizes dynamic heterogeneous panel data methodologies. Based on the long-run estimates derived from the Pooled Mean Group (PMG) estimator, variables such as inflation, real interest rates, the real effective exchange rate, and public debt exhibit a statistically significant and positive influence on NPLs. Conversely, indicators like economic growth, return on assets, credit expansion, banking inefficiency, and institutional quality show a negative correlation with NPLs. The long-term coefficients further highlight institutional quality, bank profitability, inflationary trends, and operational efficiency as prominent determinants of NPLs levels in E-7 economies. These results underscore the necessity for policymakers and regulatory bodies in these countries to integrate these factors into their financial stability strategies to bolster the robustness of the banking sector.

Keywords: Non-Performing Loans, E-7 Countries, Pooled Mean Group Estimator

JEL Codes: E4, G00, C33

E-7 EKONOMİLERİNDE TAKİPTEKİ KREDİLERİN BELİRLEYİCİLERİNİ KEŞFETMEK: MAKROEKONOMİK, BANKACILIK SEKTÖRÜ VE KURUMSAL BOYUTLAR

Öz

Takipteki krediler (NPLs 'ler), gelişmekte olan piyasa ekonomilerinde, yalnızca finansal istikrarı sağlamak için değil, aynı zamanda sürdürülebilir kalkınmayı teşvik etmek için de kritik bir faktör olarak kabul edilmektedir. Bu çalışmanın amacı, E-7 ülkelerinde NPLs'lerin potansiyel belirleyicilerini, makroekonomik, bankacılık sektörü ve kurumsal olmak üzere üç temel boyutta analiz ederek, araştırmaktır. Veri seti 2000-2020 dönemini kapsamaktadır. Çalışmada kullanılan yöntem dinamik heterojen panel veri teknikleridir. Panel havuzlanmış ortalama grup (PMG) tahmincisiinden elde edilen uzun vadeli sonuçlara göre, enflasyon, reel faiz oranı, reel efektif döviz kuru ve kamu borcunun NPLs 'ler üzerinde istatistiksel olarak anlamlı ve pozitif bir etkisi vardır. Buna karşın ekonomik büyüme, varlık getirisi, kredi büyümesi, banka verimsizliği ve kurumsal kalite NPLs ile negatif ilişkilidir. Ayrıca, uzun vadeli katsayı bulguları, kurumsal kalite, banka karlılığı, enflasyonist baskı ve işletme verimliliğinin E-7 ülkelerinde NPLs'lerin önde gelen belirleyicileri olarak ortaya çıktığını göstermektedir. Sonuç olarak bulgular, bu ekonomilerdeki politika yapıcılarının ve düzenleyici otoritelerin, bankacılık sektörünün dayanıklılığını artırmak için söz konusu faktörleri finansal istikrar çerçevelerine dahil etmelerinin önemini vurgulamaktadır.

Anahtar Kelimeler: Takipteki Krediler, E-7 Ülkeleri, Havuzlanmış Ortalama Grup Tahmincisi

JEL Kodları: E4, G00, C33

¹ Doç. Dr., Aksaray Üniversitesi, Türkiye, atalaycetin@aksaray.edu.tr. ORCID: 0000-0002-0442-8720

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Introduction

The banking sector plays a central role in shaping the structure and functioning of the financial system (Bayar, 2019, p. 96). It facilitates efficient resource allocation among economic agents through its core functions, such as accepting deposits and granting loans (Driga & Dura, 2014, p. 598). In this context, factors such as the survival of smaller-scale businesses, the promotion of international trade, and the development of strong infrastructure largely depend on the availability of these loans. Therefore, banks promote innovation by channeling funds into the economy—particularly into the industrial sector—thereby supporting the process of economic development (Allen & Carletti, 2012). In addition, banks contribute to social well-being by facilitating the flow of capital into sectors that stimulate economic activity and employment (Driga & Dura, 2014, p. 598-599). Furthermore, banks mitigate the risk of financial instability by smoothing fluctuations in the quantity and price of financial assets through their intermediary functions. However, banks are particularly vulnerable institutions within the economy, largely because of the fluctuating nature of the credit they extend. Given its interconnected structure, the banking sector enables risk to propagate quickly, affecting the entire financial framework and the general economy through contagion. This situation poses a threat to both the stability of the financial system and overall macroeconomic stability. Therefore, it is essential to minimize vulnerabilities that may lead to crisis risks in the banking sector (Allen & Carletti, 2012).

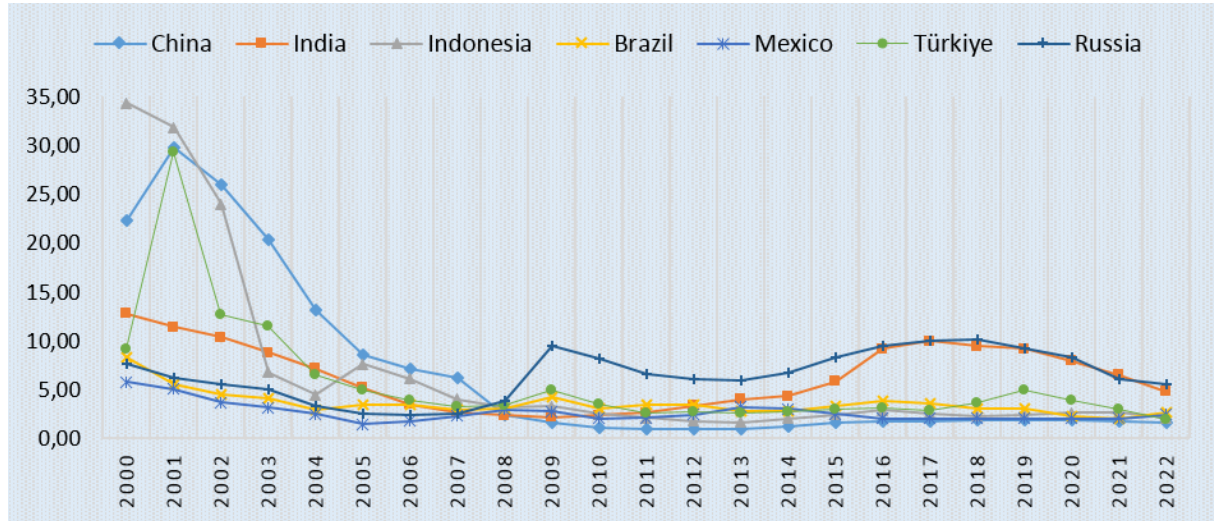
One of the most critical sources of instability in the banking sector is credit risk, which is closely linked to the rise in non-performing loan (NPLs) ratios. NPLs refer to loans whose principal or interest payments have been overdue for at least 90 days (European Central Bank [ECB], 2016). NPLs affect banks through three main channels: profitability, capital, and funding (Aiyar et al., 2015:9). In this context, NPLs reduce bank profitability by increasing loan-loss provisions, raise risk weights and constrain capital by tying it up in impaired assets. Consequently, as balance sheets deteriorate, funding costs rise and loan volumes decline (Aiyar et al., 2015, p. 10; Donnelly, Fitzpatrick, Greaney, McCann, & O'Keeffe, 2018, p. 57). Thus, NPLs are often considered potential triggers or early warning indicators of banking and financial crises (Adeola & Ikpesu, 2017, p. 32; Salas, Lamothe, Delgado, Fernández-Miguel, & Valcarce, 2024, p. 2698).

According to the International Monetary Fund (IMF), NPLs in emerging and developing economies should be promptly identified and effectively managed to mitigate their adverse effects (Eyraud et al., 2021). In these countries, economic growth and development remain among the primary policy objectives. Achieving and sustaining these goals requires the continuity of investment activities. Accordingly, the banking sector plays a crucial role in financing investments and supporting increases in economic output (Nasim, Nasir, & Downing, 2025, p. 257-258). At this point, NPLs serve as a critical indicator of banking sector stability in emerging markets, just as they do in advanced economies (Jalali, Munyonga, Isiksal, & Assi, 2023). On the other hand, the emerging seven (E-7) countries (China, India, Brazil, Mexico, Indonesia, Russia and Türkiye) hold a prominent position within emerging market economies. These countries have exhibited the highest rates of economic growth since 2016 (Tao, Umar, Naseer, & Razi, 2021, p. 2). Given their higher growth rates, it is expected that these countries will eventually take over the role of the G-7 nations (Xu et al., 2022, p. 2). As with other emerging markets, E-7 economies must maintain a sound and resilient banking system to support their ongoing economic growth. In this regard, NPLs serve as a key indicator of banking system stability in E-7 countries (Jalali et al., 2023, p. 99).

Figure 1 illustrates the trend of NPLs in the banking sectors of E-7 countries over the past 23 years. According to the figure, the share of NPLs in total loans declined across all E-7 countries between 2000 and 2008. However, following the 2008 Global Financial Crisis, NPLs ratios began to rise in several of these countries. Because NPLs tend to increase in periods of financial crisis or financial pressure (Baudino & Yun, 2017, p. 2). The post-crisis increase in NPLs was relatively

moderate in E-7 countries but became more pronounced after 2013. In particular, India and Russia experienced NPLs levels exceeding 10%. Recent data show that, during the past ten years, the ratio of NPLs has consistently exceeded the average in E-7 economies such as India, Russia, and Türkiye. The rise in NPLs in E-7 countries after 2013 suggests deficiencies in credit allocation decisions. This trend reflects a decline in financial efficiency across these economies.

Figure 1: Ratio of Non-performing Loans to Total Loans (2000-2022)



Source: Federal Reserve Bank (2025) and World Bank (2025a).

Since NPLs reflect fundamental weaknesses in both the banking sector and the broader financial system, it is essential to examine the factors contributing to their emergence. Identifying the specific determinants of NPLs in E-7 countries is particularly important for ensuring long-term financial and economic stability in these emerging economies. Despite the critical importance of this issue, there is still a notable lack of research focusing on the main drivers of NPLs within the context of E-7 countries. The motivation for this study arises from this evident gap in the literature. Accordingly, the study conducts an empirical analysis covering the two decades following the turn of the millennium, aiming to uncover the key factors influencing NPLs behavior in these economies. For this purpose, dynamic panel data methodology is adopted in the empirical phase. This study aims to contribute to the existing literature by distinguishing itself from previous research through examining the determinants of NPLs across three dimensions—macroeconomic, banking sector, and institutional—in the context of E-7 countries. Accordingly, the empirical findings offer more targeted insights that can guide policymakers in designing more effective and tailored precautionary measures. In addition, the study aims to provide policymakers and researchers with consistent and robust results that account for the dynamic relationships among economic indicators. In doing so, the findings may support the development of more realistic and data-driven policy interventions. Furthermore, this study aims to contribute to the limited body of literature examining the nexus between socio-economic indicators and NPLs within the context of E-7 economies.

This study is organized as follows. Section one provides a brief review of the relevant empirical literature. Section two presents the data, model specification and descriptive statistics. Section three outlines the econometric methodology and discusses the empirical findings. Finally, section four offers concluding remarks and policy recommendations.

1. Literature Review

Table 1 provides an overview of empirical studies in the existing literature that investigate the determinants of NPLs in developing and emerging economies. The last column of the table

presents the potential determinants used in these studies, along with the direction (positive or negative) of their estimated impact on NPLs. As shown, some indicators appear to have a bidirectional or mixed effect on NPLs.

Table 1: Empirical Literature Review

Study	Methodology	Period	Sample	Main Results
Fofack (2005)	Granger causality and fixed effects (FE) estimator	1993-2002	Sub-Saharan Africa countries	Net interest margin (-), Money supply (+), Real interest (+), Real effective exchange (+), GDP per capita (-)
Khemraj & Pasha (2009)	FE estimator	1994-2004	Guyanese banking sector	GDP growth (-), Real interest (+), Credit growth (-), Loan to asset (+), Real exchange rate (+)
Boudriga, Taktak, & Jellouli (2010)	Random effects (RE) and FE estimators	2002-2006	46 banks in 12 Middle East and North Africa (MENA) countries	Regulatory capital-capitalized banks (+), Credit growth (-), Loan loss provisions (-), Control of corruption (-), Regulatory quality (-), Rule of law (-), Voice and accountability (-), Credit information (-), Legal rights (-)
Klein (2013)	Panel vector autoregressive (VAR) analysis	1998-2011	16 Central, Eastern and South-Eastern Europe (CESEE)	Credit-to-GDP ratio (+), Real GDP (-), Inflation (+), Unemployment (+), Exchange rate (+), Higher quality of the bank's management (-), Moral hazard incentives (+), Excessive risk taking (+)
Abid, Ouertani, & Zouari-Ghorbel (2014)	Generalized methods of moments (GMM) estimator	2003-2012	16 Tunisian banking sector	GDP growth (-), Inflation (+), Real lending rate (+), Inefficiency index (+), Solvency ratio (-), ROE (-), Size (+)
Aysan, Ozturk, Polat, & Saltoğlu (2016)	VAR model, dynamic out-of-sample forecasts	2002M12-2011M4	Türkiye	Credit growth (+), Credits to assets (+), Risk appetite (+), Capacity utilization (+), Economic performance (-)
Bardhan & Mukherjee (2016)	GMM estimator	1995-2011	Indian banking sector	GDP growth (-), Inflation (+), Nominal effective exchange (+), Banks size (Mixed), Banks profit (-), Capital adequacy ratio (-)
Adeola & Ikpesu (2017)	Ordinary least squares (OLS) analysis	2005-2014	Nigeria	Inflation (+), Lending rate (+), M2 to GDP growth (+), Unemployment (+)
Koju, Koju, & Wang (2018)	Pooled-OLS, FE, RE and GMM estimator	2003-2015	30 Nepalese banking sector	Export to import ratio (+), Inefficiency (+), Assets size (+), GDP growth (-), Capital adequacy ratio (-), Inflation (-)
Kumar, Stauvermann, Arvind, & Prasad (2018)	Pooled OLS, RE and FE estimators	2000-2013	Fijian banking sector	Return on equity (ROE) (-), Capital adequacy (-), Market share based on assets (-), Unemployment (-), Time (-), Net interest margin (+)
Rachman, Kadarusman, Kevin, & Robertus (2018)	FE estimators	2008-2015	36 commercial banks listed in the Indonesian Stock Exchange	ROA (-), Credit growth (-)
Umar & Sun (2018)	Panel system GMM estimator	2005-2014	197 listed and unlisted Chinese banks	GDP growth (-), Effective interest rate (-/+), Inflation (+), Foreign exchange (+), Bank status (+), Bank risk-taking behaviour (-), Ownership concentration (+), Total equity to total assets ratio (-), Loan loss reserves to impaired loans ratio (-)

Us (2018)	GMM estimator	2002Q4-2015Q4	21 deposit banks in Türkiye	Asset size (-), GDP (-), Inflation (+), Exchange rate (+), Policy rate (+), Inefficiency (-), Capital adequacy (-)
Bayar (2019)	GMM estimator	2000-2013	Emerging Markets	Economic growth (-), Inflation (-), Economic freedom (-), ROA (-), ROE (-), Regulatory capital to risk weighted assets (-), Non-interest income to total income (-), Unemployment (+), Public debt (+), Credit growth (+), Cost to income ratio (+), Financial crisis (+)
Kuzucu & Kuzucu (2019)	GMM estimator	2001-2015	53 emerging and 30 advanced countries	In pre-crisis period; Advanced countries: Unemployment (+), GDP (-) Emerging countries: Inflation (-), GDP (-)
Rachid (2019)	GMM estimator	1997-2016	MENA and CEE countries	In post-crisis period; Advanced countries: Bank capitalization (+), GDP (-), Inflation (+) Emerging countries: FDI (+), GDP (-), Exchange rate (+), Current account balance (-) MENA; Inflation (+), Financial development (-), ROA (-), Financial crisis (+), Rule of law (+), Political stability (+), Control of corruption (+), Voice and accountability (+)
Arham, Salisi, Mohammed, & Tuyon (2020)	Pooled OLS, FE and RE estimators	2007-2017	10 Emerging Asian countries	CEE; GDP (-), Financial development (+), ROA (-), Unemployment (+), Rule of law (-), Political stability (-), Regulatory quality (-), Control of corruption (-), Voice and accountability (-)
Tatarici, Kubinski, & Barnea (2020)	GMM analysis	2005-2017	EEC countries	Unemployment (+), Real interest (+), Total external debt (-), Inflation (-), Governance indicators (-) Economic growth (-), Unemployment (+), Government effectiveness (-), Regulatory quality (-), Loan to deposit (+), Credit to GDP (+), Credit growth (+), ROA (-), ROE (-), Capital to assets (-), Non-interest income (-), Bank Z score (-)
Us (2020)	FE, RE and system GMM estimators	2002Q4 – 2015Q4	Türkiye	Regulatory capital to risk-weighted assets (+), Net profits (loss) to shareholders' equity (-), Total loans to assets (+), Other operating expenses to total assets (+), Total assets to GDP (+), Economic growth (-), Inflation (+), Exchange rate (+), Policy rate (+)
Zheng, Bhowmik, & Sarker (2020)	Autoregressive distributed lag (ARDL) model and vector error correction (VEC) model	1979-2018	59 commercial banks in Bangladesh	GDP growth (-), Unemployment (-), Exchange rates (+), Banking sector gross loans (-), Bank liquidity (+), Net operating profit (-), Bank lending rate (+), Bank deposit rate (-), Domestic credit (+)
Ahmed, Majeed, Thalassinis, &	Panel GMM estimator	2008-2018	Pakistanase banking sector	Credit growth (+), Net interest margin (+), Loan loss provision (+), Bank

Thalassinos (2021)				diversification (+), Operating efficiency (-), Bank size (-), ROA (-), Interest rates (+), Exchange rate (+), Political risk (+), GDP growth (-)
Ayhan & Kartal (2021)	Augmented mean group (AMG) estimator	2006-2018	23 Selected Countries	Credit volume (-), GDP (-), Savings (-)
Alnabulsi, Kozarević, & Hakimi (2022)	Two-stage system GMM estimator	2005-2020	74 banks in 11 MENA countries	ROA (+), Bank Size (+), Liquidity Risk (-), Bank concentration (-), GDP growth (-), Inflation (+), Unemployment (+), Control of corruption (-), Rule of law (-)
Anita, Tasnova, & Nawar (2022)	POLS, FE and RE estimator	2008-2019	8 South Asian Association for Regional Cooperation (SAARC) countries	Broad money supply (-), GDP growth (-), Government net lending/borrowing (+), Inflation (-), Sovereign debt (-)
Hakimi, Boussaada, & Karmani (2022)	Panel smooth transition regression model	2004-2017	MENA countries	Corruption (-), Government stability (-), Board size (+), Duality (+), Size (-), Bank capital to total assets (-), Liquid assets to deposits (-), Economic growth (-)
Jakubik & Kadioglu (2022)	Feasible generalised least square (FGLS) estimator	2010-2019	17 emerging and developing countries	Inflation (+), Lending rates (+), Economic growth (-), Capital adequacy (-), The ratio of net open position in foreign exchange to capital (+)
Mdaghri (2022)	Two-step system GMM estimator	2010-2017	111 commercial banks in ten MENA countries	Liquidity creation (-), Debt repayment (-), Bank size (-), Regulatory capital (-), Profitability (-), Deposits to assets (-), Tightened monetary policy (-)
Syed, Kamal, & Ullah (2022)	Dynamic common correlated effect (DCCE) model	2000-2017	7 emerging markets	Government stability (-), Corruption (+), Institutional regulation (-), Shadow economy (-), Growth rate (-), Unemployment (+), Industrial productivity (-), Interest rate (+), Credit deposit ratio (+), Bank asset to GDP ratio (+)
Goyal, Singhal, Mishra, & Verma (2023)	Panel system GMM estimator and panel Granger causality analysis	2010-2020	89 developing countries, 60 high income countries	ROA (-), Cost to income ratio (-), Non-interest income to total income (-), Capital adequacy ratio (-), Credit to GDP (-), Foreign bank assets (mixed), GDP (mixed), Unemployment (mixed), Inflation (mixed), Institutional quality (-)
Kumar, Al-Romaihi, & Aktan (2023)	Panel system GMM estimator	2000-2018	53 conventional banks in 6 Gulf Cooperation Council (GCC) economies	Non-oil real GDP growth rate (-), Inflation (-), Volatility index (+)
Saliba, Farmanesh, & Athari (2023)	GMM estimator, FE estimator, quantile regression and Granger causality	2004-2020	BRICS	Profitability (-), Capital regulation (-), Liquidity (-), Inefficiency (+), Income diversification (-), Country risk index (-), Political risk index (-), Economic risk index (-), Financial risk index (-), Financial market development (+), Lending interest rate (+), Global risk (+)

As shown in Table 1, the determinants of NPLs in developing and emerging economies are generally examined across three dimensions. From a macroeconomic perspective, many researchers have identified economic growth, inflation, interest rates, exchange rates, and public

debt as the primary macro-level determinants of NPLs. In the second dimension, related to banking sector indicators, empirical studies have commonly emphasized bank inefficiency, credit volume, and overall bank performance as key sectoral determinants. Finally, the institutional quality dimension has been addressed in a relatively limited number of studies, most of which focus on the effects of individual institutional indicators on NPLs rather than using a composite institutional quality index.

2. Data and Model Specification

This study utilizes a dynamic panel framework to empirically assess the long-run determinants of NPLs within the context of E-7 countries. The annual data covers the period from 2000 to 2020. The E-7 countries panel consists from China, India, Brazil, Mexico, Indonesia, Russia and Türkiye. Following the existing empirical literature (Abid et al., 2014; Makri, Tsagkanos, & Bellas, 2014; Kumar et al., 2018; Lee, Yahya, Habibullah, & Ashhari, 2020; Zheng et al., 2020; Ahmed et al., 2021), the main determinants are categorized into three groups: macroeconomic, banking sector-specific, and institutional factors. This classification allows for a more direct presentation of the key drivers of NPLs. In this regard, the empirical model employed in the current study is specified as follows:

$$NPL_{it} = \beta_0 + \beta_1 MACRO_{it} + \beta_2 BANKING_{it} + \beta_3 IQ_{it} + \varepsilon_{it} \quad (1)$$

where NPL_{it} represents the non-performing loans for country (or bank) i at time t ; $MACRO_{it}$ denotes macroeconomic indicators; $BANKING_{it}$ refers to banking sector-specific variables; and IQ_{it} captures institutional quality indicators. The term ε_{it} represents the stochastic error term, assumed to be white noise.

Table 2 provides detailed information about the data, including measure, definitions and sources. Additionally, the last column of Table 2 presents the expected direction of the relationship between each determinant and NPLs, based on empirical findings from the relevant literature. (see Table 1).

Table 2: Data Description, Data Sources and Expected Signs

	Measure	Definition and Sources	Expected Signs
Dependent Variable			
Non-performing loans (npl)	%	Data on bank NPLs as a percentage of gross loans are sourced from the World Bank's (2025a) world development indicators (WDI) and the Federal Reserve Bank's (2025) Federal Reserve Economic Data (FRED).	
Independent Variables			
Macroeconomic Determinants			
Economic growth (ecog)	% (annual change)	Current GDP per capita are collected from the International Monetary Fund (2025), and annual growth rates are computed by the authors.	-
Inflation rate (inf)	% (annual change)	Inflation rates are procured from WDI of the World Bank (2025a).	+ / -
Real interest rate (rir)	%	Real interest rates are obtained from the WDI of the World Bank (2025a). For Türkiye, however, the authors used nominal interest rate data from the FRED of the Federal Reserve Bank (2025) and subtracted the inflation rate to calculate the real interest rate.	+
Real effective exchange rate (refex)	Index	Real effective exchange rates (CPI Based, 2015=100) are provided from the FRED of the Federal Reserve Bank (2025).	+
Public debt (pubd)	%	Gross public debts (percent of GDP) are obtained from the International Monetary Fund (2025).	+
Banking Sector-Specific Determinants			
Return on assets (roa)	%	Ratio of net pre-tax income to total assets (ROA) are provided from the global financial database of the World Bank (2025b).	-
Credit growth (creg)	%	Credit to GDP ratios are procured from the database of Bank for International Settlements (2025). This data used as a proxy for credit expansion by following the literature (see Table 1)	+ / -
Bank inefficiency (inef)	%	Bank cost to income ratios are collected from the global financial database of the World Bank (2025b).	+ / -
Institutional Quality Determinant			
Institutional quality index (insq)	Index	Following the literature (Stoeber, 2012; Barbier & Burgess, 2021), the institutional quality index is calculated as the simple average of six institutional indicators—control of corruption, regulatory quality, political stability and absence of violence, government effectiveness, rule of law, and voice and accountability—originally developed by Kaufmann, Kraay, & Zoido-Lobaton (2000) for the World Bank. These six governance indicators are obtained from world governance indicators of the World Bank (2025c).	-

Table 3 provides descriptive measures of the variables along with the pairwise correlation coefficients. According to the findings, the standard deviations of cres and pubd are relatively higher, indicating potential heterogeneity across countries. Therefore, heterogeneous panel data estimation techniques should be employed in the analysis.

Table 3: Descriptive Statistics and Pairwise Correlation Matrix Results

Panel A: Descriptive Statistics										
	npl	ecog	inf	rir	refex	pubd	roa	creg	inef	insq
Mean	5,715	7,490	7,356	8,520	98,442	46,696	1,294	68,130	54,367	1,657
Maximum	34,400	37,774	54,915	48,504	143,722	96,006	9,805	197,275	98,928	2,140
Minimum	0,953	-33,986	-0,731	-12,856	66,943	7,446	-3,727	20,125	30,318	1,050
Std, Dev,	6,004	13,630	7,612	13,020	15,487	21,855	1,086	41,650	12,830	0,268
Observations	146	146	146	146	146	146	146	146	146	146
Panel B: Correlation Matrix										
	npl	ecog	inf	rir	refex	pubd	roa	creg	inef	insq
npl	1									
ecog	-0,056	1								
inf	0,226	-0,017	1							
rir	-0,057	-0,098	-0,007	1						
refex	-0,315	0,047	-0,082	0,095	1					
pubd	0,091	-0,142	0,071	0,473	-0,216	1				
roa	-0,311	0,331	-0,085	0,061	0,064	-0,161	1			
creg	-0,053	-0,064	-0,303	-0,137	-0,247	0,015	-0,238	1		
inef	0,143	-0,050	0,166	0,196	0,371	-0,078	-0,078	-0,500	1	
insq	-0,296	-0,179	-0,038	0,553	0,162	0,482	-0,098	-0,193	-0,014	1

Furthermore, the pairwise correlation results suggest that multicollinearity is not a concern for the panel data, as all correlation coefficients are below the 0,8 threshold indicated by Shrestha (2020). Notably, npl is most strongly correlated with refex, followed by roa, insq, and inf, respectively. While the pairwise correlation findings provide preliminary insights, it remains essential to apply advanced panel data techniques to ensure more reliable and consistent results. Accordingly, dynamic heterogeneous panel data methods will be utilized in the empirical analysis.

3. Methods and Results

This research applies advanced heterogeneous dynamic panel data methodologies to assess the underlying determinants of NPLs in E-7 countries during the 2000–2020 period. However, prior to estimation, it is crucial to assess the stationarity of the variables through unit root testing to prevent biased long-run inference. Panel unit root methodologies offer two types of tests: first-generation and second-generation. First-generation panel unit root tests are based on the assumption of cross-sectional independence among the series. However, this assumption is often unrealistic, particularly given that many macroeconomic variables exhibit co-movements across cross-sectional units. Moreover, when cross-sectional dependence is present, unit root test results can lead to misleading conclusions, including size distortions and reduced statistical power. Second-generation panel unit root methodologies tackle this issue by permitting interdependencies across units, thereby relaxing the assumption of cross-sectional independence (Baltagi & Pesaran, 2007, p. 229-230; Hurlin & Mignon, 2007, p. 2-3,8). In this context, prior to conducting unit root tests, it is necessary to investigate the presence of cross-sectional dependence for each series. Although several panel cross-sectional dependence (CD) tests are available in the literature (Pesaran, 2021), considering the characteristics of the dataset and to minimize the risk of size distortions, this study adopts the CD test proposed by Pesaran (2004). Pesaran CD test that is applicable to both stationary and non-stationary heterogeneous panel data. This test is based on the average of the pairwise correlation coefficients of the ordinary least squares (OLS) residuals. CD test statistic given as below:

$$CD = \sqrt{\frac{2T}{N(N-1)}} (\sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \rightarrow N(0,1)) \quad (2)$$

The Pesaran (CD) test operates under the null hypothesis of cross-sectional independence among the panel units. Table 4 reports the outcomes of the CD test. According to the findings, with the exception of inf and roa, all series exhibit cross-sectional dependence across units. Therefore, second-generation panel unit root tests are appropriate for the majority of the variables. Conversely, for inf and roa, which do not show cross-sectional dependence, first-generation panel unit root tests should be employed.

Table 4: Results of Pesaran's CD Test and First- and Second-Generation Panel Unit Root Tests

Panel A: CD test results										
	npl	ecog	inf	rir	refex	pubd	roa	creg	inef	insq
CD test statistics	10,511***	12,250***	1,225	3,010***	5,632***	4,324***	1,038	16,989***	5,539***	-3,010***
Panel B: First-generation panel unit root tests results										
	IPS			Fisher- ADF			Fisher- PP			
	Intercept and trend			Intercept and trend			Intercept and trend			
inf	-3,642***			37,195***			71,576***			
roa	-1,659**			22,960*			46,342***			
Panel C: Second-generation panel unit root test results										
	CIPS test results (intercept with deterministic trend)									
	npl	ecog	rir	refex	pubd	creg	inef	insq		
Level	-1,247	-4,550***	-2,724	-1,728	-1,543	-2,502	-3,153***	-3,215***		
First diff.	-3,279***	-	-2,756*	-2,809*	-3,420***	-2,945**	-	-		

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Test statistics for the CD and panel unit root tests are reported in the corresponding columns. The optimal lag lengths for both first- and second-generation panel unit root tests are selected based on the Akaike Information Criterion (AIC).

Considering the CD test findings, the IPS panel unit root test developed by Im, Pesaran, & Shin (2003), as well as the Fisher-type panel unit root tests introduced by Maddala & Wu (1999) and Choi (2001), are employed to examine the presence of unit roots in the inf and roa series. The IPS test computes the average of individual unit root test statistics and permits heterogeneity in autoregressive coefficients across cross-sectional units. Moreover, it relaxes the restrictive assumption that the autoregressive parameter ρ must be homogeneous across cross sections. In addition, Maddala & Wu (1999) and Choi (2001) developed panel unit root tests that assess the presence of a unit root by combining the p-values from individual unit root tests for each cross-sectional unit. Unlike the IPS test, the Fisher-type tests do not require a balanced panel and allow for varying lag lengths across the individual ADF regressions (Baltagi & Kao, 2000, p. 7-8). Panel B of Table 4 summarizes the empirical findings from the first-generation panel unit root tests. As shown, inf and roa are stationary at level, indicating that they follow an I(0) process.

On the other hand, second-generation panel unit root methodologies are required for the variables npl, ecog, rir, refex, pubd, creg, inef, and insq. At this stage, the Cross-Sectionally Augmented IPS (CIPS) test, a widely adopted second-generation panel unit root test developed by Pesaran (2007), is utilized. This methodology enhances the standard Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) regressions by incorporating cross-sectional averages of the lagged levels and first differences of the individual series. This procedure, known as the Cross-Sectionally Augmented Dickey-Fuller (CADF) regression, aims to account for cross-sectional dependence. CADF procedure is based on t -ratio of OLS estimation of $b_i(\hat{b}_i)$ in the following CADF regression:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + u_{it} \quad (3)$$

For mentioned t -ratio of OLS estimation stated as below:

$$t_i(N, T) = \frac{\Delta y_i' \bar{M}_w y_{i,-1}}{\hat{\sigma}_i(y_{i,-1}' \bar{M}_w y_{i,-1})^{1/2}} \quad (4)$$

where,

$$\Delta y_i = (\Delta y_{1i}, \Delta y_{2i}, \dots, \Delta y_{iT})', y_{i,-1} = (y_{i0}, y_{i1}, \dots, y_{iT-1})' \quad (5)$$

$$\bar{M}_w = I_T - \bar{W}(\bar{W}'\bar{W})^{-1}\bar{W}', \bar{W} = (\tau, \Delta \bar{y}, \bar{y}_{-1}) \quad (6)$$

$$\tau = (1, 1, \dots, 1)', \Delta \bar{y} = (\Delta \bar{y}_1, \Delta \bar{y}_2, \dots, \Delta \bar{y}_T)', \bar{y}_{-1} = (\bar{y}_0, \bar{y}_1, \dots, \bar{y}_{T-1})' \quad (7)$$

$$\hat{\sigma}_i^2 = \frac{\Delta y_i' M_{i,w} \Delta y_i}{T-4} \quad (8)$$

In addition,

$$M_{i,w} = I_T - G_i(G_i'G_i)^{-1}G_i' \text{ and } G_i = (\bar{W}, y_{i,-1}) \quad (9)$$

Pesaran (2007) also developed a cross-sectional augmented version of the IPS-test as given below:

$$CIPS(N, T) = N^{-1} \sum_{i=1}^N CADF_i \quad (10)$$

The CIPS procedure tests the null hypothesis that each series contains a unit root against the alternative that at least a proportion of the series are stationary. CIPS test results showed in panel C of Table 4. According to the findings, ecog, inef, and insq are stationary at level, indicating that they follow an I(0) process. In contrast, npl, rir, refex, pubd, and creg are found to be stationary at their first differences, implying that these variables are integrated of order one, I(1).

The findings of the panel unit root test indicate that the autoregressive distributed lag (ARDL) model is the appropriate method for estimating long-run coefficients. Furthermore, the ARDL approach adequately addresses serial correlation and endogeneity among the regressors, providing consistent and robust estimations along with valid t-statistics (Menegaki, 2019; Malik, Latif, Khan, Butt, Hussain, & Nadeem, 2020). Pesaran & Smith (1995) developed the Mean Group (MG) estimator, which provides consistent estimates of the average of the parameters across groups. However, the MG estimator neglects potential parameter homogeneity across units. Later, Pesaran, Shin, & Smith (1999) proposed the Pooled Mean Group (PMG) estimator, which combines both pooling and averaging of parameters. It allows differences in intercepts, short-term effects, and errors between groups, but assumes that the long-term effects are the same for all groups. Pesaran et al. (1999) assumed an ARDL ($p, q, q, \dots, q$) model for a given time periods ($t = 1, 2, \dots, T$) and groups ($i = 1, 2, \dots, T$):

$$y_{it} = \sum_{j=1}^p \tau_{ij} y_{i,t-j} + \sum_{j=0}^q \delta_{ij}' x_{i,t-j} + \mu_i + u_{it} \quad (11)$$

where y_{it} denotes dependent variable which is npl, x_{it} is the $k \times 1$ vector of explanatory variable variables for group I (including ecog, inf, rir, refex, pubd, roa, cres, inef, insq), μ_i states the group specific effects, δ_{ij} are the $k \times 1$ coefficient vectors, τ_{ij} are scalar coefficients of the lagged dependent variables. Under the assumption that u_{it} is an I(0) process across all cross-sectional units, cointegrated series exhibit systematic adjustments in response to deviations from the long-run equilibrium, reflecting the presence of an error correction mechanism. In this context equation 11 transformed into the below presentation:

$$\Delta y_{it} = \phi_i (y_{i,t-1} - \vartheta_i' X_{it}) + \sum_{j=1}^{p-1} \tau_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta X_{i,t-j} + \mu_i + u_{it} \quad (12)$$

where $\phi_i = -(1 - \sum_{j=1}^p \tau_{ij})$, $\vartheta_i = \sum_{j=0}^q \delta_{ij} / (1 - \sum_k \tau_{ik})$, $\tau_{ij}^* = -\sum_{m=j+1}^p \tau_{im}$ $j = 1, 2, \dots, p - 1$, and $\delta_{ij}^* = -\sum_{m=j+1}^q \delta_{im}$ $j = 1, 2, \dots, q - 1$. In addition, ϕ_i captures the rate of adjustment towards the long-run equilibrium. A statistically significant and negative value for this parameter

indicates the presence of a long-run relationship among the series (Blackburne III & Frank, 2007, p. 202).

Table 5 presents the estimated short-run and long-run coefficients of the determinants of NPLs using both MG and PMG estimators. Before discussing the results, the appropriate estimator is identified through the Hausman test. The test fails to reject the null hypothesis that the difference in coefficients is not systematic. Therefore, the PMG estimator is considered the more efficient one. In this context, the error-correction term (ECT) is found to be negative and statistically significant at the 1% level. This finding implies and confirms the existence of a long-run relationship between the variables. According to the PMG long-run estimates, all explanatory variables exert a statistically significant influence on NPLs in the E-7 countries. With respect to macroeconomic factors, economic growth (ecog) exerts a negative and statistically significant effect on NPLs, consistent with theoretical expectations. In theory, economic growth is the driving force behind the development process. However, the cyclical nature of growth directly influences banks' credit risk exposure. During periods of recession, economies typically experience high unemployment, elevated inflation rates, and reduced output levels, all of which may increase credit risk. Conversely, rising economic activity boosts household and firm consumption by expanding cash flow and financial liquidity. This, in turn, enhances confidence among borrowers and lenders, stimulates new investments, and strengthens borrowers' repayment capacity. Accordingly, credit risk tends to decline during periods of economic growth (Anita et al., 2022, p. 6). Furthermore, this result aligns with the findings of previous empirical studies (see Table 1).

Table 5: Short-run and Long-run Coefficients

	MG		PMG	
Error correction term	-1,465**	[0,777]	-0,457***	[0,186]
Long run coefficients				
<i>Macroeconomic determinants</i>				
ecog	-2,001	[2,292]	-0,040**	[0,018]
inf	-0,337	[0,553]	0,251***	[0,026]
rir	-3,195	[3,532]	0,042***	[0,013]
refex	-0,302	[0,261]	0,030***	[0,005]
pubd	-0,935**	[0,484]	0,043***	[0,008]
<i>Banking sector-specific determinants</i>				
roa	18,812	[21,684]	-1,475***	[0,263]
creg	-0,025	[0,450]	-0,084***	[0,013]
inef	0,613	[0,808]	-0,104***	[0,029]
<i>Institutional quality determinant</i>				
insq	53,230	[55,898]	-6,412***	[1,050]
Short run coefficients				
<i>Macroeconomic determinants</i>				
ecog	0,187	[0,219]	0,021	[0,017]
inf	2,293	[1,975]	0,032	[0,139]
rir	1,073	[0,789]	-0,018	[0,084]
refex	-0,135	[0,131]	-0,002	[0,087]
pubd	1,945	[1,837]	0,104	[0,097]
<i>Banking sector-specific determinants</i>				
roa	16,567	[16,502]	-0,115	[0,386]
creg	1,716	[1,621]	-0,114	[0,132]
inef	1,160	[1,109]	-0,056	[0,065]
<i>Institutional quality determinant</i>				
insq	20,489	[14,817]	-0,615	[3,357]
Hausman test statistics			0,00	(1,000)
Observations	139		139	
Number of countries	7		7	
Time span	2001-2020		2001-2020	

Note: ***, **, * indicates the significance level of %1, %5 and %10, respectively. Long and short run and error correction term coefficient results are stated in columns. Prob. value of Hausman test statistics are given in paranthesis. Test statistics of ARDL estimations are presented in brackets. The ARDL(1,1,1,1,1,1,1,1,1,1) model was selected as the appropriate specification for both estimators based on the Akaike Information Criterion (AIC).

A further key macroeconomic determinant of NPLs is the inflation rate (inf). The PMG results suggest that inflation positively affects NPLs over the long run, as expected, likely because higher price levels erode borrowers' purchasing power and impair their ability to meet debt obligations (Kumar et al., 2023, p. 194). Similar results have been reported by Klein (2013), Abid et al. (2014), Bardhan & Mukherjee (2016), Adeola & Ikpesu (2017), Jakubik & Kadioglu (2022). The real interest rate (rir) is another important macroeconomic determinant of NPLs. Accordingly, the PMG long-run results indicate a positive relationship between rir and NPLs. This result is consistent with theoretical expectations, as higher interest rates increase borrowing costs through elevated interest payments. Consequently, borrowers' ability to repay their debts weakens, thereby elevating potential credit risks (Syed et al., 2022, p. 984). Parallel results were observed in the studies of Fofack (2005), Abid et al. (2014), Adeola & Ikpesu (2017), Arham et al. (2020), Zheng et al. (2020), Ahmed et al. (2021), Jakubik & Kadioglu (2022), Syed et al. (2022), Saliba et al. (2023).

The real effective exchange rate (refex) has been identified in the literature as a significant macroeconomic contributor to the level of NPLs. PMG results indicate that NPLs increase with higher levels of refex, in accordance with the prevailing theoretical framework. This is particularly relevant for emerging and developing markets, where fluctuations in the refex can have severe impacts on economic development (Anita et al., 2022, p. 6). Moreover, an appreciation of the refex may weaken export-oriented sectors, thereby reducing the repayment capacity of borrowers operating in these sectors and increasing the risk of loan defaults (Fofack, 2005, p. 12). As a result, the level of NPLs tends to rise through this transmission mechanism. Corresponding results are found in the works of Fofack (2005), Khemraj & Pasha (2009), Klein (2013), Bardhan & Mukherjee (2016), Us (2018,2020), Zheng et al. (2020) and Ahmed et al. (2021). Another critical macroeconomic determinant of NPLs, as highlighted in prior literature, is public debt (pubd) (see Table 1). As expected, the long-run estimates from the PMG estimator reveal that public debt (pubd) has a significant positive impact on NPLs in E-7 countries. This is mainly due to government-related problems. When public debt increases, governments often cut social spending and reduce wages in public services. These actions lower household incomes, making it more difficult for individuals to repay their loans, which in turn contributes to an increase in the level of NPLs (Ofria & Mucciardi, 2022, p. 877). Corroborating findings can be found in the work of Bayar (2019), which affirm the established relationship.

As demonstrated by the empirical literature, in addition to macroeconomic determinants, banking sector-specific indicators also play a crucial role in determining the level of NPLs. In this context, consistent with expectations, the PMG long-run findings reveal that higher return on assets (roa) is associated with lower levels of NPLs. This relationship can be explained by the efficient management of banks in converting their assets into returns. As a result, increased profitability through effective management enhances a bank's resilience to credit risk and thereby leads to a reduction in the level of NPLs (Dimitrios, Helen, & Mike, 2016, p. 117; Ahmed et al., 2021, p. 4). This finding is in accordance with the results of Rachman et al. (2018), Bayar (2019), Rachid (2019), Tatarici et al. (2020), Ahmed et al. (2021) and Goyal et al. (2023). Another important banking sector-related indicator that influences NPLs is the level of total credit (creg). As shown in the long-run estimation results of the PMG estimator, NPLs tend to decline with an increase in total credit. Although the majority of the literature (see Table 1) identifies a positive relationship between credit growth and NPLs, some researchers (Khemraj & Pasha, 2009; Boudriga et al., 2010; Rachman et al., 2018; Ayhan & Kartal, 2021) have found a negative correlation. Given banks' focus on lending activities, the negative association between credit growth and NPLs indicates a disciplined approach to credit allocation, where risk control takes precedence over short-term profit motives (Boudriga et al., 2010, p. 3). Accordingly, an increase in total credit (creg) is associated with a decline in NPLs.

On the other hand, bank inefficiency (inef) represents another critical sector-specific factor widely discussed in the literature. According to PMG estimations, inefficiency exerts a significantly adverse effect on NPLs in the long run. A direct association between inefficiency and elevated NPLs levels indicates deficiencies in banking practices, including insufficient borrower oversight, inadequate collateralization, and inefficient resource utilization. However, a negative correlation between inefficiency and NPLs may indicate that more efficient banks are managing their loan portfolios effectively, leading to lower levels of credit risk (Abid et al., 2014, p. 61-62; Kumar et al., 2018, p. 196). However, a negative correlation between inefficiency and NPLs may suggest that more efficient banks are managing their loan portfolios more effectively, thereby reducing credit risk. This interpretation aligns with the findings of Us (2018).

As highlighted in the existing literature, alongside macroeconomic and sectoral factors, the institutional dimension also plays a crucial role in determining the level of NPLs. According to the long-run results of the PMG estimator, institutional quality (insq) has a strong and statistically

significant negative effect on NPLs in the E-7 countries. Well-functioning institutions support the stability of both the financial system and the banking sector through the effective implementation of regulations that promote private sector development. As a result, enhanced welfare facilitates borrowers' ability to meet their debt obligations. Through this mechanism, NPLs are reduced (Tatarici et al., 2020, p. 626-627; Alnabulsi et al., 2022, p. 5). Although many studies have examined the relationship between various institutional quality indicators and NPLs separately, similar conclusions have been drawn by Boudriga et al. (2010), Rachid (2019), Arham et al. (2020), Tatarici et al. (2020), Alnabulsi et al. (2022), Hakimi et al. (2022) and Goyal et al. (2023). According to empirical evidences, institutional quality, bank profitability (roa), inflationary pressure, and operating efficiency (inef) emerge as the primary determinants of NPLs in E-7 countries, emphasizing the complex nature of credit risk. At this point, well-functioning bank management, improvements in institutional quality, and effective monetary policy play a crucial role in maintaining financial system stability by reducing the amount of NPLs.

4. Concluding Remarks and Suggestions

As in developed economies, E-7 countries also face financial turbulences triggered by credit default risk. However, a sound financial system is essential for the sustainable development of these emerging economies. In this context, a well-functioning banking system plays a vital role in ensuring the continuity of investments, especially considering that banks dominate the majority of financial intermediation activities in both developed and developing countries. Unfortunately, the increasing volume of NPLs poses a significant threat to the stability of the banking sector and, consequently, to the broader financial system. Therefore, identifying the potential determinants of NPLs in emerging markets is of great importance—not only for academic research but also for policymakers seeking to maintain financial stability. Motivated by these concerns, this study aims to examine the long-run determinants of NPLs in E-7 countries across three key dimensions: macroeconomic, banking sector, and institutional factors.

In the initial phase of the analysis, cross-section dependence was tested across the series, which necessitated the use of second-generation panel unit root methodologies. The empirical results from the unit root tests indicated that the ARDL approach was the most appropriate estimation technique for this study. According to the long-run results of PMG, an increase in inflation rate, real interest rate, real effective exchange rate and public debt stimulates the NPLs. Conversely, improvements in economic growth, return on assets, credit growth, bank efficiency, and institutional quality are linked to reductions in NPLs. As a result, institutional quality, bank profitability, inflationary pressures, and operational efficiency are identified as the key long-term determinants of NPLs in E-7 countries. These findings suggest that policymakers and regulators in E-7 economies should take into account the multidimensional nature of NPLs determinants when formulating financial stabilization policies. Furthermore, an optimal and well-anchored monetary policy that keeps inflation within a manageable range is essential to mitigate credit risk in these economies. To this end, maintaining household solvency and sustaining demand for goods and services require a predictable, rule-based monetary policy stance. It is also essential for banks in E-7 countries to enhance their cost-efficiency and managerial capabilities. Thereby, effective asset management contributing to a reduction in NPLs due to rising bank profitability. Improved asset management practices, supported by rising bank profitability, can contribute significantly to the reduction of NPLs. Furthermore, the development and implementation of a robust institutional framework not only foster sustainable economic development but also contribute to lower NPLs ratios. This is largely due to the welfare-enhancing effects of institutional reforms, which may improve individuals' ability to meet their financial obligations. Therefore, E-7 countries are encouraged to reform and modernize their institutional environments through policies aimed at enhancing governance, strengthening the legal framework, and enforcing anti-corruption mechanisms.

As with any scientific research, this study has certain limitations. Firstly, the analysis focuses solely on seven emerging economies, which may constrain the generalizability of the findings. Future studies are therefore encouraged to expand the panel of emerging countries to enhance the robustness and applicability of the results. Secondly, the study does not include a comparison between developed and developing economies. Incorporating developed country groups—such as the G7—into future analyses would enable meaningful comparisons and help policymakers formulate more tailored, country-specific policies. Lastly, the dataset used for macroeconomic, sectoral, and institutional indicators is limited in scope. Expanding the range of potential NPLs - related indicators could provide deeper insights into the diverse factors influencing NPLs.

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