Determinants of Non-Performing Loans: An Empirical Analysis Across Major Sectors

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Abstract

This paper investigates the determinants of non-performing bank loans (NPLs) across six key sectors in Estonia from 2005 to 2023, employing a dynamic linear regression model. The analysis focuses on agriculture, manufacturing, construction, wholesale and retail trade, transportation and real estate. The model incorporates both macroeconomic factors like unemployment and real GDP growth, and sector-specific financial variables including sector-specific bank lending interest rates and profitability indicators. The results reveal strong persistence in NPLs across all sectors, with business cycle indicators, particularly the unemployment rate, consistently explaining variations in NPLs, albeit with varying impact across sectors. Sector-specific variables generally play a less important role, except in the wholesale and retail trade sector, where leverage and profitability correlate more significantly with credit risk.

Keywords: non-performing loans, banking sector, corporate debt, business cycles

JEL Classification: G01, G21, E32, E44

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1 Introduction

Non-performing loans (NPLs) being at a high level poses significant risks to financial stability, as they erode banks' balance sheets, restrict lending capacity, and can amplify systemic risks within the banking sector, particularly during periods of economic stress.

The credit quality of the loan portfolios in advanced economies was relatively stable during the early 2000s until the global financial crisis in 2008–2009. The economic recession that followed the crisis led however to a steep deterioration in the average quality of bank assets worldwide, highlighting the closeness of the relationship between loan performance and the economic cycle.

Loan performance declined to markedly different degrees across countries. The Baltic states, including Estonia, experienced particularly severe contractions in GDP during the crisis, with the result that non-performing loans surged substantially. In Estonia, NPLs in the construction sector surged from approximately 2 per cent in 2007 to nearly 20 per cent by 2009 and real estate also experienced elevated NPL levels during this period, but the extent of NPLs differed across sectors, reflecting how structural imbalances may have exacerbated the impact of economic shocks. Moreover, while some sectors like construction faced higher levels of NPLs for a prolonged period, others saw a faster recovery, revealing that the dynamics of the recovery after the crisis were heterogeneous across sectors.

The economic challenges stemming from the Covid-19 pandemic in 2020–2022 and the Russian invasion of Ukraine in February 2022 impacted the Estonian economy significantly. The conflict in Ukraine led to a sharp increase in energy prices and necessitated a realignment of trade links. A surge in inflation starting in mid-2021 prompted the European Central Bank (ECB) to raise interest rates, which quickly resulted in higher borrowing costs and an increased debt-servicing burden for households and firms. These factors combined to drive the Estonian economy into a recession, and the economy had still not fully recovered in late 2024, when the prolonged downturn was continuing to strain the debt-servicing capacity of companies and households.

The 2024 financial stability report from the Estonian central bank (Eesti Pank 2024), highlighted how the financial resilience that had developed before the ECB's monetary tightening started, and the ability of firms to raise prices and increase markups, helped mitigate the full impact on companies of the higher loan servicing costs during the recession that began in the second quarter of 2022. This resilience has helped keep non-performing loans at historically low levels not only in the corporate sector but also in consumer and mortgage lending, which benefited from strong

labour market conditions and low unemployment.

Earlier studies have largely focused on aggregate NPL ratios at the country level or divided them into broad categories like corporate, consumer or mortgage loans, and they have looked mainly at the business cycle variables that have been identified as the key determinants of NPLs (Messai and Jouini 2013; Beck et al. 2015). This paper seeks to bridge the gap between firm-level analysis within a single sector and broader analysis of total NPLs in the non-financial corporate sector. It uses a unique dataset from Eesti Pank, the central bank of Estonia, of NACE level 1 data on non-performing corporate loans to examine the heterogeneity in the dynamics of NPLs across different sectors.

We analyse the differences in loan performance across sectors in Estonia by analysing the empirical determinants of the NPL ratios in selected NACE level 1 sectors. The study runs from the first quarter of 2005 to the fourth quarter of 2023 and uses cross-sectional regressions for each sector, incorporating data from the national accounts, business cycle indicators, and other macroeconomic variables. There is limited availability for the detailed sector-level data, but we can still provide valuable insights into the specific factors that influence NPLs in different sectors.

Our findings indicate that business cycle variables, particularly the unemployment rate and to a lesser extent real GDP growth, are the primary drivers of the dynamics of NPLs across most Estonian sectors. The debt-to-gross operating surplus ratio, which serves as a proxy for the capacity of companies to service their debt, is positively associated with NPLs across several sectors, but sector-specific debt indicators are less consistently significant. Sector-specific variables like leverage and profitability play a more prominent role in wholesale and retail though.

Interest rates, whether macro rates like Euribor or sector-specific bank lending rates, have a surprisingly limited influence on NPLs but are sensitive to the chosen lag structure, suggesting that the timing of interest rate effects may vary by sector. Interest rates only tend to become statistically significant when the GFC dummy is excluded, indicating that interest rates are more sensitive when the specific shocks of the Global Financial Crisis are not controlled for.

Our analysis identifies potential spillover effects from real estate to construction, which suggests that shocks in real estate may influence the accumulation of NPLs in construction. The analysis did not however detect any evidence of spillovers in the opposite direction, and the robustness of these findings is limited by the availability of the data.

We contribute to the existing literature in three key ways. First, we bridge the gap between aggregate analysis of the determinants of non-performing corporate loans and micro-level analysis of firms by focusing on the sector-level determinants

of NPLs. Second, we contrast the effects of business cycle indicators with those of a select set of sector-specific variables, highlighting which factors play a role in explaining non-performing loans. Third, we use a brief comparative analysis to show that some of the results our sector analysis align closely with those from an aggregate analysis of non-performing corporate loans.

2 Literature Review

The empirical literature on the interaction between macroeconomic conditions and asset quality is vast and diverse. It provides both theoretical insights and empirical evidence on the determinants of NPLs and their relationship to economic fluctuations. Several papers in the banking literature examine the relationship between the macroeconomic environment and the quality of loans.

Carey (1998) argues that "the state of the economy is the single most important systematic factor influencing diversified debt portfolio loss rates". Theoretical macroeconomic models provide a foundational understanding of the relationship between NPLs and macroeconomic determinants. Seminal papers by Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke, Gertler, and Gilchrist (1999) highlight how fluctuations in economic conditions like output, unemployment or asset prices affect the financial sector through mechanisms like credit constraints, balance sheet effects, and the amplification of shocks in credit markets. These models demonstrate that economic downturns amplify financial distress, leading to higher default rates and deteriorating asset quality. Pesaran et al. (2006) build on these theoretical foundations and develop a global macro-econometric model that links changes in credit portfolio values to the business cycle. They conclude that the probabilities of firms defaulting are closely tied to macroeconomic dynamics, reinforcing the theoretical connection between NPLs and economic activity.

Empirical evidence supports this hypothesis. Quagliariello (2007) finds for example that the business cycle significantly affects NPLs for a large panel of Italian banks in 1985–2002, while Cifter et al. (2009) document a lagged impact from industrial production on the number of NPLs in Turkey between 2001 and 2007. Salas and Saurina (2002) estimate that GDP growth has a significant negative contemporaneous effect on NPLs in Spain, suggesting macroeconomic developments are transmitted rapidly to the ability of borrowers to service their loans. Other studies such as Bangia et al. (2002) and Carey (2002) provide additional evidence linking credit defaults to the business cycle.

Empirical studies corroborate the theoretical predictions by consistently finding that NPLs are countercyclical. Nkusu (2011) for example analyses data from 26

advanced economies between 1998 and 2009, and finds that NPLs have a negative relationship with GDP growth and equity price changes, and a positive relationship with unemployment and inflation. Staehr and Uusküla (2021) extend this analysis and demonstrate similar relationships using data from 26 EU countries, again confirming the strong link between NPLs and the business cycle. Beck et al. (2015) use data from 75 countries and report a negative relationship between NPLs and share prices alongside a positive correlation with lending interest rates. Festić et al. (2011) look at Eastern European economies and identify real exports, gross fixed capital formation, and net foreign assets as key negative explanatory variables of NPLs, while foreign direct investment in the financial sector is positively associated with them.

Much of the literature focuses on aggregate NPLs, but a smaller subset examines NPLs at the sector or regional level. Kukk and Levenko (2020) analyse for example how non-performing corporate loans in Estonia are influenced by alternative sources of financing such as intra-group borrowing and trade credit. S. Ghosh (2005) investigates how macroeconomic shocks impact Indian manufacturing firms, and identifies firm leverage and financing constraints as the key determinants of NPLs. However, these studies often lack a comparative perspective across sectors, leaving room for sectoral heterogeneity in NPL dynamics to be explored further.

A limited number of studies use quarterly data to examine the determinants of NPLs, offering more granular insights into the dynamics of loan performance. A. Ghosh (2017) for instance uses quarterly data to analyse NPLs in the US banking sector and finds that macroeconomic variables can affect NPLs contemporaneously. His robustness tests reveal that contemporaneous effects dominate over effects lagged by up to four quarters, which underlines how immediate the sensitivity of NPLs is to macroeconomic shocks. Louzis et al. (2012) similarly use quarterly data in one of the closest studies to our specification, and they analyse NPLs in Greece from the first lag of NPLs and some macroeconomic variables with first and second lags.

Finally, the ECB's Financial Stability Review (European Central Bank 2019) contains a brief analysis of industrial NPLs in the euro area that emphasises how corporate assets being poor in quality is a key risk to financial stability, but does not contain any empirical analysis of the determinants of NPLs at the sector level. The review highlights how NPLs are concentrated in a few sectors, particularly construction, accommodation and transport, and how the economic expansion from 2015 to 2018 helped reduce overall NPL ratios. It concludes that reduced lending by banks to distressed sectors may both reflect and exacerbate corporate solvency problems.

3 Methodology and Data

3.1 Methodology

We employ a straightforward Ordinary Least Squares (OLS) regression model to estimate how various factors influence the variation in non-performing loans across sectors. The initial model incorporates the primary determinants of non-performing corporate loans, using quarterly data with all the independent variables lagged by one quarter.

This approach stands in contrast to much of the existing literature, which predominantly uses annual data and often uses cross-sectional panel models to study the determinants of NPLs.[1] Instead of those panels, we estimate separate time-series regressions for each sector, allowing us to capture sector-specific dynamics and responses to macroeconomic variables. Our specification is very close to that of Louzis et al. (2012), who also use quarterly data and include the first lag of NPLs in their model. While their lag structure is similar to ours though, they estimate most specifications in first differences, which is different to our approach of modelling variables in levels to capture both short-term dynamics and long-run relationships. Alternative specifications of the lag structure of the variables are provided as robustness checks in Section 5.1.[2]

We estimate this model separately for each sector rather than using a panel model for two main reasons. The first is that sector-specific factors and dynamics vary significantly across sectors, and estimating separate regressions lets us capture these heterogeneous responses to macroeconomic and sector variables. Imposing homogeneity through a panel framework would obscure crucial sector-level differences, particularly between sectors that respond differently to changes in interest rates, profit margins, or external demand conditions. The second reason is that the availability of sector-specific data is limited, particularly for explanatory variables at the sectoral level.

The model is specified as follows for each sector:

[1] Most studies in the literature use some form of dynamic panel data models and often employ first-difference transformations and generalised method of moments (GMM) estimators in the style of Arellano and Bond (1991).

[2] A. Ghosh (2017) shares several methodological similarities with our work. That study uses quarterly data, includes the first lag of NPLs, and examines the effects of macroeconomic variables. However, it assumes that macroeconomic shocks can be transmitted contemporaneously within a quarter and finds from its robustness tests that contemporaneous effects are more significant than lagged effects. While our baseline model focuses on lagged explanatory variables, the results from using contemporaneous variables are available from the authors upon request.

$$NPL_t = \alpha + \delta GFC + \beta NPL_{t-1} + \gamma Z_{t-1} + \varepsilon_t \quad (1)$$

where NPL_t represents the ratio of non-performing loans at time t, and NPL_{t-1} is the lagged dependent variable, which is included to control for the persistence in NPLs over time. The vector Z_{t-1} comprises the explanatory variables, and GFC is a dummy variable that takes the value of 1 from the first quarter of 2008 to the fourth quarter of 2009 to capture the effects of the Global Financial Crisis (GFC) period, and 0 otherwise. The coefficients α, β and δ, and those in the vector γ are estimated, with ε representing the error term.

We employ a parsimonious linear parametric model, beginning with a limited set of aggregate business cycle variables to explain variations in NPLs. This approach is partly chosen because the number of observations is limited, as it ensures the model remains straightforward and avoids overfitting. As we expand the model, we sequentially introduce sector-specific variables and broader macroeconomic factors, such as house prices, that may also influence NPLs. This stepwise inclusion lets us assess whether aggregate business cycle indicators or sector-level variables exert a stronger impact on NPLs.

Using business cycle variables makes the results directly comparable across sectors, as those indicators reflect economy-wide dynamics that apply uniformly across sectors. Incorporating sector-specific variables highlights however the heterogeneous effects that sector characteristics may have on NPLs, giving a deeper insight into how sector-level factors complement or diverge from macroeconomic conditions in shaping credit risk. Including the GFC dummy accounts for the significant macroeconomic shocks experienced in Estonia during this period, when there was a sharp increase in NPLs, a considerable contraction in output, and a rise in the unemployment rate. We conduct robustness tests in Section 5 that exclude the GFC dummy or adjust the lag length of the variables.

3.2 Data

The dependent variable in all the models is the ratio of non-performing loans (NPLs) to total loans within a given sector. Loans are generally classified as non-performing when the borrower has been in arrears for more than 60 days. The data are sourced from the Bank of Estonia and provide extensive coverage of sectors at the NACE 1 level, though the degree of coverage varies across sectors.

Our analysis focuses on six key sectors that have been selected for their significance in the portfolios of loans and non-performing loans. These sectors are classified by the *Statistical Classification of Economic Activities in the European Community*

(NACE), which uses a hierarchical structure where the first level has 21 sections designated by the letters A to U. The sectors chosen for this analysis are Agriculture, Forestry and Fishing (A); Manufacturing (C); Construction (F); Wholesale and Retail Trade, including the Repair of Motor Vehicles and Motorcycles (G); Transportation and Storage (H); and Real Estate (L).[3] The data on NPLs are available for all sectors from the first quarter of 2005, except for the real estate sector, where the data begin in the third quarter of 2005.

The rationale for focusing on these sectors is that they are heavily represented in both the loan and NPL portfolios. These six sectors collectively account for 83.5% of total loans and 89.3% of total NPLs. Certain sectors hold a larger share of total NPLs than they do of all loan exposures, as real estate accounts for 39% of total loans but 42.1% of total NPLs, while manufacturing holds 12.5% of total loans but 14.9% of NPLs, making it more exposed to credit risk. The pattern is similar in wholesale and retail trade, which accounts for 11.5% of loans and 11.7% of NPLs.

The proportion of total NPLs held by other sectors is more equal to or smaller than their share of all loans. Transportation has 8.49% of loans but only 4.72% of total NPLs, suggesting loans to that sector perform better.[4]

This selection of sectors sharpens the focus onto the sectors that are most critical for understanding the dynamics of NPLs in Estonia's economy and for enhancing the supervision and monitoring of credit risk.

Figure 1 shows the dynamics of NPLs in Estonia by sector. NPL levels were overall relatively low before the GFC, averaging below 2% in most sectors. They surged dramatically during the GFC in 2008 and 2009, particularly in construction, where they peaked at nearly 30%, and in real estate and manufacturing, where they exceeded 10%. NPLs gradually declined across all sectors after the global financial crisis, and averaged around 1% in most sectors after 2021, reflecting a broad recovery and stabilising at low levels.[5] Sectors like agriculture remained relatively stable with NPLs at low levels both before and after the GFC, while the levels in construction

[3]For the sake of brevity, Agriculture, Forestry and Fishing is referred to as agriculture; Wholesale and Retail Trade, including the Repair of Motor Vehicles and Motorcycles is wholesale and retail trade; and Transportation and Storage is transportation.

[4]While some other sectors like Information and Communication Technology (ICT) are significant contributors to the Estonian economy in terms of value added, they rely very little on bank loans. Similarly, Electricity, Gas, Steam, and Air-Conditioning Supply represents 5.29% of total loans but contributes only 0.11% to total NPLs, indicating that there is minimal credit risk there. These sectors are consequently not included in the core analysis.

[5]In the raw data, some sectors recorded quarters with missing values for non-performing loans, as there were no non-performing loans during those periods. These missing values were replaced with 0% in the final dataset.

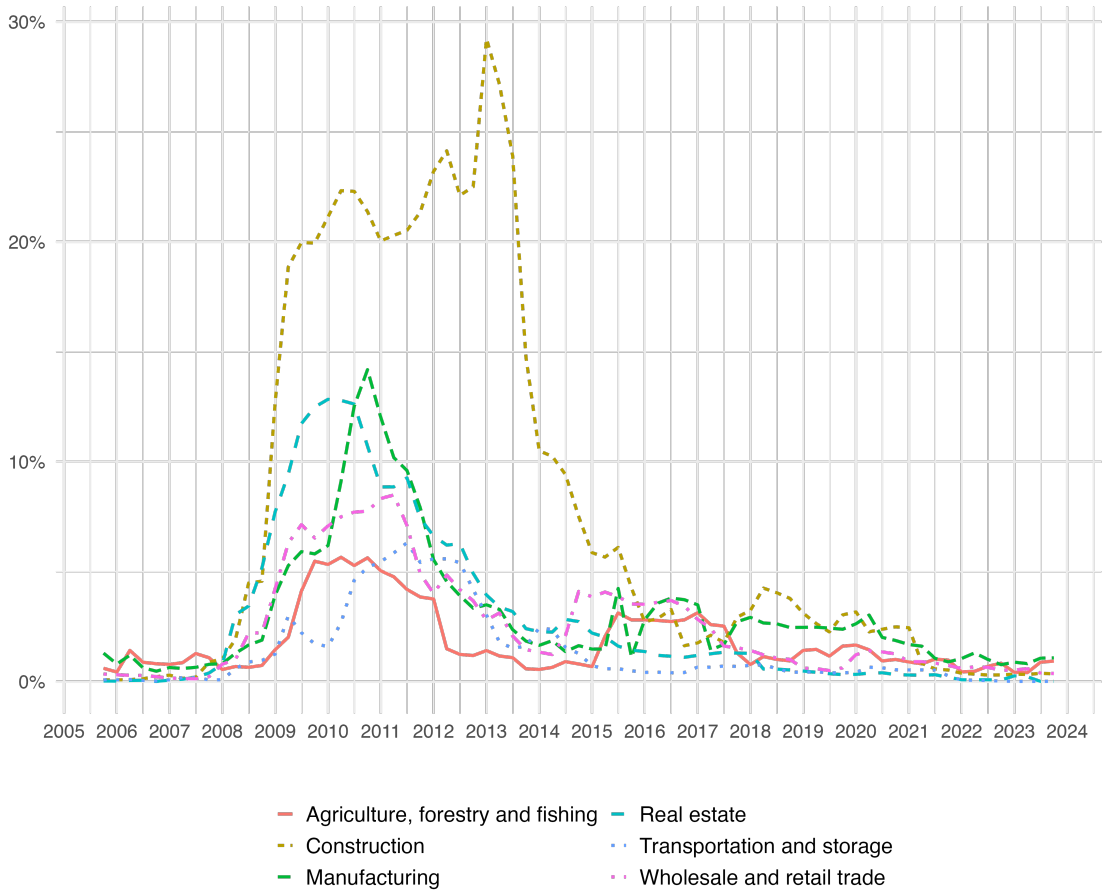

Figure 1: Ratio of non-performing loans to loan stock (%) by sector

and real estate were higher but declining.

The determinants of NPLs can broadly be categorised into two groups as macroeconomic factors and sector-specific factors. While some sector-specific variables are relevant across all sectors, others are more significant for only some sectors, with house prices particularly important for real estate for example. To analyse how interest rates affect NPLs, we first use the six-month Euribor. This represents the lower bound of interest rates that banks charge on loans and is a useful proxy for the cost of borrowing for firms as it allows for cross-sector comparison. The margins on interest rates can vary significantly from sector to sector, but Euribor provides a consistent baseline for comparison. Later in the analysis we replace Euribor with sector-specific interest rates from the Bank of Estonia. We capture the business cycle using real GDP growth and the unemployment rate as proxies.

Since our focus is on corporate debt, we also include the ratio of debt to gross operating surplus for non-financial corporations, as this shows debt relative to income generated.[6] We use the aggregate ratio of debt-to-gross operating surplus since there are no sector-specific data available on operating surplus.

We also examine the debt of non-financial corporations as a share of GDP, as this metric captures the overall leverage of the corporate sector. This ratio is widely used for evaluating the sustainability of corporate borrowing from a macroeconomic perspective. An increase in the debt-to-GDP ratio of non-financial corporations suggests a growing reliance on debt financing relative to the size of the economy, and that can indicate there may be systemic vulnerabilities, particularly if debt is growing faster than the economy. The sector-specific variables we use include the real growth of gross value added, the ratio of loans to gross value added in each sector, and the level of inflation in each sector as proxied by the growth rate of the GDP deflator for the sector. We also consider real profit growth within sectors and the ratio of profits to turnover in order to assess the financial health of the sector.

Finally we examine whether broader macroeconomic factors such as sentiment indicators, the nominal effective exchange rate, or transport volumes are significant determinants of non-performing loans. For export-oriented sectors like manufacturing, we also incorporate the share of exports in GDP as a possible explanatory variable. For construction and real estate we also include sector-specific variables

[6]The ratio of debt to gross operating surplus for non-financial corporations reflects how the sustainability of corporate debt changes over the business cycle. When the economy is expanding, gross operating surplus increases, making it easier to repay debt and lowering the ratio. Conversely in downturns, lower profits increase the ratio, signalling a reduction in debt-servicing capacity. This ratio is critical for assessing the sustainability of debt, as gross operating surplus is used for debt repayment.

such as house price growth and the cost of borrowing for house purchases. A comprehensive list of all the variables used in the analysis is given in Table C1 in the Appendix.

4 Baseline Results

The results section presents analysis of the determinants of NPLs at the aggregate and sector levels. We focus first on the macroeconomic factors that can explain aggregate non-performing corporate loans and then on the dynamics within separate sectors and the interplay between macroeconomic and sectoral variables.

4.1 Macroeconomic Determinants of Aggregate Corporate Non-performing Corporate Loans

We begin by examining the determinants of non-performing loans at the aggregate level for the non-financial corporate sector in Estonia (see Table 1). This gives us a benchmark for our sector-specific analysis and lets us assess whether the sectoral dynamics add any meaningful insights beyond the trends observed at the aggregate level. The measure of aggregate NPLs reflects the share of non-performing loans across all corporate sectors and is derived from publicly available data from the Bank of Estonia.

Specifications (1) to (7) in the regression table mirror the sector-specific regression models by focusing on the core business cycle variables and selected macroeconomic indicators that showed statistical significance in the various sectoral analyses. These specifications all examine the relationships between NPLs and factors like the unemployment rate, real GDP growth, inflation, and interest rates using variables that were shown to be important in the sector-level results.

Specification (8) excludes the dummy for the Global Financial Crisis so that the impact of the interest rate variable can be reassessed. The crisis period was marked not only by significant macroeconomic fluctuations in output and employment but also by central bank interventions that aimed to stabilise the economy. Central bank reference rates were cut during this period, but the perception of risk in corporate sectors led spreads to widen, and that may have amplified the impact of interest rates on non-performing loans.

The unemployment rate consistently shows positive and statistically significant coefficients in most of the specifications, and it probably acts as a business cycle indicator in the formation of NPLs. This finding is also in line with the sector-

Table 1: Aggregate Results for the Regression for Non-Financial Corporations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Intercept)	0.00*	−0.01**	−0.02**	−0.03***	0.01	0.00	−0.01**	0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)
NPLs aggr. NFCs (-1)	0.84***	0.85***	0.80***	0.77***	0.89***	0.84***	0.78***	0.92***
	(0.05)	(0.05)	(0.06)	(0.05)	(0.04)	(0.05)	(0.07)	(0.05)
GFC	0.01***	0.01***	0.01***	0.01**	0.01***	0.01***	0.01***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
rGDP growth (-1)	−0.02	−0.02	−0.02*	0.01	−0.02	0.00	0.00	−0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.02)	(0.02)
Inflation (-1)	0.00	−0.01	0.01	0.03**	0.01	−0.01	−0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemployment rate (-1)	0.10**	0.09**	0.11**	0.10***	0.08**	0.10**	0.15**	0.02
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.06)	(0.04)
Euribor 6M (-1)	0.01		−0.01	−0.02	−0.03	0.01	0.02	
	(0.03)		(0.02)	(0.02)	(0.04)	(0.03)	(0.04)	
Loan interest rate NFCs (-1)		0.03						0.16***
		(0.04)						(0.04)
NFC consol. debt & loans to GDP (-1)			0.02*					
			(0.01)					
Ratio debt to GOS (-1)				0.22***				
				(0.05)				
Export share in GDP (-1)					−0.02**			
					(0.01)			
Economic sentiment indicator (-1)						0.00		
						(0.00)		
Real house price growth (-1)							−0.01	
							(0.01)	
Num.Obs.	75	75	75	75	75	75	71	75
R^2 Adj.	0.98	0.98	0.98	0.99	0.98	0.98	0.98	0.98
BIC	−604.60	−605.10	−604.20	−619.80	−604.10	−601.30	−566.10	−591.60

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

specific results, suggesting that labour market conditions significantly impact NPL formation at both the aggregate and sectoral levels.

Real GDP growth is generally insignificant but becomes significant with a negative coefficient in specifications (3) and (8). The significance of real GDP growth in specification (8) is in line with some results that were observed in certain sector-specific robustness checks (see Table 4) that also exclude the GFC dummy.

These aggregate-level results provide the context for the sector-specific analysis that follows. While the aggregate data offer a broad perspective, they may obscure important differences between sectors, and so the next sections focus on selected individual sectors to explore how macroeconomic and sector-specific factors are transmitted to NPLs in distinct contexts.

4.2 Macroeconomic Determinants of Sector-Level NPLs

We follow the aggregate-level analysis presented in Table 1 by now focusing on the sector-specific results. We explore the heterogeneity across sectors by estimating a uniform specification using only the macroeconomic variables as regressors for each sector. The regression results are summarised in Table 2.

A common feature across all sectors is that NPLs are highly persistent, as evidenced by the lagged NPL coefficients being statistically significant in most cases. This suggests that past credit risk problems in a given sector tend to persist and show up as sectoral inertia in the dynamics of NPLs. NPLs proved most persistent in construction (sector F) and real estate (sector L), while they were least so in manufacturing (sector C).

The unemployment rate emerges from among the macroeconomic variables as a consistent explanatory variable of NPLs across multiple sectors, particularly in agriculture, construction, wholesale and retail trade, and transportation. NPLs in manufacturing for example increase by approximately 0.25 percentage point after a rise of one percentage point in the unemployment rate in the previous period. The unemployment rate probably serves as a key business cycle indicator for NPL determinants. One possible transmission channel is that higher unemployment reduces disposable income and so directly dampens consumer spending. This impacts sectors that are sensitive to demand, like wholesale and retail trade, transportation, and, indirectly, agriculture. Another possible transmission channel is that firms may preemptively reduce their workforce when faced with economic challenges. This may occur as firms attempt to cut costs in response to expected declines in profitability or heightened financial stress.

Real GDP growth and inflation have mixed effects by contrast, and have limited

Table 2: Regression Results for Non-Performing Loans across Sectors

	Sector A	Sector C	Sector F	Sector G	Sector H	Sector L
(Intercept)	0.00	−0.01	−0.02*	0.00	−0.01***	0.00
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
NPLs (-1)	0.81***	0.71***	0.91***	0.85***	0.82***	0.86***
	(0.06)	(0.09)	(0.08)	(0.07)	(0.06)	(0.06)
GFC	0.00	0.01*	0.02**	0.01**	0.00	0.02***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
rGDP growth (-1)	−0.02*	0.01	−0.01	−0.02	0.02	−0.03*
	(0.01)	(0.02)	(0.05)	(0.02)	(0.01)	(0.02)
Inflation (-1)	−0.02	0.01	0.03	−0.01	0.02*	−0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Unemployment rate (-1)	0.05*	0.25**	0.24	0.07**	0.12***	0.09
	(0.03)	(0.10)	(0.15)	(0.03)	(0.04)	(0.06)
Euribor 6M (-1)	−0.01	−0.06	0.05	0.00	−0.01	0.04
	(0.04)	(0.06)	(0.11)	(0.04)	(0.03)	(0.04)
Num. of Obs.	75	75	75	75	75	73
R^2 Adj.	0.90	0.91	0.96	0.95	0.95	0.99
BIC	−557.83	−463.87	−356.82	−535.90	−579.22	−547.95

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The NPLs (-1) variable represents lagged non-performing loans for each sector.

A - Agriculture, forestry, and fishing; C - Manufacturing; F - Construction; G - Wholesale and retail trade; H - Transportation and storage; L - Real estate activities.

statistical significance across sectors. The six-month Euribor rate, which serves as a proxy for broader financial conditions, is generally insignificant, suggesting that sectoral NPLs are more sensitive to local macroeconomic conditions than to changes in interest rates.

4.3 Results Using Macroeconomic and Sector-Specific Regressors

This section extends the analysis by incorporating both macroeconomic and sector-specific variables as regressors to capture the nuanced drivers of NPLs across individual sectors. We make it easier to compare across sectors by presenting the regression results for all six sectors in a single table. This highlights the macroeconomic drivers that the sectors have in common, and the individual dynamics of each sector, and so gives a comprehensive picture of the determinants of NPLs. The macroeconomic variables, which are common to all sectors, are listed first, followed by the sector-specific factors that account for differences between sectors in credit risk. Detailed sector-specific data for transportation, such as gross value added and inflation, are not available from Eurostat, and so the analysis for that sector relies more heavily on generalised macroeconomic measures, which may make it harder to capture the sectoral-specific dynamics in full for that sector. Similarly, gross value added for wholesale and retail trade is reported as an aggregate measure that includes contributions from other sectors like transportation and storage, and accommodation and food service. This aggregation may overestimate the true impact of gross value added on NPLs in wholesale and retail trade alone.

This consolidated presentation enables direct comparison of the magnitude and significance of drivers across sectors, providing deeper insights into both shared and sector-specific risks. Despite the noted limitations in sectoral data availability, the results emphasize the critical role of macroeconomic factors—particularly unemployment and the GFC dummy—in shaping credit risk across sectors, alongside the significant persistence of NPLs over time.

Table 3 shows that NPLs are persistent in all sectors, as the coefficients for the lagged NPLs remain highly significant. Furthermore, unemployment consistently emerges as a significant macroeconomic driver, while sector-specific factors like lending interest rates and the loans-to-gross value added ratio vary more in their impact across sectors.

The sector-specific regressions that incorporate both macroeconomic indicators and additional sector-specific variables allow us to explore how macroeconomic conditions and sectoral dynamics interact in shaping NPLs. It is important to note that

Table 3: Regression Results Across Sectors: Macro and Sector-Specific Factors

	Sector A	Sector C	Sector F	Sector G	Sector H	Sector L
(Intercept)	−0.01*	−0.01**	−0.02**	0.00	−0.01**	−0.01
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Macroeconomic Variables						
GFC	0.00	0.01	0.02	0.01	0.00	0.02***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Unemployment rate (-1)	0.07**	0.26**	0.12	0.08**	0.09*	0.13
	(0.03)	(0.11)	(0.12)	(0.04)	(0.05)	(0.09)
Sector-Specific Variables						
NPLs (-1)	0.82***	0.68***	0.90***	0.80***	0.82***	0.85***
	(0.06)	(0.10)	(0.08)	(0.08)	(0.06)	(0.12)
IR (-1)	0.04	−0.08	0.16	−0.10	0.03	0.02
	(0.05)	(0.07)	(0.12)	(0.07)	(0.04)	(0.08)
Loans to GVA (-1)	0.01	0.02	0.05	0.03**	–	0.00
	(0.00)	(0.03)	(0.04)	(0.01)	–	(0.01)
rGVA, growth (-1)	0.00	0.02	0.02	0.00	–	−0.01
	(0.00)	(0.02)	(0.01)	(0.01)	–	(0.01)
Inflation (-1)	0.00*	0.00	−0.01	−0.01	–	0.00
	(0.00)	(0.03)	(0.02)	(0.02)	–	(0.01)
Real profit, growth (-1)	0.00	−0.22	0.00	−0.72*	0.00	0.27
	(0.00)	(0.57)	(0.00)	(0.43)	(0.00)	(0.42)
Num. Obs.	75	75	75	75	75	73
R^2 Adj.	0.88	0.90	0.96	0.95	0.94	0.98
BIC	−547.10	−457.80	−352.00	−537.10	−583.90	−534.60

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A - Agriculture, forestry, and fishing; C - Manufacturing; F - Construction; G - Wholesale and retail trade; H - Transportation and storage; L - Real estate activities.

Macroeconomic variables are common across all sectors while sector-specific variables are unique to each sector.

which sector-specific variables are included varies across sectors, depending on their availability and relevance. The dynamics of house prices are particularly pertinent for real estate and construction for example, but less applicable to agriculture or manufacturing. To save space, the full results of these sector-specific regressions are provided in the Appendix.

Agriculture is a sector that has relatively low NPL levels, and we examine its sensitivity to macroeconomic and sector-specific factors. The regression results are summarised in Table A1 in the Appendix and reveal that real GDP growth and the unemployment rate are the key macroeconomic determinants of NPLs in this sector. In specification (1), lagged real GDP growth exhibits a negative and statistically significant relationship with NPLs, highlighting that economic contractions increase credit risk. The ratios of debt and loans to GDP do not appear to work as statistically significant proxies for NPLs in agriculture, but the debt-to-gross operating surplus ratio has a statistically significant positive relationship with NPLs in this sector.

The regression analysis for manufacturing focuses on macroeconomic determinants alongside the selected sector-specific factors that are most relevant for the sector. The results are presented in Table A2 in the Appendix and show that macroeconomic variables have a critical role in shaping NPLs, and also show the key sectoral dynamics. Lagged NPLs remain consistently significant, confirming that there is strong persistence in non-performing loans. The unemployment rate also emerges as a robust determinant with positive coefficients across several specifications, highlighting how sensitive the sector is to labour market conditions. Real GDP growth and inflation have only limited significance, but their occasional effects suggest they have some indirect influence on loan performance.

Sector-specific variables such as the share of exports in GDP and share of exports of goods in GDP are significant in specifications (5) and (6), indicating that strong performance by exports helps mitigate credit risks. By contrast, the financial conditions proxied by the Euribor rate are significant in some specifications but have an unexpected negative coefficient.

These findings suggest that while macroeconomic conditions are critical in shaping NPLs in manufacturing, sector-specific variables like export performance can provide additional explanatory power. Financial conditions appear less consistently influential, which underscores the importance of focusing on broader economic indicators. The regression results for construction are presented in Table A3. The autoregressive term for lagged NPLs remains highly significant across all the specifications with coefficients close to or above 0.9, indicating that NPLs are strongly persistent over time. The dummy variable for the Global Financial Crisis is also significant in most specifications.

The Euribor rate is generally statistically insignificant across specifications. The models also examine whether lagged non-performing loans in real estate influence NPLs in construction to give a simple, preliminary assessment of possible spillover effects. The coefficient for lagged NPLs in real estate is positive and significant in specification (4), suggesting that a higher level of NPLs in real estate is associated with an increase in NPLs in construction. This finding indicates there may be credit risk spillovers between these sectors, reflecting how interconnected they are in their economic exposure and financial vulnerability. The significance of the sector-specific variables is mixed. Real house price growth is significant in specification (5), indicating that falls in house prices are associated with a rise in NPLs in construction. Rising house prices often signal that the housing market is active, which can drive demand for construction services. Higher property values typically encourage development and expansion within the sector, bolstering demand for credit as companies invest in new projects. Conversely, falling prices dampen this demand and could cause a drop in cash flows and an increased risk of loan defaults as firms struggle to maintain profitability. At the same time, household debt-to-GDP, which could serve as a proxy for household leverage, is not statistically significant in explaining NPLs in construction.

The regression results for wholesale and retail trade presented in Table A4 show sector-specific financial variables to be more important than macroeconomic factors in explaining NPLs. The significance of broader economic indicators like real GDP growth and the unemployment rate is mixed, and sector-specific variables that relate to profitability emerge as the key determinants of credit risk.

The relationship between real GDP growth and NPLs is negative and significant in specification (1), suggesting that economic expansion reduces the probability of default. However, this effect diminishes in later specifications as more sector-specific factors are included. The unemployment rate maintains a positive and statistically significant relationship with NPLs in several specifications, indicating that worsening labour market conditions increase credit risk, though the coefficients are relatively small.

Table A4 shows that real profit growth is negatively associated with NPLs even when the dynamics of debt in the sector are controlled for. This finding is corroborated when alternative indicators of profitability are used, such as the profit-to-turnover ratio, which is statistically significant in specification (4). Similarly, the loans-to-gross value added ratio remains positively and statistically significantly related to NPLs. Interpreting this result requires caution, as the data on gross value added for wholesale and retail trade are aggregated with those for transportation and accommodation, which could inflate the apparent relationship.

The sector-specific borrowing cost, as represented by the interest rate on bank loans for the sector, remains insignificant across the specifications, indicating that changes in borrowing costs may have a limited direct impact on NPLs for this sector. The regression results presented in Table A5 show the macroeconomic variables and select sector-specific metrics that are the key determinants of NPLs in transportation. The lagged variable for NPLs is consistently positive and highly significant across all specifications, demonstrating that credit risk is strongly persistent within the sector.

The unemployment rate emerges from among the macroeconomic variables as a robust explanatory variable with positive and statistically significant coefficients across all specifications. This finding shows how sensitive transportation is to labour market conditions, as rising unemployment often signals economic stress and an increase in the risk of default.

Real GDP growth, however, has a positive coefficient in specification (2), suggesting there is a counterintuitive relationship where stronger economic growth correlates with an increase in NPLs. Similarly, inflation exhibits a weak positive association with NPLs in some specifications, though that relationship is not robust.

The sector-specific variables include transport-specific growth indicators like growth in rail and road transport and debt-related metrics, and they are generally statistically insignificant in this analysis. This suggests that the credit risk in transportation is driven more by macroeconomic factors than by sector-specific dynamics.

The regression results for real estate (L) are summarised in Table A6 and indicate that the dominant factor influencing credit risk is the persistence of NPLs. The lagged variable for NPLs is highly significant across all specifications with coefficients consistently above 0.80, which indicates strong inertia in the NPL dynamics within this sector.

The dummy variable for the Global Financial Crisis (GFC) is also statistically significant and positive in all specifications, illustrating how sensitive the sector was to the economic disruptions caused by the GFC. The bubble in Estonian real estate in the mid-2000s and its subsequent collapse during the crisis explain why credit risk was elevated in this period.

Real GDP growth is the macroeconomic variable that exhibits a negative and statistically significant relationship with NPLs in specifications (1), (4), (5) and (6), suggesting that economic growth can mitigate credit risk in real estate. However, the relationships with inflation and the unemployment rate are inconsistent and of limited statistical significance, indicating that their influence on NPLs in this sector may be secondary to that of other factors.

Sector-specific variables such as the cost of borrowing for house purchases, household debt-to-GDP, and household borrowing costs do not consistently achieve sta-

tistical significance across the different specifications for real estate. This suggests that although these factors are theoretically relevant for the dynamics of real estate, their influence on NPL outcomes appears to be limited in the Estonian context. This contrasts with the results for construction, which showed much more sensitivity to growth in real house prices. Furthermore, the lagged NPLs from construction did not significantly influence NPLs in real estate, but the opposite relationship can be seen to apply in the results for construction, as lagged NPLs in real estate significantly impact NPLs in construction. This asymmetry highlights distinct sectoral interdependencies and indicates that real estate may take the leading role in driving credit risk dynamics.

We can now compare the aggregate regression results in Table 1 with the sector-specific outcomes in Table 2. One commonality between the aggregate and sectoral analyses is the persistence of the NPLs as evidenced by the statistically significant lagged coefficients for them. This persistence is particularly pronounced in real estate and construction, where structural rigidities and the dynamics of long-term credit risk probably play a more substantial role. The heightened persistence in real estate and construction could equally be linked to the propensity for speculative bubbles to form more easily in these markets. When such bubbles burst, the resulting economic fallout and asset price corrections may cause the dynamics of NPLs to be more persistent than those in other sectors. The persistence parameter is slightly lower at the aggregate level, which may reflect the averaging effect of heterogeneous sectoral trends, and this highlights how important it is to monitor credit conditions and speculative behaviour in these sectors.

The unemployment rate consistently emerges as a significant determinant of NPLs in both the aggregate and sectoral models. This result underscores the important role played by the labour market in shaping credit risk. The impact of the unemployment rate is particularly pronounced in agriculture, wholesale and retail trade, and transportation. Similarly, real GDP growth is negatively associated with NPLs in both types of model, but its effects are more nuanced at the sectoral level. While it is statistically significant in the aggregate regressions, its impact is less consistent in individual sectors, indicating that the relationship between macroeconomic growth and credit risk is mediated by sector-specific characteristics.

The results are mixed for the Euribor rate and loan interest rates, as they are occasionally significant in both the aggregate and sectoral models. It is notable that the direction of their influence sometimes deviates from standard expectations, particularly in the aggregate models, where Euribor has a negative coefficient when it is significant.

The theoretical frameworks often suggest that higher interest rates increase debt-

servicing burdens and thereby raise NPL levels, but we find limited evidence for interest rates having a statistically significant and robust impact on NPLs. These inconsistencies may arise because financial conditions affect credit risk through different channels in different sectors, and they reflect ambiguities in the broader empirical literature on this topic. In this context, our results are in line with the mixed findings documented in previous studies, and highlight how complex this relationship is.[7]

These conflicting findings illuminate the complexity of the transmission mechanisms linking interest rates to loan performance. The interest rate rises made by the European Central Bank (ECB) in July 2022 provide additional context for Estonia. The financial resilience that firms built before the rate rises, coupled with their ability to adjust prices and sustain their profitability, appears to have cushioned the impact of higher debt servicing costs during the recession that began in the second quarter of 2022 (Eesti Pank 2024). This ability to adapt to inflationary pressures may explain why our analysis finds limited statistical significance for the effect of interest rates on NPLs among corporate loans. Alternatively, the effect of interest rates might be more pronounced for specific loan types such as consumer or mortgage loans than for the corporate loans examined here. It is also possible that these effects appear with longer lags than those captured in our model specifications, as we will discuss in Section 5.

5 Robustness

Two key methodological choices were made for the baseline specification of the model, as a short lag structure was chosen, and a dummy variable for the Global Financial Crisis (GFC) was included to capture the significant and unique impact of the crisis of 2007–2008 on non-performing loans (NPLs) across sectors. These choices are critical for isolating the short-term dynamics and accounting for macroeconomic shocks that might otherwise distort the relationships between NPLs and the explanatory variables. To test the robustness of our findings, we explore two alternative approaches to modelling. We first examine the effects of extending the lag structure of explanatory variables to assess whether longer-term dynamics alter the results.

[7]The literature provides divergent perspectives on the link between interest rates and NPLs. Studies such as Beck et al. (2015), Messai and Jouini (2013), and Jiménez and Saurina (2018) for instance report a positive relationship, suggesting that rising borrowing costs increase the probability of default by swelling repayment burdens. Conversely, other works including Louzis et al. (2012), Nkusu (2011), and Us (2017) identify a negative relationship that might reflect selection effects or the association of higher interest rates with tighter lending standards that reduce credit risks.

Second, we estimate models without the GFC dummy to evaluate whether our main conclusions remain valid when this crisis-specific adjustment is omitted.

5.1 Alternative Lag Structures

To assess the impact of alternative lag structures, we estimated two additional models, one with only the fourth lag and another with only the eighth lag, as in Staehr and Uusküla (2021).[8] The results presented in Tables B1 and B2 in the Appendix reveal distinct dynamics at different horizons, and unsurprisingly the coefficient of the lagged dependent variable diminishes as the lag length increases. The lagged NPL coefficient for many sectors is close to one in the baseline specification but it falls to around 0.5 in real estate when the eighth lag is used. This reduction reflects the declining influence of past NPL levels over longer horizons.

As the contribution of the lagged NPLs diminishes, the estimated coefficients of the macroeconomic variables tend to increase in both magnitude and significance. At shorter horizons, the macroeconomic variables of real GDP growth and the Euribor rate often exhibit small or statistically insignificant coefficients, as the lagged NPL variable dominates the explanatory power. However, these variables become both statistically significant and economically meaningful at longer horizons, albeit the effects vary across sectors. Construction and real estate show a stronger dependence on the interest rate environment when the eighth lag is included for instance, suggesting that those sectors are particularly sensitive to prolonged changes in financial conditions.

Staehr and Uusküla (2021) employ a fixed-effects model to analyse total NPLs across multiple countries using a slightly different set of macroeconomic variables, but our findings are comparable in their dynamic patterns. The sizes of the effects of macroeconomic variables in our model notably align at the eighth lag with those reported in their study. However, a key difference lies in the model fit, because the Bayesian Information Criterion indicates that our baseline specification using only the first lag gives a better-fitting model. Moreover, while the eight-lag structure in Staehr and Uusküla (2021) is suitable for their objective, it introduces potential econometric challenges such as residual autocorrelation, as their specification relies solely on the eighth lag of the dependent and explanatory variables. Our shorter lag structure in contrast mitigates these issues by focusing on the immediate dynamics,

[8]The longer lag structure employed by Staehr and Uusküla (2021) fits with their emphasis on prediction and early warning systems, which are critical tools for macroprudential policymaking. By employing an eight-lag specification, their approach lets them identify which indicators are significant over a two-year horizon, giving policymakers ample time to respond proactively.

Table 4: Regression Results for Non-Performing Loans across Sectors; Excluding GFC Dummy

	Sector A	Sector C	Sector F	Sector G	Sector H	Sector L
(Intercept)	0.00	−0.01	−0.01	0.00	−0.01***	0.01
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
NPLs (-1)	0.82***	0.73***	0.92***	0.89***	0.83***	0.98***
	(0.06)	(0.08)	(0.08)	(0.07)	(0.06)	(0.07)
rGDP growth (-1)	−0.03**	−0.02	−0.08	−0.04**	0.01	−0.08***
	(0.01)	(0.02)	(0.06)	(0.02)	(0.02)	(0.02)
Inflation (-1)	−0.02*	0.00	0.01	−0.02	0.01	−0.02*
	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)
Unemployment rate (-1)	0.05*	0.23**	0.19	0.04	0.11***	−0.06
	(0.03)	(0.10)	(0.15)	(0.03)	(0.04)	(0.07)
Euribor 6M (-1)	0.02	0.01	0.27**	0.08**	0.03	0.16***
	(0.03)	(0.05)	(0.12)	(0.04)	(0.02)	(0.05)
Num. of Observations	75	75	75	75	75	73
R2 Adj.	0.90	0.91	0.96	0.94	0.95	0.98
BIC	−560.78	−466.47	−356.44	−535.37	−581.47	−529.62

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Sectors: A - Agriculture, forestry, and fishing; C - Manufacturing; F - Construction; G - Wholesale and Retail Trade; H - Transportation and Storage; L - Real Estate.

reducing omitted variable bias, and ensuring robustness in capturing the interplay between NPLs and the key macroeconomic factors.

5.2 Impact of Removing the GFC Dummy

Excluding the GFC dummy lets us assess the broader macroeconomic dynamics that have influenced the economy after the GFC. There have been several other significant economic shocks since 2008, including the Covid-19 pandemic and the subsequent inflationary surge, which was partly driven by geopolitical events such as the Russian invasion of Ukraine. These shocks may have affected macroeconomic stability in different ways to the GFC, providing a more up-to-date understanding of credit risk.

A comparison of the regression results for construction with and without the GFC dummy (see Table 4) highlights several important differences. Excluding the Global

Financial Crisis dummy from the model significantly alters the dynamics of NPLs, particularly in construction and real estate, which were the sectors most affected by the GFC. The negative impact of real GDP growth on NPLs becomes stronger in real estate, suggesting that macroeconomic fluctuations have a more pronounced effect on NPLs in real estate when the GFC is not explicitly controlled for.

Excluding the GFC dummy affects the macroeconomic variables by giving a stronger role to the six-month Euribor rate, which becomes significant at the 5% level in several specifications without the GFC dummy. This indicates that interest rates influence NPLs more in the construction sector when the specific effects of the GFC are not controlled for. Similarly, real GDP growth and inflation show marginal increases in their coefficients without the GFC dummy, though these effects remain generally weak or insignificant.

Excluding the GFC dummy makes the sector-specific interest rate particularly important among sector-specific factors, as it becomes significant in the model without the GFC dummy. This indicates that sector-level borrowing costs have a stronger impact on NPLs when GFC-type shocks are not controlled for. The loan-to-gross value added ratio in construction also becomes significant without the GFC dummy, suggesting there is greater sensitivity to the dynamics of debt at the sector level.

Excluding the GFC dummy leads to notable shifts in the significance of key variables in construction. The six-month Euribor rate, which was previously insignificant, now has a substantial positive effect on NPLs. A rise of 25 basis points in the Euribor rate would lead to an increase of 0.068 percentage point in NPLs in construction.

The robustness test results for real estate, which are presented in Table B4, similarly indicate some shifts in the significance of variables and the magnitude of coefficients from the baseline model. Excluding the GFC dummy also enhances the significance of the six-month Euribor rate in several specifications including (1), (2), (4) and (5). Real GDP growth consistently shows a significant negative relationship with NPLs in this robustness check across multiple specifications, suggesting that economic growth effectively mitigates credit risk in the real estate sector when the crisis period is excluded.

6 Conclusion

This paper investigates the determinants of non-performing loans across six key sectors in Estonia using a dynamic linear regression model. The analysis focuses on the impact of both macroeconomic factors and sector-specific financial variables on NPLs. The empirical methodology uses quarterly data from 2005 to 2023 and

time-series regressions for each sector to estimate the relationship between NPLs and a range of economic indicators.

The findings show that NPLs are highly persistent across all sectors, with past loan performance exerting a lasting impact on future credit risk. This persistence highlights the strong path dependency in the dynamics of NPLs, where historical credit risk conditions continue to shape later outcomes. The Global Financial Crisis led to a rapid rise in NPLs, exposing structural imbalances in sectors that are particularly vulnerable to macroeconomic shocks. Macroeconomic business cycle indicators, particularly the unemployment rate, were found to play a critical role in affecting NPL levels. The consistent relationship between unemployment and NPLs underscores the pivotal importance of labour market conditions in determining credit risk, as employment directly affects the capacity of businesses and households to repay their loans.

Certain macroeconomic factors with sector-specific relevance, such as house prices and the share of exports in GDP, exhibit statistical significance in explaining NPLs in specific sectors. House prices are particularly significant in the construction sector for instance, while the share of exports in GDP is important in sectors that are heavily reliant on international trade, such as manufacturing. This suggests that while these variables may not be universally useful as indicators for tracking aggregate NPLs, they offer valuable insights for specific sectors like construction or manufacturing.

Future research could therefore explore several directions. First, updating this study with data from 2024 would illuminate any delayed effects there may be on NPLs from the period of high interest rates, particularly by showing whether the financial buffers of businesses were exhausted before the ECB started easing its monetary policy. Second, a comparative analysis of NPL dynamics across other small, open economies would help determine whether Estonia's patterns reflect broader regional trends. More granular sector-specific financial data and loan characteristics would also give us a deeper understanding of how internal financial dynamics interact with macroeconomic shocks.

Finally, while our econometric framework primarily captures conditional correlations, the approach may leave some questions about the underlying dynamics of NPL formation and the mechanisms driving the observed relationships unanswered. We find for instance that business cycle variables such as the unemployment rate or the debt-to-gross operating surplus ratio correlate with NPLs, but we cannot definitively conclude whether these factors directly cause changes in NPLs or whether they are influenced by other unobserved variables. More advanced econometric techniques could let us disentangle these relationships, and they could provide insight into possible spillover effects across sectors, particularly by capturing the indirect effects of

shocks within one sector on NPL formation in others, as these are only partially observed in our current analysis.

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Appendix

A Detailed Sector-Level Regression Results

Table A1: Agriculture (A) Sector Regression Results

	(1)	(2)
(Intercept)	0.00	−0.02*
	(0.01)	(0.01)
NPLs A (-1)	0.80***	0.75***
	(0.07)	(0.08)
GFC	0.00	0.00
	(0.00)	(0.00)
rGDP, growth (-1)	−0.03*	0.00
	(0.01)	(0.02)
Inflation (-1)	−0.02	0.00
	(0.01)	(0.02)
Unemployment rate (-1)	0.04	0.03
	(0.03)	(0.03)
Euribor 6M (-1)	−0.02	−0.03
	(0.04)	(0.04)
NFC consol. debt & loans to GDP (-1)	0.01	
	(0.01)	
Ratio debt to GOS (-1)		0.18*
		(0.09)
Num. Obs.	75	75
R^2 Adj.	0.89	0.90
BIC	−554.10	−559.80

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Manufacturing (C) Sector Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	−0.03*	−0.05***	−0.01*	−0.04	0.02	0.02
	(0.01)	(0.02)	(0.01)	(0.06)	(0.01)	(0.01)
NPLs C (-1)	0.70***	0.69***	0.69***	0.71***	0.75***	0.77***
	(0.09)	(0.08)	(0.09)	(0.09)	(0.08)	(0.09)
GFC	0.00	0.00	0.01**	0.01	0.00	0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)
rGDP growth (-1)	0.00	0.06**	0.04	0.02	0.01	0.01
	(0.02)	(0.03)	(0.06)	(0.04)	(0.03)	(0.03)
Inflation (-1)	0.02	0.06**	0.01	0.00	0.05	0.04
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)
Unemployment rate (-1)	0.22**	0.16*	0.27**	0.26**	0.25***	0.24**
	(0.10)	(0.09)	(0.10)	(0.11)	(0.09)	(0.09)
Euribor 6M (-1)	−0.08	−0.09*	−0.08	−0.05	−0.16**	−0.17**
	(0.06)	(0.05)	(0.07)	(0.07)	(0.08)	(0.07)
NFC consol. debt & loans to GDP (-1)	0.02					
	(0.02)					
Ratio debt to GOS (-1)		0.43***				
		(0.15)				
Industrial confidence indicator (-1)			0.00			
			(0.00)			
NEER (-1)				0.00		
				(0.00)		
Export share in GDP (-1)					−0.04**	
					(0.02)	
Export share goods in GDP (-1)						−0.06**
						(0.02)
Num. Obs.	75	75	75	75	75	75
R^2 Adj.	0.90	0.92	0.90	0.90	0.91	0.91
BIC	−461.10	−472.40	−460.30	−459.80	−464.70	−466.30

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Construction (F) Sector Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	−0.01	−0.03	−0.02*	0.01	−0.01	−0.03
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
NPLs F (-1)	0.91***	0.90***	0.91***	0.85***	0.89***	0.90***
	(0.08)	(0.08)	(0.08)	(0.10)	(0.08)	(0.08)
GFC	0.02**	0.02*	0.02**	0.01	0.01	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
rGDP growth (-1)	0.00	0.01	−0.03	−0.02	0.07	0.00
	(0.05)	(0.05)	(0.10)	(0.05)	(0.07)	(0.05)
Inflation (-1)	0.02	0.04	0.02	0.02	0.01	0.03
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Unemployment rate (-1)	0.25	0.21	0.25	−0.22	0.24	0.19
	(0.15)	(0.14)	(0.15)	(0.13)	(0.16)	(0.12)
Euribor 6M (-1)	0.05	0.04	0.04	0.08	0.18	0.03
	(0.10)	(0.10)	(0.12)	(0.09)	(0.11)	(0.10)
NFC consol. debt & loans to GDP (-1)	−0.01					
	(0.03)					
Ratio debt to GOS (-1)		0.13				
		(0.19)				
Construction confidence indicator (-1)			0.00			
			(0.00)			
NPLs Real Estate (L) sector (-1)				0.54**		
				(0.24)		
Real house price growth (-1)					−0.05**	
					(0.02)	
HH debt to GDP (-1)						0.05
						(0.04)
Num. Obs.	75	75	75	73	71	75
R^2 Adj.	0.96	0.96	0.96	0.96	0.96	0.96
BIC	−352.50	−352.80	−352.60	−346.20	−332.30	−353.40

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Wholesale and Retail Trade (G) Sector Regression Results

	(1)	(2)	(3)	(4)
(Intercept)	−0.02**	−0.03***	0.00	0.01
	(0.01)	(0.01)	(0.00)	(0.00)
NPLs G (-1)	0.77***	0.74***	0.86***	0.77***
	(0.09)	(0.08)	(0.06)	(0.09)
GFC	0.01	0.00	0.01**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
rGDP growth (-1)	−0.03*	0.02	−0.03	
	(0.02)	(0.02)	(0.03)	
Inflation (-1)	0.01	0.03**	0.00	
	(0.01)	(0.01)	(0.02)	
Unemployment rate (-1)	0.06*	0.06**	0.08**	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
Euribor 6M (-1)	−0.05	−0.05	−0.01	
	(0.04)	(0.04)	(0.04)	
NFC consol. debt & loans to GDP (-1)	0.04*			
	(0.02)			
Ratio debt to GOS (-1)		0.32***		
		(0.10)		
Consumer confidence indicator (-1)			0.00	
			(0.00)	
Sector G bank loan interest rate (-1)				−0.07
				(0.08)
Sector G rGVA, growth (-1)				0.00
				(0.01)
Sector G inflation (-1)				−0.01
				(0.02)
Sector G loans to Sector GVA (-1)				0.04**
				(0.02)
Sector G profit to turnover (-1)				−0.26***
				(0.09)
Num.Obs.	75	75	75	75
R^2 Adj.	0.95	0.95	0.94	0.95
BIC	−538.90	−546.70	−532.30	−541.90

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Transportation (H) Sector Regression Results

	(1)	(2)	(3)	(4)
(Intercept)	−0.01*	−0.02**	−0.01***	−0.01***
	(0.01)	(0.01)	(0.00)	(0.00)
NPLs H (-1)	0.82***	0.83***	0.82***	0.82***
	(0.06)	(0.06)	(0.06)	(0.06)
GFC	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.01)
rGDP growth (-1)	0.02	0.03*	0.02	0.01
	(0.01)	(0.02)	(0.02)	(0.02)
Inflation (-1)	0.02	0.03*	0.01*	0.02
	(0.01)	(0.01)	(0.01)	(0.03)
Unemployment rate (-1)	0.11***	0.09**	0.12***	0.12***
	(0.04)	(0.03)	(0.04)	(0.04)
Euribor 6M (-1)	−0.01	−0.01	−0.01	0.00
	(0.03)	(0.03)	(0.03)	(0.04)
NFC consol. debt & loans to GDP (-1)	0.01			
	(0.01)			
Ratio debt to GOS (-1)		0.09		
		(0.06)		
Rail transport of goods, growth (-1)			0.00	
			(0.00)	
Street transport of goods, growth (-1)				0.00
				(0.00)
Num.Obs.	75	75	75	70
R2 Adj.	0.94	0.94	0.94	0.94
BIC	−575.30	−577.60	−574.90	−530.50

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Real Estate (L) Sector Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	−0.02*	−0.03***	0.00	0.00	−0.01	−0.02**
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
NPLs L (-1)	0.81***	0.77***	0.86***	0.90***	0.82***	0.78***
	(0.08)	(0.07)	(0.07)	(0.08)	(0.09)	(0.08)
GFC	0.02***	0.01***	0.02***	0.02***	0.02***	0.01***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
rGDP growth (-1)	−0.04*	−0.01	−0.03	−0.03*	−0.02	−0.03*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Inflation (-1)	0.00	0.02**	−0.01	−0.01	−0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemployment rate (-1)	0.10	0.12**	0.09	0.08	0.12	0.11
	(0.06)	(0.06)	(0.07)	(0.06)	(0.09)	(0.07)
Euribor 6M (-1)	0.02	0.01	0.04	0.03	0.05	0.01
	(0.04)	(0.03)	(0.17)	(0.04)	(0.06)	(0.04)
NFC consol. debt & loans to GDP (-1)	0.02					
	(0.01)					
Ratio debt to GOS (-1)		0.24***				
		(0.08)				
Cost of borrowing for house purchases (-1)			0.00			
			(0.26)			
NPLs F (-1)				−0.02		
				(0.01)		
Real house price growth (-1)					−0.01	
					(0.01)	
HH debt to GDP (-1)						0.05**
						(0.02)
Num. Obs.	73	73	73	73	71	73
R^2 Adj.	0.99	0.99	0.98	0.99	0.98	0.99
BIC	−545.90	−552.90	−543.70	−545.80	−527.00	−547.70

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B Additional Regression Tables

Table B1: Regression Results for Non-Performing Loans across Sectors (4 Lags)

	Sector A	Sector C	Sector F	Sector G	Sector H	Sector L
(Intercept)	0.01**	−0.01	−0.04**	0.00	−0.02***	0.02***
	(0.00)	(0.01)	(0.02)	(0.01)	(0.00)	(0.01)
NPLs (-4)	0.34***	0.20	0.63***	0.48***	0.30***	0.90***
	(0.12)	(0.13)	(0.17)	(0.12)	(0.10)	(0.11)
rGDP growth (-4)	−0.13***	−0.17***	−0.20**	−0.14***	0.01	−0.22***
	(0.02)	(0.03)	(0.09)	(0.03)	(0.02)	(0.04)
Inflation (-4)	−0.06***	−0.06**	0.13	−0.05**	0.02	−0.02
	(0.02)	(0.03)	(0.12)	(0.02)	(0.01)	(0.04)
Unemployment rate (-4)	0.08	0.50***	0.74*	0.17*	0.41***	−0.28**
	(0.05)	(0.16)	(0.37)	(0.10)	(0.04)	(0.13)
Euribor 6M (-4)	0.21**	−0.07	0.83**	0.15	−0.10	0.56***
	(0.08)	(0.16)	(0.37)	(0.11)	(0.08)	(0.16)
Num.Obs.	72.00	72.00	72.00	72.00	72.00	70.00
R^2 Adj.	0.65	0.76	0.81	0.81	0.84	0.93
BIC	−451.40	−378.00	−234.60	−426.10	−483.30	−422.70

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B2: Regression Results for Non-Performing Loans across Sectors (8 Lags)

	Sector A	Sector C	Sector F	Sector G	Sector H	Sector L
(Intercept)	0.02***	0.03***	−0.06***	0.02***	−0.02***	0.03***
	(0.00)	(0.01)	(0.02)	(0.01)	(0.00)	(0.01)
NPLs (-8)	0.03	0.10	0.40*	0.33***	−0.05	0.58***
	(0.12)	(0.10)	(0.21)	(0.12)	(0.07)	(0.18)
rGDP growth (-8)	−0.15***	−0.34***	−0.23*	−0.23***	−0.14***	−0.23***
	(0.02)	(0.04)	(0.13)	(0.03)	(0.02)	(0.04)
Inflation (-8)	0.02	0.14	0.71**	0.14*	0.15***	0.17**
	(0.07)	(0.10)	(0.32)	(0.08)	(0.05)	(0.08)
Unemployment rate (-8)	−0.07	−0.03	0.95***	−0.08	0.37***	−0.41**
	(0.06)	(0.10)	(0.35)	(0.09)	(0.05)	(0.18)
Euribor 6M (-8)	0.56***	0.90***	1.32*	0.65***	0.17	1.40***
	(0.11)	(0.24)	(0.68)	(0.17)	(0.13)	(0.21)
Num.Obs.	68	68	68	68	68	66.00
R^2 Adj.	0.66	0.77	0.81	0.74	0.83	0.89
BIC	−424.00	−357.50	−221.00	−379.80	−447.20	−362.70

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B3: Construction (F) Sector Regression Results; Excluding GFC Dummy

	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	−0.03	−0.04*	−0.01	0.02**	−0.01	−0.04*
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
NPLs F (-1)	0.90***	0.91***	0.92***	0.85***	0.89***	0.90***
	(0.08)	(0.08)	(0.08)	(0.10)	(0.08)	(0.08)
rGDP growth (-1)	−0.08	−0.02	−0.09	−0.05	0.06	−0.06
	(0.05)	(0.05)	(0.09)	(0.05)	(0.07)	(0.06)
Inflation (-1)	0.03	0.06*	0.01	0.01	−0.01	0.02
	(0.03)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)
Unemployment rate (-1)	0.18	0.14	0.19	−0.31**	0.20	0.12
	(0.14)	(0.13)	(0.14)	(0.13)	(0.15)	(0.12)
Euribor 6M (-1)	0.21*	0.16	0.27**	0.15	0.31**	0.17
	(0.12)	(0.12)	(0.13)	(0.10)	(0.13)	(0.12)
NFC consol. debt & loans to GDP (-1)	0.03					
	(0.04)					
Ratio debt to GOS (-1)		0.34*				
		(0.21)				
Construction confidence indicator (-1)			0.00			
			(0.00)			
NPLs L (-1)				0.62**		
				(0.24)		
Real house price growth (-1)					−0.07***	
					(0.02)	
HH debt to GDP (-1)						0.09*
						(0.05)
Num.Obs.	75	75	75	73	71	75
R^2 Adj.	0.95	0.95	0.95	0.96	0.96	0.96
BIC	−352.60	−354.50	−352.10	−349.90	−335.30	−355.00

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B4: Real Estate (L) Sector Regression Results; Excluding GFC Dummy

	(1)	(2)	(3)	(4)	(5)	(6)
(Intercept)	−0.02	−0.03***	0.01	0.01*	0.00	−0.02*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
NPLs L (-1)	0.90***	0.82***	0.99***	1.04***	0.93***	0.84***
	(0.07)	(0.07)	(0.08)	(0.08)	(0.12)	(0.08)
rGDP growth (-1)	−0.08***	−0.02	−0.08***	−0.08***	−0.05*	−0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Inflation (-1)	0.00	0.03**	−0.02*	−0.02*	−0.02*	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemployment rate (-1)	−0.02	0.03	−0.07	−0.07	−0.02	−0.01
	(0.06)	(0.06)	(0.08)	(0.07)	(0.12)	(0.07)
Euribor 6M (-1)	0.12**	0.08*	0.27	0.14***	0.18***	0.09
	(0.05)	(0.04)	(0.22)	(0.05)	(0.06)	(0.06)
NFC consol. debt & loans to GDP (-1)	0.03*					
	(0.02)					
Ratio debt to GOS (-1)		0.34***				
		(0.08)				
Cost of borrowing for house purchases (-1)			−0.16			
			(0.33)			
NPLs F (-1)				−0.03**		
				(0.01)		
Real house price growth (-1)					−0.02	
					(0.01)	
HH debt to GDP (-1)						0.07**
						(0.03)
Num.Obs.	73	73	73	73	71	73
R^2 Adj.	0.98	0.98	0.98	0.98	0.98	0.98
BIC	−530.20	−543.40	−525.70	−529.10	−512.30	−534.00

Robust standard errors in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

C Additional Data

Table C1: Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
NPLs A (%)	73	1.80	1.48	0.41	5.66
NPLs C (%)	73	3.08	2.94	0.48	14.19
NPLs F (%)	73	7.73	8.93	0.08	29.23
NPLs G (%)	73	2.53	2.38	0.13	8.49
NPLs H (%)	73	1.38	1.77	0.01	6.32
NPLs L (%)	73	2.88	3.78	0.01	12.84
Loan interest rate A (%)	73	4.19	1.45	2.15	7.33
Loan interest rate C (%)	73	3.85	1.41	2.17	6.70
Loan interest rate F (%)	73	4.94	1.22	2.95	8.64
Loan interest rate G (%)	73	4.30	1.39	2.21	6.92
Loan interest rate H (%)	73	3.94	1.61	1.65	8.73
Loan interest rate L (%)	73	3.98	1.40	2.10	7.61
real GDP, growth (%)	73	2.13	5.94	−18.60	12.45
Inflation rate (%)	73	4.48	5.08	−2.04	24.14
Unemployment rate (%)	73	7.67	3.35	4.03	18.30
Euribor 6M (%)	73	1.16	1.71	−0.54	5.18
NFC consol. debt and loans to GDP (%)	73	70.97	9.44	54.95	91.35
Household debt to GDP (%)	73	41.83	6.04	32.00	57.52
Real house price growth (%)	72	3.72	15.14	−40.98	45.09
Construction confidence indicator (index)	73	−5.53	24.47	−71.13	44.80
Consumer confidence indicator (index)	73	−9.92	11.16	−37.87	11.67
Economic sentiment indicator (index)	73	98.42	10.38	68.73	119.43
Industrial confidence indicator (index)	73	−0.22	12.70	−32.50	24.93
Financial constraints indicator (index)	73	3.63	1.96	0.00	8.80
NFC Loan average agreed bank loan interest rate (%)	73	3.45	1.35	2.25	6.62
Cost of borrowing for house purchases (%)	73	3.32	1.21	2.09	6.25
NFC Ratio debt to gross operating surplus (%)	72	10.03	1.96	7.26	16.00
NEER (index)	73	102.09	3.20	97.03	109.53
Export share in GDP (%)	73	74.77	8.36	58.70	88.20
Export share goods in GDP (%)	73	49.68	6.78	35.80	63.50
Rail transport of goods, growth (%)	73	−11.11	21.53	−46.92	63.56
Street transport of goods, growth (%)	67	−0.29	14.76	−37.42	42.42
Sector A loans to Sector GVA (%)	73	66.49	23.98	32.05	112.61

Continued on next page

Variable	Obs	Mean	Std. Dev	Min	Max
Sector C loans to Sector GVA (%)	73	29.14	6.94	18.07	48.63
Sector F loans to Sector GVA (%)	73	18.21	9.80	7.66	43.36
Sector G loans to Sector GVA (%)	73	19.36	6.33	11.84	31.83
Sector L loans to Sector GVA (%)	73	139.87	35.64	96.15	213.35
Sector A real GVA, growth (%)	73	0.30	22.98	−52.56	71.68
Sector C real GVA, growth (%)	73	3.05	11.06	−29.16	37.19
Sector F real GVA, growth (%)	73	3.56	15.48	−43.67	49.26
Sector G real GVA, growth (%)	73	1.26	9.40	−27.19	19.79
Sector L real GVA, growth (%)	73	3.33	6.96	−8.42	24.19
Sector A inflation (%)	73	10.11	34.39	−48.68	153.40
Sector C inflation (%)	73	3.53	5.04	−5.74	19.55
Sector F inflation (%)	73	3.80	10.91	−26.94	31.62
Sector G inflation (%)	73	5.00	4.42	−4.37	16.31
Sector L inflation (%)	73	4.91	8.30	−11.19	31.78
Loan interest rate NFCs	73	3.84	1.38	2.22	6.76
Sector A bank loan interest rate (%)	73	4.19	1.45	2.15	7.33
Sector C bank loan interest rate (%)	73	3.85	1.41	2.17	6.70
Sector D bank loan interest rate (%)	73	3.53	1.31	0.87	8.47
Sector F bank loan interest rate (%)	73	4.94	1.22	2.95	8.64
Sector G bank loan interest rate (%)	73	4.30	1.39	2.21	6.92
Sector H bank loan interest rate (%)	73	3.94	1.61	1.65	8.73
Sector L bank loan interest rate (%)	73	3.98	1.40	2.10	7.61
Sector A profit to turnover (%)	73	2.07	5.50	−14.06	15.02
Sector C profit to turnover (%)	73	5.77	2.09	1.26	9.80
Sector F profit to turnover (%)	73	4.53	3.63	−2.47	12.77
Sector G profit to turnover (%)	73	3.48	1.13	−0.07	5.84
Sector D profit to turnover (%)	73	8.43	5.36	−16.54	22.61
Sector H profit to turnover (%)	73	5.08	2.52	−1.91	10.06
Sector L profit to turnover (%)	73	30.26	9.15	5.82	50.97
Sector A real profit (%), growth	73	−219.14	1087.68	−8194.63	596.69
Sector C real profit (%), growth	73	0.02	0.32	−0.60	0.95
Sector F real profit (%), growth	73	67.17	449.10	−95.28	3798.98
Sector G real profit (%), growth	73	0.04	0.26	−0.48	0.87
Sector D real profit (%), growth	73	14.00	55.00	−53.64	300.84
Sector H real profit (%), growth	73	38.70	153.37	−87.44	807.67
Sector L real profit (%), growth	73	0.05	0.24	−0.53	0.63

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Variable	Obs	Mean	Std. Dev	Min	Max

A - Agriculture, forestry, and fishing; C - Manufacturing; F - Construction; G - Wholesale and retail trade; H - Transportation and storage; L - Real estate activities.

The statistics are based on available observations, with missing values omitted. Data are reported quarterly, and growth rates are presented in year-on-year terms. To address the presence of extreme observations and outliers, sector-specific interest rates and sector-specific export growth rates have been adjusted using the supersmoother technique, as outlined by Friedman 1984. Additionally, an annual moving sum of GVA has been applied to the quarterly sector-level loans to gross-value added indicators. This transformation is in line with the approach commonly used by the ECB in calculating debt-to-GDP ratios.