




## Article

# Macroeconomic Factors of Consumer Loan Credit Risk in Central and Eastern European Countries

Rasa Kanapickienė <sup>1,\*</sup> , Greta Keliuotytė-Staniulėnienė <sup>1</sup> , Deimantė Vasiliauskaitė <sup>1</sup> , Renatas Špicas <sup>1</sup>,  
Airidas Neifaltas <sup>1,2</sup> and Mantas Valukonis <sup>1</sup>

<sup>1</sup> Department of Finance, Faculty of Economics and Business Administration, Vilnius University, 10222 Vilnius, Lithuania; greta.keliuotyte-staniuleniene@evaf.vu.lt (G.K.-S.); deimante.teresiene@evaf.vu.lt (D.V.); renatas.spicas@evaf.vu.lt (R.Š.); airidas.neifaltas@evaf.vu.lt (A.N.); mantas.valukonis@knf.vu.lt (M.V.)

<sup>2</sup> Department of Statistical Analysis, Faculty of Mathematics and Informatics, Vilnius University, 03225 Vilnius, Lithuania

\* Correspondence: rasa.kanapickiene@evaf.vu.lt

**Abstract:** In the scientific literature, there is a lack of a systematic approach to credit risk factors. In addition, insufficient attention is still paid to analysing the macroeconomic factors of consumer loan credit risk. Thus, this research aims to evaluate the macroeconomic factors of consumer loan credit risk in Central and Eastern European countries' banking systems. The findings of the study can be formulated as follows. After analysing scientific literature on credit risk factors, an improved and detailed (at five different levels) classification of factors influencing banking credit risk is proposed. This classification can be beneficial for more enhanced analysis of the factors influencing banking credit risk for the whole loan portfolio as well as for different types of loans, e.g., consumer loans. For quantitative evaluation of the impact of macroeconomic factors on consumer loan credit risk, the methods of panel data analysis and bivariate and multiple regressions are employed. Eleven CEE countries in the period from 2008 to 2020 are analysed. The results revealed that the aggregate of general macroeconomic condition factors is negatively related to consumer loan NPLs. Moreover, the economic growth, stock market, foreign exchange market, and institutional environment factors proved to be risk-decreasing, while credit market and bond market factors had a risk-increasing impact. The results of this research might help financial institutions manage credit risk more efficiently and also might be relevant to governments and central banks when selecting and applying fiscal and monetary policy measures. This study also makes policy recommendations.

**Keywords:** credit risk; consumer loans; non-performing loans; macroeconomic factors



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## 1. Introduction

At the micro-level, as the scientific literature (Mpofu and Nikolaidou 2018; Priyadi et al. 2021) considers, credit risk is the most critical risk that banks face in their operations. On the one hand, credit risk is often defined at the micro-level as the “risk of a loan not being (partially or totally) paid to the lender” (Naili and Lahrichi 2022a). On the other hand, its consequences can occur at the macro-level due to the banking system’s “strong impact on the entire economy” (Koju et al. 2020; Rashid and Intartaglia 2017), i.e., high credit risk has “an impact on the economic stability of a country” (Priyadi et al. 2021).

In this context, the issue of financial crises becomes interesting. The 2008/2009 global financial crisis has increased the interest in “the factors that may trigger a banking crisis” (Castro 2013). In this context, credit risk analysis is critical as it could detect signs of “alarm when the financial sector becomes more vulnerable to shocks” (Castro 2013) and take measures to prevent a possible crisis (Castro 2013; Agnello and Sousa 2014; Agnello et al. 2011). It also raises the question of whether other types of crises (e.g., COVID-19) could be the cause of a banking crisis.

As stated in the literature (Melecky and Sulganova 2015; Naili and Lahrichi 2022a), since the 2008/2009 global financial crisis, research has focused on the factors influencing banking credit risk, in particular macroeconomic factors. It emphasises that macroeconomic factors are a source of systemic risk. Furthermore, empirical studies (e.g., Jiménez and Saurina (2004); Bonfim (2009); Nkusu (2011)) support the approach that macroeconomic factors “should be included in the analysis since they have considerable influence on the changes of credit risk” (Castro 2013). Koju et al. (2020) conclude that “empirical studies on the determinants of credit risk are essential for a stable economy”.

However, in theoretical studies (e.g., Melecky and Sulganova (2015); Naili and Lahrichi (2022a)), the different macroeconomic factors are analysed without systematising or classifying them. It shows that there is a lack of a systematic approach to credit risk factors which makes the issue of classifying factors that affect banking credit risk an essential one. Therefore, we suggest analysing not only general macroeconomic condition factors (empirical studies are often limited to them) but also factors of the direction of the economy, the financial market conditions, and the institutional environment.

Researchers emphasise the importance of credit risk assessment and point out that credit risk is “typically measured by non-performing loans” (NPLs) (Gila-Gourgoura and Nikolaidou 2018). This indicator is widely used in studies (Buncic and Melecky 2013; Beck et al. 2015; Karoglou et al. 2018; Foglia 2022; Naili and Lahrichi 2022a). The importance of NPLs is often highlighted in studies at the micro-level, i.e., at the bank level (e.g., “high amount of NPLs leads to a decrease in profitability of the banks” (Yüksel et al. 2018), “high levels of NPLs at banks will have a negative impact on the banks’ income and the sustainability of their businesses” (Haniifah 2015) (as cited by Priyadi et al. (2021)). Furthermore, the importance of NPLs is analysed in academic papers at the macro-level, i.e., at the banking system level (e.g., they are described as “the contributing factor to the credit risk of the banking system” (Mileris 2013)).

It should be noted that most studies tend to analyse NPLs for the whole bank loan portfolio. However, the levels of NPLs for different loan types vary, and there is a lack of research. Hence, it remains relevant to analyse NPLs for different loan types. As the level of NPLs is higher for consumer loans than other loans, this implies a higher credit risk. Therefore, these loans have been selected for this study. From a Fintech perspective, it should be considered that alternative (to banks) lenders also participate in the market (according to the researchers Kaminskyi and Nehrey (2021), “non-bank lending is widespread”, i.e., “32% of all loans provided by non-banking institutions” which provide “efficient and effective lending services to underserved individuals” (Kaminskyi and Nehrey 2021).

Finally, Melecky and Sulganova (2015) state that researchers tend to “focus only on one country” rather than “larger panels”. It is, therefore, relevant to investigate the impact of macroeconomic factors on NPLs in different countries. In this context, we consider it appropriate to analyse and compare the new EU countries, i.e., to address the issue by focusing on Central and Eastern European countries.

This study aims to evaluate the macroeconomic factors of consumer loan credit risk in Central and Eastern European countries’ banking systems.

To reach the aim, the following objectives have been set out:

- (1) to improve the classifications of factors influencing both systematic and unsystematic banking credit risk; to advance the classification of macroeconomic factors influencing consumer loan credit risk by analysing not only the group of general macroeconomic condition factors but also other groups;
- (2) to assess the overall (aggregate) impact of the general macroeconomic condition factors on the consumer loan credit risk;
- (3) to assess the impact of the macroeconomic condition factors (i.e., factors of (i) the direction of the economy, (ii) financial market conditions, and (iii) institutional environment) on the consumer loan credit risk;

- (4) to assess the overall (aggregate) impact of the macroeconomic factors on the consumer loan credit risk.

The important contributions of this research are the following:

- (i) To investigate the systematic and unsystematic factors influencing banking credit risk, it is necessary to classify them at different levels. An analysis of the scientific literature on credit risk factors has concluded that no single approach exists, i.e., different trends can be identified. This study proposes an improved and detailed (at five different levels) classification of factors influencing banking credit risk. This classification can be beneficial for more enhanced analysis of the factors influencing banking credit risk for the whole loan portfolio and for different types of loans, e.g., consumer loans.
- (ii) Previous studies have analysed only a few of the most commonly identified macroeconomic determinants of banking credit risk, while other potential determinants have remained outside the scope of the study. This study focuses on a more detailed classification of the macroeconomic determinants of banking credit risk.

Furthermore, this study examines the determinants of banking credit risk by focusing on consumer loans, i.e., on a single loan category. In previous studies, a detailed analysis of the consumer loan credit risk determinants has yet to be carried out, i.e., such detailed analysis of the determinants of consumer loan credit risk has not been conducted in previous studies. Moreover, it should be mentioned that central banks all over the world analyse potential risks to the financial stability of the finance industry and prepare financial stability reports. The main drawback of these reports, especially now, is that these reports appear quite seldom, two or four times per year, and the data and situation in the financial sector can change dramatically in the short term. Of course, there is also an element to risks that are forecasted in various scenarios, but in this case, it is not easy to focus on national-level risks, so central banks usually analyse broad tendencies, which sometimes cannot be the case for the local financial industry.

For quantitative evaluation of the impact of macroeconomic factors on consumer loan credit risk, the methods of panel data analysis and bivariate and multiple regression are employed. Eleven CEE countries in the period from 2008 to 2020 are analysed. The results revealed that the aggregate of general macroeconomic condition factors is negatively related to consumer loan NPLs. Moreover, the economic growth, stock market, foreign exchange market, and institutional environment factors proved to have a risk-decreasing impact, while credit market and bond market factors were risk-increasing. The results of this research might help financial institutions manage credit risk more efficiently and be relevant to governments and central banks when selecting and applying fiscal and monetary policy measures.

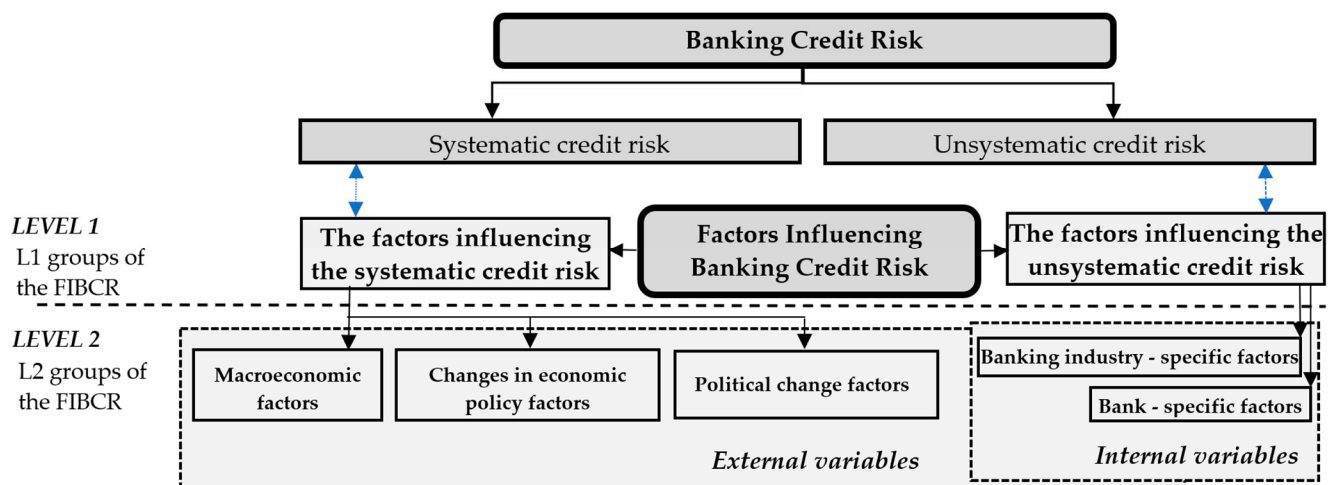
This paper consists of an introduction, five main sections, and conclusions. In Section 2, the factors influencing systematic and unsystematic banking credit risk are analysed theoretically, and the classification of factors influencing banking credit risk is proposed. Section 3 discusses the selection of dependent and independent variables and hypotheses. In Section 4, the data selection and model specification are described. Section 5 presents the results of the quantitative assessment of the impact of macroeconomic variables on consumer loan credit risk. Section 6 discusses these results. Section 7 presents the study conclusions.

## 2. Classifications of Factors Influencing Systematic Banking Credit Risk

To achieve the research aim, i.e., to evaluate the macroeconomic factors of consumer loan credit risk in Central and Eastern European countries' banking systems, it is necessary to investigate the factors influencing banking credit risk (FIBCR) and classify them at different levels. Having analysed the classifications of factors influencing credit risk (FICR) presented in previous theoretical studies and empirical research, it has been concluded that there is no single approach, and different research trends could be identified. Therefore, it is appropriate to improve this classification of the FIBCR. Furthermore, it should be noted

that in theoretical analysis, not only banking but also enterprise and country credit risk is discussed. Further, we justify the logic of our proposed classification.

The components of banking credit risk are classified into: (i) systematic and (ii) unsystematic credit risk (see Figure 1). At this stage, it is appropriate to define the following risks. We follow the definition of “systemic risk” formulated by Directive 2013/36/EU (European Parliament 2013), that is, “systemic risk” means a risk of disruption in the financial system with the potential to have serious negative consequences for the financial system and the real economy. According to Yurdakul (2014), systematic credit risk “stems from the variability of economic, political, and social life and affects all financial (monetary and capital) markets and all securities (financial assets) traded in markets”. Meanwhile, unsystematic credit risk means “the risk created by a firm or the characteristics of the industry in which the firm operates”.



**Figure 1.** The components of banking credit risk and the classification of factors influencing banking credit risk (until Level 2).

According to this classification, the FIBCR should be divided similarly. At the first level (L1 in our classification), the factors are classified according to the components of the banking credit risk, i.e., there are two groups of factors: (i) the factors influencing the systematic credit risk (according to Mpofu and Nikolaidou (2018), systematic factors defined as “factors that influence the likelihood of borrowers paying their debts”) and (ii) the factors influencing the unsystematic credit risk. It should be noted that not all researchers use this level of classification. In our study, these factors are further classified at several levels.

At the second level (L2), the FIBCR groups are discussed in more detail. It should be noted that researchers have different opinions and emphasise various characteristics of credit risk factors. Different groups of researchers distinguish

- (1) only macroeconomic factors such as the FICR (e.g., Castro (2013); Mileris (2013); Washington (2014); Beck et al. (2015); Koju et al. (2020)).
- (2) only bank-specific factors such as the FICR (e.g., Boyd and De Nicoló (2005); Podpiera and Weill (2008); Rossi et al. (2009); Haq and Heaney (2012); Zhang et al. (2016)).
- (3) both macroeconomic and bank-specific variables such as the FICR (e.g., Salas and Saurina (2002); Espinoza and Prasad (2010); Louzis et al. (2012); Abusharbeh (2020)). For instance, Abusharbeh (2020) examines the influence of macroeconomic and bank-specific factors on credit quality (in Palestine, 2007–2018). The analysis uses five macroeconomic factors and three bank-specific factors. In the analysis of the nine largest Greek banks from 2003 to 2009, Louzis et al. (2012) examine the effect of macroeconomic and bank-specific variables on loan quality. As macroeconomic variables that are exogenous to the banking industry, the authors use (i) the real GDP

- growth rate, (ii) the unemployment rate, and (iii) the lending rates. Louzis et al. (2012) emphasise that bank-specific variables possess additional explanatory power, and in their research, the authors use the following variables: return on equity, solvency ratio, inefficiency, non-interest income, leverage ratio, size, and ownership concentration. Several different models in one research are presented by Dimitrios et al. (2016), i.e., the models use (i) only macroeconomic variables, (ii) only bank-specific variables, and (iii) both macroeconomic and bank-specific variables.
- (4) both macroeconomic and banking-industry-specific variables such as the FICR (e.g., Ghosh (2015); Zheng et al. (2020)). More specifically, after empirical research, Nikolaidou and Vogiazas (2017) conclude that the analysis of the determinants of NPLs “primarily points to the importance of macroeconomic factors and to lesser-extent industry factors” (in the five Sub-Saharan Africa (SSA) countries). Zheng et al. (2020) have discovered the impact of these determinants of NPLs across the entire banking system of Bangladesh for the period 1979–2018, and the results of the research show that both macroeconomic and industry-specific factors influence NPLs significantly. Ghosh (2015) examines macroeconomic (i.e., state-level banking-industry-specific as well as region economic) and banking-industry-specific determinants of NPLs in both commercial banks and savings institutions in the US for 1984–2013.
  - (5) three groups of the FICR, i.e., (i) macroeconomic, (ii) banking-industry-specific, and (iii) bank-specific variables. For instance, Naili and Lahrichi (2022a) provide a structured review of the literature on the determinants of NPLs and discuss three groups of NPL determinants: macroeconomic, industry-related, and bank-specific determinants. Additionally, the analysis of the data of 53 banks listed in five Middle Eastern and North African emerging markets between 2000 and 2019 and the empirical study by these authors indicate that NPLs can be explained “mainly by macroeconomic variables and bank-specific factors”, whereas industry-specific factors, specifically interbank competition, have an insignificant impact on NPLs.

Based on the models analysed, it is possible to distinguish between different groups of studies, which deal with three groups of NPL determinants: (i) macroeconomic, (ii) banking-industry-specific, and (iii) bank-specific factors (or various combinations of these factors). As Naili and Lahrichi (2022b) state, the use of macroeconomic factors is based on the fact that “the country’s business cycle affects the capacity of debtors to repay their loans”. The possible correlation between bank lending strategies, bank efficiency, bank profitability, ownership structure, and loan problems (i.e., NPLs) encourages using bank-specific factors. Finally, the use of banking-industry-specific factors is explained based on the “franchise value hypothesis” developed by Keeley (1990): “as competition in the banking sector upsurges, banks demonstrate higher risk exposures” (Naili and Lahrichi 2022a).

In addition to the groups of factors mentioned above, the classifications also distinguish more unique groups of FICR, for instance, (i) a group of financial market factors (e.g., Naceur and Omran (2011); Gila-Gourgoura and Nikolaidou (2018)) and (ii) a group of institutional environment factors (e.g., Naceur and Omran (2011); Mileris (2013); Melecky and Sulganova (2015)).

The following classification requires special attention. Castro (2013) and Mpofu and Nikolaidou (2018) classify the factors affecting systematic credit risk into three groups: (i) macroeconomic factors; (ii) changes in economic policy factors (e.g., changes in monetary policy, economic legislation changes, changes in tax policy, export stimulation, import restrictions); and (iii) political change factors (e.g., changes in the goals of leading political parties). As emphasised by Castro (2013), these three groups “can have an important influence on the likelihood of borrowers paying their debts”; however, as Castro (2013) and Mpofu and Nikolaidou (2018) state, changes in variables in the second group (i.e., in economic policies) and the third group (i.e., political changes) are challenging to examine; thus, the researchers mainly “focus on the macroeconomic factors”.

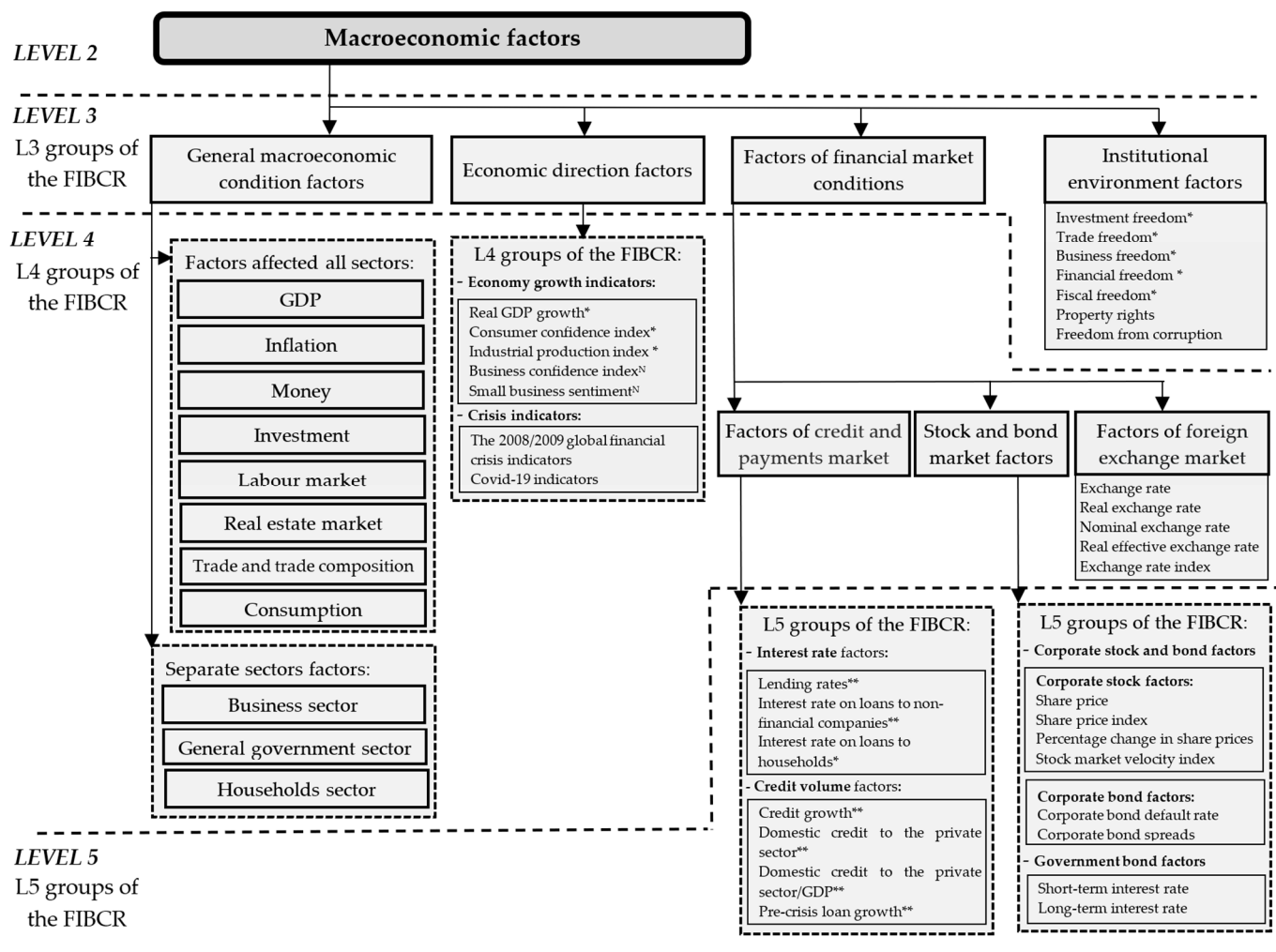


Based on the theoretical analysis, at the second level of classification, the authors of this paper support the approach by [Castro \(2013\)](#) and [Mpofu and Nikolaidou \(2018\)](#) and propose to distinguish the following groups (L2 groups) of the factors affecting the systematic banking credit risk: (i) macroeconomic factors, (ii) changes in economic policy factors, and (iii) political change factors. Additionally, (i) banking-industry-specific factors and (ii) bank-specific factors could be used as the factors affecting the unsystematic credit risk (see Figure 1).

While at the second classification level (L2), researchers' views can be grouped into distinct groups, the classifications at levels L3–L4 are even more unique; therefore, each classification should be separately considered. At the third level (L3), the factors affecting systematic banking credit risk are investigated in more detail, providing some examples.

- (1) [Liao and Chang \(2005\)](#) combine economic and financial variables and identify three factors: (i) the real economy, (ii) inflation, and (iii) housing. According to the authors, the real economic factor includes the following variables: GDP deflator, industrial production, personal income, and unemployment. The inflation factor includes (i) the consumer price index (CPI) and (ii) the producer price index (PPI). The housing factor includes the following five variables: (i) house price index (HPI), (ii) delinquency of all US real estate mortgage loans, (iii) delinquency of US real estate subprime mortgage loans, (iv) foreclosure of all US real estate mortgage loans, and (v) foreclosure of US real estate subprime mortgage loans.
- (2) [Figlewski et al. \(2012\)](#) and [Mileris \(2013\)](#) distinguish macroeconomic factors into three groups: (i) general macroeconomic condition factors (e.g., unemployment rate, inflation, etc.), (ii) economic direction factors (this group includes the real GDP growth, the growth of industrial production, and the change in consumer sentiment), and (iii) factors of the financial market conditions (this group includes interest rates (such as a 3-month T-Bill rate, a long-term interest rate (10-year Treasury), stock market returns (such as S&P 500 returns, Russell 2000 index returns, etc.), and the corporate bond default rate).
- (3) In addition to the studies discussed above, in the context of classification, it is worth discussing the study by [Feldkircher \(2014\)](#). To explain the distinct response of the real economy of the countries to the 2008 global financial crisis, the researcher uses 43 macroeconomic determinants that measure macroeconomic risks and divides them into six groups, i.e., not only the (i) "GDP and investment", (ii) "money and inflation", (iii) "monetary regime", (iv) "trade and trade composition", and (v) "business environment and labour market" groups but also the group of "institutional quality" are distinguished.

Based on the theoretical analysis, at the third level of classification, the following groups (L3 groups) of the FIBCR are suggested to be distinguished: (i) general macroeconomic condition factors, (ii) economic direction factors (e.g., this group includes not only economy growth but also crisis indicators), (iii) factors of the financial market conditions, and (iv) institutional environment factors (see Figure 2). This approach is based on the following assumptions: firstly, to analyse macroeconomics, it is necessary to explore not only the condition of the macroeconomy but also its direction; secondly, as [Figlewski et al. \(2012\)](#) state, "the performance of the stock market is an indicator of the general health of the corporate sector". By analogy, it is assumed that factors of financial market conditions are the indicators of the general health of the corporate, government, and financial sectors. Thirdly, the findings by [Boudriga et al. \(2010\)](#) show "the importance of institutional environment in enhancing banks credit quality".



**Figure 2.** The classification of macroeconomic factors influencing banking credit risk (until Level 5). N—Newly proposed factor. \* Factor could also be classified as a general macroeconomic condition factor. \*\* Factor could also be classified as a general macroeconomic condition factor (financial sector).

At the fourth level, the factors of the financial market conditions are grouped in more detail, and the L4 group of each of the different market factors is distinguished, i.e., factors of the (i) credit and payment market, (ii) stock and bond market, and (iii) foreign exchange market. Finally, at the fifth level, stock and bond market factors are divided into factors of (i) corporate stock and bond and (ii) government securities.

Fifth-level (L5) groups of macroeconomic factors are analysed in Section 3, where the independent variables of the research are discussed.

### 3. Research Hypotheses

The research methodology was formulated based on (i) the analysis of the scientific literature and suggested detailed classification of macroeconomic factors influencing banking credit risk and (ii) the identification of the macroeconomic factors of consumer loan credit risk. The study consisted of two stages: (i) dependent and independent variables were selected, and (ii) the assessment models were compiled (which are discussed below). It should be noted that, in this analysis, a broad approach was used, i.e., studies for banking, country, and enterprise credit risk.

### 3.1. The Dependent Variables

Researchers accentuate the importance of credit risk assessment; however, various credit risk proxies are highlighted by different authors. Further, some examples are provided. After performing the theoretical research, some researchers ([Mpofu and Nikolaidou 2018](#)) claim that credit risk is typically measured by non-performing loans (NPLs) or loan loss provisions. Other researchers ([Beck et al. \(2015\)](#)) point out that, generally, the literature suggests four measures of credit risk, i.e., expected default frequencies, loan loss provisions, loss given default, and NPLs. Similarly, [Love and Turk Ariss \(2014\)](#) state that, commonly, different proxies of loan quality “including loan loss provisions, NPLs, and loan write-offs” are used in studies.

A detailed analysis of the scientific literature shows that researchers propose many different credit risk proxies (see Table A1). It is worth mentioning that some authors refer to the credit risk proxy as NPLs. However, in reality, the NPL ratio is used, e.g., [Abusharbeh \(2020\)](#) states that “non-performing loans divided by loans provided used as proxy for credit risks”, or [Nikolaidou and Vogiazas \(2017\)](#) adopt dependent variable credit risk proxied by NPLs and explain that “NPLs are the ratio of non-performing loans to total loans”; [Bayar \(2019\)](#) investigates NPLs and defines that the “dependent variable is bank non-performing loans to total gross loans”.

Furthermore, illustrations can be found in the literature, where the limited availability of data has led to the use of different credit risk proxies. For instance, [Karoglou et al. \(2018\)](#) explore the credit risk factors, and (i) in the case of Bulgaria, the authors measure credit risk by “the growth rate of the ratio of loss and doubtful loans to total loans (DNPL)”; (ii) in the case of Romania, they use “the growth rate of the ratio of loan loss provision to total loans (DLLP)”.

Based on previous studies, the NPLs for consumption to total loans ratio is selected as a proxy of banking credit risk, i.e., the dependent variable. For CEE countries, the data for retail loan NPLs is used since the data of NPLs for consumer loans is unavailable. In addition, to investigate the relationship between macroeconomic factors and credit volumes, this study includes an additional dependent variable, i.e., total loans for consumption (see Table A1).

### 3.2. The Independent Variables and Development of Hypotheses

Based on the theoretical analysis, four groups (L3 groups of the FIBCR) of macroeconomic variables (i.e., groups of (i) general macroeconomic condition factors, (ii) factors of the direction of the economy, (iii) factors of the financial market conditions, and (iv) institutional environment factors) were selected as the potential factors of the consumer loan NPLs. Their descriptions and the possible relationships with the consumer loan NPLs are discussed below.

#### 3.2.1. Variables of General Macroeconomic Conditions

This research is a continuation of previous authors’ research ([Kanapickienė et al. 2022](#)). There, the general macroeconomic condition factors are analysed. These factors are separated and divided into twelve L4 groups of the FIBCR. Firstly, at this level, eight groups of factors affected by all sectors are distinguished, i.e., (i) economic growth, (ii) inflation, (iii) money, (iv) investment, (v) labour market, (vi) real estate market, (vii) trade and trade composition, and (viii) consumption. Secondly, factors of four different sectors are distinguished, i.e., factors of the (i) business sector, (ii) financial sector, (iii) general government sector, and (iv) household sector. In this study, the general macroeconomic condition factors, which included the general macroeconomic condition factors without the group of the financial sector factors that could characterise the credit and payment market, were analysed. These factors are transposed to the group of credit and payment market factors. Finally, the results of the simple linear regression assessment ([Kanapickienė et al. 2022](#)) disclosed that in the group of CEE countries, such variables as GDP and labour market appeared to have contributed to the increase in the share of non-performing consumer



loans, whereas inflation and real estate market variables were associated to the decrease in consumer NPLs; simultaneously, the impact of variables from other groups appeared to be mixed-nature or insignificant.

As the behaviour of the different regressors varies, it is appropriate to use multiple linear regression, i.e., from each of the above-mentioned groups, the “best-performing” variables are selected, then further used to form a multiple-regression model and construct an aggregate variable. This allows for assessing the overall impact of the general macroeconomic condition factors on NPLs.

In summary, according to the results of the prior empirical research, it is assumed that the aggregate variable of the general macroeconomic condition factors is expected to impact NPLs negatively. It is consistent with economic logic, i.e., the better macroeconomic condition leads to lower NPLs, given the fact that here it is considered that an increasing aggregate variable indicates a better macroeconomic situation.

Based on these arguments, Hypothesis 1 is formulated:

**Hypothesis 1 (H1).** *The aggregate variable of the general macroeconomic condition factors negatively affects NPLs.*

### 3.2.2. Variables of the Direction of the Economy

Economy growth indicators were the main drivers of non-performing loans. [Beck et al. \(2015\)](#) support this statement and state that “a drop in global economic activity remains the most important risk for bank asset quality”. Within this group, it is proposed to identify the following factors: (i) real GDP growth, (ii) consumer confidence index or consumer sentiment index, (iii) business confidence index or small business sentiment index when the research object is enterprises, and (iv) industrial production index. Further, we analyse these indicators in more detail.

Firstly, GDP growth factors are discussed. (i) [Naili and Lahrichi \(2022a\)](#) distinguish the “GDP growth” indicator in the theoretical research. (ii) Many researchers (e.g., [Mileris \(2013\)](#); [Maltritz and Molchanov \(2014\)](#); [Ghosh \(2015\)](#); [Haniifah \(2015\)](#); [Nikolaidou and Vogiazas \(2017\)](#); [Carvalho et al. \(2020\)](#)) analyse this indicator in the theoretical background for empirical research. (iii) However, this indicator is rarely used in empirical studies (e.g., [Haniifah \(2015\)](#)); it is usually modified to “GDP growth rate”. As [Koju et al. \(2020\)](#) state, the GDP growth rate “is the most commonly used macroeconomic indicator”.

In the theoretical background for empirical analysis, researchers use “real GDP growth” (e.g., [Mileris \(2013\)](#); [Ghosh \(2015\)](#)), GDP growth rate (e.g., [Bonfim \(2009\)](#); [Koju et al. \(2020\)](#)), real GDP growth rate (e.g., [Mileris \(2013\)](#); [Mpofu and Nikolaidou \(2018\)](#)), GDP per capita growth rate (e.g., [Mpofu and Nikolaidou \(2018\)](#)), and real GDP per capita growth rate (e.g., [Maltritz and Molchanov \(2014\)](#)).

In empirical research, researchers favour GDP growth rate (e.g., [Maltritz and Molchanov \(2014\)](#); [Carvalho et al. \(2020\)](#)), real GDP growth rate (e.g., [Mileris \(2013\)](#); [Ghosh \(2015\)](#); [Mpofu and Nikolaidou \(2018\)](#)), GDP per capita growth rate (e.g., [Koju et al. \(2020\)](#)), and real GDP per capita growth rate ([Ghosh 2015](#)). Researchers emphasise the relationship between GDP growth indicators and credit risk. However, previous research has shown mixed results (see Table A2(a)).

Secondly, [Figlewski et al. \(2012\)](#) point out that the “behaviour of consumers and investors is strongly influenced by their subjective sentiment”. It should be noted that several measures are available, e.g., the consumer confidence index ([Doshi et al. 2017](#)) or the consumer sentiment index ([Figlewski et al. 2012](#)). Moreover, the findings of the credit risk research show that the impact of the consumer confidence index on the country’s default intensity ([Doshi et al. 2017](#)) or the impact of the consumer sentiment index on “the corporate transitions into” the default ([Figlewski et al. 2012](#)) is significantly negative. Since the results using these indices are pretty similar, only one of these indices could be employed and reported. When the research object is enterprises, using a business confidence index or small business sentiment index is suggested.

Thirdly, economic growth could be measured using the industrial production index (Priyadi et al. 2021). Moreover, the findings suggest that the impact of this index on bank credit risk is insignificant (e.g., Gila-Gourgoura and Nikolaidou (2018); Priyadi et al. (2021)).

In summary, according to the results of the majority of researchers, economic growth variables are expected to impact NPLs negatively. Based on these arguments, Hypothesis 2 is formulated:

**Hypothesis 2 (H2).** *Economy growth variables negatively affect NPLs.*

Banking distress is typically preceded by slowing economic growth (Wong et al. 2010). Marcucci and Quagliariello (2008) (as cited by Karoglou et al. 2018) point out the cyclical behaviour of bank default rates and conclude that “default rates change across the business cycle”, and “they decline during expansions and increase during recessions”. Other researchers (Kjosevski et al. 2019) explain this in more detail: the 2007–2008 global economic crisis led to the deterioration of economic activity, borrowers had more difficulties repaying their debts to banks, increasing NPLs.

Finally, the findings of research by Mpofu and Nikolaidou (2018) have suggested that the 2008/2009 global financial crisis had a positive and significant impact on NPLs. Based on these arguments, Hypothesis 3 is formulated:

**Hypothesis 3 (H3).** *Crisis variables positively affect NPLs.*

### 3.2.3. Variables of the Financial Market Conditions: (i) Factors of the Credit and Payment Market

When analysing stock and bond market factors, it is worth distinguishing the following groups (i.e., the L5 groups of the FIBCR): (1) interest rates and (2) credit volume. As Koju et al. (2020) point out, most studies have identified interest rates as the most significant macroeconomic indicators of NPLs. Interest rate as a determinant of credit risk is analysed by the following researchers: Mileris (2013); Maltritz and Molchanov (2014); Melecky and Sulganova (2015); Karoglou et al. (2018); Carvalho et al. (2020); Priyadi et al. (2021); and Naili and Lahrichi (2022a).

The findings indicate that interest rates have an impact on credit risk. However, previous studies have shown mixed results (see Table A2(b)).

The study by Aver (2008) should be discussed separately since it analyses the research results of macroeconomic factors that “influenced the systematic credit risk of the Slovenian banking loan portfolio”. In the model creation process, 13 different interest rates are employed. As a result, the author creates a multiple linear regression model with seven statistically significant variables, five of which represent interest rates. The impact of those interest rates on credit risk is mixed. More precisely, the increase in the real interest rate on short-term consumption loans and the Lombard interest rate and/or the real interest rate on long-term home loans increase the Slovenian banking system portfolio credit risk. However, the increase in the real interest rate on long-term fixed asset loans and/or the interbank interest rate has the reverse effect.

As Beck et al. (2015) state, lending interest rates are standard empirical determinants of bank asset quality. Therefore, in studies, a group of researchers (e.g., Louzis et al. 2012; Beck et al. 2015; Carvalho et al. 2020; Zheng et al. 2020) specify the “interest rate” variable and use the “lending interest rate”. Furthermore, the findings of the studies on the relationship between lending interest rate and credit risk have been mixed (see Table A2(c)).

In the case of companies’ credit risk in the Eurozone, Carvalho et al. (2020) assessed the potential contribution of macroeconomic determinants to the credit risk (i.e., to the probability of a firm being in default), and their results confirm that the interest rate on loans to non-financial companies (annual average) “reveals a positive influence on the probability of default”. It means that higher debt servicing costs reduce the ability of companies to meet their financial commitments.

In studies, researchers present different modifications of “interest rate”. Most authors use the variable “interest rate” (e.g., [Mileris \(2013\)](#); [Melecky and Sulganova \(2015\)](#); [Karoglou et al. \(2018\)](#); [Abusharbeh \(2020\)](#); [Priyadi et al. \(2021\)](#)). Researchers also use other modifications of this variable, for example, short-term interest rate (e.g., [Maltritz and Molchanov \(2014\)](#); [Karoglou et al. \(2018\)](#)), long-term interest rate (e.g., [Castro \(2013\)](#); [Carvalho et al. \(2020\)](#)), spread between the long- and short-term interest rate (e.g., [Castro \(2013\)](#)), real interest rate (e.g., [Castro \(2013\)](#); [Messai and Jouini \(2013\)](#); [Ghosh \(2015\)](#)), effective interest rate (e.g., [Umar and Sun \(2018\)](#)), the interest rate on loans to non-financial companies (annual average) (e.g., [Carvalho et al. \(2020\)](#)), the interest rate on loans to households (e.g., [Gila-Gourgoura and Nikolaidou \(2018\)](#)), and the interest rate on deposits (e.g., [Gila-Gourgoura and Nikolaidou \(2018\)](#)). As discussed above, [Aver \(2008\)](#) uses thirteen different interest rates (including real and nominal interest rates on a loan type, i.e., on business loans, long-term home loans, long-term fixed asset loans, and short-term consumption loans). Therefore, in further research, the following variables in the interest rate variable group are suggested: (i) lending rates, (ii) interest rate on loans to non-financial companies, and (iii) interest rate on loans to households.

**Hypothesis 4a (H4a).** *Payment market variables positively affect NPLs.*

In the credit risk context, credit growth variables are also important. As stated by [Sulganova \(2016\)](#), excessive credit growth “may lead to an increase in credit risk in the future”. Therefore, it is relevant to include this factor in the study.

As a macroeconomic condition factor, credit growth is used widely in credit risk studies (e.g., [Castro \(2013\)](#); [Feldkircher \(2014\)](#); [Nikolaidou and Vogiazas \(2017\)](#); [Karoglou et al. \(2018\)](#); [Carvalho et al. \(2020\)](#)). The findings indicate that credit growth has an impact on NPLs; however, previous studies have shown mixed results (see Table A2(d)).

In studies, researchers present different modifications of “credit growth”. Most authors use the variable “credit growth” (e.g., [De Bock and Demyanets \(2012\)](#); [Castro \(2013\)](#); [Feldkircher \(2014\)](#); [Beck et al. \(2015\)](#); [Karoglou et al. \(2018\)](#); [Bayar \(2019\)](#)) or “credit growth rate” (e.g., [Bonfim \(2009\)](#); [Blanco and Gimeno \(2012\)](#)). Researchers also use other modifications of this variable, for example, “domestic credit growth to the private sector by commercial banks” ([Washington 2014](#)), “cumulative credit growth” ([Berkmen et al. 2012](#)), “the growth rate of the private credit to GDP” ([De Bock and Demyanets 2012](#)), “logarithm of total loans” ([Nikolaidou and Vogiazas 2017](#)), and “domestic credit to the private sector by banks to GDP” ([Mpofu and Nikolaidou 2018](#)).

[Feldkircher \(2014\)](#) uses “pre-crisis credit growth” as a determinant of crisis difficulty to identify the “initial macroeconomic and financial market conditions that help explain the distinct response of the real economy of a particular country to the recent global financial crisis”. Consequently, in further research, the following variables in the credit growth variable group are suggested: (i) credit growth, (ii) domestic credit to the private sector, (iii) domestic credit to the private sector to GDP, and (iv) pre-crisis loan growth. To sum up, despite mixed findings of credit and payment market variables, many studies demonstrate these variables’ positive impact on credit risk, more precisely, on NPLs. Based on these arguments, Hypothesis 4 is formulated:

**Hypothesis 4b (H4b).** *Credit market variables positively affect NPLs.*

#### 3.2.4. Variables of the Financial Market Conditions: (ii) Factors of the Stock and Bond Market

Researchers on banking credit risk discuss that the stock and bond market factors are considered one of the main macroeconomic factors influencing credit risk. For instance, [Koju et al. \(2020\)](#) claim that share prices have been identified “as the most significant macroeconomic indicators of NPLs by a majority of studies”. In the same way, [Castro \(2013\)](#) (as cited by [Gila-Gourgoura and Nikolaidou \(2018\)](#)) points out that share price indices are “crucial in determining credit risk”. [Foglia \(2009\)](#) and [Gila-Gourgoura and Nikolaidou](#)

(2018) suggest that market-based variables such as factors of a corporate bond can be strong influencers of credit risk.

Firstly, proxies that could describe the corporate stock and bond factors are considered. Corporate stock factors could be proxied by different variables: share price (e.g., [Koju et al. \(2020\)](#)), the percentage change in stock market prices (e.g., [Abusharbeh \(2020\)](#)), share price index (e.g., [Nikolaidou and Vogiazas \(2017\)](#); [Gila-Gourgoura and Nikolaidou \(2018\)](#)), percentage growth rate of the share price indices (e.g., [Castro \(2013\)](#)), stock market index (e.g., [Aver \(2008\)](#); [Abusharbeh \(2020\)](#); [Carvalho et al. \(2020\)](#); [Naili and Lahrichi \(2022a\)](#)), stock market returns (e.g., [Mileris \(2013\)](#)), and the market volatility index ([Gila-Gourgoura and Nikolaidou \(2018\)](#)). According to researchers ([Lehmann and Manz \(2006\)](#); [Foglia \(2009\)](#); [Gila-Gourgoura and Nikolaidou \(2018\)](#)), corporate bond factors could be proxied by corporate bond spreads.

Researchers investigate the relationship between the factors of corporate stocks and bonds and credit risk. The performed analyses report varying research results (see Table A2(e)). Corporate stock factors can be considered as “an indicator for the state of the economy” ([Castro 2013](#)) and provide a general indication of the enterprise’s financial conditions. It is, therefore, logical that corporate stock variables have a negative impact on credit risk. As [Castro \(2013\)](#) states, “an increase in the stock prices—that reflect an improvement in the financial conditions—contributes to a reduction of the rate of non-performing loans”. On the other hand, [Kavkler and Festic’ \(2010\)](#) (as cited by [Nikolaidou and Vogiazas \(2017\)](#)) point out that the “excessive growth of finance deteriorates NPL dynamics due to the overheating of the economies”.

With regard to corporate bond factors, they have a similar impact on credit risk as interest rates. Researchers ([Lehmann and Manz 2006](#)) argue that “higher corporate bond spreads contribute to higher credit risk”.

Based on the above, it is proposed to identify the following factors in the group of corporate stock and bond factors: (i) corporate stock factors (i.e., share price, share price index, percentage change in share prices, stock market velocity index) and (ii) corporate bond factors (specifically, corporate bond spreads).

To summarise, despite these mixed findings of studies on different variables, many studies reveal the negative impact of corporate stock group variables on credit risk. Therefore, they are expected to affect NPLs negatively. Based on these arguments, Hypothesis 5 is formulated:

**Hypothesis 5 (H5).** *Corporate stock group variables negatively affect NPLs.*

As regards corporate bond factors, they are expected to affect the NPLs positively. Based on these arguments, Hypothesis 6 is formulated:

**Hypothesis 6 (H6).** *Corporate bond group variables positively affect NPLs.*

Researchers discuss not only corporate bond factors but also government bond factors. More precisely, they explore the government bond factors as one of the macroeconomic factors affecting credit risk. The analyses present varying research results (see Table A2(f)). In addition, researchers have distinguished both long-term (e.g., [Duffie et al. \(2007\)](#); [Carvalho et al. \(2020\)](#)) and short-term (e.g., [Maltritz and Molchanov \(2014\)](#); [Nikolaidou and Vogiazas \(2017\)](#); [Karoglou et al. \(2018\)](#)) interest rates. Considering the beforementioned information, it is suggested to use a similar classification for research on credit risk in future.

To summarise, despite these mixed findings of studies on different variables, many studies reveal the positive impact of these group variables on credit risk. Therefore, they are expected to affect NPLs positively. Based on these arguments, Hypothesis 7 is formulated:

**Hypothesis 7 (H7).** *Government bond interest rates positively affect NPLs.*

### 3.2.5. Variables of the Financial Market Conditions: (iii) Factors of the Foreign Exchange Market

Researchers on banking credit risk discuss that the foreign exchange market factors are considered one of the main macroeconomic factors influencing credit risk. Theoretical analysis by [Koju et al. \(2020\)](#) shows that exchange rates have been identified “as the most significant macroeconomic indicators of NPLs by a majority of studies”. Other researchers also support this statement (e.g., [Espinoza and Prasad \(2010\)](#); [Castro \(2013\)](#); [Mileris \(2013\)](#); [Beck et al. \(2015\)](#); and [Radivojević et al. \(2019\)](#)). This finding suggests that further research is needed.

Firstly, the present study investigates the variety of exchange rate measurement units. In scientific papers, researchers have presented various modifications of exchange rates used as macroeconomic variables. After analysing the literature, i.e., theoretical analyses and the theoretical background for empirical analysis, the following variables can be distinguished:

(i) the majority of researchers (e.g., [Melecky and Sulganova \(2015\)](#); [Gila-Gourgoura and Nikolaidou \(2018\)](#); [Bayar \(2019\)](#); [Radivojević et al. \(2019\)](#); and [Carvalho et al. \(2020\)](#)) use the variable as “exchange rate”, (ii) the real exchange rate as a measure is used, e.g., by [Nikolaidou and Vogiazas \(2017\)](#) and [Karoglou et al. \(2018\)](#), (iii) [Kjosevski et al. \(2019\)](#) have used the real effective exchange rate, and (iv) the real exchange rate index has been used by [Wong et al. \(2010\)](#) and [Mileris \(2013\)](#). In empirical studies, the researchers have also used various exchange rate modifications: exchange rate (e.g., [Aver \(2008\)](#); [Washington \(2014\)](#); [Abusharbeh \(2020\)](#)), real exchange rate (e.g., [Castro \(2013\)](#); [Kjosevski et al. \(2019\)](#)), the nominal exchange rate (e.g., [Stolbov \(2017\)](#)), real effective exchange rate (e.g., [Melecky and Sulganova \(2013\)](#); [Nikolaidou and Vogiazas \(2017\)](#)), real effective exchange rate index (e.g., [Wong et al. \(2010\)](#)), and nominal effective exchange rate (e.g., [Nkusu \(2011\)](#); [Beck et al. \(2015\)](#)). Therefore, regarding the factors of the foreign exchange market, it is considered that it is worth distinguishing the following variables: exchange rate, real exchange rate, nominal exchange rate, real effective exchange rate, and exchange rate index.

Secondly, the findings of studies have been mixed (see Table A2(g)). In this respect, the results obtained by [Melecky and Sulganova \(2015\)](#) are interesting. The authors have carried out a detailed theoretical study, i.e., the researchers have examined 33 studies that include 90 models and have distinguished the “five most common macroeconomic” determinants of NPL ratio, one of which is the exchange rate. Though the exchange rate is a relevant variable, it is not included in about 43% of the models considered by researchers.

According to the meta-analysis of empirical literature by [Melecky and Sulganova \(2015\)](#), the effect of the exchange rate on credit risk is mixed. This result could be explained as follows: “there is almost the same number of models” with the statistically significantly positive (22% models) and with the statistically significantly negative (21% models) estimates of this determinant. Furthermore, about 13% of models have insignificant estimates.

Thirdly, researchers are trying to explain the following mixed results. It should be noted that an increase in the real exchange rate represents a depreciation of the domestic currency and vice versa. Hence, according to [Kjosevski et al. \(2019\)](#), real depreciation negatively affects import-oriented enterprises, and conversely, it positively impacts the performance of export-oriented enterprises. In the analysis of NPLs, exchange rates are relevant for the following relationship. According to [Kjosevski et al. \(2019\)](#), domestic currency depreciation can reduce the net value of enterprises if they have substantial foreign currency liabilities. Thus, enterprises may become riskier for crediting, as they need to obtain additional funds in domestic currency to repay their loans. Moreover, enterprises are likely to face difficulties when meeting their obligations to banks. Consequently, NPLs will increase, and banks’ balance sheets will deteriorate.

Considering that previous studies show mixed results for the exchange rate variables, we conclude that, in this study, these variables are expected to have a mixed relationship with the NPLs. Based on these arguments, Hypothesis 8 is formulated:



**Hypothesis 8 (H8).** *Exchange rate variables negatively affect NPLs.*

### 3.2.6. Variables of the Institutional Environment

Researchers on banking credit risk (e.g., [Boudriga et al. \(2010\)](#); [Bayar \(2019\)](#)) discuss that the institutional environment factors are considered to be a very important determinant of credit quality. Godlewski (2004) and Breuer (2006) (as cited by [Boudriga et al. \(2010\)](#)) emphasise that the relationship between institutions and NPLs “has not been sufficiently examined by the literature”. Therefore, this issue should be explored in more detail.

Institutional environment factors describe governance practices related to (i) investment and capital inflows, in particular restrictions on investments; (ii) freedom of international trade, by considering, in particular, the existence of tariffs; (iii) business freedom; (iv) independence and efficiency of the country’s financial sector; (v) fiscal practices and the tax burden; and (vi) (private) property rights. Finally, the freedom from corruption indicator describes the level of corruption (perception). Thus, accordingly, we propose to identify the following factors: (i) investment freedom; (ii) trade freedom; (iii) business freedom; (iv) financial freedom; (v) fiscal freedom; (vi) property rights, and (vii) freedom from corruption indicators (see Figure 2). The research also shows the significance of these indicators. As an example of the impact of variables of the institutional environment on credit risk, the findings by [Maltritz and Molchanov \(2014\)](#) are summarised in Table A2(h).

[Haq and Heaney \(2012\)](#) emphasise that “country-level bank regulation may form an important element of bank risk management”. However, “it is difficult to capture this effect”. Therefore, the researchers ([Haq and Heaney \(2012\)](#); [González \(2005\)](#)) use the economic freedom index (EFI) to measure this effect. It should be noted here that the economic freedom index includes “business freedom, trade freedom, fiscal freedom, freedom from government, monetary freedom, investment freedom, financial freedom, property rights, freedom from corruption, and labour freedom” ([González \(2005\)](#)) (as cited by [Haq and Heaney \(2012\)](#)). According to [Haq and Heaney \(2012\)](#), higher values of this index “reflect reduced levels of regulation” that “might be associated with greater economic and legal stability” and “with lower bank risk levels”. On the other hand, a higher EFI may also indicate “inadequate regulation levels, with consequently increased bank risk levels”. Even though the effect of the index may be mixed, the authors note that it tends “to capture cross-country variation in regulation”. The findings by [Haq and Heaney \(2012\)](#) show that the EFI is negatively associated with bank credit risk and is statistically significant. This result indicates that “greater levels of economic freedom, particularly in terms of lower levels of regulation and government intervention,” generate lower bank credit risk. Similar results are achieved by [Bayar \(2019\)](#) who concludes that “economic freedom (institutional development) had a negative impact on NPLs”.

In this research, the institutional environment variables are expected to impact NPLs negatively. Based on these arguments, Hypothesis 9 is formulated:

**Hypothesis 9 (H9).** *Institutional environment variables negatively affect NPLs.*

## 4. Data and Methodology

### 4.1. Data Selection

To reach the main aim of this research, i.e., to evaluate the macroeconomic factors of consumer loan credit risk in Central and Eastern European countries’ banking systems, data from eleven countries (Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, Estonia, Latvia, and Lithuania) are further analysed. Regardless of the fact that Albania also belongs to the group of CEE countries, it was decided to eliminate this country from further research, taking into account that Albania is not a member of the European Union, which partly causes the problems of data availability and uniformity arising in the case of this country (too small dataset). For this, the panel data models using annual data are employed. This research covers the longest possible

period depending on NPL data series available for panel estimation: from 2008 to 2020 (143 observations).

After an extensive analysis of the scientific literature (Section 3), the independent variables or factors of consumer loan credit risk (from previously discussed groups) were selected for further research, of which were (i) 44 variables of the general macroeconomic condition of different groups (see [Knapickienė et al. \(2022\)](#)); (ii) 8 variables of the direction of the economy; (iii) 11 variables of financial market conditions; and (iv) 5 variables of the institutional environment. Variables of the direction of the economy, financial market conditions, institutional environment, and “best-performing” variables of general macroeconomic condition for each group, as well as their symbols, units of measurement, and sources of data, are provided in Table A3. The data are collected from Eurostat, ECB, OECD, OurWorldinData, Worldbank, The Heritage Foundation, CEIC, and other institutions’ databases and sources. The data are analysed using the Eviews software package.

Firstly, variables in Table A3 were checked for stationarity. For that purpose, we used the Levin, Lin, and Chu  $t^*$  test. The results of the unit root test for variables of the direction of the economy, financial market conditions, and institutional environment, as well as of “best-performing” variables of general macroeconomic condition for each group, are provided in Table A4. As can be seen from Table A4, 4 variables of the direction of the economy, 8 variables of financial market conditions, and 4 variables of the institutional environment appeared to be stationary in the case of CEE countries. Moreover, according to [Knapickienė et al. \(2022\)](#), 39 variables of general macroeconomic condition appeared to be stationary in the case of CEE countries. These variables are used for further research (variables are differenced when necessary, see Table A4). The table of descriptive statistics of the economy’s direction, financial market conditions, and institutional environment can be offered upon request. Further, the specification of the research model is discussed.

#### 4.2. Model Specification

Pursuing the main aim of this research, i.e., to evaluate the macroeconomic factors of consumer loan credit risk in Central and Eastern European countries’ banking systems, research consisting of several steps is conducted. These steps are discussed in more detail below.

Step 1. Assessment of the impact of macroeconomic factors on consumer loan credit risk in CEE countries. Taking into account a relatively narrow data set for CEE countries (13 yearly observations for each country), it is presumed that the application of the traditional regression technique to assess the relationship between selected macroeconomic factors and consumer loan credit risk for each CEE country separately would not allow for obtaining accurate enough results. However, in the case of relatively short data series, the panel data approach is more favourable than the analysis of only cross-sectional or time-series models. Thus, following the approach used by [Espinoza and Prasad \(2010\)](#), [Nkusu \(2011\)](#), [De Bock and Demyanets \(2012\)](#), [Castro \(2013\)](#), [Beck et al. \(2015\)](#), and [Mpofu and Nikolaidou \(2018\)](#), panel data models are chosen to assess the impact of macroeconomic factors on consumer loan credit risk in CEE countries. As a starting point, the panel models with an invariant constant are created (Equation (1)); after that, the models with fixed (Equation (2)) and random effects (Equation (3)) are formed and evaluated.

$$Y_{it} = \alpha + \beta X_{it} + u_{it} \quad (1)$$

where:

$i = 1, 2, \dots, N$  and  $t = 1, 2, \dots, T$ ;

$N$ —number of cross-sections;

$T$ —number of periods;

$Y_{it}$ —dependent variable;

$\alpha$ —intercept;

$\beta$ —coefficient;  
 $X_{it}$ —independent variable;  
 $u_{it}$ —error.

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \quad (2)$$

where:

$\alpha_i$ —intercept;

$$Y_{it} = \alpha_i + \beta X_{it} + (u_i + v_i) \quad (3)$$

where:

$u_i + v_i$ —error.

After that, the most appropriate model (constant, fixed, or random effect) is chosen for each pair of dependent and independent variables. This choice is based on the results of statistical tests (F test and Hausman test).

Step 2. Overall assessment of the impact of macroeconomic factors using multiple regression models. Having evaluated the relationship between each pair of dependent and independent variables, it is now possible to reject insignificant variables, i.e., factors of consumer loan credit risk. Moreover, it is possible to identify the “best-performing” (statistical significance/probability and R squared) variables from each group of macroeconomic factors discussed in Section 3.

1. At first, analysing the group of general macroeconomic condition factors, the “best-performing” variable representing each L4 group of the FIBCR is selected. Based on the previously mentioned criteria and according to the results obtained by Kanapickienė et al. (2022), the following variables are selected: GDP gap (output GAP), GDP deflator, money supply (M2) growth rate, long-term unemployment rate, capital investment, current account balance, house price index, industry value to GDP, budget balance to GDP, and wages and salaries per employee. The multiple regression models of the overall (aggregate) impact of the general macroeconomic condition factors on the consumer loan credit risk are constructed.
2. Secondly, the “best-performing” variables representing the groups of factors of the direction of the economy, financial market conditions (credit and payment market, stock and bond market, foreign exchange market), and institutional environment are selected (these are consumer confidence index, cases of COVID-19, domestic credit to private sector to GDP, share price index, exchange rate, and investment freedom). Then, multiple regression models of the overall (aggregate) impact of the macroeconomic factors on the consumer loan credit risk are constructed.

In the next section, the results of the research are discussed.

## 5. Results

The results of the assessment of the impact of selected macroeconomic factors on consumer loan credit risk in the group of CEE countries are provided in Tables A5, A6 and A8. Further in this section, the results are discussed separately for groups of general macroeconomic condition factors as well as factors of the direction of the economy, factors of financial market conditions, and institutional environment factors.

### 5.1. Variables of the General Macroeconomic Condition

As this research is a continuation of previous authors' research (Kanapickienė et al. (2022)) that employed bivariate panel regression models to assess the overall (aggregate) impact of general macroeconomic condition factors on consumer loan NPLs, in the first step of this research, the multiple regression models including the “best-performing” variables from the different groups of general macroeconomic condition factors (analysed in detail

by Kanapickienė et al. (2022)) are constructed. The “best-performing” variables are chosen based on statistical characteristics (statistical significance/probability and R squared).

The results of correlation analysis (Pearson) (offered upon request) show that in the case of CEE countries, none of the selected variables is highly correlated (correlation coefficient  $< 0.80$ ), which means that they all can be included in a multiple regression model. The primary multiple regression model for selected “best-performing” variables of consumer loan credit risk in the group of CEE countries is provided in Table A5.

Finally, step by step, excluding insignificant variables, two final models for selected “best-performing” variables of consumer loan credit risk in the group of CEE are created. The F and Hausman tests show that the most appropriate model is the panel model with fixed effects (Model 1) and random effects (Model 2). The overall assessment of the impact of general economic condition factors using the final model allows us to state that (i) GDP deflator (inflation variable) (Model 1) and house price index (real estate market variable) (Models 1–2) appeared to have a risk-decreasing effect, (ii) while current account balance (trade and trade composition indicator) (Model 2), industry value to GDP (business sector variable) (Model 2), and budget balance to GDP (government sector indicator) (Models 1–2) appeared to have a risk-increasing effect in CEE countries (Table A5).

Thus, it could be stated that in the case of the group of CEE countries, Hypothesis 1 (H1), stating that the aggregate variable of the general macroeconomic condition factors negatively affects NPLs, can be supported.

### 5.2. Variables of the Direction of the Economy

As can be seen from Table A6, three of the analysed variables of the direction of the economy (consumer confidence index, cases of COVID-19, and COVID-19 pandemic (dummy variable)) appeared to have a statistically significant impact on consumer loan credit risk in CEE countries: (i) consumer confidence index as an economic growth indicator demonstrated statistically significant negative (i.e., risk-decreasing) impact on consumer loan credit risk, and (ii) cases of COVID-19 and COVID-19 pandemic (dummy variable) as COVID-19-related indicators were also shown to have a statistically significant negative impact on credit risk. However, the financial crisis indicator (a dummy variable—the 2008–2009 global financial crisis) did not demonstrate a statistically significant effect.

Thus, it could be stated that in the case of CEE countries, Hypothesis 2 (H2), highlighting that economic growth variables negatively affect NPLs, can be supported. On the other hand, Hypothesis 3 (H3), stating that crisis variables positively affect NPLs, cannot be supported.

Moreover, it can be mentioned that results also revealed no significant relationships between loans for consumption and economic growth, as well as crisis variables in the group of CEE countries (Table A7).

### 5.3. Variables of the Financial Market Conditions: (i) Factors of the Credit and Payment Market

According to the results (Table A6): (i) there was a statistically significant positive effect of the domestic credit to private sector to GDP on NPLs, (ii) while the effect of credit growth appeared to be statistically insignificant.

Thus, it could be pointed out that in the case of the group of CEE countries, Hypothesis 4b (H4b), stating that credit market variables positively affect NPLs, can be at least partially supported.

Regarding Hypothesis 4a (H4a), indicating payment market variables positively affect NPLs, it could be stated that due to the problem of data scarcity and the results of the variables' stationarity assessment, there were no variables of the payment market that could be used for further research. Therefore, at this stage, *it is not possible to confirm or reject the H4a*.

Moreover, it can be mentioned that results also revealed no significant relationships between loans for consumption and credit growth, as well as interest rate variables in the group of CEE countries (Table A7).

#### 5.4. Variables of the Financial Market Conditions: (ii) Factors of the Stock and Bond Market

According to the results (Table A6), three out of four analysed stock and bond market variables appeared to have a statistically significant impact on consumer loan credit risk in the group of CEE countries: (i) bond market indicators (short-term interest rate and long-term interest rate) appeared to have a statistically significant positive impact on NPLs; (ii) one stock market indicator (stock price index) was proven to have a statistically significant negative impact on NPLs; and (iii) another stock market indicator (percentage change in stock market prices) did not demonstrate a statistically significant effect.

Thus, it could be specified that in the case of the group of CEE countries, Hypothesis 5 (H5), stating that corporate stock group variables negatively affect NPLs, can be at least partially supported. Hypothesis 7 (H7), stating that government bond interest rates positively affect NPLs, can also be supported.

Regarding Hypothesis 6 (H6), indicating that corporate bond group variables positively affect NPLs, it should be mentioned that due to the problem of data scarcity and the results of the variables' stationarity assessment, there were no variables of the corporate bond market that could be used for further research. Therefore, at this stage, *it is not possible to confirm or reject the H6*.

Moreover, it can be mentioned that results also revealed no significant relationships between loans for consumption and bond market indicator variables in the group of CEE countries (Table A7).

#### 5.5. Variables of the Financial Market Conditions: (iii) Factors of the Foreign Exchange Market

The results in Table A6 show that one of the foreign exchange market indicators (exchange rate) appeared to have a statistically significant negative impact on consumer loan credit risk in CEE countries (another indicator—real exchange rate—appeared to have no statistically significant effect).

Thus, it could be stated that in the case of the group of CEE countries, Hypothesis 8 (H8), expressing that exchange rate variables negatively affect NPLs, can be at least partially supported.

Moreover, it can be mentioned that results also revealed no significant relationship between both loans for consumption and foreign exchange market variables in the CEE countries (Table A7).

#### 5.6. Variables of the Institutional Environment

The results in Table A6 show that (i) two of the analysed institutional environment variables (property rights and investment freedom) appeared to have a statistically significant negative impact on consumer loan credit risk in CEE countries, while (ii) the rest of institutional environment variables (freedom from corruption and business freedom) did not demonstrate any statistically significant effect on NPLs.

Thus, it could be affirmed that in the case of the group of CEE countries, Hypothesis 9 (H9), stating that institutional variables negatively affect NPLs, can be at least partially supported.

Moreover, it can be mentioned that results also revealed (i) no significant relationships between loans for consumption and three out of four institutional environment variables (freedom from corruption, property rights, and business freedom) in the group of CEE countries, while (ii) investment freedom appeared to have a positive effect on loans for consumption (Table A7).

The summarizing tables of the results of all estimations of macroeconomic factors of consumer loan credit risk in the group of CEE countries can be offered upon request.

#### 5.7. Overall Assessment of the Impact of Macroeconomic Factors

In the last step of the research, the multiple regression models that include the “best-performing” variables from each of the groups analysed—(i) general macroeconomic condition factors, (ii) factors of the direction of the economy, (iii) factors of financial market



conditions ((a) factors of the credit and payment market, (b) factors of the stock and bond market, (c) factors of the foreign exchange market), and (iv) institutional environment factors—are constructed. The variables are chosen based on statistical characteristics (statistical significance/probability and R squared).

The results of correlation analysis (Pearson) (offered upon request) show that in the case of CEE countries, none of the selected variables is highly correlated (correlation coefficient  $< 0.80$ ), which means that they all can be included in a multiple regression model. The primary multiple regression model for selected “best-performing” variables of consumer loan credit risk in the group of CEE countries is provided in Table A8.

Finally, step by step, excluding insignificant variables, the final model for selected “best-performing” variables of consumer loan credit risk in the group of CEE countries is created. The results of the F and Hausman tests allow us to state that the most appropriate model is the panel model with fixed effects (Table A8).

## 6. Discussion

This section discusses and compares the results of this research to those of previous research in the field.

As our research revealed the statistically significant effect of the aggregate variable of general macroeconomic factors on NPLs, i.e., allowed to support Hypothesis 1 (H1), it can be stated that, as economic logic suggests, better macroeconomic conditions lead to lower NPLs or consumer loan credit risk. This result also coincides with the results by [Džidić et al. \(2022\)](#), who, after analysing the macroeconomic determinants of NPLs in Bosnia and Herzegovina, confirmed that deteriorating macroeconomic conditions lead to the increase of non-performing loans.

The research also allows stating that economic growth variables are significantly negatively related to NPLs, i.e., Hypothesis 2 (H2) can be supported. From the perspective of the effect of the economic growth variable, the consumer confidence index, it could be stated that the results of this research coincide with the results of [Doshi et al. \(2017\)](#) and [Figlewski et al. \(2012\)](#), stating that the relationship between consumer confidence and rate of default is significant and negative. It shows that the increasing confidence of consumers is related to the decrease in consumer loan credit risk.

However, in the case of CEE countries, the research revealed no statistically significant effect of financial crisis variables on NPLs, i.e., Hypothesis 3 (H3) could not be supported. From the perspective of the effect of financial crisis variables, it could be stated that the obtained results contradict the results listed by Marcucci and Quagliariello (2008) (as cited by [Karoglou et al. \(2018\)](#)), stating that default rates increase during recessions, as well as the results of [Castro \(2013\)](#) and [Kjosevski et al. \(2019\)](#) who pointed out the substantial increase in credit risk during the 2007–2008 global economic crisis, and the results of [Mpofu and Nikolaidou \(2018\)](#), who indicated a positive and significant impact of the global financial crisis on NPLs.

On the other hand, our research revealed the significant impact of another pandemic-induced crisis—the COVID-19 pandemic. Interestingly, the effect appeared to be negative, i.e., risk-decreasing; this is not a particularly surprising fact given the scale of aid packages and measures implemented during this challenging period.

According to the results of our research, the credit growth (measured as domestic credit to private sector to GDP) demonstrated a statistically significant positive effect on NPLs, i.e., Hypothesis 4 (H4) can be at least partially supported. These results, showing the risk-increasing effect of credit growth, coincide with the results obtained by [De Bock and Demyanets \(2012\)](#), who indicated an insignificant impact of credit growth on credit risk in a sample of 25 emerging countries (1996–2010), as well as with results obtained by [Castro \(2013\)](#) (in GIPSI countries, 1997–2011), [Karoglou et al. \(2018\)](#) (in Romania and Bulgaria, 2001–2015), [Bayar \(2019\)](#) (in emerging market economies, 2000–2013), and [Tatarici et al. \(2020\)](#) (in EEC countries, 2005–2017) stating that the effect of credit growth on credit risk is positive. However, these results contradict the results of [Washington \(2014\)](#) and [Agic and](#)

Gacic (2021), who revealed a negative relationship between credit growth variables and NPLs.

Moreover, in the case of CEE countries, corporate stock group variables appeared to be significantly negatively related to NPLs, while government bond interest rates have proven to have a significant positive effect on NPLs, i.e., Hypotheses 5 (H5) and 7 (H7) can be supported. The result, showing a negative relationship between the stock market indicator and NPLs, coincides with the results obtained by Yurdakul (2014) (as cited by (Gila-Gourgoura and Nikolaidou (2018))), who indicated that the Istanbul Stock Exchange index reduces credit risk in the long run, Castro (2013), who stated a negative influence of the variables of corporate stock on credit risk, and Messai and Gallali (2019), who revealed the negative impact of the stock price index variable on NPLs for the panel of 19 European countries. At the same time, the findings of this research contradict the results obtained by Aver (2008), who revealed a positive relationship between the credit risk of the loan portfolio and the stock exchange index, as well as results obtained by Abusharbeh (2020) who showed that the stock market index insignificantly impacts NPLs. From the perspective of bond market indicators, it could be stated that the results of our research coincide with results obtained by Nikolaidou and Vogiazas (2017), who revealed a significantly positive effect of the 90-day Treasury bill rate on NPLs; results obtained by Gashi et al. (2022) that, after analysis of the macroeconomic determinants of NPLs in the Western Balkans, confirm the positive relationship between interest rates and NPLs; results obtained by Pluskota (2021), who indicated that increasing interest rates on bonds leads to an increase in NPLs; and with results presented by Gila-Gourgoura and Nikolaidou (2018) that document that the interest rate spread has a positive effect on new bad loans. At the same time, the results of this research contradict the results obtained by Maltritz and Molchanov (2014), stating that the effect of one year US interest rates on the country's credit risk is negative, and Nikolaidou and Vogiazas (2017), indicating that the 90-day Treasury bill rate has a negative but statistically insignificant effect on NPLs.

As this research revealed a statistically significant negative effect of exchange rate on NPLs, i.e., allowed to support Hypothesis 8 (H8), it can be stated that the results of this research coincide with results obtained by Washington (2014), who found exchange rate to be negatively and significantly related to NPLs. On the other hand, our results contradict those obtained by Anita et al. (2022), Nkusu (2011), Castro (2013), and Kjosevski et al. (2019) indicating a positive effect of exchange rate on consumer loan credit risk, and those obtained by Aver (2008), Wong et al. (2010), Nkusu (2011), Nikolaidou and Vogiazas (2017), and Abusharbeh (2020) showing that exchange rate is the insignificant determinant of NPLs.

Finally, in the case of CEE countries, this research revealed a statistically significant negative impact of institutional environment variables on NPLs, i.e., Hypothesis 9 (H9) could be at least partially supported. These results coincide with the results obtained by Haq and Heaney (2012), showing that these factors are negatively associated with bank credit risk, and their impact is statistically significant, as well as results obtained by Bayar (2019), who indicated that institutional development factors have a negative impact on NPLs.

The overall assessment of the impact of macroeconomic factors using the final model allows us to state that the GDP deflator (inflation variable) and house price index (real estate market variable) appeared to have a risk-decreasing effect, while industry value to GDP (business sector variable), budget balance to GDP (government sector indicator), and domestic credit to private sector to GDP (credit and payment market indicator) appeared to have a risk-increasing effect in CEE countries. These results at least partially coincide with the results obtained by Anita et al. (2022), who, after analysing macroeconomic determinants of NPLs in eight South Asian Association for Regional Cooperation countries, revealed a statistically significant negative effect of inflation and a positive effect of government budget balance variables, as well as with the results of Gashi et al. (2022) showing a

negative relationship between inflation and NPLs, but contradict the results of [Messai and Gallali \(2019\)](#) stating the positive effect of the inflation rate and NPLs.

## 7. Conclusions

In theoretical studies and empirical research, many approaches for the classifications of factors influencing credit risk are applied. Therefore, to evaluate the factors influencing credit risk, it is necessary to advance the classifications of factors influencing both systematic and unsystematic banking credit risk and improve the classification of macroeconomic factors influencing banking credit risk by dividing these factors into different levels and using a systematic approach. In the suggested classification, these factors are classified at five different levels. At the first level, the factors influencing banking credit risk (FIBCR) are classified according to the components of the banking credit risk, i.e., factors influencing systematic and unsystematic banking credit risk. At the second level, a deeper approach is taken, and it is proposed to distinguish the following groups (L2 groups) of the factors affecting the systematic banking credit risk: (i) macroeconomic factors, (ii) changes in economic policy factors, and (iii) political change factors. Additionally, (i) banking-industry-specific factors and (ii) bank-specific factors could be used as the factors affecting the unsystematic credit risk. At the third level of classification, it is suggested to distinguish the following groups (L3 groups) of the macroeconomic factors: general macroeconomic condition factors, economic direction factors, factors of the financial market conditions, and institutional environment factors. A more profound approach is adopted at the fourth–fifth level, and the different group factors are systematised and detailed.

Such classification allows for identifying the factors that significantly impact NPLs from each of the most profound level groups and avoiding autocorrelation between these factors. In addition, researchers and credit risk policymakers would be able to identify the key factors influencing banking credit risk.

The results of the research conducted revealed that

- (i) economy growth indicators proved to have a risk-decreasing effect in CEE countries; the effect of crisis indicators (COVID-19-related variables) appeared to have an impact (risk-decreasing) on NPDs.
- (ii) it was confirmed that, in the case of CEE countries, credit market indicators have statically significant positive (risk-increasing) or statistically insignificant effects on NPLs.
- (iii) most of the analysed stock and bond market variables appeared to have a statistically significant impact on consumer loan credit risk in the group of CEE countries: bond market indicators proved to have a positive impact on NPLs, while stock market indicators had a negative impact.
- (iv) one of the foreign exchange market indicators (exchange rate) appeared to have a statistically significant negative effect on NPLs in CEE countries.
- (v) property rights and investment freedom variables appeared to have a statistically significant negative impact on consumer loan credit risk in CEE countries, while the effect of the rest of the institutional environment variables was proven to be insignificant.

It is considered that the nature of credit risk is similar worldwide; therefore, the findings of this research can also be used in the global context, not only in the case of CEE countries. Nevertheless, when analysing every country or region case by case, attention should be paid to macroeconomic factors and other factors influencing consumer loan credit risk. Some unique national factors are inherent in government support policy for the credit market and the position of local regulators (how central banks or other supervisors regulate and support the credit market and help manage credit risk). Macroeconomic variables as economic growth indicators support the credit market and help credit institutions to manage credit risk. With economic growth, consumer loans and other loan holders have sufficient funds to cover their credit expenses because of growing salaries. However, in the long run, we should be cautious because when economic growth initiates inflation growth, central banks start to increase the base interest rate level. Then the credit risk of loans

with no fixed interest rate increases. Nowadays, there is a situation where central banks are increasing base rates very rapidly, and the debt burden for the loan takers increases significantly, so this process simultaneously increases credit risk for financial institutions. Thus, the mentioned credit market factors, such as interest rates, significantly affect credit risk because they are directly related to the household's ability to cover liabilities. At the beginning of an interest rate increase, no significant influence on the level of the non-performing loan portfolio is observed. Still, in the long run, it can cause a significant increase in credit risk and NPL portfolios, especially where there is no support from the government for credit risk management. Bond and stock market indicators can be called not-direct factors for the loan market but correlate with the latter. Bond and stock markets are global, so their effect is global; therefore, it can be said that only national government support policies can adjust the levels of credit risk. Bond yields increase when central banks increase base rates, and the level of increasing yields increases credit risk. Stock markets are based on expectations and future events; accordingly, the effect on credit risk differs. An increasing stock market signals a growing economy, which means that the credit risk is controlled and manageable. Obviously, this factor cannot be only concentrated because many other factors affect the stock market and can change its tendencies in opposite directions for a while. The other results of our research can also be applied to a global context.

Based on our study results and considering the current situation in the economy, it is recommended to policymakers to support the consumer loan market since it is a significant source of economic growth. Lately, central banks have increased base interest rates significantly, and household interest rates have increased simultaneously. It means that the purchasing power of households decreases, and it cannot support economic growth at the same time; it increases credit risk and significantly threatens the financial system's financial stability. It is considered that central banks have already done enough to manage inflation levels, and they do not need to increase base interest rates anymore since it can affect a considerable credit risk increase in the global financial system.

Some countries' governments have already started to support loan markets, especially for young households. The primary purpose is to lower the interest rate burden and, at the same time, support economic growth. The authors of this article think that governments should support not only the mortgage loan market but also the consumer loan market. Now, inflation growth is not only because of higher consumption. The reasons for the increase in price levels are different because we have much higher expenses as a result of the energy crisis, regional instabilities, and other factors. Thus, the solution to manage inflation by sharply increasing the base interest rate is not the best-case scenario because it can cause more financial damage than benefits. Therefore, it is recommended for central banks not to increase base interest rates anymore and for the governments to support low-income households in managing their credit risk by covering a certain amount of their interest expenses.

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## Appendix A

**Table A1.** Credit risk proxies in research studies.

Credit Risk Proxies	Authors
(1) expected default frequency	(Sommar and Shahnazarian 2009; Beck et al. 2015; Mporu and Nikolaidou 2018)
(2) probability of default (PD)	(Jiménez and Saurina 2004; Bonfim 2009; Buncic and Melecky 2013; Johnson et al. 2017; Carvalho et al. 2020)
(3) loan loss provisions	(Quagliariello 2007; Buncic and Melecky 2013; Karoglou et al. 2018)
(4) loss given default	(Beck et al. 2015; Mporu and Nikolaidou 2018)
(5) new bad debts	(Quagliariello 2007)
(6) loan loss reserves	(Love and Turk Ariss 2014)
(7) non-performing loans (NPLs)	(Buncic and Melecky 2013; Beck et al. 2015; Gila-Gourgoura and Nikolaidou 2018; Karoglou et al. 2018; Mporu and Nikolaidou 2018; Koju et al. 2020; Foglia 2022; Naili and Lahrichi 2022a)
(7a) NPLs ratio	(De Bock and Demyanets 2012; Buncic and Melecky 2013; Kiosevski and Petkovski 2017; Zheng et al. 2020)
(7b) The logit transformation	(Espinoza and Prasad 2010)

**Table A2.** The relationship between macroeconomic variables and credit risk indicated in research studies.

The Impact of GDP Growth Variables on Credit Risk	Authors
(i) significantly positive	(a) The impact of GDP growth variables on credit risk
(ii) negative	(Beck et al. 2015)
(iii) significantly negative	(Gila-Gourgoura and Nikolaidou 2018) (cite Messai and Jouini's (2013) findings); (Washington 2014)
(iv) insignificant	(Espinoza and Prasad 2010; Nkusu 2011; De Bock and Demyanets 2012; Castro 2013; Washington 2014; Beck et al. 2015; Mporu and Nikolaidou 2018)
	(Aver 2008; Haniifah 2015)
(i) positive	(b) The impact of interest rates on credit risk
(ii) negative	(Espinoza and Prasad 2010; Castro 2013; Messai and Jouini 2013; Abusharbeh 2020)
(iii) insignificant	(Sulganova 2016; Karoglou et al. 2018)
	(Maltritz and Molchanov 2014); (Ghosh 2015)
(i) positive	(c) The impact of lending interest rate on credit risk
(ii) insignificant	(Louzis et al. 2012; Washington 2014; Beck et al. 2015; Zheng et al. 2020)
	(De Bock and Demyanets 2012)
(i) positive	(d) The impact of credit growth on credit risk
(ii) negative	(Castro 2013; Karoglou et al. 2018; Bayar 2019; Tatarici et al. 2020)
(iii) insignificant	(Washington 2014; Agic and Gacic 2021)
	(De Bock and Demyanets 2012)
(i) positive	(e) The impact of the variables of corporate stock on credit risk
(ii) negative	corporate stock (Aver 2008),
(iii) insignificant	spread of corporate over government bond yields (Lehmann and Manz 2006)
	corporate stock (Castro 2013; Yurdakul 2014 (as cited by Yurdakul (2014)))
	stock market index (Abusharbeh 2020)
(i) positive	(f) The impact of government bond factors on credit risk
	government bond yield (Bonfim 2009)
(ii) significantly positive	the spread between the yield on the 10-year Italian government bond and the corresponding German one
(iii) negative	(Gila-Gourgoura and Nikolaidou 2018)
(iv) significantly negative	the 90-day Treasury bill rate (in the banking systems of Uganda and Namibia) (Nikolaidou and Vogiazas 2017)
(v) insignificant	government bond interest rate (Maltritz and Molchanov 2014)
	the 90-day Treasury bill rate (in the banking systems of South Africa) (Nikolaidou and Vogiazas 2017)
	the average interest rate on a 1-year T-bill (in the banking system of Zambia) (Nikolaidou and Vogiazas 2017)
	the US 10-year Treasury yield (Duffie et al. 2007)
(i) significantly positive	(g) The impact of exchange rate on credit risk
(ii) significantly negative	(Nkusu 2011; Castro 2013; Kiosevski et al. 2019)
(iii) insignificant	(Washington 2014; Nikolaidou and Vogiazas 2017)
	(Aver 2008; Wong et al. 2010; Nkusu 2011; Nikolaidou and Vogiazas 2017; Abusharbeh 2020)
(i) significantly positive	(h) The impact of the institutional environment factors on credit risk
(ii) insignificantly positive	trade freedom (in developed countries) (Maltritz and Molchanov 2014)
	business freedom (in developed countries) (Maltritz and Molchanov 2014)
	trade freedom (in emerging economies) (Maltritz and Molchanov 2014)
	business freedom (in emerging economies) (Maltritz and Molchanov 2014)
(iii) insignificantly negative	fiscal freedom (in developed countries and in emerging economies) (Maltritz and Molchanov 2014)
	freedom from corruption, property rights, financial freedom, investment freedom (both in developed countries and in emerging economies) (Maltritz and Molchanov (2014)



## Appendix B

**Table A3.** Research variables, symbols, and data sources.

Symbol	Variable	Measurement Unit	Data Source
<b>Dependent variables</b>			
Y1	Non-performing loans for consumption-to-total loans	Percent	Deloitte
Y2	Total loans for consumption	Mln. Eur.	ECB Statistical Data Warehouse
<b>Factors of direction of economy</b>			
<b>Economy growth indicators</b>			
X1	Real GDP growth rate	Percent	FRED Economic Data; own calculations
X2	Consumer confidence index (CCI)	Index (points)	Eurostat
X3	Industrial production index	Percent	OECD Statistics
<b>Crisis indicators</b>			
X4	Cases of COVID-19	Total number of cases per mln.	Matheu et al. (2020)
X5	Deaths from COVID-19	Total number of deaths per mln.	Matheu et al. (2020)
X6	Stringency index	Index (points)	Matheu et al. (2020)
X7	COVID-19 pandemic	Dummy variable (0 = no pandemic; 1 = pandemic)	-
X8	The 2008–2009 global financial crisis	Dummy variable (0 = no crisis; 1 = crisis)	-
<b>Factors of financial market conditions</b>			
<b>Factors of credit and payment market</b>			
X9	Credit growth	Percentage change	CEIC Data Global Database
X10	Domestic credit to the private sector	Mln. Eur.	ECB Statistical Data Warehouse
X11	Domestic credit to private sector-to-GDP	Percent	Worldbank Data
X12	Interest rates on loans to non-financial companies	Percent	OECD Statistics
X13	Interest rates on loans to households	Percent	OECD Statistics
<b>Factors of stock and bond market</b>			
X14	Share price index		CEIC Data Global Database
X15	Percentage change in stock market prices		CEIC Data Global Database
X16	Short-term interest rate		OECD Statistics
X17	Long-term interest rate		OECD Statistics
<b>Factors of foreign exchange market</b>			
X18	Exchange rate		Eurostat
X19	Real exchange rate		FRED Economic Data
<b>Institutional environment factors</b>			
X20	Freedom from corruption	Index (points)	The Heritage Foundation
X21	Property rights	Index (points)	The Heritage Foundation
X22	Investment freedom	Index (points)	The Heritage Foundation
X23	Trade freedom	Index (points)	The Heritage Foundation
X24	Business Freedom	Index (points)	The Heritage Foundation
<b>Factors of general macroeconomic condition</b>			
X1 <sup>mcee</sup>	GDP gap (Output gap)	Per cent	OECD Statistics
X2 <sup>mcee</sup>	GDP deflator	Per cent	CEIC Data Global Database
X3 <sup>mcee</sup>	Money supply (M2) growth rate	Per cent	CEIC Data Global Database
X4 <sup>mcee</sup>	Long-term unemployment rate	Per cent	Eurostat
X5 <sup>mcee</sup>	Capital investment	Per cent of GDP	The Global Economy
X6 <sup>mcee</sup>	Current account balance	Per cent	Worldbank Data
X7 <sup>mcee</sup>	House price index	Index (points, annual average)	Eurostat
X8 <sup>mcee</sup>	Industry-value-to-GDP	Per cent	Worldbank Data
X9 <sup>mcee</sup>	Budget-balance-to-GDP	Per cent	Eurostat
X10 <sup>mcee</sup>	Wages and salaries per employee	Eur.	OECD Statistics

Source: compiled by the authors.

**Table A4.** Results of the unit-root (Levin, Lin and Chu) test.

Dependent Variables				
	Levin, Lin and Chu t *	Probability		
Y1	Non-performing loans for consumption-to-total loans	−9.672	<0.0001 **	
Y2	Total loans for consumption	−4.698	<0.0001 **	
Factors of direction of economy				
Economy growth indicators				
X1	Real GDP growth rate	-	-	-
X2	Consumer confidence index (CCI)	−5.418	<0.0001 **	
X3	Industrial production index	-	-	-
Crisis indicators				
X4	Cases of COVID-19		<0.0001 **	
X5	Deaths from COVID-19	-	-	-
X6	Stringency index	-	-	-
X7	COVID-19 pandemic	-	-	-
X8	The 2008–2009 global financial crisis	-	-	-
Factors of financial market conditions				
Factors of credit and payment market				
X9	Credit growth	−2.960	<0.0001 **	1st diff.
X10	Domestic credit to the private sector	-	-	-
X11	Domestic credit to private sector-to-GDP	−3.429	<0.0001 **	
X12	Interest rates on loans to non-financial companies	-	-	-
X13	Interest rates on loans to households	-	-	-
Factors of stock and bond market				
X14	Share price index	−4.885	<0.0001 **	
X15	Percentage change in stock market prices	−16.042	<0.0001 **	
X16	Short-term interest rate	−38.344	<0.0001 **	
X17	Long-term interest rate	−7.181	<0.0001 **	
Factors of foreign exchange market				
X18	Exchange rate	−2.051	0.020 *	
X19	Real exchange rate	−8.793	<0.0001 **	
Institutional environment factors				
X20	Freedom from corruption	−3.553	<0.0001 **	
X21	Property rights	−3.445	<0.0001 **	1st diff.
X22	Investment freedom	−5.361	<0.0001 **	
X23	Trade freedom	-	-	-
X24	Business Freedom	−6.531	<0.0001 **	
Factors of general macroeconomic condition				
X1 <sup>mcee</sup>	GDP gap (Output gap)	−7.018	<0.0001 **	
X2 <sup>mcee</sup>	GDP deflator	−3.874	<0.0001 **	1st diff.
X3 <sup>mcee</sup>	Money supply (M2) growth rate	−2.384	0.009 **	
X4 <sup>mcee</sup>	Long-term unemployment rate	−7.243	<0.0001 **	1st diff.
X5 <sup>mcee</sup>	Capital investment	−14.219	<0.0001 **	
X6 <sup>mcee</sup>	Current account balance	−5.773	<0.0001 **	
X7 <sup>mcee</sup>	House price index	−6.276	<0.0001 **	1st diff.
X8 <sup>mcee</sup>	Industry-value-to-GDP	−3.154	<0.0001 **	
X9 <sup>mcee</sup>	Budget-balance-to-GDP	−9.339	<0.0001 **	1st diff.
X10 <sup>mcee</sup>	Wages and salaries per employee	−8.679	<0.0001 **	1st diff.

Source: compiled by the authors. Note: 1st diff.—variable is stationary at first difference; 2nd diff.—variable is stationary at second difference; \*\*—99% confidence level; \*—95% confidence level; - variable is non-stationary neither at first nor at second difference.

**Table A5.** Results of multiple panel regression analysis for selected “best-performing” general macroeconomic condition variables of consumer loan credit risk in CEE countries (non-performing loans for consumption-to-total loans ratio (Y1)).

Symbol	Variable	Primary Model			Final Model I			Final Model II		
		Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
C		2.207	0.254	0.799	8.397	21.878	<0.0001 **	1.726	0.696	0.487
X1 <sup>mcee</sup>	GDP gap (Output gap)	0.078	0.486	0.629						
X2 <sup>mcee</sup>	GDP deflator	−0.396	−2.195	0.032 *	−0.598	−4.322	<0.0001 **			
X3 <sup>mcee</sup>	Money supply (M2) growth rate	−0.089	−1.515	0.134						
X4 <sup>mcee</sup>	Long-term unemployment rate	0.044	0.810	0.421						
X5 <sup>mcee</sup>	Capital investment	−0.339	−1.472	0.146						
X6 <sup>mcee</sup>	Current account balance	0.025	0.132	0.896				0.238	2.005	0.048 *
X7 <sup>mcee</sup>	House price index	−0.149	−2.321	0.023 *	−0.165	−4.232	<0.0001 **	−0.242	−6.014	<0.0001 **
X8 <sup>mcee</sup>	Industry-value-to-GDP	0.532	1.543	0.128				0.219	2.297	0.024 *
X9 <sup>mcee</sup>	Budget-balance-to-GDP	0.121	1.122	0.266	0.201	2.553	0.012 *	0.212	2.545	0.012 *
X10 <sup>mcee</sup>	Wages and salaries per employee	−0.121	−0.689	0.493						
	<b>R-squared</b>		0.353			0.329			0.354	
	<b>F test</b>		<0.0001			<0.0001			<0.0001	
	<b>Hausman test</b>		<0.0001			<0.0001			0.182	
	<b>Model</b>		Fixed effects			Fixed effects			Random effects	
	<b>Observations</b>		87			106			106	

Source: compiled by the authors. Note: \*\*—99% confidence level; \*—95% confidence level; <sup>mcee</sup>—selected “best-performing” variable from the group of general macroeconomic condition variables for the group of CEE countries.

**Table A6.** Results of panel regression analysis for macroeconomic determinants of consumer loan credit risk in CEE countries (non-performing loans for consumption-to-total loans ratio (Y1)).

Symbol	Variable	Coefficient	t-Statistic	Prob.	R sq.	Observ.	F Test	Hausman Test	Model
<b>General macroeconomic condition factors</b>									
<b>Factors of direction of economy</b>									
<b>Economy growth indicators</b>									
X2	Consumer confidence index (CCI)	−0.094	−3.599	0.001 **	0.107	110	0.000	0.177	Random effects
<b>Crisis indicators</b>									
X4	Cases of COVID-19	$-7.37 \times 10^{-5}$	−3.794	<0.0001 **	0.117	111	0.000	0.519	Random effects
X7	COVID-19 pandemic	−3.015	−3.518	0.001 **	0.102	111	0.000	0.299	Random effects
X8	The 2008–2009 global financial crisis	−0.768	−0.663	0.509	0.004	111	0.000	0.829	Random effects
<b>Factors of financial market conditions</b>									
<b>Factors of credit and payment market</b>									
X9	Credit growth	−0.023	−0.661	0.510	0.004	108	0.000	0.267	Random effects
X11	Domestic credit to private sector-to-GDP	0.191	5.391	<0.0001 **	0.003	111	0.000	0.011	Fixed effects
<b>Factors of stock and bond market</b>									
X14	Share price index	−0.018	−3.714	<0.0001 **	0.609	111	0.000	0.057	Fixed effects
X15	Percentage change in stock market prices	0.008	0.422	0.674	0.002	111	0.000	0.805	Random effects
X16	Short-term interest rate	0.675	3.728	0.003 **	0.118	104	0.000	0.158	Random effects
X17	Long-term interest rate	0.839	5.758	<0.0001 **	0.243	105	0.000	0.174	Random effects
<b>Factors of foreign exchange market</b>									
X18	Exchange rate	−0.101	−3.031	0.003 **	0.592	111	0.000	0.001	Fixed effects
X19	Real exchange rate	0.018	0.257	0.798	0.001	111	0.000	0.798	Random effects
<b>Institutional environment factors</b>									
X20	Freedom from corruption	−0.005	−0.300	0.765	0.005	111	0.000	0.032	Fixed effects
X21	Property rights	−0.082	−2.233	0.028 *	0.045	108	0.000	0.667	Random effects
X22	Trade freedom	−0.162	−2.939	0.004 **	0.074	111	0.000	0.521	Random effects
X24	Business Freedom	0.139	1.424	0.157	0.019	108	0.000	0.144	Random effects

Source: compiled by the authors. Note: \*\*—99% confidence level; \*—95% confidence level.

**Table A7.** Results of panel regression analysis for total loans for consumption (Y2) in CEE countries.

Symbol	Variable	Coefficient	t-Statistic	Prob.	R sq.	Observ.	F Test	Hausman Test	Model
<b>General macroeconomic condition factors</b>									
<b>Factors of direction of economy</b>									
<b>Economy growth indicators</b>									
X2	Consumer confidence index (CCI)	−7.698	−0.382	0.702	0.001	138	0.000	0.456	Random effects
<b>Crisis indicators</b>									
X4	Cases of COVID-19	0.020	1.138	0.257	0.009	139	0.000	0.632	Random effects
X7	COVID-19 pandemic	1183.849	1.519	0.131	0.017	139	0.000	0.329	Random effects
X8	The 2008–2009 global financial crisis	−504.121	−0.788	0.432	0.004	139	0.000	0.326	Random effects
<b>Factors of financial market conditions</b>									
<b>Factors of credit and payment market</b>									
X9	Credit growth	−1.719	−0.074	0.942	0.007	130	0.000	0.016	Fixed effects
X11	Domestic credit to private sector-to-GDP	32.683	1.493	0.137	0.016	137	0.000	0.214	Random effects
<b>Factors of stock and bond market</b>									
X14	Share price index	7.804	2.241	0.027 *	0.036	139	0.000	0.710	Random effects
X15	Percentage change in stock market prices	−3.659	−0.321	0.748	0.001	139	0.000	0.428	Random effects
X16	Short-term interest rate	44.007	0.394	0.694	0.006	132	0.000	0.028	Fixed effects
X17	Long-term interest rate	57.422	−0.559	0.577	0.003	127	0.000	0.168	Random effects
<b>Factors of foreign exchange market</b>									
X18	Exchange rate	−31.869	−1.461	0.146	0.015	139	0.000	0.151	Random effects
X19	Real exchange rate	−3.366	−0.071	0.943	0.001	139	0.000	0.307	Random effects
<b>Institutional environment factors</b>									
X20	Freedom from corruption	10.489	1.114	0.267	0.009	139	0.000	0.668	Random effects
X21	Property rights	−16.007	−0.550	0.583	0.002	130	0.000	0.759	Random effects
X22	Trade freedom	156.236	3.715	<0.0001 **	0.091	139	0.000	0.144	Random effects
X24	Business Freedom	−62.287	−0.946	0.346	0.007	130	0.000	0.251	Random effects

Source: compiled by the authors. Note: \*\*—99% confidence level; \*—95% confidence level.



**Table A8.** Results of multiple regression analysis for selected “best-performing” variables of consumer loan credit risk in the group of CEE countries (non-performing loans for consumption-to-total loans ratio (Y1)).

Symbol	Variable	Primary Model			Final Model		
		Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
C		−13.435	−1.403	0.165	−10.786	−1.989	0.049 *
X1 <sup>mcee</sup>	GDP gap (Output gap)	−0.181	−1.105	0.273			
X2 <sup>mcee</sup>	GDP deflator	−0.029	−0.176	0.860	−0.334	−2.510	0.014 *
X3 <sup>mcee</sup>	Money supply (M2) growth rate	0.009	0.165	0.869			
X4 <sup>mcee</sup>	Long-term unemployment rate	0.053	1.070	0.288			
X5 <sup>mcee</sup>	Capital investment	0.061	0.277	0.782			
X6 <sup>mcee</sup>	Current account balance	0.195	1.126	0.264	0.258	2.396	0.019 *
X7 <sup>mcee</sup>	House price index	−0.164	−2.617	0.011 *	−0.164	−4.333	<0.0001 **
X8 <sup>mcee</sup>	Industry-value-to-GDP	0.841	2.640	0.011 *	0.429	2.206	0.030 *
X9 <sup>mcee</sup>	Budget-balance-to-GDP	0.035	0.355	0.723	0.143	1.933	0.046 *
X10 <sup>mcee</sup>	Wages and salaries per employee	−0.001	−0.135	0.892			
X2	Consumer confidence index (CCI)	0.025	0.690	0.492			
X4	Cases of COVID-19	$-1.81 \times 10^{-5}$	−0.573	0.568			
X11	Domestic credit to private sector-to-GDP	0.138	3.793	<0.0001 **	0.154	5.059	<0.0001 *
X14	Share price index	−	−	−			
X18	Exchange rate	−0.130	−2.596	0.012 *			
X22	Investment freedom	−0.066	−1.016	0.313			
R-squared			0.542			0.158	
F test			0.000			0.000	
Hausman test			0.000			0.000	
Model			Fixed effects			Fixed effects	
Observations			86			106	

Source: compiled by the authors. Note: \*\*—99% confidence level; \*—95% confidence level; <sup>mcee</sup>—selected “best-performing” variable from the group of general macroeconomic condition variables for the group of CEE countries.

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