Credit Risk Determinants in the Banking Sectors of the Baltic States

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Declaration:
Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any academic degree.

Igor Novikov _____

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Introduction

The banking sector as many other sectors of the economy is constantly going through various types of changes, transformations, amendments and improvements. There are numerous reasons for that: globalization, constantly toughening competition between participants in the banking market, deregulation, rapid development of financial and related products and services, demographic trends and technological changes.

The presented list is definitely not comprehensive, and the risk measurement and management activities related to these remain the fundamental logic of the work of the banking sector. The list of risks, faced every day by banks, is substantial and there is no point to present it here. But risk measurement and management ought to be permanently and appropriately organized and performed.

Risks can be divided into two main groups: the group of main/primary risks and the group of secondary risks. Risk measurement and management of any bank is to concentrate mainly on risks of the first group and monitor any changes in their behaviour and the influence of the determinants of these risks.

Without doubt credit risk belongs ingenuously to the risks of the first group. Credit risk is present in a large number of products and services. There are many definitions of credit risk. However, they all describe the necessity to determine the possibility of the repayment of the loan by the borrower. Therefore credit risk measurement as a measurement of borrowers' default possibility relies definitely on the analysis of components, i.e. determinants of credit risk.

Since sound economic growth and an effective banking system are strongly related, the weakness or imperfection of financial intermediation can contribute to the possible problems of the economic system, resulting in the recession of the economy, and negative macroeconomic developments would bring about financial vulnerability.

Financial or banking crises are not isolated or rare events. Failures of banking systems to perform operations have affected both developed and transition countries. Honohan (1997, 1998) notes that the resolution cost[1], paid out in these countries, constituted the total amount of 250 billion US dollars. These costs have been borne by various economic units such as depositors and creditors of failed banks, governments or their agencies. Caprio and Klingebiel (1996) and Evans (2000) report that generally transfer payments for covering banking losses made up 6–25% and occasionally up to 40–55% of GDP.

Honohan (1998) states that after the period of 1950–75, considered as free of banking failures, the cycle of new substantial bank failures followed and that

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[1] The resolution cost is the sum of the outlays made by government or its agencies to cover incurred obligations, recoveries on assets of a failed bank.

was much worse than prior to 1950. Llewellyn (2002) argues that the bankruptcy rate among commercial banks has been greater than since the period of the great depression.

Honohan (1997) emphasizes the correlated similarities between the crises of the 1930s and the crises experienced in developed and transition countries during the last quarter-century, for example, in Latin American countries, such as Argentina, Chile and Uruguay in 1979–83 and later in Mexico in 1994, in the Nordic countries in 1987–94 and in Japan since 1992, also the lending boom in the developing countries that started at the end of the 1970s and ended in 1982. The crises were the definite hybrid of macro- and microeconomic factors.

Since international financial markets have become more integrated the banking problems in the emerging markets have substantial consequences for both local economies and the economies of international investors.

Two-thirds of the IMF member-countries suffered from substantial banking system problems during the period 1980–96. According to estimates by Caprio and Klingebiel (1996), the total losses of industrialized countries were as follows: for Finland (1991–93) up to 8% of GDP, for Japan (1990s) more than 100 bn USD, for Norway (1987–89) up to 4% of GDP, for Sweden (1991) 6.4% of GDP, for saving and loan crises in the USA (1984–91) 3.2% of GDP with possible cost of 180 bn. USD and the most severe result for Spain (1977–85) 16.8% of GDP. The total losses of many developing countries for the analogous period were even severer, for example, Argentina (1989–90) 55.3% of GDP, Chile (1982–85) 41.2% of GDP, Bulgaria (1990s) 14% of GDP.

Based on the number of financial crises, which have emerged in the developed and in the developing countries, banking crises could be treated as increasingly common events, especially in the developing world.

However, the financial crisis that started in 2007 confirmed the opposite view. According to the results of Laeven and Valencia (2010), the financial crisis concentrated mainly in the advanced economies, where financial systems are large, integrated and well developed unlike the experience of any previous crises faced in various developing or emerging market economies, as the data of Figure 1 illustrate.

The level of non-performing loans in the developed European countries fluctuated around 2% within the period 2001–08, but during 2009 this ratio grew up to 7.55% (Figure 1), making the growth 234%. The fluctuation of the level of non-performing loans for transition European countries had much larger amplitude. The ratio fell from 11.55% in 2002 to 4.52% in 2007. After 2007 and over the next two years the level of non-performing loans grew in all mentioned regions: world – 56%, Europe – 274%, developed European countries – 376%, transition European countries – 207%.
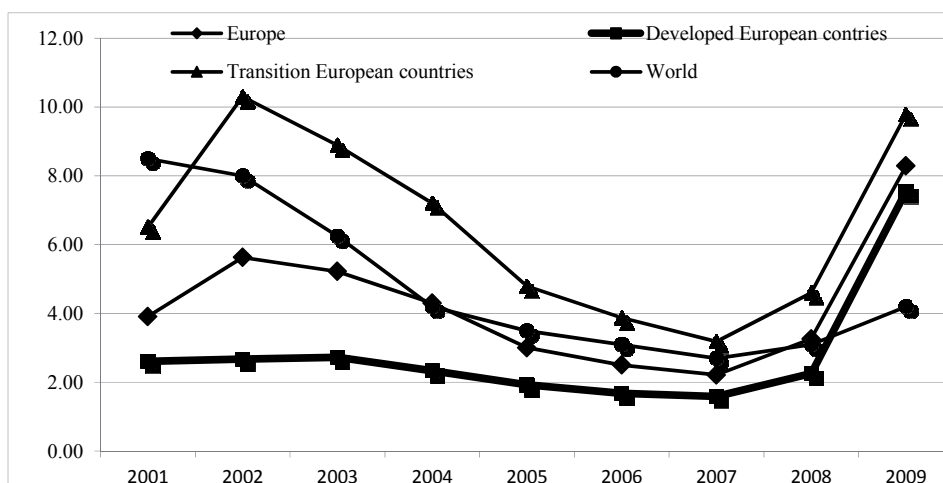
Figure 1. The level of non-performing loans in various world regions
Note: Author's calculation.
Source:http://search.worldbank.org/quickview?view_url=http%3A%2F%2Fdatabanksear
ch.worldbank.org%2FDataSearch%2FLoadReport.aspx%3Fdb%3D2%26cntrycode%3D
%26sercode%3DFB.AST.NPER.ZS%26yrcode%3D

In view of the strong interconnection between the financial institutions of developed countries liquidity shortage followed and prompted large-scale government interventions.

The overall output losses of the crises in 2007–09 were higher compared to the previous ones (Table 1). The same is true about the public debt.

Table 1. The cost of the financial crises

	Direct fiscal cost	**Increase in public debt**	**Output losses**
Median (% of GDP)			
Old crises (1970–06)			
Advanced economies	3.7	36.2	32.9
Emerging markets	11.5	12.7	29.4
All	10.0	16.3	19.5
New crises (2007–09)			
Advanced economies	5.9	25.1	24.8
Emerging markets	4.8	23.9	4.7
All	4.9	23.9	24.5

Source: Laeven and Valencia (2008, 2010)
Note: New crises include Austria, Belgium, Denmark, Germany, Iceland, Ireland, Latvia, Luxembourg, Mongolia, Netherlands, Ukraine, United Kingdom and United States

On the other hand, the total amount of direct fiscal costs of the new crises associated with the financial sector intervention was approximately twice lower compared to the previous ones. In spite of this, extremely high direct fiscal costs were recorded for Iceland, Netherlands, United Kingdom, Luxemburg, USA, Belgium (see, Laeven and Valencia, 2010). In Greece, Latvia and Spain direct financial costs achieved an especially severe level, threatening their economic stability and the stability of the financial system. These results of the current crises are preliminary ones only since still there is no evidence of positive changes of the market situation.

The described banking system failures and the results of the previous and the new crises in 2007–09 make it necessary to re-estimate how financial and banking systems' regulation and supervision are to be executed.

Generally, the banking system is an area with most particularly defined legislation and based on it regulation and supervision systems. Governments and their empowered authorities have employed a whole set of policies meant to support and provide financial sector stability and to avoid or actively and effectively deal with the possible financial crises (for example, minimum requirements worked out and approved by Basel Committee on Banking Supervision).

Supervision authorities of many developed and transition countries have adopted these requirements for their national financial markets. International experience and requirements form the basis of unification of legislation, regulation and supervision should guarantee the avoidance of financial market's possible distress. On the other hand, the existence of such unification is not an ultimate cure for financial crises, but just a definite precondition.

To achieve a sound policy and further financial stability it is necessary to focus first on the identification of policy priorities and secondly on their constant correction and improvement. This is possible as a result of responses constantly received through commercial banks' supervised activities and their financial results. Normally such responses depend on the revealed internal factors of the crises and some other inputs, which remain unresolved. For this reason it is important to add changing the macroeconomic environment as an integral part of the mentioned policies.

Commercial banks' weaknesses apparent through inadequate legislation, weak corporate governance, incentive structures within banks and other negative factors escalate the financial crises and interfere with crises resolution. Uncontrolled financial liberalization could lead to the mentioned distress. Therefore sound risk management policies applied within commercial banks will lead to weighed decisions made by banks management. Especially it implies for a small country with the open economy, where the banking sector holds the dominant position.

Since the beginning of the 1990s up to the present time most of the transition countries have been going through a constant process of banking system

restructuring. Because of a whole set of the underlying reasons they have experienced serious banking system distress over that period. The three Baltic States are not an exception.

After the restoration of the independence at the beginning of the 1990s the Baltic States have suffered from several financial crises. Although these crises had different initial causes, as a common result a constant revising and improvement of existing risk management policies have followed, providing relevant credit risk measurement.

The first crises of the banking systems of the Baltic States had some common origins. The initial point of the development of the banking systems of all three Baltic States came from the separation from the monobank system of the former Soviet Union. The central banks as a core of the national banking systems were established and quick licensing of new commercial banks and rapid development of new private-owned commercial banks followed (see Table 2).

Table 2. The number of banks and branches of foreign banks in the Baltic States

	1992	1993	2011	Change in the number of banks, 2011/1992	% Change, 2011/1992
Estonia	42	21	18	−24	−57%
Latvia	61	55	30	−31	−51%
Lithuania	N/A	27	20	−7	−26%*

Note: * – changes for Lithuania are calculated using data of the year 1993
Source: Fleming, Chu and Bakker (1996), www.fi.ee, http://eng.bankasoc.lv, www.lb.lt, Lepik (1996)

The data of Table 2 demonstrate that within the last 19 years the number of banks in Estonia has decreased by 24 down to 18, in Latvia by 31 down to 30 and in Lithuania by 7 down to 20 banks and branches of foreign banks.

Initially many commercial banks of the Baltic States were established by various production enterprises, located in the Baltic States. Since the restoration of the independence of the Baltic States many old sale channels were lost and enterprises were forced to search for new ones, they needed working capital and substantial investments into new technologies. Investing into commercial banks has been seen as a financing possibility for investment resources needed.

Such strong connection between enterprises-shareholders and their financing commercial banks led to the rapid development of various problems, such as moral hazard, non-performing loans, fraud risk and others. Often financing was granted with the pledge of banks shares whose owner was an enterprise-shareholder with the explanation that in case of a failure with loan repayment the bank could sell the pledged shares at the open market.

The problem with that type of collateral is its value. If the bank generates positive cash flows and sufficient profit, the value of the shares consists of the proportion in the equity and the additional value based on the future cash flows.

If positive cash flows are generated constantly, the value of pledged shares will grow; otherwise the value of the shares will converge to zero.

Since many investment projects covered by banks shares as collateral failed at the beginning of the 1990s, the level on non-performing loans was substantial, some bank bankruptcies followed and the supervision authorities implemented changes in the legislation prohibiting banks to use their shares as collateral.

The first banking crises emerged in all Baltic States approximately within the same time period, 1992–95. Estonia faced two financial crises, one in 1992, when the number of insolvent banks constituted 41% of the financial system assets, and the other in 1994, when the Social Bank, which held 10% of the banking market, bankrupted.

The number of commercial banks in Latvia decreased from 61 in 1992 down to 33 in 1996. The years 1994 and 1995 were severe for the Latvian banking sector, since licenses for several commercial banks were cancelled and in 1995 one of the largest banks (Bank Latvija) and eight other banks (Latvijan Deposit Banks, Centra Bank, Olipmija, Latintrade Bank, Alejas Bank, Kredo-Bank and two other banks) which held up to 40% of the market, bankrupted (see Fleming and Talley, 1996 and Caprio and Klingebiel, 1996).

The Lithuanian first banking crisis started in 1995 and finished in 1996. As a result of the following distress the Central Bank withdrew the license of the country's largest private bank and of one mid-size private bank. As an additional measure to balance the market situation state intervention into two small commercial banks followed (see Fleming and Talley, 1996 and Caprio and Klingebiel, 1996).

General conclusions of risk measurement of that period are insufficient and inadequate legislation, regulation and supervision, corruption and bad risk management policies, rapid assets growth, insider and political influences (Fleming and Talley, 1996; Fleming, Chu and Bakker, 1996; Männasoo and Mayes, 2009). Given that, several serious legislation changes were initiated and passed by the parliaments of the Baltic States. One of the important changes was the mandatory increase of banks' equity up to 5 mln. EUR. A new period of banking sector development through consolidation followed.

New banking sector problems in the Baltic States emerged in 1998–99 after Russian economic distress began. In Estonia three commercial banks bankrupted (EVEA Bank, Maapank, Era Bank) and several commercial banks merged: Union Bank with the Bank of Tallinn, Hansabank with Savings Bank and Investment Bank with Forex Bank. Before the merger of Forex Bank and Investment Bank the Forex Bank was taken over by the Bank of Estonia.

This crisis was not so severe for the Latvian banking sector: one bank self-liquidated and one bankrupted; 19 of 24 banks ended 1999 with profits (see Latvian bank account).

Lithuania suffered less directly compared to the other two Baltic States. The State Commercial Bank (state-owned) was liquidated and Litimpeks Bank bankrupted in 1999. New and immediate amendments of legislation followed.

As a new development stage of the banking systems of the Baltic States Skandinavska Enskilda Banken and Föreningssparbanken (Swedbank) started acquiring commercial banks in all Baltic States in 1998 creating a holding, which covered the Baltic and Nordic States. The coming of the Scandinavian banks provided a stability of the banking market. However, they started to compete for a bigger market share, and banking sector instability followed.

The financial crisis, which started in 2007, has demonstrated that commercial banks' management of the three Baltic States has concentrated mainly on the increasing of the market share and providing constantly growing profit to their shareholders. This type of the commercial banks' behaviour is in compliance with Thakor and Besanko (2004), who confirmed this statement examining the consequences of various types of banking competition. They have reported that increased interbank competition may lead to a total worsening of all borrowers' welfare.

The credit risk measurement efficiency of a banking system can be presented by two parameters: profitability and the level of non-performing loans. The idea of dependence of the banking system credit risk on the level of profitability was proposed by Minsky (1992, p. 6) in his 'financial instability hypothesis', according to which 'banking is taken seriously as a profit-seeking activity'. Total debt or indebtedness is taken as the second main parameter in this hypothesis.

Berger and DeYoung (1997) propose the use of cost efficiency as an important indicator regarding the future level of non-performing loans and problem banks. They state that the reduction in cost efficiency precedes the growth of non-performing loans and on the other hand the reduction in the level of non-performing loans will result in the reductions of monitoring cost (cost efficiency). The reduction of the bank's capital is seen as an additional factor for banking instability.

There have been published several research works concentrating on the influence of credit risk determinants of a single country (for example, Fainštein and Novikov, 2010, 2011; Kattai, 2010), estimating bank distress reasons for Eastern European transition economies over the period 1995–2004 (see Männasoo and Mayes, 2009) and the distress problems in the Baltic States at the beginning of the 1990s, for example, Fleming and Talley, 1996; Fleming, Chu and Bakker, 1996. No analogous researches including comparative analysis of credit risk determinants of all three Baltic States for the financial crises in 2007–09 have been performed yet.

The main scientific contribution and novelty of this thesis is in developing of relevant credit risk model that is increasingly important for the stability of any banking system. Based on the development of credit risk determinants in the past, the forecasts of changes in the general level of credit risks or some of their parts will lead to the acceptance of appropriately measured credit risk. The research aims to propose an innovative approach to credit risk measurement that

can be easily amended according to the permanently changing market conditions and used for forecasting the loan activity of banks.

Another possible way of use of the model proposed in the thesis is estimation of the general level of the credit risk taken banking sector by the supervision authorities of the three Baltic States. This will allow minimising the risk of overheating the economy. The results of the research would be interesting for banking sectors and policy makers responsible for the development of the economic policy.

Permanent monitoring of credit risk determinants is a basis for the mentioned policies and for further decision-making processes. Against this background and in order to provide stable economic development, it is important to analyse what type of credit risk determinants played the most crucial role in the growth of non-performing loans in the Baltic States. This is my second motivation of the thesis.

Additionally the quantitative research of the thesis focuses on the interaction of several credit risk determinants acting simultaneously.

The thesis consists of five main chapters. Figure 2 demonstrates the scheme of the thesis with the aim to help the reader to get a better descriptive overview.

In an introduction into the research field I present the innovation and novelty of the research and define the hypotheses that are to be proved or rejected based on the results of the empirical analysis.

Chapter 1 presents an analytical framework of credit risk analysis. A literature review is given and the results of the previous researches and analyses defining the reasons of the earlier financial or banking crises are discussed. Three types of the credit risk determinants – macroeconomic, banking sector and real estate market variables – are reviewed.

Chapter 2 concludes the factors of credit risk associated with the development of the banking sectors of the Baltic States. The main aim of this chapter is to present the changes of different credit risk determinants pointing out the dependence of the Baltic States on the short-term liabilities granting long-term loans. Also the changes and the influence of other related and important factors are analysed and described.

Based on the theoretical information, considered in chapter 1 and the analysis of credit risk determinants of the banking sector of the Baltic States, presented in chapter 2, the initial model specification and variables are described in chapter 3. Also the causality of the variables is analysed.

Chapter 4 defines the methodological approaches and concentrates on the econometric analysis of the influence of the credit risk determinants of the banking systems of the Baltic States on the level of non-performing loans. To achieve the aim of the thesis two econometric approaches are applied: time series analysis and panel data analysis. The results based on the presented approaches are combined and considered in chapter 5.

Discussions on the topic of the research are presented in chapter 5. The chapter is divided into three sections, presenting the introductory part of the chapter, further results interpretation, where the results of time series and panel data analysis are separately considered. Remarks on supervision authorities' activities end the chapter.

In a conclusion I summarize the observations and present the implication of the results.

The list of the literature used in the thesis, the summary in the Estonian language and the abstract end the thesis. The summary and the abstract present the most important patterns of the research, include the implications of the results and draws conclusions.
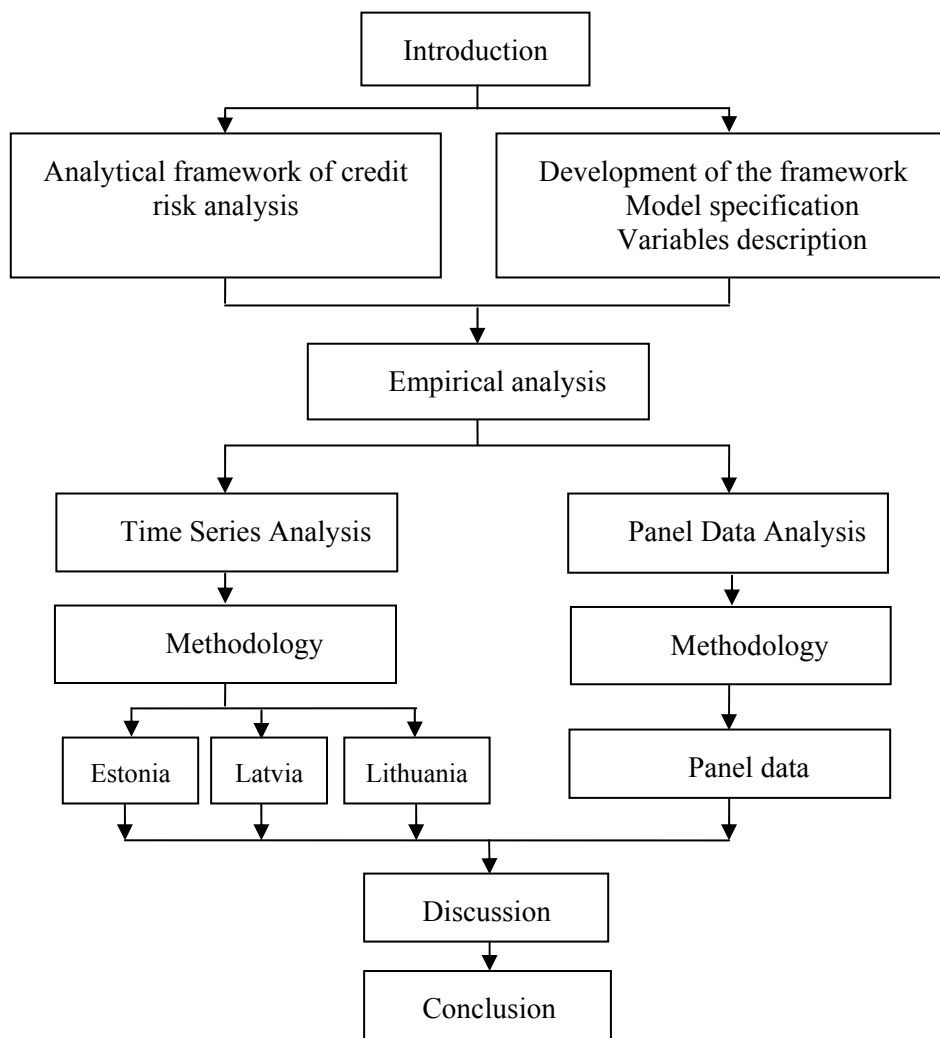
Figure 2. Scheme of the thesis

The appendices presented after the references contain additional, descriptive information and are referred to in the text of the thesis.

The main idea of the research is to empirically investigate and compare the evolution and the influence of credit risk determinants of the banking systems of the three Baltic States, i.e. the influence of macroeconomic and banking sector variables on the level of non-performing loans in each Baltic State, in order to define the similarities and differences.

A secondary goal was to analyse the effect of loan portfolio growth on the level of non-performing loans in these countries and to define the type of influence of the variables, i.e. long-term or short-term.

The third aim was to determine what type of influence the variables have, i.e. long-term or short-term one.

The thesis aims to prove or reject the following hypotheses:

Hypothesis 1: All independent variables of the research that is macroeconomic, banking sector and real estate market variables, have long-term influence on the level of non-performing loans.

Hypothesis 2: Macroeconomic variables are important for predicting the level of non-performing loans.

Hypothesis 3: The rapid growth of indebtedness is crucial to the growth of non-performing loans.

Hypothesis 4: The rapid growth of real estate markets is an extremely important variable in forecasting the level of non-performing loans.

Hypothesis 5: Response of banks to the negative changes of credit risk determinants was not proper and effective.

The results of the thesis provide the following contributions:

1. Since the initial reasons and the results of the negative impact of the financial crises in 2007–09 on the level of non-performing loans in the Baltic States have not been researched jet, the main empirical contribution is in defining the reasons of the banking crises in 2007–09 and comparing them between the three Baltic States.

    Any banking crisis causes possible financial sector instability, distress and the one of the main tasks of any supervision authority to avoid it. The results of the research help properly to estimate trends of the market development and minimise the risk of overheating the economy. Against

this background the results can be used by commercial banks, supervision authorities and policy makers of any country especially with open economy.

2. An innovative approach of credit risk analysis based on the combined influence of different credit risk determinants, which can be used for forecasting the financing activity of banks, has been developed and tested empirically.
3. The efficiency of credit risk determinants analysis, applied by banks before the financial crises in 2007–09, was researched, identified and compared between all three Baltic States.
4. The simultaneous impact of all independent variables on the level of non-performing loans was estimated.
5. Since all Baltic States have had a substantial growth of the real estate market, additionally the influence of the growth of the real estate market on the level of non-performing loans was tested.

Acknowledgements

Abbreviations

Abbreviations used in the thesis are the following:

RNPL   – the ratio of non-performing loans to the aggregated loan
                    portfolio of banks
GALP   – the growth of a banks' aggregated loan
GGDP   – the growth rate of the real GDP
RRE   – the growth rate of the real estate market of the Baltic States
UN   – the unemployment rate
OLS   – Ordinary Least Squares procedure
VECM   – Vector Error Correction Model
the ADF test   – the Augmented Dickey–Fuller test
AIC   – Akaike Information Criteria
BIC   – Bayesian Information Criteria
FPE   – Final Prediction Error
LM   – Lagrange Multiplier
LS   – Least Square Method
EGLS   – Estimated Generalized Least Square Method

1. Analytical Framework of Credit Risk Analysis

1.1. Common Elements in the Banking System Distress

If other incomes are taken as a constant, generally the business of banking relies on the earning of interest rate net margins coming from the difference of interest incomes of loans granted and the cost of deposits taken. In spite of the regulatory institutions' requirements for the existence of adequate risk management policies within commercial banks, banking system distresses are likely to emerge since banks are vulnerable to both external and internal causes of crises with possible failures and mistakes of regulation and supervision.

Banks are intermediaries of different capital flows. Movements of capital are difficult to forecast and model. Therefore, based on the nature of the internal functioning, banks are prone to crises. According to Breuer (2006), serving the central role in the resources allocation between borrowers and lenders the banking sector can fall a victim to possible conflicts of interests distorting the banks' function and threatening the economic growth and stability.

Given that, credit risk is one of the many factors with a substantial influence on the stability of a banking system. It is important to measure and control the determinants of credit risk, especially at the aggregated level.

Based on the information of determinants' changes in the past and present, the credit risk estimation process results in the forecast efficiency and accuracy defining the banking system's dependence on the different types of input parameters.

Llewellyn (2002) proposes that almost every banking crisis is a complex sequence between economic, financial and structural weaknesses. Going into further detail, macroeconomic, banking sector and also microeconomic level variables are the most important for credit risk measurements.

Corsetti, Pesenti and Roubini (1998) and Llewellyn (2002) emphasize that banking crises have multidimensional roots and simultaneous convergence of various negative contributory factors will usually lead to a financial or banking crisis.

According to Goldstein and Turner (1996), Lindgren, Garcia and Saal (1996), Corsetti, Pesenti and Roubini (1998), Brealey (1999), Llewellyn (2002), researches of previous financial crises faced by developed and transition countries demonstrate the following initial and common characteristics of banking problems development: external and domestic macroeconomic volatility; lending booms associated with rapid assets' prices' growth, followed by collapses and sudden invested capital withdrawals; ineffective, inadequate and weak legal framework and based on it sudden and rapid financial liberalization; inadequate banking practice, fraud and moral hazard risks; structural weakness of the system allowing for the absence of effective market

discipline and weak supervision; heavy government involvement and uncontrolled lending to related counterparts; exchange rate regimes.

Based on the characteristics of banking problems of the 1980s and 1990s, Honohan (1998) points out three major factors contributing to the emergence of financial crises: (1) increased volatility of real and especially nominal macroeconomic determinants during the fourth quarter of the century, (2) rapidly growing general level of the indebtedness of the economy not covered by an adequate level of the banking equity and (3) a recognition factor according to which banking insolvency problems started to be treated as such, aiming to work out and apply special means to recover banks having problems. However, in analysing the patterns of systemic financial failures, he includes besides the macroeconomic epidemics and endemic crises in a government-permeated banking system also poor management and other microeconomic subfactors.

Borio, Furfine and Lowe (2001) additionally emphasize the risk of concentrating the banking activity on the rapid increase of the loan portfolio, since this creates constantly deteriorating balance sheet equality, lowering the share of the equity and allowing for the disbalance between the illiquid long-term assets (i.e. granted loans) and liquid short-term liabilities (i.e. deposits).

Breuer (2006) argues that besides the internal factors of the banking sector the set of other non-banking, political and legal institutions and non-banking regulation and supervision, also institutional corruption will have a definite and strong impact on the level of non-performing loans. The institutional aspect of the country may have a negative impact.

A peculiar contribution to the analysis of banking sector distress was made by De Jonghe (2010) using bank-level data. He proposes that possible bank problems and the instability of the banking system emerge if banks shift in their activity to non-traditional banking operations, such as non-interest income, commissions- related businesses etc.

Given that, the whole set of the described variables used for research purposes could be roughly divided into three main groups: macroeconomic variables, internal factors related to banking system functioning and other factors, for example legislation, the effectiveness of supervision. Since other factors can be eliminated by relevant efficient legislation and other normative acts, macroeconomic and banking sector variables remain the ones to which constant attention is to be paid.

Männasoo and Mayes (2009) performed an analysis with the purpose to define the warning indicators for banking crises prediction. Based on the panel data of 600 banks from 19 Eastern European transition countries and using three types of variables, macroeconomic, bank-specific, and bank sector structure, they demonstrated that macroeconomic variables are sufficiently effective to determine when possible problems are likely to emerge. Banking sector structural variables can define which country is more likely to have possible distress under definite macroeconomic conditions.

Therefore inclusion of macroeconomic and banking sector variables into research provides a relevant and valuable ground for analysing and modelling economic processes. According to de Juan (2002), implementing only actions for macroeconomic balance without the adequate support of the financial sector characteristics would be ineffective or even counterproductive.

1.2. The Macroeconomic Determinants of Banking System Stability

IMF (2000), Llewellyn (2002), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007) and Bonfim (2009) report that macroeconomic variables are to be included into credit risk analysis since they have considerable influence on the changes of credit risk at the aggregated level. Lindgren, Garcia and Saal (1996) concluded that many financial crises have had macroeconomic origins and besides have been related with sudden withdrawal of liquid external capital from the country.

Negative changes of macroeconomic variables are usually treated as external negative shocks. External negative shock can be interpreted as the negative difference between the real and expected value of macroeconomic parameters. A negative shock can be spurred by the adjustment of any macroeconomic parameter leading the economy into the recession stage after a period of strong growth.

Fisher (1933) introduced the impact of the general level of indebtedness on the economy. Fisher (1933) and Pesola (2001) stated that the rise of the instability of a banking system becomes apparent when the level of indebtedness of an economic unit grows constantly. The influence of the external negative shocks starts to play a more crucial role. The internal dynamics of the economy is important, but the growth of instability appears exactly with the external negative changes.

Pesola (2005) proposes that the existence of 'definite reasons' can cause a rapid growth of the indebtedness level, which together with the influence of an external negative shock can become a reason for instability in the banking sector.

Various countries have different levels of aggregated indebtedness, and there is no correct answer when the level of aggregated indebtedness becomes crucial for a banking system. Minsky (1992) stated the following reason: internal dynamics of the economy and the system of state interventions provide for its existence within definite limits. In other words, the financial markets are constantly unstable and external shocks, as the reason for the system becoming unstable, are to be taken into consideration.

Based on the idea of external negative shock, Pesola (2005) gives a description of credit risk development at the aggregated level. Rapidly growing indebtedness becomes the reason for the possible increase of instability of the banking system. When conditions for the deterioration of macroeconomic indicators exist, there is an essential decrease in the solvency of the banks'

customers. These changes cause the growth of non-performing loans. Furthermore, if the economic conditions remain unchanged or have a further negative tendency, the level of loan losses can lead to the bankruptcy of some banks. Fisher (1933) presented a similar end of the cycle.

According to Aroa, Giulini, Ittner and Pauer (2001), the monitoring of macroeconomic indicators is especially important in the situation of unsoundness because of procyclicality of the economy and related with it cyclical factors, since most of the commercial banks are impacted by the same set of input factors. The experience of the previous crises has affirmed that there is a definite set of variables that have the most significant influence, for example, rapid growth of the real GDP associated with the growth of the loan portfolio and assets prices.

Honohan (1998) links the evolution of the banking crises to the possible regime shift, which alters the internal and external conditions of shocks to the economic and financial system. After years of stability or constantly improving market conditions the market participants cannot adequately assess the changes in the economy and underestimate their negative influence in the future operating on the basis of rules and procedures that were effective within the previous environment earlier. As a result, a rapid growth of non-performing loans could follow.

Llewellyn (2002) goes further and notes that the changes of macroeconomic conditions could be seen neither sufficient nor necessary conditions for banking crises to emerge. Therefore internal functioning problems of commercial banks, the absence of the adequate regulation and supervision and other related factors predetermine the banking system to failing.

1.3. The Banking System's Internal Factors

There is a considerable number of research papers that explain reasons of the rapid growth of credit risk in the banking sector, which has its origins in the internal functioning of the banking system, for example, Davis (1995), Drees and Pazarbasioglu (1998), Gourinchas, Valdes, and Landerretche (1999), Keeton (1999), Llewellyn (2002).

The banking sector crises in Argentina (1981), Chile (1981–82), Colombia (1982–83), Mexico (1995), Uruguay (1982), Norway (1987), Finland (1991–92), Japan (1992) and Sweden (1991) emerged as a result of rapid growth of credit risk, as Gavin and Hausmann (1998) concluded.

Investigating the macroeconomic and financial structure determinants that contributed to the financial crises in 2007, Caprio, D'Apice, Ferri, Giovanni, Poupolo and Walter (2010) reported that the probability of the emerging of a problem during the financial crises in 2008 was inherent in the countries with higher levels of loan/deposit ratio. On the other hand it was lower for countries with higher levels of (1) net interest margin, (2) concentration in the banking sector, (3) bank activities restrictions and (4) private monitoring.

Net interest margin determines the orientation of a banking system to the traditional activity. Logically, if this variable tends to decrease, the banking system shifts to non-traditional activities and the following changes could result in the banking systems' possible distress (see also De Jonghe, 2010 for the relationship between banking sector distress and the shift in banking activity).

Beck, Demirguc-Kunt and Levine (2006), using data of 69 countries from 1980 to 1997, analyse the influence of the bank concentration, bank regulations and national institutions on the expectancy of a country suffering a systemic banking crisis. They present that, in spite the differences in commercial bank regulatory policies between countries, the crisis is less likely to appear in the country with a more concentrated banking system, fewer regulatory and supervision restrictions on the commercial banks and the existence of better-developed national institutions that foster competition. Additionally, the authors remark that the channels through which the stability of the financial system depends on the concentration and competition influence are unknown and need particular researches.

Using data from more than 2 500 firms of 37 countries Beck, Demirguc-Kunt and Levine (2005) investigated the deepness of bank corruption treated as an obstacle regarding clients' financing. The authors find that regulation and supervision based on the empowering the supervising institutions through direct monitoring, control and impact on the bank activity do not provide any improvement in banking lending. According to the authors by empowering the private monitoring through forcing banks to disclose the adequate information regarding their activity will have a particularly beneficial effect on the integrity of bank lending in countries with sound legislation systems.

Mehrez and Kaufmann (1999) investigated the impact of poor transparency (in other words, corruption) on the possibility of the banking crises in the liberalized environment using a model with imperfect information on the data of 56 countries from 1977 to 1997. The results of their research suggested that because of the lack of transparency, i.e. absence of private monitoring, banks have incentives to raise their loan portfolios over the optimal level given by the value of the collateral. As the final result this can delay the crisis, but its magnitude will be much larger.

Aarma (2001), analysing the financial reports of four Estonian banks, argues that the stability of the banking sector has had a positive effect on the customers' attitude towards banks. The respective banks' transparency allows for the creation of the future long-term relationships between the bank and the customers.

Pesola (2001), Borio, Furfine and Lowe (2001), Caruana (2002), Ferguson (2004), Jimenez and Saurina (2006) and Bonfim (2009) conclude that the result of wrong decisions of financing will become apparent only during the period of recession of the economy and this definitely will cause the growth of non-performing loans and loan losses.

Keeton (1999) and Gourinchas, Valdes and Landerretche (1999) confirmed that the faster the growth of the general level of indebtedness, the more substantial loan losses will be.

Rapid growth of bank lending becomes especially crucial for the banking system in a short run since long-term projects of the private sector could usually be financed with the short-term capital inflow intermediated by the banking system, see for example, Llewellyn (2002). According to his estimates, based on the data of South Asian countries for the period 1990–1997, the severest banking lending to the private sector was in Hong Kong growing from 141.84% to 174.24% of the GDP, next came Taiwan (from 100.41% to 146.23% of the GDP), Thailand (from 64.39% to 116.33%), China (from 85.51% to 101.07%) and Philippines (from 19.17% to 56.63%). As a result of such rapid loan portfolio growth the level of non-performing loans in the total lending achieved 14% in China, 13% in Thailand, 14% in Philippines, 10% in Malaysia, 13% in Indonesia and 8% in South Korea (see, Corsetti, Pesenti and Roubini, 1998).

Because of such lending and the rapid expansion of the whole banking system, relevant credit risk analysis does not proceed in time for rapidly changing market conditions during the periods of macroeconomic expansion. Therefore banks are frequently unable to get fresh and adequate information about the creditworthiness of borrowers. This brings financing to such types of projects that if detailed analyses had been properly conducted, the borrower would never have received the requested financing.

Borrowers who have earlier financed investments projects with less favourable conditions than the new ones start to demand changing the financing conditions regarding the prolongation term of contracts and reduction of interest rates. Having the purpose of keeping the borrower as a customer further and also cash flows generated by the customer project financed by the bank, banks are ready to make concessions losing in that case the part of the profit related with the financed project realization. Also, the decrease of both current and future profits forces banks to a further reduction of quality barriers and to grant loans with more variable conditions to less solvent customers.

During a period of growth lenders and borrowers are confident about the payback of the financed or soon to be financed projects. Borrowers are able to generate the sufficient level of cash flows needed for loan repayment. According to Minsky (1992), the decision making process regarding possible financing of the project is followed by a period of replacement of present cash flows for the future cash flows, which are generated or to be generated according to the forecasts in the future. Thereby, the expectation of profit to be earned in the future from the realization of the project is an incentive for making investments in the present. Therefore, profit expectation depends on making investments in the future and the realized profit is determined by investments. Consequently, following the logic of Minsky, investments are made in the present as borrowers and lenders are confident and expect the continuation of investments in the future. This is made at the expense of new debt obligations.

Given that, the improvement of conditions of loan agreements concluded earlier for the borrower has both positive and negative influences. As a positive influence, an increase of free cash flows can be expected, which become available after covering all expenses and making all payments regarding the existing financial obligations and which can be directed as new investments into financed projects.

A negative influence appears when an additional free cash flow that has become available is directed for receiving and servicing new financial obligations. At the same time the purpose of the project can be speculative and this makes the borrower more vulnerable to the external negative shock. Taking into consideration the project realization experience of other borrowers, where projects can be already realized and finished, and the possibility of selection of a speculative project is quite high, as there is a project with stable cash flows and it can be seen as a definite possibility of additional speculative earnings. Additionally, a borrower having a project with constant cash flows can get financing having this project as collateral. At the same time this new financing can be invested into the development of a speculative project and therefore the increased indebtedness can substantially worsen the possibility of the repayment of the financial obligation.

At the same time the financing of the above mentioned shift in the supply of loan resources is frequently done not with the resources available in the economy, but by attracting short-term external financing nominated in a foreign currency. As a result of the growth of the volume of the aggregated loan exposure the volume of external financing will grow respectively. This means that the above-described scheme is repeated: profit – investments, and so forth. The situation with the external financing attracted by banks remains stable, that is, the loan contracts are prolonged on the favourable conditions until the credit market of the country is in a stable position and there are no signs of a recession in the economy.

If external negative shocks appear, a bank's creditor can refuse to prolong a loan contract and this can entail serious consequences with liquidity. Thereby, on the one hand, intensive attraction of external and short-term financing can give respective support to the growth of the aggregated loan exposure of the country, but, on the other hand, such an additional negative shock that can intensify the instability of the banking system may subsequently appear.

Pesola (2001) states that a bank's stability depends on the customer's stability. Borio, Furfine and Lowe (2001) confirm this statement arguing that banks' stability to a large extent depends on the borrowers' financial stability and positive perspectives of their development and that in turn connects the stability of the banking sector with the stability of the whole economy. This is one of the basic reasons why macroeconomic and banking sector risk related variables should be used contemporaneously.

The greater the number of non-performing loans, the less stable the banking sector is and an increase in the number of loan losses will take place. According

to Pesola (2001, 2005, 2007), the main reason for the increase of aggregated credit risk is the growing aggregated indebtedness. Together with the deterioration of macroeconomic factors it is impossible for borrowers to repay their existing financial obligations. Subsequently, this will lead to a negative chain reaction throughout the whole economy. This means that the level of the credit risk financed by the banking system will become critical when the cash flows of realized projects become insufficient for covering payments needed for meeting the loan contract obligations and cause a fall in assets prices with their purchase financed by banks.

Borio, Furfine and Lowe (2001) propose that there exists definite information asymmetry between borrowers and lenders. Generally, when economic conditions are unfavourable and collateral values are low, even a borrower with a positive cash flow and good collateral would find it difficult to obtain the financing. With an improvement of the economic conditions and an increase of collateral values borrowers are able to get new additional financing. This accelerates economic and financial cycles. Additionally, market participants have different and inappropriate responses to the financial procyclicality. Given that, the procyclicality of the financial system could derive from the mentioned asymmetry. As an ultimate outcome, the development of the financial sector procyclicality could result in distress.

Marcucci and Quagliariello (2008, 2009) propose that the more risky a bank's loan portfolio, the more cyclically it responds to the changes in the business cycle. For example, the influence of the business cycle on the loan portfolio with the lower quality of assets during times of recession is more than three times higher than on a bank with more quality assets in the portfolio. Besides, its influence during times of recession is more than four times higher than during a period of economic growth.

Economic growth contributes to the growth of banks' profits. Increasing the aggregated exposure of the existing loan portfolio supports a bank's continued growth through financing various investment projects, some with a negative cash flow during the period of project realization.

Eichengreen and Arteta (2000), based on data of economies of emerging markets, stated that the combination of financial liberalization and the respective macroeconomic conditions create definite preconditions for an unstable and uncontrolled credit boom.

According to Gourinchas, Valdes and Landerretche (1999) and Pesola (2001), the appearance of financial liberalization in the banking sector without the respective state regulation frequently becomes the reason for a credit boom, which can lead to an unstable banking system and later on to a banking crisis. Previously Mehrez and Kaufmann (1999) presented the idea of private monitoring, confirming that the high possibility of banking crises depends directly on the level of transparency of the banking system in the conditions of financial liberalization.

Demirgüc-Kunt and Detragiache (1998) analyse the empirical relationship between banking crises and financial liberalization, based on the panel data of 53 countries for the period 1980–95. However, regulation and supervision variables were not included into the research. They found that a financially liberalized system creates a fruitful basement for the emergence of banking crises. On the other hand, a strong institutional environment, adequate supervision and a low level of corruption can avoid the negative influence of financial liberalization.

As an ultimate result of making the financial environment more liberal, banks supply more free resources to the market and the loan resources start to grow, see for example, Keeton (1999). It simply means that banks start 'selling the loans'.

Minsky (1992) points out three types of borrowers: Hedge Borrower, who has sufficient cash flows for the repayment of financial obligations and accrued interests; Speculative Borrower, whose cash flows are sufficient only for interest payments and Ponzi Borrower, whose project realization does not see any cash flow existence and the financial obligation taken for the realization of the project can be repaid only by selling the financed assets. Tendencies of financing the three described borrowers by the banking sector can be easily traced during the development of the business cycle, i.e. economic growth.

Initially, the Ponzi Borrower and Speculative Borrower become problem customers, as the former does not have any cash flow at all and the latter can repay accrued interests only. In the conditions of the deterioration of the economic situation banks start to demand the repayment of the principal financial obligation. This also causes the necessity of pre-term cancellation of loan agreements and the compulsory sale of the pledged assets, i.e. debt liquidation, in the conditions of negative economic growth brings about bigger loan losses, as faster deterioration of the value of assets occurs and the speed of the deterioration can be treated as an indicator of the level of substantially overpriced real estate objects, being in force during the credit boom until the end of the period of recession Pesola (2001). This fact affirms that the credit policy of banks regarding risk management was based on the substantially overpriced real estate and its further growth was assumed. According to Minsky (1992), this can lead to the collapse of the value of assets. A worse development of the economic situation could be the full absence of a possibility for assets' realization in the free market.

Also, a deterioration of the economic situation causes a negative influence on the Hedge Borrower. According to Pesola (2001), a negative economic shock has a negative influence on the balance sheet of a company and this leads to a substantial deterioration of its assets value. Thereby, the liabilities in the balance sheet see no changes. An additional factor affecting the company is falling cash flows and when the cash flows reach its critical level repayment of the taken loan principal and their interest will become impossible. Such change of the cash flow of the company immediately decreases its investments and this in turn influences its further development. Like its assets value the productivity of the

company and the company's value will decrease. This has a substantial negative influence on the possibility of receiving an additional financing needed for the further development of the company under the pledge of its assets. This aggravates the general level of indebtedness of the production sector and this, subsequently, can cause a chain reaction of bankruptcies (Xavier and Rochet, 1997).

As a consequence, banks substantially change the loan policy and practically stop the financing of projects in spite of the presence of adequate borrowers who are able to repay financial obligations based on the sufficient cash flows. According to Jimenez and Saurina (2006), only banks' best customers are able to receive new credit financing. Thereby, the decisions regarding the financing of a new project will be more adequately considered and mistakes caused by credit activity will become progressively smaller.

Jimenez and Saurina (2006) point out the banks' request of having additional collateral of the project for covering risks, which can be treated as a signal of toughening loan policy. First such practice appears in the activity of a single bank and during quite a short period of time it can be carried into the whole banking system. However, during the period when real estate prices decrease giving additional collateral by a borrower with a high level of indebtedness can be a solution to the loan repayment. Receiving the additional collateral at the moment it is presented can be treated as a virtual solution to such a problem as price decrease; anyway it reveals the negative cover of the project regarding the value of the collateral, and an additional collateral can just in some way lower loan losses produced by the project. Full cover of the losses and repayment can be possible only with the new rise of real estate prices.

Borio, Furfine and Lowe (2001) propose that the analysis of the macroeconomic determinants of credit risk is analytically useful to be presented using market risk, i.e. the risk of a substantial decrease of the underlying assets. Regarding financing underlying assets mean the collaterals of the granted loans.

There is a large number of research works arguing that a rapid loan portfolio growth contributes substantially to a rapid growth of assets prices and therefore demand on them, for example, Berg (1993), Benink and Llewellyn (1994) and Andersson and Viotti (1999).

Borio, Furfine and Lowe (2001), Davis and Zhu (2004) and Goodhart, Hofmann and Segoviano (2005) state that a rapid growth of indebtedness follows a rapid growth of the price level of the real estate market. It makes the acquisition of new financing more widely available. Prices of real estate projects financed by banks grow constantly and this growth virtually reduces the risk level of financed or soon to be financed projects. In this case any borrower can receive additional financing because of the growth in the value of the collateral, which can be at any moment easily sold by the bank in case of possible problems with the customer's insolvency. As a result, additional financing should not be supported by the cash flow of the customer.

Blaschke, Jones, Majonni and Peria (2001), Bonfim (2009), Jimenez and Saurina (2006), Pesola (2001, 2005, 2007), Shanazarian and Asberg-Sommar (2008) and other authors concentrated mainly on the analysis of the influence of macroeconomic variables on the credit risk growth. Therefore, research into the contemporary influence of macroeconomic, banking sector and microeconomic level variables, together with the rapid growth of aggregated indebtedness on the level of non-performing loans, can be considered as insufficient, especially in the case of a small country with an open economy.

1.4.   Conclusion

Banking is, by its nature of internal functioning, prone to crises. Almost every banking crisis is a complex sequence between economic, financial and structural weaknesses. Generally, the banking sector earning comes from the interest rate margins. Given that, credit risk is among many factors with a substantial influence on the stability of a banking system. It is important to measure and control the determinants of credit risk, especially at the aggregated level.

An analytical framework of credit risk analysis presents the respective environment for an adequate credit risk measurement. According to the whole set of the scientific researches, based on the data of many banking crises that have emerged in transition and developed countries, there are several types of determinants that directly or indirectly influence a banking system.

The set of the variables that can cause banking sector distress depends on the level of the development of the economy and its banking sector, their internal structure and relationships, legislation and the effectiveness of the regulation and supervision.

Macroeconomic variables and variables based on the internal factors of the banking sector are the most important for analysing credit risk determinants. Macroeconomic variables should usually be used to determine if a banking crisis is going to emerge and banking sector variables will provide the information which country is more likely to have possible distress under the definite macroeconomic conditions.

Given that, credit risk measurement is to be based on up-to-date usage of macroeconomic and banking sector variables. Considering the purpose of the research some additional variables could be added. Before beginning the testing of the proposed hypotheses, comparative analysis of the banking sectors of the Baltic States will be performed and further an initial model will be presented.

2. The Banking Sectors of the Baltic States

2.1.   Comparative Analysis

The Baltic States are small countries with open economies, which depend substantially on export–import transactions and foreign investments. The

financial sectors of the Baltic States can be treated as financially liberalized. The banking sectors of the Baltic States hold the dominant position in the financial system of the countries and are substantially integrated into the European financial markets. Estonia joined the Euro area at the beginning of 2011.

By the end of 2009, 7 commercial banks and 9 foreign bank branches operated in Estonia, 21 commercial banks and 8 foreign bank branches in Latvia and 9 commercial banks and 7 branches of foreign banks in Lithuania (also see Appendix 4).

In spite of the different number of banking institutions, the banking sectors of all Baltic States witnessed a similar situation. Swedish banks have made considerable investments into capturing a large market share through their subsidiary banks. Their market share of loans granted in Estonia made up 66% of the total by the end of 2009 and received deposits 74.7% (Table 3). In Latvia the market share of loans granted decreased to 39.7% from the second quarter of 2008 to the fourth quarter of 2009 and received deposits to 27.1%.

The smallest downfall in the market shares of Swedish banks occurred in Lithuania, where the market share of loans granted was 49.3% and of received deposits, 53.6% (see Table 3). If the market shares of the branches of foreign banks (Nordea, DNB Nord and Danske Bank) are added to the statistics of Table 3, the total market share of the banking institutions with foreign owners will constitute a larger part of the market in the Baltic States compared to the market shares of the banking institutions based on the local capital.

Until the end of 2008 the Latvian banking sector differed from the banking sectors of the other two Baltic States in consequence of the presence of Parex Bank, a bank based on the local investor's capital. Its market share by assets made up 13.8% by the end of 2008, by deposits, 19.2% and by loans, 11.4%. At the end of 2008 this bank was overtaken by the Latvian government because of its huge liquidity problems. After restructuring this bank is in the sale process to a foreign investor.

Therefore, on the one hand, banking concentration as one of the preconditions for banking sector stability has been fulfilled. On the other hand, the presented market shares have direct connections to the number of banking institutions operating in the country. The greater the number of actively operating banking institutions in a country, the harder competition between them could follow. The large number of banks, especially in Latvia, strongly supported the overheating of the economies and loan markets of the Baltic States.

Table 3. Balance of granted loans and received deposits of banks with Swedish shareholders

	30.06.08			31.12.08			30.06.09			31.12.09		
	Est	**Lat**	**Lith**	**Est**	**Lat**	**Lith**	**Est**	**Lat**	**Lith**	**Est**	**Lat**	**Lith**
Loans granted												
Swedbank	48.8%	29.6%	22.0%	46.8%	26.0%	21.2%	44.9%	25.0%	29.3%	44.0%	24.9%	28.5%
SEB	22.2%	16.7%	30.6%	22.0%	14.4%	29.7%	22.4%	14.7%	21.7%	22.1%	14.8%	20.8%
The market share of the two banks	71.0%	46.3%	52.6%	68.8%	40.4%	50.9%	67.3%	39.7%	51.0%	66.1%	39.7%	49.3%
Deposits												
Swedbank	54.5%	21.2%	30.4%	52.0%	16.0%	28.7%	51.2%	15.9%	25.0%	52.2%	15.4%	25.3%
SEB	25.8%	15.6%	25.7%	25.5%	12.5%	27.2%	24.8%	12.3%	29.0%	22.5%	11.7%	28.3%
The market share of the two banks	80.3%	36.8%	56.1%	77.5%	28.5%	55.9%	76.0%	28.2%	54.0%	74.7%	27.1%	53.6%

Note: author's calculation. Est refers to Estonia, Lat to Latvia and Lith to Lithuania.
Source: Initial data obtained through the Internet from the Estonian Supervision Authority (http://www.fi.ee), the Association of Latvian Commercial Banks (http://www.bankasoc.lv/) and the Association of Lithuanian Banks (http://www.lba.lt/).

Banking system stability and economic growth are complementary processes. The stability of the banking system contributes to the stability of the economy and supports economic growth. Pesola (2001) states that a stable macroeconomic environment results in the stability of a banking system. Banks frequently contribute to the credit risk growth with incorrect and inadequate in time credit risk analysis.

Until the year 2008 all Baltic States were constantly referred to as Baltic tigers because of the high growth rate of their economies (Table 4).

Table 4. Growth rate of the GDP volume

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EU (27 countries)	3.9	2	1.3	1.3	2.5	2	3.2	2.9	0.7	–4.2
Latvia	6.9	8	6.5	7.2	8.7	10.6	12.2	10	–4.2	–18
Lithuania	3.3	6.7	6.9	10.2	7.4	7.8	7.8	9.8	2.8	–14.8
Estonia	10	7.5	7.9	7.6	7.2	9.4	10	7.2	–3.6	–14.1

Note: percentage change to the previous year
Source: obtained through the Internet from the Eurostat (http://epp.eurostat.ec.europa.eu)

The annual average growth rate of the real GDP of Latvia was 8.76% for the period 2000–07, for Lithuania 7.49% and for Estonia 8.35%. It was 3.5–3.6 times higher than the average growth of the European Union members. Later on, in 2009 the real GDP of Estonia declined to 14.1%, while in 27 other European countries the average decline was 4.2%. Only Latvia and Lithuania faced a more considerable real GDP decline: 18.0% and 14.8%, respectively (see Table 4).

All three Baltic States have also been constantly suffering from a continuous reduction of the population, which started in 1990 (see Table 5).

Table 5. Decrease in the populations of the Baltic States from 1997 to 2009

	Estonia	Latvia	Lithuania
Decrease in population, number	–107,660	–239,300	–293,100
Decrease in population, %	–7.43%	–9.57%	–8.05%

Note: author's calculation
Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/) and the Statistics Lithuania (http://www.stat.gov.lt/en/)

During the period 1997–09 the population in Estonia decreased by 7.43%, in Latvia by 9.57% and in Lithuania by 8.05%. The greatest downfall in population was witnessed by the Latvian economy. Thus, quite a substantial amount of taxes was not received in all Baltic States before the crisis and after it.

The real GDP per capita presents additional information regarding economic development in the Baltic States. According to the calculations, over the years 1998–2009 the real GDP per capita increased in Estonia 1.63 times, in Latvia 1.61 and in Lithuania 2.22 times (Table 6).

Table 6. The real GDP per capita, EUR

Year	Estonia	Latvia	Lithuania
1998	4033	2658	2690
2009	6573	4287	5969
Growth 1998–2009, times	1.63	1.61	2.22

Note: author's calculation.
Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/), and the Statistics Lithuania (http://www.stat.gov.lt/en/).

At the same time the biggest real GDP per capita measured in EUR was achieved by the Estonian economy (6573 EUR). The respective number for the Latvian economy was 4287 EUR and for the Lithuanian economy 5969 EUR, respectively.

The insufficient analysis of credit risk determinants by all banks in the Baltic States and strong dependence of current consumption on short-term foreign investments caused more substantial recession of the economies than in other European countries (see Table 4) and a substantial decrease of the real estate market (see Figure 5).

Since 1990 the banking systems of the three Baltic States have faced several financial crises. During the financial crisis in 2007–09 the rapid growth of the real GDP was substantially supported by the rapid loan portfolio growth in every Baltic State. During the period from 1997 to 2009 the Latvian banking sector experienced the most considerable growth in their loan portfolios, i.e. +2975%. This growth was 2.84 times higher than the growth of the loan portfolio granted by the Estonian banking system (i.e. 1049.27% respectively) and 2.12 times higher than the growth of the loan portfolio granted by the Lithuanian banking system (i.e. 1402.34%). As a result, a significant growth of non-performing loans and instability followed.

Following the logic of Caprio, D'Apice, Ferri, Giovanni, Poupolo and Walter (2010) the higher the loan/deposit ratio, the higher is the probability of banking system distress. The data in Figure 3 completely confirm this precondition.
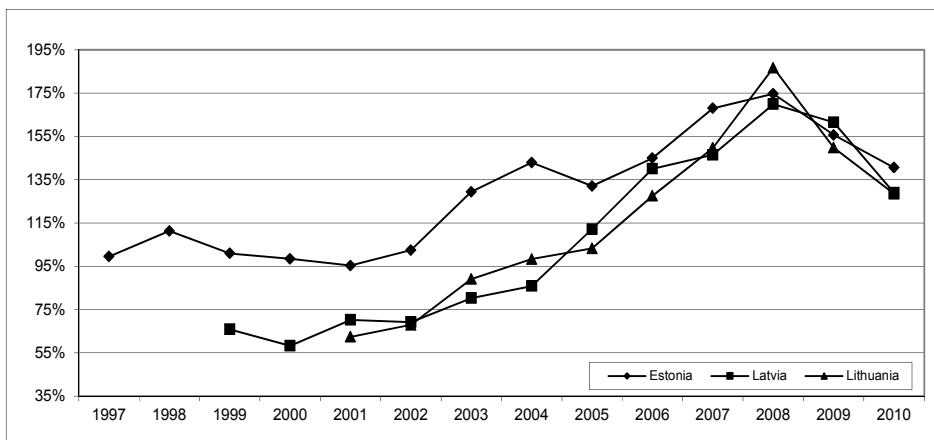
Figure 3. The loan/deposit ratio of the banking sectors of the Baltic States
Note: author's calculation.
Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info/), the Bank of Latvia (http://www.bank.lv/), the Association of Latvian Commercial banks (http://eng.bankasoc.lv), the Association of Lithuanian Banks (http://www.lba.lt/), and the Bank of Lithuania (http://www.lb.lt).

During the so-called Russian crisis all loans granted were covered by attracted deposits, excluding Estonia in 1998 (Figure 3). Even such a small change of the ratio for Estonia and the historical data of banking sectors previously presented demonstrate that Estonia faced in 1998 the most serious banking sector distress among the Baltic States. As to the 1998 distress, other reasons also are to be considered, for example, securities' investments.

The loan/deposit ratios in the three Baltic States started to deteriorate approximately in 2001–02 and this negative cycle ended in 2008 (Figure 3). The change of the ratio during the period 2001–08 constituted 83.25% for Estonia, 141.99% for Latvia and 199% for Lithuania. The speed of the ratio change increased in 2008 for Latvian and Lithuanian banking systems. The growth of the Estonian market ratio started to slow down. Therefore during the financial crisis in 2007–09 the Latvian and Lithuanian markets faced more substantial banking sector distress compared to the Estonian market.

The rapid growth of the real GDP was substantially supported by loans given by the banking system of every Baltic State (Table 7).

Table 7. The general level of indebtedness in the Baltic States measured as the ratio of the aggregated loan portfolio to the nominal GDP

Year	Estonia	Latvia	Lithuania
1998	30.35%	41.22%	12.47%
1999	31.80%	57.78%	14.38%
2000	35.52%	70.40%	13.43%
2001	37.31%	99.62%	14.99%
2002	41.06%	99.18%	17.00%
2003	50.69%	103.34%	23.04%
2004	61.07%	119.29%	29.68%
2005	71.71%	155.55%	41.98%
2006	84.89%	197.04%	50.46%
2007	100.53%	204.32%	60.52%
2008	103.22%	207.47%	63.80%
2009	112.84%	238.77%	70.85%

Note: author's calculation.
Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/), the Statistics Lithuania (http://www.stat.gov.lt/en/), the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt).

The general level of indebtedness in the Baltic States, measured as aggregated loan portfolio divided by the real GDP, grew rapidly and substantially during the period 1998–2009: for the Estonian economy 3.72 times, for the Latvian economy 5.79 times and for the Lithuanian economy 5.68 times. The general level of indebtedness changed for the mentioned period for the Estonian economy from 30.35% to 112.84%, for the Latvian economy from 41.22% to 238.77% and for the Lithuanian economy from 12.47% to 70.85%.

Table 8 presents the actual combined growth rate of the aggregated loan portfolios of the Baltic States' banking systems (see also Appendix 2).

Table 8. The combined growth rate of banks' aggregated loan portfolio

	Estonia	Latvia	Lithuania
From 1997 to 2009	1049.27%	2975.78%	1402.34%

Note: author's calculation.
Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt).

During the period from 1997 to 2009, the Latvian banking sector experienced the most considerable growth in their loan portfolios, i.e. +2975%. This growth was 2.84 times higher than the growth of the loan portfolio of the Estonian banking system and 2.12 times higher than that of the Lithuanian banking system. As a result, a significant growth of non-performing loans and instability followed.

In spite of the rapid and constant growth of the aggregated loan portfolio, the negative changes in the net interest margin earned by banks were remarkable (Figure 4).
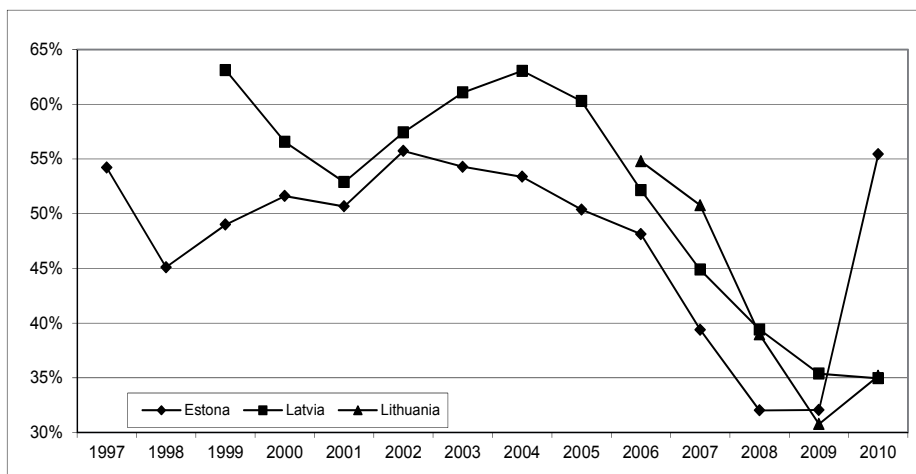
Figure 4. The net interest rate margin earned by the Baltic States' banks
Note: author's calculation.
Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info/), the Bank of Latvia (http://www.bank.lv/), the Association of Latvian Commercial banks (http://eng.bankasoc.lv) and the Association of Lithuanian Banks (http://www.lba.lt/).

According to previous researches (see chapter 1), if the interest rate margin earned by banks tends constantly to decrease, the stability of the banking system will diminish and possible distress could follow. The net interest rate margin for the banking systems of the three Baltic States was falling from 2004 up to 2008 (Figure 4). The most significant decrease was faced by the Latvian banking system. The following reduction of the ratio reveals the deterioration of the quality of the credit risk analysis as the banks aimed to enlarge market shares and the number of clients.

The Latvian banking system witnessed a substantial growth of its aggregated loan portfolio. Having no reliable base for loan repayments, for example the growth of the population together with GDP per capita, the decrease of the Latvian economy was more substantial compared with the other Baltic States (Table 9).

Table 9. The combined growth of the real GDP for two comparable periods

	Estonia	Latvia	Lithuania
Year 1998 to 2007	89.31%	101.28%	76.08%
Year 1998 to 2009	56.83%	58.28%	54.19%

Note: author's calculation.
Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/) and the Statistics Lithuania (http://www.stat.gov.lt/en/).

Although compared to 1998 the Latvian economy had grown by 101.28% by the year 2007, due to the fall in the next two years the growth decreased to 58.28% by the end of 2009. The fall for the Estonian and the Lithuanian economy was smaller (see Table 9).

The growth of the real GDP was partially supported by substantial investments into real estate markets and related sectors, for example construction, in all three Baltic States. Many investments into constantly growing real estate markets had speculative purposes and were financed by loans aiming to earn profit after a recurrent increase of prices. As a result many investments were not covered by required cash flows. Finally, the rapid downfall of the real estate markets in all Baltic States, which started in 2007, caused a substantial growth of non-performing loans since it was not possible to sell real estate objects, incomes of many investors were insufficient to serve loans and the value of real estate investments turned out to be much lower compared to loan balances.

The best way to present the volume of a real estate market is to use concluded contracts measured in national currencies. However, this statistics is only available for the Estonian market. Instead of this the number of deals concluded during the period was used as the base statistics. For the Lithuanian market quarterly data of the number of dwelling transactions were used.

The volume of the real estate market for Estonia, measured in the number of concluded deals, decreased by 21% by the end of 2007, by 31% by the end of 2008 and by 23% by the end of 2009 (see Appendix 3). The analogous results for the Latvian real estate market were 19%, 33% and 20%. The Lithuanian real estate market decreased in 2008 and 2009 by 38% and 40%, respectively.
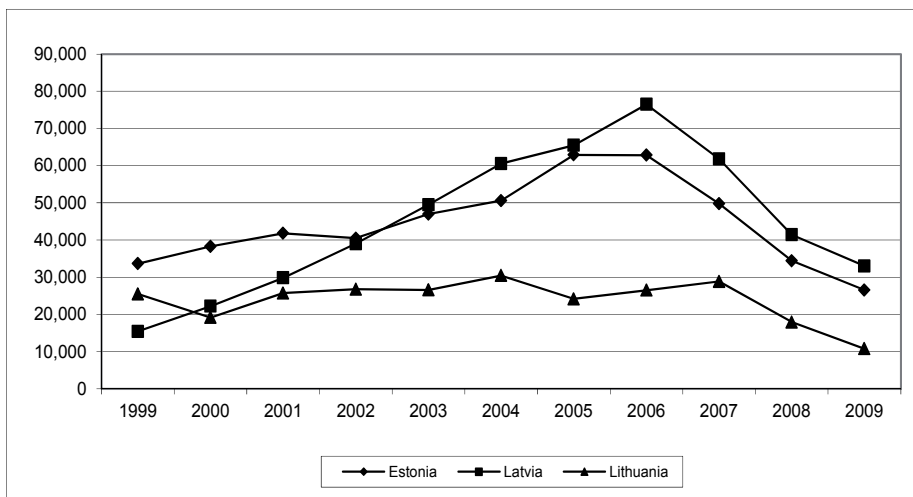
Figure 5. The number of real estate deals concluded in the Baltic States
Source: Data obtained through the Internet from the Statistics Estonia
(http://www.stat.ee/), the Land register of Latvia (http://www.zemesgramata.lv) and
the Land register of Lithuania (http://www.registrucentras.lt/ntr/stat/).

The greatest growth and fall were faced by the Latvian real estate market (Figure 5). The Estonian real estate market also suffered a substantial fall.

Understanding credit risk determinants helps to maintain financial stability and minimize possible losses. Banks, as privately owned companies, try to maximize their profits, and this requires respective policies of credit risk management and pricing of loan products. Neglecting these would result in substantial losses (Table 10).

Table 10. The aggregated losses (in EUR) of the banking sectors of the Baltic States in 2009

	Estonia	**Latvia**	**Lithuania**
Aggregated losses of banking sector	579,800,084	1,100,449,058	1,060,143,014
Aggregated losses of banking sector per capita	433	487	316

Note: The aggregated losses of banking sector per capita are calculated by authors. Based on the data of profit and loss statement.
Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/), the Statistics Lithuania (http://www.stat.gov.lt/en/), the Bank of Estonia (http://www.eestipank.info), the Association of Latvian commercial banks (http://www.bankasoc.lv/), the Association of Lithuanian Banks (http://www.lba.lt/).

The biggest losses for the financial year of 2009 and losses per capita were suffered by the Latvian banking system (Table 10).

The insufficient and temporally inadequate analysis of credit risk determinants can be considered as the initial reason for the rapid development of the financial crises that started in the Baltic States in 2007–08. This caused a substantial growth of the level of problem loans (Figure 6, see also Appendix 1).
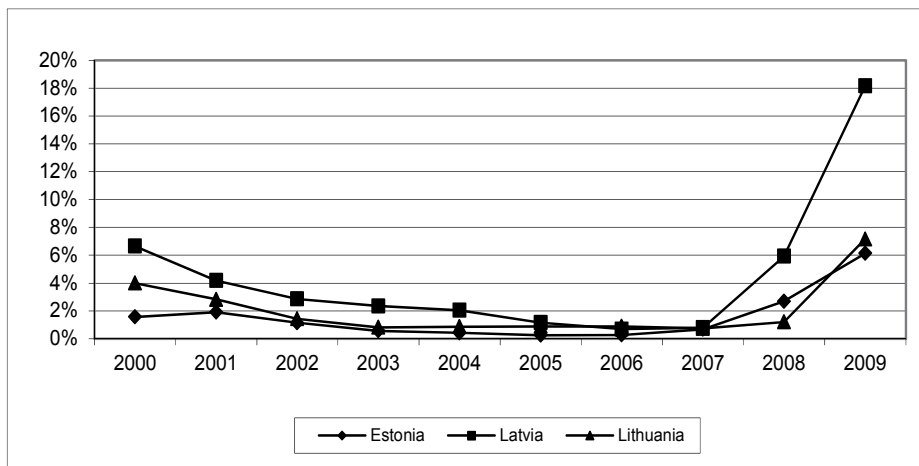
Figure 6. The level of non-performing loans in the Baltic States as a percentage of aggregated loan portfolios
Note: author's calculation.
Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt).

To calculate the level of non-performing loans for the Estonian banking system the volume of overdue loans over 60 days was used, for the Latvian banking system close-watch loans plus non-performing loans and for the Lithuanian banking system impairment loans were used. The use of identical data of problem loans for the three Baltic States was not possible because of different methodological approaches to statistics. In spite of this Figure 6 illustrates precisely the tendencies dominating in the banking sectors of the Baltic States. The level of non-performing loans started to grow in 2008 and achieved its peak in 2009 (Figure 6).

To more precisely demonstrate the situation with the Lithuanian banking system, Appendix 5 presents the exact level of the non-performing loans for the period 30.06.08–31.12.09. In the second quarter of 2007 the methodology of calculating non-performing loans was changed. Therefore the time series constructed using the new methodology is not sufficiently long to make analyses. Figure 6, however, illustrates that the Lithuanian banking system undoubtedly witnessed a substantial growth of non-performing loans during 2008–09.

Based on the data presented above it can be concluded that Latvia experienced the greatest problems in the economy and in the banking system

compared with the two other Baltic States. The constant decrease in population and the real GDP per capita meant a more balanced and conservative growth of the total economy. However, the figures in Table 4 contradict this statement about the development of the Latvian economy. Latvia has had the highest growth rate of the real GDP. As shown above has been presented it was achieved with borrowed resources.

2.2. Conclusion

The banking systems of the three Baltic States have faced several crises. Since these crises have had different initial causes the problem regarding adequate analysis and monitoring of credit risk determinants remains.

The financial crisis in 2007–09 caused a substantial growth of the level of non-performing loans in all Baltic States. This growth followed the rapid deterioration of the macroeconomic conditions.

An additional factor that aggravated the banking sector distress was rapid growth of the loan portfolio and associated with it rapid development of the real estate market. As a result the prices of real estate objects used as collaterals for the majority of loan projects did not correlate with the real value of the assets. Banks overestimated the rapid growth of the real estate market and did not pay attention to the real credit risk of the financed projects. Temporally inadequate credit risk measurement caused wrong allocation and pricing of attracted resources. Therefore, with the rapid fall of the real GDP a period of a rapid growth of unemployment and huge loan losses followed. The changes in unemployment reflect the level of possible development of the economy. The economies of the Baltic States have suffered from substantial impacts of high unemployment rates, especially Latvia.

3. Model Specification and Description of Variables

3.1. Development of the Research Framework

According to Timmerman (2001), the approaches to credit risk analysis could be split into two groups: traditional and asymmetric information models (Table 11). Traditional approaches concentrate on the data of the financial crises that have actually appeared, neglect the non-cyclical causes of financial crises and stress the cyclical determinants that are the major factors of the financial crises.

Therefore banking crises are too restrictively defined. Monetarist approach also neglects the intrinsic causes of the fragility of banks. To perform analysis a wide range of indicators could be used. Keynesians advise concentration on the demand side, monetarists on the monetary aggregates, such as interest rates, market liquidity, etc.

The asymmetric models, focusing mainly on the information asymmetry between the bank and the borrower, present an important, additional possibility

for financial crisis analysis. These models give a strict definition of the financial crisis and suit well since the banking sector is an intermediation related business. Information asymmetry is related with two types of definitions, adverse selection and moral hazard, which are directly related with banking sector.

Mishkin (1991) presents five initial reasons for financial crises to appear: increases in interest rates, stock market declines, increases in uncertainty, bank panics and unanticipated declines in the aggregate price level. Describing the anatomy of the financial crises he places the adverse selection and moral hazard in the central point of his model (see Appendix 7). Dividing the financial crises development into three, consistent stages, the economic distress ends with the debt-deflation (see also Fisher, 1933). The drawback of Mishkin's (1991) approach is that it fails to consider the factors that do not intensify the asymmetric information problems.

Another possible classification of credit risk analysis models, which is similar to the classification presented by Bonfim (2009), is as follows:

1. models based on the financial analysis ratios;
2. models based on the market information;
3. models based on both macroeconomic parameters, and a definite number of unique parameters peculiar only to the analysed processes.

The founder of first group of models is Altman (1968). The parameters of such models can be easily used for performing the financial analysis of borrowers.

Table 11. Synopsis of the main approaches to financial crises

Approach	Source of financial crises	Main advantage of the approach	Main drawback of the approach	Preferred indicators
Essentially empirical	Sources identified in an ad hoc manner, often by reference to the depression of the 1930s	Simplicity. Episodes close to on-the-ground reality. Recreate the historical and the socio-economic environment	Concentrates on crises which have actually occurred, failing to consider potential crises	Very wide-ranging sets of indicators
Keynisian	Insufficient global demand	Stress on the cyclical factors which constitute a major determinant of financial crises	Neglects the non-cyclical causes of financial crises	Aggregate demand and its components, or more rapidly available indicators
Monetarist	Financial crises always have a monetary origin (inadequate development of monetary aggregates or inappropriate interest rates)	Emphasis on the importance of monetary stability	Neglects the intrinsic causes of fragility of banks. Financial crises too restrictively defined	Interest rates, monetary aggregates, interbank market liquidity, etc
Asymmetric information models	Problems of adverse selection (poor choice of co-contractors) and moral hazard (harmful behaviour of co-contractors) The main factors aggravating the moral hazard or adverse selection are the deterioration of repayment capacities, the rise in real interest rates and the volatility of asset prices	Strict definition of financial crises Very structured theoretical foundations, well suited to the banks' intermediation activity	Approach essentially centred on market and credit risks Fails to consider the crisis factors which do not intensify the asymmetric information problems	Solvency and liquidity of companies, households and banks Nominal and real interest rates Inflation rates Share and bond prices and exchange rates (affecting guarantees)

Source: National Bank of Belgium, Economic Review, p.11 (2000), Timmerman (2001), p. 120.

The models of second type are used for finding the possibility of default of a borrower using the existing market information. The use of ratios can help to determine the result of research. These models are mainly used in cases when the parameters applied in research include the existing rating and it is necessary to determine how different market data can influence changes of a borrower's credit rating. Models of this type are used in the research work of Koopman, Kraussl, Lucas and Monteiro (2009).

The models of third type, where macroeconomic parameters are used, help to determine causal relationships. Many researchers, for example IMF (2000), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007), Bonfim (2009) report that the usage of macroeconomic parameters substantially improves the outcome of research. Models of this type are used in the research work of Meyer and Yeager (2001), Gasha and Morales (2004), Pesola (2001, 2005, 2007), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007), Marcucci and Quagliariello (2008, 2009), Bonfim (2009) and others.

In addition two types of credit risk analysis models can be identified depending on the required inputs: (i) models that are presented as a simple function and (ii) models presented as a composite function.

Exogenous variables used in the models of first type are presented as percentage change of various parameters treated as credit risk determinants. Blaschke, Jones, Majonni and Peria (2001) studied the sensitivity of unexpected loan losses to negative external shocks. They used exogenous variables such as nominal interest rate, inflation rate and percentage changes of the real GDP and percentage changes in terms of trade. Shanazarian and Asberg-Sommar (2008) analysed distance to default or the ratio of the value of company equity to the standard deviation of assets' market value, where a company's equity value is based on the future cash flows. They used as exogenous variables the 3-month state bonds' interest rate, the interstate index of industrial production and the interstate consumer price index. These models confirm the proposition that the quality of the loan portfolio depends on the economic cycle.

The models of second type use composite exogenous variables, where one independent parameter is multiplied by a ratio of two other ones, for example: Pesola (2001, 2005).

It should be noted that endogenous variables in both types of models are presented as a ratio of two variables and can be interpreted as default rate, probability of default, default frequency measure, expected default frequency etc., for example: Meyer and Yeager (2001), Pesola (2001, 2007), Gasha and Morales (2004), Jimenez and Saurina (2006), Marcucci and Quagliariello (2008, 2009) and Bonfim (2009).

Since there is a strong bias of the mentioned models to one type of variables, and in order to better understand links between credit risk and macroeconomics, banking sector and microeconomic level variables, a new model was

constructed. This model is based on a linear function between variables, and the causality of them will be discussed in the next section.

3.2. Causality of Variables, Model Specification and Description of Variables

The variable mainly used as a dependent variable is the quotient of non-performing loans to the aggregated loan portfolio, for example: Meyer and Yeager (2001), Gasha and Morales (2004), Jimenez and Saurina (2006), Bonfim (2009), Pesola (2001, 2007) (Appendix 8). Instead of non-performing loans, the changes in non-performing loans or loan losses can be used, for example: Marcucci and Quagliariello (2008, 2009). The following interpretation allows tracking changes of the variables, but the usage of changes of non-performing loans will shorten the time series. The variable loan losses is difficult to use because of its identification problem. Considering the problems with other variables, the ratio of non-performing loans to the aggregated loan portfolio was applied.

The following ratio has been used by Meyer and Yeager (2001), Gasha and Morales (2004), Jimenez and Saurina (2006) and Pesola (2001, 2007).

The banking sectors of the Baltic States suffered from several financial crises: for example, in 1992–95, 1998–99 and 2007–09 (See Figure 6 for historical changes in the level of non-performing loans in the Baltic States). These crises had different reasons and could be treated separately if there is a necessity to analyse a certain period of the development of the banking system.

There is quite a large set of macroeconomic variables suitable for this kind of analysis, such as a fall in the GDP growth, output gap, high level of inflation, volatile exchange rate of a currency, stock market fall, credit boom, constantly decreasing export and deterioration of conditions of trade balance etc. In adddition, Koopman, Lucas and Klaassen (2005) presented in their work the presence of cyclicality between GDP and the number of bankruptcies. Koopman, Kraussl, Lucas and Monteiro (2009) emphasized the growth of GDP, short-term interest rates, default spreads and volatility of the stock market as the main macroeconomic variables contributing to the growth of credit risk and the number of bankruptcies. Besides the macroeconomic variables the authors emphasized also the conditions of crediting. Carling, Jacobson, Linde and Roszbach (2007) using macroeconomic data such as output gap, yield curve and households' expectations presented the changes in these parameters as a cause of the of bankruptcies of companies. Pesola (2001, 2007) emphasized the importance of macroeconomic data in performing analyses of appearing instability in the banking system and its further possible crisis. Many authors, for example Pesola (2001, 2007), Carling, Jacobson, Linde and Roszbach (2007) and Marcucci and Quagliariello (2008, 2009), used output gap as the main macroeconomic parameter, but with special attention to comparison of aggregated indebtedness and GDP. Jimenez and Saurina (2006), analysing the influence of macroeconomic parameters on the growth of the volume of the loan

portfolio and related to it growth of credit risk, used the macroeconomic parameters such as GDP growth and decrease in the real interest rate. Implementation of variables depends on the purpose of the research. According to Borio, Furfine and Lowe (2001), all these risks are impacted by changes of the macroeconomic policies and developments.

Generally, GDP related variables are used as a basis of macroeconomic variables. There are variations of variables: the real GDP growth, output gap, GDP growth rate, per capita income growth etc. The annual average growth rate of the real GDP for the period 2000–07 was 8.76% for Latvia, 7.49% for Lithuania and 8.35% for Estonia (see Table 4). These results were 3.5–3.6 times higher compared with European Union members' average growth. However, in 2008 and 2009 the annual growth rate of the real GDP in the Baltic States turned to be negative (except for Lithuania in 2008). Considering this, the real GDP growth was chosen as the first independent variable. Meyer and Yeager (2001), Gasha and Morales (2004), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007), Marcucci and Quagliariello (2008, 2009) and Bonfim (2009) also used the growth rate of the real GDP as a basis of macroeconomic variables.

Another macroeconomic variable used in research is the unemployment rate. This parameter describes the state of the labour market and has a direct influence on the level of non-performing loans. Meyer and Yeager (2001) and Bonfim (2009) included labour market data into their researches.
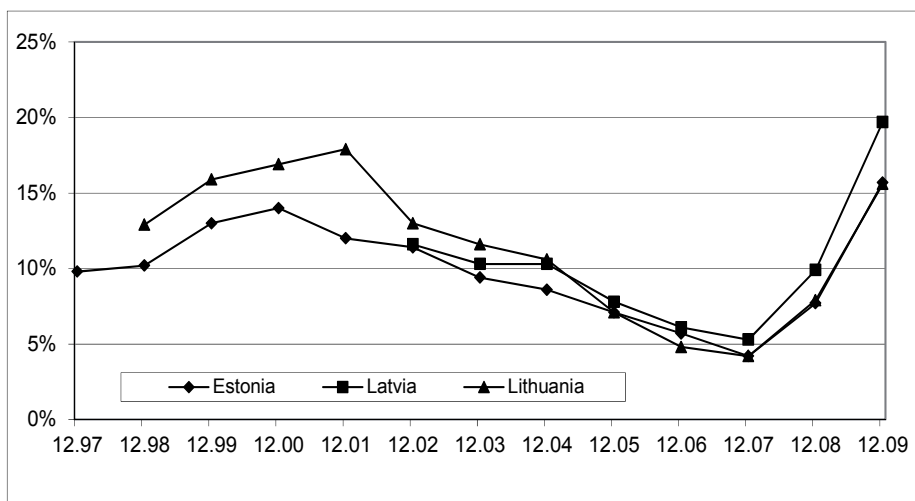
Figure 7. Unemployment rate of the Baltic States
Source: Data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/), the Statistics Lithuania (http://www.stat.gov.lt/en/).

The changes in the unemployment rate for the three Baltic States were analogous during the period December 2001–December 2007, when the unemployment

rate decreased substantially and reached the level of 4.2%–5.3% (Figure 7). Taking this and the rapid growth of the loan market in the Baltic States and the related real estate market as an investment place for private persons into consideration, unemployment rate was used as the second independent variable.

As a banking sector variable, I used in the current research the growth of an aggregated loan portfolio. Marcucci and Quagliariello (2008, 2009) used an analogous variable. As I have been stated before, rapid growth of indebtedness causes further growth of non-performing loans during a recession of the economy. Most rapid growth of indebtedness started in the Baltic States during the period 2005–07 (Table 7). This situation gives additional reason for the use of the real GDP growth and the growth of the aggregated loan portfolio as the variables in the research.

The real estate market faced a rapid growth of prices in the years 2004–06 (see Figure 5 and Appendix 3) and a tremendous decline during the period 2007–09. Considering this the growth rate of the real estate market was chosen as the fourth independent variable.

Next the respective theoretical relationship between the variables for the research is to be specified. The estimations are based on aggregated quarterly data. Table 12 presents the time range and the initial number of observations for the three Baltic States.

Table 12. Initial time range and number of observations of the research for the three Baltic States

	Estonia	**Latvia**	**Lithuania**
Time range	July 1997–2009 4Q	2002 1Q–2009 4Q	2004 1Q–2009 4Q
Initial number of observations	51	32	24

The general theoretical relationship between the variables for the estimation of non-performing loans is as follows:

$$RNPL_t = \beta_0 + \beta_1 GALP_t + \beta_2 GGDP_t + \beta_3 RRE_t + \beta_4 UN_t + \varepsilon_t \qquad (1)$$

where $RNPL_t$ is the ratio of non-performing loans to the aggregated loan portfolio of banks;

$GALP_t$ is the growth of a banks' aggregated loan;

$GGDP_t$ is the growth rate of the real GDP;

RRE_t is the growth rate of the real estate market of the Baltic States and

UN_t is the unemployment rate.

Lis, Pages and Saurina (2000) point out that according to standard practice a loan is treated as non-performing if some part of this loan or interest is more than 90 days overdue.

However, for Estonia the statistics covers non-performing loans that are only 60 days overdue. Because of this limitation, non-performing loans 60 days

overdue had to be used in analysis. Initial data for calculation were obtained from the Bank of Estonia.

For Latvia the initial data for *RNPL* calculation were obtained from the Financial and Capital Market Commission, which collected the statistics of the variable until the end of 2008. Up to the end of 1999 only annual data of close watch loans plus non-performing loans were collected. Since the beginning of 2000 quarterly statistics of the variable is available. Since 2009 only statistics on non-performing loans more than 90 days overdue is available. Considering that statistics on loans or accrued interests more than 90 days overdue was collected since the fourth quarter 2004 and data also were adjusted in the fourth quarter 2006, this statistics was not used due to the short time period and an adjustment that shifted the data substantially.

In order to make the research more appropriate and to take into account the substantial changes of the Latvian market in 2009, the time series of close watch loans plus non-performing loans were extrapolated over fourth periods up to the fourth quarter of 2009. The extrapolation was calculated by multiplying the quarterly data of non-performing loans more than 90 days overdue with the average ratio of close watch loans plus non-performing loans to non-performing loans more than 90 days overdue for the period fourth quarter 2006–fourth quarter 2008.

For Lithuania the initial data for the calculation were obtained from the Bank of Lithuania. The Bank of Lithuania collected two types of variables describing non-performing loans: the ratio of impairment losses to the aggregated loan portfolio and the ratio of non-performing loans to the aggregated loan portfolio. The use of the latter variable would be preferable, but the break in the time series because of the change in the definition of non-performing loans in the second quarter of 2008 made their use impossible due to absence of data. Until the end of 2005 only annual data of impairment losses were collected. Since the beginning of 2006 quarterly statistics of the variable is available. To include respective changes of the banking market the time range was prolonged up to the first quarter of 2004. The interpolation of data was based on the annual data.

In spite of the different initial data for the calculation of dependent variables for the three Baltic States, the changes in the level of their non-performing loans were analogous (Figure 6).

The initial data for the calculation of $GALP_t$ were obtained from the Bank of Estonia, the Financial and Capital Market Commission for the Latvian market and the Bank of Lithuania. In all Baltic States the aggregated loan portfolio grew constantly up to the third/fourth quarter of 2008 (see also Appendix 2).

The initial data for the calculation of $GGDP_t$ were obtained from the Estonian, Latvian and Lithuanian statistics. Data were seasonally adjusted. The growth of the real GDP in Estonia and Latvia continued up to the end of 2007 and in Lithuania up to the end of 2008 (Table 4).

The initial data for the calculation of RRE_t were obtained from the Estonian Statistics, the Land Register of Latvia and the Bank of Lithuania and the

Cadastre Registers of Lithuania. The growth rate calculation is based on the number of concluded deals per quarter for Estonia and Latvia and on the number of dwelling transactions per quarter for Lithuania.

The period from 2003 up to 2007 can be treated as a period of real estate boom for Estonia (Pesola, 2001, p. 13). From first quarter 2003 to fourth quarter 2006, the growth of concluded real estate deals on quarterly basis was up 418.45%. From second quarter 1997 to second quarter 2003, the respective growth was 115.01%. The ratio of concluded real estate deals to the real GDP was 55% by the fourth quarter of 2006, with an average ratio of 20.44% for the period second quarter 1997 to fourth quarter 2009. This ratio decreased substantially by the end of 2009 and reached the level of 2002, i.e. 14.66%.

For Latvia the period from first quarter 2003 up to third quarter 2007 can be considered as a period of real estate boom (Pesola, 2001, p. 13). During the time period from first quarter 2003 to fourth quarter 2006, the growth of the concluded real estate deals on quarterly basis was up 114%. From first quarter 2002 to fourth quarter 2002, the growth was 45%. If the number of concluded deals within a quarter measured in Lats was used, the influence of constantly growing real estate prices should be included definitely.

Compared to the Estonian and the Latvian markets the development of the real estate market in Lithuania was stable during the period from 1999 to 2007 (Figure 5). Actually the changes of the Lithuanian real estate market are underestimated, since the relevant variable covers quarterly number of dwelling transactions. If other types of real estate transactions were included, the picture would be analogous to those of Estonia and Latvia.

The number of concluded deals within a quarter measured in the national currencies has more explanation power compared to the data presented above because the changes in the real estate prices would be included. Unfortunately, use of such data was not possible due to the absence of respective data for the Latvian and the Lithuanian market.

As to the unemployment rate no additional normalization of the variables was used.

Before going to the empirical chapter of the thesis it is worth mentioning that banks and branches of foreign banks operating in Estonia represent the Estonian banking sector. According to the legislation only banks are to present obligatory reports to the financial supervision authority. The banking sector's data used in the thesis include data of the Estonian banks only. Data of the branches of the foreign banks are not presented in the official banking statistics.

Banks and branches of foreign banks operate in Latvia according to the Credit Institution Law. Responsibility for supervising and collecting respective banking statistics is executed by the Financial and Capital Market Commission. The banking sector's data used in the thesis include data of banks and branches of foreign banks.

Banks and branches of foreign banks operate in Lithuania according to the Law on Financial Institutions. Responsibility for supervising and collecting

respective banking statistics is executed by the Bank of Lithuania. Therefore the banking sector's data used in the article include data of banks and branches of foreign banks.

Compared to the data of the Estonian banking sector, the Latvian and Lithuanian banking statistics gives the full picture of the banking sector.

The calculations, presented in the empirical analysis chapter, were performed using EViews software.

4. Empirical Analysis and an Overview of the Results

General economic developments play a substantial role in the development of the banking sector. Therefore it is expedient to assume that the levels of non-performing loans and macroeconomic, banking sector and real estate sector variables of the research have common trends. Since the long-term relationships between the level of non-performing loans and four macroeconomic, banking sector and real estate sector variables will be studied and further analysis provides evidence of co-integration in the system, the Vector Error Correction Model (VECM) is applied. The VECM is suitable to analyse issues previously discussed because of its ability to distinguish combined deal with common trends in the time series and to conduct impulse response analysis.

4.1. Methodological Approach for Time Series Analysis

In general, if time series are non-stationary, the estimates calculated using the Ordinary Least Squares procedure (OLS) and research conclusions based on non-stationary time series will be inaccurate. This will easily cause the wrong interpretation of results and incorrect forecasts.

Since the theory proposes that if some time series are non-stationary in levels, the combination of such differenced time series may have one or several co-integrating connections and therefore be $I(1)$ co-integrated, the VECM is employed.

To investigate whether time series are non-stationary the Augmented Dickey–Fuller test (1979, 1981) has to be carried out. This test is based on three types of the equations:

$$Y_t = \rho Y_{t-1} + \varepsilon_t \tag{2}$$

$$Y_t = \alpha + \rho Y_{t-1} + \varepsilon_t \tag{3}$$

$$Y_t = \alpha + \rho Y_{t-1} + a_2 t + \varepsilon_t \tag{4}$$

where Y is a vector of some variable with $Y_0 = 0$, ρ is a real number, ε_t is a sequence of independent normal random variables with mean zero and variance σ^2, $[\varepsilon_t \sim N(0, \sigma^2)]$. According to the augmented Dickey–Fuller test (1979, 1981),

the time series are stationary if $|\rho| < 1$. If $|\rho| > 1$, the time series are non-stationary and the variance of the time series grows exponentially with t.

Granger (1983) proposes that the Error Correction Model can present a system of time series of co-integrated variables. The postulate of VECM states that disequilibrium in one period is to be corrected in the next period, i.e. the long-term equilibrium is presented as follows (Granger and Engle, 1987):

$$\beta_t x_t = 0 \tag{5}$$

where x_t is a vector of some variable x and β_t is a co-integrating vector. Equilibrium error e_t denotes the deviation from long-run equilibrium, and in most time periods x_t will not be in equilibrium or $e_t = \beta_t x_t$.

The VECM developed by Johansen (1991) can be presented as follows:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \Phi D_t + \mu + \varepsilon_t \tag{6}$$

where Γ denotes an ($n \times n$) matrix of coefficients and contains information on short-term relationships among variables; Π is an ($n \times n$) coefficient matrix, which can be decomposed as $\Pi = \alpha\beta'$, where α and β compose an ($n \times r$) matrix with full rank r. Variables $\beta_{(1)}, \ldots, \beta_{(r)}$ of matrix β are linearly independent co-integrating vectors. Variables α of the matrix are the adjustment coefficients by stationary linear combinations. D_t are seasonal dummies.

The main principle of the Johansen procedure lies in the estimation of the rank of the matrix and its characteristic roots by performing a co-integration test. After that the two important parameters to be estimated in the VECM model are β and α coefficients.

Prior to running the co-integration test, the optimal VECM autoregressive lag length is to be determined. This can be done using information criteria, such as AIC (Akaike Information Criteria) and BIC (Bayesian Information Criteria) (Winker, 2000) or a residual autocorrelation test (Jacobson, 1993). Liew (2004) found evidence that AIC and FPE (Final Prediction Error) provide better results with small samples.

The co-integration test for two variables was proposed by Engle and Granger (1987). Further improvement for several variables was made by Johansen (1991).

The test for the estimation of the number of characteristic roots is given by the following statistics:

$$L_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \qquad (7)$$

and

$$L_{\text{max}}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (8)$$

where r is the number of co-integrated vectors, $\hat{\lambda}_i$ denotes estimated values of characteristic roots (eigenvalue) obtained with matrix estimation. Assumptions of the rank of co-integration are not used for calculating characteristic roots calculations. T is the number of observations applied.

The first statistic tests the null hypothesis that the number of co-integrating vectors is less or equal to r. If the hypothesis could not be rejected, the values of $L_{\text{trace}} = 0$ if $\lambda_i = 0$. If the alternative hypothesis finds support, the estimations are greater than 0 and values of L_{trace} converge to larger positive values and $\ln(1 - \hat{\lambda}_i)$ will have a negative sign. If that is the case, the null hypothesis is rejected against the alternative hypothesis.

The second statistic tests the null hypothesis that the number of co-integrating vectors is larger than $(r+1)$ or equal to r. If the values of estimated characteristic roots will converge to zero, L_{max} also converge to zero. If the alternative hypothesis is correct, L_{max} will converge to positive values larger than critical values and the null hypothesis is rejected against the alternative hypothesis. Determination of the statistical significance of coefficients is based on t-statistics.

When the VECM is constructed the results of the model are interpreted by impulse response functions. The impulse response function presents the effect of one standard deviation shock in a variable on current and future values of other variables. The generalized impulses proposed by Pesaran and Shin (1998) are used, since this function does not depend on the VAR order.

To confirm whether the model presents valid results, various tests for misspecification are conducted. I have chosen the LM test for autocorrelation in the residuals, White's heteroskedasticity test and the Jarque–Bera test.

The results of the LM test for autocorrelation in the residuals show that there is no residual autocorrelation problem for the model because all P-values are larger than the 0.05 level of significance. The absence of heteroskedasticity in the residuals of the VECM is tested by White's heteroskedasticity test. The results of this test show that there is no heteroskedasticity in the residuals, since the P value is larger than the 0.05 level of significance. The normality test presents the multivariate extensions of the Jarque–Bera test, where the third and fourth moment of residuals with the analogue values of normal distributions are

compared. The residuals factorization method developed by Urzua (1997) was used in the thesis. The normality test indicated normal distribution of residuals.

4.2.   Economic interpretation of the variables

Since the banking sectors of the three Baltic States will be analysed and the number of observations differs between countries the model for the research was constructed using five variables after their deliberate and explicit analysis. The model of the ongoing analysis has to be relatively simple and transparent. As a result of model selection there will be no need for substantial resources and complex calculations and the results of the research will not be difficult to interpret.

The purpose of the model is to provide the environment to study the effects of shocks of macroeconomic, banking sector and real estate market variables on the level of non-performing loans aiming to explain the initial reasons for the growth of non-performing loans in the three Baltic States. The foreign macroeconomic variables as exogenous variables are not included in the analysis. Since all three Baltic States are small countries with open economies the relevant influence of variables of such type is internally reflected in the changes of the real GDP and investments of banking sectors because the majority of banks have foreign shareholders and financing of their development is provided by mother banks located abroad.

As the system consists of five variables, five shocks are distinguished in the analysis. The identification of structural shocks is based on the quarterly data for ($RNPL_t$ $GGDP_t$, UN_t $GALP_t$, RRE_t,), where $GGDP_t$ presents a percentage change of the real GDP, i.e. growth of the real GDP partially supported by substantial investments in the real estate market and the rapid growth of aggregated loan portfolio of the banking sectors of the three Baltic States; UN_t denotes the series of unemployment rate shocks driven by negative changes in the economy; $GALP_t$ denotes the percent changes of the aggregated loan portfolio of every Baltic State driven by banking management aiming to increase the market share and profit and RRE_t is the percent changes of the real estate markets of the Baltic States.

The structural shocks are obtained from the reduced form residuals by a linear transformation $e_t = A\varepsilon_t$ where A is such that structural shocks vector has identity covariance matrix $\varepsilon_t \sim (0, I_K)$. Then the reduced form residual covariance matrix is decomposed as $\Sigma_{e_t} = AA'$. The identification of the shocks is presented in the following equation.

$$e_t = \begin{pmatrix} e_t^{RNLP} \\ e_t^{RRE} \\ e_t^{GALP} \\ e_t^{GGDP} \\ e_t^{UN} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{\text{shock of deterioration of economic conditions}} \\ \varepsilon_t^{\text{real estate demand shock}} \\ \varepsilon_t^{\text{loan resources supply shock}} \\ \varepsilon_t^{\text{external negative shock}} \\ \varepsilon_t^{\text{shock of economic recession}} \end{pmatrix} \qquad (9)$$

The effect of shocks of interest on $RNPL_t$ is expected to be as follows: regarding changes of $RNPL_t$ there is a complex shock of several variables, starting with the decrease of $GGDP_t$ and followed by negative changes of $GALP_t$ and related variables such as UN_t and RRE_t.

It is clear that the growth rate of the real estate market has a negative correlation with $RNPL_t$. The negative changes of RRE_t are initially spurred by the recession of the economy. The strength and the deepness of $RNPL_t$ response is determined by the level of investments in the real estate markets and the general level on indebtedness in the country. Since all three Baltic States witnessed substantial investments in the real estate markets it is assumed that $RNPL_t$ is to have relevant large-scale responses to the negative changes of the real estate market.

The recession of the economy presented as a decline of $GGDP_t$ is considered as a negative shock to $GALP_t$. The type of shock to $GALP_t$ imposed by the recession of the economy depends on the economic situation. A negative correlation is expected to exist between the aggregated loan portfolio and $RNPL_t$. Considering the negative shock imposed on $GGDP_t$ and $GALP_t$, the shock to $GALP_t$ comes with some time lag after the negative shock was imposed on $GGDP_t$. As a result the response of $RNPL_t$ to the mentioned development of the variables comes into force in several quarters. The speed of $RNPL_t$ response depends on the strength of the imposed shocks. The growth of the aggregated loan portfolio and favourable economic conditions decrease the level of non-performing loans. But the rapid growth of the aggregated loan means that during the recession of the economy many loan projects fail since credit analysis was not performed correctly. The strength of $RNPL_t$ response depends on the speed of the earlier growth of the aggregated loan portfolio. The faster the growth was, the deeper $RNPL_t$ response would be achieved.

In spite of the fact that macroeconomic variables are of the same research field, it can be stated that two different macroeconomic variables could affect the level of non-performing loans in two opposite ways. An external negative shock spurred by the change of any macroeconomic parameter leads to the decrease of $GGDP_t$ and the relevant response of $RNPL_t$ represents the growth of the aggregated level of non-performing loans. A negative correlation is expected between $GGDP_t$ and $RNPL_t$ because the growth of the economy provides possibilities for new investments and increasing incomes. A favourable economic situation creates the ground for proper and successful loan repayments. The size of $RNPL_t$ response depends on the speed of the recession, its deepness caused by the shock and the composite parts of the GDP. The growth of the economy imposes a positive shock to $RNPL_t$ and the level of non-performing loans will decrease. The positive shock remains in force until the period when the development reaches the so–called critical level and free resources are invested into less profitable, long-term and short-term, speculative projects and covered by substantial short-term investments from abroad.

The recession of the economy presented as a decline of $GGDP_t$ is a negative shock to UN_t. The size of the response of $RNPL_t$ depends on the speed of the recession and the volume of the aggregated loan portfolio. The recession of the economy is considered as an initial negative shock to UN_t. The volume of the aggregated loan portfolio is an additional supporting factor since the higher the level of aggregated loan portfolio, the higher the level of UN_t that can be achieved. As a result a stronger response of $RNPL_t$ will occur.

4.3. Econometric Analysis of the Estonian Banking System

4.3.1. Unit Root and Co-Integration Tests

Before going to VECM all variables are tested for presence of unit root in the time series. By performing the ADF test the null hypothesis of presence of unit root in the time series is tested. Table 13 presents the results of unit root tests for five variables.

Table 13. Estonia: augmented Dickey–Fuller test results

	Intercept	Trend and Intercept
GALP	−2.01007	−1.15262
ΔGALP	−3.37729**	−8.20360**
GGDP	−0.84797	−1.24183
ΔGGDP	−16.6934***	−16.6155***
RNPL	−1.21053	1.23296
ΔRNPL	−3.01655**	−3.40097*
RRE	−3.36591**	−3.59013**
ΔRRE	−3.36591**	−26.6728***
UN	−1.14325	0.09904
ΔUN	−5.19197***	−5.31096***

Notes: (1) Δ denotes 1st differences, (2) *, ** and *** refer to rejection of the unit root at the 10%, 5% and 1% level, respectively.

The results of the test indicate that the time series of all variables, except *RRE*, are non-stationary in levels. The first-differenced time series found all to be stationary. The null hypothesis of presence of unit root is rejected for most variables at the 5% significance level, except for *RNPL*, for which the null hypothesis is rejected at the 10% significance level. When trend and intercept in time series are applied, the null hypothesis of unit root is rejected for all variables at least at the 5% significance level. The results of the Dickey-Fuller test presented in Table 13 indicate that the time series are $I(1)$ co-integrated.

Since the variables are co-integrated of the same order, an optimal autoregressive lag has to be found and the co-integration test to be performed. Based on the AIC and Lagrange Multiplier (LM) test the optimal autoregressive lag was found to be 3.

By using the optimal autoregressive lag length, the co-integration procedure was estimated with the purpose to choose the optimal model and the number of co-integrating vectors. The model with no deterministic trend (restricted constant) with two co-integrating vectors was chosen. A gradually better L_{trace} result was achieved by the model with a linear deterministic trend, but based on this choice the constructed VECM had worse results. According to the ADF test (see Table 13) the model with no trend is preferable, since results for all variables are significant at 5%.

Table 14. Estonia: Johansen's test for co-integrating vectors

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.763233	136.0197	76.97277	0.0000
At most 1 *	0.495686	69.74849	54.07904	0.0011
At most 2 *	0.316503	38.25889	35.19275	0.0226
At most 3 *	0.23171	20.7544	20.26184	0.0428
At most 4	0.171049	8.629352	9.164546	0.0631
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None *	0.763233	66.27116	34.80587	0.0000
At most 1 *	0.495686	31.48960	28.58808	0.0207
At most 2	0.316503	17.50449	22.29962	0.2045
At most 3	0.231710	12.12505	15.89210	0.1788
At most 4	0.171049	8.629352	9.164546	0.0631

Note: * denotes rejection of the hypothesis at the 0.05 level.

In Table 14, the trace statistics (L_{trace}) and the max-eigen statistics (L_{max}) have a different number of co-integrating vectors (4 and 2, respectively). In case the statistics have a different number of co-integrating vectors, it is recommended that the respective number of co-integrating vectors be selected based on the economic interpretation of co-integrating relations. Following that reasoning the model with two co-integrating vectors was chosen.

4.3.2. VECM Specification

After the co-integrating rank and optimal lag structure are determined, the VECM for Estonia is specified as follows:

$$\Delta x_t = c_0 + \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + \Gamma_3 \Delta x_{t-3} + \alpha \beta' x_{t-1} + \varepsilon_t \qquad (10)$$

where $x_t = [RNPL_t,\ RRE_t,\ GALP_t,\ GGDP_t,\ UN_t]$, $\varepsilon_t \sim N(0,\Omega)$.

Table 15 summarizes the estimates for the beta coefficients in the long-run relationships in the estimated model. Almost all coefficients are significant at the 5% level and have the expected sign.

Table 15. Estonia: β coefficients of co-integrating vectors

	RNPL	RRE	GALP	GGDP	UN	C
Coint.1	1	0	0.49238**	0.53416*	0.16935**	–1.09746**
			[5.01073]	[1.90900]	[2.31205]	[–4.09812]
Coint.2	0	1	–2.75392**	–23.1307**	–4.29456**	25.7952**
			[–2.68296]	[–7.91373]	[–5.61297]	[9.22143]

Note: *t*-statistics are in square brackets; * and ** present statistical significance of the variable at the 10% and 5% level, respectively.

The real GDP changes have the greatest influence regarding long-run relationships. The other variables, such as loan portfolio growth, changes of real estate market and unemployment have their respective influence in the long run.

Adjustment coefficients of co-integrating vectors returning the variables to the long-run equilibrium after shocks are presented in Table 16.

Table 16. Estonia: α adjustment coefficients

	RNPL	GALP	GGDP	RRE	UN
Coint.1	–0.17500*	–0.34765	2.23777	–4.65912	–0.00456**
	[1.9297]	[0.9534]	[0.0192]	[0.4180]	[–3.1259]
Coint.2	0.01383**	–0.07980**	0.10319**	–0.59742	0.03847**
	[–2.3517]	[1.8858]	[–2.5093]	[1.4796]	[–2.2235]

Note: *t*-statistics are in square brackets; * and ** denote statistical significance of the variable at the 10% and 5% level, respectively.

The adjustment coefficients of the real GDP growth, loan portfolio growth and unemployment are statistically significant.

4.3.3. Specification Tests for Estimated Model Validity

Table 17 presents the summarized results of three specification tests for normal distribution in the residuals, which have been performed to confirm the validity of the estimated VECM.

Table 17. Estonia: results of LM test, White's heteroskedasticity test and the Jarque–Bera test

	LM test				White's hetero-skedasticity	Jarque–Bera
Explanation	**No autocorrelation**				**No hetero-skedasticity**	**Normality test**
No. of lags	Lag 1	Lag 2	Lag 3	Lag 4		
P value	0.6412	0.5612	0.5758	0.1327	0.3204	0.5384

The results of the three conducted tests confirm that the VECM is correctly specified.

4.3.4. Impulse Response Functions

The diagrams in Figure 8 depict impulse responses of an endogenous variable of the estimated model with 3 lags and 2 co-integrating vectors to one-standard deviation structural innovations. The length of the forecast is 16 quarters (4 years).
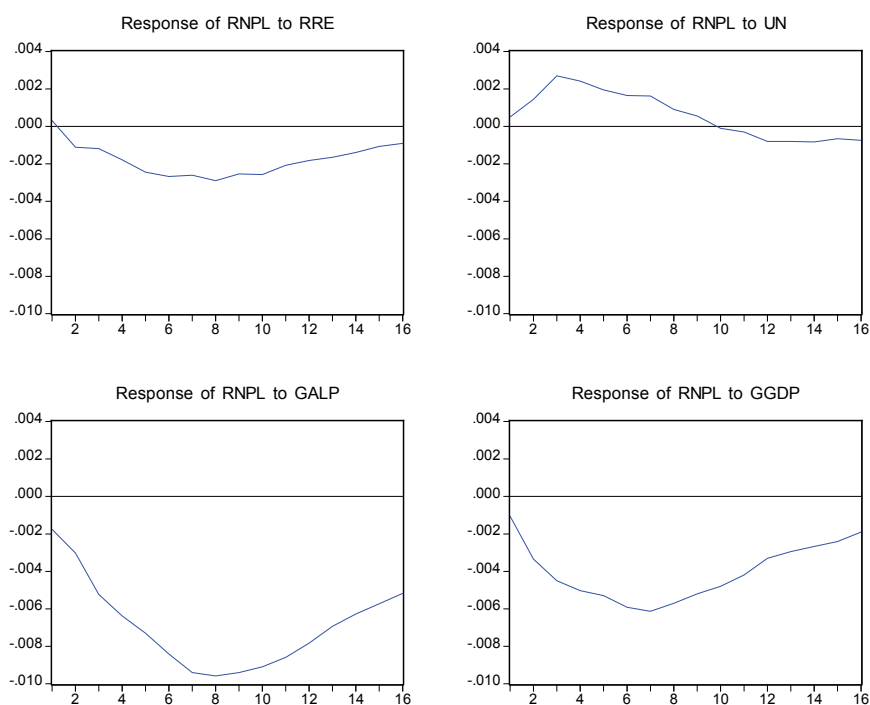
Figure 8. Estonia. Response of RNPL to GGDP, GALP, RRE and UN

Initial estimates of the model demonstrate that *RNPL* decreases with the growth of the real GDP. When the seventh quarter is reached the growth of the real GDP

by 1% causes the decrease of problem loans by 0.613%. The further growth of the real GDP can cause the growth in the level of problem loans. This fact is quite realistic since the achievement of the so–called critical level of the real GDP can result in an increase of problem loans. The results prove the first hypothesis that the real GDP is an important variable for predicting the level of non-performing loans.

The influence of a rapid loan portfolio growth is quite similar to that of the real GDP. Until the seventh quarter the real GDP and loan portfolio growth will cause a fall in the level of non-performing loans. Such a relationship between the real GDP, loan portfolio and non-performing loans is natural. Nevertheless, the influence of the real GDP growth vanishes in the 7th quarter, but the influence of the loan portfolio growth continues until the 8th or 9th quarter. This represents some time shift in the changes between variables or proves a direct influence of an external negative shock, which is seen as the initial point for the deterioration of economic conditions. The further growth of the real GDP and loan portfolio causes the opposite changes in the level of non-performing loans, i.e. they start growing. This change in the variable movement direction is interpreted as the deterioration of barriers of credit risk analysis and a substantial decrease in the quality of loans granted. As a result, more speculative deals will be financed. These facts prove the second hypothesis that rapid growth of indebtedness has crucial consequences to the growth of non-performing loans. The influence of a rapid loan portfolio growth comes with some time lag after negative effects have been caused by the respective changes in the real GDP. The stronger influence of rapid loan portfolio growth also proves the proposition that banks' analysis of credit risk was insufficient in the previous quarters. If banks had run stricter credit risk policies the impulse responses of *RNPL* to *GALP* would have been smoother and could have meant less non-performing loans.

Changes of the real estate market (*RRE*) caused analogous influence as *GGDP* and *GALP* did. Compared to *GGDP* and *GALP*, the influence of *RRE* turned out to be two to three times weaker by the 7th quarter depending on the compared variable. The third hypothesis, which states that the changes of the real estate market are an extremely important variable, has been partially proved. Namely, the results of the thesis have proved that the rapid growth of the real estate market prices did play some partial, important role regarding the growth of non-performing loans. The influence of *RRE* has not been as crucial as it has been previously assumed. The influence of *RRE* has also appeared with a time lag as was reported for *GALP*.
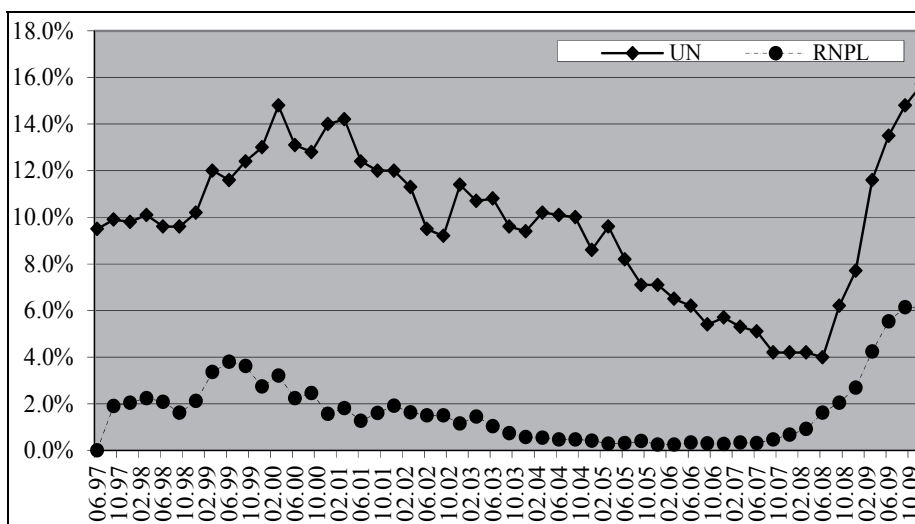
Figure 9. Estonia. The unemployment rate and the level of non-performing loans
Note: author's calculation.
Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info) and the Estonian Statistics (http://www.stat.ee).

There is an interesting influence of the unemployment rate on the level of problem loans. It is obvious that the determination of the unemployment influence is much more precise if the analysis is performed with mortgage loans only. The current data of non-performing loans consist of combined data of private persons and companies. A decrease in *UN* by 1% causes *RNPL* growth of 0.25% by the 3rd and 4th quarters.

Further unemployment growth can cause the growth of non-performing loans and simultaneous movements of the variables. Analogous changes in the movements of the variables *UN* and *RNPL* were observed since the fourth quarter of 2005 to the second quarter of 2008, as presented in Figure 9. During the period from second quarter 1999 to first quarter 2001, the variables moved in opposite directions.

4.4. Econometric Analysis of the Latvian Banking System

4.4.1. Unit Root and Co-Integration Tests

Before going to VECM all variables are tested for presence of unit root in the time series. By performing the ADF test the null hypothesis of presence of unit root in the time series is tested. Table 18 presents the results of unit root tests for five variables.

Table 18. Latvia: augmented Dickey–Fuller test results

	Intercept	Trend and Intercept	None
GALP	−0.824496	−2.016232	−0.556911
Δ*GALP*	−6.936370***	−7.825566***	−6.996698***
*GGD*P	−2.315578	−3.368343*	−0.593914
Δ*GGDP*	−7.937462***	−4.481037***	−8.017798***
RNPL	−2.345088	0.595062	−0.590346
Δ*RNPL*	−2.419857	−3.376735*	−2.501572**
RRE	−8.855302***	−8.652788***	−9.042066***
Δ*RRE*	−8.855302***	−8.652788***	−9.042066***
UN	−1.654730	1.153160	1.108449
Δ*UN*	−3.655796**	−4.285633**	−3.527406***

Notes: (1) Δ denotes 1st differences, (2) *, ** and *** refer to rejection of the unit root at the 10%, 5% and 1% level, respectively.

The results of the test indicate that the time series of all variables, except *GGDP* time series with trend and intercept and *RRE*, are non-stationary in levels. The first-differenced time series found all to be stationary. The null hypothesis of presence of unit root is rejected for most variables at the 5% significance level, except for *RNPL*, for which the null hypothesis is rejected at the 10% significance level if trend and intercept is included and at 5% without trend and intercept. Results inTable 18 indicate that the time series are *I*(1) co-integrated.

Since the variables are co-integrated of the same order, the optimal autoregressive lag has to be found and the co-integration test has to be performed. Based on the AIC and Lagrange Multiplier (LM) test the optimal autoregressive lag was found to be 2.

By applying the optimal autoregressive lag length, the co-integration procedure was estimated with the purpose to choose the optimal model and the number of co-integrating vectors. The model with trend and intercept with two co-integrating vectors was chosen.

Table 19. Latvia: Johansen's test for co-integrating vectors

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.821334	119.6018	88.8038	0.0001
At most 1 *	0.677953	71.37912	63.8761	0.0102
At most 2	0.566665	39.65354	42.91525	0.1021
At most 3	0.319356	16.2387	25.87211	0.4735
At most 4	0.177361	5.466659	12.51798	0.5308
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None *	0.821334	48.22267	38.33101	0.0027
At most 1	0.677953	31.72557	32.11832	0.0558
At most 2	0.566665	23.41484	25.82321	0.1007
At most 3	0.319356	10.77204	19.38704	0.537
At most 4	0.177361	5.466659	12.51798	0.5308

Note: * denotes rejection of the hypothesis at the 0.05 level.

In Table 19, the trace statistics (L_{trace}) and the max-eigen statistics (L_{max}) have an analogous number of co-integrating vectors (2 and 1 respectively). In case the statistics have a different number of co-integrating vectors, it is recommended that the respective number of co-integrating vectors be chosen based on the economic interpretation of co-integrating relations. Following that principle the model with two co-integrating vectors was chosen.

4.4.2. VECM Specification

After the co-integrating rank and optimal lag structure are determined, the VECM for Latvia is specified as follows:

$$\Delta x_t = c_0 + \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + \alpha \beta' x_{t-1} + \varepsilon_t \qquad (11)$$

where $x_t = [RNPL_t, \ RRE_t, \ GALP_t, \ GGDP_t, \ UN_t]$, $\varepsilon_t \sim N(0,\Omega)$.

Table 20 summarizes the estimates for the beta coefficients in the long-run relationships in the estimated model. Almost all coefficients, except *UN*, are significant at the 5% level and have the expected sign.

Table 20. Latvia: β coefficients of co-integrating vectors

	RNPL	GALP	GGDP	RRE	UN	@TREND (02Q2)	C
CointEq1	1	0	0.7854** [6.634]	−0.0461** [−2.726]	0.0705 [0.363]	0.0016** [2.419]	−0.8071
CointEq2	0	1	−3.7687** [−4.614]	0.4208** [3.608]	−1.146 [−0.854]	−0.003 [−0.767]	2.4607

Note: *t*-statistics are in square brackets; * and ** denote statistical significance of the variable at the 10% and 5% level, respectively.

As in the Estonian case, the real GDP changes have the greatest influence regarding long-run relationships. The other variables, such as changes of the real estate market and unemployment have their respective influence in the long run.

Adjustment coefficients of co-integrating vectors returning the variables to the long-run equilibrium after shocks are presented in Table 21.

Table 21. Latvia: α adjustment coefficients

	RNPL	GALP	GGDP	RRE	UN
CointEq1	−1.31783** [−3.29998]	1.783735 [1.27835]	1.856777** [2.80468]	−5.743665 [−0.79109]	−1.43866** [−4.27659]
CointEq2	−0.16951** [−2.38055]	0.209286 [0.84120]	0.490154** [4.15235]	−3.043193** [−2.35074]	−0.11236* [−1.87314]

Note: *t*-statistics are in square brackets; * and ** denote statistical significance of the variable at the 10% and 5% level, respectively.

The adjustment coefficients of the real GDP growth, real estate market growth and unemployment are statistically significant.

4.4.3. Specification Tests for Estimated Model Validity

Table 22 presents the summarized results of three specification tests for normal distribution in the residuals, which have been performed to confirm the validity of the estimated VECM.

Table 22. Latvia: results of LM test, White's heteroskedasticity test and the Jarque–Bera test

	LM test			White's heteroskedasticity	Jarque–Bera
Explanation	**No autocorrelation**				**Normality test**
				No heteroskedasticity	
No. of lags	Lag 1	Lag 2	Lag 3		
P value	0.762	0.9381	0.9788	0.3586	0.99

The results of the three conducted tests confirm that the VECM is correctly specified.

4.4.4. Impulse Response Functions

The diagrams in Figure 10 present the impulse response functions constructed on the responses of an endogenous variable of the estimated model with 2 optimal lags and 2 co-integrating vectors to one-standard deviation structural innovations. The data were forecast for 9 quarters (2.25 years).

In spite of the different time range in the Estonian and Latvian banking sector analysis, the results received and responses of the endogenous variable are similar. The difference between the Latvian and the Estonian market appears in the terms or speed of the response of *RNPL* to the impulses of exogenous variables.
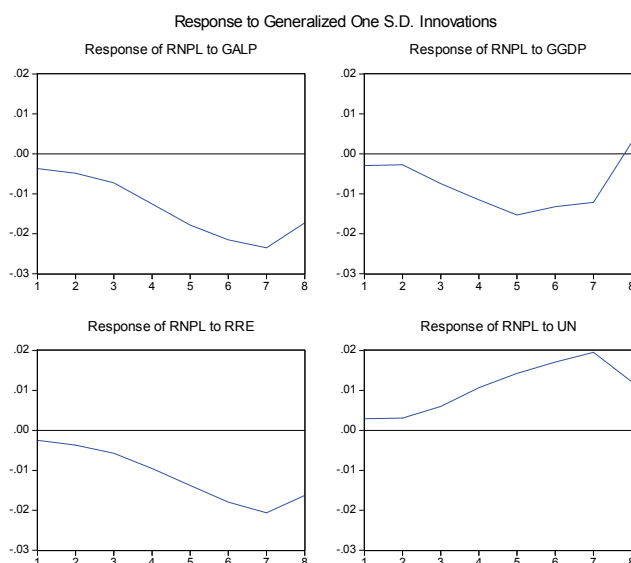
Figure 10. Latvia. Response of RNPL to GGDP, GALP, RRE, UN

The results of the research support the expectations that the initial impact on the level of non-performing loans comes from the changes in the real GDP, as Figure 10 illustrates. If the fifth quarter is reached the growth of the real GDP by 1% causes the decrease of problem loans by 0.0163%. The further growth of the real GDP causes the growth in the level of *RNPL*. This fact is quite realistic since the achievement of the so–called critical level of the real GDP can result in an increase of problem loans. The results prove the first hypothesis that the real GDP is an important variable for predicting the level of non-performing loans.

The impacts of *GALP* and *RRE* have quite identical trends. The loan portfolio and real estate market growth until the 7th quarter causes a fall in the level of non-performing loans (Figure 10). Taking into account the changes of the real GDP, this relationship between these variables is natural. Nevertheless, the influence of the real GDP growth vanishes in the 5th quarter, but the influence of the loan portfolio and real estate market growth continues up to the 7th quarter. This indicates some time shift in the changes between variables or proves the direct influence of the external negative shock, which is seen as the initial point for deterioration of economic conditions. The further growth of the real GDP, loan portfolio and real estate market causes the opposite changes in the level of non-performing loans, i.e. they start growing. This change in the movement direction of variables is interpreted as the deterioration of barriers of credit risk measurement and a substantial decrease in the quality of loans granted. As a result, more speculative deals will be financed. These facts completely prove the second and third hypotheses that rapid growth of indebtedness and real estate market has crucial consequences to the growth of non-performing loans. The influence of the rapid loan portfolio and real estate market growth comes with some time lag after negative effects have been caused by the respective changes in the real GDP. The stronger influence of the rapid loan portfolio and real estate market growth also proves the proposition that banks' analysis of credit risk determinants was insufficient in the previous quarters. If banks had run stricter credit risk policies, the impulse responses of *RNPL* to *GALP* and *RNPL* to *RRE* would have been smoother and could have meant less non-performing loans.

There is an interesting influence of the unemployment rate on the level of problem loans. However, as to the interpretation of results of *UN*, the time range of the research of the Latvian market should be taken into consideration.
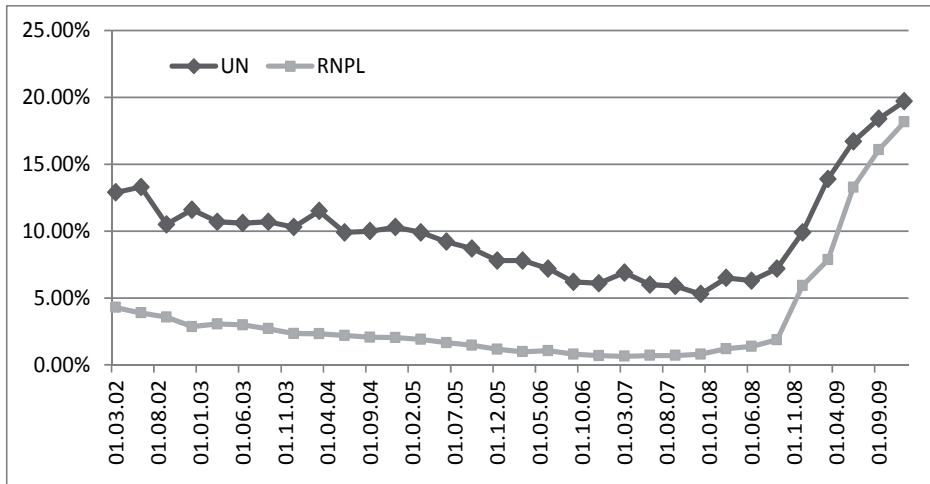
Figure 11. Latvia. The unemployment rate and the level of non-performing loans

Note: author's calculation.
Source: Initial data obtained through the Internet from the Statistics Latvia (www.csb.gov.lv/) and the Financial and the Capital Market Commission of Latvia (http://www.fktk.lv).

The movements of *UN* and *RNPL* variables presented in Figure 9 for Estonia are analogous to the movements of Latvian *UN* and *RNPL* variables presented in Figure 11. The difference in the response of *RNPL* to the impulses of *UN* for the Estonian and the Latvian market is in the speed of the changes of the variables. Therefore the impulse response of *RNPL* to *UN* for the Estonian and the Latvian market has some differences.

4.5. Econometric Analysis of the Lithuanian Banking System

4.5.1. Unit Root and Co-Integration Tests

Before going to VECM all variables are tested for presence of the unit root in time series. By performing the ADF test the null hypothesis of presence of unit root in the time series is tested. Table 23 presents the results of unit root tests for five variables.

Table 23. Lithuania: augmented Dickey–Fuller test results

	Intercept	Trend and Intercept	None
GALP	−0.824496	−2.016232	−0.556911
ΔGALP	−6.936370***	−7.825566***	−6.996698***
GGDP	−2.315578	−3.368343*	−0.593914
ΔGGDP	−7.937462***	−4.481037***	−8.017798***
RNPL	−2.345088	0.595062	−0.590346
ΔRNPL	−2.419857	−3.376735*	−2.501572**
RRE	−8.855302***	−8.652788***	−9.042066***
ΔRRE	−8.855302***	−8.652788***	−9.042066***
UN	−1.654730	1.153160	1.108449
ΔUN	−3.655796**	−4.285633**	−3.527406***

Notes: (1) Δ denotes 1st differences, (2) *, ** and *** refer to rejection of the unit root at the 10%, 5% and 1% level, respectively.

The results of the test indicate that the time series of all variables, except *GGDP* time series with trend and intercept and *RRE*, are non-stationary in levels. The first-differenced time series was found to be stationary. The null hypothesis of presence of unit root is rejected for most variables at the 5% significance level, except for *RNPL*, for which the null hypothesis is rejected at the 10% significance level if trend and intercept is included and at 5% without trend and intercept. Results of Table 23 indicate that the time series are $I(1)$ co-integrated.

Since the variables are co-integrated of the same order, the optimal autoregressive lag has to be found and the co-integration test has to be performed. Based on the AIC and Lagrange Multiplier (LM) test the optimal autoregressive lag was found to be 1.

By using the optimal autoregressive lag length, the co-integration procedure was estimated with the purpose to choose the optimal model and the number of co-integrating vectors. The model with trend and intercept with two co-integrating vectors was chosen.

Table 24. Lithuania: Johansen's test for co-integrating vectors

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.821334	119.6018	88.8038	0.0001
At most 1 *	0.677953	71.37912	63.8761	0.0102
At most 2	0.566665	39.65354	42.91525	0.1021
At most 3	0.319356	16.2387	25.87211	0.4735
At most 4	0.177361	5.466659	12.51798	0.5308
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.**
None *	0.821334	48.22267	38.33101	0.0027
At most 1	0.677953	31.72557	32.11832	0.0558
At most 2	0.566665	23.41484	25.82321	0.1007
At most 3	0.319356	10.77204	19.38704	0.537
At most 4	0.177361	5.466659	12.51798	0.5308

Notes: * denotes rejection of the hypothesis at the 0.05 level.

In Table 24, the trace statistics (L_{trace}) and the max-eigen statistics (L_{max}) have an analogous number of co-integrating vectors (2 and 1, respectively). In case the statistics have a different number of co-integrating vectors, it is recommended that the respective number of co-integrating vectors be chosen based on the economic interpretation of co-integrating relations. Following that principle the model with two co-integrating vectors was chosen.

4.5.2. VECM Specification

After the co-integrating rank and optimal lag structure are determined, the VECM model for Lithuania is specified as follows:

$$\Delta x_t = c_0 + \Gamma_1 \Delta x_{t-1} + \alpha\beta' x_{t-1} + \varepsilon_t \tag{12}$$

where $x_t = [RNPL_t, RRE_t, GALP_t, GGDP_t, UN_t]$, $\varepsilon_t \sim N(0,\Omega)$.

Table 25 summarizes the estimates for the beta coefficients in the long-run relationships in the estimated model. Almost all coefficients are significant at the 5% level and have the expected sign.

Table 25. Lithuania: β coefficients of co-integrating vectors

	RNPL	RRE	UN	GALP	GGDP	C
CointEq1	1	0	−0.015473 [−0.76981]	0.038097** [2.46065]	−0.092433** [−11.4552]	0.042329
CointEq2	0	1	−9.281128** [−2.45457]	4.494286 [1.54302]	−22.37207** [−14.7381]	17.59466

Note: *t*-statistics are in square brackets; * and ** denote statistical significance of the variable at the 10% and 5% level, respectively.

The real GDP changes have greater influence regarding long-run relationships. The other variables, such as loan portfolio growth, changes of the real estate market and unemployment have their respective influence in the long run.

Adjustment coefficients of co-integrating vectors returning the variables to the long-run equilibrium after shocks are presented in Table 26.

Table 26. Lithuania: α adjustments coefficients

	RNPL	RRE	UN	GALP	GGDP
CointEq1	0.375469** [2.02315]	41.87474 [1.29142]	−3.453867** [−2.25271]	−9.72321 [−1.30472]	11.28868 [1.19698]
CointEq2	−0.001624* [−1.84834]	−0.019225 [−0.12526]	0.014033** [1.93365]	0.044423 [1.25930]	0.040878 [0.91569]

Note: *t*-statistics are in square brackets; * and ** denote statistical significance of the variable at the 10% and 5% level, respectively.

The adjustment coefficient of unemployment is statistically significant.

4.5.3. Specification Tests for Estimated Model Validity

Table 27 presents the summarized results of three specification tests for normal distribution in the residuals, which have been performed to confirm the validity of the estimated VECM.

Table 27. Lithuania: results of LM test, White's heteroskedasticity test and the Jarque–Bera test

	LM test		White's heteroskedasticity	Jarque–Bera
Explanation	No autocorrelation		No heteroskedasticity	Normality test
No. of lags	Lag 1	Lag 2		
P value	0.1801	0.0309	0.4355	1.00

The results of the three conducted tests confirm that the VECM is correctly specified.

4.5.4. Impulse Response Functions

The diagrams in Figure 12 present the impulse response functions constructed on the responses of the dependent variable of the estimated model with one optimal lag and two co-integrating vectors to one-standard deviation structural innovations. The data were forecast for 10 quarters (2.5 years). Research is based on a short time range and the tendency of the development of responses of an endogenous variable is described.

The results of the current research completely proved all hypotheses. The level of non-performing loans was most strongly influenced by the changes of the real GDP and *RRE* (Figure 12).
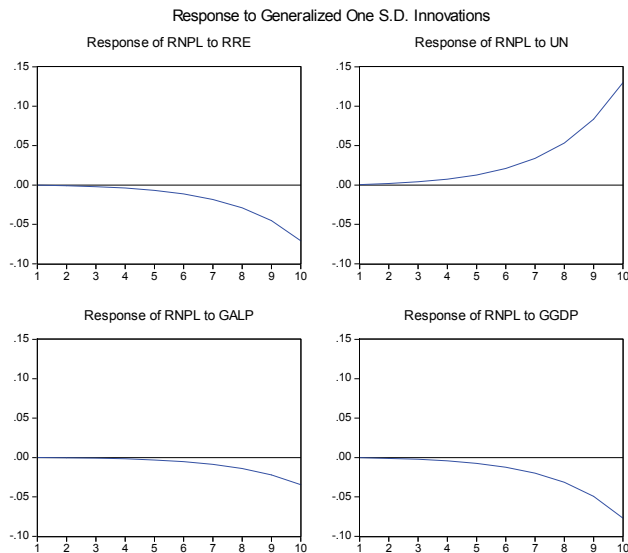
Figure 12. Lithuania. Response of RNPL to GGDP, GALP, RRE and UN

The changes of the real estate market have certain influence on the level of non-performing loans, but it is weaker than the influence of the real GDP and *GALP*.

The influence of *UN* is analogous to the influences of *UN* in Estonia and Latvia (Figure 13).
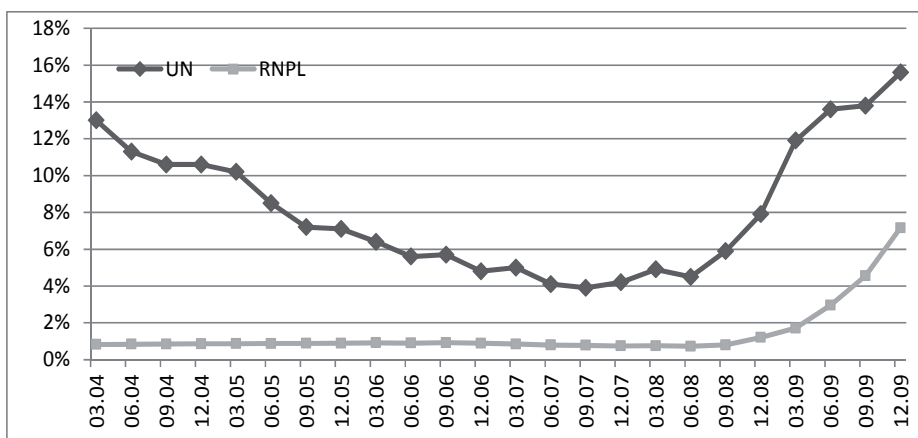
Figure 13. Lithuania. The unemployment rate and the level of non-performing loans

Note: author's calculation.
Source: Initial data obtained through the Internet from the Statistics Lithuania (www.stat.gov.lt/en/) and the Bank of Lithuania (http://www.lb.lt).

4.6.   Conclusion

In order to analyse the individualities and similarities of all three Baltic States for the financial crises in 2007–09 the VECM was applied. The VECM is suitable to perform analysis of such type since it has the ability to distinguish combined deal with the common trends in the time series and to conduct impulse response analysis. There were analysed long-term relationships between the level of non-performing loans and four macroeconomic, banking and real estate sector variables. Five types of shock imposed on the variables studied were proposed and identified with the aim to find out the direction and the strength of *RNPL* impulse responses caused by the changes of other variables.

The main shocks were identified as follows: shock of the deterioration of economic conditions, external negative shock, shock of recession of the economy, loan resources supply shock and real estate demand shock. In spite of the presence of five shocks their influence is simultaneous and depends on the changes of the real GDP. The changes of the real GDP are the driving force for other shocks to appear. The influence of other shocks has to emerge with some time lag because of the adjustment to the changing economic conditions. The speed and strength of changes of variables are determined by their development in the previous periods. The faster the growth of a variable, the deeper the subsequent fall.

As a result of analysis, the consequences of the influence of the variables on *RNPL* were presented and explained. It was demonstrated that that compared to two other Baltic States Latvian economy has the most difficult situation. This is due to the thoughtless policies adopted by politicians and the behaviour of the banking sector aiming at constant growth of the market share and profit.

4.7. Analysis of Panel Data of the Three Baltic States

The economies of the three Baltic States are more or less similar in culture and geographical neighbourhood, their rapid economic growth and banking sector development for the past twenty years, membership of the European Union, openness for trade and foreign investments, especially with the European Union. Taking the similarities of the Baltic States into account I pooled their three cross-sectional quarterly data for various periods into a panel data set to conduct panel data regression analysis aiming to examine the hypotheses presented in the introduction and to confirm or reject the results based on time series analysis. Moreover I hope to attain more precise estimation with the smaller standard errors.

4.7.1. Model Specification

The estimations are based on quarterly panel data, which in general cover the period from the third quarter of 1997 up to the fourth quarter of 2009 (Table 28). This time range includes at least two financial crises affecting the banking systems of the Baltic States. Since the initial data for the three Baltic States have different time ranges, the panel will be unbalanced panel.

Table 28. Time range of initial data for the three Baltic States

Country	Time range
Estonia	1997 3Q–2009 4Q
Latvia	2002 1Q–2009 4Q
Lithuania	2004 1Q–2009 4Q

The use of a longer time sample was not possible due to the absence of the data for non-performing loans for the banking sectors and also data for unemployment rates for the Latvian and Lithuanian economies.

As defined in the section 4.2, the general theoretical relationship between the variables for the estimation of non-performing loans is as follows:

$$RNPL_{it} = \beta_0 + \beta_1 GALP_{it} + \beta_2 GGDP_{it} + \beta_3 RRE_{it} + \beta_4 UN_{it} + \eta_i + \varepsilon_{it} \quad (13)$$

where $RNPL_{it}$ is the ratio of non-performing loans to the aggregated loan portfolio of banks for country i in year t;

$GALP_{it}$ is the growth of a banks' aggregated loan relevant to country i at time t;

$GGDP_{it}$ is the growth rate of real GDP for country i at time t;

RRE_{it} is the growth rate of the real estate market of the Baltic States relevant to country i in year t;

UN_{it} is the unemployment rate for country i in year t;

η_i represents the individual effect of a country and reflects the unique risk profile of the country;

ε_{it} are idiosyncratic errors.

4.7.2. Analyzed Periods

Based on the data in Figure 14 and in order to perform econometric estimations, analysis is conducted for three periods: (1) 1997 3Q–2009 4Q, (2) 2002 1Q–2006 4Q and (3) 2007 1Q–2009 1Q, that is for the whole sample and two sub-samples.
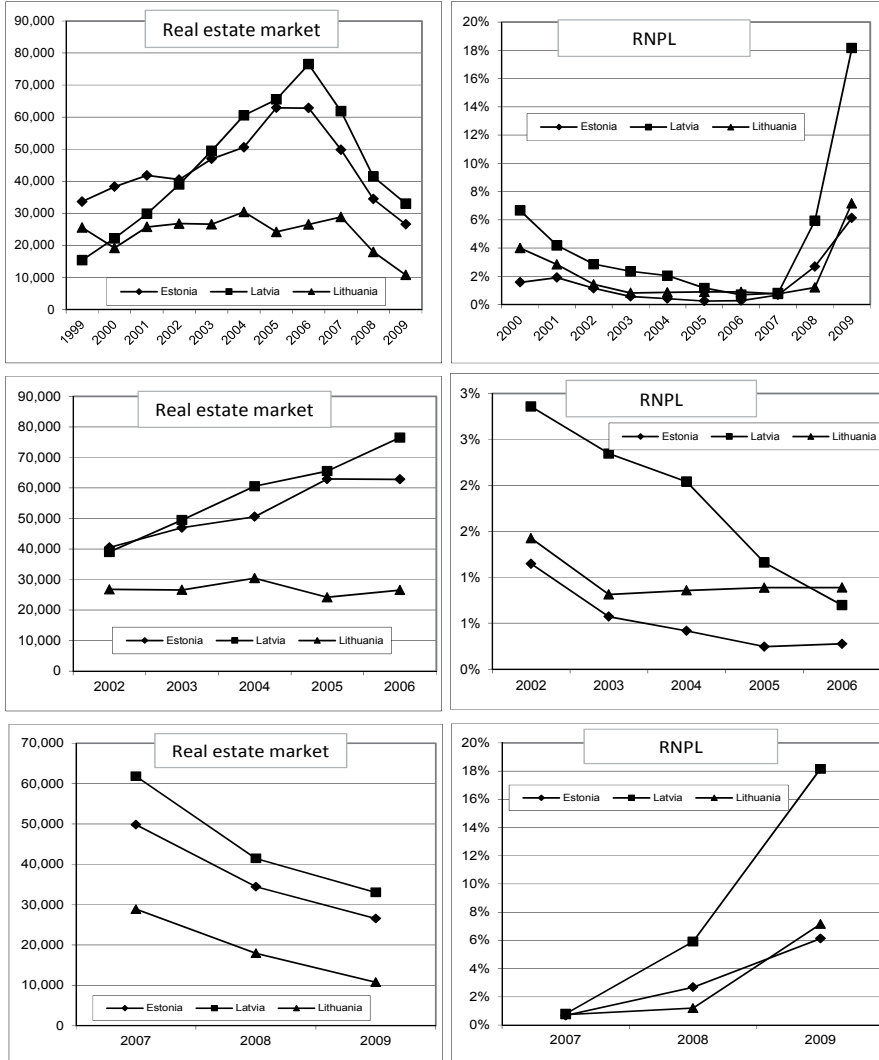
Figure 14. The level of non-performing loans and the number of concluded real estate deals
Source: Data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt), the Statistics Estonia (http://www.stat.ee/), the Land Register of Latvia (http://www.zemesgramata.lv) and the Land register of Lithuania (http://www.registrucentras.lt/ntr/stat/).

The selected time periods represent three stages of market development. The first period (1997 3Q–2009 4Q) covers the whole period of the research and includes at least two financial crises.

The period from 1997 3Q up to 2001 4Q was not included since it is constructed on the Estonian data only and results based on it could not describe the changes in all three Baltic States.

The second period (2002 1Q–2006 4Q) represents the period of a constant growth of the economies of the three Baltic States.

The third period (2007 1Q–2009 1Q) is a period of a dramatic downfall of the economies and real estate markets of the Baltic States, rapid growth of non-performing loans and unemployment rates.

4.7.3. Econometric Estimations

Since individual effects are represented in the model and they have definite economic meaning it has to be decided whether a fixed effect or a random effect model is to be applied. To find it out the Hausman test was conducted for the three analysed periods under the null hypothesis that the difference in coefficients is not systematic and the fixed effect model is appropriate (Table 29).

Table 29. Hausman test results

Period	chi2(4)	Prob>chi2
1997 3Q–2009 4Q	23.87	0.0001
2002 1Q–2006 4Q	94.33	0.0000
2007 1Q–2009 1Q	2.68	0.6125

Note: author's calculation.

The test results for the first and the second period are satisfactory and suggest that the fixed effect panel data model is to be applied. This model assumes that the slope coefficients are constant for all cross-section units, and intercept varies over individual cross-section units but does not vary over time. Therefore, η_i are assumed to be fixed parameters to be estimated, ε_{it} are independent and identically distributed (IID (0, σ_ε^2)), and independent variables are assumed to be independent of the ε_{it} for all i and t.

The result for the third period indicates that the random effect panel data model is to be used. In that case $\eta_i \sim IID$ (0, σ_η^2) and $\varepsilon_{it} \sim IID$ (0, σ_ε^2). To have more unified results the results calculations for the third period will include both fixed and random effects.

The model estimation for the fixed effect is done with two estimation methods: Least Square (LS) and Estimated Generalized Least Square (EGLS), in which cross-section weights are used. The results based on the EGLS were additionally included into the analysis since some results based on the LS

method turned out to be unsatisfactory (especially for the third period). A summary of the estimation results is presented in Table 30.

The basic estimation was done for the first sample period: 1997 3Q–2009 4Q. The model is able to explain more than 63% or 57% (depending on the estimation method) of the observed changes in the non-performing loans, which is satisfactory. The coefficients have expected signs (except *GGDP*) and, in spite of the method used, *GALP* and *UN* are very significant variables regarding changes of non-performing loans. *GGDP* is significant with the PLS method only and *RRE* is not significant at all. The preliminary results indicated that all variables except *RRE* have long-term influence on the level of non-performing loans.

The results of estimations based on the data of the second period (2002 1Q–2006 4Q) are quite similar to the results of the first period. The model for the second period is able to explain more than 75% and 76% (depending on the method) of the observed changes in the non-performing loans, which is satisfactory and better than for the first and second periods. The coefficients have expected signs (except *GGDP*) and in spite of the method used *GALP* and *UN* are significant variables regarding changes of non-performing loans. *GGDP* and *RRE* are not significant at all.

The results based on the data of three periods confirm that *RRE* has a rather short-term effect on the level of non-performing loans. Compared to the first and the second analysed period, the significance of *GALP* during the third period has decreased, but remains satisfactory. The satisfactory significance of *GALP* during the first two analysed periods proved the hypothesis that the rapid growth of indebtedness was crucial to the growth of non-performing loans and the rapid growth of *GALP* had more influence on the level of non-performing loans than the changes of *GGDP*.

The variables *RRE* and *UN* are the only significant ones during the third analysed period. For the third period the model is able to explain more than 76% and 80% (depending on the method) of the observed changes in *RNPL*. The coefficients also have the expected signs.

The results of the third analysed period partially prove the fourth hypothesis that the rapid growth of real estate markets is an extremely important variable in forecasting the level of non-performing loans. During a long-term period the changes of the real estate market have no effect on the level of non-performing loans, since during the period of the extension of the economy the constant growth of real estate market prices supports further investments and the possible influence depends on how such investments are made. As comparative analysis demonstrated the growth of the real estate markets of the Baltic States substantially relied on the strong support of the constant loan portfolio and real estate market growth. This pair of factors was extremely crucial regarding the level of non-performing loans in the Baltic States.

Table 30. Panel data based regression analysis

	Fixed effect model						Random effect model
	Period 1		Period 2		Period 3		Period 3
	1997Q3–2009Q4		2002Q1–2006Q4		2007Q1–2009Q1		2007Q1–2009Q1
Variable	(LS)	(EGLS)	(LS)	(EGLS)	(LS)	(EGLS)	(Pooled EGLS)
Constant	7.5567**	7.5383**	3.4208*	3.9337*	–3.1905	0.2676	–4.8718
	[2.0825]	[2.4908]	[1.7065]	[1.8601]	[–0.7910]	[0.0793]	[–1.2129]
GALP	–0.2197**	–0.1463***	–0.0630**	–0.0551**	0.1504	0.1218	0.0313
	[–3.7152]	[–3.0509]	[–2.4691]	[–2.2526]	[0.9094]	[1.0831]	[0.4168]
GGDP	0.1144*	0.0515	0.0202	0.0083	–0.1842	–0.1856	–0.0401
	[1.9751]	[1.1266]	[0.9086]	[0.4143]	[–1.0790]	[–1.6348]	[–0.4775]
RRE	0.0124	0.0114	0.0082	0.0068	0.0462**	0.0477***	0.0375**
	[0.9957]	[1.1492]	[1.5353]	[1.3278]	[2.3099]	[2.9773]	[1.8136]
UN	0.5026***	0.3839***	0.1875***	0.1887***	0.5795***	0.4980***	0.6112***
	[8.6337]	[7.8173]	[5.0978]	[5.2133]	[5.4365]	[6.5537]	[5.4251]
Number of obser-vations	104	104	50	50	27	27	27
R^2	0.6374	0.5725	0.7589	0.7611	0.7578	0.8040	0.7278
Adj. R^2	0.6150	0.5460	0.7253	0.7277	0.6852	0.7453	0.6783
F-statistic	28.4167	21.6488	22.5613	22.8274	10.4303	13.6772	14.7079
DW	0.4684	0.4233	0.5747	0.5824	0.9610	0.8787	0.7617
Log likely-hood	–202.6998		–30.6267		–33.8845		
LR Chi 2	23.8037	9.3365	36.5926	24.1641	3.1517	2.7289	
Prob > Chi2	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)	(0.08)	

Notes: *t*-statistics are in square brackets. *, ** and *** denote statistical significance of the variable at the 10%, 5% and 1% level, respectively. Individual cross-sectional constants are not presented here. Dependent variable is *RNPL*, the ratio of non-performing loans to the aggregated loan portfolio of banks.

The results of all periods confirmed that macroeconomic variables such as *GGDP*, *UN* and banking sector variable *GALP* have a long-term effect on the level of non-performing loans. *RRE* has a short-term effect only and its effect is usually spurred by other variables, as for example, *GALP*. Regarding this the influence of that variable can be eliminated from respective credit risk

measurement. Since macroeconomic variables such as *GGDP*, *UN* and banking sector variable *GALP* have a long-term effect on the level of non-performing loans they are extremely important in predicting the level of non-performing loans.

Special attention should be paid to *UN*. This variable is significant regarding all three analysed periods. The significance of this variable is proved by high of unemployment rates for all Baltic States (see also Figure 7). However, the unemployment rate for all Baltic States had not decreased by the end of 2010: Estonia – 16.9%, Latvia – 17.2, Lithuania – 17.1.

5. Discussion

Based on the results of the previous chapters, this chapter presents comprehensively generalized conclusions, relationships and trends between the hypotheses listed in the introduction, chosen variables and the methodological approach used to perform the research.

5.1. The Role of Banks in the Evolution of Crises

The central role of banks is to ensure the adequate resources allocation between borrowers and lenders. Following that banks can any time fall a victim since there are constant conflicts of interest distorting the banks' function and threatening economic growth and stability, for example Breuer (2006).

The banking sectors of the Baltic States have had several financial crises, for example Fleming, Chu and Bakker (1996), Caprio and Klingebiel (1996), Fleming and Talley (1996), Adahl (2002), Männasoo and Mayes (2009). They had different initial causes, and as a logical consequence, a constant improvement of the regulation and supervision followed.

The financial crises in 2007–09 that emerged in the banking systems of the Baltic States have affirmed that banking functioning involves an internal risk that under certain circumstances could lead to the banking sector distress. One of such risks to be constantly managed and monitored is credit risk.

Considering this, the main aim of this research was through the empirical investigation and comparison of the evolution and influence of several credit risk determinants to analyse the banking crises in the Baltic States and to demonstrate that in these countries banks as primary financial institutions did not pay relevant attention to the cyclical changes of credit risk determinants.

The principal purposes of banks in the Baltic States had become increasing the market share and a constant growth of the profit. At the beginning of the 2000s Swedish banks made considerable investments into capturing an large market share through their subsidiary banks. Such behaviour is completely consistent with Minsky's (1992) idea that banks are profit-seeking institutions and therefore financial markets are persistently unstable.

To achieve their purposes banks supported a rapid and substantial loan portfolio growth. Since a sizeable part of the granted loans was invested into the real estate market, its rapid growth followed. These market distortions before the financial crises in 2007–09 resulted in a substantial growth of non-performing loans.

5.2.   Interpretation of the Research Results

5.2.1.   Results Based on Time Series Analysis

The current section focuses on the estimation of the role of macroeconomic and banking sector determinants in the credit risk measurement of the Estonian, Latvian and Lithuanian banking systems.

Due to absence of quarterly data for some variables the time ranges of research for the analysed countries are different. During the analysed period, i.e. from the second quarter of 1997 to the fourth quarter of 2009, the Estonian banking system faced two financial crises. The second crises had a more significant influence than the first one. Data of the Latvian and the Lithuanian banking system cover the financial crisis in 2007–09 only. The effect of different factors on non-performing loans is ultimately of empirical interest.

The analytical framework of credit risk analysis included the results of earlier researches. Five hypotheses were proposed in the introductory part. For Latvia and Lithuania hypotheses 1–5 were proved completely. For the Estonian banking system hypotheses 1, 2, 3 and 5 were proved completely and hypothesis 4 partially.

A vector error correction model (VECM) was applied to identify long-term relations between variables as well as short-term fluctuations between them. A market comparative analysis concentrated on the comparison of the development of economies and also the banking systems of the Baltic States. The analytical framework presented the initial model specification and variables selection process. The model is based on aggregated data of three macroeconomic variables. Two banking sector variables are also included.

The influence of four variables – the real GDP growth, loan portfolio growth, real estate market changes and the unemployment rate – were investigated. The choice of the variables was dictated by the significant growth of the real GDP, the real estate market and the level of indebtedness. The achieved results indicate that all used variables are statistically significant and have their definite influence on the level of the non-performing loans. It is obvious that independent variables augment one another.

The bigger the number of actively operating banks, the greater the competition between market participants and the greater are the problems faced during the period of economic recession. Strong competition and profit targets encourage market participants to ignore relevant and adequate credit risk barriers and to rely on the possibility of the continuation of the existing growth providing more new loan resources to the market. Compared to the other Baltic States, the

Latvian banking sector has the largest number of market participants, totalling 29, the Swedish banks have the lowest market share in that market (see also Table 3). As an ultimate result of strong competition between market participants and neglection of proper analysis of credit risk determinants, the Latvian economy faced in 2009 the greatest real GDP decrease (by–18%), the highest level of non-performing loans (18.16%) and the highest number of aggregated losses of the banking system (by 487 EUR per capita).

Considering also research results of IMF (2000), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007) and Bonfim (2009) macroeconomic variables are important for predicting the level of non-performing loans.

It was demonstrated that for the banking systems of the Baltic States the changes of the real GDP had an initial influence on the growth on the level of non-performing loans. This is important because the other variables move with some time lag following the changes of the real GDP, and additional time is required for them to make the respective adjustments. The longer the adjustment period, the higher the level of non-performing loans will be. Compared to the other Baltic States, the Latvian economy had the longest adjustment period of other variables, which resulted in the highest level of non-performing loans.

Regarding the growth of the real GDP and its components, their proportion and financing are to be considered. The more the growth of the real GDP relies on the current consumption and short-term financing without the cover of the respective export volume, the greater the possibility that problems will be faced during the recession. Figure 15 presents the balance of the current accounts of the Baltic States for the period 1998–2009. According to it, the highest level of deficit was faced by the Latvian economy.
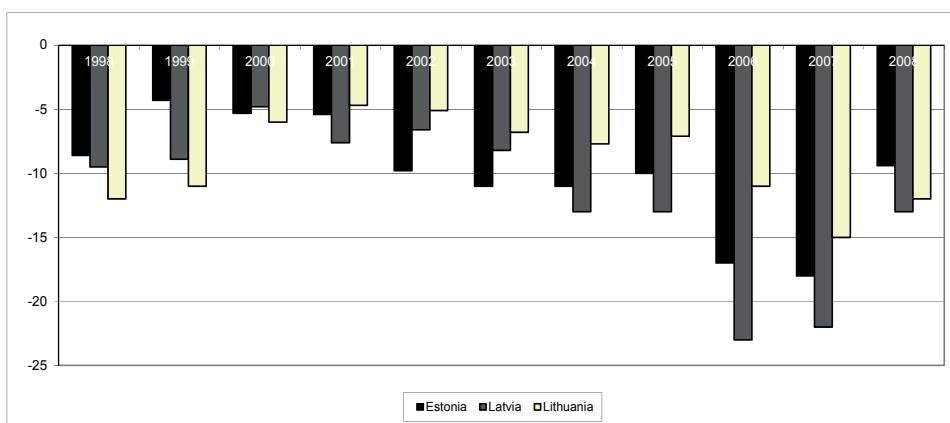
Figure 15. Current account balance of the Baltic States
Note: percentage of GDP.
Source: obtained through the Internet from the Eurostat (http://epp.eurostat.ec.europa.eu)

The third hypothesis was also proved completely for all Baltic States: the rapid growth of indebtedness is crucial to the growth of non-performing loans. It was demonstrated that parallel growth of variables such as the real GDP and loan portfolio until a definite period, which was different for every country, caused a fall in the level of non-performing loans. Such a relationship between the real GDP, loan portfolio and non-performing loans can be treated as natural. A continued growth of the real GDP and loan portfolio caused the opposite changes in the level of non-performing loans, i.e. they started growing. The substantial influence of the constant growth of *GALP* was especially vividly proven for the Latvian banking system. The change in the direction of variable movement is interpreted as the deterioration of barriers of credit risk analysis and a substantial decrease in the quality of loans granted. As a result more speculative deals will be financed. In conclusion, granting such loans will cause the growth of problem loans with some lags.

The results of the research and data of Appendix 6 confirm that the faster the growth of the general level of indebtedness, the more substantial the level of non-performing loans will be. As the Baltic States are small countries with open economies, the basic principle of the forecasting of the growth of aggregated loan portfolio is consideration of the changes of the real GDP, its components and their proportion. Neglecting it resulted in the high level of non-performing loans, as presented in Appendix 6. The repayment of loans granted is to be supported by the current cash flows generated by projects. If new investments are made, they are to generate additional cash flows sufficient for loan repayment. The development projects with loan repayment after completion of the project are to be treated as high risk projects and fallback plans are to be worked out.

The influence of *RRE* has played an important role regarding the growth of non-performing loans in Latvia and Lithuania, but in Estonia it has not been as crucial as expected. Since the real estate market was growing constantly it was seen as an efficient and profitable investment area. The rapid growth of the real estate market in the Baltic States was substantially supported by loan resources invested by banking sectors. As a result the real estate and credit booms developed simultaneously, supporting each other.

The level of unemployment determines a certain portion of problem loans. In general, there are granted mortgage loans. The growth of unemployment has its respective influence on problem loan growth. For a more definite analysis of the relationship between unemployment and non-performing loans, a future study should be based on mortgage loans only.

The models' performance was evaluated with three relevant tests. The results of tests confirmed that the VECMs for the three Baltic States were correctly specified.

5.2.2. Results Based on Panel Data Analysis

The current section focuses on the estimation of the role of macroeconomic determinants in the credit risk measurement of the Baltic States' banking systems, based on the econometric panel estimation framework.

Due to absence of quarterly data on *RNPL*, *UN* and *RRE* variables for the Latvian and the Lithuanian markets, the panel is unbalanced and the fixed effect is applied for two first periods and the fixed and random effects for the third period.

The dependent variable is the level on non-performing loans. The influence of four explanatory variables – real GDP growth, loan portfolio growth, real estate market changes and the level of unemployment rate – were investigated. The achieved results indicate that all used variables are statistically significant and have their definite influence on the level of the non-performing loans.

Like time series analysis, panel data analysis proved that the bigger the number of actively operating banks, the tougher the competition between market participants and the bigger the problems during the period of recession. Strong competition and profit targets encourage market participants to ignore proper barriers in analysis of credit risk determinants and to rely on the possibility of the continuation of the existing growth, which will provide more new loan resources to the market. Compared to the other Baltic States, the Latvian banking sector has the largest number of market participants – 29. Besides the Swedish banks have the lowest market share in Latvia (see also Table 3). As an ultimate result of strong competition between market participants and neglecting proper credit risk analysis the Latvian economy faced in 2009 the greatest the real GDP decrease (by 18%), the highest level of non-performing loans (18.16%) and the highest number of aggregated losses of the banking system (487 EUR per capita).

According to the estimation results, macroeconomic and banking sector variables have long-term effects on the level of non-performing loans. Changes of the real estate market have short-term influence and the impact of this variable is usually associated with or supported by the co-influence of other variables. In the current research it was rapid growth of the aggregated loan portfolio. Since the real estate market had been growing constantly, it was seen as an efficient and profitable investment area. The rapid growth of the real estate market in the Baltic States was substantially supported by loan resources invested by the banking sectors. As a result, the real estate and credit booms developed simultaneously, supporting each other. This hypothesis of the importance of the real estate market was proved partially and it has not been as crucial as it was assumed. If the relevant analysis of credit risk determinants is applied, the effect of changes of the real estate market can be controlled and usually managed.

Identically to the results of researches by IMF (2000), Jimenez and Saurina (2006), Carling, Jacobson, Linde and Roszbach (2007) and Bonfim (2009), macroeconomic variables were proved to be important regarding predicting the

level of non-performing loans. The results of the research have demonstrated for the banking systems of the Baltic States that the changes of the real GDP have an initial influence on the growth on the level of non-performing loans. Also the growth of unemployment has its definite influence on the problem loan growth.

The third hypothesis was also proved completely: the rapid growth of indebtedness has been crucial to the growth of non-performing loans. The constant and rapid loan portfolio growth has played an even more substantial role than changes of the real GDP.

The results of the panel data analysis and data of Appendix 6 confirm that the fast growth of the general level of indebtedness is associated with the more substantial level of the non-performing loans.

5.3.   Remarks Regarding Supervision Authorities

Considering the initial causes of the financial crises in 2007–09 and its preliminary consequences it is hard to object the fundamental thought proposed by Caprio (2009) that the time has come to 're-think' or 're-evaluate' the role of the financial market and the way it is regulated and supervised. Since banking supervision is a key factor to prevent and limit possible distress of poor management, the regulation and supervision of the financial market is to become more dynamic considering all possible financial innovations and their direct and indirect impact on the financial institutions.

Besides the macroeconomic factors considered in the theory as the most important factors for financial crises to emerge numerous researches (see IMF (2000), De Juan (2002), Llewellyn (2002), Carling, Jimenez and Saurina (2006), Jacobson, Linde and Roszbach (2007), Bonfim (2009)) stress that the management of any bank is one of the most important originators of all banking crises. Therefore the combined influence of insufficient and inappropriate supervision and weak management as a major element could lead to substantial problems of a single bank and the whole banking system.

Kent and D'Arcy (2001) confirm that supervision authorities are to pay substantial attention to the changes of the macroeconomic environment and guarantee that banks' lending practice and therefore credit risk analysis respond adequately to the changes in risk determinants following the business cycle.

Based on the experience of the Latin American macroeconomically volatile financial market, Gavin and Hausmann (1998) go further and propose that supervision authorities are to recognize the macroeconomic roots of many banking crises and constantly monitor them. It is especially important regarding the potential generation of a lending boom by the banking sector. They argue that supervision authorities need to make relevant attempts to slow down the rapid development of lending booms, albeit sometimes focusing on the capitalization of the individual bank would be less effective and the usage of monetary policy instruments would suit better for slowing down the lending boom.

Barth, Caprio and Levine (2004), assessing the relationships between regulatory supervision and banking sector development on 107 countries, propose that supervision will be more effective and efficient if banking sector participants disclose the appropriate and adequate market information, i.e. provide transparency and empower private-owned corporates to control banks.

Bank concentration is a possible additional way for providing financial market stability. So, Allen and Gale (2004) and Hellman, Murdock and Stiglitz (2000) propose that bank concentration provide financial stability and the sector would be less prone to the possible distress through enhancing market power and boosting banks profit. The position of Barth, Caprio and Levine (2004) is that few banks will be more monitored by the private sector, i.e. through transparency, and banks will be more effective and efficient.

However, Caminal and Matutes (2002) present the opposite point of view arguing that less competition will lead to larger loans, extensive risk taking, and higher possibility of financed projects failure. A concentrated banking system would tend to receive all possible subsidies and therefore risk analysis and risk management would become of secondary importance, which would result in a constantly lowering quality of the loans granted.

Since the results of the current thesis have affirmed that the commercial banks of the three Baltic States did not pay due attention to the changes in the macroeconomic environment and other credit risk determinants the banks' credit risk management appeared to be misleading and supported the overheating of the economies.

What conclusion can be drawn from all this? There is no single correct and common answer for the banking sector regulation and supervision. There are many factors to be included into that process. Therefore one remark could be made or advice might be given. Financial market supervision is to be and to remain dynamic providing the respective level of transparency of the banking sector, necessary being efficient and effective in constraining possible booms.

Conclusion

One of the most important factors of any banking sector is its stability. Different types of policies, such as proper analysis and monitoring of credit risk determinants (macroeconomic, financial etc.), are to provide a respective mechanism for avoiding unexpected macroeconomic negative shocks. Stable and manageable development of the economies and banking systems based on the robust financial environment is to be supported by the relevant credit risk measurement policies.

To conduct the analysis five variables were chosen based on the conclusion provided by the previous researches and analysis of the banking sectors of the Baltic States. They are as follows: the ratio of non-performing loans to the aggregated loan portfolio of banks treated as dependent variable, the growth of a banks' aggregated loan, the growth rate of real GDP, the growth rate of the real estate market of the Baltic States and the unemployment rate.

Two methods were employed to perform the analysis: VECM and panel data analysis. Individual information and peculiarities of the Baltic States were analysed by VECM. The analysis of the generalized sample was based on the panel data analysis.

To perform the above–mentioned analysis and to correctly interpret the results the main shocks were identified as follows: shock of the deterioration of economic conditions, external negative shock, shock of recession of economy, shock of loan resources supply and real estate demand shock.

The level on non-performing loans is always to be monitored, controlled and managed. Banking risk management is to define the composite part of that variable, estimate and forecast possible negative changes of various parts of aggregated loan portfolios since investments into one definite market segment could result in substantial loan losses if negative macroeconomic shocks appeared.

The results of the current research have proven that the banks of the Baltic States did not pay relevant attention to the changes of credit risk determinants. Following the aim of the constant increasing of the market share and the profit banks have been neutral to the adequate credit risk measurement allowing the financing of high risk projects.

Based on the hypotheses, presented in the introductory part, the research findings are the following:

Hypothesis 1: All independent variables of the research that is macroeconomic, banking sector and real estate market variables, have long-term influence on the level of non-performing loans.

Panel data analysis proved that macroeconomic and banking sector variables have long-term influence on the level of non-performing loans. The changes of

the real estate market have short-term effect on the level on non-performing loans and are usually spurred and associated with negative changes of another variable. The basis for any adequate credit risk analysis is to be the splitting of credit risk determinants into two groups: driving credit risk determinants and supporting credit risk determinants.

Driving credit risk determinants could be treated as determinants with a long-term effect. Supporting credit risk determinants have short-term influence and they aggravate the influence of driving determinants. As a result various policies have to be implemented to manage these types of credit risk determinants.

Hypothesis 2: Macroeconomic variables are important for predicting the level of non-performing loans.

Macroeconomic variables as driving credit risk determinants need constant monitoring and managing. The results of the research confirm that the banks of the Baltic States have not drawn adequate attention to the negative changes of the macroeconomic variables.

Hypothesis 3: The rapid growth of indebtedness is crucial to the growth of non-performing loans.

The study demonstrated that the faster the growth of indebtedness, the greater the growth on non-performing loans that follows. Thus, hypothesis 3 has found complete proof for all three Baltic States. As an especially rapid growth of aggregated indebtedness was witnessed by the Latvian economy, this country suffered the most intense decline of the economy.

Hypothesis 4: The rapid growth of real estate markets is an extremely important variable in forecasting the level of non-performing loans.

Since the real estate market variables have a short-term influence on the level of non-performing loans, the rapid growth of the real estate market has had its definite influence but it varied between the countries. The influence on the Estonian market was not as crucial as it was assumed. Oppositely, the Latvian and Lithuanian markets suffered substantially from the impact of the negative changes of the real estate market.

As the research has demonstrated the substantial influence of the rapid growth of the aggregated loan portfolio caused the extremely high investments into the real estate market seen as a possible, profitable area.

Hypothesis 5: Response of banks to the negative changes of credit risk determinants was not proper and effective.

The research conclusions define that the measurement of credit risk determinants applied by banks of the Baltic States has not been sufficiently effective since banks concentrated mainly on increasing their market share and profit assuming that the economic growth would last further. Too many real

estate projects have been financed. Many of them are unfinished and the real value of these investments is hard to estimate. Therefore many years will pass until there is real coverage to these unreturned investments.

The research concentrated on the influence of four independent variables. Depending on the purpose of future researches the list of the variables is to be amended and some other conclusions could be drawn. In spite of the results of the research there is no concrete and unique answer to the question of measuring credit risk determinants, but banks as trust institutions are supposed first of all to take care of the clients' deposited resources providing stability to the whole economy, and secondly earn adequate income to their shareholders. Ignoring any of such principles will again lead to financial crises.

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Appendix 1. The Percentage of Non-Performing Loans in the Banks' Aggregated Loan Portfolio in the Baltic States

Year	Estonia	Latvia	Lithuania
2000	1.57%	6.65%	3.99%
2001	1.91%	4.18%	2.83%
2002	1.15%	2.86%	1.42%
2003	0.57%	2.35%	0.81%
2004	0.42%	2.04%	0.86%
2005	0.25%	1.16%	0.89%
2006	0.28%	0.70%	0.89%
2007	0.68%	0.80%	0.74%
2008	2.68%	5.92%	1.20%
2009	6.13%	18.16%	7.16%

Note: author's calculation.

Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt).

Appendix 2. The Annual Growth Rate of the Banks' Aggregated Loan Portfolio in the Baltic States

Year	Estonia	Latvia	Lithuania
1998	12.23%	46.05%	30.05%
1999	11.56%	16.10%	12.42%
2000	28.42%	27.77%	-2.64%
2001	18.86%	50.52%	18.64%
2002	22.77%	29.92%	21.43%
2003	38.42%	41.21%	48.25%
2004	33.81%	45.97%	41.83%
2005	35.57%	58.89%	62.54%
2006	41.78%	56.21%	38.10%
2007	39.96%	37.19%	42.94%
2008	4.49%	11.21%	19.11%
2009	-5.92%	-6.99%	-8.82%

Note: author's calculation.

Source: Initial data obtained through the Internet from the Bank of Estonia (http://www.eestipank.info), the Financial and Capital Market Commission of Latvia (http://www.fktk.lv) and the Bank of Lithuania (http://www.lb.lt).

Appendix 3. The Growth Rates of the Real Estate Markets in the Baltic States

Year	Estonia	Latvia	Lithuania
	EEK	LVL	LTL
2000	13.75%	43.98%	-24.85%
2001	9.29%	34.45%	34.08%
2002	-3.09%	30.75%	4.12%
2003	15.91%	26.86%	-0.68%
2004	7.70%	22.30%	14.43%
2005	24.35%	8.19%	-20.59%
2006	-0.13%	16.76%	9.76%
2007	-20.75%	-19.19%	8.74%
2008	-30.84%	-32.97%	-37.81%
2009	-22.89%	-20.27%	-39.94%

Note: author's calculation.

Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Land Register of Latvia (http://www.zemesgramata.lv) and the Land Register of Lithuania (http://www.registrucentras.lt/ntr/stat/).

Appendix 4. Dynamics of the Number of Banks of the Country-Members of the European Banking Federation

Country *	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Estonia	7	7	7	7	7	7	9	14	13	15	16	16
Latvia	28	24	22	23	23	23	23	23	24	25	27	29
Lithuania	13	13	14	13	13	13	12	12	11	11	11	11

Source: Data obtained through the Internet from the European banking statistics (http://www.ebf-fbe.eu/).

* - the number of banks in the Table can differ from the number of banks and branches with the license to operate as a credit institution due to the fact that some banks or branches are not member of the local banking association.

Appendix 5. The Growth of the Level of Non-Performing Loans in Lithuania

Date	Non-performing loans / Aggregated loan portfolio
30.06.2008	2.4%
30.09.2008	2.6%
31.12.2008	4.6%
31.03.2009	8.2%
30.06.2009	11.3%
30.09.2009	14.9%
31.12.2009	19.3%

Source: Data obtained through the Internet from the Bank of Lithuania (http://www.lb.lt).

Appendix 6. Influence of the Aggregated Loan Portfolio Growth on the Level of Non-Performing Loans in the Baltic States

	Estonia	Latvia	Lithuania
Aggregated loan portfolio annual growth, 1997-2009	1049.27%	2975.78%	1402.34%
The level of non-performing loans in 2009	6.13%	18.16%	7.16%

Note: author's calculation.

Source: Initial data obtained through the Internet from the Statistics Estonia (http://www.stat.ee/), the Statistics Latvia (http://www.csb.gov.lv/), and the Statistics Lithuania (http://www.stat.gov.lt/en/).

Appendix 7. Development of Financial Crises

| Increase in Interest Rates | Stock Market Decline | Increase in Uncertainty |

↓ ↓ ↓

Adverse Selection and Moral Hazard Problems Worsen
Decline in Aggregate Economic Activity

↓

Bank Panic

Typical Financial Crisis

↓

Adverse Selection and Moral Hazard Problems Worsen
Decline in Aggregate Economic Activity

- -

Price Level Decline

Debt-Deflation

↓

Adverse Selection and Moral Hazard Problems Worsen
Decline in Aggregate Economic Activity

Source: Mishkin (1991)

Appendix 8. Dependent Variables of Previous Researches

Article	Dependent variable			
Pesola, 2001	**LTL** - Loan losses per bank's outstanding lending stock	**Number of bankruptcies**	-	-
Pesola, 2007	**LTL** - Net loan losses per bank's outstanding lending stock	**Number of bankruptcies**	-	-
Marcucci and Quagliariello, 2007	dr^{it} - default rate of bank's borrowers	-	-	-
Marcucci and Quagliariello, 2009	dr_{it} - default rate of bank's borrowers	-	-	-
Bonfim, 2009	**Credit default** -credit and interest which have become overdue within the last 3-6 months.	-	-	-
Meyer and Yeager, 2001	**Adjusted ROA** - net income plus provision expense as a percentage of total assets	**Non-performing loans to total loans**	**Loan losses to total loans**	**Real estate owned as a percentage of total assets**
Carling, Jacobson, Linde´ and Roszbach, 2006	**Probability of default**	-	-	-
Gasha, Morales, 2004	**Non-performing loans, %**	-	-	-
Jiménez and Saurina, 2006	**Non-performing loans** – the quotient between non-performing loans and total loans	-	-	-

Appendix 9. Macroeconomic Independent Variables

Article	Macroeconomic variables					
Pesola, 2001	Y^e - expected income growth i.e. expected (or lagged) GDP growth	**YS**=Y-Ye - income surprise (Y-actual GDPp growth)	**RS** - change in interest rate	**ES** - change in exchange rates (alternatively terms of trades)	**D** - total debt (aggregated loan portfolio)	**W** - total assets in the economy or nominal GDP
Pesola, 2007	**YS**=income surprise (YS = y – ye, where y = actual nominal percentage growth of GDP, ye = expected nominal percentage growth of GDP)			**ES** - change in exchange rates (alternatively terms of trade)	**L** - total debt (aggregated loan portfolio)	**Y** - total assets in the economy or nominal GDP
Marcucci, and Quagliariello, 2007, 2009	**GDPGt** - growth rate of GDP	**GAPHPt** - the output gap computed as the difference between the GDP and the Hodrick-Prescott (HP) filtered series	**GAPTt** - the output gap computed as the difference between the GDP and a linear trend			
Bonfim, 2009	**National accounts**	**Inflation**	**Labour market data**	**Interest rates**	**Stock market prices**	
Meyer and Yeager, 2001	**Unemployment rate**	**Employment growth**	**Per capita income growth**	**Personal income growth**		
Carling, Jacobson, Lindé and Roszbach, 2006	**Output gap**	**The real GDP Growth**	**Household expectations**	-	-	-
Gasha and Morales, 2004	**GDP growth**					
Jiménez, and Saurina, 2006	**GDPGt** - the real rate of growth of gross domestic product	**RIRt** - the real interest rate, calculated as the interbank interest rate less the inflation of the period	-	-	-	-

Appendix 10. Banking Sector Independent Variables

Banking sector variables					
Marcucci and Quagliariello, 2007	**ln(TA)** - the total banks' assets in logs.	**lgrit** - loan growth rate.	-		
Marcucci and Quagliariello, 2009	**ln(TA)** - the total banks' assets in logs.	**lgrit** - loan growth rate.	-		
Bonfim, 2009	**Loans** - (aggregated loan portfolio)	**Loan loss provisions**	-	-	
Carling, Jacobson, Lindé and Roszbach, 2006	**Bank pay-remark** - a dummy variable taking the value of 1 if the firm has a "non-performing loan" at a bank in the preceding four quarters	**Legal pay-remark** - a dummy variable taking the value of 1 if the firm has a payment remark due to one or more of the following events in the preceding four quarters: a bankruptcy petition, issuance of a court order to pay a debt, seizure of property	**D** – total debt (aggregated loan portfolio)	-	-
Jiménez, and Saurina, 2006	**LOANGit** - the rate of the growth of loans for bank I	**HERFRit** - the Herfindahl index of bank i in terms of the amount lent to each region	**HERFIit** - the Herfindahl index of bank i in terms of the amount lent to each industry	**COLINDit** - the percentage of fully collateralized loans to households over total loans for bank i	**COLFIRit** - the percentage of fully collateralized loans to firms over total loans for bank i	**SIZEit** - the market share of bank i

Appendix 11. Elulookirjeldus

1. Isikuandmed

   Ees- ja perekonnanimi: Igor Novikov
   Sünniaeg ja –koht: 24.11.1974, Venemaa
   Kodakondsus: Eesti

2. Kontaktandmed

   Aadress: Kuldala 7-13, Peetri küla, Rae vald, 75312, Harjumaa, Eesti
   Telefon: + 372 5109 268
   E-posti aadress: classic@infonet.ee

3. Hariduskäik

Õppeasutus (nimetus lõpetamise ajal)	Lõpetamise aeg	Haridus (eriala/kraad)
Tallinna Tehnikaülikool, Majandusteaduskond		Doktoriõpe / finantsökonoomika
Tallinna Tehnikaülikool, Majandusteaduskond	1998	Rahvamajandus / Sotsiaalteaduste magister
Tallinna Tehnikaülikool, Majandusteaduskond	1996	Ärikorraldus / Ökonomisti nimetus; vastavalt Eesti Vabariigi valitsuse otsusele nr. 220 (06.06.2005) saadud kvalifikatsioon (5 aastase õppekava alusel) on võrdsustatud magistri-kraadiga
Nõmme keskkool	1991	Keskharidus Lõpetasin hõbemedaliga

4. Keelteoskus (alg-, kesk- või kõrgtase)

Keel	Tase
Eesti	Kõrgtasemel
Vene	Emakeel
Inglise	Kõrgtasemel
Saksa	Algtasemel

5. Täiendusõpe

Õppimise aeg	Täiendusõppe läbiviija nimetus
10.2009	Loan restructing possibilities. Loan Workout Seminar. Mary Ellen Collins (EBRD endine töötaja)
11-15.10.1999	Eesti Pangaliit
Jaanuar 1998	Eesti Pangaliit
Kevad, 1995	The Baltic University

6. Teenistuskäik

Töötamise aeg	Tööandja nimetus	Ametikoht
04/2011 - …	AB bank Snoras Eesti Filiaal	Filiaali juhataja
08/2010 - 03/2011	Citadele Panga Eesti Filiaal	Krediididirektor, Krediidiadministratsiooni osakonna juhataja Krediidikomitee esimees Halbade laenude monitooringu grupi esimees
05/2009 - 12/2010	Horwood Project OÜ	Finantsjuht
07/2006 - 07/2010	Parex Panga Eesti Filiaal	Krediididirektor, Krediidiadministratsiooni osakonna juhataja Krediidikomitee esimees Halbade laenude monitooringu grupi esimees
11/2005 - 07/2006	Business Advisor OÜ	Investeeringute osakonna juhataja
07/2005 - 10/2005	AVR Transservice AS	Finantsjuht
06/2004 - 07/2005	Parex Panga Eesti Filiaal	Peaanalüütik
04/2003 - 06/2004	Parex Panga esindus Eestis	Laenuosakonna juhataja
03/2000 - 04/2003	Tallinna Äripanga AS	Laenuosakonna juhataja
03/2000 - 04/2003	TBB Liisingu AS	Tegevjuht
08/1999 - 03/2000	Tallinna Äripanga AS	Finantsanalüütik
01/1999 - 08/1999	E – Investeeringugrupi AS (Norma Grupi tütarettevõte)	Finantsanalüütik
09/1998 - 01/2005	Tallinna Tehnikaülikool	Lektor
06/1997 - 08/1999	NG Kapital AS (Norma Grupi tütarettevõte)	Finantsanalüütik
02/1996 - 05/1997	Tallinna Äripanga AS	Finantsanalüütik

7. Teadustegevus

Artiklid:

1) Novikov, Igor (2011). The Empirical Estimation of the Influence of Credit Risk Determinants in Baltic States' Banking Sector. *Journal of Modern Accounting and Auditing*, [ilmumas].

2) Novikov, I.; Fainštein, G. (2011). The Comparative Analysis of Credit Risk Determinants In the Banking Sector of the Baltic States. *Review of Economics & Finance*, 3, 20 - 45.

3) Fainštein, Grigori; Novikov, Igor (2011). Macroeeconomics determinants of credit risk in Estonian banking sector. In: Роль финансово-кредитной системы в реализации приоритетных задач развития экономики. Сборник докладов.: Материалы 4(15)-й международной научной конференции, Санкт-Петербург, 17-18 февраля 2011. (Toim.) prof. V.Leontjev, prof. N.Radkovskaja. Санкт-Петербург: Издательство Санкт-Петербугского Государственного Университета Экономики и Финансов, 2011, 45 - 48.

4) Fainštein, Grigori; Novikov, Igor (2011). The role of macroeconomic determinants in credit risk measurement in transition country: Estonian example. *International Journal of Transitions and Innovation Systems (IJTIS)*, 1(2), 117 - 137.

5) Novikov, Igor; Fainštein, Grigori (2010). Credit risk determinants in Estonian banking sector. *Doctoral School in Economics and Innovation (1 - 13)*. Estonia, Tallinn: Tallinn University of Technology.

6) Novikov, Igor; Fainštein, Grigori (2010). Credit risk determinants in Estonian banking sektor. *Journal of International Scientific Publications: Economy & Business*, 4, 295 - 309.

Konverentsid:

1) 19 – 20.05.11. BMDA 9-s aastakonverents 2011 (Eesti). Teema: "How to become efficient and effective at the same time".

2) 28 - 29.01.11. Eesti Majandusteaduse Seltsi aastakonverents 2011. Roheline majandus.

3) 14 – 16.10.10. "Innovation driven entrepreneurship". International conference BMRA2010. ISM University of Management and

Economics, Vilnius, Lithuania. Ettekanne teemal: The role of macroeconomic determinants in credit risk measurement in transition country: Estonian example.

4) 02 – 06.09.10. 9-th International Symposium Economy & Business. Economic development and Growth. Sunny Beach, Bulgaria. Ettekanne teemal: Credit risk determinants in Estonian Banking Sector.

5) 26 - 29.07.10. Doctoral School of Economic and Innovations. Roosta, Estonia. Ettekanne teemal: Credit risk determinants in Estonian Banking Sector.

8. Kaitstud lõputööd

Sotsiaalteaduste magister: *Aktsiate hindamine väärtpaberiturul*. Detsember 1998. Tallinna Tehnikaülikool, Rahvamajanduse instituut, Rahanduse ja panganduse õppetool.

Ökonomist (kõrgharidus): *Väärtpaberiportfelli formeerimise võimalusi pangas*. Detsember 1996. Tallinna Tehnikaülikool, Rahvamajanduse instituut, Rahanduse ja panganduse õppetool.

9. Teadustöö põhisuunad

    Pangandus. Krediidiriskid, nende maandamine ja juhtimine

10. Teised uurimisprojektid: puuduvad

Appendix 12. Curriculum Vitae

1. Personal data

    Name: Igor Novikov
    Date and place of birth: 24.11.1974, Russia

2. Contact information

    Address: Kuldala 7-13, Peetri küla, Rae vald, 75312,
                                   Harjumaa, Estonia
    Phone: + 372 5109 268
    E-mail: classic@infonet.ee

3. Education

Educational institution	Graduation year	Education (field of study/degree)
Tallinn University of Technology, Tallinn School of Economics and Business Administration		Phd in Economics
Tallinn University of Technology, Tallinn School of Economics and Business Administration	1998	Department of Economics / Master of Science
Tallinn University of Technology, Tallinn School of Economics and Business Administration	1996	Business Administration / Title of Economist; According to the Regulation of Government of Estonian Republic nr. 120 (06.06.2005) received qualification (5 year program) is equal to the Master Degree
Nõmme Senior Secondary School	1991	High education Graduated with silver medal.

4. Language competence/skills (fluent; average, basic skills)

Language	Level
Estonian	Fluent
Russian	Mother tongue
Inglish	Fluent
German	Basic skills

5. Special Courses

Period	Educational or other organisation
10.2009	Loan restructing possibilities. Loan Workout Seminar. Mary Ellen Collins (EBRD former employee)
11-15.10.1999	Estonian Banking Association
January 1998	Estonian Banking Association
Spring, 1995	The Baltic University

6. Professional Employment

Period	Organisation	Position
04/2011 - …	AB Bank Snoras Estonian Branch	Head of the Branch
08/2010 - 03/2011	Citadele Bank Estonian Branch	Credit Director, Head of Credit Administration Department, Head of Credit Committee, Head of Bad Loans Committee
05/2009 - 12/2010	Horwood Project OÜ	Financial manager
07/2006 - 07/2010	Parex Bank Estonian Branch	Credit Director, Head of Credit Administration Department, Head of Credit Committee, Head of Bad Loans Committee
11/2005 - 07/2006	Business Advisor OÜ	Head of Investments Department
07/2005 - 10/2005	AVR Transservice AS	Financial Director
06/2004 - 07/2005	Parex Bank Estonian Branch	Chief Analyst
04/2003 - 06/2004	The Representative Office of Parex Bank in Estonia	Head of Loan Department
03/2000 - 04/2003	Tallinna Äripanga AS	Head of Loan Department

03/2000 - 04/2003	TBB Liisingu AS	CEO
08/1999 - 03/2000	Tallinna Äripanga AS	Financial Analyst
01/1999 - 08/1999	E – Investeeringugrupi AS (Subsidiary of Norma Grupp)	Financial Analyst
09/1998 - 01/2005	Tallinn University of Technology	Lector
06/1997 - 08/1999	NG Kapital AS (Subsidiary of Norma Grupp)	Financial Analyst
02/1996 - 05/1997	Tallinna Äripanga AS	Financial Analyst

7. Scientific work

   Articles:

1) Novikov, Igor (2011). The Empirical Estimation of the Influence of Credit Risk Determinants in Baltic States' Banking Sector. *Journal of Modern Accounting and Auditing*, [forthcoming].

2) Novikov, I.; Fainštein, G. (2011). The Comparative Analysis of Credit Risk Determinants In the Banking Sector of the Baltic States. *Review of Economics & Finance*, 3, 20 - 45.

3) Fainštein, Grigori; Novikov, Igor (2011). Macroeeconomics determinants of credit risk in Estonian banking sector. In: Роль финансово-кредитной системы в реализации приоритетных задач развития экономики. Сборник докладов.: Материалы 4(15)-й международной научной конференции, Санкт-Петербург, 17-18 февраля 2011. (Toim.) prof. V.Leontjev, prof. N.Radkovskaja. Санкт-Петербург: Издательство Санкт-Петербугского Государственного Университета Экономики и Финансов, 2011, 45 - 48.

4) Fainštein, Grigori; Novikov, Igor (2011). The role of macroeconomic determinants in credit risk measurement in transition country: Estonian example. *International Journal of Transitions and Innovation Systems (IJTIS)*, 1(2), 117 - 137.

5) Novikov, Igor; Fainštein, Grigori (2010). Credit risk determinants in Estonian banking sector. *Doctoral School in Economics and Innovation (1 - 13)*. Estonia, Tallinn: Tallinn University of Technology.

6) Novikov, Igor; Fainštein, Grigori (2010). Credit risk determinants in Estonian banking sektor. *Journal of International Scientific Publications: Economy & Business*, 4, 295 - 309.

Conferences:

1) 19 – 20.05.11. BMDA 9-th international conference 2011 (Estonia). Theme: "How to become efficient and effective at the same time".

2) 28 - 29.01.11. Annual Conference of Estonian Economic Association. 2011. Green Economy.

3) 14 – 16.10.10. "Innovation driven entrepreneurship". International conference BMRA2010. ISM University of Management and Economics, Vilnius, Lithuania. Presentation: The role of macroeconomic determinants in credit risk measurement in transition country: Estonian example.

4) 02 – 06.09.10. 9-th International Symposium Economy & Business. Economic development and Growth. Sunny Beach, Bulgaria. Ettekanne teemal: Credit risk determinants in Estonian Banking Sector.

5) 26 - 29.07.10. Doctoral School of Economic and Innovations. Roosta, Estonia. Presentation: Credit risk determinants in Estonian Banking Sector.

8. Defended theses

Master in Social Science: *Shares Estimation at Securities' Market*. December 1998. Tallinn University of Technology, Tallinn school of economics and business administration.

Title of Economist: *The possibilities for formation of securities portfolio in a bank*. December 1996. Tallinn University of Technology, Tallinn school of economics and business administration.

9. Main areas of scientific work/Current research topics

    Banking sector. Credit risks, their estimation and management

10. Other research projects: none.

Kokkuvõte

Nii nagu teised majandusharud, on ka pangandussektor seotud pidevate ja erinevate muutuste, paranduste ja täiustamistega. Seda põhjustavad muuhulgas globaliseerumine, pidevalt tihenev konkurents pangandusturu osalejate vahel, riikliku sekkumise vähendamine, finantsteenuste ja nendega seotud toodete kiire areng, demograafilised trendid ja tehnoloogia areng.

Kuna stabiilne majanduskasv ja efektiivne pangandussüsteem on omavahel tugevalt seotud, siis võib finantsvahenduse nõrkus või ebatäiuslikkus põhjustada majandussüsteemis probleeme, mille tulemusena tekib majanduse langus, mis omakorda põhjustab finantssektori ebastabiilsuse.

Finants- ja panganduskriisid ei ole isoleeritud ega haruldased nähtused. Pangandussüsteemide võimetus teostada operatsioone on avaldanud mõju nii arenenud kui ka arenevatele riikidele. Honohan (1997, 1998) märgib, et mainitud riikides ulatusid kahjude katteks makstud kulud 250 mlrd USDni. Seda kulu pidid katma erinevad majanduslikud üksused - pankrotistunud pankade kliendid ja investorid, valitsused ja nende agentuurid. Caprio ja Klingebiel (1996) ning Evans (2000) näitavad, et enamasti jäävad pangandussektorite kahjude katteks kulunud summad vahemikku 6-28% SKP-st, kohati lausa 40-55%.

Rahvusvaheliste finantsturgude üha suurema integreerituse tõttu on arenevate riikide pangandussektorite probleemidel olulised tagajärjed nii kohalike kui ka rahvusvaheliste investorite majandusele. Lähtudes nii arenevates kui arenenud riikides puhkenud finantskriiside arvust, saab panganduskriise käsitleda üha rohkem kui tavapärast nähtust, seda eriti arenevates riikides.

Samas, kui eelmised kriisid puhkesid just arenevates ja üleminekuriikides, siis 2007.a. puhkenud kriis, nagu tõendavad Laeven ja Valencia (2010) uuringu tulemused, kontsentreerus peamiselt arenenud riikides, kus finantssüsteemid on suured, integreeritud ja hästi arenenud.

Kommertspankade nõrkused, mis tulenevad ebapädevast juhtimisest, pankade struktuurist ja muudest negatiivsetest faktoritest, tugevdavad finantskriisi ning takistavad selle kiiret lahendamist. Finantssektori kontrollimatu liberaliseerimine põhjustab samuti ülaltoodud probleeme. Seega aitavad pankades kasutusele võetud riskijuhtimise meetmed pankade juhtkondadel kaalutud otsuseid vastu võtta. See on eriti oluline avatud majandusega väikeriigile, kus pangandussektoril on domineeriv positsioon.

Üldiselt on pangandussektor üks seadusandlusega kõige paremini reguleeritud tegevusalasid. Valitsused ja nende volitatud järelevalveorganid on kasutusele võtnud terve hulga meetmeid eesmärgiga tagada finantssektori pidev stabiilsus ning ennetada ja vältida võimalikke finantskriise.

Paljude arenevate ja arenenud riikide järelevalveorganid võtsid need nõuded ja meetmed kasutusele kohalike finantsturgude reguleerimiseks. Seetõttu rahvusvaheline kogemus finantsturgude reguleerimisel ja järelevalve teostamisel

ning nende põhjal koostatud nõuded tagavad erinevate riikide vastava seadusandluse unifitseerimise ja ühtlustamise ennetamaks ja vältimaks finantskriise. Unifitseeritud seadusandluse olemasolu ei ole finantskriisi vältimise ainuravim, kuid on selle kindel eeltingimus.

1990ndate aastate algusest kuni praeguseni on peaaegu kõik üleminekuriigid kokku puutunud pangandussüsteemide pideva restruktureerimisega. Paljudel erinevatel põhjustel on need riigid sel perioodil kogenud mitmeid panganduskriise. Erandiks ei ole siinkohal ka Balti riigid. Kuigi nendel kriisidel olid erinevad algpõhjused, järgnes enamasti krediidiriski mõõtmine ning olemasolevate riskijuhtimise poliitikate täiendamine ja uuendamine.

2007. aastal puhkenud finantskriis näitas, et kolme Balti riigi kommertspankade juhtkonnad olid keskendunud peamiselt turuosa kasvatamisele ja pangaomanikele pidevalt kasvava kasumi tagamisele. Pankade sellist käitumistüüpi on kirjeldatud Thakor ja Besanko (2004). Analüüsides pankade erinevaid konkurentsitüüpe, on nad kirjeldanud, kuidas kasvanud pankadevaheline konkurents võib viia laenajate heaolu täieliku halvenemiseni.

Käesoleva doktoritöö peamine teaduslik panus ja uudsus seisneb vastava sobiva krediidiriski mudeli leidmises, mis on eriti tähtis igasuguse pangandussüsteemi stabiilsuse tagamisel. Lähtudes krediidiriski determinantide arengust minevikus ning krediidiriski muutuste või selle koostisosade üldtaseme prognoosist, viib antud mudel korralikult ja põhjalikult mõõdetud krediidiriski aktsepteerimiseni. Käesolevas doktoritöös pakub autor innovatiivse meetodi krediidiriski mõõtmiseks, milles saab kergesti teha vajalikke muudatusi vastavalt muutuvatele turutingimustele ning mida saab kasutada pankade laenutegevuse prognoosimiseks.

Teine võimalus doktoritöös väljapakutud mudeli kasutamiseks seisneb pangandussektori poolt võetud krediidiriski üldtaseme hindamises kolme Balti riigi järelevalveorganite poolt. See võimaldab minimeerida majanduse ülekuumenemise riski. Analüüsi tulemused võivad pakkuda huvi nii pangandussektori esindajatele kui ka poliitikutele, kes vastutavad majanduspoliitika arengu ja edendamise eest.

Krediidiriski determinantide pidev monitooring on mainitud poliitikate ja edaspidise otsustusprotsessi alus. Eelnevat arvesse võttes ning tagamaks stabiilset majanduskasvu, on vaja välja selgitada, missugused krediidiriski determinandid avaldasid kõige negatiivsemat mõju halbade laenude kasvule Balti riikides. See on antud doktoritöö teine ülesanne. Doktoritöö empiiriline uuring keskendub mitme krediidiriski ühismõjule.

Uuringu peamine idee on empiiriliselt välja selgitada ning võrrelda kolme Balti riigi pangandussüsteemide krediidiriski determinantide arengut ja mõju, s.t. makromajanduslikke ja pangandussektori faktorite mõju iga Balti riigi halbade laenude tasemele selleks, et kindlaks teha sarnasusi ja erinevusi. Sekundaarne eesmärk on analüüsida laenuportfelli kasvu efekti halbade laenude tasemele mainitud riikides. Kolmas eesmärk on kindlaks teha, kas nimetatud faktorid avaldavad pika- või lühiajalist mõju.

Doktoritöö peamisteks väärtusteks peab autor järgnevat:

1. Kuna aastatel 2007-2009 puhkenud finantskriisi negatiivset mõju halbade laenude kasvule pole seni uuritud, seisneb käesoleva dissertatsiooni peamine empiiriline panus 2007-2009 a. panganduskriisi esialgsete põhjuste uurimises ja kindlakstegemises ning nende võrdlemises kolme Balti riigi lõikes.

   Kuna panganduskriis põhjustab finantssektori ebastabiilsust, on finantssektori järelevalveorganite üheks peamiseks ülesandeks neid kriise ennetada ja vältida. Dissertatsiooni tulemused aitavad turuarengu trende hinnata ja majanduse ülekuumenemise riske maandada. Seda arvestades võivad uuringu tulemused pakkuda erilist huvi erinevate, eriti aga avatud majandusega riikide kommertspankadele, järelevalveorganitele ja poliitikutele.

2. Antud töös on välja pakutud, arendatud ja empiiriliselt katsetatud krediidiriski analüüsi innovatiivset meetodit, mis põhineb krediidiriski erinevate determinantide ühismõjul, ning mida saab kasutada pankade finantstegevuse planeerimiseks ja prognoosimiseks.

3. Panganduse krediidiriski determinantide efektiivsust on doktoritöös uuritud, identifitseeritud ja võrreldud kolme Balti riigi vahel.

4. Hinnatud on kõikide sõltumatute muutujate ühismõju halbade laenude tasemele.

5. Kuna Balti riikides toimus kinnisvaraturu märkimisväärne kasv, on täiendavalt testitud kinnisvaraturu kasvu mõju halbade laenudele.

Doktoritöö koosneb järgmistest osadest: sissejuhatus, töös kasutatud lühendid, krediidiriski analüüsi analüütiline keskkond, kolme Balti riigi pangandusturu arengu võrdlus, mudeli spetsifikatsioon ja muutujate valik, empiiriline analüüs ja selle tulemused, tulemuste arutelu, kokkuvõte, viidatud kirjanduse loetelu ja vajalikud lisad. Töö lõppu on lisatud eestikeelne ja ingliskeelne kokkuvõte.

Eelmiste uuringute informatsiooni ja Balti riikide pangandussektori analüüsi tulemuste alusel oli analüüsi teostamiseks valitud viis muutujat. Need on: halbade laenude suhe agregeeritud laenuportfelli kui sõltuv muutuja, pankade agregeeritud laenuportfelli kasv, reaalse SKP kasv, Balti riikide kinnisvaraturgude kasvunorm ja töötuse määr.

Analüüsi läbiviimiseks on kasutatud kahte meetodit: VECM (*Vector Error Correction Model*) ja paneelandmetel põhinevat analüüsi. Individuaalset informatsiooni ja Balti riikide iseärasusi on analüüsitud VECM abil. Üldistatud andmete analüüsiks on kasutatud paneelandmete analüüsi.

Eelpool kirjeldatud meetodite kasutamisel ja tulemuste interpreteerimisel identifitseeriti peamised šokid järgnevalt: majanduslike tingimuste halvenemine, negatiivne välisšokk, majanduse langusšokk, laenuressursside pakkumisšokk ja kinnisvara nõudlusšokk.

Analüüsi tulemused kinnitasid, et järgides turuosa ja kasumi kasvu, ei pööranud

Balti riikide pangad piisavat tähelepanu krediidiriski determinantide muutustele, mistõttu finantseerisid kõrge riskiga projekte.

Käesoleva dissertatsiooni tulemused on järgmised:

Hüpotees 1: Analüüsi kõikidel sõltumatutel muutujatel (makromajanduslikud, pangandussektori ja kinnisvaraturu muutujad) on pikaajaline mõju halbade laenude tasemele.

Paneelandmetel põhinev analüüs kinnitas, et makromajanduslikel ja pangandussektori muutujatel on pikaajaline mõju halbade laenude kasvule. Kinnisvaraturu muutustel on lühiajaline mõju halbade laenude kasvule ning antud muutuja hakkab mõju avaldama teise muutuja negatiivse mõju ilmnemisel. Korraliku krediidiriski analüüsi teostamise aluseks on krediidiriski determinantide jagamine kahte gruppi: primaarsed ja sekundaarsed.

Primaarsed krediidiriski determinandid on need, mis avaldavad pikaajalist mõju. Sekundaarseteks võib pidada neid, mis avaldavad lühiajalist mõju ning tekivad teiste primaarsete muutujate negatiivse mõju toel. Sellest lähtuvalt tuleb võtta kasutusele erinevaid poliitikaid sõltuvalt sellest, millise krediidiriski determinandiga tegemist on.

Hüpotees 2: Makromajanduslikud muutujad on tähtsad ennustamaks halbade laenude taset.

Makromajanduslikud muutujad on krediidiriski primaarsed determinandid ning neid on vaja pidevalt monitoorida ja kontrollida. Käesoleva dissertatsiooni tulemused kinnitasid, et Balti riikide kommertspangad ei pööranud piisavat ja õigeaegset tähelepanu makromajanduslike muutujate negatiivsetele muutustele.

Hüpotees 3: Koguvõlgnevuse taseme kiire kasv avaldab negatiivset mõju halbade laenude tasemele.

Analüüs näitas, et mida kiirem on koguvõlgnevuse kasv, seda suurem on oodatav halbade laenude kasv. Seega on hüpotees 3 saanud täieliku kinnituse kolme Balti riigi osas. Kuna Lätis oli koguvõlgnevuse kasv Balti riikide lõikes kõige kiirem, oli antud riigil ka kõige suurem majanduse langus.

Hüpotees 4: Kinnisvaraturu kiire kasv on oluliselt tähtis muutuja ennustamaks halbade laenude taset.

Kuna kinnisvaraturu muutujal on lühiajaline mõju halbade laenude kasvule, avaldas kinnisvaraturu kiire areng teatud mõju, kuid ta oli Balti riikide lõikes erinev. Eesti turul ei avaldanud kinnisvaraturu muutuja nii tugevat mõju, kui oli prognoositud. Vastupidine olukord tekkis aga Lätis ja Leedus, kus turud said kinnisvaraturu kiire arengu ja sellele järgneva tugeva languse tõttu oluliselt kannatada.

Dissertatsiooni tulemused näitasid, et agregeeritud laenuportfelli ja kinnisvaraturu muutujad olid omavahel tihedalt seotud ning toetasid üksteist,

kuna investeeringud kinnisvaraturgudel olid väga kasumlikud ja madalama riskiga paigutused.

Hüpotees 5: Pankade reaktsioon krediidiriski determinantide muutustele ei olnud vastav ja efektiivne.

Analüüsi järeldused kinnitasid, et Balti riikide kommertspankade krediidiriski determinantide mõõtmine ja hindamine ei olnud piisavalt efektiivne, kuna pangad keskendusid oma tegevuses rohkem turuosa ja kasumi kasvatamisele, eeldades, et majanduse kasv jätkub ka edaspidi. Tänaseks on paljud kinnisvaraprojektid lõpetamata ja nende reaalset väärtust on raske hinnata. Seega läheb veel aastaid, kuni tekib reaalne kate investeeritud vahenditele.

Seega on alati vajalik monitoorida, kontrollida ja maandada halbade laenude taset. Panganduse riskijuhtimine seisnebki antud muutuja koostisosade kindlakstegemises, hindamises ja agregeeritud laenuportfelli erinevate osade võimalike negatiivsete muutuste ennustamises, kuna diversifitseerimata investeeringud põhjustavad negatiivse välisšoki korral olulisi kahjumeid.

Abstract

The banking sector as many other sectors of the economy is constantly going through various types of changes, transformations, amendments and improvements. There are numerous reasons for that: globalization, constantly toughening competition between participants in the banking market, deregulation, rapid development of financial and related products and services, demographic trends and technological changes.

Since sound economic growth and an effective banking system are strongly related, the weakness or imperfection of financial intermediation can contribute to the possible problems of the economic system, resulting in the recession of the economy, and negative macroeconomic developments would bring about financial vulnerability.

Financial or banking crises are not isolated or rare events. Failures of banking systems to perform operations have affected both developed and transition countries. Honohan (1997, 1998) notes that the resolution cost, paid out in these countries, constituted the total amount of 250 billion US dollars. These costs have been borne by various economic units such as depositors and creditors of failed banks, governments or their agencies. Caprio and Klingebiel (1996) and Evans (2000) report that generally transfer payments for covering banking losses made up 6–25% and occasionally up to 40–55% of GDP.

Since international financial markets have become more integrated the banking problems in the emerging markets have substantial consequences for both local economies and the economies of international investors.

However, the financial crisis that started in 2007 confirmed the opposite view. According to the results of Laeven and Valencia (2010), the financial crisis concentrated mainly in the advanced economies, where financial systems are large, integrated and well developed unlike the experience of any previous crises faced in various developing or emerging market economies.

Generally, the banking system is an area with most particularly defined legislation and based on it regulation and supervision systems. Governments and their empowered authorities have employed a whole set of policies meant to support and provide financial sector stability and to avoid or actively and effectively deal with the possible financial crises.

Supervision authorities of many developed and transition countries have adopted these requirements for their national financial markets. International experience and requirements form the basis of unification of legislation, regulation and supervision should guarantee the avoidance of financial market's possible distress. On the other hand, the existence of such unification is not an ultimate cure for financial crises, but just a definite precondition.

Since the beginning of the 1990s up to the present time most of the transition countries have been going through a constant process of banking system

restructuring. Because of a whole set of the underlying reasons they have experienced serious banking system distress over that period. The three Baltic States are not an exception.

After the restoration of the independence at the beginning of the 1990s the Baltic States have suffered from several financial crises. Although these crises had different initial causes, as a common result a constant revising and improvement of existing risk management policies have followed, providing relevant credit risk measurement.

The main scientific contribution and novelty of this thesis is in developing of relevant credit risk model that is increasingly important for the stability of any banking system. Based on the development of credit risk determinants in the past, the forecasts of changes in the general level of credit risks or some of their parts will lead to the acceptance of appropriately measured credit risk. The research aims to propose an innovative approach to credit risk measurement that can be easily amended according to the permanently changing market conditions and used for forecasting the loan activity of banks.

Another possible way of use of the model proposed in the thesis is estimation of the general level of the credit risk taken banking sector by the supervision authorities of the three Baltic States. This will allow minimising the risk of overheating the economy. The results of the research would be interesting for banking sectors and policy makers responsible for the development of the economic policy.

Permanent monitoring of credit risk determinants is a basis for the mentioned policies and for further decision-making processes. Against this background and in order to provide stable economic development, it is important to analyse what type of credit risk determinants played the most crucial role in the growth of non-performing loans in the Baltic States. This is my second motivation of the thesis.

Additionally the quantitative research of the thesis focuses on the interaction of several credit risk determinants acting simultaneously.

The results of the thesis provide the following contributions:
1. Since the initial reasons and the results of the negative impact of the financial crises in 2007–09 on the level of non-performing loans in the Baltic States have not been researched jet, the main empirical contribution is in defining the reasons of the banking crises in 2007–09 and comparing them between the three Baltic States.

    Any banking crisis causes possible financial sector instability, distress and the one of the main tasks of any supervision authority to avoid it. The results of the research help properly to estimate trends of the market development and minimise the risk of overheating the economy. Against this background the results can be used by commercial banks, supervision authorities and policy makers of any country especially with open economy.

2. An innovative approach of credit risk analysis based on the combined influence of different credit risk determinants, which can be used for forecasting the financing activity of banks, has been developed and tested empirically.
3. The efficiency of credit risk determinants analysis, applied by banks before the financial crises in 2007–09, was researched, identified and compared between all three Baltic States.
4. The simultaneous impact of all independent variables on the level of non-performing loans was estimated.
5. Since all Baltic States have had a substantial growth of the real estate market, additionally the influence of the growth of the real estate market on the level of non-performing loans was tested.

To conduct the analysis five variables were chosen based on the conclusion provided by the previous researches and analysis of the banking sectors of the Baltic States. They are as follows: the ratio of non-performing loans to the aggregated loan portfolio of banks treated as dependent variable, the growth of a banks' aggregated loan, the growth rate of real GDP, the growth rate of the real estate market of the Baltic States and the unemployment rate.

Two methods were employed to perform the analysis: VECM and panel data analysis. Individual information and peculiarities of the Baltic States were analysed by VECM. The analysis of the generalized sample was based on the panel data analysis.

To perform the above–mentioned analysis and to correctly interpret the results the main shocks were identified as follows: shock of the deterioration of economic conditions, external negative shock, shock of recession of economy, shock of loan resources supply and real estate demand shock.

The level on non-performing loans is always to be monitored, controlled and managed. Banking risk management is to define the composite part of that variable, estimate and forecast possible negative changes of various parts of aggregated loan portfolios since investments into one definite market segment could result in substantial loan losses if negative macroeconomic shocks appeared.

The results of the current research have proven that the banks of the Baltic States did not pay relevant attention to the changes of credit risk determinants. Following the aim of the constant increasing of the market share and the profit banks have been neutral to the adequate credit risk measurement allowing the financing of high risk projects.

Based on the hypotheses, presented in the introductory part, the research findings are the following:

Hypothesis 1: All independent variables of the research that is macroeconomic, banking sector and real estate market variables, have long-term influence on the level of non-performing loans.

Panel data analysis proved that macroeconomic and banking sector variables have long-term influence on the level of non-performing loans. The changes of the real estate market have short-term effect on the level on non-performing loans and are usually spurred and associated with negative changes of another variable. The basis for any adequate credit risk analysis is to be the splitting of credit risk determinants into two groups: driving credit risk determinants and supporting credit risk determinants.

Driving credit risk determinants could be treated as determinants with a long-term effect. Supporting credit risk determinants have short-term influence and they aggravate the influence of driving determinants. As a result various policies have to be implemented to manage these types of credit risk determinants.

Hypothesis 2: Macroeconomic variables are important for predicting the level of non-performing loans.

Macroeconomic variables as driving credit risk determinants need constant monitoring and managing. The results of the research confirm that the banks of the Baltic States have not drawn adequate attention to the negative changes of the macroeconomic variables.

Hypothesis 3: The rapid growth of indebtedness is crucial to the growth of non-performing loans.

The study demonstrated that the faster the growth of indebtedness, the greater the growth on non-performing loans that follows. Thus, hypothesis 3 has found complete proof for all three Baltic States. As an especially rapid growth of aggregated indebtedness was witnessed by the Latvian economy, this country suffered the most intense decline of the economy.

Hypothesis 4: The rapid growth of real estate markets is an extremely important variable in forecasting the level of non-performing loans.

Since the real estate market variables have a short-term influence on the level of non-performing loans, the rapid growth of the real estate market has had its definite influence but it varied between the countries. The influence on the Estonian market was not as crucial as it was assumed. Oppositely, the Latvian and Lithuanian markets suffered substantially from the impact of the negative changes of the real estate market.

As the research has demonstrated the substantial influence of the rapid growth of the aggregated loan portfolio caused the extremely high investments into the real estate market seen as a possible, profitable area.

Hypothesis 5: Response of banks to the negative changes of credit risk determinants was not proper and effective.

The research conclusions define that the measurement of credit risk determinants applied by banks of the Baltic States has not been sufficiently effective since banks concentrated mainly on increasing their market share and profit assuming that the economic growth would last further. Too many real estate projects have been financed. Many of them are unfinished and the real value of these investments is hard to estimate. Therefore many years will pass until there is real coverage to these unreturned investments.

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