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Macroeconomic Business Cycle Indicators of Credit Risk Increase in Commercial Banks

The macroeconomic factors were analyzed in this paper that allow to predict the increase of banks' clients credit risk when the stages of business cycle change. The statistical model was developed to predict the growth of doubtful and non-performing loans in the commercial banks loan portfolios.

Keywords: banks, business cycle, credit risk, macroeconomics, statistical analysis.

Straipsnyje analizuojami makroekonominiai veiksniai, leidžiantys prognozuoti bankų klientų kredito rizikos lygio padidėjimą kintant verslo ciklo stadijoms. Sudarytas statistinis modelis leidžiantis prognozuoti abejotinų ir neveiksnių paskolų dalies padidėjimą komercinių bankų paskolų portfeliuose.

Raktiniai žodžiai: bankai, verslo ciklas, kredito rizika, makroekonomika, statistinė analizė.

JEL Classifications: C53/E32/E44/G21.

Introduction

In the recent downturn of business cycle the significant deterioration of macroeconomic indicators in Lithuania has emerged. The experience of several resent years has shown that the ability of banks to sustain the stability in macroeconomic shocks has very strong impact on whole economy. The unfulfilled financial market expectations, the increased credit and liquidity risks of the participants in the general economy, the negative effects resulting from the bursting of asset price bubbles, and signs of deteriorating macroeconomic fundamentals bring a challenge to banks in credit risk management. The ability to predict risk indicators and possible consequences of systemic risk contribution during a financial crisis is very important for every bank. The increase in corporate insolvency, bankruptcies and unability to repay debts of households induce banks to screen and monitor borrowers more carefully, thereby reducing the risk of default and increasing the repayment probability.

The banks must have the instruments for the assessment of credit risk for the calculation of minimum capital which depends on the amount of loans and their

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risk. Also the profit of banks is closely related to the ability of debtors to pay back the principal and the interest. Banks analyze the financial rates and other data of every company but equally it is important to consider the economic environment and the systemic risk factors.

The object of this research is the macroeconomic indicators of the debtors' credit risk in banks.

The aim of this research is to estimate the business cycle effect on debtors credit risk in commercial banks and to develop the statistical model for the prediction of non-performing loans growth.

The tasks of research:

1. Analyzing the scientific literature to assess the main business cycle effects on credit risk found by other researchers.
2. To estimate the recent fluctuations of macroeconomic indicators in Lithuania and to find the interrelations of the commercial banks performance indicators with macroeconomy.
3. To develop the statistical model for the prediction of non-performing loans growth.

The methods of this research are: the analysis of scientific publications and the statistical data analysis of Statistics Department of Lithuania, Bank of Lithuania, EUROSTAT, European Central Bank, World Bank.

Managing the credit risk it is important for bankers to understand the interrelations between the credit risk of debtors, bank's performance results and the macroeconomic changes in a country. Analyzing the statistical data of Lithuanian banking system and economic fluctuations, this research interlinks the indicators of commercial banks that are related with loan portfolio credit risk and with macroeconomy. The understanding and experience

of recent economic downturn can have positive impact on credit risk management policy making for banks in future.

The Business Cycle Effect on Credit Risk in Banks

Business cycles are the type of fluctuation found in the aggregate economic activity. A cycle consists of expansions occuring at about the same time in many economic activities, followed by similarly general reccesions, contractions, and revivals which merge into the expansion phase of the next cycle (Mullineux, 2011). This section aims to estimate how these fluctuations influence the credit risk in commercial banks, the activity results of financial institutions and overall financial system of countries.

The financial crisis is a common factor that simultaneously throws multiple financial institutions into financial distress. The assets of different financial institutions are usually correlated because of their exposure to such common factors as loans for companies belonging to the same industry, exposure to a certain asset class, information problems, or macroeconomic factors (Suh, 2012). O. Castren et al. (2010) proved the impact of national and international macroeconomic and financial shocks on euro area firms' expected probabilities of default which characterize the dynamic evolution of credit risk in banks' corporate loan portfolios. Losses generally follow a protracted deterioration in asset quality and stem from adverse macroeconomic shocks, market failures, government interference, or fraud. Most of bank crisis theories are based on changes in economic fundamentals, and regard banking crises as a natural consequence of business cycles. Credit grows rapidly when the economy is

in upturn, as investors are more optimistic about the future and lending standards deteriorate. When economic conditions slow, the entire negative changes cause a collapse in credit. This procyclicality of the financial system makes it fragile and vulnerable to crises. More recent theories view banking crises as an outcome of asset price bubbles not based on economic fundamentals (Laeven, 2011). Asset price bubbles often develop during such booms, resulting in a sustained deviation between asset prices and fundamentals that cannot be explained by random shocks. Asset price bubbles are associated with periods of aggregate over-confidence and overoptimism in security markets, often attracting new traders and speculators to the market. Their presence, leading to over-inflated asset prices and excessive aggregate risk-taking, seems a clear common feature in the banking crises (Connor et al., 2012). In a booming economy, revenues of households and businesses improve and increase the ability to service debt payments. In their quest to increase market share during a boom, banks extend their lending activities often reaching out for lower credit quality borrowers. However, the extension of credit to subprime borrowers inevitably increases non-performing loans (NPLs) when a recession subsides and asset prices fall. Thus, macroeconomic shocks are inevitably transmitted to banks' balance sheets through a worsening of their credit portfolio (Love, Ariss, 2014).

The relationship between default probabilities and the business cycle has already been documented by M. Bruche and C. Gonzalez-Aguado (2010). They estimated different rating transition matrices for periods of high, medium and low GDP growth and found that especially default probabilities were affected.

The research also report that when looking for default risk, taking into account macroeconomic conditions substantially improves the credit risk assessment results (Bruche, Gonzalez-Aguado, 2010). Also one of the major issues of concern with regard to credit risk is a contagion in the credit market, such that default by one firm tends to precipitate defaults by others. The defaults due to unfavorable macroeconomic conditions affect many firms at the same time because bankruptcy by one firm infects other healthy but vulnerable firms and leads them to default (Figlewski et al., 2012). The banks use the statistical models that are integrated into the credit risk management systems that allow analysts and managers to depict the expected performance of individual loans and portfolio segments under different economic scenarios. With this information managers can optimize lending decision-making to assess the appropriate risk levels of the loan portfolios (Chih-Hsing et al., 2014).

The demand for financial services tends to grow as economies expand and societies become wealthier (Sufian, Habibullah, 2010). A. Diaz and F. Perera-Tallo (2011) interconnect the credit with inflation and affirm that the optimal inflation rate is positive. The credit is sustainable when inflation is not negative, credit and welfare are increasing for low levels of inflation until reaching a threshold level. The stability of credit supply is enabled by good credit portfolio and lower share of non-performing loans (Festic, 2012). In a booming and prosperous economy, a firm's demand for capital increases, and borrowers are more solvent because of increased profitability. Therefore, banks adopt looser screening standards and lend actively (Liu, Chen, 2012). The banks promote economic growth and have positive effects on real

economic activity when banking sector is more developed and efficient. Since the activity makes the borrower more likely to succeed, banks are willing to offer larger loans to such borrowers (Cetorelli, Peretto, 2012). The borrowers and lenders are overconfident during the upward phase of the business cycle about investment projects and their ability to repay and regain their loans. Banks' over optimism about borrowers' future prospects brings about more liberal credit policies with lower credit standards requirements. On the other hand, during recessions, banks face non-performing loans and specific provisions that let them tighten further credit supply, complicating the prospects of a recovery in economic activity. These variations in lending are generally more than proportional to the changes in economic activity, suggesting that there are changes in bank loan supply that tend to accentuate the business cycle (Bouvatier et al., 2012).

In a recession, banks severely scrutinize borrowers and lend passively. At the same time, the loan supply affects economic development and further causes economic procyclicality. Thus, economic conditions may affect the strength of banks' screening practices. In general, credit risk spreads become high in a recessionary economy (Liu, Chen, 2012). The most industries tend to have lower profits during recessions so that the perceived credit risk in the general economy is likely to increase. To compensate the increased risk, lenders demand higher interest rates. Lending and borrowing activities will therefore decline. The subsequent credit crunch results the decline in economic activity and increases the probability of a recession (Ng, 2012). During the slow-growth cycle firms are credit-constrained and cannot finance their working capital from banks in order

to continue the regular operations. Once the production is interrupted, the sales decline and a company is incapable of servicing its accounts payable on time. Under such circumstances, accounts payable accumulate and bank lending declines. Thus, these two variables are negatively related to one another. The accumulated payable is a sign of distress with respect to not fully utilizing production capacity, because of insufficient working capital (Huang et al., 2011). During the crises periods the spread of financial crises is typical from the financial sector to the real sector within a country and across countries. The strong contagion effects were found in many developing countries and usually no region or specific group of countries has been immune to shocks associated with crisis. However, the several real economy sectors, especially healthcare, telecommunication and the IT sector, were less affected by contagions (Dungey, Gajurel, 2014).

H. D. Khieu et al. (2012) note that in credit risk modeling an important role play recovery rates (1 – LGD) on defaulted loans. The recovery rate is converse to the loss given default (LGD), which is percentage of loss over the total exposure when bank's counterparty goes to default. These researchers classify factors that affect loan recoveries into four groups: loan characteristics, recovery process characteristics, borrower characteristics, and external factors, such as macroeconomic conditions and industry characteristics. The collateral values, which affect the loan recovery rates, decline as economic conditions deteriorate, whereas the number of defaults also increases in a weak economy. Firm assets will be sold at lower values in distressed industries because the most likely buyers are firms in the same industry that are also in distress (Khieu et al., 2012).

In the economic downturns banks can meet the need to increase their capital ratio either by issuing new equity or by reducing loans. It has been shown, theoretically and empirically, that banks reduce lending more often than they recapitalize. The banks are likely to cut back lending when either economic conditions are poor or raising new capital is costly. Because the bank capital constraint is more likely to be binding during economic downturns, recapitalization would not be easy and the banks may meet the capital ratio by reducing lending. This is especially in case when the economy is weak, as the insufficient bank capital adequacy ratio may cause a credit crunch (Hyun, Rhee, 2011).

Corporate bankruptcy usually impacts the liquidity of capital markets and the development of an economy. An accurate prediction model not only assists banks and institutional investors objectively to assess credit risks of investments but also may reduce the adverse impacts of bankruptcies on the economy (Lin, Wang, 2011). Finally, the precise risk assessment is important as the Basel II requires the banking industry to meet minimum regulatory capital requirements based on the calculation of the probability of loan default, and therefore more accurate default assessment allows for more efficient utilisation of regulatory capital, a further source of competitive advantage (Marshall et al., 2010).

To avoid banking crises, regulators devise mechanisms to monitor banks' risk taking behavior. It is commonly argued that disruption in the financial system can lead to a reduction in investment and other economic activity. Further, bank depositors face profound loss because of bank failures and governments tend to incur large costs in remedying a banking crisis. To avoid this type of systemic form of bank insolvency, the regulators have emphasized greater reliance on market discipline in the regulatory framework along with implicit government support and explicit deposit insurance for banks' creditors, central bank's lending of last resort, and bank insolvency resolution procedures (Haq et al., 2014). Since the 2007–2008 financial crisis one of the priorities for banking regulators has become the bank lending behavior in the economic fluctuations. The new Basel Committee on Banking Supervision (BCBS) regulation demands that, during the depression, banks should estimate the default probability more conservatively and they should establish more capital (Hyun, Rhee, 2011). In particular, the BCBS in Basel III Agreement proposes to introduce a countercyclical capital buffer. The capital buffer would be made during periods of excessive credit growth in order to smooth the credit cycle and protect the banking sector from the accumulation of financial imbalances. Also the BCBS advocates a change in loan loss provisioning behaviors toward more forward looking provisioning practices. These measures seek to increase the cost of making loans in terms of capital and loan loss provisions during the upward phase of the cycle (Bouvatier, Lopez-Villavicencio, Mignon, 2012). Better understanding of what drove the worsened banking indicators during the crisis should also help to identify how financial regulation and supervision could be better designed to more effective credit risk management. This in turn suggests that banks should focus their attention not only on containing normal risks fluctuations but also on addressing their readiness to withstand the sudden economic downturn (Milne, 2014). According to Caprio, D'Apice, Ferri

and Puopolo (2014), the early signals of what happened in banking systems starting from 2008 were already embedded in the financial characteristics of the countries and their banks several years before the crisis erupted. Then, the use of such back-in-time variables in credit risk management is justified by the fact that these contain information about the health of the financial system in the past and how it can evolve over time. As a consequence, they may be useful in understanding the genesis of the crises in banks.

Research Methodology

The first stage of empirical research aims to highlight the deterioration of banks' performance results in recent Lithuanian business cycle downturn. The changes of these internal consolidated banks' indicators were analyzed: the doubtful and non-performing loans, loan portfolio, interest income, interest expenses, net interest income, deposits, deposit interest rates, new credits and their interest rates, provisions and net income.

The second stage of empirical research aims to identify the recent business cycle in Lithuanian economy and to highlight the main changes of banks performance indicators related to the credit risk increase of debtors. The business cycle fluctuations were measured by the GDP, gross capital formation (investments), exports, compensation of employees and consumption expenditures of households. Together with these macroeconomic factors the changes of other indicators were estimated that have the impact on banks' loan portfolio credit risk: the number of bankrupted enterprises, unemployment rate, revenue, net income and net profitability of Lithuanian enterprises, proportion of profitable and loss making enterprises, realty price indexes.

In the third stage of the empirical research the polynomial regression models for the macroeconomic variables were developed that are able to warn about the beginning of possible economic boom period. The significant deviations from trend are measured by the mean absolute percentage errors (MAPE). The correlation analysis was implemented to assess the relations between macroeconomic variables in the business cycle fluctuations. Complementing the macroeconomic rates the relative business and households indebtedness indicators were calculated to measure the average critical indebtedness that cause the credit risk increase problems for banks in economic downturn. As the polynomial regression models alow to identify the beginning of economic boom period, the further developed partial least squares (PLS) regression model predicts the beginning of crisis period where the banks meet the problem of increased credit risk levels and high proportion of doubtful and non-performing loans. The PLS regression model includes the macroeconomic and indebtedness variables.

The analyzed in this research rates of GDP, compensation of employees, exports, investments, consumption expenditures of households, unemployment and bankruptcy of enterprises aim to highlight the salient slump of Lithuanian economy in 2009. The aggregated business indicators of revenue, profit and loss also have to show the recent significant fluctuations in business performance. The analysis of statistical data of commercial banks allows to interrelate their changing annual activity results with changes in macroeconomic conditions of Lithuania. The research tries

to affirm that credit risk of debtors is very sensitive to macroeconomic fluctuations. The proportion of doubtful and non-performing loans, interest income of banks, net profit, loan portfolio, amount of new credits, provisions and impairment of loans vary significantly in respect of macroeconomic changes. The calculated relative rates of enterprises and households indebtedness will show the negative impact of loan portfolio overmuch expansion on the ability of debtors to meet their financial obligations.

The Fall of Banks' Financial Indicators in Recent Business Cycle of Lithuanian Economy

To find a significant coincidence between the macroeconomic indicators and the change of debtors' credit risk the loan portfolio and the proportion of doubtful and non-performing loans (NPLs) in banks were analyzed (Figure 1). The Lithuanian banks met the highest problem of NPLs growth in 2009 when this proportion in one year increased by 17,9 % to
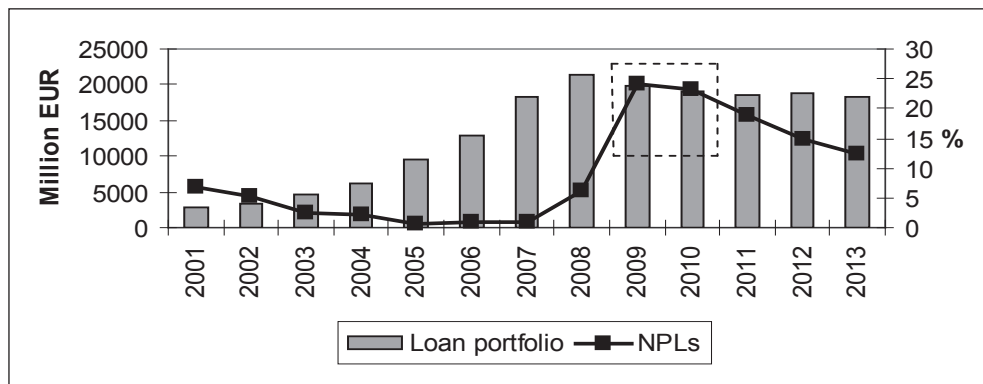

Fig. 1. **The loan portfolio and non-performing loans in Lithuanian banks**

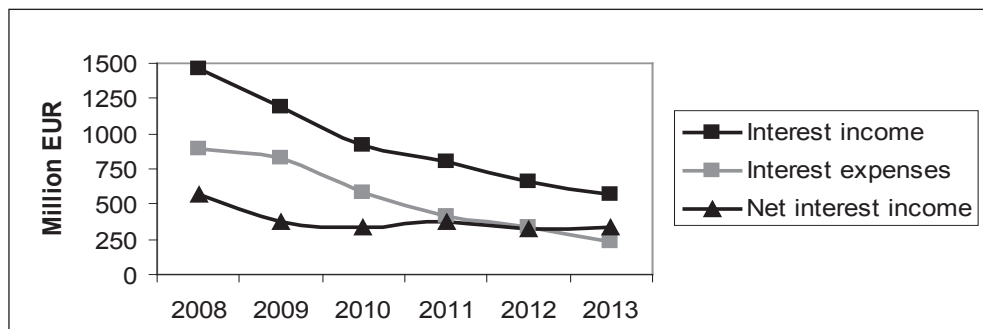*Source*: Bank of Lithuania, 2014; World Bank, 2014.

Fig. 2. **The interest income and expenses in Lithuanian banks**

Source: Bank of Lithuania, 2014.

the value of 24 %. That point the sudden increase of credit risk in the overall loan portfolio and new potential borrowers in banks because 24 % of debtors became insolvent and could not meet the financial obligations for banks in 2009. In 2010 this rate remained almost the same (23,3 %) while in further 3 years this high negative proportion in banks' loan portfolios constantly decreased to 12,5 % in 2013.

Such situation required to tighten the lending policy because banks had to form high provisions due to the debtors' insolvency. The loan portfolio in years 2009–2011 constantly decreased (Figure 1). The highest loan portfolio of commercial banks was in 2008 (21 370 million EUR), which in 2011 decreased by 13,7 % to 18 437 million EUR. This decrease of loan portfolio together with the high proportion of insolvent debtors decreased the banks' interest income (Figure 2).

In 2008, when the loan portfolio was the highest and the proportion of doubtful and non-performing loans in Lithuanian banks were 6,1 %, the banks earned 1 459 million EUR of interest income.

But in further years the interest income declined and in 2013 banks earned only 569 million EUR of interest income. The decrease comparing to the year 2008 was 61 %.

The significant decrease of net interest income was only in 2009, when this rate decreased by 35,4 % from 571 million EUR to 369 million EUR. In 2010 the decrease of net interest income was 9,2 % and in 2011 the net interest income increased by 13,8 % to 381 million EUR. In 2013 the net interest income remained the same as in 2010 (335 million EUR). This favourable situation is affected by the reduced interest expenses for the deposits in years 2010–2013 (Figure 3).

Despite the growth of deposits by 18,9 % in 2010 (compared to 2008) and negligible decrease by 5 % in 2011, the considerably reduced deposit interest rates allowed to have less interest expenses in 2010 and further years (Figure 2). The average deposit interest rates in Lithuanian banks from 7,7 % were reduced to 4,6 % in 2010 and to 0,6 % in 2013. So the overall interest expenses decreased by 73,6 %:
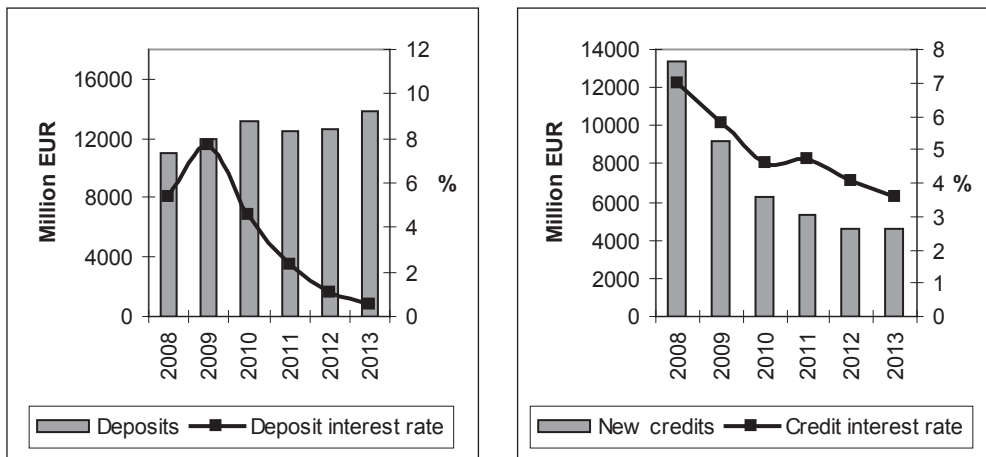

Fig. 3. **The deposits, new credits (business and households) and average interest rates in Lithuanian banks**

Source: Bank of Lithuania, 2014.

Provisions and net income of Lithuanian banks, million EUR

	2008	2009	2010	2011	2012	2013
Provisions	3,4	40,4	−18,0	−4,0	2,8	−1,2
Net income	251,2	−1062,8	−80,0	323,3	209,0	277,4

Source: Bank of Lithuania, 2014.

from 888 million EUR in 2008 to 234 million EUR in 2013. In this situation since 2009 banks were able to keep the net interest income almost stable at 330–369 million EUR yearly. Also the reduction of deposit interest rates was stimulated by the reduced demand of money in banks, because until 2013 the amount of new credits highly decreased (Figure 3).

In 2008 the banks have lent out 13 331 million EUR of new credits for non-financial corporations and households. In 2009 the amount of new credits decreased by 31,3 % to 9 157 million EUR. Despite the improved macroeconomic indicators of Lithuania in further years, banks limited the lending. The amount of new credits in 2010 decreased by 53 % and in 2013 decreased by 65,5 % compared to 2008. Also the reduced average interest rates for new credits negatively affected the interest income of banks in 2010–2013 (Figure 3). The limited ability of banks to lend new credits was mainly influenced by the increased doubtful and non-performing loans to 24 % in 2009 (Figure 1). The lending in 2010–2013 did not expand because the high proportion of non-performing loans remained 12,5 % and higher.

In 2009 when the quality of loan portfolios in banks disimproved and the high proportion of loans became doubtful and non-performing, the banks had to form the extensive provisions of 40,4 million EUR (Table 1). The banks add provisions

to the expenses of a year in income statement, so this negative factor increased the net loss of Lithuanian banks. The activity of banks in 2009 was loss-making and the aggregated loss was 1 062,8 million EUR. In 2010 there was not necessity for new provisions and the loss decreased to 80 million EUR. In 2011–2013 banks earned 209–323,3 million EUR of net income. This profit growth is related to the improved macroeconomic conditions in the country, so the next chapter aims to find the economic factors explaining the changes of analyzed banks' performance indicators.

The Economic Factors of Credit Risk Growth in Banks

The analysis of scientific publications has shown that the slump of macroeconomic environment usually negatively influences the ability of debtors in banks to repay their credits. The recent changes of macroeconomic indicators reflect the significant business cycle fluctuations in Lithuanian economy (Figure 4). The effect of these fluctuations on doubtful and non-performing loans (NPLs) in banks in this chapter will be analyzed.

The most downturn is visible in year 2009 when the GDP decreased by 17,8 % from 32 414 million EUR to 26 654 million EUR. The important factor considering the ability to repay the
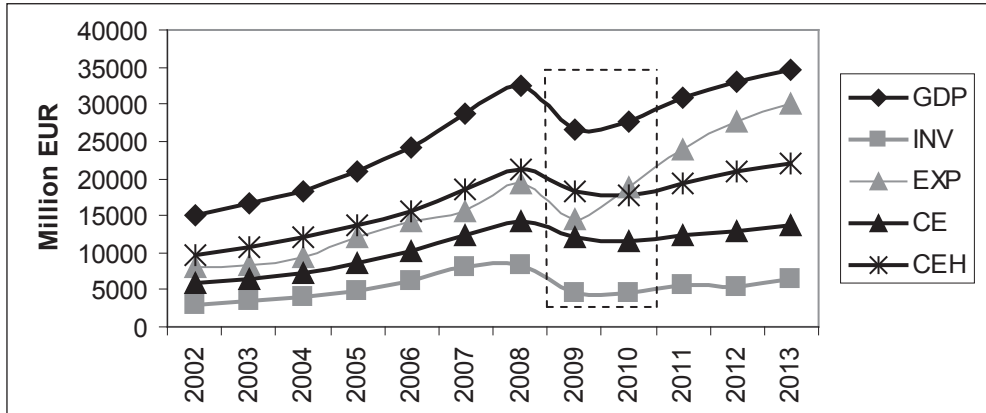
Fig. 4. **The macroeconomic indicators of Lithuania in 2002–2013**

consumer and realty loans is compensa-
tion of employees (CE) which in 2009
decreased by 16,6 %. This slump of em-
ployees' compensation reduced the final
consumption expenditure of households
and non-profit institutions serving house-
holds (CEH) by 14,1 %. The decrease in
consumption expenditure negatively af-
fected the ability of Lithuanian enterprises
to repay the business loans, because the
decreased demand of goods and services
in home market reduced the revenue and
profit of companies. This negative impact
also was reinforced by the decrease of ex-
ports (EXP) by 25,2 % in 2009. The eco-
nomic activity slowdown in addition re-
flects the decrease of gross fixed capital
formation (investments, INV) by 44,3 %.
After this considerable economic down-
turn, in 2010 the stabilization of macro-
economic indicators was observed and
in 2011 the restrained growth has started
(Figure 4).

The possibility to increase the num-
ber of non-performing loans in banks
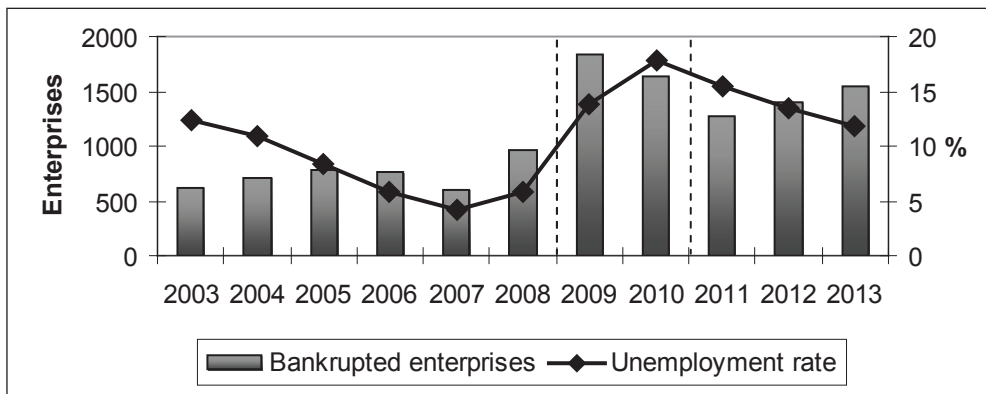also is influenced by the bankruptcy and

Fig. 5. **The bankrupted enterprises and unemployment rate in Lithuania**

unemployment statistics. The higher number of bankrupted companies means the increasing unability to fulfil the financial obligations for creditors. As a consequence of insolvency the bankruptcy process in companies is being started. The higher unemployment rate for banks increases risk of loss in retail credits. In 2009 the number of bankrupted enterprises increased by 92,7 % (Figure 5).

The unemployment in 2009 increased by 8 % but the peak was reached in 2010 when this rate was 17,8 %. Figures 4 and 5 point that there is a lag in 1 year between social and business statistics related with the economic downturn. The GDP, exports and investments were the least in 2009 but the highest unemployment rate and the least compensation of employees were in 2010. As a consequence the final consumption expenditure of households in 2010 decreased 16,2 % compared to year 2008.

The business cycle reflects the fluctuation of aggregated revenue and net income of Lithuanian companies. The revenue in 2005–2008 constantly increased and the average annual increase rate was 19,3 %.

So in the peak point of economics growth (year 2008) the revenue of Lithuanian companies reached 63 650 million EUR. In economic downturn the revenue decreased 29,4 % to 44 966 million EUR. After the year 2009 the revenue constantly grew and in 2012 it was 64 845 million EUR or 144,2 % of the revenue in year 2009 (Figure 6).

The highest net income of Lithuanian companies was in 2007 (5 156 million EUR). Despite the increasing revenue in 2008, the net income decreased by 71,2 % to 1 483 million EUR. That influenced the significant decrease of net profitability (net profit margin) of companies from 9,2 % in 2007 to 2,3 % in 2008 (Figure 6). The worst situation was in 2009, where the aggregated net income of Lithuanian companies was negative (–1 926 million EUR), also the net profitability ratio of this year was negative. In years 2010–2012 the net income and net profitability were positive what indicates the profitable activity of companies.

In 2009 the number of profitable companies in Lithuania decreased by 26,4 % (comparing to year 2007) to
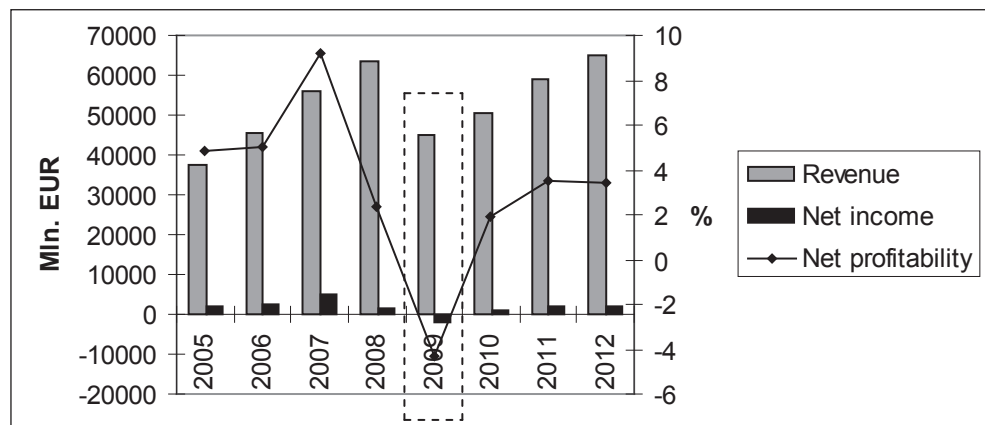

Fig. 6. **The revenue, net income and net profitability of Lithuanian enterprises**

Source: Statistics Lithuania, 2014.

19 282 enterprises. The number of loss-making companies in years 2007–2009 increased by 81,3 % to 27 074 enterprises. So in the period of the most economic downturn in 2009 the number of loss-making companies was 1,4 times higher than number of profitable companies (Figure 7). Comparing to the year 2009, in further period of economic growth, the number of profitable companies increased by 92,8 % in 2011 to 37 183 enterprises. Also the number of loss-making companies decreased by 53,9 % to 12 491 enterprises.

The highest profit of profitable companies was in 2007 (6 552 million EUR), which in 2009 decreased by 70 % to only 1 966 million EUR (Figure 7). The highest loss of loss-making companies was in 2009 when it reached 3 707 million EUR.
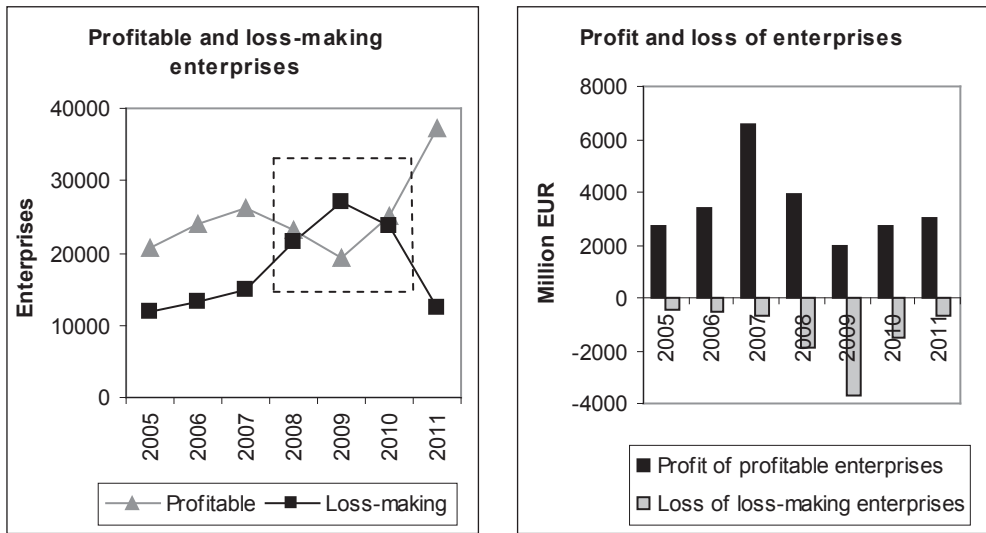

Fig. 7. **The profitable and loss making enterprises**
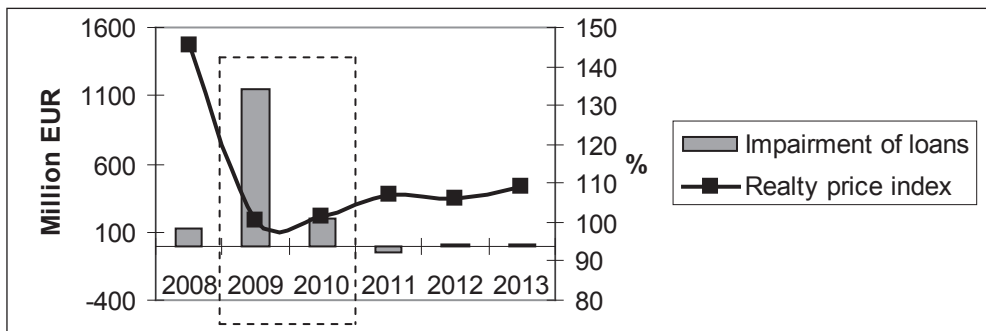
Source: Statistics Lithuania, 2014.

Fig. 8. **The impairment of loans and realty price index**

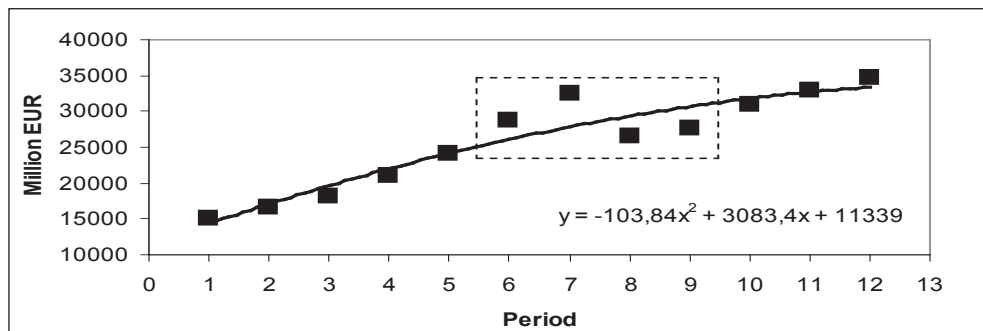*Source*: Bank of Lithuania, 2014; Statistics Lithuania, 2014.

Fig. 9. **The polynomial regression model of GDP growth**

These indicators in years 2010 and 2011 have shown the significant improvement that reflect the better business situation in companies and growth in whole economy.

Another important factor of loss-making bank activity in 2009 is impairment of loans and other receivables (Figure 8).

The value of loans in 2009 decreased by 1 143,5 million EUR, in 2010 it decreased by 201,2 million EUR. These negative changes in loan portfolio are interrelated with the realty price index calculated by the Statistics Department of Lithuania. The basic period in Figure 8 is year 2010 when the realty price index was equal to 100 %. So the very significant slump in realty prices was observed in 2009 (–45,3 %) that increased the loss given default (LGD) values in banks. If debtors did not repay the loan, banks had to realize the assets in the market with significantly lower prices.

The analyzed macroeconomic rates have certainly affirmed the fluctuations of business cycle in Lithuanian economy and it is evident that these fluctuations highly affected the credit risk of debtors in commercial banks and their financial results. The next chapter aims to develop the statistical model able to predict the possible sudden growth of NPLs in banks.

The Statistical NPLs Growth Prediction Model

The sudden high NPLs growth in banks started in 2009 when the Lithuanian macroeconomic indicators deteriorated. So the early warning patterns of pre-crisis period can allow banks to foresee the forthcoming NPLs problem. As the GDP rate is often the main macroeconomic indicator the polynomial regression model was developed to visualize the theoretical Lithuanian GDP growth eliminating the effect of business cycle (Figure 9). The simulated continuous growth includes the years from 2002 (1st period) to 2013 (12th period).

According to Figure 9 the analyzed 2002–2013 years were divided into 4 periods (Table 2). The years 2002–2006 can be characterized as the period of stable GDP growth in average by 12,3 % yearly. The pre-crisis period of 2007–2008 the average annual GDP growth reached 16 %. This sudden increase can be one of the indicators predicting the economic downturn and debtors' credit risk changes. For the after-crisis economics growth period the restrained average GDP increase by 6,8 % was typical. To measure the business cycles fluctuations quantitatively the GDP

Table 2

The statistical indicators of GDP rate in different economic periods

Period	Growth	Boom	Crisis	Growth
Years	2002–2006	2007–2008	2009	2010–2013
Average GDP growth (%)	12,3	16,0	−17,8	6,8
MAPE (%)	4,3	11,0	0	4,4

rates of years 2002–2013 were compared to the predicted values by the polynomial regression model and the MAPE were calculated. In both economic growth periods these errors are almost the same (4,3 % and 4,4 %) while the boom period has the error of 11 % and it is higher by 2,5 times than in continuous growth periods.

The other macroeconomic indicators of Figure 4 fluctuated similarly to GDP. Their correlation matrix is given in Table 3. In addition the inflation rate (INF) was included into further analysis because its changes can help to explain the NPLs problem in banks: in the economic growth period of 2002–2006 the average inflation rate was 1,6 % while in boom period it reached the average of 8,3 %.

The correlation coefficients mostly show the quite strong relations between GDP and other macroeconomic indicators changes. Especially strong correlation was observed between GDP and consumption expenditures of households where it is equal to 1. Despite the fact that exports has one of the strongest correlations to GDP it was eliminated from further NPLs

prediction model development due to its sudden increase in after-crisis growth period. Since 2010 the exports in average grew by 20,1 % yearly while the increase of other indicators was only in range from 3,5 % to 8,5 % (Figure 4).

To find the deviations from trend the polynomial regression models were developed for the investments, exports, compensation of employees and consumption expenditures of households (Figures 10 and 11). Such regression modeling can allow banks to identify the beginning of economic boom period evaluating the MAPE (Formula 1) values:

$$MAPE = \left(\frac{1}{n} \cdot \sum \left| \frac{Y(t)-Y}{Y} \right| \right) \times 100\%, \qquad (1)$$

where $Y(t)$ are the predicted values, Y are the observed values and n is the number of years analyzed.

The periods in the regression models are numbered from year 2002 (1) to year 2013 (12). Because the exports in after-crisis period grew suddenly and in boom and crisis the significant deviations are not

Table 3

Correlation matrix of Lithuanian macroeconomic indicators in 2002–2013

	GDP	INV	EXP	CE	CEH	INF
GDP	1,00	0,73	0,92	0,98	1,00	0,49
INV	0,73	1,00	0,50	0,79	0,74	0,85
EXP	0,92	0,50	1,00	0,84	0,90	0,19
CE	0,98	0,79	0,84	1,00	0,99	0,58
CEH	1,00	0,74	0,90	0,99	1,00	0,50
INF	0,49	0,85	0,19	0,58	0,50	1,00
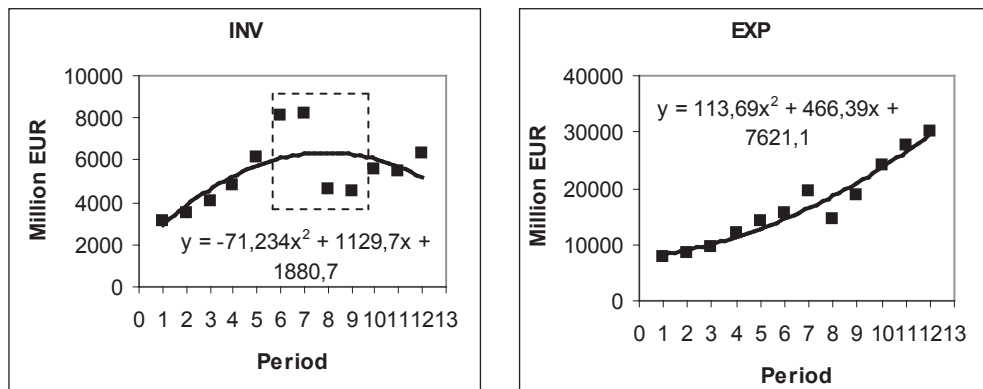
Fig. 10. **The polynomial regression models of investments and exports growth**

INV: $y = -71,234x^2 + 1129,7x + 1880,7$

EXP: $y = 113,69x^2 + 466,39x + 7621,1$

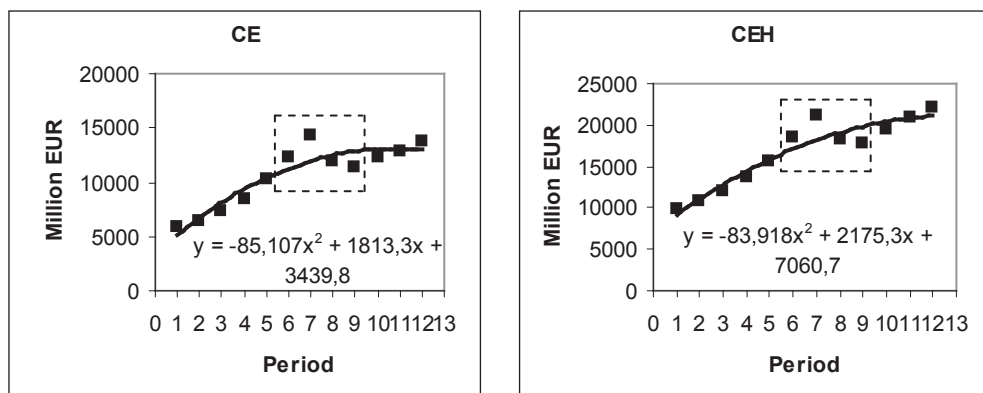**Fig. 11.** **The polynomial regression model of compensation of employees and consumption expenditures of households growth**

CE: $y = -85,107x^2 + 1813,3x + 3439,8$

CEH: $y = -83,918x^2 + 2175,3x + 7060,7$

visible, only the GDP, INV, CE and CEH regression models can be used.

The MAPE values of INV, CE and CEH polynomial regression models are calculated in Table 4. The early warning about the possible beginning of economic boom period the MAPE increase rates are in range of 1,7–2,8 times.

Table 4

The MAPE values of polynomial regression models

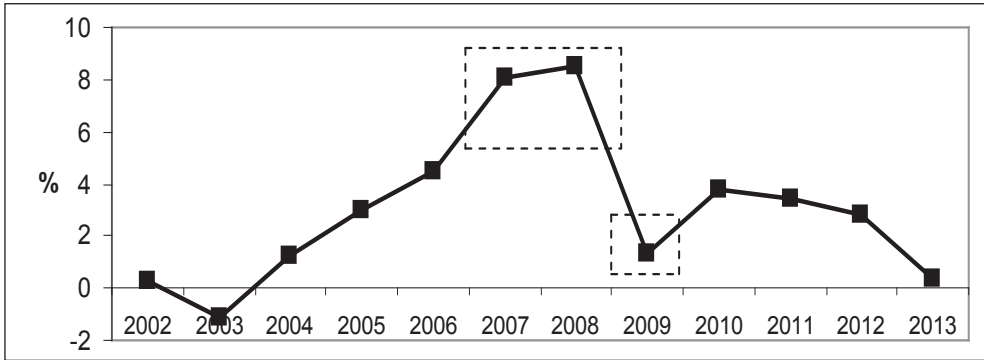| Period		Growth (%)	Boom (%)	Change
Years		2002–2006	2007–2008	
Economic indicators	INV	8,6	24,0	x 2,8
	CE	7,4	12,7	x 1,7
	CEH	4,8	11,0	x 2,3

Fig. 12. **The inflation rate in Lithuania**
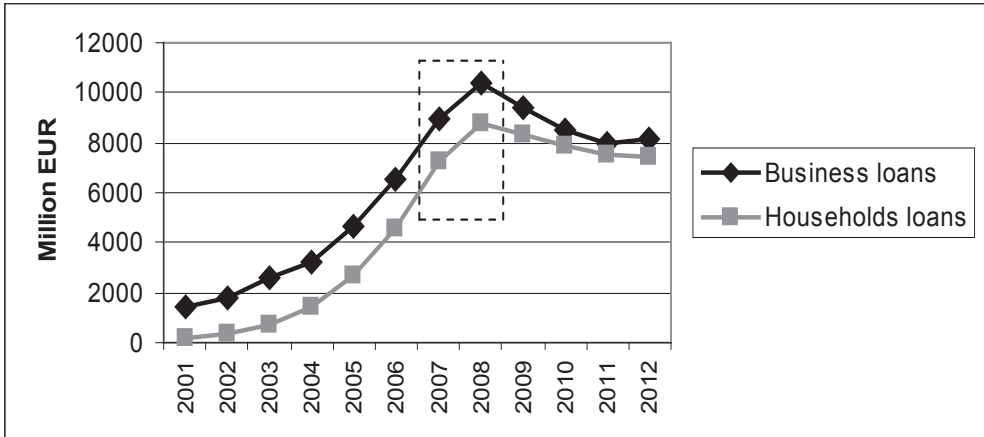
Source: Statistics Lithuania, 2014.

Fig. 13. **The Lithuanian banks consolidated loan portfolio**

Source: Bank of Lithuania, 2014.

The another important economic boom indicator is the inflation rate. In economic growth period since 2003 the inflation rate every year in average increased by 1,87 % and in 2006 it was 4,5 %. The boom period was conspicuous by the high inflation of 8,1–8,5 %. While the economic downturn in 2009 reduced this rate to 1,3 % (Figure 12).

Together with the macroeconomic downturn in 2009 the other factor of NPLs problem in banks was the high indebtedness of banks' clients. Since 2001 the business loans portfolio increased by 612,7 % to 10 370 million EUR in 2008. The households loans portfolio in this period increased by 3 875,5 % to 8 746 million EUR (Figure 3).

In Table 5 the indebtedness rates were calculated that reflect the changes of debt burden for business enterprises and households. The estimated critical indebtedness indicators before the economic downturn statistically can help to foresee the similar problems for banks in future.

The business loans (BL) in 2008 reached peak when the average financial debt for banks of 1 company was 242,4 thousands

The indebtedness rates of business enterprises and households in Lithuania (%)

Rate	2005	2006	2007	2008	2009	2010	2011	2012
BL/R	44,9	55,9	60,4	70,7	85,5	64,1	54,3	48,5
BL/GDP	22,2	27,3	31,2	32,0	35,4	30,7	25,6	24,7
HL/CE	31,8	44,6	58,8	60,9	69,9	69,1	61,6	57,5
HL/GDP	12,9	19,0	25,2	27,0	31,4	28,6	24,4	22,5

EUR. Also the households loans (HL) in 2008 were the highest when 1 inhabitant of Lithuania had the average 2,599 thousands EUR debt for banks. The important factor of debtors insolvency in 2009 can be considered also the high indebtedness of year 2008, that became too high burden for enterprises and households in worse economic conditions. The relative rates of business loans to revenue (BL/R), business loans to GDP (BL/GDP), households loans to compensation of employees (HL/CE) and households loans to GDP (HL/GDP) were calculated in Table 5 to measure the business and households indebtedness in Lithuania. When the revenue of companies in 2009 decreased by 29,4 % (Figure 6), statistically in average 85,5 % of revenue Lithuanian companies had to accrue for banks if a company wanted to repay all financial debts. Similarly the economic downturn in 2009 increased the credit risk of household loans, because not only the value of assets decreased as indicated the realty price index, but also the relation between households debt and compensation of employees highly increased. In 2009 employees for 1 EUR of their salary had 0,699 EUR of debts for banks.

Because the year 2009 was the economic downturn in Lithuania, the most important indebtedness indicators for banks are of the year 2008. It can be concluded that the deterioration of banks'

loan portfolio in future is very probable when the business loans to revenue rate reaches 70,7 %, business loans to GDP – 32 %, households' loans to compensation of employees 60,9 % and households loans to GDP – 27 %.

For the NPLs percentage prediction the partial least squares (PLS) regression model was developed. The independent variables are the annual growth rates (%) of macroeconomic and indebtedness rates together with inflation. The annual growth rates of independent variables (except inflation) (Formula 2) in this model are calculated:

$$\Delta X_t = \left(\frac{X_t}{X_{t-1}} - 1 \right) \times 100\% , \qquad (2)$$

where X is the independent variable of the partial least squares regression model, t is the number of current year.

The PLS regression model (Formula 3) is:

$$\begin{aligned}
NPLs_{t+1} = {} & 1{,}815944 - 0{,}350327 \cdot \Delta GDP_t - \\
& - 0{,}151491 \cdot \Delta INV_t + 0{,}117687 \cdot \Delta EXP_t - \\
& - 0{,}925545 \cdot \Delta CE_t - 0{,}058249 \cdot \Delta CEH_t + \\
& + 0{,}145183 \cdot \Delta BL/R_t + 0{,}261620 \cdot \Delta BL/GDP_t + \\
& + 0{,}097235 \cdot \Delta HL/CE_t + \\
& + 0{,}214472 \cdot \Delta HL/GDP_t + 0{,}595362 \cdot INF_t,
\end{aligned} \qquad (3)$$

Using the macroeconomic and indebtedness variables of a period t the PLS regression model predicts the proportion
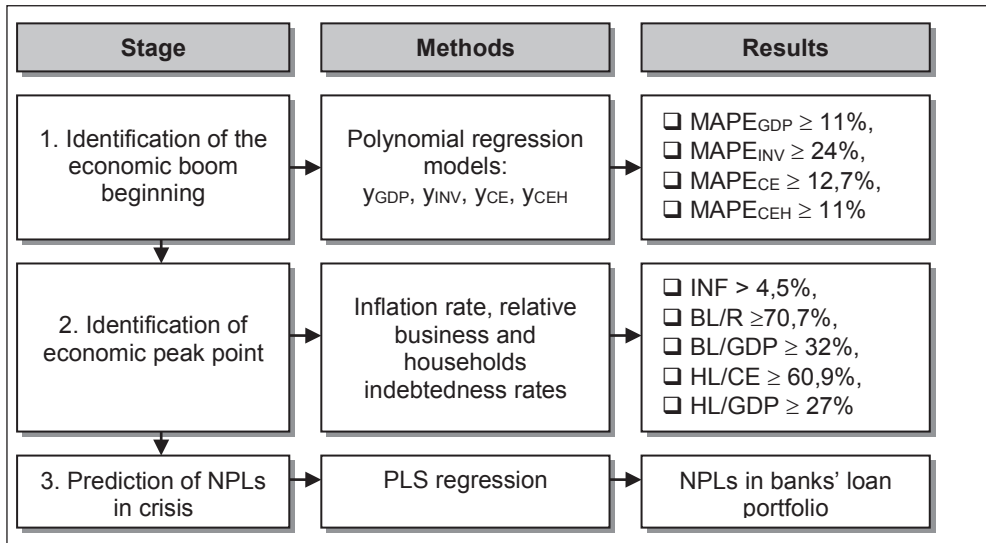
Fig. 14. **The conceptual scheme of developed model**

of NPLs in banks' loan portfolios for the period $t + 1$. The estimated prediction accuracy of the analyzed data sample is 100 % (MAPE is equal to 0). The general scheme of all analysis process is shown in Figure 14.

The analyzed rates in this research affirmed the interrelation between the downturn of business cycle in country's economy and increase in debtors credit risk in banks. The main problem that arose for banks in downturn is the high proportion of doubtful and non-performing loans that was the consequence of the debtors unability to meet their financial obligations. This mainly reduced the financial results of banks and limited their ability to lend new credits in the period of restrained economic growth. The developed statistical model can allow to reduce the negative impact of economic downturn on banks loan portfolio quality warning about the possible losses and help to manage the credit risk in banks considering the changes of economic conditions.

Conclusions

The analysis of scientific publications allows to maintain that business cycles have the strong impact on credit risk of debtors in banks. The changes in economic environment downgrade the banking system performance and it is considered as a natural consequence of business cycles. The amount of credits grows rapidly when the economy is in upturn because of favourable financial state of companies and unrestricted lending standards. When economic conditions slow the higher proportion of insolvent companies and households cause the disimproved banks' activity results and strict lending.

The empirical research confirmed that the negative macroeconomic changes can be considered as the important factors increasing the credit risk of business and consumer debtors. Currently in credit risk assessment process banks use the internal credit rating models seeking to assess credit risk according to loan applicants'

data objectively and reduce potential loss of insolvent debtors. Because the credit risk of debtors in Lithuania is very sensitive to macroeconomic fluctuations, developing the internal credit risk assessment models banks should involve macroeconomic rates as very important independent variables. Also banks should tighten the credit policy in the period of economic growth because the too high indebtedness of debtors in Lithuania was observed. Banks' over-optimism about borrowers' future prospects and insufficient consideration of macroeconomics was disadvantageous. The reduced loan portfolio growth rate in the period of growing economy can improve the financial results of banks in downturns and to increase their ability to lend new loans that are very important activating the whole economy after downturns.

The developed statistical model allows to identify the beginning of excessive economic growth analyzing macroeconomic indicators. The GDP, investments, compensation of employees, consumption expenditures of households and inflation are the important factors related to the credit risk changes in banks. The peak point of the bussiness cycle and the economic downturn can be predicted analyzing the relative indebtedness rates of companies and households. The partial least squares regression model characterizes the existing dependence between analyzed indicators and NPLs, also it predicts the proportion of NPLs in banks. Because the credit rating models in banks assess only the specific risk of every loan applicant, the supplementary comprehensive analysis of the macroeconomic conditions allows to manage the loan portfolios more efficiently.

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Ričardas MILERIS

KREDITO RIZIKOS DIDĖJIMO KOMERCINIUOSE BANKUOSE MAKROEKONOMINIAI VERSLO CIKLO RODIKLIAI

S a n t r a u k a

Komercinių bankų veiklos stabilumo užtikrinimas neabejotinai reikšmingas ne tik patiems bankams, bet ir kitiems šalies finansų sistemos dalyviams. 2009 metų verslo ciklo nuosmukio laikotarpiu Lietuvoje reikšmingai pablogėjo šalies makroekonominiai rodikliai. Tuo pačiu komerciniose bankuose abejotinų ir neveiksnių paskolų dalis per metus padidėjo iki 24 %, o bankų konsoliduotas grynasis nuostolis sudarė 1 926 mln. EUR. Šiuos neigiamus pokyčius lėmė bankų skolininkų kredito rizikos lygio padidėjimas ir jų nesugebėjimas vykdyti prisiimtų finansinių įsipareigojimų. Šio straipsnio

tikslas – atskleisti verslo ciklo poveikį skolininkų kredito rizikai komerciniuose bankuose ir sudaryti statistinį modelį, leidžiantį prognozuoti abejotinų ir neveiksnių paskolų augimą atsižvelgiant į šalies makroekonominius rodiklius. Straipsnyje analizuoti BVP, darbo užmokesčio, eksporto, infliacijos, investicijų, namų ūkių vartojimo išlaidų, nekilnojamojo turto kainų indeksų, nedarbo ir įmonių bankroto rodiklių pokyčiai. Taip pat atliktas įmonių pardavimo pajamų, pelno ir nuostolių svyravimų statistinis vertinimas. Šių rodiklių sugretinimas su bankų veiklos rezultatais leido nustatyti bendras jų kitimo tendencijas ir įvertinti neigiamo poveikio mastą. Tyrimas atskleidė, jog bankų skolininkų gebėjimas vykdyti finansinius įsipareigojimus Lietuvoje yra labai jautrus makroekonominiams svyravimams. Abejotinų ir neveiksnių paskolų dalis, bankų palūkanų pajamos, grynasis pelnas, paskolų portfelis, naujų paskolų apimtys, specialiųjų atidėjimų dydis, paskolų ir gautinų sumų vertės sumažėjimas priklauso nuo šalies ekonomikos būklės. Sudarytos BVP, investicijų, darbo užmokesčio ir namų ūkių vartojimo išlaidų prognozavimo polinominės regresijos lygtys, kurių MAPE paklaidų reikšmingų pokyčių vertinimas leidžia identifikuoti galimą ekonomikos laikino intensyvaus augimo laikotarpio pradžią. Infliacijos ir santykinių verslo bei namų ūkių įsiskolinimo rodiklių vertinimas leidžia numatyti ekonomikos piko laikotarpį ir prognozuoti nuosmukio pradžią. Dalinių mažiausių

kvadratų regresijos modeliu, vertinant makroekonominius ir santykinius įsiskolinimo rodiklius, galima prognozuoti abejotinų ir neveiksnių paskolų dalies bankuose augimą. Taigi analizuoti neigiami makroekonominiai pokyčiai gali būti laikomi reikšmingais veiksniais, didinančiais įmonių ir gyventojų kredito riziką. Klientų kredito rizikos vertinimo procese bankai naudoja vidaus kredito reitingų modelius, kuriais siekiama objektyviai įvertinti potencialių skolininkų kredito rizikos lygį ir sumažinti galimus nuostolius dėl skolininkų nemokumo. Sudarydami statistinius kredito rizikos vertinimo modelius, bankai į analizuojamų nepriklausomų kintamųjų rinkinį turėtų įtraukti šalies makroekonominius rodiklius. Taip pat bankai turėtų taikyti griežtesnę klientų finansavimo politiką ekonomikos augimo laikotarpiu, nes atliktas tyrimas parodė Lietuvoje veikiančių bankų klientų sparčiai didėjusį įsiskolinimą iki ekonominio nuosmukio pradžios. Neadekvatus bankų optimizmas dėl klientų gebėjimo vykdyti finansinius įsipareigojimus ir nepakankamas makroekonominių veiksnių vertinimas reikšmingai lėmė jų patirtus nuostolius. Ekonomikos augimo laikotarpiu sumažintas paskolų portfelio augimo tempas sudarytų prielaidas mažesniems bankų nuostoliams dėl klientų nemokumo esant nuosmukiui. Dėl to pagerėtų bankų veiklos rezultatai ir būtų padidintos galimybės teikti naujas paskolas, reikšmingas ekonominio aktyvumo šalyje padidinimui po ekonominio nuosmukio.