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THE MEASUREMENT OF CONCENTRATION RISK IN LOAN PORTFOLIOS

ABSTRACT. The current financial and economic situation, as well as requirements of consumers changes very quickly. For this reason, banks have to update their portfolio of the services all the time. Nevertheless, lending remains one of the most important and most profit-generating activities for the banks. Providing loans, banks are exposed with many risks: credit risk, liquidity risk, market risk, operational risk and others. Usually, the most important risk is credit risk. Often it comes from undue concentration of loan portfolios. Concentration risk in loan portfolios arises from uneven distribution of credit across sectors or providing large loans to individual borrowers. In this context, this article analyses definition and importance of concentration risk in the loan portfolio. Causes of concentration risk and methods that are used to measure concentration risk are also examined in this article. The third part of this article analyses how the loan portfolio changed in Lithuanian bank's during 2004 - 2010 years. Concentration risk in the loan portfolio, depending on the loans given for different sectors of economic activity, is measured in this article as well.

Introduction

Relevance and the level of theme investigation. Banks are one of the most important financial institutions in a modern economic system which provides a wide range of financial services. Despite a great variety of banking services, providing loans remains one of the most important services which provide a majority of income for banks. However, providing loans for banks is not only a profitable activity and an important source of income, but also a source of the risk. While controlling loan portfolios, banks should deal not only with measurement problems of clients' credit solvency, i.e. they should estimate not only client's abilities to assume financial obligations in the present and future, but also focus on concentration risk, which raises in credit portfolios from uneven credit distribution among separate borrowers (concentration of one relatively large credit) or industrial or regional sectors (sectoral concentration). Banks should also precisely measure their loan portfolio, which is the main

source of the risk, i.e. they should assess the value of the portfolio, components thereof and their proportions in the portfolio as well as other variables. Having noticed that loan concentration resides in one of segments, they should try to diversify the portfolio or apply other measures to control concentration risk.

Concentration risk gains not so much attention in scientific literature, because usually attention is paid on general credit risk of the portfolio which raises due to disability of borrowers to apply the undertakings or due to the change of borrowers' credit rating. There are few researches on loan concentration risk in Lithuania. This theme was investigated theoretically by V. Valvonis (2007). Also, G. Šimkus and M. Mendelevičius (2006) made an empirical research which estimated loan concentration in Lithuanian banks by industry. Concentration risk is investigated widely in foreign literature. It was investigated by Deutsche Bundesbank (2006), T. Adams *et al.* (2006), K. Dullmann ir N. Masschelein (2006), J. York (2007), L. B. Langrin ir K. Roach (2008).

Depending on concentration risk which is not widely investigated in Lithuania, this article analyses concentration risk in the loan portfolio as well as various methods to measure it. The loan portfolio of Lithuanian banks and its concentration by loans provided for different sectors of economic activities are analysed as well.

The essence of scientific problem is formulated as follows: how loan concentration risk influences stability of banks activities.

The research object is loan concentration risk.

The research goal is to investigate the measurement of loan concentration risk in banks.

In order to achieve the research goal, the *research tasks* are set as follows:
1) to analyse loan concentration risk and its sources;
2) to investigate the methods for the measurement of concentration risk in sectors;
3) to define changes in the loan portfolio in Lithuanian banks in 2004-2010;
4) to investigate concentration in the loan portfolio of Lithuania banking sector in 2004-2010 by different sectors of economic activities.

The methods of the research. While analysing theoretical assumptions of managing concentration risk in the loan portfolio, a general scientific method of research is used in the article i.e. a comparative analysis of scientific literature and interpretation about the control of loan concentration risk, as well as synthesis, abstract, induction and deduction. Composition, structure and concentration risks of loans provided by Lithuanian banks are measured while doing the analysis and applying statistical data.

1. Concentration Risk, its Reasons and Sources

Banks face various risks while managing their activities. The risk could be treated as a synonym of uncertainty. Uncertainty is not a negative point in finance: there is a possibility for better results than they are expected to be alongside not as good as they are expected to be (Jasinavičus, Tamošiūnienė, Sokol, 2011). The main risks for banks are credit risk, interest rate risk, liquidity risk, exchange risk, operational risk etc. Banks that operate internationally also depend on risk of different countries as well as of cross-border transfers. However, these risks are not the only risks. These risks are not terminative, because different banks are dependent on distinct types of risks.

Taking into account the fact that lending is the main activity of most commercial banks and the loan portfolio usually is an important part of bank assets as well as income gained from it which is one of the main sources of banks' income, it could be stated that the most important risk for banks is credit risk. As it is stated in literature, credit risk in banks

raises firstly because of undue concentration in the loan portfolio (Deutsche Bundesbank, 2006; Valvonis, 2007; York, 2007). Thus, one of the main parameters which should gain most attention while investigating portfolio credit risk is its concentration.

1.1. The concept and the essence of concentration risk

Credit concentration risk is described differently in scientific literature. According to T. Adams *et al.* (2006), concentration is concerned with possessing certain relatively large positions in the loan portfolio of a bank. Having defined credit concentration risk, V. Valvonis (2007) indicates that this is an opportunity for a bank to undergo a relatively large (in comparison to capital, wealth, income of a bank or, if it is possible to measure, risk which is taken by or accepted to the bank) loss from credits so that permanent activities in a bank would be disturbed. A similar view is provided by Deutsche Bundesbank (2006) which states that concentration risk in credit portfolios arises because of an uneven distribution among separate borrowers (concentration of a single borrower) or sectors of industry, facilities and geographical regions (sectoral concentration). Taking into consideration the fact that a bank which provides credits is never secure about the sector where changes or declines could happen, it is under the risk to undergo great losses as it provides a great part of loans to one sector (Adams *et.al.*, 2006). Hence it could be stated that concentration risk in the loan portfolio arises when the value of a bank loan portfolio provided for a single borrower or a group of borrowers is rather large and this is the reason why the risk of loss raises to a bank.

According to J. York (2007) Deutsche Bundesbank (2006) credit concentration is one of the main reasons for banks to undergo loss. Moreover, a lot of bank crises appeared because of inappropriate control of concentration risk during the last 25 years. A financial crisis in 2008 may also be related with concentration risk. According to R. Kuodis (2010) the beginning of a crisis was related with a financial crisis which began in summer in 2007. It appeared in one of the market segments in USA, to be more precise, in the sub-prime mortgage market. However, loss spread over Europe and all over the world because of fear that European banks would undergo great losses as they possessed papers related with loans of sub-prime mortgage market.

As the house prices increased and the requirements for a loan were reduced by banks, a number of provided mortgages increased as well. A number of sub-prime loans also increased as families that had little chance to repay the loan gained this very type of loan. Banks agreed such a risk because new financial possibilities appeared in the market. Some time ago, a bank which provided a mortgage kept it in the balance until it was repaid. Recently, banks could add a great number of mortgages into one purse and sell a financial tool i.e. a paper secured by mortgages for investors that could not check a separate quality of the loan (Kuodis, 2010). Hence, a number of loans increased, banks sought for benefit and paid less attention to the control of concentration risk. However, house prices declined approximately 30% in 2006-2009. Therefore a lot of problems arose for people who took the loans. As the value of the property of residents declined, the usage was also declined, unemployment increased, persons' ability to pay declined. Therefore it influenced economics and banks that provided loans.

Lithuanian banks or banks of the Baltic States are not exceptional. The research of international rating agencies "Moody's Investors Service" states that banks in the Baltic States, which provided risky loans during the period of economic rise, are dependent from unitary large loans. The agency analysed 20 largest loans that were provided by rated banks. It appeared that banks in the Baltic States are more likely to be dependent from unitary large loans in comparison to financial institutions in other developing countries of East Europe, Middle Asia and Latin America. According to representatives of this agency, the risk of loans

in the Baltic States has always been high. This tendency became more stable in 2004-2006 because of the competition during the period of economic rise as well as banks' willingness to earn more. Hence, a very weak control of the risk was even reduced because of the banks' competition for market share. This led to a high loan concentration in the market. Thus, it is obvious that loan concentration is particularly relevant to Lithuanian banks.

1.2. The reasons and sources of concentration risk

Loan concentration risk could be measured differently. According to V. Valvonis (2004) these main criteria of measurement could be drawn: by borrowers (large loans), by related borrowers, by borrowers related to a bank and inner loans, by sectors of economic activities, by foreign countries, by groups of related countries, by types of loans, by means of loans security and others. It happens because the rise of one of these groups in the portfolio could determine the rise of concentration risk. Hence, it could be stated in general that concentration risk in the loan portfolio could be analysed by many views of classification of the loan portfolio. Sources of loan concentration risk must be determined in banks. The change of such concentration must also be measured regarding various economic situations (Valvonis, 2004; Lithuanian bank, 2008).

There are various reasons for the appearance of credit concentration risk. According to V. Valvonis (2007) credit concentration risk rises in banks due to the reasons as following:

1. *The specialization of banks.* Some banks specialize in certain areas of activities (they credit companies that carry out a certain economic activity) with the aim of becoming a leader of the market.

2. *Seeking for higher profit.* Sometimes credit concentration risk appears because when a rapidly increasing economic activity comes into being, banks positively measure its perspectives and expect higher than the average profits (e.g. from the rise of costs of assets, higher margin of credits or charges).

3. *The reasons outside the control of the bank.* Credit concentration risk may arise due to the reasons outside the control of the bank, e.g. a small-size market, in which the bank is operating.

Concentration risk may arise from various sources in the bank. Usually these sources fulfill certain groups of loans, i.e. groups of loans by currencies, by economic sectors, by the aim of the credit etc. Summarizing a given classification of loans by V. Valvonis (2007), Deutsche Bank (2006) the main sources of credit concentration risk can be drawn (*Pic. 1*).

As it is seen in *Figure 1*, a lot of separate sources of concentration risk are highlighted, but the above mentioned sources are not terminative because new sources of the risk may appear in every case. Moreover, not all the above mentioned sources of the risk are equally essential to all banks.

Having analysed all possible sources of the risk as well as having summarised the highlighted sources of credit concentration risk by V. Valvonis (2007) and Deutsche Bundesbank (2006), K. Dullmann ir N. Masschelein (2006), they can be divided into two main groups of concentration risk:

- *Concentration risk of one relatively large credit or borrower.* The term „concentration risk of a single borrower" implies the (specific) risk of the loan portfolio in a certain company. The risk appears because of a relatively large credit provided for a single borrower.

- *The risk of related borrowers.* Credit risk of related borrowers and of related common factors arises from an undue provision of loans to one of the above mentioned sectors. As it has been mentioned above, economic activity, geographical region, drawing currency etc. could be treated as separate sectors. If risk factors adversely changed, all

borrowers that are dependent on common risk factors would undergo financial difficulties. This would lead to a great common loss of credits which could disturb the normal activity of the bank.
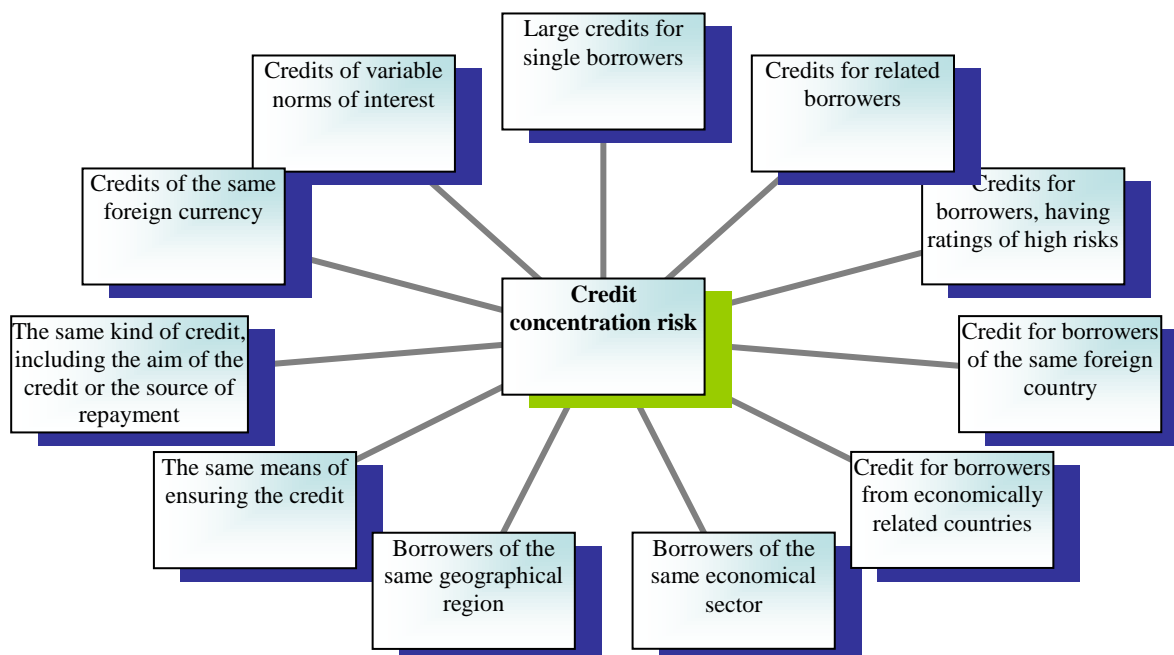

Figure 1. The sources of credit concentration risk
Source: made by the authors according to Valvonis, V. (2007). The measurement and control of the risk of the credit concentration, p. 96-97

Moreover, according to BCBS (2000), V. Valvonis (2007), credit risk of borrowers under the normal conditions of bank activities can be independent. However, such links may appear under the adverse conditions. Hence, if possible, potential relationship between borrowers must be measured under adverse conditions of bank activities and the credit must not be provided for borrowers that possess ratings of high risk.

2. The Methods to Measure Sectoral Concentration Risk

Although large loans remain the main reason of concentration risk, sectoral concentration becomes more frequent. The essential measurement point of sectoral concentration risk is the distribution of analysed sectors. Ideally, the classification of sectors should allow distributing all risk factors affecting every sector. Moreover, the asset correlation should be large in one sector but it should remain small in separate sectors. However, this distribution is often simplified to the distinction of sectors by economic activities while measuring concentration in the bank loan portfolio. Although this classification was not set up for this aim, it could be observed that a separate sector of economic activities is influenced by another risk (Deutsche Bundesbank, 2006). Certain models to measure sectoral concentration risk are distinguished.

- *The Herfindahl-Hirschman Index (HHI)*. The Herfindahl-Hirschman Index is a best-known and widely used measure among accumulative indicators of concentration. The formula of the index may be drawn as follows:

- $HHI = (\%S_1)^2 + (\%S_2)^2 + (\%S_3)^2 + \ldots + (\%S_i)^2 + \ldots + (\%S_n)^2$

here % S – a percentage of every loan of the loan portfolio in decreasing order.

A well-diversified portfolio with a great number of small loans has an HHI value close to zero and a high concentrated portfolio can represent a very high HHI value. As a last resort, if one sector gets all loans, the HHI is equal to one (Deutsche Bundesbank, 2006). However, two restrictions arise while applying this coefficient: firstly, the dependence of credit risk among sectors is not taken into consideration and the HHI does not provide any information of the economic capital necessary to cover the risk.

- *The Gini coefficient*. This coefficient may be used as the concentration index. According to G. Šimkus and M. Mendelevičius (2006) as well as L.B. Langrin, K. Roach (2008), the Gini coefficient is estimated as follows:

$$G(b) = 1 - \frac{2}{n}\sum_{j=1}^{n}\upsilon_j^b - \frac{1}{2}, kai \upsilon_j^b = \sum_{i=1}^{j} \overset{\cup b}{x}_i$$

Where: υ_j^b – the cumulative total of loans, provided for several kinds of least credited economic activities j, parts b in the bank loan portfolio; $\overset{\cup b}{x_i}$ – parts of loans b provided for economic activity i in ascending order of the bank loan portfolio.

The Gini index value varies from zero to one. The closer to zero, the more equal distribution of loans in the portfolio is. The closer to one, the less equal distribution of loans in the portfolio is. Hence, the coefficient close to zero defines the portfolio in which loans are well diversified. The coefficient close to one defines a high concentrated portfolio. Practically, when the Gini coefficient value is higher than 0,300 it could be stated that inequality of loan distribution exists (Langrin, Roach, 2008).

The main disadvantage of usage of the Gini coefficient for measurement of loan concentration is that the coefficient does not pay attention to the value of the loan portfolio. For example, a portfolio which consists of several sectors of the same size will be of a smaller coefficient than a larger better diversified portfolio which possesses loans of different values. Another point is that the Gini coefficient can increase if another comparatively small loan for another sector is included into portfolio despite the fact that it reduces concentration (Deutsche Bundesbank, 2006).

- *Distance measures* show how far the structure of the loan portfolio of one or another bank is from a determined basic structure. According to G. Šimkus and M. Mendelevičius (2006); L. B. Langrin and K. Roach (2008), these main distance measures can be drawn: maximum absolute distance (DM1), the sum of differences in the structure of the loan portfolio and the basic structure (DM2), the square sum of differences in the structure of the loan portfolio and the basic structure (DM3), differences in the portfolio structure and the basic structure in comparison with a part of loans for a certain segment in the structure of the loan portfolio as well as a part of a segment or loans provided for it in the basic structure (DM4). It also includes differences between the structure of the loan portfolio and the basic structure in comparison with a part of loans for a certain segment in the structure of the loan portfolio and a part of a segment or loans provided for it in the basic structure (DM5). All distance measures varies from 0 to 1, the closer to 1 the measure is, the larger the concentration is.

- *Multi-factor models*. By contrast to the HHI index, traditional multi-factor models regard to risk factors that make a great impact on sector. The sum of the risk depends on colleration of various factors. This model determines how a separate loan put in portfolio influences the risk. Deutsche Bundesbank (2006) states that multifactor models are a classical type of measurement of sectoral concentration risk. Hence, this model enables measurement of loan concentration for one large loan as well as sectors. However, correlation between

sectors and companies is required to know. Having known this data, it is possible to find an expected loss of the portfolio and necessity of economic capital to cover the loss.

The measurement of concentration risk in Lithuania is determined by the decision of Lithuanian bank „Due to regulations of the organisation of inner control and risk measurement (management)" (2008). According to this statement, Lithuania banks should use the Herfindahl-Hirshmann index, the Gini coefficient and model-based methods etc. in order to measure concentration risk.

To sum up, sectoral concentration may be measured by the HHI index, the Gini coefficient and distance measures indicating the portfolio gap from the basic portfolio. Moreover, multi-factor models are distinguished so that every sector closely link to a certain risk factor providing a certain weight. Losses from concentration in the loan portfolio may also be measured. Despite all the above mentioned models, every bank may apply inner models of measurement.

3. The Analysis of Concentration in the Loan Portfolio of the Lithuanian Banking Sector

Changes in the loan portfolio of the Lithuanian banking sector in 2004-2010 may be divided into two periods. In the first period i.e. 2004-2008 the loan portfolio increased rapidly (*Figure 2*) and the highest value of 71440.9 mln. LTL in the portfolio was achieved in 2008. The growth of loans was rather rapid. In 2004-2007 the portfolio usually increased about 48% every year but in 2008 this growth slightly decreased remaining positive. To compare 2009 and 2008, the decrease of 14% in the portfolio was observed. The same tendency remained in 2010 when the loan portfolio decreased 5.23% in comparison to one year ago. Although the portfolio decreased during the last year, the loan portfolio increased 3.45 times during 2004-2010.
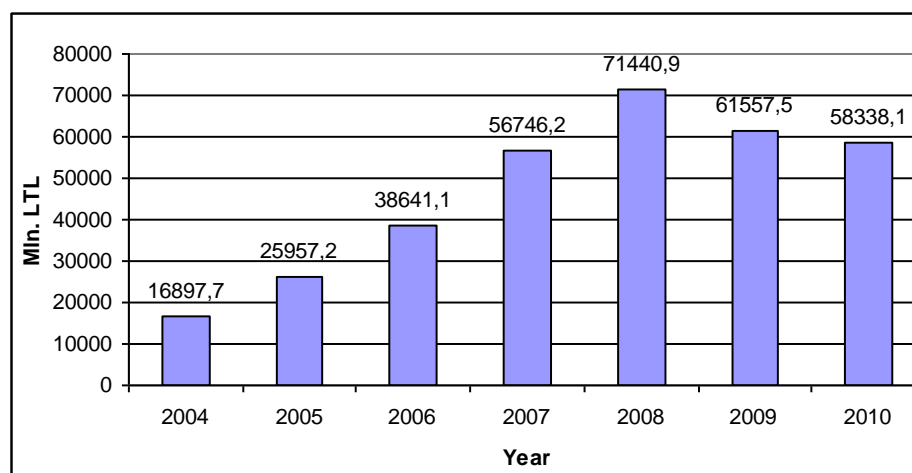

Figure 2. The loan portfolio of the Lithuanian banking sector
Source: made by the authors, with reference to data of Lithuanian bank

While analysing a composition of the loan portfolio by loans provided for different sectors of economic activities, it could be observed that a number of loans provided for immovable properties, renting and sector of other business activities increased in 2004-2010 (*Figure 3*). However, less a percentage point of 1.11 of loans were provided in 2010 than in 2009 and it represented 19.09% of the whole loan portfolio. Also, rather a large part of the portfolio in 2010 was occupied by loans provided for manufacturing industry (9.4%), wholesale and retail (8.75%) and financial intermediation (5.6%). Loans for other sectors of economic activities occupied a small part of the portfolio (less than 5%) during the period considered.
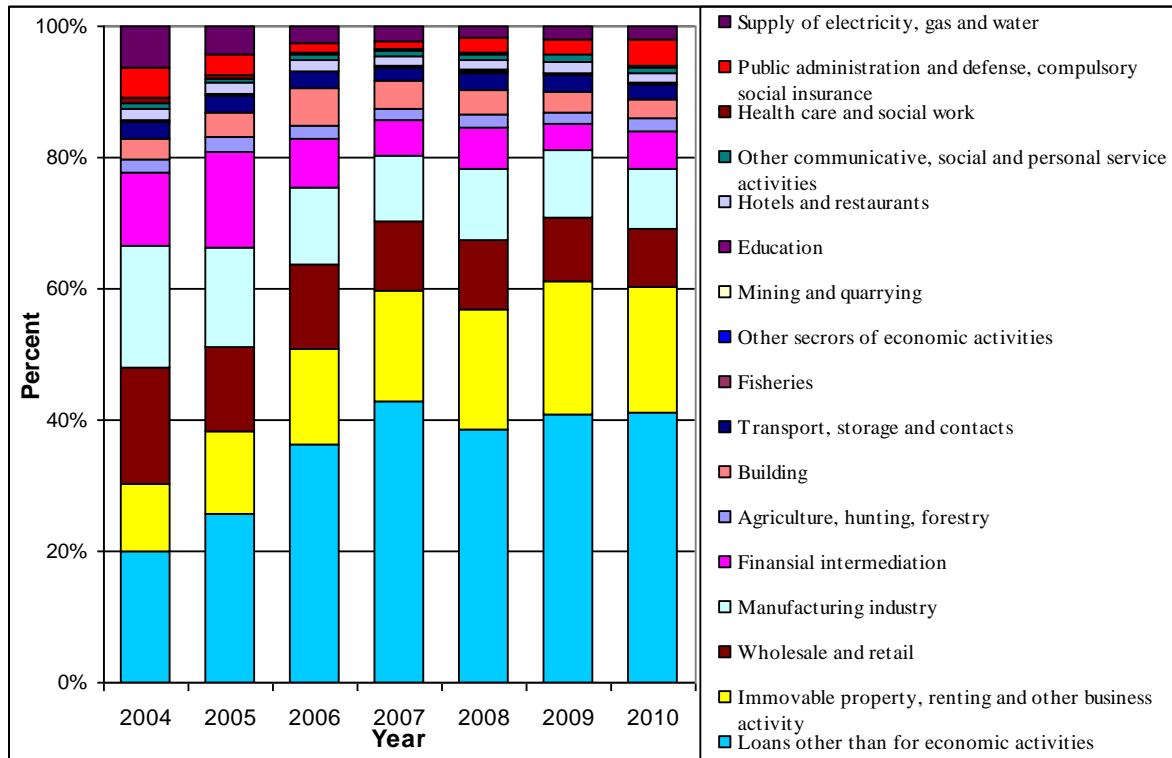
Figure 3. A composition of the loan portfolio of Lithuanian banking sector by economic activities
Source: made by the authors, with reference to data of Lithuanian bank

Analysing four groups of loans occupying the largest part of the loan portfolio, it could be observed that their parts developed differently in 2004-2010 (*Figure 4*).
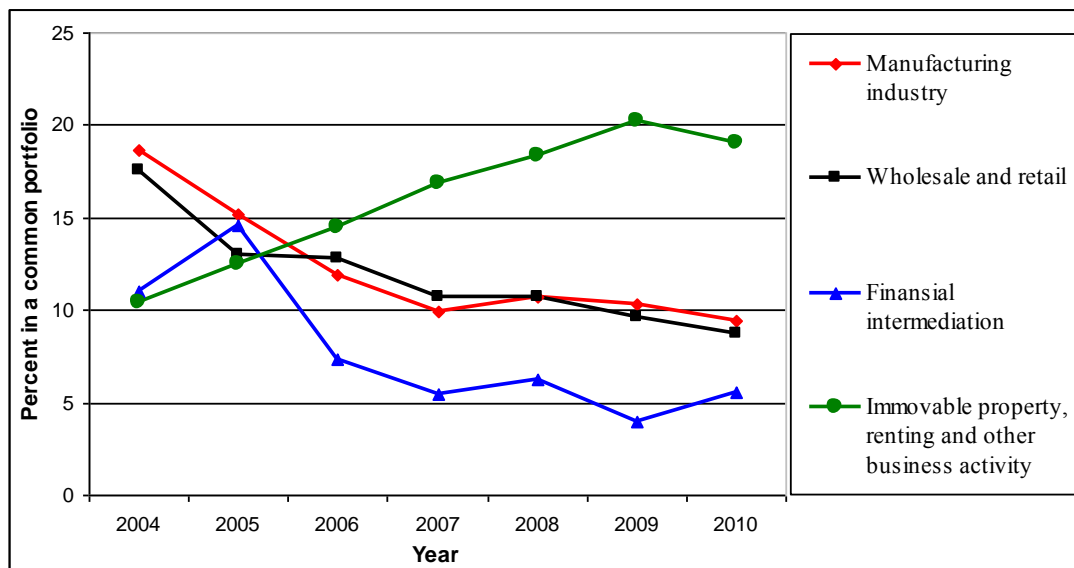

Figure 4. Changes of loan groups indicating the largest part in 2004-2010
Source: made by the author, with reference to data of Lithuanian bank

Figure 4 shows that a part of loans provided for financial intermediation, manufacturing industry and wholesale and retail decreased in the portfolio. However, a part provided for the sector of immovable property increased. Hence, it could be stated that the portfolio became more and more concentrated in a group of immovable properties and concentration of the portfolio was reduced by the rest three groups of economic activities.

Further on, analysing loan portfolio concentration of Lithuanian banking sector, the Gini coefficient and the Herfindahl-Hirschman index (HHI) were applied as these methods are recommended by Lithuanian bank (2008) for measurement of concentration.

Table 1. The HHI and the Gini coefficient of the loan portfolio in Lithuanian banks

Years	2004	2005	2006	2007	2008	2009	2010
Gini	0,600	0,620	0,674	0,714	0,690	0,707	0,699
HHI	0,137	0,149	0,195	0,240	0,212	0,233	0,230

Source: made by the authors.

Table 1 demonstrates that according to the Herfindahl-Hirschman index, concentration of loans provided by Lithuanian banking sector for separate economic activities is of acceptable level and the loan portfolio can be treated as rather diversified. However, in 2004-2010 concentration in the loan portfolio increased. In 2004 the lowest level of concentration was detected when the HHI coefficient achieved 0.137. The highest concentration in the loan portfolio was in 2007 when the rate achieved 0.24. In comparison to 2010 and 2004, the index increased 67.88%. Thus, it could be stated that the loan portfolio provided by Lithuanian banks in 2010 was much more concentrated than in 2004, although improvement of diversification of the loan portfolio was observed during the last years.

Results of the Gini coefficient shows that the loan portfolio is distributed unevenly by sectors of economic activities. It happens because when a result of the Gini coefficient is higher than 0.300 it could be stated that there are essential disparities of distribution. During the period concerned, the Gini coefficient has always been above this rate. The same as the HHI index, the Gini coefficient was the lowest in 2004 and it increased until 2007. It means that in 2007 the loan portfolio of Lithuanian banking sector was least diversified. In 2008-2010 a result of the Gini coefficient remained rather high, although a slight decrease of concentration in the loan portfolio was also observed.

To sum up the results, it is obvious that concentration in the portfolio of Lithuanian banking sector increased by economic activities in 2004-2007 and it slightly decreased from 2008. Loans concentrate mostly in the sector of immovable property and renting. A percentage part of loans provided for this sector decreases slowly in a general portfolio. Thus, it could be stated that Lithuanian banks depend on this very economic activity. Also, loans for manufacturing industry, wholesale and retail and financial intermediation determine rather a large part of the portfolio. However, the value of the loans provided for these sectors decrease in comparison to 2004 and 2010. Therefore the risk from these economic sectors also decreases.

Conclusions

1. Concentration risk in bank loan portfolios appears as the value of credits provided for a single borrower or a group of borrowers is rather high and thus, the risk of loss arises to the bank. The main reasons of credit concentration are specialization of banks, seeking for higher profit and the other reasons outside the control of the bank. A number of sources of

concentration risk may be high but the main source remains large credit for separate borrowers, related borrowers, borrowers of the same sector, loans of the same foreign currency etc. To sum up all sources of the risk, they can be divided into two main groups- the risk of one relatively large credit and sectoral concentration risk.

2. Sectoral concentration risk has a great significance because if risk factors change adversely, all borrowers that are influenced by common risk factors would undergo financial difficulties. Therefore, a great common loss of credits would be expected. To avoid this, separate sectors must be attentively distinguished and sectoral concentration risk must be measured. Usually sectors are divided by sectors of economic activities because it is observed that every sector is influenced by distinct risk factors. To measure sectoral concentration risk, various methods are used: the Herfindahl-Hirschman index, the Gini coefficient, distance measures, multi-factor models and other models that are made and used by any bank to fulfill its own needs.

3. Having analysed the loan portfolio of Lithuanian banking sector, it is obvious that the portfolio was larger in 2010 rather than in 2004. In 2004-2007 the loan portfolio increased rapidly and the decrease was observed from 2008. However, the portfolio decreased slower in 2010 than in 2009.

4. Having analysed loans provided for different sectors of economic activities, it is obvious that loans are mostly provided for immovable property, renting and a sector of other business activities (19.09%). Also, rather a large part of the portfolio was occupied by loans provided for manufacturing industry (9.4%), wholesale and retail (8.75%) and financial intermediation (5.6%) in 2010. The Gini index shows that loans by economic activities in Lithuanian banks are distributed unevenly. The Herfindahl-Hirschman index does not indicate significant concentration in the portfolio. However, the HHI and the Gini coefficients defining concentration of the portfolio increased in 2004-2007. In 2008 both rates decrease showing an increased diversification of the loan portfolio, although this decrease is not significant. Thus, it could be stated that the loan portfolio of Lithuanian banking sector by sectors of economic activities became more concentrated and dependent on a sector of immovable property and renting during the period concerned.

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