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Banking Sector Competition and Net Interest Margin in the Baltic Countries

Master's Thesis

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I have written this Research paper/Bachelor Thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

Abstract

Banking sectors in diverse countries react differently to the development of the economy because of the factors that relate to the competition level in the sector. This paper studies the relationship between the banking sector competition and the interest rate changes for the period of 2005-2021 in the Baltic countries. Three primary indicators of competition are studied in relation to the banks' net interest margin. The first indicator, Herfindahl–Hirschman index, is a classic and a straightforward measure of the market concentration. The second indicator is Panzar-Rosse H statistic, which focuses on the gross revenue elasticity of demand. The third one is Risk-Adjusted Lerner Index, considering the non-performing assets in the cost transition formula. The results show how competition in the Baltics banking sector relates to the net interest margin. Further, the thesis addresses the benefits and weaknesses of competition measures and the usefulness of net interest margin.

Keywords: Baltics banking sector, competition measurement, net interest margin

Kokkuvõte

Riikide pangandussektorid reageerivad majanduse arengutele erinevalt sõltudes konkurentsi tasemest. Käesoleva töö eesmärk on uurida Balti riikide pangandussektorite konkurentsi ning intressimäärade seost ajavahemikul 2013 kuni 2021. Arvesse on võetud kolm konkurentsi põhiindikaatorit ning neid suhtestatase pankade intressimarginaaliga. Esimene indikaator, Herfindahl–Hirschman'i indeks on klassikaline ning lihtne mõõde turu kontsentratsiooni mõõtmiseks. Teine indikaator on Panzar-Rosse H statistik, mis keskendub brutotulu nõudluse elastsusele. Kolmas indikaator on riskiga kohandatud Lerneri indeks, mis arvestab kulude ülemineku valemis probleemseid varasid. Tulemused näitavad meile, kuidas konkurents Baltikumi pangandussektoris on seotud puhta intressimarginaaliga. Lisakas analüüsitakse erinevate konkurentsi näidikute tugevusi ja nõrkusi ning puhta intressimarginaali seoste mõistmisel.

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Contents

1. Introduction

Considering the remarkable role of banking sector in whole financial system, it is important for the policy makers to understand the extent of competition in it. It is well-accepted that competition stands to be one of the key factors to stimulate developments in the real economy. The question of competition in financial sectors, particularly in banking, is not only important for avoiding financial crisis, but also for its impact on the dynamics in the real economy and the degree of it may be crucial for the market developments. The impact of the degree of the competition on the improvement of the outcome is hugely dependent on the type of the market and provided service or product. Increase in the level of the competition in the banking sector can lead to an increasing deposit interest rates and decreasing loan interest rates. In other words, it will lead to a drop the net interest margin. The higher the competition, the more the banks tend to take risks, thus making the market more instable by increasing the chance of failure (Vives, 2010). Consequently, the competition effect on the changes in the bank interest rate differences worth being under detailed analysis.

In this paper, I analyze how banking competition relates to the net interest margin of the banks in order to reveal the connection between the two parts and see how well each measurement method describes the actual level of competition. The Net interest margin is taken as the dependent variable because it describes the difference between the interest rates of deposits and loans in the given bank (Noel et al. 2017).

There has been introduced various methods of how to measure competition in the banking sector and most of them have come to life in the second half of the twentieth century. There are two major branches in the literature in the discussion of the question of competition measurement. The first stream includes Structure-Conduct-Performance Paradigm, claiming that the increase in the market concertation may bring to illegal cooperation of the operating firms, which may worsen the situation of that certain industry. The second stream is the Non-Structural Approach of the competition measurement, including the Lerner Index, Panzar-Rosse Model and more recently developed Boone Indicator.

I hereby discuss three main indicators in relation to the net interest margin. First, I analyze the Herfindahl Hirshcman index in order to understand the market concentration level of the banking sector. Second indicator is Panzar-Rosse H statistics, received from the revenue function of the banks. Finally yet importantly, Lerner Index of competition is considered. I adjust risk factor in the Lerner index in order to get the model results closer to the reality because in practice those factors matter in the question of the relationship between banks and customers. To do that, I have added the Non-Performing Assets in the transition cost function, receiving Marginal Cost in the Lerner Index formula.

Above-mentioned methodologies of measuring the degree of competition are featured by diverse privileges and disadvantages, and the application of three of them in one equation is a way to compensate the effects of their drawbacks. Many researchers have found that not always same inferences can be achieved by applying the different competition measurement methods in the banking sector (Wilson et al. 2013).

This motivates me to discuss the indicators altogether in comparison with another more general indicator (NIM) in order to show their relationship and to see how well they describe the market. In order to understand the rate of the Net Interest Margins of the Baltics' banking sector, Figure 1.1 shows the NIM over years, giving us an opportunity to see the outlying values, too.

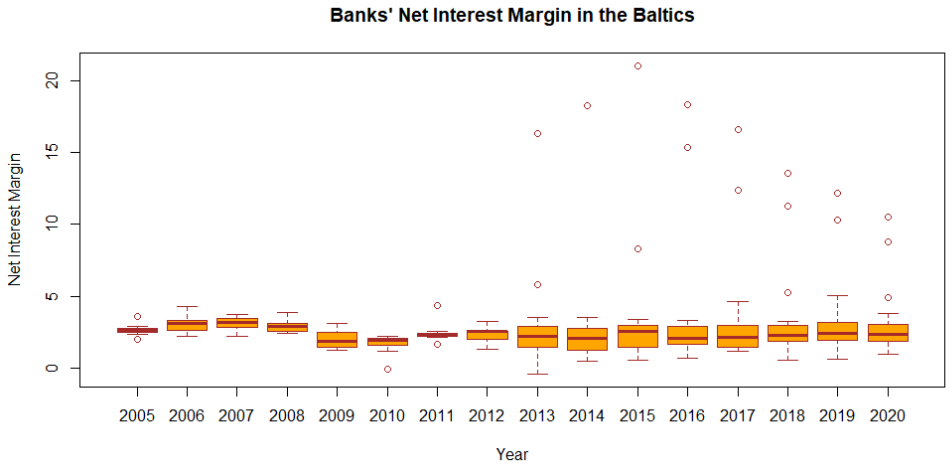

Figure 1.1: Net Interest Margin of the Baltics' commercial banks

Source: Author's calculations, Bank Focus data is used

From Figure 1.1, it is obvious that the average trend of the NIM stays under the five and only for recent years, there are outlying high values. Ceteris paribus, the high value of NIM can be an indicator of high profit in the bank. Additionally, I introduce the Z-Scores of the banks in the three of the Baltic countries, based on the Bank Focus balance sheet data in Figure 1.2.

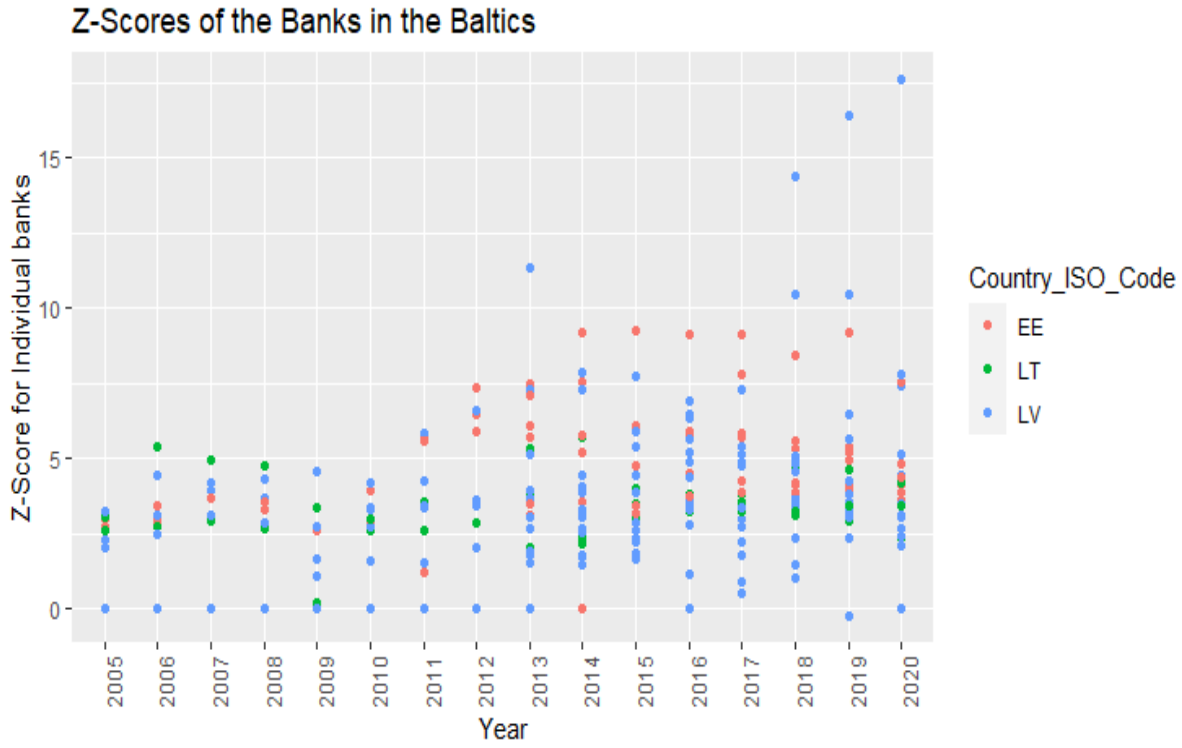

Figure 1.2: Z-Scores of the Baltics' commercial banks by country

Source: Author's calculations, Bank Focus data is used

Note: The data does not necessarily cover all the banks existing in the Baltics but only those, the balance sheet information of which is available in Bank Focus.

Bank Z-Scores estimates the probability of the insolvency of the individual banks (Boyd and Runkle, 1993). Higher Z-Scores mean that there is lower probability that the banks will be in bankruptcy. From Figure 1.2, it is obvious that while there are some banks with values close to zero most of them average close to four.

The structure of the thesis is as follows: I start with the chapter "Literature Review", where I begin the analysis of the academic literature with the bank sector interest rate, net interest margin and pay much attention on the three main measures of the banking sector competition (Herfindahl-Hirschman Index, Lerner Index and Panzar-Rosse H-Statistics). In the next chapter -

"Methodology and Data", I begin describing the data used for the empirical investigation and continue introducing the three already mentioned methodologies of how to measure the competition in the banking sector. In the "Results" chapter, I represent the outcome from the three competition measures and assess the impact of it by applying linear regression and GMM. "Conclusion" chapter includes the main summaries of the research and my contributions in the thesis.

2. Literature Review

The current neoclassical approach of the banking firm originates from Tobin's (1963) theory of the banking firm and Klein's (1973) publications in the field, where three main factors define the interest rates of the deposits: the market structure, the economic indicators, and the degree of banking sector competition. Interestingly differing from this approach, years after that, Ho and Saunders (1981), considering the banks as risk-averse firms, offer some more indicators of defining the bank loan and deposit interest rates. These determinants include the bank's risk aversion degree, transaction size and the variance of the interest rates in addition to what was suggested earlier.

Pirtouscheg et al. (2015) focuses on the assumption that while competition determines the roof of the spread level, the interest rate determines its floor. This postulate shows the impressive interrelation of the competition and the interest rate spreads, which should be considered a supportive argument for determining the impact of the banking sector competition on the Net Interest Margin.

Market competition in relation with the interest rate changes has been under the detailed analysis in different academic articles over the last era and banking competition has emerged to have thorough theoretical and empirical results at the end of 20th and during 21st century (Bikker, Leuvensteijn, 2013, Bresnahan 1982, Panzar and Rosse 1987, Boone, 2008).

There is an interesting relationship between the degree of competition and bank interest rates. Those bank products/services, which have lower demand elasticities, are priced less competitively, as presented in the Monti-Klein model (Klein, 1971, Monti, 1972). This implies that the impact of the degree of competition is supposed to be present in the changes of the bank interest rates. In addition to this, it is known that an increase in banks' market power implies higher Net Interest Margin (Maudos and Fernandez de Guevara, 2004). In a euro area based study, Gropp et al. (2007) show that banking competition positively affects the degree of bank interest rate pass-through applying the Panzar-Rosse H-statistic method.

Männasoo (2013, p. 22), in the article of the Determinants of the Bank Interest Spreads in Estonia, concludes that the degree of banks' spread in Estonia is essential for the financial risks in the global markets, reasoning that when the uncertainty rises, banks tend to behave more risk-averse in order to maximize their profits.

The market conditions are dependent to the factors that define the market. In their research of the impact of the crisis on EU countries, Burke and Garcia (2017) find out that after the financial crisis, banks in Latvia have shown improvements in general expenses, while in Lithuania and Estonia significant improvement is noticed in the administrative expenses. Since such expenses are included in the main analysis of the thesis, the assumption is directly related to the final results.

As competition is considered to be one of the important market forces in the banking industry, its significance is discussed by many experts and scientists. Bain (1951) promoted the Structure-Conduct-Performance (SCP) paradigm, which is a key basis of the many discussions of nowadays banking competition measurements. SCP argues that if there is high competition in the market, then it will force the firms behave in a way which will support the competition in order to be able to survive, which on the other hand will affect their performance. In the opposite case, it will work the other way around and will support the monopolistic market.

In the process of competition measurement, Herfindahl and Hirschman play a key role. Albert Hirschman (1945) proposed an index of market concentration measurement. Later Orris Herfindahl (1950) suggested a similar concentration index in his dissertation. Thus, the index is called Herfindahl-Hirschman index of concentration measurement, which is based on the firm's assets in the total market.

Bresnahan (1982) proposed the marginal cost - marginal revenue way of competition measurement. The price elasticity of demand is considered the basis of the model suggested by Bresnahan. Lau (1982) worked on the same model with the purpose of using aggregate data for defining the market power.

In the US banking sector competition was once measured by Shaffer (1989) finding competitive market results. Shaffer applied Bresnahan's model and found that there is a perfect competition in the US banking sector.

Another model similar to Bresnahan's methodology is Panzar-Rosse model (1987). In this model a modification in factor input prices is considered in order to explore the revenue changes. PR model results in three types of market structure: perfect competitive, oligopolistic and monopolistic. I urge to mention at this stage that the above mentioned and some of upcoming models and methodologies have advantages and disadvantages based on the structure that they are applied on. These characteristics are introduced below.

Interesting results are found by Park (2009) after the research in the Korean banking system. It showed drop in the competition before the crisis in 1997 and increase in it after that. The crisis dramatically affected the Korean economy by making the growth rate to -5.8%. However, the study by Park showed positive pattern right after the crisis.

It is known that the usage of PR test is very wide and does not cover only the banking industry (Panzar and Rosse (1977), Sullivan (1985)). Jacob Shaffer and Splerdijk (2009) find that imperfect competition cannot be determined by the price equation and scaled revenue function. This conclusion underqualified the results of the findings of Shaffer (1982a, 2004a), Nathan and Neave (1989). Yet this statement need further discussion in order to be accepted.

Lately, Boone (2008) suggested a new approach to the competition measurement which is focused on the profit and the efficiency of the market. However, it is yet unanswered whether the indicator is able to measure the competition in the industry properly or it fails in doing so.

Genesove and Mullin (1998) presented that elasticity-adjusted Lerner index can differentiate between price and non-price wars. They have done the analysis on the sugar industry in the 1890 - 1914 period.

Abba Lerner (1934) suggested a way of market power detection by considering firm's price and marginal cost. In this case marginal cost is derived from a transition cost function by considering several factors. The Lerner index shows the relative difference of the loan interest rates and marginal costs being divided over the interest rates.

Beck (2013) claims that Lerner's index can work perfectly without specifying the location difference between the banks. Spierdijka and Zaourasa (2018) analyzed the competition level in the US banking sector and found out that there is statistically significant market power in the industry.

Interestingly, Fernandez de Guevara (2005) highlights that Lerner's index may fail correctly defining the market power by overrating the results because of not consideration of risk factors. Additionally, Vives (2008) states that good substitutability s not considered correctly in the Lerner's index. However, one of the privileges of the Lerner's index is that it does not need instead of output prices it considers the total revenue, which is easily accessible from the bank financial statements.

Having the previously discussed literature in thorough consideration, it becomes crucial to use several competition measurement methodologies in order to understand its possible impact on the Net Interest Margin of banks, considering the above-discussed advantages and disadvantages of the approaches.

3. Methodology and Data

In economics, one of the ways of relevantly addressing the competition in the banking sector is to measure its level and thus find out what problems may keep the competition being down or what factors stimulate its growth so that government policies may act reasonable.

In this section, three main types of competition measurement methods are described, starting from the comparatively simple Herfindahl-Hirschman index of market concentration to more data requiring methods of Panzar-Rosse H-statistic and Risk-Ajusted Lerner Index. In the results part, I apply the outcomes of the three methods into one regression function in order to find out the relationship between the competition and the Net Interest Margin. As mentioned in the Literature Review section, each of the competition measurement methods has its advantages and disadvantages and this is the reason that I use three of them aiming at complementing the effects of their drawbacks by each other.

Before I discuss the three competition measurement methodologies, let us formulate the final regression function to be used at the end of the analysis.

$$NIM_{ct} = \alpha_c + \beta_{1,c} HHI_{ct} + \beta_{2,c} PR_{ct} + \beta_{3,c} LI_{ct} + \gamma_{1,c} \mathrm{GDP}_{ct} + \gamma_{2,c} Inflation_{ct},$$

where NIM is for Net Interest Margin, HHI is the calculated HHI index, PR is the Panzar-Rosse H-statistics and LI is the Lerner Index. c stands for country and t indicates the time. α is the intercept, β, γ and δ are for the coefficients.

The formula is going to be used separately for each country in the Baltics (Estonia, Latvia and Lithuania). The data in the calculations is obtained from Orbis Bank Focus Database by Bureau Van Dijk. Balance-sheet bank level data is used for the Commercial banks in the Baltics for the period of 2005-2020. Such balance-sheet data for the banks has the problem of the possible consolidation for the bank branches, which sometimes ends up giving double value for each of them. To encounter this problem correctly, I followed the Bank Focus instructions of the consolidation types and filtered the data in a way that it keeps as much unconsolidated data as possible. The types of the consolidations and their preferable order can be found in the Appendix

2. Additionally, due to the accessibility of some data in the banks' financial reports, I checked and updated some data from their reports aiming at having as correct database as possible. In total, 26 banks are considered in the calculations of the following methodologies.

3.1 Herfindahl-Hirschman Index

A popular approach of assessing the concentration level of a market is using the Herfindahl-Hirschman index (1945) for calculating the market concentration. In 1945 Albert O. Hirschman introduced this index and Orris Herfindhal presented it in his unpublished dissertation. The result of the index is the presentation of the level of the concentration in the banking sector, where monopoly is introduced by the maximum value and the perfect competition – by the minimum value of the index. The index is as follows:

$$HHI = \sum_{i=1}^{N} D^2{}_i,$$

where D_i shows the share of the financial company in the market. The index outcome will be divided into three parts of having low ($HHI < 0.1$), moderate ($0.1 < HHI < 0.18$) and high ($0.18 < HHI < 1$) concentration in the market. For finishing the HHI index calculations, one needs to have a data of the market share for each of the firms in the market. In this case it is about the assets weights of the banks in the total assets of the market. However, a key drawback of HHI in the process of determination of the impact of competition on the Net Interest Margin is that there may be situations, where concentration of the operating firms may increase due to more efficient work in the market, meaning that efficient firms enlarge by dropping the number of more inefficient firms (Bikker et al. 2013).

Gini index comes to be another way of calculating the equally distribution of the shares in the market, in this case, the banking sector. The Gini index is a statistical coefficient, which is based on the Lorenz curve and is calculated by the ratio between the areas of the actual curve and the equally dividing line over the area of the whole triangle.

3.2 Panzar-Rosse Model Analysis

Panzar-Rosse model of competition measurement, suggested in 1977 and improved further later, uses gross revenue elasticities to assess the competition. Being used in diverse areas, the model has been widely applied in the banking sector competition estimation for more than three decades. The model can be derived from the firm's profit-maximization condition and uses cross sectional data to estimate the competition.

Following Nathan & Neave (1989), Shaffer (2004), the Revenue equation of the Panzar-Rosse model is applied. The model has log of Net Income on the left-hand side of the equation as a dependent variable:

$$\log NI = \alpha + \sum_{i=1}^{n} \beta_i \log w_i + \sum_{j} \gamma_j \log CF_j + error,$$

where NI is Net Income, w_i is the i-th input factor, n is the number of the independent variables (expenses as input factors) and CF is control factors featured to the firm. α, β and γ are the coefficients for the corresponding variables. The Panzar and Rosse pay special attention to the input factor coefficients, which is β_i in this case and they claim that their sum shows the level of the competition in the considered market, which is the banking sector in our case. In this model, the indicator, which shows the level of competition in the industry, is received by summing the beta coefficients of the input factors in the regression model.

While understanding the idea behind the H-statistics value, one needs to consider the two opposite cases of the market types: perfect competition and monopoly. It is well known that no firm earns any profit if the market is perfectly competitive, meaning that if input prices are modified, then marginal costs are changed with the same size, hence they will have one to one change. This means that once the H statistics is one, the market must be in perfect competition and analogically, in case of monopoly the direction of the changes in the costs and economic profits of the bank have opposite signs. Thus, negative H statistics will tell about the monopoly in the market.

Following Shaffer, Bikker and Spierdijk (2009, Utrecht) the reduced form of the revenue equation for the Panzar-Rosse model is as follows:

$$\log TR = \alpha + \sum_{i=1}^{n} \beta_i \log w_i + \sum_{j} \gamma_j \log CF_j + error,$$

where TR is Total Revenue, w_i is the i-th input factor, n is the number of the independent variables (expenses as input factors) and CF is control factors featured to the firm. α, β and γ are the coefficients for the corresponding variables.

This approach has been widely used in the empirical studies of the competition measurement by Shaffer (1982a, 2004a), Carbo et al. (2009). It is crucial to consider that there are several avriations from the general equation of the Panzar-Rosse model, offered by different empirical studies. For example, there is P-R price equation where instead of Total Assets (TA) is the dependent variable. This approach can be found in the analysis of De Bandt and Davis (2000), Mamatzakis et al. (2005). Alternatively, there is price equation, which includes the ratio of total revenue over total assets in the log. The first two will be classified as unscaled measures, while the latter one is the scaled. The types of the equations with exact dependent and independent variables used for the calculations for this paper is introduced in the "Results" section with their corresponding outcomes.

Regardless of the type of the dependent variable, the H statistic is the sum of the beta coefficients, meaning that it adds up the elasticities of the total revenue considering the input prices for each of them (Bikker et al., 2012):

$$H = \sum_{i=1}^{n} \beta_i.$$

Before interpreting the values of the H-statistics, it is necessary to mention that H-statistics assessments are valid in case of long-run market equilibrium (Shaffer, 1982). Shaffer has introduced the Return on Assets (ROA) methods to estimate whether where the market is in the long-run equilibrium. For this approach, it is needed to calculate the H^{ROA}-statistics, getting from the ratio of total income to total assets. If the H^{ROA} is equal to zero, the market is in the equilibrium in the log-run.

If the market is in monopoly, the H value is negative ($H \leq 0$) (Panzar and Rosse, 1987). If $0 < H < 1$, the level of the competition in the market is considered to be monopolistic (Panzar and

Rosse). In case if $H = 1$, the market is in perfect competition. Not positive H-statistics implies monopoly, because it happens when rise in the input prices affects negatively on the bank's income, which in its own turn, tells us about the highest possible revenue for the bank, indicating monopoly-related behavior in the market. Less strict is the case when H-statistics is between zero and one. This situation can be explained as rather monopolistic behavior in the market. Finally, when H-statistics is one, the market is considered to be in perfect competition.

This explanation is rather standard approach to the Panzar-Rosse model, because after several decades of the creation of the model, many articles have been published, proving diverse shortcomings of the model, where the interpretation of H statistics may not be valid in certain situations.

Interestingly, as Bikker, Shaffer and Spierdijk discuss that the H-statistic may be restriced of being smaller than one or even smaller or bigger than zero, depending on the short and long run equilibrium and the shape of the average cost function. This implies that the interpretation of the H-statistics is hugely dependent on the circumstances and the industry features. Empirically studying more than 18000 banks for the period of 1986-2004, Bikker et al. have shown another disadvantage of the Panzar-Rosse model. Their results have leaded to the conclusion that measurement of the competition, calculated by neither the price nor the unscaled revenue formulas give significant results, disproving many results, obtained before this article.

While the P-R model gives us opportunity to have quantitative imagination about how the banks compete in and out of the equilibrium, there have been suggested many shortcomings, which need to be considered for the valid interpretation of the index. Juan Manuel Sanchez-Cartas claims that government should not use the P-R model as a determinant for the existence of the monopoly in the market. He justifies the statement by proving that H statistics can be positive in the existence of the monopoly. While this disadvantage of the H statistics makes us think of it as a less significant indicator compared to the others (e.g. Lerner Index), it does not necessarily mean that P-R model gives completely improper measurement.

In their recent study on the P-R revenue test, Shaffer and Spierdijk, by analyzing five versions of oligopolistic market, have proved that regardless the condition of the market, the H statistic can be positive or negative, which means that Shaffer disproves the earlier accepted concept that H statistics is non-positive in the case of monopoly (Shaffer, Spierdijk, 2015). This discovery puts the interpretation of the results of many empirical studies under question and shows that Panzar-Rosse model is not always a good measure of competition. Interesting result of the Panzar-Rosse model is achieved in the discussion of the high technological growth in the market. Gunji and Yuan (2017) have proved that when the firms choose a saddle point, Panzar-Rosse statistics can be attained even when technological advancements provide with higher ROA, resulting H-statistic to be more than one.

3.3 Lerner-Index Model Analysis

The Market Power index, offered by Abba Lerner in 1934, was going to become the basis of widely applied model of measuring monopolistic power in the market (Lerner, 1934).
Lerner index is determined as the ratio of the difference of the Price and Marginal Cost over the Price of the product. In this case, under the product I mean the financial services, provided by the banks, on which I consider to estimate the competition. Lerner's index gets values from zero to one, indicating monopolistic power when the index goes to one and competitive market condition when it drops to zero. The index is as follows:

$$L_{it} = \frac{P_{it} - MC_{it}}{P_{it}},$$

where P is equal to the average price of the discussed product/service and MC is the Marginal Cost. Each bank is indexed as i and time as t. It is worth mentioning that average price can be received by dividing the Total Revenues over the Total Assets.

The Banks' Total Cost function is obtained following the method applied by Lin et al. (2014). The estimation of the Total costs can be done via this formula:

$$\ln TC_{it} = \alpha_0 + \alpha_1 \ln TA_{it} + \frac{1}{2}\alpha_2 (\ln TA_{it})^2 + \alpha_3 \ln w_{1it} + \alpha_4 \ln w_{2it} + \alpha_5 \ln w_{3it} +$$
$$\alpha_6 \ln TA_{it} \ln w_{1it} + \alpha_7 \ln TA_{it} \ln w_{2it} + \alpha_8 \ln TA_{it} \ln w_{3it} ,$$

where i is the individual Bank, t is time; TC is Total Cost (Interest expenses, labor expenses and the other expenses) and TA is Total Assets.
w_1 is labor price, w_2 price of borrowed funds, w_3 is physical capital prices.

After it, the first order derivative of the Total Cost function is taken in order to receive the Marginal Cost function:

$$MC_{it} = \frac{\partial TC_{it}}{\partial TA_{it}} = \frac{TC_{it}}{TA_{it}}(\widehat{\alpha_1} + \widehat{\alpha_2}\ln TA_{it} + \widehat{\alpha_6}\ln w_{1it} + \widehat{\alpha_7}\ln w_{2it} + \widehat{\alpha_8}\ln w_{3it}).$$

Then the estimated MC values for each bank for each period of time is used to calculate the Risk-Adjusted Lerner index averaged for each of the periods for each of the countries.
It is worth mentioning that Fernandez de Guevara et al. (2005) revealed the importance of the risk factor in the Lerner index and claimed that Lerner index may fail if the risk taking or risk averse behavior is not considered properly. This argument gives enough fundamental judgements to think about some modification on the Lerner Index, in order to have the risk factor, considered in it. Following Arrawatia, Misra et al. (2019), I include Non-Performing Assets in the right hand-side of the transitional cost function in order to adjust the calculations for the risk.

Consequently, after using the general Lerner Index formula, I apply the NPA modification in the calculations, thus, I use the following formulas:

$$\ln TC_{it} = \alpha_0 + \alpha_1 \ln TA_{it} + \frac{1}{2}\alpha_2 (\ln TA_{it})^2 + \alpha_3 \ln w_{1it} + \alpha_4 \ln w_{2it} + \alpha_5 \ln w_{3it} +$$
$$\alpha_6 \ln TA_{it} \ln w_{1it} + \alpha_7 \ln TA_{it} \ln w_{2it} + \alpha_8 \ln TA_{it} \ln w_{3it} + \beta ln NPA_{it} TA_{it},$$

where all the symbols possess the same meaning and NPA indicates Non-Performing Assets.

From the transitional cost function, Marginal Cost is receive again by taking the derivative of Total Costs:

$$MC_{it} = \frac{\partial TC_{it}}{\partial TA_{it}} = \frac{TC_{it}}{TA_{it}}(\widehat{\alpha_1} + \widehat{\alpha_2}\ln TA_{it} + \widehat{\alpha_6}\ln w_{1it} + \widehat{\alpha_7}\ln w_{2it} + \widehat{\alpha_8}\ln w_{3it} + \hat{\beta} ln NPA_{it}).$$

Lerner index is one of the most used methodologies in the question of competition measurement. It was accepted so much that once Tibor Scitovsky (1984) named it as “the first clear, rigorous and definitive statement of Pareto optimality” (p. 1551).

Vives (2008) has presented the high level of the correlation between the Lerner Index and Boone indicator, which keeps us back from using Boone indicator simultaneously with the Lerner index because their results in most cases should be very similar.

4. Results

In the empirical analysis, I used Baltics Banking annual data for the period of 2005 to 2020 for all the methodologies. In order to understand how the banking sector in the Baltics states operate, firstly, I introduce some descriptive statistics. Using Bank Focus data for the period of 2005-2020, it is possible to visualize Baltic banks' total assets by country (see Figure 4.1).

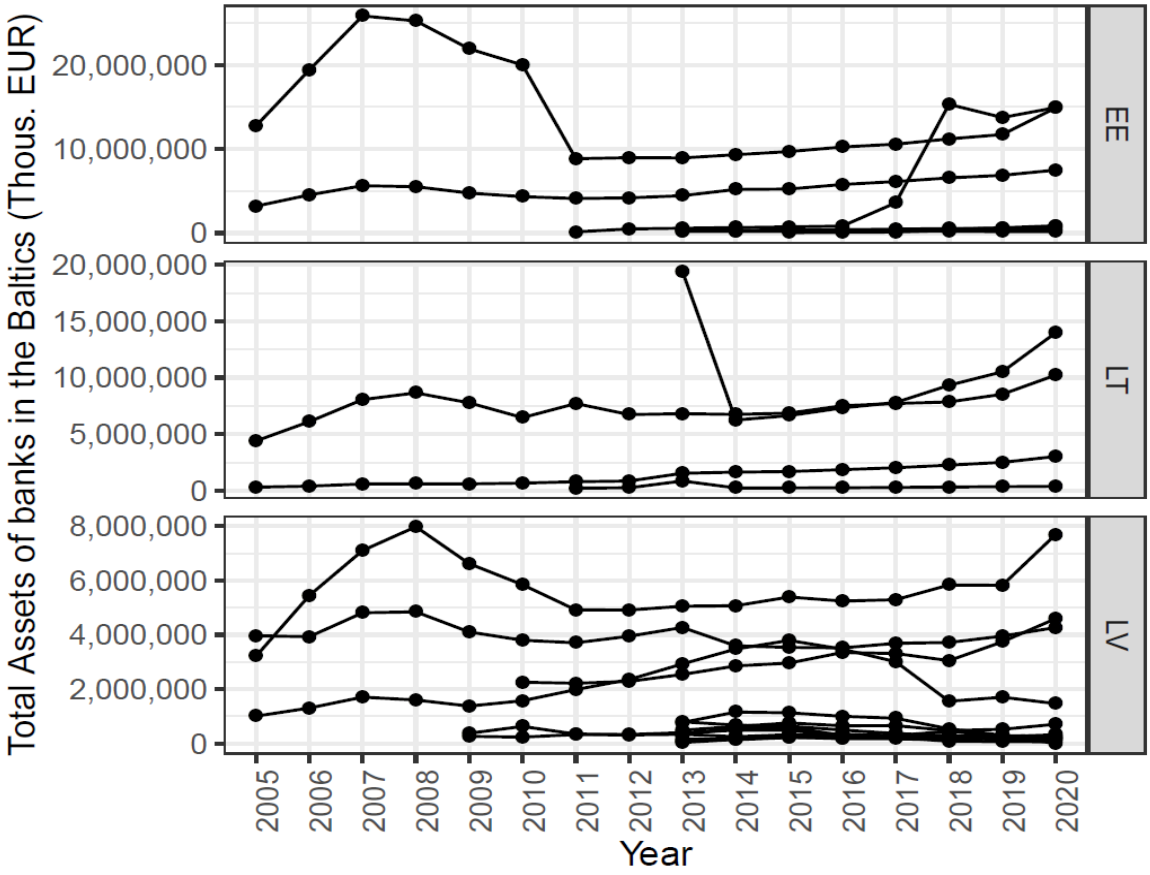

Figure 4.1. Total Assets of banks in the Baltics (thous. EUR)

From Figure 4.1, it is easily noticeable that before 2008, there were fewer banks in the three countries, compared to the recent years, which, at first glance, tells us about potential increase in the degree of competition. This is also because of the available reports in the dataset.

Now in order to understand whether how much of the market the top banks possess in the entire market, I discuss the 5-bank asset concentration for Estonia, Latvia and Lithuania.

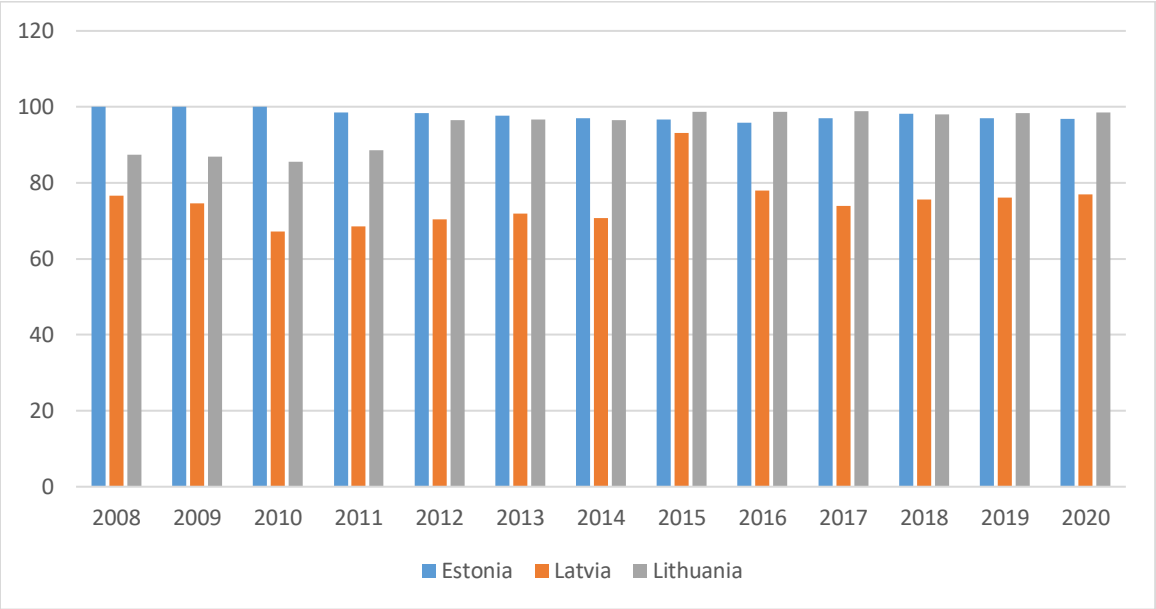

Figure 4.2. 5-bank asset concentration in Estonia, Latvia and Lithuania

Source: World Bank Database

Note: The Data is updated by the author using Bank Focus data for recent years

Indeed, it comes to be obvious from the graph that top five banks take most of the market in case of Estonia and Lithuania, while for Latvia they seem to take comparatively lower position, while being more than half of the market for all the years.

However, the consideration of the whole banks operating in the focus market is a must, thus I turn to my first competition measurement method – Herfindahl-Hirschman index, which is rather a concentration measure itself.

4.1 Herfindahl-Hirschman Methodology Results

The Herfindahl Hirschman index shows us the squared weights' sums of the banks' total assets in the Baltic countries. Now it is time to have a look at the way that HHI changes over the years.

Below, Figure 4.3 shows the Herfindahl Hirschman index over the period of 2005-2020 is presented.

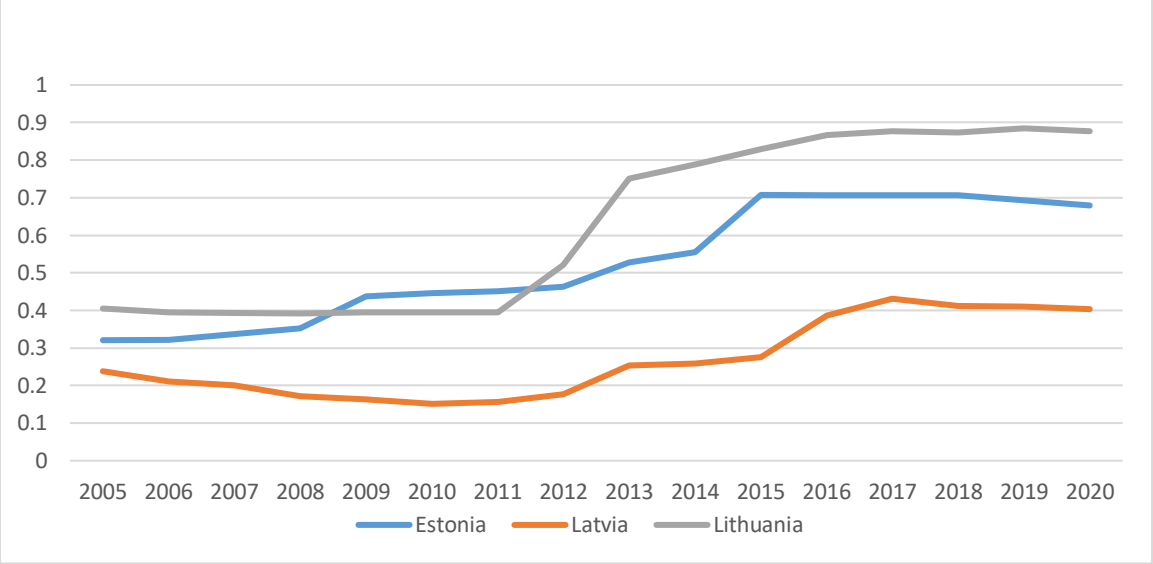

Figure 4.3. Herfindahl-Hirschman index for the Baltics.

Source: Author's calculations, Bank Focus data.

As already discussed, market concentration is moderate in case of HHI belonging to the scale of 0.1 to 0.18. This is only visible for Latvia for the period of 2008-2012. This can be possible due to the more normal distribution of the Total Assets of the banks. For the more recent years, Lithuania has highest banking sector concentration, compared to Latvia and Estonia. However, theoretically, it can happen so that the HHI increases because more efficient banks leave out the less efficient banks from the market (Bikker et al. 2013). This implies that it is crucial to look at other possible measures of competition to address the question of the impact of the degree of it on the Net Interest Margin.

4.2 Panzar–Rosse Methodology Results

Using the Bank Focus data for the period of 2005-2020, I measured Panzar-Rosse H-statistics for the Baltic countries, following the methodology set out in Bikker et al. (2012). Hence, I consider the labor, physical capital and funding costs in the regression function. For the labor costs, I take

into consideration the ratio of Stuff Expenses and Administrative Expenses over Total Assets, for the physical capital, I apply the ratio of Interest Expense and other Operating Expense over the Total Assets. Finally, for the funding, I use the ratio of Interest Expenses and Total Assets as well as Deposits and Short-term Funding from the bank balance sheet data. The H-statistics is received by applying a scaled measure of Net Income over the Total Assets, meaning that I sum up the coefficients in the regression function for the labor, physical capital and funding variables.

I also take into consideration firm-specific control variables, which are Return on Average Assets, the ratio of Equity and Total Assets and Interest Earning Assets. All variables stand under log function in the regression equation.

The equation will be as follows:

$$\left(\log\frac{NI}{TA}\right)_{ct} = \alpha_{ct} + (\beta_1)_{ct}\left(\log\frac{IE}{TA}\right)_{ctk} + (\beta_2)_{ct}\left(\frac{AE}{TA}\right)_{ctk} + (\beta_3)_{ct}\left(\log\frac{SE}{TA}\right)_{ctk} + (\beta_4)_{ct}\left(\log\frac{IE}{FA}\right)_{ctk} + (\beta_5)_{ct}\left(\log\frac{OE}{TA}\right)_{ctk} + (\beta_6)_{ct}DF_{ctk} + (\gamma_1)_{ct}(ROAA)_{ctk} + (\gamma_2)_{ct}\left(\log\frac{EQ}{TA}\right)_{ctk} + (\gamma_3)_{ct}\left(\log\frac{IEA}{TA}\right)_{ctk} + error,$$

Where c is for country, t is for time and k is for the bank in each country. IE is for Interest Expenses, TA is for Total Assets, AE is for Administrative Expenses, SE is for Stuff Expenses, IE is for Interest Expenses, OE is for Operating Expenses, DF stands for Deposits and Short-term Funding, ROAA is for Returns on Average Assets, EQ is for Equity and IEA is for Interest Earning Assets.

Applying time specific fixed effects, I receive the H-statistics, the results of which are presented in the following figures for separately for Latvia, Lithuania and Estonia.

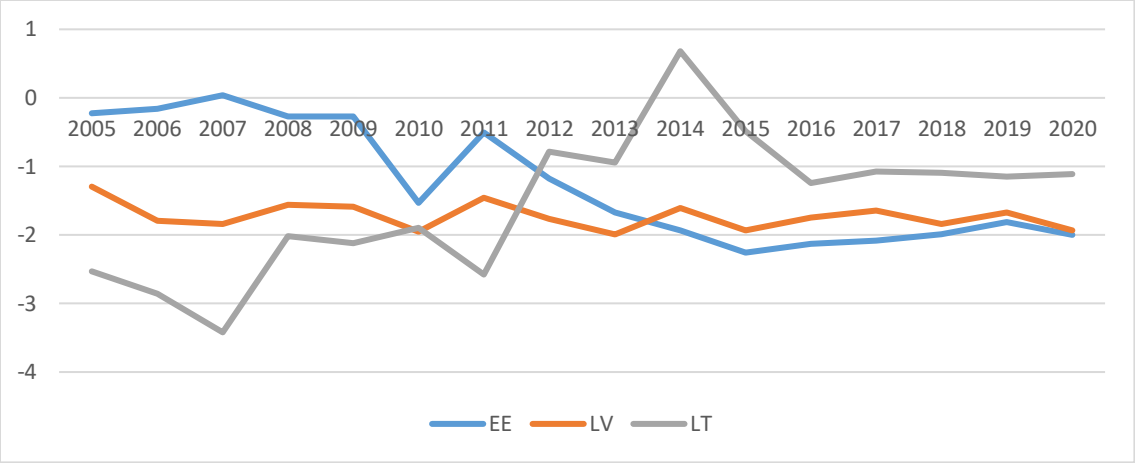

Figure 4.4. Panzar-Rosse H-statistics in the Baltics over the period of 2005-2020

Source: Author's calculations, Bank Focus Data.

It can be noticed from the Figure 4.4 that the H statistics present falling values for Estonia, meaning that the degree of competition is dropping over time. Particularly, because the values are below zero, it can be assumed that there is monopoly in the banking sector of Estonia, which has been close to be considered monopolistic and managed to show positive results only in 2007, confirming monopolistic market structure. These results correspond with the results of the Herfindahl-Hirschman index for Estonia.

In case of Latvia, it can be noted monopoly market for the whole period with some variety in numbers, which does not significantly change anything in the interpretation of the market structure, letting us conclude that there is monopoly in the Latvian banking sector.

In case of Lithuania, it can be noted the opposite order of movement of the competition level over the years, meaning that the market tends to get close to be called monopolistic, instead of monopoly and it happens in the year 2014. Based on the results of the PR H-statistics, the highest possible competition level is seen in Lithuania in 2014. However, this does not surely need to be true in all cases, because some recent publication show that in some oligopoly cases, H statistics is positive and fails to show the real situation in the market (Shaffer, Sperdijk, 2020).

After having the results for the P-R model, it is the exact time to check whether the market is in the long-term equilibrium or not. In order to do so, I will input ROAA as a dependent variable in

the P-R equation (Molyneux et al., 1994; Majid & Sufijan, 2006). The Equation will look as follows:

$$\log(1 + ROAA) = \alpha_{ct} + (\beta_1)_{ct}\left(\log\frac{IE}{TA}\right)_{ctk} + (\beta_2)_{ct}\left(\frac{AE}{TA}\right)_{ctk} + (\beta_3)_{ct}\left(\log\frac{SE}{TA}\right)_{ctk} + (\beta_4)_{ct}\left(\log\frac{IE}{FA}\right)_{ctk} + (\beta_5)_{ct}\left(\log\frac{OE}{TA}\right)_{ctk} + (\beta_6)_{ct}DF_{ctk} + (\gamma_1)_{ct}\left(\log\frac{EQ}{TA}\right)_{ctk} + (\gamma_2)_{ct}\left(\log\frac{IEA}{TA}\right)_{ctk} + error.$$

The variables in the right-hand side of the equation are defined in the beginning of section 4.2. The market will be in the log-term equilibrium, when the sum of the beta coefficients (H-statistics) equals to zero. However, if it is less than zero, the market is not in the long-term equilibrium. Our results show that the market is out of the equilibrium only for 2007-2009. For the rest of the discussed periods, the market is in the long-term equilibrium.

4.3 Lerner Index Methodology Results

In this section, I turn to the analysis of the third introduced index, which is the Lerner index. Using the transitional cost function, I obtain the marginal costs for each bank and applying it in the general Lerner Index, I receive the final results over the period of 2005-2020. Firstly, I consider the Lerner Index, generally used by many academic articles, following Lin et al. (2014). The results of the averaged Lerner Index over the periods of 2005-2020 is introduced in Figure 4.5.

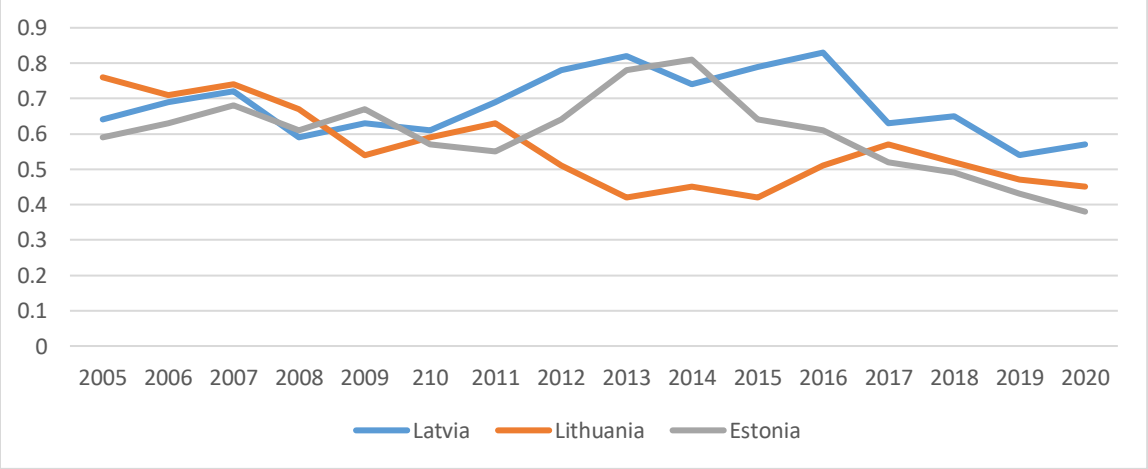

Figure 4.5. Plotting Average Lerner index for the Baltic countries

Source: Author's calculations, Bank Focus Data.

As mentioned in the previous chapter, larger Lerner index tells us about higher market power. One can notice higher market power in Latvia, then comes Estonia and comparatively lower values are present in case of Lithuania, which at this stage is an indicator that the banking sector competition is higher in Lithuania compared to the two other Baltic countries. Overall, there is a tendency of the increase of the Risk-Adjusted Lerner Index after 2009, meaning that the degree of competition is dropping at that time.

Fernandez de Guevara et al. (2005) showed that if the risk taking/averse behavior is not taken into consideration in the Lerner Index, it might fail to give proper results because of the specific feature of the banking sector. Considering this, after having the Lerner Index calculated in a usual way, I am modifying the index by adding Non-performing assets in the cost transition equation, in order to consider risk in the analysis following Arrawatia, Misra et al. (2019). The results are presented in Figure 4.6.

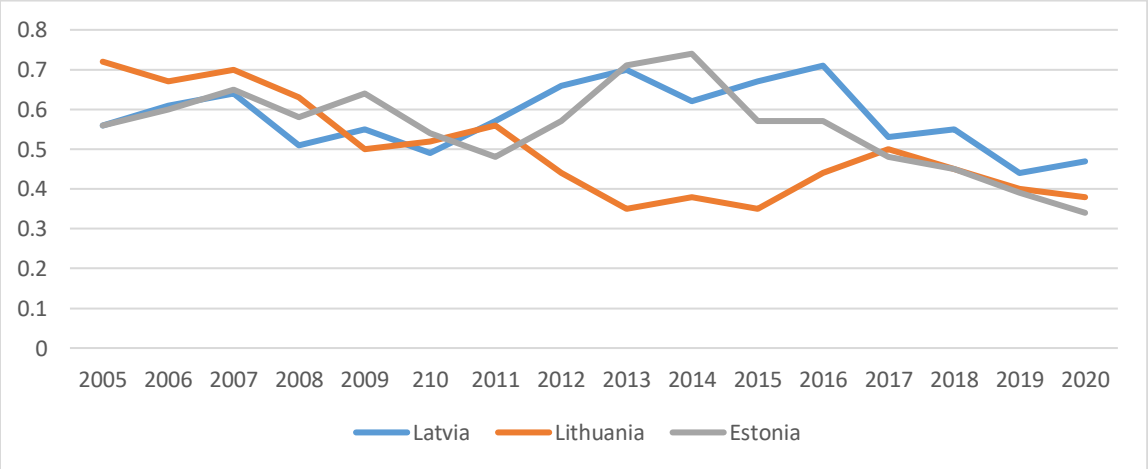

Figure 4.6. Plotting Average Risk-Adjusted Lerner index for the Baltic countries

Source: Author's calculations, Bank Focus Data.

From Figure 4.6, it is easily noticeable that while the overall tendency of the indices are kept, the values are less in the case where risk is considered, compared to a situation without such adjustment. Nevertheless, for more recent years, there is positive tendency of increasing the degree of competition, shown by the overall downward tendency of the Risk-Adjusted Lerner Index on Figure 4.5.

4.4 Relationship between Net Interest Margin and Banking Competition

Finally, I take these three measurement values into a regression function, in order to understand the relationship between the banking sector competition and the Net Interest Margin. I start the measurement by considering time series data, obtained by the results of the three competition measures and I average Net Interest Margin per year. I also include GDP growth rate and inflation level as control variables in the equation.

The results of the OLS for the three countries give us the following relations between the competition indices and NIM.

Estonia: $NIM = -1.102 + 6.839HHI + 0.894PR + 1.897LI + 0.046GDP + 0.042Inflation$

Latvia: $NIM = 1.089 + 3.332HHI - 0.524PR - 0.716LI + 0.025GDP + 0.067Inflation$

Lithuania: $NIM = -0.135 + 2.457HHI - 0.269PR + 1.036LI + 0.025GDP + 0.061Inflation$

It is noticeable that HHI, GDP and Inflation have positive relation on the NIM in all the three countries, PR H-statistics is correlated with NIM negatively in Latvia and Lithuania. Considering the fact, that the increase in HHI, PR and LI means drop in the level of the competition, I can conclude that in case of Estonia all the three measures confirm the rise in the Net Interest Margin when the Competition decreases, which is analogical.

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Next, I move to using the bank level Net Interest Margin data with the Competition measures to assess the relationship between the competition and the margin. I start with the fixed effects, random effects and pooling on the panel data of 416 observations. The results are presented in table 1.

Table 1. Pooling, Within and Fixed effects methods results

	Dependent variable:	
	NIM	
Pooling	Within	Fixed
HHI	-31.164	51.982
151.718		
	(34.334)	(59.648)
(109.745)		
PR	1.606	-2.135
-19.959**		
(8.778)	(6.642)	(5.911)
LI	43.661	41.419
36.146		
(52.063)	(57.184)	(50.427)
GDP	-0.252	-0.530
0.889		
	(2.489)	(2.106)
(1.726)		
Inflation	1.946	0.125
-1.928		
	(3.590)	(3.187)
(2.720)		
Constant	221.066***	
5.185		
	(37.846)	
(4.151)		
Observations	416	416
392		
R2	0.343	0.438
0.155		
Adjusted R2	0.310	0.373
0.110		
F Statistic	10.318*** (df = 20; 395)	14.509*** (df = 20; 372)
3.407*** (df = 20; 371)		
Note:		*p<0.1;
**p<0.05; ***p<0.01		

Source: Author's calculations

By including fixed effects or year dummies in the regression, I am controlling for the mean differences across banks. Considering the significant restriction of fixed effects of not giving the opportunity to measure the impact of variables that do not have much within-group variation, I move to the within effects and Pooling. However, the goodness of the results (R squared) is not so high (0.343), which leads us to move to the next GMM and IV analysis. In the table 2 it is shown the results of the GMM and IV analysis of the panel data of 416 observations.

Table 2. Main results using GMM and IV

	Dependent variable:		
	NIM		y
	GMM	instrumental variable	GMM
	(1)	(2)	(3)
HHI	-130.637***	-220.587***	
	(21.097)	(35.284)	
PR	11.329*	181.110***	
	(6.257)	(41.773)	
LI	129.023***		
	(40.025)		
GDP	0.644		
	(0.650)		
Inflation	4.910***		
	(1.345)		
xHHI			-223.494***
			(52.608)
xPR			160.546***
			(59.817)
Constant	156.982***	552.821***	515.165***
	(25.913)	(73.210)	(104.256)
Observations	416	416	416
R2		-1.124	
Adjusted R2		-1.134	
Residual Std. Error		130.330 (df = 413)	
Note:		*p<0.1; **p<0.05; ***p<0.01	

Source: Author's calculations

It is obvious from the table 2 that HHI shows high negative significant relation to the dependent variable, meaning that the rise in the concentration will bring in drop in the mean of the margin. PR H-statistics results show opposite relation compared to HHI. Based on the already mentioned

discussion of the PR H-statistics being able to only divide the market into three types, I need to do the conclusion also including the risk-adjusted Lerner Index results. Risk-adjusted Lerner index shows positive significant relation towards Net Interest Margin and because we know that high value of LI means low level of competition, we can draw a conclusion that the increase in the competition will drop the Net Interest Margin.

To sum up the results, it is easily noticeable that the competition measures affect the Net Interest Margin in a way that an increase in the degree of competition will increase the Net Interest Margin, which is an expected result.

Conclusion

The importance of the competition in the banking sector comes from its nature of being as usual as the other markets, from the side of the development perspectives and as much unique as the question of stability and efficiency come to impact. In this paper, I study the relationship between several competition indicators and the Net Interest Margin in the Baltic countries.

First, I estimate the situation of the competition in the Baltic countries by applying three different methods. Starting from the standard concentration indices, I go to non-structural methods of Panzar-Rosse H statistics and Lerner Index. For the latter, I adjust risk in order to have more realistic results. H statistics appear to be positive for all the cases, which is a good sign from the perspective that it might drop the chances of the monopoly in the markets. Apart from that, the risk-adjuasted Lerner index, shows us low values on average, again mostly confirming the statement that for Latvia and Estonia the market power is higher than for Estonia. This is done to uncover the level of impact that the competition may have on the Net Interest Margin, which in its essence shows how the interest rates of loans and deposits vary from each other.

The results of HHI show us that Lithuania seems to have most of the concentration in the recent years, for the earlier years, Estonia has higher concentration level. However, having in mind the assumption that higher HHI may also speak about more efficient and competitive market (Bikker et al. 2013), I leave the rest of the conclusions dependent upon the results of the other methods.

The results of the Panzar-Rosse model help us know that the markets are in monopoly in most of the cases. Interestingly, for Lithuania, the results of H-statistic show better competition than for Estonia or Latvia.

The results of the Lerner Index show that Lithuania has on average lowest values, meaning that Market Power for each of the bank is lower there, so the competition is higher. The relationship of the Competition measures and NIM in the Baltic countries show us that in most of the cases, the rise of the competition affects the Net Interest Margin in an opposite direction.

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4. Central Bank of Lithuania https://www.lb.lt/en/
5. World Bank https://www.worldbank.org/en/home
6. Euribor Rates https://www.euribor-rates.eu/en/

Appendices

Appendix 1.

Commercial bank names, the data of which are used in all the calculations.

Estonia	Latvia	Lithuania
LUMINOR BANK AS	SWEDBANK AS	SWEDBANK AB
SWEDBANK AS	AS CITADELE BANKA	AB SEB BANKAS
AS SEB PANK	SEB BANKA AS	SIAULIU BANKAS
COOP PANK	RIETUMU BANK GROUP	UAB MEDICINOS BANKAS
BIGBANK AS	AS BLUEORANGE BANK	
INBANK AS	RIGENSIS BANK AS	
AS TBB PANK	NORVIK BANKA AS	
	REGIONALA INVESTICIJU BANKA	
	AS LPB BANK	
	RIGENSIS BANK AS	
	BALTIC INTERNATIONAL BANK	
	SIGNET BANK AS	
	INDUSTRA BANK AS	
	AS "PRIVATBANK	
	AS EXPOBANK	

Appendix 2.

Bank balance sheet data consolidation and its preference used in the calculations.

C1: statement of a mother bank integrating the statements of its controlled subsidiaries or branches with no unconsolidated companion

C2: statement of a mother bank integrating the statements of its controlled subsidiaries or branches with an unconsolidated companion

C* Additional Consolidated statement

U1: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned bank with no consolidated companion.

U2: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned bank with an consolidated companion.

U* Additional Unconsolidated statement

The Preference: U1 > U2 > U* > C1 > C2 > C*

Appendix 3.

Table A1. Description of Panel Data

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
X	416	208.500	120.233	1	104.8	312.2	416
Consolidation_code	416	2.192	1.040	1	2	2	5
Year	416	2,012.500	4.615	2,005	2,008.8	2,016.2	2,020
HHI	416	0.393	0.204	0.151	0.210	0.451	0.885
PR	416	-1.569	0.633	-3.421	-1.936	-1.453	0.680
LI	416	0.590	0.115	0.380	0.510	0.670	0.830
GDP	416	2.647	6.038	-14.839	1.575	5.634	11.986
Inflation	416	3.331	3.685	-1.085	0.219	4.371	15.402

Note: Table A1 provides with descriptive statistics for the panel data of net interest margin and competition indices.

Appendix 4.

Table A2. Regressions by countries

	Dependent variable:		
	NIM		
	Estonia	Latvia	Lithuania
HHI	6.839**	3.332***	2.457***
	(2.355)	(0.682)	(0.489)
PR	0.894*	-0.524	-0.269**
	(0.404)	(0.352)	(0.118)
LI	1.897	-0.716	1.036
	(1.291)	(0.993)	(0.867)
GDP	0.046**	0.025**	0.025*
	(0.019)	(0.010)	(0.014)
Inflation	0.042	0.067**	0.061*
	(0.041)	(0.025)	(0.031)
Constant	-1.102	1.089	-0.135
	(1.496)	(0.882)	(0.860)
Observations	16	16	16
R2	0.616	0.827	0.785
Adjusted R2	0.423	0.740	0.677
Residual Std. Error (df = 10)	0.352	0.237	0.264
F Statistic (df = 5; 10)	3.203*	9.533***	7.295***
Note:	*p<0.1; **p<0.05; ***p<0.01		

Appendix 5.

Pooling, Within and Fixed effects methods results

	Dependent variable: Net Interest Margin		
	Pooling	Within	Fixed
HHI	-31.164	51.982	151.718
	(34.334)	(59.648)	(109.745)
PR	1.606	-2.135	-19.959**
	(6.642)	(5.911)	(8.778)
LI	43.661	41.419	36.146
	(57.184)	(50.427)	(52.063)
GDP	-0.252	-0.530	0.889
	(2.489)	(2.106)	(1.726)
Inflation	1.946	0.125	-1.928
	(3.590)	(3.187)	(2.720)
factor(Year)2006	3.393	4.359	5.400
	(21.741)	(18.493)	(13.637)
factor(Year)2007	-0.357	5.556	18.458
	(22.977)	(19.907)	(19.689)
factor(Year)2008	-19.735	-6.161	46.285
	(50.780)	(43.937)	(40.923)
factor(Year)2009	-29.992	-40.915	8.243

	(61.031)	(51.826)	(50.409)
factor(Year)2010	-34.156	-47.341	-24.865
	(35.659)	(30.807)	(36.707)
factor(Year)2011	-28.196	-30.150	2.233
	(22.034)	(18.640)	(30.617)
factor(Year)2012	-24.997	-34.055	-1.171
	(25.645)	(22.145)	(33.887)
factor(Year)2013	-97.114***	-119.292***	-97.667**
	(30.356)	(28.341)	(38.287)
factor(Year)2014	-113.565***	-136.616***	-104.932***
	(30.728)	(28.910)	(39.998)
factor(Year)2015	-87.489***	-117.760***	-97.703**
	(31.352)	(31.586)	(43.023)
factor(Year)2016	-101.811***	-137.027***	-116.394**
	(31.949)	(33.586)	(46.542)
factor(Year)2017	-114.958***	-146.378***	-117.608**
	(29.134)	(30.747)	(46.347)
factor(Year)2018	-99.697***	-131.253***	-98.855**
	(29.538)	(31.139)	(46.908)
factor(Year)2019	-82.630***	-114.192***	-73.334
	(31.755)	(32.939)	(47.796)

```
factor(Year)2020          -62.425                  -99.547**
-55.670
                          (38.912)                  (39.433)
(51.677)

Constant                 221.066***
5.185
                          (37.846)
(4.151)

------------------------------------------------------------------------------
----------------
Observations                416                       416
392
R2                         0.343                     0.438
0.155
Adjusted R2                0.310                     0.373
0.110
F Statistic      10.318*** (df = 20; 395) 14.509*** (df = 20; 372)
3.407*** (df = 20; 371)
==============================================================================
================
Note:                                                          *p<0.1;
**p<0.05; ***p<0.01
```

Appendix 6.

Panzar-Rosse Within Estimator Summary results for the Baltic countries

	Dependent variable:		
	log(Net_Income_TOAS)		
	Estonia	Latvia	Lithuania
log(Int_Exp_TOAS)	0.436	-0.636	0.015
	(0.357)	(0.424)	(0.320)
Adm_Exp_TOAS	-45.165	-52.730	31.827
	(70.773)	(59.181)	(52.585)
log(Stuff_EXP_TOAS)	-1.912	1.160**	0.766
	(3.620)	(0.543)	(0.896)
log(Int_Exp_Fixed_Assets)	-0.179	0.190	-0.063
	(0.296)	(0.150)	(0.352)
log(Oper_Exp_TOAS)	-0.108	0.099	-0.299
	(0.231)	(0.212)	(0.282)
Deposits_Short_Term_Funding	-0.00000	-0.000	0.00000
	(0.00000)	(0.00000)	(0.00000)
ROAA	1.742*	0.148	0.754***
	(0.590)	(0.095)	(0.176)
log(Equity_TOAS)	-2.195	1.030*	0.184
	(1.560)	(0.561)	(0.630)

log(Int_Earn_Assets)	-0.561	0.462
2.146		
	(0.737)	(1.033)
(1.365)		
factor(Year)2006	-0.160	-1.793**
-2.854*		
	(0.436)	(0.735)
(1.196)		
factor(Year)2007	0.038	-1.843**
-3.421		
	(0.540)	(0.802)
(1.573)		
factor(Year)2008	-0.272	-1.558**
-2.019*		
	(0.602)	(0.746)
(0.847)		
factor(Year)2009		-1.592*
		(0.933)
factor(Year)2010	-1.532***	-1.951***
	(0.441)	(0.708)
factor(Year)2011	-0.502	-1.453**
-2.574		
	(0.475)	(0.705)
(1.429)		
factor(Year)2012	-1.176*	-1.768**
-0.788		
	(0.584)	(0.688)
(0.729)		
factor(Year)2013	-1.668**	-1.992**
-0.948		
	(0.721)	(0.800)
(0.848)		
factor(Year)2014	-1.935**	-1.608*
0.680		
	(0.780)	(0.827)
(0.812)		
factor(Year)2015	-2.258**	-1.934**
-0.486		
	(0.859)	(0.873)
(0.742)		
factor(Year)2016	-2.133**	-1.744**
-1.239		

```
                                  (0.927)                (0.838)
(0.972)

factor(Year)2017                 -2.086**               -1.642*
-1.075
                                  (0.984)                (0.828)
(1.189)

factor(Year)2018                 -1.990**               -1.837**
-1.097
                                  (0.946)                (0.842)
(1.267)

factor(Year)2019                 -1.813**               -1.668*
-1.146
                                  (0.861)                (0.902)
(1.428)

factor(Year)2020                 -2.002**               -1.936**
-1.112
                                  (0.871)                (0.900)
(1.612)

-------------------------------------------------------------------------
------------------
Observations                        56                     89
28
R2                                 0.788                  0.483
0.985
Adjusted R2                        0.552                  0.125
0.867
F Statistic                4.212*** (df = 23; 26) 2.024** (df = 24; 52)
9.086** (df = 22; 3)
=========================================================================
==================
Note:                                                        *p<0.1;
**p<0.05; ***p<0.01
```

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