Charles University

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

The Impact of Competition on Bank Performance

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Academic Year: **2016/2017**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, 15.5.2017

Signature

Acknowledgments

I would like to express my gratitude to prof. Ing. Oldřich Dědek CSc. for supervision of this thesis and providing me with suggestions and corrections of the content. Special thanks to my parents for their unlimited support.

Bibliographic Record

Kupka, P. (2017): "The impact of competition on bank performance." pgs. 71 Master's Thesis, *Charles University in Prague.*

Number of characters: 93,804

Abstract

This thesis studies the way in which basic bank characteristics differ with respect to level of the market competition. Under our hypotheses, banks operating in more competitive environment are associated with higher overall risk, improved loan portfolio quality and lower equity ratio. Estimation was carried out using difference GMM estimator with help of instrumental variables which provided us also with heteroskedasticity and autocorrelation robust standard errors. According to the recent literature, this estimator is very efficient for empirical research based on unbalanced panel data with short time period and wide range of cross-sectional data as those used in this thesis. By applying these methods, we obtained results confirming all three hypothesis with strong statistical significance. Therefore, we conclude that competition impacts bank risk profile.

JEL Classification	G21, G31, L16,
Keywords	bank competition, risk-taking, portfolio quality, equity ratio, financial stability

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Abstrakt

Tato práce studuje způsob jakým se mění základní bankovní vlastnosti s ohledem na úroveň tržní konkurence. Podle našich hypotéz jsou banky operující v konkurenčnějším prostředí spojeny s vyšším celkovým rizikem, lepší kvalitou portfolia půjček a nižším poměrem vlastního kapitálu. Pro odhadování byla použita metoda diferencí GMM s pomoci intrumentálních proměnných, která poskytuje i směrodatné odchylky v případě heteroskedasticity a autokorelace. Nejnovější literatura doporučuje právě tuto metodu v kombinaci s nevyváženými panelovými daty, která mají krátkou časovou dimenzi a široký reprezentativní průřez, tak jako je to v našem případě. Použitím těchto metod jsme získali výsledky, které se silnou statistickou jistotou potvrzují všechny tři naše hypotézy. Proto tedy docházíme k závěru, že konkurence má dopad na rizikovost bank.

Klasifikace JEL	G21, G31, L16,
Klíčová slova	bankovní konkurence, rizikovost, kvalita portfolia, poměr vlastního kapitálu, finanční stabilita

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Master's Thesis Proposal

Author	Bc. Petr Kupka
Supervisor	prof. Ing. Oldřich Dědek CSc.
Proposed topic	The Impact of Competition on Bank Performance

Motivation The impact of bank competition on their performance remains a widely debated issue. At present, researchers investigate either the competition-stability or the competition-fragility relationships. The two seemingly conflicting theories present ideas whether tougher competition in banking sector is beneficial or rather destructive for stability of banking market.

Under the traditional "competition-fragility" view, higher bank competition erodes market power, decreases profit margins, and results in reduced franchise value that encourages bank risk taking (e.g. Marcus 1984; Keeley 1990; Demsetz et al. 1996; Carletti and Hartmann 2003). Under the alternative "competition-stability" view, more market power in the loan market may result in greater bank risk as the higher interest rates charged to loan customers make it more difficult to repay loans and exacerbate moral hazard and adverse selection problems. But even if market power in the loan market results in riskier loan portfolios, the overall risks of banks may not necessarily if banks protect their franchise values by increasing their equity capital or engaging in other risk-mitigating techniques. Findings of Boyd and De Nicolo (2005); Boyd et al. (2006) and De Nicolo and Loukoianova (2006) are in support of the alternative "competition-stability" theory.

It will be interesting to explore these theories more deeply and test their validity. As Berger et al. states these theories need not to be excluding each other. Following the methods used by proponents of both these theories, this thesis should bring additional evidence and test the previous research findings.

Hypotheses

Hypothesis #1: Banks tend to take higher risks when operating in more competitive market.

Hypothesis #2: In loan market, concentration increases risk of bank portfolios.

Hypothesis #3: Banks with higher market power have higher equity capital ratios.

Methodology For carrying out the research there will be required variables expressing competition in banking market, stability of each individual bank, portfolio quality and other variables needed for assessing structural market differences.

As regards the first hypothesis, literature suggests to use HHI index for deposits as well as for loans and Lerner index to get the proxies for market competition. In terms of the stability, Z-index and equity to total assets ratio are commonly used (e.g. in Berger, Klapper, and Turk-Ariss, 2009 and Ariss, 2010). For expressing market competition in loans market, only HHI index for loans is applied and ratio of non-performing loans allows expressing risk of corresponding bank portfolio. By means of these variables, the second hypothesis can be tested. Finally, equity capital ratios are available directly from financial statements of each bank.

All the data needed are provided in Bankscope 2015 database or are available by Doing Business project. Data will be processed in Stata 12 software.

Expected Contribution This thesis should bring new evidence of bank performance under different levels of competition. As it was already described, literature provides no consensus regarding this topic. Therefore, following the methods applied by proponents of both competition-stability and competition-fragility views on one dataset, this work could contribute to the resolution. Moreover, it is likely that different types of banks will provide different results. I will divide my findings into three categories: investment, commercial and retail banking as the differences might be important for suggesting appropriate policy.

Outline

1. Motivation: Readers will be introduced into the topic as well as importance of this topic will be explained to them.

2. Literature Review: I will state relevant literature in the two seemingly conflicting theories of "competition-stability" and "competition-fragility". Moreover, there will be literature describing the impact of competition on bank performance as well.

3. Data: There will be a description of databases, assumptions and approaches applied to the data which are to be used for the research.

4. Methods: I will explain various methods for measuring competition in banking sector as well as measures for loan portfolio and chosen bank characteristics e.g. size, equity capital ratios and liquidity ratios.

5. Results: I will present the effect of market power on bank characteristics and portfolio measures.

6. Concluding remarks: I will summarize my findings, discuss them and find implications for policy.

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Chapter 1

Introduction

During last two decades, there is a growing interest in exploring the link between competition and stability both theoretically and empirically. Originally, banking supervision stuck to the principle that excessive competition can endanger solvency of some big and important market participants and, therefore, worsen stability of entire financial system. Increase of competition by deregulation or removal of entry barriers allow more banks to operate, while offering larger scale of products at the same time which, according to Keeley (1990), should decrease their franchise value. Banks are then more prone to take the risks in attempt to keep former profits. Carrying more risk, e.g. by investing into riskier assets or taking higher leverage, certainly undermines individual bank's stability and increases possibility of bank's default which, in macroeconomic perspective, makes such banking environment less stable. In more concentrated markets, banks may protect their franchise value with pursuing safer strategies making the entire system more stable. This theory, in literature commonly referred as competition-fragility view, basically argues that more concentrated banking systems are less likely to suffer from market failure. Many theoretical papers and empirical evidence supporting this view (e.g. Marcus, 1984; Keeley, 1990; Demsetz *et al.*, 1996; Carletti & Hartmann, 2002) were published.

Alternatively, competition-stability view proposed by Boyd & De Nicolo (2005) is based on idea that banks operating in less competitive environment are allowed to charge higher interest rates which makes their customers, both businesses and individuals, harder to repay the loans. As a consequence, banks' loan portfolios embody more non-performing loans and ends up being more risky. This credit risk arising from borrowers' moral hazard deteriorates banking sta-

bility. Authors proposed risk-shifting paradigm which claims that stronger competition in the loan and deposit markets fortifies market stability through mitigated credit risk of borrowers. Findings of Boyd & De Nicolo (2005), Boyd *et al.* (2006) and De Nicolò & Loukoianova (2007) are in support of the competition-stability view confirming that bank risk-taking is associated with higher concentration in the banking market. Recently, Martinez-Miera & Repullo (2010) introduced model allowing the relationship between competition and stability to be U-shaped. This model unifies risk-shifting effect proposed by Boyd & De Nicolo (2005) and franchise value theory introduced by Keeley (1990). Therefore, market that is too competitive as well as too concentrated may hinder banking market stability which was already supported by results of Liu *et al.* (2013).

Market competition is, of course, not the only determinant of stability in financial markets. Apart from competition, mainly macroeconomic conditions as well as governmental interventions are, according to the literature, among the sources of financial markets' troubles. Above all, inflationary explosion, strong deterioration in trade, rapid expansion of credit, currency shocks and high lending provided by central bank or government are considered to be factors, often observable in emerging or transformation economies, making fragile banks more likely to fail. In order to examine the soundness of an individual banks, regulators of the US use CAMELS system, a monitoring system used for bank scoring based on capital adequacy, asset quality, management capabilities, earnings, liquidity and sensitivity. Therefore, these characteristics are perceived to be efficient in signalling of which banks are prone to be hit by a crisis fatally. Nevertheless, financial market competition is undoubtedly to be mentioned aside of all determinants of the financial markets' stability.

The objective of this thesis is to examine the competition and stability relationship by employing multiple competition measures. As both views are supported by numerous findings and seem to be theoretically correct, there may be no simple solution to this topic which would unify these two conflicting views. Moreover, literature based on cross-sectional analysis often came to different conclusions than papers using panel data. Therefore, our results based on panel data might be substantially different from those derived from other type of data. Using the data provided by Orbis Bank Focus database, this thesis tests whether banks tend to take higher risks when operating in more competitive markets, whether higher market power is associated with riskier loan portfolios and whether banks present in less competitive markets tend to keep higher

equity ratios. All these hypotheses are supported by the literature, however, as there is no consensus on this topic, opposing literature can be found as well. In this thesis, the methodology is described in detail as the literature shows that the methodology choice determines greatly results of the analysis. The main goal is to explore how banking market reacts to the change in competition. Presented results are also divided per specialization which banks predominantly operate in. Therefore, it may help to decide, whether competition should be changed by means of further deregulation and liberalization when pursuing certain banking market feature (e.g. stability or efficiency) and what potential side effects such policy may have on other characteristics of the banking sector.

This thesis starts with literature review, Chapter 2, which consists of theoretical and empirical literature. Then, methodology of this thesis is presented, Chapter 3, where our research questions, estimation methodology, competition measures and other variables are introduced. This is followed by the Chapter 4 which describes data applied in empirical part of the thesis. Chapter 5 states our estimation results and discussion of the findings with respect to recent literature. This chapter is also enlarged of an additional analysis. Finally, conclusion part, Chapter 6, summarizes the main points and findings of this thesis.

Chapter 2

Literature Review

2.1 Theoretical Literature

Recently, Berger *et al.* (2009) summarized the two contradicting views on whether and how bank competition influences bank stability. In the theoretical literature, the competition-fragility view has long been prevailing. It is supported by the franchise value paradigm which is based on the idea that banks take limited risks to receive secure and stable rents in return for their services. In the environments with higher competition, these rents are being split among more banks. In order to maintain the previous rents, banks tend to undertake more risky investment which brings them the desirable level of rents. However, the overall risk taken by banks is greater which leads to greater financial instability. Marcus (1984) was among the earliest in this literature. One-period model presented by the author shows how franchise value decreases once banks chose to undertake riskier investments. Chan *et al.* (1986) supported the franchise value paradigm by presenting that increased competition reduces banks' surplus from identifying prime borrowers which is the reason for lending portfolio deterioration. The two period model used by Keeley (1990) explains clearly that decrease in franchise value leads to greater risk-taking behaviour. Theoretical work by Besanko *et al.* (1993) shows that stronger competition erodes also the informational rents arisen from relationship banking, therefore, risk-taking incentives are strengthened.

Suarez (1994) used dynamic model with infinite periods to show the trade-off between financial distress and market power. He argues that once market power decreases, e.g. as a result of increased competition, banks largely engage in riskier policies. Similarly, Matutes & Vives (2000) explore the way

banks' market power affects risk-taking with main focus on the deposit market. They assumed that banks are of limited liability and the costs of potential failure are often socialized which means that management and owners are hit by the consequences of the failure only in limited manner. Considering this, they supported this view with the intuitive argument that once rents decrease the buffer, originated from accumulated profits, protection of the bank against shocks is reduced. As a result, competition enhances bank's fragility. Hellmann *et al.* (2000) developed a dynamic model of moral hazard based on which they argue that competition can cause banks to act less prudently. They express belief that capital requirements do not sufficiently reduce impacts of bankers' gambling. Hence, they recommend deposit rate controls to be added as an regulatory measure. However, results of dynamic model of imperfect competition, developed by Repullo (2004), show that risk-based capital requirements work effectively. This means that even if bankers change their preference towards risks, e.g. as a result of increased competition, equity ratios based on risk-weighted asset of banks control the risk-shifting incentives well enough.

Alternatively to these papers, the competition-stability literature supports the idea that increased market power of banks erodes bank stability. Boyd & De Nicolo (2005) presented a model according to which banks with higher market power tend to use it for both increasing the borrowing rates as well as decreasing the rates on deposits. Therefore, it might be more difficult for borrowers to repay the loans which makes the loan portfolio more risky. In a moral hazard environment assumed by Stiglitz & Weiss (1981), investors who need to repay higher interests tend to consider projects with higher returns which are, however, associated with more risk. Such translation would lead to more defaults of such projects, therefore, in higher risk of failure for banks.

Paper presented by Caminal & Matutes (2002) focuses on connection of market power and risk of bank failures. It takes into account that competition makes banks to invest in monitoring systems allowing them to reduce information asymmetries problems. They were able to confirm both competition-fragility as well as competition-stability views. On the one hand, higher market power provides more monitoring incentives, as presented by Chan *et al.* (1986). Boyd & De Nicolo (2005) support this with argument that market power leads to higher loan rates which translate in riskier loans provided. According to the authors, the direction of the relationship depends on monitoring costs banks have to spend.

Martinez-Miera & Repullo (2010) amended model presented by Boyd &

De Nicolo (2005) of assumption of imperfect correlation among borrowers. The hypothesis is based on following thoughts. If more competitive environment makes banks to reduce interest margins, these banks receive less interest payments, thus, banks' profits are reduced. Accumulated excessive profits may serve as a buffer against negative shocks which make the bank more resilient. Therefore, neither excessive market power nor strong competition seem to enhance bank stability. The authors presented model with U-shape relationship between bank competition and risk of bank failure which unifies these seemingly contradicting views and represents the balance between these two forces.

2.2 Empirical Literature

There were many empirical researches examining the competition and stability relationship in banking industry. In the empirical part, Keeley (1990) used Tobin's q as a measure of bank's market power which shows higher values in less competitive markets. To examine the key relationship he estimated the effect of q on banks' default risk being considered as inverse proxy for market bank's stability. He found that banks possessing greater market power were less likely to default based on data from US over the period between 1970 and 1986. This study provides empirical evidence in favour of the competition–fragility hypothesis. There is one more important information in this paper, Keeley (1990) finds that more powerful banks operate with more equity relative to assets. The explanation can be that large banks were perceived as more reliable, with lower risk premiums on uninsured certificates of deposit, that's why they were equipped with more capital 'buffer' against eventual financial distress.

US and Canadian banking systems were compared in Bordo *et al.* (1993). After analyzing data for period between 1920 and 1980, authors concluded that Canadian banks are less likely to fail than US ones as the Canadian banking industry is more concentrated. In fact, authors considered the Canadian banking market an oligopoly at that time. However, this study uses simple number of firms in the market to compare the market concentration which may not be a reliable indicator.

Another support for the competition-fragility hypothesis was brought by Demsetz *et al.* (1996). They examined the relationship of franchise value, indicator of market power as franchise value refers to discounted expected future profits, and the risk-taking behaviour. Applying Tobin's q on US banks' data for period from 1986 to 1994, they found that banks of high franchise value hold

more capital relative to assets and operate with less risky portfolios leading to lower levels of overall risk. Also, negative relationship between franchise value and systemic risk related to the banking sector as whole was observed to be negative.

Brewer & Saidenberg (1996) examine relationship between portfolio risk and the franchise value. The risk carried by a bank was measured by standard deviation of its own stock, i.e. the more risk associated with a bank the higher volatility of its stock was, and the actual price of bank's stock as it expresses the discounted future profits equivalent to the franchise value. There was found negative relationship among assets risk and franchise value. However, Jayaratne & Strahan (1998) states that after US government allowed banks to expand geographically and banks could set up their branches statewide, bank performance improved significantly with portion of non-performing loans going down sharply. Therefore, more competitive market had opposite effect on the franchise value than previous study concluded. Hannan & Prager (1998) examined the effects on deposit interest rates and banks' profitability as a result of lowering the legal barriers to enter the regional banking markets in late 1980s and early 1990s. Authors concluded that higher competition, resulting from liberalization of interstate branching and operations, is connected to the lower profits earned by the banks and possible growth of loan losses. Moreover, Hellmann *et al.* (2000) show that after financial market liberalization in Japan during 1990s, the competition increased the banks' profitability and the franchise value of banks based domestically declined. The authors also express belief that this fact contributed to the East Asian crises and to the weakening of the Japanese financial system. In contrast to Jayaratne & Strahan (1998), eight years later Dick (2006) shows a positive and significant relationship between branching deregulation and increased rate of loan losses resulting from the Riegle-Neal Act effective in US since 1994.

Staikouras & Wood (2000) compared the Greek and Spanish banking systems in terms of structure, inflation, output fluctuations and profitability for data from 1980s and 1990s. Based on standard measures of market concentration, they inferred that Spanish bank system was less concentrated but more profitable and stable than the Greek one. Thus, they provide certain evidence for competition stability hypothesis. Beck *et al.* (2006) support this hypothesis with their cross-country analysis of 69 countries between 1980 and 1997. They examined relationship between bank concentration ratio, based on total share of the top three largest banks in terms of assets. They show that more

concentrated banking systems are less likely to get in systemic crisis, however, they do not explain the channels through which the competition impacts the stability.

According to Claessens & Laeven (2004), higher bank concentration, measured as a total share of the largest five banks, leads to more intensive competition captured by the H-statistic introduced by Panzar & Rosse (1987). Despite the significance of original positive relationship, robustness analysis results showed that this relationship can be insignificant, thus, concentration measures may not be appropriate way of expressing the competition in banking industry.

Schaeck *et al.* (2006) applied quite different methods in exploring the competition and stability relationship. First, they decided to use the Panzar-Rosse's H-statistic for measuring of banking market competition. Second, they employed logit model and duration analysis which is based on idea that the more stable systems work longer without crises. Using panel data from 38 countries collected for period from 1980 to 2003, they concluded that more competitive markets experience crises less often and the survival of such banking systems is longer.

Different sample was used by Boyd *et al.* (2006) to examine the interconnection between competition and financial fragility. Despite the fact that the sample used consists of two subsets, cross-sectional observations of 2,500 US banks from year 2004 and panel data records of 2,600 in years from 1993 to 2004, the results were consistent for both subsets. It was found positive relationship between concentration, measured by standard concentration measures, and the risk-taking behaviour of a bank. Banks present in markets with higher competition, expressed by the Herfindahl-Hirschmann index, turned out to be taking less risk, thus, were less likely to go bankrupt. The risk associated with a particular bank was measured by the inverse Z-index.

Based on panel data of 10,000 bank-year observations for 133 countries from period over years 1993-2004, De Nicolò & Loukoianova (2007) show that relationship between concentration and likelihood of bank failure observed by Boyd *et al.* (2006) is even stronger when controlling for ownership structure and correcting for state-owned banks with dominant market position. Authors also found that risk profiles of foreign privately owned banks are higher than comparable domestically based state-owned banks.

Additional support of competition-stability theory brings Jiménez *et al.* (2007). Similarly to Boyd *et al.* (2006), they measured both market concentra-

tion and competition, however, instead of Herfindahl-Hirschmann index, Lerner index was applied. Banks' distress, or rather banks' risk-taking behavior, was captured by ratio of non-performing loans to total loan commonly referred as NPL ratio. Based on Spanish banks' data for period 1988-2003, they found that NPL ratio does not depend on standard concentration ratios, nevertheless, there was found a negative dependence between competition and banks' risk-taking. Thus, the more market power bank possesses, the lower rate of non-performing loans it has in its portfolio.

Interesting findings were brought by Yeyati & Micco (2007). They analyze Latin American banking market during 1990s, the period of accelerated concentration and foreign penetrations. Using the Panzar-Rosse's H-statistic for measuring the market competition, the authors concluded that increased concentration did not weaken the competition. Also, it was found that industry competition was negatively associated with bank risk. Moreover, there was observed a positive link between foreign penetration and banking sector stability.

Berger *et al.* (2009) shows that different methods applied in carrying out a research can lead to different results. In their study, Lerner index and Herfindahl-Hirschmann index were used for measuring market competition while banks' risk aversion was expressed by NPL ratio and Z-index. By examination of 8,235 banks from 23 countries they reached to conflicting findings supporting both competition-stability and competition-fragility views.

The effect of entry barriers removal and deregulation of financial services on competition and efficiency in the European Union banking market examine Casu & Girardone (2009). The regulatory changes boosted consolidation trend which did not necessarily cause increase in market competition and banks' efficiency. Employing both standard concentration ratios and Panzar-Rosse H-statistic on data from mayor EU banking markets over the period from 1997 to 2003, authors show that concentration may not affect level of competition and that there is little evidence that more efficient bank systems are the more competitive ones.

Additionally, Ariss (2010) examines how higher degree of market power impacts bank efficiency and stability in emerging countries. Based on data from 821 banks in 60 countries over the period from 1999 to 2005, the results suggest that increase in market power brings higher stability in banking system and increased profitability. There were, however, observed significant cost inefficiencies. The author states that stressed banking systems in developing

economies may be helped by allowing them to consolidate, thus, he clearly supports competition fragility view.

Liu *et al.* (2013) present findings consistent with the theory published by Martinez-Miera & Repullo (2010) which supports U-shape relationship between risk and competition. The authors applied Z-index measure of overall risk and Lerner index to capture the market power of individual banks. Based on data of 10 European countries in the period 2000-2008 and controlling for bank specific and regional specific variables, a non-linear relationship between bank competition and stability was found. Therefore, in relatively competitive markets, the further increase of competition contributes to market fragility, whereas markets with lack of competition are expected to be more stable when competition strengthens.

Fungáčová & Weill (2013) focused on bank failures in Russia over the period from 2001 to 2007. Their dependent variable was a dummy variable of bank failure, equal to one if a bank license was revoked in one case and when equity ratio was less than 10 % in other case. Thus, logit model was used. Capturing the competition by Lerner index, they found that more intensive competition in the market contributes to undermining of the financial stability, hence, evidence supporting competition-fragility view.

Empirical results support both competition-stability and competition-fragility views. As Carletti & Hartmann (2002) point out, this literature can be divided into four groups: the first group uses regression of bank risk measure on bank market power measure, the second type assesses influence of mergers or banks of higher size on potential diversification and risk reduction effects, the third type of literature employs cross-sectional samples from countries with different competition to discuss the efficiency and risk in banking industry and finally fourth group uses bank stock return correlations to express systemic risk while linking it to the market concentration.

Of course, competition is not the only determinant of banking stability. For example Caprio & Honohan (1999), paper exploring predispositions to financial sector difficulties in emerging markets, divides causes of banking problems in volatility of the banking environment and degree of political interference in bank regulation. The environment volatility is understood as macroeconomic fluctuations and frequency of regime changes. Apart from macroeconomic shocks, González-Hermosillo *et al.* (1997) mentions rapid growth of credit and contagion effects among factors making fragile banks more likely to fail, therefore, effects which undermine financial sector stability. Rapid credit growth is

suggested to be an indicator of financial markets troubles also by Hausmann & Gavin (1995) and Sachs *et al.* (1996). Kunt & Detragiache (1999) attempts to construct a reliable system for monitoring banking sector fragility. In this study, currency collapse, inflationary explosion and strong trade deterioration are considered to be elements contributing to overall fragility. Honohan (2000) divides indicators of a financial system fragility systematically into three groups based on the source of crisis. Distress coming from macroeconomic problems is linked with high loan-to-deposit ratios in home or foreign currency and again high growth rates of credit. Crises arising from government interventions are associated with increased government borrowing and lending provided by central bank to the banking system. However, no abnormal behavior was found to be corresponding with third type origin of crises which is microeconomic pressure. Finally, various bank characteristics are examined in Rojas-Suarez & Weisbrod (1998) with a view to finding indicators representing distress in banking sector. This paper suggests that deposit interest rate, interest rate spread between lending and deposits, growth of credit and inter-bank debt provide better signals of bank strengths then CAMELS system. This is a monitoring system used for bank scoring based on capital adequacy, asset quality, management capabilities, earnings, liquidity and sensitivity applied by regulators of the US.

Chapter 3

Methodology

3.1 Research Questions

In this section, the logic of our hypotheses and their intuition are explained. They aim to describe the way banks adapt to increased competition. All three hypotheses arise either from competition-stability or competition-fragility views, hence, there are theories and empirical evidence both supporting and disproving them as presented in Sections 2.1 and 2.2.

Is Competition a Source of Banking Fragility?

The first hypothesis is based on the idea that under the conditions of increased competition, management finds harder to deliver preset profits. In order to earn the promised profits, management may tend to undertake an investments carrying higher profits but also higher risks which increases the risk profile of a bank and ,therefore, also probability of its failure. A highly competitive sector might be relatively richer in such banks which makes it less stable. Following this logic, banks operating in sectors with higher competition are associated with higher risk profiles and make the sector less stable which is in line with the competition-fragility theory and formulates our first hypothesis.

Does Competition Reduce Loan Portfolio Risk?

The second hypothesis specifies the relationship between loan portfolio risk and competition. In general, one of the ways companies can compete is in terms of price. In the banking environment, this could be translated into interest rate competition. In short, banks operating in the environment of higher compe-

tition tend to set the interest rate on loans under the interest rate offered by their competitors. In contrast to that, there are banks which do not have to compete hard may remain the loan interest rates relatively higher. According to the competition-stability theory, businesses financed through such uncompetitive banking sector may be more likely to default due to the additional interest rates costs. As the risk of the loan portfolio is derived from the risk profile of the businesses these loans were provided to, lack of competition influences, through the interest rate, the risk of loan portfolio. Therefore, under the second hypothesis the lower competition results in higher loan portfolio risk.

Do Banks with Market Power Have Higher Equity Ratios?

Under the third hypothesis, banks present in less competitive markets have higher equity ratio. The intuition behind stems from franchise value theory. Banks operating with certain market power are able to use this power to price their products higher or avoid risky investments. Either they earn extraordinary profit or they are of safer risk profile. The result of both ways is higher share value and lower costs of equity financing. At the same time, as these banks do not need to compete with others, they do not need to operate with additional risk arising from increased leverage which would increase their profits. Having no risk in losing customers, they might simply set their prices higher without increasing the risk excessively.

3.2 Competition Measures

Lerner Index

Lerner index is the most known and used competition measure of those applied in this thesis. It was introduced by Lerner (1934) as a way to express market power of a monopolist. If market power is present, firm is able to price its production above the marginal costs. This logic was translated also to other market structures where perfect competition and pure monopoly serve rather as a benchmarks. Most market structures fit between these two extremes, thus, firms operating in such markets possess at least some market power. In general, it is assumed that a firm enjoys less market power with increasing competitiveness in the market. Regarding its application, market competition

of any industry type can be captured by Lerner index as it expresses percentage markup.

To express deposits market competition, approach developed by Iwata (1974) and Appelbaum (1982) was used. In this setting, bank b sets the combination of price charged p_b and quantity produced q_b to maximize profits based on its cost structure and overall level of competition in the market. Banks in the industry solve

$$\max_{q_b} \Pi_b = p(Q, z) - c(q_b, w_b),$$

where $p(\ )$ is inverse demand function, $\sum_b q_b = Q$ is industry output, z is vector of exogenous variables influencing demand, $c(\ )$ is a cost function and w_b is an input price vector. From the first order condition we get

$$p_b = c'(q_b, w_b) - \frac{\Theta_b}{\epsilon}, \tag{3.1}$$

where $\Theta_b = \frac{\partial Q/\partial q_b}{Q/q_b}$ refers to conjectural elasticity of industry output with respect to the bank's b output and $\epsilon = \frac{\partial Q/\partial p}{Q/p}$ is price elasticity of demand. Then $L \equiv -\Theta_b/\epsilon$ is the Lerner index. Angelini & Cetorelli (2003) applied following specification on production technology of three inputs (deposits, capital and labour) using trans-log specification for the cost function.

$$\begin{aligned} \ln(c_b) = {} & c_0 + s_0 \ln(q_b) + \frac{s_1}{2} \ln^2(q_b) + \sum_{i=1}^{3} c_i \ln(w_{ib}) + \ln(q_b) \sum_{i=1}^{3} s_{i+1} \ln(w_{ib}) \\ & + c_4 \ln(w_{1b}) \ln(w_{2b}) + c_5 \ln(w_{1b}) \ln(w_{3b}) + c_6 \ln(w_{2b}) \ln(w_{3b}) \\ & + \sum_{i=1}^{3} c_{i+6} \ln^2(w_{ib}) + \sum_{d} c_d \, dummy_d \end{aligned} \tag{3.2}$$

The dummy variable is a zero-one type and allows us to control for potential market power heterogeneity as we strive for results varying by bank's specialization and country of bank's origin.

To be able to estimate the Equation 3.1 we express it in the following way:

$$p_b = \frac{c_b}{q_b} \left(s_0 + s_1 \ln q_b + \sum_{i=1}^{3} s_{i+1} \ln w_{ib} \right) + \sum_{d} \lambda_d \, dummy_d, \tag{3.3}$$

where we get the marginal cost being the first expression on the right-hand side and λ_d represents the average estimated value for particular group. Equations 3.2 and 3.3 are estimated simultaneously through 3SLS to address the possible correlation of unobserved error with the explanatory variables, where p_b and

$\ln(c_b)$ are considered endogenous variables and all the explanatory variables are used as instruments.

Panzar-Rosse's H-statistic

Very general test for market power is implied by Panzar-Rosse model featured by Panzar & Rosse (1987). It is based on idea that every change in input prices is followed by quick and significant movement of the same direction in prices of products and services provided in strongly competitive market. In case of the opposite market benchmark, monopoly, there is low, if any, output prices response to the input price changes as monopolist is not forced to and does not risk loss of market share. Of course, we can expect that the input-output prices response, measured by H-statistic, will result to be between zero and one as both perfect competition and monopoly are rare market structures.

In banking environment, the Panzar-Rosse model was applied by Bikker *et al.* (2012) on unbalanced panel data taken from Bankscope database, predecessor of Orbis Bank Focus database. As we use similar data from the same database it may be useful to follow the literature most utilized model specification of those presented in Bikker *et al.* (2012). Thus, our Panzar-Rosse model specification is:

$$\ln(TR/TA) = \alpha + \sum_{i=1}^{n} \beta_i \ln w_i + \sum_j \gamma \ln CF_j + \delta \ln TA + \epsilon, \tag{3.4}$$

where TR is total revenue, w_i the $i-$th input factor price, CF the other firm-specific control factors, and TA stands for total assets. Rosse & Panzar (1977) shows that the competitive structure of the market is reflected by the sum of input price elasticities:

$$H = \sum_{i=1}^{n} \beta_i \tag{3.5}$$

In banking industry, this specification was used also by Molyneux *et al.* (1994), Bikker *et al.* (1998), Bikker & Haaf (2002), Claessens & Laeven (2004) and Schaeck *et al.* (2006). Accounting for bank's size by including the total assets variable is considered as strong improvement compared to the original model. When estimating this model, OLS regression was applied. Bikker *et al.* (2012) suggests applying FGLS to deal with heteroskedasticity. However, as unbiased estimates of the Panzar-Rosse's H-statistic is sufficient for our purposes, there are no further steps undertaken for addressing its statistical significance. The

fact that the regression coefficients, our Panzar-Rosse's H-statistic is composed of, are unbiased was checked by Durbin-Wu-Hausman test for endogeneity.

Boone Competition Measure

Idea behind Boone's model is that more efficient firms, meaning those operating with lower marginal costs, can either invest more resources to get higher market share or can get the share by lowering their prices. This dependence is stronger the more competitive pressure is present in the market. This competition measure developed by Boone (2008) puts no more requirements on data than price costs margin models and seems to be theoretically correct at the same time. In our specification, inspired by Van Leuvensteijn *et al.* (2011), we assume a banking industry where bank i produces a portfolio of products q_i, competes in Cournot style, faces a linear demand curve,

$$p(q_i, q_{j\neq i}) = a - bq_i - d\sum_{j\neq i} q_j, \tag{3.6}$$

has constant marginal costs mc_i and maximizes profits $\Pi_i = (p_i - mc_i)q_i$ where the choice variable is q_i and we assume both $a > mc_i$, $0 < d \leq b$. From the first-order condition for Nash equilibrium in the Cournot competition we get

$$a - 2bq_i - d\sum_{i\neq j} q_j - mc_i = 0. \tag{3.7}$$

If $q_i > 0$ for all of the N banks then

$$q_i(c_i) = \frac{(2b/d-1)a - (2b/d+N-1)mc_i + \sum_j mc_j}{(2b+d(N-1))(2b/d-1)}. \tag{3.8}$$

In this market, competition is higher when the services produced by various banks are closer substitutes, d increases, or when costs required to enter the market decreases. Boone *et al.* (2004) proved the model intuition that more efficient banks' shares increase when either service substitution is stronger or entrance costs are lower. Thus, we es following relationship:

$$\ln(s_i) = \alpha + \beta \ln(mc_i), \tag{3.9}$$

where $s_i = p_i q_i / \sum_j p_j q_j$ is the market share of bank i so we expect β, referred as Boone indicator, to be negative. As marginal costs are again unobservable,

we use translog cost function (TCF), based on Van Leuvensteijn *et al.* (2011), of the following form:

$$\begin{aligned}\ln(c_{it}^h) = \alpha_0 + \sum_{h=1}^{H-1} \alpha_h d_i^h + \sum_{t=1}^{T-1} \delta_t d_t \\ + \sum_{h=1}^{H} \sum_{j=1}^{K} \beta_{jh} \ln(x_{ijt}) d_i^h \\ + \sum_{h=1}^{H} \sum_{j=1}^{K} \sum_{k=1}^{K} \gamma_{jkh} \ln(x_{ijt}) \ln(x_{ikt}) d_i^h + v_{it},\end{aligned} \tag{3.10}$$

where costs c_{it}^h refer to particular bank i in year t of type h. There is a commercial, cooperative, investment, mortgage, saving and asset management & private banking type of a banks. Indexed variables d are dummy variables allowing us to distinguish between bank types and time periods. The explanatory variables x_{ikt} represent three groups of variables: bank output component K_1 (e.g. loans, securities and other services), input prices K_2 (e.g. wage rates, deposit rates and other expenses) and control variables $K - K_1 - K_2$ such as equity ratio. Out parameters α^h, β_{jh} and γ_{jkh} vary with bank type h. They weren't set restricting conditions as in Van Leuvensteijn *et al.* (2011) such as homogeneity in the input prices and cost-exhaustion. Continuing with this cost function, linear in input prices, marginal costs of output for bank i of type h in year t are

$$\begin{aligned}mc_{ilt}^h = \frac{\partial c_{it}^h}{\partial x_{it}} = \frac{c_{it}^h}{x_{it}} \frac{\partial \ln(c_{it}^h)}{\partial \ln(x_{it})} \\ = \frac{c_{it}^h}{x_{it}} \left(\beta_{1h} + 2\gamma_{1lh} \ln(x_{ilt}) + \sum_{k=1, k\neq l}^{K} \ln(x_{ikt}) \right) d_i^h.\end{aligned} \tag{3.11}$$

The procedure for obtaining the marginal costs is as follows. In first step, it was obtained the regression coefficients from the regression, under the log-log specification, of the total costs on all the inputs, outputs, control and dummy variables as it is in Equation 3.10. Then, the coefficients were applied in Equation 3.11 together again with the explanatory variables from the TCF Equation 3.10 to express the marginal costs. These, together with market share of each individual bank, were used in regression with following equation:

$$\ln(s_{ilt}) = \alpha + \sum_{t=1}^{T} \beta_t d_t \ln(mc_{ilt}) + \sum_{t=1}^{T} \gamma_t d_t + u_{ilt}, \tag{3.12}$$

where (s_{ilt} expresses market share constructed based on total assets, proxy for bank's output. As suggested by Van Leuvensteijn *et al.* (2011), this regression was estimated with 2SLS estimator where one year lagged marginal costs were used as instrumental variables. As well as in case of previous competition measures, the statistical significance of the estimates is for purposes of this thesis not important, therefore, the question of heteroskedasticity is not addressed.

3.3 Bank Performance Indicators

Overall Risk

There are more way how to express financial stability of a bank. For example, Berger *et al.* (2009) used ratio of non-performing loans to total loans (NPL), as higher ratio indicates higher credit risk of in bank's portfolio, equity to total assets ratio (E/TA) expressing a capital 'buffer' bank has against accumulated losses, and Z-score. According to Beck (2008), NPL ratio expresses credit risk, however, does not capture entire financial distress measured bank is under. Also, E/TA ratio does not individually explain likelihood of bank's failure. It is rather a measure of capital held as a protection against financial distress, but it does not express relative strengths of the financial distress and the capital protection. Many authors (e.g. Boyd *et al.*, 2006; Hesse & Cihak, 2007; Lepetit *et al.*, 2008) used the Z-score measure:

$$Z_{it} = \frac{ROA_{it} + E_{it}/TA_{it}}{\sigma_{ROA_{it}}}, \tag{3.13}$$

where bank i in year t has return on assets rate ROA_{it}, equity to total assets ratio E_{it}/TA_{it} and return on assets standard deviation $\sigma_{ROA_{it}}$. Z_{it} expresses how many standard deviations in returns is a bank i away from going bankrupt. Therefore, the higher the Z-score the further bank i is from bankruptcy and the more stable the bank is. This commonly used measure unfortunately turned out as not very suitable for this thesis as we have only limited time period data available which is crucial for computation of reliable estimate of return on assets standard deviation $\sigma_{ROA_{it}}$. Alternatively, risk weighted asset (RWA), which was introduced by Basel I (1998) in order to strengthen the stability of the international banking system, and thus eliminate the differences in national capital requirements, reflects risk exposure of a bank as well. According to the

Le Leslé & Avramova (2012), the RWA provides a common measure for bank's risks, ensures that the capital allocated to assets corresponds to the risks and also can potentially signalize where the destabilizing asset class bubbles are emerging . It divides both on and off bank's balance sheet assets into certain categories according to its credit risk. These categories are assigned with a weights which express proportion of the category with respect to total assets. Furthermore, these credit risk weighted assets are complemented by multiplying factor representing the operational and market risk as described in Basel III (2010). Risk density (RD)

$$RD_{it} = \frac{RWA_{it}}{TA_{it}} \tag{3.14}$$

expresses risk exposure intensity of a bank as applied in Le Leslé & Avramova (2012) and discussed in Ferri & Pesic (2016). Therefore, RD is considered to be reflecting banks' risk profile reliably.

Loan Portfolio Risk

As it was already mentioned, the ratio of non-performing loans (NPL) to total amount of money lent out

$$NPL\ ratio_{it} = \frac{defaulted\ loans_{it}}{total\ loans_{it}} \tag{3.15}$$

expresses credit risk of bank's portfolio. This ratio was used by Jiménez *et al.* (2007) and Berger *et al.* (2009) as it is very simple measure of a bank's loan portfolio quality. Of course, every bank strives for managing their portfolio with low NPL ratio as unexpectedly many defaulted loans affect its profits and may lead to bank's bankruptcy. However, having portfolio with NPL ratio close to zero raises question of whether such a bank lent out all money it had available to loans. In other words, focusing too much on its customer quality may increase opportunity cost of not lending to customers who would repay the loan. Thus, optimal NPL ratio maximizes bank's net interest income.

Equity Ratio

There are many performance indicators which could have been included in our analysis of competition influence. Equity ratio (E/TA), known as one of the solvency ratios, can be interpreted in multiple ways. It measures the amount of assets that is financed by owner's investments and reflects the ability of the

company to repay its obligations and sustain its operations in the long-term. The equity ratio can be interpreted also as the bank's ability to absorb a reasonable amount of loss arising from unexpected risks. The higher the equity ratio, the better ability of the bank to withstand negative shocks. Moreover, excessively high E/TA can mean under-utilization of financial leverage as additional debt carried could increase bank's profits. It can also be a good indicator for analysts, as higher funding from the owner's represents their believe in company's performance and that its future returns overcome alternative investments which may carry less risk. Furthermore, the ratio might be used as an indicator of the autonomy in making investments, as companies with more debt will be required to fulfill certain debt covenants set by creditors which would limit the way they operate their business.

3.4 Control Variables

As we always intend to explore inter-dependencies among a pair of variables, there are certain bank specific and country specific variables to be added. These variables are supposed to explain part of the variation in the dependent variable. Otherwise, this explanatory power could be incorrectly ascribed to the main explanatory variable which would let to overstating its significance and misleading conclusions.

Bank Specific Variables

There are three variables added in order to describe banks' size, funding structure and profitability closer, one variable per each characteristic. These proxies are total assets, equity ratio, both used as bank specific variables in Bikker *et al.* (2012), and return on average assets ratio (ROAA) which relates net income to the assets this income was generated from. Moreover, banks are divided into six groups, as described in detail in Section 4, based on their specialization: commercial banks, savings banks, cooperative banks, real estate and mortgage banks, private banking and asset management companies and investment banks. This classification, together with the information of size, funding structure and profitability, provides certainly sufficient bank specification for the purposes of our regressions.

Country Specific Variables

In addition to the bank specific variables, country specific variables are needed to mitigate the risk of correlated omitted variables. As written in Section 2.2, financial market instability is likely to arise from volatility of the economic environment such as production or trade shocks, accelerated credit expansion or inflation. As competition is the only condition of the environment we are interested in, following macroeconomic proxies were added to control for differences in country characteristics: GDP growth, used e.g. also in Agoraki *et al.* (2011), Hassan *et al.* (2011) or Lee & Hsieh (2013), and inflation (Cihák *et al.* 2006). Furthermore, according to Karolyi *et al.* (2012), a measure of trade to GDP is added to represent the global integration. Finally, ratio of private credit divided to GDP is used as a proxy for credit expansion (Beck *et al.* 2010).

3.5 Models

In this section, specifics of our models, used for setting the key relationships of our hypotheses, are presented as well as estimation methods applied for their examination. There are three very similar models stated which are designed in a way so that we can test the three main hypotheses. Therefore, they differ only in the dependent variables.

Overall Risk vs Competition

The first hypothesis aims to explain the relationship between the tendency to take a risk and the level of competition. Thus, the model looks as follows:

$$\begin{aligned} risk\ density_{it} =& \beta_0 + \beta_1 * risk\ density_{i,t-1} \\ &+ \beta_2 * competition\ measure_{it} + \\ &+ \sum_{j=1}^{4} \beta_{j+2} * country\ specific_{jit} + \\ &+ \sum_{k=1}^{3} \beta_{j+6} * bank\ specific_{kit} + \epsilon_{it} \end{aligned} \tag{3.16}$$

As described in Section 3.3, risk density is computed as a ratio of risk-weighted assets to total assets. Competition measures, i.e. Lerner index, Panzar-Rosse's H-statistic and Boone measure, presented in Section 3.2, were

all individually included as the main explanatory variables. This means that this model and also the two following were estimated three times, once for each of the competition measures. Additionally, the control variables, stated in Section 3.4, are part of the model too as they allow us to explore the desirable relationship without the unobserved effects occurring within a banks and conditions of economic environment this bank operates in. To get an unbiased estimate of the observed relationship, control variables are complemented by instrumental variables which are always two lags of all explanatory variables.

Loan Portfolio Risk vs Competition

Our second model relates to the hypothesis according to which increased competition leads to lower loan portfolio risk. As explained in Section 3.3, the loan portfolio risk is proxied with a portion of non-performing loans to all loans provided. Therefore, the second model

$$\begin{aligned} portfolio\ loss_{it} =& \beta_0 + \beta_1 * portfolio\ loss_{i,t-1} \\ &+ \beta_2 * competition\ measure_{it} + \\ &+ \sum_{j=1}^{4} \beta_{j+2} * country\ specific_{jit} + \\ &+ \sum_{k=1}^{3} \beta_{j+6} * bank\ specific_{kit} + \epsilon_{it} \end{aligned} \tag{3.17}$$

is, with exception of the dependent variable, indifferent to the first one.

Equity Ratio vs Competition

Under the third hypothesis, banks in less competitive markets tends to be more equity funded. Thus, equity proportion as a source of funding is taken as the dependent variable.

$$\begin{aligned} equity\ ratio_{it} = & \beta_0 + \beta_1 * equity\ ratio_{i,t-1} \\ & + \beta_2 * competition\ measure_{it} + \\ & + \sum_{j=1}^{4} \beta_{j+2} * country\ specific_{jit} + \\ & + \sum_{k=1}^{2} \beta_{j+6} * bank\ specific_{kit} + \epsilon_{it} \end{aligned} \tag{3.18}$$

Again the right-hand side of the equation is almost the same as in the first model with one exception. Unlike the first two models, there are only two bank specific control variables included in this model, total assets and ROAA, since the third, equity ratio, is here present as this model's dependent variable.

3.6 Estimation Methodology

In this section, the methodology applied for the estimation of our models is introduced. As the methodology is relatively complicated and extensive, this section was documented rather briefly with an emphasis on essential so that basic intuition is provided. It is recommended to follow the references attached.

Models presented in previous section are estimated using a form of difference generalized method moment (GMM) estimator, also known as Arellano–Bond estimator, with instrumental variables suitable for our dynamic panel data. Roodman (2006) summarizes comprehensibly entire framework of this estimation process, developed by Arellano & Bond (1991), including situations suitable for this estimation framework, assumptions to be tested, corresponding tests to be used or alternative steps to be done. According to Roodman (2006): "The Arellano–Bond estimator is designed for situations with:

1) small T, large N panels, meaning few time periods and many individuals;

2) a linear functional relationship;

3) one left-hand-side variable that is dynamic, depending on its own past realizations;

4) explanatory variables that are not strictly exogenous, meaning they are correlated with past and possibly current realizations of the error;

5) fixed individual effects; and

6) heteroskedasticity and autocorrelation within individuals but not across them."

Our data are unbalanced panel taken from 4,104 banks over the period from 2011 to 2015, as could be read in detail in Section 4, thus, meeting the condition 1). Also conditions 2) and 3) are met thanks to the specifications of our models as described in previous section. In general, the model looks quite like:

$$\begin{aligned} y_{it} &= \alpha y_{i,t-1} + x'_{it}\beta + \epsilon_{it} \\ \epsilon_{it} &= \mu_i + v_{it} \\ E(\mu_i) = E(v_{it}) &= E(\mu_i v_{it}) = 0 \end{aligned} \tag{3.19}$$

where the unobserved error term consists of the fixed effects, μ_i, and idiosyncratic disturbances, v_{it}. First step of the difference GMM is the following differencing transformation:

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + x'_{it}\beta + \Delta v_{it}. \tag{3.20}$$

By means of this transformation we were able to remove the time invariant fixed effects, μ_i, from the equation. This is the reason why the difference GMM allows for fixed effects as stated in 5). Moreover, standard errors adjusted of potential heteroskedasticity and autocorrelation effects are obtained and used for the statistical significance testing of our parameter estimates, therefore, point 6) is addressed too.

Regarding the endogeneity of explanatory variables in 4), difference GMM allows to address this possible inconsistency with instrumental variables. Roodman (2006) recommends to utilize lags of all variables included in the models due to probable unavailability of other variables, nevertheless, any variable may be included as an instrument. Inclusion of two lags of the explanatory variables as instruments and two lag of the dependent variable among the explanatory variables helps us to obtain estimates without a bias from autocorrelation. To check for validity of instruments there are two tests to be carried out: Sargan-Hansen test for joint validity of overidentifying restrictions and test for autocorrelation in idiosyncratic disturbances. The Sargan-Hansen test, first presented by Sargan (1958) and edited by Hansen (1982) for purposes of GMM, is basically testing that the instrumental variables are jointly uncorrelated with v_{it}.

The Hansen J test statistic is of χ^2 distribution degrees of freedom equal to the degree of overidentification. Concerning the test of autocorrelation in idiosyncratic disturbances, it is addressing potential endogeneity of explanatory variable's second or longer lags which may be used as instrumental variables as well. Lets shift our level equation to $t-2$:

$$\begin{aligned} y_{i,t-2} &= \alpha y_{i,t-3} + \beta x'_{i,t-2} + \epsilon_{i,t-2} \\ \epsilon_{i,t-2} &= \mu_i + v_{i,t-2} \end{aligned} \tag{3.21}$$

Here can be clearly seen that y_{it-2} depends on $v_{i,t-2}$. If the $v_{i,t-1}$ and $v_{i,t-2}$ are correlated, the error term in Equation 3.20, $\Delta v_{it} = v_{it} - v_{i,t-1}$, is correlated with the y_{it-2} as well which makes such instrument endogenous. Since Δv_{it} and $\Delta v_{i,t-1}$ are negatively correlated by default thanks to the $v_{i,t-1}$, the test of autocorrelation is carried out based on second-order serial correlation in differences Δv_{it} and $\Delta v_{i,t-2}$.

To sum it up, we generally apply the difference GMM estimator with help of all explanatory variables and their two lags as instrumental variables. This estimator is also applied for computation of standard deviation of parameters estimates robust against heteroskedasticity and autocorrelation. Validity of the instrumental variables is checked with Sargan-Hansen test and autocorrelation test as described above. All deviations from this standard procedure are reported in Section 5 together with estimation results of corresponding model.

Chapter 4

Data

Methods described in previous section were applied on data from Orbis Bank Focus database provided by Bureau van Dijk. The dataset contains financial statements data over the years from 2011 till 2015 of banks from all 28 countries of European Union. There were included only those banks which were according to the Orbis Bank Focus database recognized as an active bank with following specializations: commercial banks, savings banks, cooperative banks, real estate and mortgage banks, private banking and asset management companies or investment banks. Banks were sorted into these categories according to the North American Industry Classification System (NAICS) which classifies businesses to support improved collecting, analyzing, and publishing of statistical data. The NAICS codes sort the businesses based on the primary activity the company. Banks, considered by Orbis Bank Focus database being active, but without any data provided were, of course deleted, as well as observations of banks with negative assets or operating expenses.

When choosing the accounting data to match the economic models for competition measures, the methods suggested by the literature, e.g. Angelini & Cetorelli (2003), Bikker *et al.* (2012) or Van Leuvensteijn *et al.* (2011) were followed. Bank's output is expressed by total assets and price is proxied by sum of total interest revenues and fees as a ratio of total assets. Costs of inputs, i.e. deposits, labour and capital, are respectively represented by total interest paid on deposits as a ratio of total deposits, personal expenses to total assets and total operating expenses, net of personal expenses, again expressed as a ratio to total assets. Bikker *et al.* (2012) correctly point out that costs of labour might be better captured based on number of employees instead of total assets, however, their paper is based on database which, as well as in

this thesis, provides only limited amount of banks with reliable information of employee numbers.

Table 4.1 presents split of our observations per country, which observed banks were established in, and main bank specialization. As we can see, the second most represented banks are the savings banks, especially from Austria and Germany. This is due to the special form of the Sparkassen, savings banks usually established to serve customers in certain geographic area, which are legally recognized as an individual entities, though they formed groups within which they share costs and risks. In our dataset, it is impossible to distinguish savings banks which are part of these groups and which are not. Therefore, their legal independence was followed and these banks are considered to be individual institutions. It is important that there are at least 40 bank observations for every country and enough observations for every bank type in our dataset. Thus, we can rely that potential difference among the origin or type of a bank is without any small sample bias.

Tables 4.2 and 4.3 show basic summary statistics for the dependent variables together with the key variables expressing the level of competition and control variables respectively. Presented data are after winsorising of data below 1th and above 99th percentile which means that observations originally below the 1th percentile of the population are set to have the same values as the observation representing the 1th percentile. Analogical adjustment was done also for data above 99th percentile.

Table 4.1: Dataset per Country and Type

	comb	coob	invb	privbnam	renmb	savb	total
at	379	625	180	25	85	2150	3444
be	125	25	20	35	5	20	230
bg	115	5	10	5	0	0	135
cy	70	5	10	5	5	0	95
cz	85	10	5	10	0	0	110
de	558	4593	88	135	183	2423	7980
dk	150	20	6	5	40	140	361
ee	35	10	0	0	0	0	45
es	260	288	38	15	133	0	734
fi	110	10	15	60	0	0	195
fr	482	349	75	65	100	115	1186
gb	533	5	237	160	140	10	1085
gr	35	5	5	0	0	0	45
hr	130	5	5	5	0	0	145
hu	100	5	10	15	0	0	130
ie	45	25	5	20	0	0	95
it	435	1905	80	65	20	155	2660
lt	40	0	0	0	0	0	40
lu	290	10	15	50	5	10	380
lv	90	0	0	0	0	0	90
mt	40	5	10	5	0	0	60
nl	140	5	10	15	15	5	190
pl	160	5	5	5	0	0	175
pt	95	10	19	5	10	25	164
ro	100	4	10	0	0	0	114
se	125	15	40	250	0	0	430
si	55	10	5	0	0	0	70
sk	45	5	10	10	0	0	70
Total	4827	7959	913	965	741	5053	20458

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Table 4.2: Summary Statistics: Dependent and Key Explanatory Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
LI	20458	0.03	0.33	-0.77	0.84
PR	20458	0.51	0.03	0.39	0.55
B	20458	-0.58	0.61	-1.21	1.07
NPL	9058	7.78	8.92	0.01	50.43
RD	8174	0.56	0.18	0.05	1.12

Variables: Lerner index (LI), Panzar-Rosse's H-statistic (PR), Boone competition measure (B), proportion of non-performing loans (NPL), risk density (RD)

Table 4.3: Summary Statistics: Control Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
GGDP	20458	1.12	1.53	-2.93	4.54
inf	20458	1.53	1.08	-0.50	4.48
trade	20458	91.39	47.17	55.47	438.16
credit	20458	94.32	27.54	29.89	253.57
TA	20458	1.04E+07	4.74E+07	1.11E+04	3.87E+08
EQtoTA	14119	11.60	11.37	1.48	84.17
ROAA	14104	0.38	1.28	-5.32	7.73

Variables: Growth of gross domestic product (GGDP), inflation (inf), trade as percentage in relation to the GDP (trade), credit to a private sector as percentage in relation to the GDP (credit), total assets (TA), equity ratio (EQtoTA), return on average assets (ROAA)

Chapter 5

Results

In this chapter, our findings are presented and then discussed in relation to recent literature. We state the estimation results of our models corresponding to the underlying hypotheses from Section 3.1. It is also important to keep in mind the intuition of the measures of competition, stated in Section 3.2, and performance indicators, mentioned in Section 3.3, so that the relationships between these two groups of variables are interpreted correctly. As stated in the discussion part, the results may strongly vary with the use of different kind of measure even when this measure should be expressing the same bank characteristic.

5.1 Overall Risk vs Competition

According to our first hypothesis, banks operating under higher competition should evince more risk. Our measure of risk, risk density (RD), is by definition the higher the more risk a bank carries. Similarly, the Panzar-Rosse's H-statistic (PR) increases as the measured segment's competition gets tougher. Unlike to these two measures, higher values of the Lerner index (LI) and the Boone competition measure (B) indicate presence of market power and lack of competition. This can be also seen in Table 5.1.

Since both the Lerner index and the Boone competition measure are supposed to decrease as competition increases, they are positively correlated. Panzar-Rosse's H-statistic is, however, negatively correlated with both of them. Thus, based on our first hypothesis we expect the risk density to be positively

Table 5.1: Correlation among Competition Measures

Variable	LI	PR	B
LI	1.00		
PR	-0.41	1.00	
B	0.54	-0.47	1.00

Variables: Lerner index (LI), Panzar-Rosse's H-statistic (PR), Boone competition measure (B)

related to the Panzar-Rosse's H-statistic and negatively related to the Lerner index and the Boone competition measure.

In Table 5.2, there are presented estimation results of the first hypothesis. There are three columns, each for one competition measure being the key explanatory variable. Specification of all three regression models is exactly the same but the measure of competition: constant, lag of risk density, competition measure, country specific variables (i.e. GDP growth, inflation, credit and trade as a percentage of GDP) and bank specific variables (i.e. total assets, equity ratio and return on average assets). Among the instrumental variables there are always all these 9 explanatory variables and their two lags. So we have 27 instrumental variables in each of these three estimation equations.

Table 5.2: Difference GMM Estimation: Overall Risk vs Competition

	(1)	(2)	(3)
RD	LI	PR	B
Constant	0.0576***	-0.0838***	0.0329***
	(0.00972)	(0.0319)	(0.0103)
L.RD	0.831***	0.831***	0.824***
	(0.0174)	(0.0170)	(0.0175)
LI	-0.0157**		
	(0.00662)		
PR		0.255***	
		(0.0532)	
B			-0.0164***
			(0.00328)
GGDP	0.00291*	0.00312**	0.00447***
	(0.00162)	(0.00145)	(0.00140)
inf	-0.00425*	-0.00111	-0.00146
	(0.00246)	(0.00223)	(0.00219)
credit	9.97e-05**	0.000124**	0.000196***
	(5.07e-05)	(5.11e-05)	(5.33e-05)
trade	8.13e-05	0.000129**	9.72e-05*
	(5.03e-05)	(5.34e-05)	(5.03e-05)
TA	-4.79e-11**	-4.13e-11*	-3.46e-11
	2.08e-11	2.11e-11	2.12e-11
EQtoTA	0.00141**	0.00140**	0.00158***
	(0.000586)	(0.000580)	(0.000582)
ROAA	-0.00322	-0.00363	-0.00317
	(0.00228)	(0.00228)	(0.00227)
Observations	5,248	5,248	5,248
Test for AR(2) - z:	1.06	1.00	1.07
Sargan-Hansen test - χ^2_{18}:	20.83	23.12	16.55

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variables: Lerner index (LI), Panzar-Rosse's H-statistic (PR), Boone competition measure (B), proportion of non-performing loans (NPL), risk density (RD), growth of gross domestic product (GGDP), inflation (inf), trade as percentage in relation to the GDP (trade), credit to a private sector as percentage in relation to the GDP (credit), total assets (TA), equity ratio (EQtoTA), return on average assets (ROAA)

Let us start with the Model (1) having the Lerner index as a key explanatory variable. We can see that the estimated relationship is negative with at least 95% certainty which is in support of our hypothesis. Also estimate of co-

efficient at Boone competition measure, in Model (3), is negative and strongly significant. Panzar-Rosse's H-statistic, Model (2), is estimated to have positive coefficient of 0.255 with standard error estimate, which are robust to heteroskedasticity and autocorrelation of errors, of 0.0532 which makes this slope estimate very significant as well. The test of second order autocorrelation in idiosyncratic errors is not rejected. This means that we cannot deny the null hypothesis of no correlation among Δv_{it} and $\Delta v_{i,t-2}$ which is necessary to be sure that $y_{i,t-2}$ and further lags are not endogenous instrumental variable. Joint validity of our overidentifying restrictions, based on Sargan-Hansen test, cannot be excluded as well. Since we are not able to reject validity of our instruments, we assume that they contribute well to consistency of our coefficients' estimates. All the examined coefficients resulted to be significantly confirming our first hypothesis. It may be interesting to notice that all included variables, but return on average assets and inflation, appeared to have a significant explanatory power of the risk density. This means that by omitting to include these variables into the model our estimates might have been biased.

5.2 Loan Portfolio Risk vs Competition

Second hypothesis suggests that the loan portfolio risk is higher in markets with banks which possess market power which is assumed to be the opposite of competition. Loan portfolio risk, captured by the proportion of non-performing loans (NPL), is supposed to be higher when there is a higher proportion of default loans. Since the intuition of competition measures was briefly mentioned already in previous section, we know that in order to the second hypothesis to be valid the proportion of non-performing loans is expected to be in positive relation to the Lerner index and the Boone measure and in negative relation to the Panzar-Rosse's H-statistic.

As it can be observed from the Table 5.3, the estimation specification of the second set of models is very similar to the first one. The only changes were made in the dependent variable which is NPL and, of course, in the first explanatory variable with is the first lag of the proportion of non-performing loans. The same adjustment was made in instrumental variables, so we have again 27 instrumental variables applied for purposes of all three models. Besides these changes, the estimation is quite the same as in case of our first hypothesis.

Table 5.3: Difference GMM Estimation: Loan Portfolio Risk vs Competition

	(1)	(2)	(3)
NPL	LI	PR	B
Constant	-0.578	8.433***	0.288
	(0.800)	(3.192)	(1.417)
L.NPL	0.814***	0.796***	0.805***
	(0.0324)	(0.0351)	(0.0357)
LI	0.975**		
	(0.395)		
PR		-16.19***	
		(5.182)	
B			0.615
			(0.404)
GGDP	-1.263***	-1.291***	-1.398***
	(0.110)	(0.100)	(0.111)
inf	-1.154***	-1.352***	-1.314***
	(0.162)	(0.169)	(0.157)
credit	0.0422***	0.0430***	0.0418***
	(0.00606)	(0.00664)	(0.00720)
trade	0.0131***	0.00959***	0.0144***
	(0.00307)	(0.00300)	(0.00309)
TA	-7.50e-09**	-1.01e-08***	-9.88e-09**
	(3.34e-09)	(3.87e-09)	(4.40e-09)
EQtoTA	0.0102	0.00229	-0.00103
	(0.0704)	(0.0684)	(0.0749)
ROAA	-1.786***	-1.765***	-1.777***
	(0.205)	(0.211)	(0.213)
Observations	6,040	6,040	6,040
Test for AR(2) - z:	1.61	1.62	1.55
Sargan-Hansen test - χ^2_{18}:	21.48	22.31	19.93

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variables: Lerner index (LI), Panzar-Rosse's H-statistic (PR), Boone competition measure (B), proportion of non-performing loans (NPL), risk density (RD), growth of gross domestic product (GGDP), inflation (inf), trade as percentage in relation to the GDP (trade), credit to a private sector as percentage in relation to the GDP (credit), total assets (TA), equity ratio (EQtoTA), return on average assets (ROAA)

The Lerner index in Model (1) appears to be positively affecting the non-performing loans and, given the standard deviation being less than a half of

the coefficient estimate, it is also significantly different from zero. In the second model of this set, Model (2), the coefficient estimate of Panzar-Rosse's H-statistic is negative and with more than 99% certainty non-zero. Both Models (1) and (2) are in line with our second hypothesis, moreover, their evidence is statistically very strongly assured. Despite the fact that the slope coefficient of the Boone competition measure in Model (3) is positive, which supports our second hypothesis, it turned out to be insignificant which means that we cannot surely consider it to be indifferent from zero. Thus, the Boone competition measure is statistically not influencing the NPL which does not affirm our hypothesis, but it also does not contradict it. The test of second order autocorrelation in idiosyncratic disturbances is almost on the edge of rejection. However, the significance of the coefficients for Lerner index in Model (1) respectively for Panzar-Rosse's H-statistic in Model (1) are so strong that even small bias would not probably change the conclusion. All three values of Sargan-Hansen J-statistic from this set of models are between 19 and 24 which means that we cannot reject the hypothesis of valid instruments. As all three models support the second hypothesis in terms of sign of the relationship, out of which two very significantly, it is not unreasonable to claim that the evidence is generally in favour of the hypothesis.

5.3 Equity Ratio vs Competition

Our last hypothesis specifies the relationship between competition and equity ratio. The equity ratio (EQtoTA) is simply a relationship of equity to total assets and is meant to be higher in markets with lower levels of competition. Therefore, according to our third hypothesis, the equity ratio increases as the Lerner index or the Boone measure increase or when the Panzar-Rosse's H-statistic decreases.

Table 5.4 presents results of an estimation framework similar to those already discussed with respect to the first and second hypothesis. In this set of estimation models, the equity ratio is taken as the dependent variable and its lag is the first explanatory variable. Therefore, there are only 8 explanatory variables for each model in this set. Instrumental variables were adjusted in similar manner. There are 24 instrumental variables, all explanatory variables and their two lags.

Table 5.4: Difference GMM Estimation: Equity Ratio vs Competition

	(1)	(2)	(3)
EQtoTA	LI	PR	B
Constant	3.624***	9.902***	14.23***
	(0.886)	(3.020)	(1.965)
L.EQtoTA	0.343***	0.225***	0.0672
	(0.0661)	(0.0767)	(0.0933)
LI	3.301***		
	(0.553)		
PR		-10.62**	
		(5.176)	
B			4.098***
			(0.648)
GGDP	0.655***	0.582***	0.359**
	(0.133)	(0.134)	(0.143)
inf	0.655***	0.410***	0.157
	(0.164)	(0.154)	(0.175)
credit	0.0396***	0.0488***	0.00506
	(0.0102)	(0.0118)	(0.0128)
trade	-0.0112***	-0.00768**	-0.0180***
	(0.00356)	(0.00374)	(0.00494)
TA	-4.05e-08***	-4.45e-08***	-5.92e-08***
	(1.15e-08)	(1.48e-08)	(2.19e-08)
ROAA	1.053***	0.883**	0.510
	(0.365)	(0.433)	(0.527)
Observations	9,787	9,787	9,787
Test for AR(2) - z:	0.61	0.99	1.04
Sargan-Hansen test - χ^2_{16}:	17.78	19.65	16.24

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variables: Lerner index (LI), Panzar-Rosse's H-statistic (PR), Boone competition measure (B), proportion of non-performing loans (NPL), risk density (RD), growth of gross domestic product (GGDP), inflation (inf), trade as percentage in relation to the GDP (trade), credit to a private sector as percentage in relation to the GDP (credit), total assets (TA), equity ratio (EQtoTA), return on average assets (ROAA)

According to the results of the Model (1), the slope coefficient of Lerner index is positive and, with its robust standard deviation equal to approximately one sixth of the coefficient estimate, it is also statistically very strongly significant. Very similar observation can be done in case of the Boone competition

measure in Model (3). Its coefficient is also positive and with higher probability than 99% it is non-zero. Negative and statistically strong impact on the equity ratio has also the Panzar-Rosse's H-statistic in Model (2). Again, all relationships are of expected sign and high significance. Both tests examining the validity of our instrumental variables indicate no rejection, so there is no sign of bias in our estimates. Thus, as all three key explanatory variables turned up being as expected, we can conclude that the estimation results confirm the third hypothesis.

5.4 Additional Analysis

In this section, we would like to use the advantage of our data and the possibility to split the banks according to their type and country of operation. First, by means of principal component analysis (PCA), we try to simplify measuring of competition so that we have only one competition proxy. Second, all main variables are split per type and country and one by one discussed. Third part compares the relationships explored in our first two hypotheses across the bank type.

Simplifying Competition through PCA

In order to make the interpretation of this sections' results more straight forward, it was constructed one more variable which should be capturing the competition pattern from Lerner index, Panzar-Rosse's H-statistic and Boone competition measure. This variable was obtained by means of principal component analysis. Since the higher values of the Lerner index and Boone competition measure are associated with lower levels of competition, we multiplied their values by minus one. Therefore, all three competition proxies increase as competition increase. The results of principal component analysis applied on adjusted measures of competition is to be seen in Table 5.5. We can see that the fist principal component, Comp1, explains 65% of the mutual variance of the three competition measures. In Table 5.6, it can be seen that the first principal component leaves only 34%, 30% and 41% of the proxies Lerner index, Boone competition measure and Panzar-Rosse's H-statistic unexplained.

Thus, the first principal component is taken as a single proxy for bank competition. Table 5.7 presents its summary statistics and Table 5.8 shows

Table 5.5: PCA of Adjusted Competition Measures

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.94	1.34	0.65	0.65
Comp2	0.60	0.15	0.20	0.85
Comp3	0.46	.	0.15	1.00

Table 5.6: First Principal Component of the Adjusted Competition Measures

Variable	Comp1	Unexplained
negLI	0.58	0.34
negB	0.60	0.30
PR	0.55	0.41

Variables: Lerner index multiplied by minus one (negLI), Panzar-Rosse's H-statistic (PR), Boone competition measure multiplied by minus one (negB)

the correlation matrix between the fist principal component and the original proxies. Here we can see why it was important to adjust the Lerner index and Boone measure. All four competition measures are now positively correlated. This allow us easier interpretation of this measure. Simply, the higher the first principal component is the more competitive the market. Moreover, the first principal component is very strongly correlated with all three remaining variables. Therefore, we can assume that the first principal component can, for the purposes of the additional analysis, substitute the role of the original measures reliably and easier to follow.

Table 5.7: Summary Statistics: First Principal Components

Variable	Obs	Mean	Std. Dev.	Min	Max
Comp1	20504	0.00	1.39	-4.86	1.99

Variables Decomposition

Since our data can be divided in to groups according to the bank type, which reflects the main bank specialization, and country, this section compares our main variables based on these characteristics.

Table 5.8: Correlation Matrix of All Competition Measures

Variable	negLI	negB	PR	comp
negLI	1.00			
negB	0.54	1.00		
PR	0.41	0.47	1.00	
Comp1	0.81	0.84	0.77	1.00

Variables: Lerner index multiplied by minus one (negLI), Panzar-Rosse's H-statistic (PR), Boone competition measure multiplied by minus one (negB), first principal component of the adjusted competition measure (Comp1)

Competition Decomposition

The first variable to be explored is the first principal component of the competition measures, Comp1. In Table 5.9, its split per bank type is stated. We can see that the cooperative banks followed by the savings banks face relatively highly competitive environment. On the other side, there are real estate banks and mortgage banks those which possess relatively more market power. Table 5.10 presents the Comp1 per country. In this comparison, German banking appears to be by far the most competitive. On the contrary, Baltic countries together with Bulgaria and Romania indicate very low levels of competition which might be because of their young market economy.

Table 5.9: First Principal Component per Bank Type

type	Mean	Std. Dev.	Freq.
comb	-0.94	1.11	4837
coob	0.86	1.01	7919
invb	-1.64	0.80	884
privbnam	-1.30	0.80	585
renmb	-2.89	1.04	726
savb	0.37	0.83	5553
Total	0.00	1.39	20504

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Table 5.10: First Principal Component per Country

country	Mean	Std. Dev.	Freq.
at	-0.13	0.55	3445
be	-0.95	0.56	230
bg	-2.69	0.63	135
cy	-2.24	0.68	95
cz	-1.88	0.80	110
de	1.20	0.79	8003
dk	-1.67	0.97	362
ee	-3.09	0.83	45
es	-0.83	0.62	743
fi	-0.08	0.64	195
fr	-1.85	0.93	1187
gb	-1.01	0.88	1094
gr	-1.55	0.56	45
hr	-1.77	0.55	145
hu	-2.81	0.64	130
ie	-1.54	1.10	95
it	0.26	0.42	2660
lt	-1.07	0.52	40
lu	-2.44	0.36	380
lv	-1.78	0.59	90
mt	-0.97	0.58	60
nl	-1.83	0.85	190
pl	-1.97	0.44	175
pt	-1.63	0.72	165
ro	-2.42	0.44	115
se	-1.61	0.96	430
si	-1.40	0.47	70
sk	-2.24	0.58	70
Total	0.00	1.39	20504

Overall Risk Decomposition

The overall risk can, when considered for a sector, express the extend to which certain market is fragile. The more risky banks market has the more likely is that there will be one bad apple which, through the contagion in financial markets, spoils the whole bunch. Table 5.11 shows the decomposition of the overall risk with respect to the bank type. Based on this table, we conclude that cooperative and savings banks are slightly of higher risk than others. In contrast, the real estate banks and mortgage banks exhibit relatively less risk profile. This, together with the observation of competition decomposition by

bank type, somehow supports our fist hypothesis where more competitive banks are supposed to be of higher overall risk. As regards the market fragility, Table 5.12 displays the overall risk for all EU28 countries. According to this table, the Greek and Slovak banking markets are prone to fragility the most. The most stable markets are, in contrast, in Luxembourg and France.

Table 5.11: Overall Risk per Bank Type

type	Mean	Std. Dev.	Freq.
comb	0.55	0.23	1743
coob	0.59	0.14	4177
invb	0.49	0.31	190
privbnam	0.42	0.26	137
renmb	0.39	0.24	252
savb	0.56	0.12	1675
Total	0.56	0.18	8174

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Table 5.12: Overall Risk per Country

country	Mean	Std. Dev.	Freq.
at	0.57	0.21	200
be	0.41	0.23	36
bg	0.62	0.15	34
cy	0.58	0.18	36
cz	0.56	0.19	35
de	0.57	0.14	3799
dk	0.64	0.21	275
ee	0.56	0.20	18
es	0.53	0.23	68
fi	0.41	0.18	74
fr	0.37	0.20	160
gb	0.46	0.25	298
gr	0.71	0.17	29
hr	0.64	0.17	88
hu	0.46	0.23	35
ie	0.45	0.25	40
it	0.58	0.17	2329
lt	0.59	0.13	19
lu	0.32	0.17	48
lv	0.59	0.19	24
mt	0.53	0.17	25
nl	0.49	0.26	89
pl	0.62	0.23	60
pt	0.56	0.29	64
ro	0.53	0.19	46
se	0.53	0.20	194
si	0.56	0.23	26
sk	0.69	0.23	25
Total	0.56	0.18	8174

Loan Portfolio Quality Decomposition

Next variable to be explored is the loan portfolio quality proxied by the ratio of non-performing loans. This variable can be influenced by macroeconomic conditions (e.g. higher default rate during recession as some businesses may be short of sufficient proceeds to repay the loans) or the quality customers' creditworthiness is estimated. Table 5.13 presents this variable for each bank type separately. It can be observed that the commercial and investment banks have substantially higher rate of non-performing loans. This might stem from the nature of their operations. Loans provided by investment banks are ex-

pected to be of relatively higher risk but also of higher return. Concerning the commercial banks, increased rate of non-performing loans may be due to the consumption loans which are often based only on application data. People borrowing for their consumption are possibly more liable to get in payment troubles. Also, lack of behavioural data applied for estimation of creditworthiness contributes to deteriorated loan portfolio quality. On the opposite side of the list, there are private banks and asset management institutions followed by the savings banks. Great variety of the NPL averages are to be seen in Table 5.14. For example, the ratio of non-performing loans of the country with worst loan portfolio quality, Greece, is more than thirty times higher than for Finland which is the country with banks having the best quality of their loan portfolios.

Table 5.13: Loan Portfolio Quality per Type

type	Mean	Std. Dev.	Freq.
comb	10.82	11.62	2190
coob	7.74	7.56	4424
invb	10.34	13.16	166
privbnam	3.38	6.26	165
renmb	5.65	9.54	297
savb	4.72	6.11	1816
Total	7.78	8.92	9058

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Table 5.14: Loan Portfolio Quality per Country

country	Mean	Std. Dev.	Freq.
at	7.35	8.43	114
be	4.26	3.23	34
bg	24.39	14.57	64
cy	24.19	18.20	48
cz	8.89	10.11	70
de	3.28	3.16	3889
dk	14.67	12.58	239
ee	6.27	7.84	26
es	10.86	8.41	180
fi	1.02	0.83	49
fr	6.02	7.33	636
gb	5.84	9.78	376
gr	31.59	12.86	31
hr	17.74	11.50	100
hu	20.98	10.41	34
ie	12.79	12.18	50
it	13.03	8.15	2336
lt	12.04	8.11	26
lu	3.17	3.18	47
lv	18.59	16.06	45
mt	9.06	10.71	30
nl	3.98	3.74	61
pl	8.37	5.14	94
pt	11.03	10.78	74
ro	24.84	12.84	66
se	1.82	3.44	240
si	18.73	12.67	53
sk	13.91	14.63	46
Total	7.78	8.92	9058

Equity Ratio Decomposition

The last variable to be decomposed is the equity ratio. Section 3.3 contains a part describing many perspectives for interpretation of the equity ratio. In this part, we will consider equity ratio as a measure of efficiency which a bank uses its capital resources with and as a buffer against accumulated loss. Table 5.15 shows the average equity ratio per bank type. We can see that among our banks the cooperative banks and the real estate banks and mortgage banks are of the lowest equity ratio which makes them the most vulnerable against financial distress. At the same time, it shows that these banks utilize efficiently their

financial leverage. The investment banks have, with equity ratio of 26.15%, quite strong equity buffer. As regards this variable across EU countries, Table 5.16 states that on average the lowest equity ratios are in Slovenia and the highest, more than twice as high, are in the UK.

Table 5.15: Equity Ratio per Bank Type

type	Mean	Std. Dev.	Freq.
comb	13.13	14.68	3302
coob	9.74	4.13	5416
invb	26.15	27.28	642
privbnam	16.11	19.79	364
renmb	9.54	13.89	476
savb	10.34	5.78	3919
Total	11.60	11.37	14119

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Table 5.16: Equity Ratio per Country

country	Mean	Std. Dev.	Freq.
at	12.80	13.14	2815
be	17.82	22.40	147
bg	12.04	10.90	102
cy	12.55	14.71	59
cz	9.77	4.48	73
de	9.69	7.37	4799
dk	11.92	8.38	289
ee	16.95	9.92	29
es	13.85	18.02	413
fi	9.59	8.60	100
fr	11.03	10.03	749
gb	18.01	22.59	748
gr	12.45	14.39	35
hr	10.90	4.91	125
hu	11.67	6.20	75
ie	10.80	8.49	68
it	10.87	7.23	2361
lt	11.96	5.44	28
lu	11.63	13.53	212
lv	9.66	5.97	56
mt	18.92	23.19	38
nl	12.47	14.82	125
pl	11.48	4.61	126
pt	15.19	14.88	99
ro	11.36	5.79	75
se	15.10	9.78	269
si	8.74	3.31	53
sk	11.95	9.59	51
Total	11.60	11.37	14119

Relationships Decomposition

In this part, we also decompose the first two examined relationships per bank type. The estimation methodology was done in the very same way as in Sections 5.1 and 5.2. The only differences are that the estimation was done only for banks being of particular type and that there is only one competition variable, first principal component of the three competition variables. This means that the models were also specified the same way, the same instrumental variables were applied and the same tests were carried out.

Overall Risk vs Competition Decomposition

Table 5.17 presents the relationship of the first hypothesis, examined also in Section 5.1, across the bank type. There were only the slope coefficients at the Comp1 variable and their significance included in the table as they carry the most important information for purposes of this comparison. Overall, we can see that the first hypothesis is significantly confirmed also with use of Comp1 variable: The higher the competition the more risky it is expected to be. The same holds also for cooperative banks. However, the relationship was estimated to be negative for private banks and asset management institutions and also for commercial banks for which is this negative relationship strongly statistically significant. For the savings banks, investments banks and real estate and mortgage banks is the relationship expected to be positive but statistically insignificant. Therefore, there are significant differences in estimation of the role which competition has on the overall risk depending on the bank type not only by the size but also by the direction.

Table 5.17: Overall Risk vs Competition per Bank Type

VARIABLES	RI vs Comp1
comb	-0.010**
coob	0.022***
savb	0.002
invb	0.007
privbam	-0.024
renmb	0.002
overall	0.010***

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

Loan Portfolio Quality vs Competition Decomposition

Our second hypothesis suggests that the loan portfolio quality is higher for banks operating in more competitive markets. As the loan portfolio quality is proxied by the ratio of non-performing loans, we expect negative relationship between the NPL and Comp1. The overall results confirm the sign of the relationship with strong statistical significance. Table 5.18 spits this relationship for various bank types. This relationship is estimated to be negative for all the bank types, however, the size and the statistical significance differ. In commercial banking, competition is estimated to have the strongest impact on the portfolio quality. Also, savings banks and real estate and mortgage banks indicate improved portfolio quality in markets with higher competition. As regards cooperative banks, investment banks, private banks and asset management companies, for these bank types there is negative relationship estimated but it turned out to be statistically insignificant.

Table 5.18: Loan Portfolio Quality vs Competition per Bank Type

VARIABLES	NPL vs Comp1
comb	-0.570***
coob	-0.101
savb	-0.438**
invb	-0.608
privbam	-0.254
renmb	-0.243*
overall	-0.305***

Bank types: commercial banks (comb), cooperative banks (coob), real estate and mortgage banks (renmb), private banking and asset management companies (privbnam), investment banks (invb), savings banks (savb).

5.5 Discussion

Our findings confirm that banks operating under higher competition bear more of overall risk, get higher proportion of loans provided by them repaid and operate with lower equity ratio.

This also means that banks operating in markets where it is hard to gain a market power, e.g. as a result of regulatory framework, have to compete harder to deliver certain profits or to keep in business. This contest is done through investments that are riskier than in less competitive markets. On one hand, it brings higher returns which can result in the sought profitability. On the other hand, doing so increases the risk profile of the bank and, from macroeconomic perspective, undermines banking stability.

As regards the proportion of bad debts in the portfolio, our results show that competition pushes banks to compete on interest rates which, according to the theory, makes their customers easier to repay the loans as the interest rate is not that high. At the same time, as there is less unpaid loans, there is less bad debt provisions needed which makes the interest rate even lower.

Higher equity ratio may be sign of a buffer against financial distress, but also source of inefficiently used debt leverage. Findings of this study suggest that competitive environment makes banks operate efficiently with higher debt leverage and, therefore, with lower reserves. That fact that higher debt leverage allows banks to perform more investments and lower reserves protect them less from financial distress together with the fact that these banks are of higher risk profile contributes to the conclusion that competition decrease stability.

Our findings can be related to the literature review in Sections 2.1 and 2.2. The positive relationship between competition and risk-taking behaviour, as we found out by confirming the first hypothesis, is an evidence in support of the competition-fragility theory which was already widely supported. For example Ariss (2010) and Fungáčová & Weill (2013) bring similar evidence when increased competition, captured in both cases by the Lerner index, was reportedly associated with higher banking risk and decrease in stability respectively. Recently, Leroy & Lucotte (2017) published their study, where by examining European banks over the period from 2004 to 2013, therefore the background the their dataset is comparable to ours, it was observed negative relationship between market power and risk-taking behavior which is consistent with our findings.

The second confirmed hypothesis was based on the competition-stability

theory which also has a great amount of proponents. Beck *et al.* (2006) used the same proxy for expressing the portfolio risk, ratio of non-performing loans, and concluded equally that this ratio is significantly lower in banking markets that evidence higher competition. Interestingly, Berger *et al.* (2009) concluded that the competition-stability and competition-fragility views do not necessarily have to contradict each other. In their study, application of the ratio of non-performing loans led to the results supporting the competition-fragility view and application of Z-score, rather the overall risk of a bank, affirmed the competition-fragility theory which is the very same conclusion as our thesis brings. The key for understanding brings Zigraiova & Havranek (2016). In their extensive meta-analysis of 31 studies, their research focuses especially on publication bias, however, they observed that the conclusions in these studies depend greatly on the methodology applied. Most importantly, the choice of a proxy for either financial stability or bank competition impact the results. For example ratio of non-performing loans, Z-score, risk density or equity ratio can all be used as a proxies in estimation of bank stability, nevertheless, the underlying data these measures were constructed from differ substantial, so the interpretation should differ as well.

The main limitation of this thesis lies in the underlying data. As it missed longer time period it was not possible to explore dynamics of examined relationships or comparison of our estimated in the period before and after the financial crisis. Our data were acceptably rich in variables applied, however, for smaller banks the amount of data missing was higher which might cause certain bias.

This thesis enriches reader with understanding of how could bank react when bank competition changes and what is the intuition of such behaviour. Examined indicators represent certain characteristics which when aggregated to the level of entire market may be more or less desirable for the policy makers. Based on contribution brought in this thesis, it can be better understood which policy, whether increase of competition or decrease of competition, should be aimed at in order to address certain undesirable pattern in the market. Our findings suggest that allowing for higher competition brings additional overall risk into the market, which can make it more fragile, but improves the portfolio quality of banks present in this market and provides cheaper debt funding to the businesses which may boost the economy.

Chapter 6

Conclusion

The purpose of this thesis is to explore the way how performance of a bank differs when this bank operates in more or less competitive market. The tendency to take higher risk, quality of the loan portfolio and the proportion of equity as a source of funding were the three main characteristics examined in relation to the competition.

As the financial stability is considered to be very important and fragile counterpart of an economy, there was considerable volume of literature published on its relation to the competition. This literature is usually divided into competition-stability view, banks in more competitive markets are bear less risk which makes the sector more stable, and competition-fragility view, banks present in less competitive environment are considered less likely to default. Moreover, franchise value theory proposes that banks able to exert market power may abuse this power in order to earn higher profits which banks in competitive markets need to compensate with additional financial leverage.

Empirical literature suggests Lerner index, Panzar-Rosse's H-statistic and Boone measure as measures of market competition. In order to capture overall risk, loan portfolio risk and equity ratio, our estimation methods used risk density, proportion of non-performing loans and ratio of equity to total assets respectively as their proxies. These variables were constructed based on the panel data with time length of five years, from 2011 till 2015, for all 28 member countries of European Union from the Orbis Bank Focus provided from Bureau van Dijk. For estimation of examined relationships were used difference generalized method of moments estimator with help of instrumental variables which is also robust to heteroskedasticity and autocorrelation which is very suitable estimator for unbalanced panel data with short time period and wide range

of cross-sectional data. Validity of instrumental variables was also checked by means of test of second order autocorrelation in differences of idiosyncratic errors and Sargan-Hansen test which ensured us that our instrumental variables are not endogenous and, therefore, our estimates are unbiased.

In general, estimation results turned out to be in support of our hypothesis. According to the findings, overall bank risk is significantly higher in markets with higher competition which was supported by all competition measures. This observation strongly confirms competition-fragility theory as more more risky banks are more likely to default with put entire financial system in threat. The second hypothesis specifying the dependency of loan portfolio risk on various levels of competition predicted negative relationship among these two variables. The sign of the relationship was predicted by all three competition proxies, nevertheless, only two of the coefficient estimates were statistically significant. Finally, out third hypothesis examining the impact of competition on the equity ratio. It was expected higher equity ratio in markets with less competition which was also strongly supported by the estimation results. Therefore, we can conclude that banks in more competitive markets are associated with increased overall risk, improved quality of loan portfolio and lower equity ratio.

Despite the vast amount of literature published on this topic, this is one of the first comprehensive studies that confirm both competition-stability and competition-fragility theories with use of only one dataset. The reason for this is, as stated, the choice of proxy applied and the variable this proxy should express. Since competition-fragility theory suggests that competition increases overall risk associated with a bank and competition-stability view is based on the idea of competitive pressure on loan interest rates and its quality, its possible that these theories do not need to exclude each other. Empirical part of this study supports this thought. Moreover, to our best knowledge it is the first study that examine these two seemingly conflicting theories for multiple bank types. Although the relationship between the loan portfolio quality and competition is more or less consistent across the bank type, the impact of competition on overall risk is far less homogeneous. However, this study does not offer explanation of these differences (e.g. related to characteristic of their core operations or investments made) and we recommend this topic to be researched further.

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