Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

How Bank Competition Influences Financial Stability

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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, December 30, 2016

Signature

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Abstract

This paper investigates the link between financial stability and bank competition by means of the Arellano & Bond (1991) GMM model using annual panel data over the period 2000 – 2014 for 205 countries. Our data source is a new, richer and updated dataset The Global Financial Development Database available at World Bank. Due to the specifics of this dataset we are able to use new combinations of measures of financial stability and of bank competition and to study their relationship in greater depth. We find a positive link between financial stability and bank competition. Furthermore, our results provide evidence that it matters what measures of financial stability and bank competition we apply. Lastly, we ascertain that the relationship between financial stability and bank competition does not change over time.

Keywords	Financial Stability, Bank Competition, Dynamic GMM, the Arellano and Bond Estimator

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Abstrakt

Tato práce zkoumá vztah mezi finanční stabilitou a bankovní konkurencí pomocí Arellano & Bond (1991) GMM modelu za použití panelových dat pro 205 zemí v letech 2000-2014. Zdrojem našich dat je nová, bohatší a aktualizovaná databáze The Global Financial Development Database dostupná na internetových stránkách World Bank. Díky specifikům této databáze můžeme použít nové kombinace měr finanční stability a bankovní konkurence a jsme schopni zkoumat jejich vztah více do hloubky. Výsledky ukazují pozitivní vztah mezi finanční stabilitou a bankovní konkurencí. Analýza také odhaluje, že záleží na tom, jaké míry finanční stability a bankovní konkurence jsou aplikovány. Také se ukazuje, že vztah mezi finanční stabilitou a bankovní konkurencí se v průběhu času nemění.

Klíčová slova	Finanční stabilita, bankovní konkurence, dynamická GMM, the Arellano and Bond estimátor

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Master's Thesis Proposal

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Notes: The proposal should be 2-3 pages long. Save it as "yoursurname_proposal.doc" and send it to mejstrik@fsv.cuni.cz, tomas.havranek@ies-prague.org, and zuzana.irsova@ies-prague.org. Subject of the e-mail must be: "JEM001 Proposal (Yoursurname)".

Proposed Topic:

How Bank Competition Influences Financial Stability

Motivation:

Financial stability is a very important factor which enables financial processes, facilitates the flows between creditors and debtors and plays a crucial role in allocating effectively the financial funds so that they could support economic growth and development. Financial instability would place in danger not only these aspects but due to spill-over effects also another sectors of the economy what could lead in the worst scenario up to financial crisis with bad consequences for the economy.

There are two theories discussing bank competition: *competition-fragility hypothesis* which supposes that banks are more willing to take excessive risks what leads to fragility and *competition-stability hypothesis* which suggests that more competitive system is more resilient thanks to lower lending rates which results in higher profitability of firms and lower credit risk for banks. Bank competition is closely related to financial stability and that is why it is worthy to study if it is one of the significant factors influencing financial stability.

This knowledge could be used in states where the financial system is not very stable. This question was investigated in the past. For example Havranek and Zigraiova (2015) who made an overview of current literature on the relationship between bank competition and financial stability show that written studies do not allow to conclude the existence of a significant effect of bank competition on financial stability. Despite of this fact, existing empirical literature provides a little support for the competition-fragility and competition-stability hypothesizes. I am going to study the interplay

between bank competition and financial stability as well but using extended, new and more actual data.

Hypotheses:

1. Hypothesis 1: Bank competition reduces financial stability.

2. Hypothesis 2: The effect of bank competition on financial stability does not depend on what measures of competition and stability we use.

3. Hypothesis 3: The effect of bank competition on financial stability changes over time (for example during a crisis).

Methodology:

As this thesis is focused on the influence of bank competition on financial stability first I have to determine the measurable proxies which will well represent these variables. Measures for financial stability might be Z-score or non-performing loans (NPL). Measures for the bank competition might be the Lerner index or H-Statistic.

In the next step I have to pick up the panel of countries for which are these data available. I will use data from The World Bank databank where I found the data for 43 countries for 13 years. Since the data are dynamic panel data I expect they will be correlated with the idiosyncratic error which is utilized to describe error which both changes across units and changes over time. The correlation with the idiosyncratic error would mean endogeneity hence the fixed and random effects would be inconsistent and I will probably have to use the Arellano-Bond estimator.

Expected Contribution:

I expect the contribution of this question to be investigating this question with new dataset which is richer than previous databases used up to now and contains new measures of competition and stability. This means that I can deeper study and verify the real relationship between the financial stability and bank competition.

As I mentioned above the results could be used in states where the financial system is not very stable, it could help to better understand the effect so that the governments and central banks would know which direction to control the bank competition, whether support it or restrict it.

Outline:

1. Introduction – I will introduce the topic, present the motivation and describe the structure of the thesis.
2. Literature review – I will discuss existing related papers examining the influence of bank competition on financial stability.
3. Data description – I will describe the dataset, explain why I use selected variables and data sources.
4. Methodology – I will depict used methods, compare their advantages and disadvantages to other methods used in literature and describe estimation methods and tests used.
5. Results – I will present the results.
6. Conclusion – I will recap the results, comment on their contribution and on possible future research.

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Acronyms

BCTBD – Bank Credit to Bank Deposit

BI – the Boone indicator

CAR – Capital Adequacy Ratio

CG – Credit Growth

CHTT – Change of Terms of Trade

CONC – Concentration

D – Depreciation

E – Equity Ratio

GDPG – Gross Domestic Product Growth

GMM – Generalized Method of Moments

I – Inflation

LI – the Lerner index

NPL – Non-Performing Loans

RIR – Real Interest Rate

ROA – Returns on Assets

ROE – Returns on Equity

TA – Total Assets

ZS – Z-score

Introduction

"Financial stability is a condition in which the financial system – comprising of financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances, thereby mitigating the likelihood of disruptions in the financial intermediation process which are severe enough to significantly impair the allocation of savings to profitable investment opportunities". (European Central Bank, 2015a)

Financial stability is a very important factor which enables financial processes, facilitates the flows between creditors and debtors and plays a crucial role in the effective allocation of financial funds which, in turn, supports economic growth and development. Conversely, financial instability endangers these aspects of the economy and can impact other sectors due to spill-over effects and ultimately leads to, in the worst scenario, a financial crisis with severe consequences for the economy. It is bad for economic growth, unemployment, and it is a source of real costs. Banks play a key role in the topic of financial stability. A question that arises is if the structure of the financial market, particularly competition in the banking system, matters for financial stability. The objective of this thesis is to investigate this question.

This thesis begins with a theoretical background where we explain what is meant by financial stability and bank competition, and why are they so interconnected. After that we state and describe our hypotheses. This is followed by a literature review. We mainly distinguish two groups of literature. We do so based on two theories discussing bank competition in relation to financial stability: the *competition-fragility hypothesis* which supposes that it is the banks' propensity to take excessive risks what leads to fragility and the *competition-stability hypothesis* which suggests that a more competitive system is more resilient thanks to lower lending rates which results in higher profitability of firms and lower credit risk for banks.

In Chapter 2, we start with methodology used for the analysis. The Arellano and Bond (1991) model is employed. Next, we describe our dataset. We use panel data over the period 2000 – 2014 for 205 countries. The source of our nine measures of the two variables of our main concern (financial stability and bank competition) is The Global Financial Development Database available at the World Bank website. We consider this to be one of the contributions to this topic because a) this database is richer than previous databases used until now, and b) contains new measures of

competition and stability. This means that we can study the research question in greater depth and we can verify the real relationship between financial stability and bank competition. The other contribution of this paper is that we estimate the model with various pairs of financial stability and bank competition measures which, according to our current knowledge, have not been used in all these combinations yet. Furthermore, one of the measures we apply (bank credit to bank deposit), as far as we are aware, has never been used before to represent financial stability in this context. This section of the thesis also contains a detailed description of each measure, winsorising modification and stationarity testing.

This brings us to the most important part of the study, the estimation results. The findings of the analysis of each hypothesis are presented individually in separate sections. The first hypothesis formulated was that *Bank competition reduces financial stability*. Based on our results we have to reject it, hence, we cannot support the argument that bank competition reduces financial stability. The second hypothesis states that *the effect of bank competition on financial stability does not depend on what measures of competition and stability we use*. The results made us also refute our second hypothesis, thus, we cannot say that the link between bank competition and financial stability is independent of the measures used. The third hypothesis was that *the effect of bank competition on financial stability changes over time (for example during a crisis)*. Based on our estimation we have to reject the third hypothesis as well which means we cannot claim that the impact of bank competition on financial stability changes over time.

Chapter 1: Theoretical Background

In this thesis we discuss the impact of bank competition on financial stability, therefore let us first explain these two terms, describe what they stand for, mention their possible measures and compare their actual state among countries.

1.1 Financial Stability

Financial system can be considered to be stable in case when it is able to survive and absorb shocks and is less likely to experience disturbance in the process of financial intermediation that are so serious they would damage the allocation of funds to the right profitable investment opportunities. (European Central Bank, 2015a)

We may distinguish three parts of the financial system. The first part, *financial intermediaries,* includes banks, insurance companies and institutional investors who direct their fund to those who want to borrow rather than to lenders/investors. *Financial markets* constitute the second part of the system. These markets are places where borrowers and lenders meet, for instance stock exchanges or money markets. The third part is *financial market infrastructures* which serve as a tool for the flow of money and other financial assets between sellers and buyers. Financial market infrastructures are, for example, payment systems or security settlement systems. (European Central Bank, 2016b)

Financial stability as a whole, however, is a part of a larger financial development process. Imagine a country with extremely loose lending standards where banks loan almost every possible borrower without regular loan monitoring and risk management. At first sight, it might seem efficient for a while because of the fast growth. If banks do not approve loans and manage risk properly, it may lower the costs, but it only leads to a situation where banks do not have control over the money they lent. This creates instability and could end up in a crisis. (Cihak et al., 2012)

According to the European Central Bank there are some requirements that have to be met so that we could say a financial system is stable. The transfers of resources between savers and investors should be easily and efficiently done. Financial risks must be reasonably accurately evaluated, judged and rated as well as properly managed. The state of the financial system should be resilient enough to be able to handle financial and real economic shocks. If at least one of these assumptions does

not hold or any of these characteristics are disrupted then the financial system might become less stable. (European Central Bank, 2016b)

Hence, to prevent instability of the financial system, it is essential to identify the main sources of risks and vulnerabilities, to forecast and to adopt a forward-looking approach. Some of the potential risks and vulnerabilities include ineffective allocation of financial resources by savers to financiers and misevaluated or mismanaged financial risks. This suggests some possible ways of measuring financial stability.

Havranek & Zigraiova (2015), in their meta-analysis, investigated papers dealing with bank competition and financial stability as well. They summarized what measures of financial stability have been used in the past. They found out that the most frequent proxy of financial stability is z-score statistic. In other investigative papers, the indicator of non-performing loans as a share of total loans is utilized to represent financial stability. Alternatively, some authors estimate financial stability using profitability indicators or their volatility (ROA, ROE or ROA volatility, ROE volatility). In several papers financial stability occurs as capitalization represented by CAR - capital adequacy ratio or by equity-total assets ratio. Stability was also measured by probability of bankruptcy or Logistic R2 Merton's distance-to-default model. Some studies use a crisis dummy or a bank failure dummy to express financial stability. Cihak et al. (2012) mention other possible indicators of financial stability, including "excessive" credit growth.

1.2 Bank Competition

Competition is usually considered a good efficiency support in all industries. In banking sector, however, it is not so simple because efficiency of this sector goes hand in hand with the financial stability. Globally the banking sector has been opened more what led to increase in bank entry, to closed and concentrated markets, and to more diversified opportunities and lower costs of capital. Nevertheless, this financial integration, deregulation and liberalization of banking sector means higher competition and led in many countries to a bank crisis (highlighting the need for a deeper understanding of the issue). (Perotti & Suarez, 2003)

Furthermore, the importance of the topic of the trade-off between bank competition and financial stability is amplified not only by globalization but by the developing technology and its progress as well. Reaching an effective level of competition and the optimal balance between competition and stability will become even more challenging with the rapid evolution of financial services industries. Overall,

financial products and financial markets are becoming much more complex and global and this induces new competition policy and regulatory issues. (Claessens, 2009) The existing approaches will have to be adjusted which may also lead to changes in empirical investigation results.

In his article, Beck (2008) describes the measures of bank competition used across various papers on similar topics. To express bank competition with numbers is even more complicated than it is in the case of financial stability. Some were defined and are frequently used in studies, though. Beck (2008) divides them into three groups. The first group can be called market structure measures. It includes Herfindahl indices, number of banks or concentration ratios. These metrics explain bank competition only as a market share and do not account for the deductions from the competitiveness of banks. Their values are approximations as they do not consider the difference in the behaviour of banks with diverse ownerships nor the fact that the banks' competition might be of a different line of business. Furthermore, neither the structure-conduct-performance hypothesis (that bank behaviour is affected by market structure) nor the efficient structure hypothesis (that performance determines market structure) has been confirmed in the literature.

The second group of bank competition measures (for instance H-Statistics) compares the bank's competitive behaviour by considering the output in reaction to input prices and restricting the cost function of banks. In the case of perfect competition, both marginal costs and total revenue move along together due to the rise of input prices. In case of imperfect competition this effect does not happen. The outcome of the measurement based on the prerequisite of profit-maximization is valid only if the specific market is in equilibrium, though. Across the literature, estimates of H-Statistics differ considerably. Likewise, the Lerner index also measures the market power of banks as the share of the difference between output prices (in practice total revenues) and marginal costs on output prices. In markets with perfect competition, the difference between output prices and marginal costs would equal to zero. It differs, however, in markets with less competitiveness. The proper lending risk adjustment of the prices has to be done. (Beck, 2008). We presume that the Boone indicator also belongs to this group. Introduced by the Boone (2008) in his paper, it is a new theory-based measure of competition. It is the elasticity of profits divided by marginal costs what theoretically makes it a better measure than the two mentioned above.

The third group of measures takes into account the various formal and informal barriers to and requirements for entry for both foreign and domestic banks as well as

banking system regulations, activity limitations and other rules which may preclude challenging performance of new banks. The measures can also allow for a wider framework of the whole system, such as the informational or contractual frameworks. Some of the difficulty in measuring bank competition may lie in selecting the correct definition for the specific market. In cross-country papers, however, this is not such a problem, since the whole country's economy is usually the relevant market. Although the assumption does not have to be always correct anyway. While employing bank completion measures, one should remember that they are usually measured on the institutional basis, not the product basis (e.g. payment, deposit, and lending services). In other words, bank competition is typically supposed to be the same across various products provided by banks. (Beck, 2008)

1.3 Hypotheses

In this paper we concentrate on the following issues. We try to reveal the relationship between bank competition and financial stability and decide whether competition between banks is supportive of financial stability or not. Mainly we shed the light on three questions: Does bank competition decrease financial stability? Is the effect of bank competition on financial stability dependent on the measures we use? Does the influence of bank competition on financial stability change over time? We endeavour to verify the following three hypotheses in this study:

Hypothesis 1: Bank competition reduces financial stability.

Motivation: Strong competition among banks pushes them to bear more risks which causes fragility of the financial system as a whole. We want to find out whether this statement is applicable in today's countries.

Hypothesis 2: The effect of bank competition on financial stability does not depend on what measures of competition and stability we use.

Motivation: The values of any measures representing bank competition or financial stability should somehow reflect the same situations, events, states and movements happening in the banking sector and the financial system. Hence, we believe that the selection of proxies does not matter. The key question is if we are even able to measure bank competition and financial stability accurately.

Hypothesis 3: The effect of bank competition on financial stability changes over time (for example during a crisis).

Motivation: Generally, changes over time occur especially during strong events like, for instance, a financial crisis. Hence, it is expected that the effect of bank competition on financial stability is also different over time.

We want to analyse these claims, their significance and persistence, using dynamic GMM estimator—the Arellano & Bond (1991) model.

1.4 Literature Review

We offer a brief review of literature dealing with the relationship between bank competition and financial stability. First, we focus on the literature which studies whether the relationship between strong bank competition and financial stability is negative or positive, respectively.

C*ompetition-fragility hypothesis* supposes that it is the banks' propensity to take excessive risks what leads to fragility. Some investigations estimate that less competitive and more saturated banking systems represent more stable financial systems, as higher incomes should discourage excessive risk-taking and create a buffer against fragility. The oldest paper we mention in this study is from Marcus (1984) and deals with the traditional view of bank finance where the Federal Deposit Insurance Corporation[1] ignores the influence of potential bankruptcy costs. According to this traditional view, banks can maximize their value by exploiting non-risk-rated deposit insurance. However, it pays no attention to the possible loss of valuable bank charter caused by insolvency. Marcus (1984) shows that acknowledgment of this effect makes the optimum of financial policy different and can encourage both, the risk-averting and the risk-taking behaviour. When he takes into account the devaluation of bank charter he finds out that the risk-taking approach is more likely to occur. This means that if the bank system is somehow deregulated (by easier entry or devaluing charters) the probability of insolvency increases. In context of our study we can say that if the bank competition is not restricted, because it is positively influenced by deregulation, there is a higher risk of financial instability.

Chan et al. (1986) also comes up with similar results. He explains the decrease of quality of bank assets in the beginning of 1980's. Whether loan applications are properly checked or not determines the quality of the bank assets. The quality

[1] Federal Deposit Insurance Corporation operates as an independent agency which provides deposit insurance promising the safety of accounts of depositors in member banks.

preservation then depends on how much extra profit might come out of this proper examination of the borrowers. That, in turn, depends on the possibility to reuse the information. In their paper, Chan et al (1986) studied two changes which had occurred in banking system back then: the increase in bank competition and intensification of temporal volatility in credit risks of a borrower. The stronger bank competition had decreased the informational surplus of banks and the volatility in borrower credit risk had weakened information reusability. Therefore the proper examination of loan applications had diminished which had worsened the quality of bank assets. They also established that a rise in deposit insurance premium lowers proper asset examination and leads, once again, to worsened quality of bank assets.

Despite using a different model, Keeley (1990) presents similar results to Marcus (1984) and Chan et al. (1986). Marcus (1984) applies the options model in his paper, while Keeley (1990) estimates by state preference model. He investigates the theory that the rising competition causes decline in bank charter values, which intimidates banks to increase asset risk and reduce capital, hence augmenting the default risk. His results illustrate that deregulation leads to higher competition of banks and pressure on profits which, in turn, decreases the monopoly rents (a measure of market power). That induces a problem between bank-owners and the deposit insurance funds because the bank-owners are suddenly inclined to take on additional risk. The overall financial stability drops due to such risk-taking behaviour.

Boot & Thakor (1993) examine the possibility of a bank regulator prioritizing his own interests over the social welfare and investigate the impact of this on regulatory reform in banking and deposit insurance. As a side finding they discover, similarly to the results of Chan et al. (1986) and Marcus (1984), that with higher competition, the motivation of banks to properly examine loan applications from borrowers is lower, which worsens financial stability.

In their book, Allen & Gale (2000), study the development of financial system in some of the most developed countries and estimate models of several problematic aspects of financial system design. They also show that in more competitive systems, the incentives for individual banks to properly examine borrowers is lower and that this contributes to risk of fragility of financial system. They claim this occurs because in the more competitive systems, banks receive less informational rents from the relationship with borrowers. Hence their book suggests that a more competitive environment, where the institutions and government intervene less and where there are fewer entry barriers and limitations, would induce more fragility (as it happened in the 1970s and 1980s in the USA and in some emerging markets). Furthermore,

they demonstrated that perfect competition[2] could, at first, help banks to avoid providing liquidity to other banks that had suffered a temporary liquidity shortage. In a system where all bank are price-takers and their buying or selling transactions are supposed to have no impact on the rest of the market, none of the banks is motivated to provide liquidity to a bank in trouble. This bank will fail in the end which will have negative consequences for the whole sector. Nevertheless, Saez & Shi (2004) argue that a small amount of banks is able to collaborate with strategical plans and voluntarily provide liquidity to a bank with temporary liquidity shortage.

Boot & Greenbaum (1993) and Matutes & Vives (2000) studied the financial system where the banking sector was regulated and thus competition was limited. They claim that, in these circumstances, the banks have more opportunities to earn revenues and have a relatively strong protection in the form of capital. Hence the banks do not feel such pressure to take excessive risk and this supposedly has a positive effect on the financial system stability. While investigating liberalization, moral hazard in banking, prudential regulation and whether capital requirements are a sufficiently deterrent for gambling behaviour, Hellman et al. (2000) similarly found that, in banking sector with barriers to entry and restrictions of competition, banks are able to earn more and thus do not tend to deal with extra risky business. That is beneficial because it helps prevent financial fragility. Furthermore, their main finding is that the capital requirements are not a sufficient tool for discouraging banks from gambling and excessive risk-taking behaviour in competitive markets. The deposit rates ceilings is another regulatory instrument that is necessary as well.

Negative relationship between bank competition and financial stability is also shown in a paper from Matutes & Vives (1996). They claim that welfare becomes better with deposit insurance because, thanks to the insurance, collapse is forestalled, the market is extended and frictions (transport costs) are minimized. Nevertheless, simultaneously, deposit insurance may raise stronger competition among banks, causing a decline in the benefits of diversification and eventually increasing the likelihood of collapse. In addition, they mention that concentration should not be used as a measure of bank competition because it is not a consistent signal. Likelihood of a bank's distress is given endogenously by what the depositors assume and multiple equilibriums may occur.

[2] "*Perfect competition is the opposite of a monopoly, in which only a single firm supplies a particular good or service, and that firm can charge whatever price it wants because consumers have no alternatives and it is difficult for would-be competitors to enter the marketplace."* (Investopedia, 2015)

Smith (1984) shows that more bank concentration and less bank competition may be positive for liability risk as well. He suggests that if the information about the distribution of probability of depositor's liquidity needs stays private and relationships in the banking sector last longer due to lower competition, then less competition means increase in stability.

Cordella & Yeyati (2002) investigate the effect of a rise in competition, due to deregulation and relaxation of barriers to entry, on the risk-taking behaviour of banks and the determination of interest rates in the bank competition model for deposits. Their findings illustrate that in such model there is a positive correlation between the higher competition and interest rates and between higher competition and risk-taking behaviour. Moreover, higher competition lowers profit. With premiums of risk-adjusted deposit insurance, however, banks reduce their cost of funding by committing to minor asset risk even in a more competitive system.

Similarly, Perotti & Suarez (2003) examine the trade-off between competition and stability but in a dynamic scenario with the charter value depending on market competition in the future. Banks usually lean towards speculative lending where they balance their short-term gains from the risk they had to take with the charter value risk loss. The results indicate that due to active policies which deal with bank failures and mergers of troubled banks with the heathy ones (which is connected with greater concentration and lower competition), the motivation of banks to be more prudent and careful to take risks is higher. This results in increase charter value of the healthy banks that can strengthen stability and lower the probability of a systemic banking crisis. Simultaneously, their model emphasizes the significance of considering the effect of dynamic incentives for banks.

The competition-fragility hypothesis is also supported by Boyd et al. (2006), Uhde & Heimeshoff (2009), and Yeyati & Micco (2007) who discovered that in an environment with higher bank competition, bank collapse is more frequent.

There are also a few papers with ambiguous results, for example, Allen & Gale (2000). They ask a question: "What are the efficient levels of competition and financial stability?" They applied various models in their study and their findings indicate that the results of the models are not all the same. They claim that the interplay between bank competition and financial stability is complex with some models predicting that competition increases stability.

Another study which brings heterogeneous findings is from Beck et al. (2006). They study bank system fragility, bank competition and bank concentration and the

relationship among them. They investigate the effect of the national bank concentration, bank regulation and national institutions on the probability of a systemic banking crisis in a given country. They used cross-country data of 79 countries and found that, in countries with lower bank concentration, a systemic crisis is less probable. In addition, in countries where national institutions and regulatory policies restrict competition, the probability of systemic banking crisis is higher. However, contrary to what was expected, the data did not support the competition-fragility hypothesis which supposes that more competition causes greater fragility. It seems that both bank concentration and competition, are positively correlated with financial stability, as Beck (2008) and Matutes & Vives (1996) also point out, indicating that bank concentration is not an appropriate proxy of bank competition.

The first study that supports the competition-stability hypothesis that we mention is Canoy et al. (2001). They studied competition from both theoretical and empirical point of view. Although the theory is likely to indicate a negative relationship between bank competition and financial stability, their empirical investigation exposes that there is a number of forms of competition which do not harm financial stability. For example, growth in competition among already active banks affects financial stability in a very limited way. Despite this, they encourage the regulation of bank competition by claiming that it lowers the competition and hence increase the stability.

In his paper, Beck (2008) studied and compared the difference between the bank-level and more recent cross-country papers' results. For instance, Keeley (1990) uses bank-level data while we are going to use cross-country data like, for example, Beck et al. (2006). He argued that, based on bank-level studies, it is not possible to conclude any explicit or unambiguous verdicts about the relationship between bank competition and financial stability while the findings from cross-country studies show mostly a positive interplay. Moreover, he provides two inferences from the review of related empirical and theoretical literature. First, while investigating a similar topic, it is important to take the reciprocal impact of market structure and regulatory policies into consideration. Second, bank concentration, even though it is a quite popular proxy of bank competition, is not really an appropriate one. Any potential impact it may have on financial stability occurs via different channels than bank competition's influence does.

Boyd & De Nicoló (2005) question the argument that profits get higher with the banks' market power and thus bank stability. They argue that this claim omits a potential effect of the market power of banks on behaviour of firms. Rather than

banks speculating about the riskiness of their assets, more likely, borrowers are the ones who choose how risky their investments, covered by bank loan, will be. Boyd & De Nicoló (2005) argue that a concentrated banking system improves market power. Under such circumstances, banks are able to increase their interest rates charged to firms. Nevertheless, their estimations indicate that while firms are expecting higher risk with these increased interest rates being set, the likelihood of loans becoming non-performing increases. Hence, with their model, they found a relationship with a positive correlation between bank concentration and bank fragility and thus a greater likelihood of systemic risk as well. Despite this, lower lending rates encourage borrowing, as they diminish the cost to investors, support profitability of firms and lower the risk of credit portfolios of banks, thus leading to a more resilient financial system overall.

Similarly, Caminal & Matutes (2002) claim that banks in an environment with low competition have a higher propensity to engage in risk-taking behaviour than in a more competitive environment. The risk-taking behaviour again leads to greater likelihood of systemic failure.

Mishkin (1999), is also an advocate of the competition-stability hypothesis. He investigates financial consolidation and its dangers and opportunities and supports two of the most classical arguments of the proponents of the competition-stability view. The first one is that there it is the smaller number of banks in a concentrated system what makes the system less stable. The second one is that the policy makers are more worried about bank failures because it would cause a much bigger system shock than for a system where there are lots of banks. Banks in these concentrated environments are more supported by subsidies and "too-big-to-fail" policies. Such policies are based mainly on the size of the bank and the assumption that it is almost impossible for it to fall. Mishkin (1999) found out that that such policies boost risk-taking incentives greatly and thus the instability of banking system increases. Moreover, he claims that big banks in a concentrated system can intensify the risk. It means that if concentration increases or decreases financial stability will move in the same direction.

In addition, Schaeck & Cihak's (2012) and Berger's (2009) papers provide evidence of a negative relationship between competition and systemic bank fragility. Larger capital ratios in concentrated systems offset stronger tendencies to take risk. Schaeck et al. (2006) discovered a negative link between competition of banks and systemic bank fragility. According to them a higher competition leads to smaller probability of systemic distress and it takes longer for a crisis to start in a competitive bank system.

Overall, it seems that the positive link between financial stability and bank competition was shown in cross-country studies as opposed to bank-level studies and in more recent papers rather than older ones. Cross country studies, however, bring mixed results regarding bank concentration, one of the bank competition measures. This only confirms what some of the papers suggested—that concentration is not an adequate measure of bank competition. This is because the impact of bank concentration on financial stability happens through different channels than lack or surplus of competition. Unlike the relatively clear findings obtained from the cross-country studies, the conclusions of bank-level studies are somewhat ambiguous. This phenomenon occurs probably because bank-level studies do not take into consideration the regulatory framework. (Beck, 2008)

Chapter 2: Effects of Bank Competition on Financial Stability

In the beginning of the second chapter we describe in detail the methodology used in this paper. We also present our dataset, its source, the range of time period used, number of countries included and we define all variables and their measures. In the end of this chapter we explain the results of our econometric investigation for each of our hypotheses.

2.1 Methodology

In this section we briefly describe and explain the econometric technique employed in this study. A short overview of the term stationarity and testing methods of this assumption will be provided. The reason why we chose the Arellano & Bond (1991) panel data model will be included as well as the detailed instructions of the model.

Stationarity is one of the main assumptions in all time-series analyses. Granger and Newbold (1974) proved that the results of OLS methods used on non-stationary data are most likely to be very misleading. Such situation is called spurious regression. Even though their study was originally meant for time-series models, its findings can also be employed in panel datasets. (Nguyen & Nilsson, 2014) The spurious regression sets in when trending over time appears in the dataset. Other reasons why it is necessary to have the data stationary for econometric modelling were specified and include the following. The structure of stationary series does not change over time. The time of a shock consequence is infinite if the data are not stationary. The assumptions for asymptotic analysis are not met either in the case of non-stationarity. Several subsequent studies have proven the effect of non-stationary variables in panel datasets. However, they have also shown that it is less damaging in the case of panel dataset than in case of single time series as one cross-sectional unit in panel dataset is averaged over less than time-series. (Nguyen & Nilsson, 2014) The bottom line is that almost no econometric model can properly evaluate a dataset with non-stationary series. In order to gain reliable estimations, non-stationary data have to be transformed into stationary data.

Examples of non-stationary processes are deterministic trend and random walk with or without drift. In the case of deterministic trend processes, the trend needs to be subtracted, then the data become stationary. Processes with random walk are

converted into stationary dataset by subtracting y_{t-1} from y_t, this technique is called differencing. A random walk process with both drift and deterministic trend, has to be detrended as well as differenced in order to obtain stationarity.

Currently, there are numerous stationarity tests available that have diverse structures which address the assumptions we make about the dataset. Testing stationarity on a panel is more difficult than in the case of simple time-series data. Some obstacles may occur that make the testing even more complicated: a panel with an unobserved heterogeneity which is often present within the panel, a panel with cross-sectional dependence or an unbalanced panel. In the chapter 2.3 below we provide the results of the stationarity test. Due to the unbalancedness of our panel we applied the Fisher's panel unit root test developed by Maddala & Wu (1999).

While choosing the right technique for our research we took into consideration several facts which led us to pick the dynamic GMM estimator—the **Arellano & Bond (1991)**. According to Roodman (2006), İskenderoğlu & Tomak (2013), and Mileva (2007), it is an appropriate estimator if:

- The dependent variable is a function of its own past realizations which means we have to include a lag of the dependent variable (y_{t-1}) to be one of the independent variables. This makes the whole model dynamic and gives rise to autocorrelation.
- The dataset is a panel with small T (a small number of time periods) and large N (many individuals).
- The functional relationship is linear.
- Fixed effects of individuals occur. These time-invariant, unobserved country-specific characteristics (for instance, demographics, geography) may be correlated with explanatory variables.
- The model contains endogenous variables which are correlated with past and probably current realizations of the regression error. The causal relationship may go both directions (the independent variables influence the dependent one and vice versa). The Arellano & Bond (1991) model was criticized by the Arellano & Bover (1995) for cases when the model does not contain any strictly exogenous variables and T (number of time periods) is very small. Our panel consists of 15 time periods, which should be enough to overcome this limitation.

- Heteroscedasticity and autocorrelation (within countries, not across them) is present.

The Arellano & Bond (1991) model controls for these issues that can occur while estimating. The equation estimated in this study is:

$$Stability\ Measure_{it} = \beta_0 + \beta_1 * Stability\ Measure_{i,(t-1)} + \\ + \beta_2 * Competition\ Measure_{it} + \beta_k X_{kit} + u_{it}\,, \quad (1)$$

where i = 1, N = 205 countries, t = 1, T = 15 years, and X_{kit} is a set of the following control variables: real GDP growth, inflation, real interest rate, change of terms of trade, depreciation, and credit growth. u_{it} is an error term which consists of e_{it} (observation-specific errors) and v_i (unobserved time-invariant, country-specific effects):

$$u_{it} = e_{it} + v_i\,. \quad (2)$$

To deal with the endogeneity problem and, to some extent, the individual fixed effects problem, the Arellano & Bond (1991) model uses lagged levels of the endogenous variables and all available past information of the dependent and the independent variables as instruments. This forestalls the correlation between the endogenous variables and the error term—as the endogenous regressors are pre-determined. In order to solve the problem with time-invariant individual fixed effects, the first difference of the original regression equation is made:

$$\Delta SM_{it} = \gamma_0 + \gamma_1 \Delta SM_{i,(t-1)} + \gamma_2 \Delta CM_{it} + \gamma_k \Delta X_{kit} + \Delta e_{it}, \quad (3)$$

where i = 1, N = 205 countries, t = 1, T = 15 years, SM_{it} is a financial stability measure, $SM_{i,t-1}$is its lag, CM_{it} is a bank competition measure, X_{it} is again a set of the control variables listed above, and u_{it} is the error term. (Mileva, 2007) The model is treated as a system of equations, where each equation stands for each time period. Time period t = 3 is the first one where it is possible to use an instrumental variable. The equation looks as follows:

$$SM_{i3} - SM_{i2} = \gamma_0 + \gamma_1(SM_{i2} - SM_{i1}) + \gamma_2(CM_{i3} - CM_{i2}) + \gamma_k(X_{ki3} - \\ - X_{ki2}) + (e_{i3} - e_{i2}). \quad (4)$$

In the equation (4), SM_{it} is not correlated with the error term and thus acts as a valid instrument because it is not correlated with $(e_{i3} - e_{i2})$, but only with $(SM_{i2} - SM_{i1})$. The

first difference of the regressors eliminates the problem with the individual fixed effects v_i because, since the fixed effects are time-invariant, the equation gives us:

$$\Delta u_{it} = \Delta e_{it} + \Delta v_i\,, \tag{5}$$

$$u_{it} - u_{i,(t-1)} = \left(e_{it} - e_{i,(t-1)}\right) + (v_i - v_i) = \left(e_{it} - e_{i,(t-1)}\right). \tag{6}$$

Although the first differencing eliminates the fixed effects, it simultaneously makes the lagged dependent variable correlated with the error term, which may bring biased results. For that reason, the approach of instrumental variables is employed. In the concept of this estimator, the instrumental variables may be: lags of the endogenous lagged dependent variable, lags of the endogenous independent variables, lags of the exogenous variables, and current values of the exogenous variables. (Davis & End, 2010)

The equation for the next period is:

$$SM_{i4} - SM_{i3} = \theta_0 + \theta_1(SM_{i3} - SM_{i2}) + \theta_2(CM_{i4} - CM_{i3}) + \theta_k(X_{ki4} - \\ - X_{ki3}) + (e_{i4} - e_{i3}), \tag{7}$$

where SM_{i1} and SM_{i2} are valid instruments. Hence, to generalize it, the set of valid instruments in period *T* is ($SM_{i,1}$, …, ($SM_{i,(T-2)}$)). (Naveed, et al., 2011)

The problem of autocorrelation caused by the dependent variable being lagged is solved as the lagged dependent variable is first-differenced and instrumented as well. (Mileva, 2007) In short, the Arellano & Bond (1991) model makes the first difference to remove the individual fixed-effects problem and uses all available lags of the independent and dependent variables as instruments to cope with the endogeneity problem.

To check the validity of the results, Arellano & Bond (1991) and Arellano & Bover (1995) came up with two specification tests: the Sargan test and the second order autocorrelation test. The Sargan test of over-identifying restrictions checks the instruments' overall validity. The second order autocorrelation test verifies the second order autocorrelation in the residuals because its absence is required so that the proposed instruments are valid. While the autocorrelation of first order of error term is expected, its presence or absencedoes not affect the results' validity. (İskenderoğlu & Tomak, 2013) If these conditions are satisfied, there is no reason to consider the results to be invalid and the Arellano & Bond (1991) estimator will provide consistent results. (Nguyen & Nilsson, 2014)

2.2 Data Description

With respect to the data availability we use annual unbalanced panel data over the period 2000 – 2014 for 205 countries. The source of the measures of the two variables of our main concern (financial stability and bank competition) is The Global Financial Development Database available at the World Bank website (2016a). Z-score represents financial stability and the Boone indicator represents bank competition while we analyse and comment on our first hypothesis. To test our second hypothesis we use 6 different measures of financial stability (z-score, capital adequacy ratio, non-performing loans, bank credit to bank deposit, return on assets (ROA), and return on equity (ROE)) and 3 different measures of bank competition (the Boone indicator, the Lerner index and concentration) from the same database. To discuss our third hypothesis we employ z-score as the financial stability measure and estimate the effect of the 3 bank competition measures on it. While choosing control variables influencing financial stability, we got inspired by several cross-country studies investigating this question: Beck, Demirgüç-Kunt and Levine (2006), Demirgüç-Kunt, Detragiache (2002), Boyd, de Nicoló and Jalal (2006), Schaeck, Cihak and Wolfe (2006), Schaeck, Cihak (2012). We use real GDP growth, inflation, change of terms of trade, real interest rate depreciation, and credit growth. These data are also available at World Bank.

In the Table 1 below we provide the descriptive statistics for all of our variables and their measures.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
id	3075	103.00	59.19	1.00	205.00
year	3075	2007.00	4.32	2000.00	2014.00
ZS	2622	11.51	7.93	-5.04	40.75
BCTBD	2642	92.28	53.93	17.43	432.06
NPL	1564	6.88	6.88	0.10	37.30
CAR	1583	16.31	5.01	6.70	36.00
ROA	2584	1.44	1.46	-4.37	7.30
ROE	2599	14.28	13.81	-52.49	77.06
BI	2385	-0.07	0.14	-0.88	0.31
LI	1859	0.27	0.13	-0.10	0.76
CONC	2198	72.59	19.80	23.78	100.00
GDPG	2908	4.01	4.57	-14.15	25.26
I	2904	6.84	9.76	-17.22	74.30
RIR	2128	6.71	9.24	-28.40	48.34
CHTT	2175	140.72	1939.77	-104.91	27316.27
D	2448	0.03	0.21	-1.00	2.06
CG	2608	0.48	0.49	0.00	2.27

Source: author's computations.

The Table 2 below presents the correlation matrix.

Table 2: Correlation Matrix

	I	GDPG	CHTT	RIR	D	CG	CONC	LI	BI
I	1	-	-	-	-	-	-	-	-
GDPG	0.060	1	-	-	-	-	-	-	-
CHTT	0.019	0.034	1	-	-	-	-	-	-
RIR	-0.479	-0.099	-0.045	1	-	-	-	-	-
D	0.410	-0.190	-0.006	-0.035	1	-	-	-	-
CG	-0.319	-0.149	-0.001	-0.184	-0.101	1	-	-	-
CONC	-0.034	0.031	-0.072	0.030	-0.003	-0.009	1	-	-
LI	-0.016	0.196	-0.003	-0.147	-0.061	-0.014	0.126	1	-
BI	-0.090	-0.007	0.022	0.041	-0.023	-0.032	-0.012	0.021	1

Source: author's computations.

2.2.1 Measures of Financial Stability

Z-score or, in other words, distance to default, compares returns and capitalization with risk indicator, volatility of returns. It is calculated according to the following formula:

$$Z_{it} = \frac{ROA_{it} + {}^{E_{it}}/_{TA_{it}}}{\sigma_{ROA_{it}}}, \quad (8)$$

where ROA_{it} is the rate of return on assets, ${}^{E_{it}}/_{TA_{it}}$ is the equity ratio to total assets, and $\sigma_{ROA_{it}}$ is the return on assets' standard deviation. (Havranek, Zigraiova, 2015)

Z-score is very popular as a measure of financial stability. It is inversely proportional to the likelihood of failure of financial institutions. This means the likelihood of the value of the institution's debt becoming higher than the value of its assets. The higher the z-score is, the lower the probability of insolvency. There are some advantages and disadvantages of using this measure. One benefit is that it is possible to use z-score as a financial stability indicator even for institutions for which any highly-developed market based data do not exist or are not obtainable. Another advantage of z-score is that it allows the risk of insolvency to be compared across various groups of institutions. Even though the institutions may vary in type of ownership or have different objectives, they all are exposed to the risk of default. In contrast, the disadvantage arises from the fact that z-scores are based on accounting data only. Thus, the quality of the data is derived from and dependent on the quality of the general accounting and the auditing structure. Hence, if the reported data are smoothed down by financial institutions, the overall appraisal of financial stability might be more positive than it is in reality. Finally, Z-score variable also takes into consideration each institution individually and potentially ignores the risk of the fail of one financial institution leading to a loss of other financial institutions. (Cihak et al., 2012)

Non-performing loans (NPL) are all loans in which cases the scheduled payments have not been made for at least 90 days, summed up and divided by total gross loans (total value of the loan portfolio). The limit is set to 90 days because it is assumed that the loans are about to be in default really soon or they already are if the scheduled payments have not made within this time period. The probability of a non-performing loan to be repaid in full is usually considered to be very low. Nevertheless, if the payments of a non-performing loan start to be made again, the loan becomes re-performing even if some of the missed payments are still overdue. According to Cihak & Hesse (2010), non-performing loans are not a good measure of

financial stability as they are an indicator of only one possible risk that banks have to face and they do not represent the bank's soundness as a whole. In spite of that NPL is a commonly and quite frequently used measure of financial stability.

Bank credit to bank deposits are financial funds which the private sector borrows from domestic money banks, divided by total deposits. Domestic money banks include commercial banks and financial institutions which provide the service of transferable deposits (for example demand deposits). Total deposits in the denominator are composed of demand, saving, and time deposits of deposit money banks. Bank credit to bank deposit ratio is used by investors and policy makers to evaluate and compare practices of lending institutions. The higher the ratio is, the lesser liquidity the bank possesses. That can mean that the bank does not have enough funds to cover any sudden and unexpected money requirements and it is dependable on borrowed funds too much. If the ratio is low, the bank is not facing the risk of covering unforeseen money requirements. Nonetheless, it means that the bank's earnings may be much lesser than its potential. (Investopedia, 2016d) Even though bank credit to bank deposits ratio may be considered a normal financial stability measure it, according to our current knowledge, has not been used yet to represent financial stability in studies discussing the impact of bank competition on financial stability.

Capital adequacy ratio is known under the abbreviation **CAR** or also CRAR as capital-to-risk weighted assets ratio. It is the bank's capital as a share of the bank's risk weighted assets. Bank's capital, the numerator, consists of two components: tier one capital and tier two capital. Tier one capital absorbs losses without a bank terminating trading and tier two capital absorbs losses in case of insolvency. CAR is used to determine the efficiency and stability of financial systems all around the world and to protect and help depositors. The larger the bank's CAR, the grater is the level of protection of depositors' funds. The minimum capital adequacy ratios are important for ensuring the banks dispose of adequate amount of reserves to absorb losses before they enter insolvency and lose the funds from depositors. CAR lowers the risk of insolvency of the banks and by that it supports the stability and efficiency of financial systems because in case of a bank insolvency, the confidence in the whole financial market system is shaken and unsettled. (Investopedia.com, 2016a)

Return on Assets or **ROA** provides a notion of how profitable an institution (a bank, a company, etc.) is comparative to the total assets it possesses. It shows how effectively the assets are used to make profits. In the numerator of its formula is the net income (company's annual earnings), and in the denominator of the formula are

the total assets. The assets compose of equity and debt and both of these financing types are used to finance the operations of the bank. Investors can infer from ROA how effectively the bank makes net income out of the funds it has to invest. The larger the ROA figure, the better, as the bank obviously invests less and earns more money. For instance, if bank A earns $2 million net income and has $10 million of total assets, bank A's ROA is 20%. Nevertheless, if bank B has the same net income but its total assets are $20 million, ROA of bank B is 10%. This example clearly illustrates that bank A, the bank with larger ROA, is more effective in transforming its investments into profits. The ROA indicator is substantially dependent on the industry, so from this point of view it should be a good measure of financial stability.

Return on Equity or **ROE** (also known as RONW – Return on Net Worth) indicates the profitability of an institution based on how much profit it makes with the money invested by shareholders. The numerator of the formula composes of net income that the institution earns and the denominator is the amount of shareholders' equity. Similarly to ROA, it is expressed as percentage. ROE provides a very good comparison of the profitability among institutions within the same industry and this is why it is considered to be a good measure of financial stability in the context of its influence from bank competition. (Investopedia.com, 2016b)

2.2.2 Measures of Bank Competition

Measuring bank competition is even more difficult than financial stability. This is why we can test our hypothesis with only three bank competition measures while we have six measures of financial stability. Currently, there are more than three bank competition measures (H-Statistic, Herfindahl-Hirschman index, market fluidity etc.) that exist, but data availability prevents us from using some of these potential metrics. In our paper, we use those three that had data available for the years 2000-2014.

The **Boone indicator** is a measure of bank competition which is based on profit-efficiency in the banking sector. It is represented by the elasticity of profits divided by marginal costs. The elasticity is calculated as the regression of logarithm of profits on the logarithm of marginal costs. The obtained coefficient is the elasticity. The idea of the Boone indicator is that higher efficiency of banks implies an increase in profits. Therefore, the higher the Boone indicator, the weaker the competitive behaviour of financial institutions is. In this paper, we use this indicator calculated by the methodology of Schaeck and Cihak (2010), in which marginal costs are used instead of average costs. The country level values were procured from primary bank-level data from Bankscope. The Boone indicator is quite new, hence it has not been used

much yet as a measure of bank competition in the framework of its relationship with financial stability. As far as we know, it has not been used in combination with all the measures of financial stability in this context either.

The **Lerner index** indicates the market power in the banking sector. It is calculated as the difference between output prices and marginal costs, relative to prices. The prices are obtained by dividing total bank revenue by assets. The marginal costs are a result of estimation of translog cost function with regard to output. The calculation method used is as described by Demirgüç-Kunt & Martínez Pería (2010). The larger the value of the Lerner index, the weaker the bank competition is.

Concentration (in fact, 5-bank asset concentration) is the sum of all assets of the five largest banks of a given country divided by total commercial banking assets in that country. Total assets are: total earning assets, cash and due from banks, foreclosed real estate, fixed assets, goodwill, other intangibles, current tax assets, deferred tax, discontinued operations and other assets. (World Bank, 2016a) The larger concentration is the weaker bank competition is.

2.2.3 Other Control Variables

In this part, we describe our additional control variables—since bank competition is, of course, not the only factor influencing financial stability—we have to also include other independent variables in our models.

Real GDP growth captures a macroeconomic development which affects the quality of bank assets. (Demirgüç-Kunt, Detragiache, 2002) It is expressed as a percentage which indicates a change in individual countries' gross domestic product from one period to another, in our case from one year to the next one. The rate of growth of real GDP is a constant dollar number and so it can be considered a consistent measure, free of skews from phases of extreme deflation or inflation. GDP is the sum of consumer, business, and government spending plus the total of exports minus imports. To take into consideration the inflation and provide the real GDP values, the GDP has to be divided by 1 plus inflation since the base year (in our case, the base year is 2010). Government designates and periodically updates the base year so that it can be used as a general point of comparison for economic data. After this computation the growth rate is calculated: real GDP growth at T= (real GDP at T - real GDP at (T-1)) / real GDP at (T-1). (Investopedia.com, 2016c)

Inflation displays the rate of change of price in the whole economy. It is measured by the GDP price deflator which is calculated by dividing nominal GDP (in current

local currency) by real GDP (in constant local currency) and then multiplied by 100. Inflation is, like real GDP growth, a macroeconomic factor playing an important role in influencing bank assets quality.

Change of terms of trade equals to (the terms of trade at T - the terms of trade at (T - 1)) / terms of trade at (T - 1). The terms of trade measures the country's trading efficiency, how much goods and services it is able to export compared to how much it imports. It actually means dividing the total amount of exports by total amount of imports and then multiplying by 100. If the result is larger than 100%, more capital is coming in than going out, and vice versa. The dataset is in constant local currency. (Worldbank.com, 2016b)

What is meant by the **real interest rate** is the lending interest rate measured by the GDP deflator to ensure it is adjusted for inflation. The lending interest rate represents the cost of funds of banks and directly influences bank profitability.

The variable **Depreciation** refers, in reality, to the rate of exchange rate depreciation. The exchange rate is the official one, designated by the national authorities or in the exchange market which is legally sanctioned. The exchange rate is an expression of local currency units relative to the US dollar and is an annual average, computed from monthly averages. The degree of exchange rate depreciation measures to what extent are banks exposed to foreign exchange risk and how vulnerable are they to unexpected or impulsive capital outflows induced by the demand for the currency.

Credit growth itself is very important. The financial sector would not be so efficient and it would lack the ability to provide proper financial tools and services without credit growth. Extreme credit growth, however, has been indicated as one of the key factors linked with banking crises. (Demirgüc-Kunt & Detragiache, 1997, Kaminsky & Reinhart, 1999) Credit growth stems from the undue optimism of households and firms regarding their future income and asset prices. They borrow more money than they are able to redeem when their future income is not what they expected. It leads to an increase in non-performing loans and, if it is an immoderate rise, the country falls into a crisis (as it happened, for example, in 2007 in the USA). The advantage of this measure is that it is relatively simply observable. Moreover, it may predict the financial instability. The disadvantage is that this variable is not able to capture the point when the problems for the financial sector have already set in. (Cihak et al., 2012)

2.3 Winsorising and Testing of Stationarity

The first step of the econometric investigation, preceding the econometric modelling itself, is data inspection followed by potential modifications of the data. Bearing this in mind, we let Stata draw scatter plots and linear plots which enabled us to detecte some outliers in our dataset. To get rid of this problem, which could distort the estimation results, we winsorized the data. Winsorizing (or winsorization) is a method that sets the values of the outliers to a specified percentile of the data, so that they are less different from the normal distribution curve. For instance, winsorization of 90% would set both the bottom and the top 5% tails of data to the value of the 5^{th} percentile and the 95^{th} percentile respectively. 90% winsorizing is only one of many options, in this paper, we apply 99.9% winsorizing which means we only transform 0.05% of non-missing data on each side.

As explained earlier, it is important to test stationarity before launching into the econometric estimation itself. Because our data are unbalanced panel data we implement Fisher's test. The null hypothesis of this test assumes that all series are non-stationary and the alternative indicates that at least one series in the panel is stationary. The null hypothesis of non-stationarity is strongly rejected for all our variables at 1% significance level. All our variables should be stationary also in theory. Hence we conclude that the variables are stationary and we proceed with the estimation of the Arellano & Bond (1991) GMM model without any further modifications.

2.4 Econometric Investigation

The Econometric Investigation section presents the actual results of our three hypotheses estimated by the Arellano & Bond (1991) GMM model. The model is employed on yearly, unbalanced, country-level panel data in years 2000 – 2014 of 205 countries. Our equation can by generally expressed as follows:

$$Stability\ measure_{it} = \alpha + \beta * Stability\ measure_{i,(t-1)} + \\ + \gamma * Competition\ Measure_{it} + \delta_{kit} X_{kit} + e_{it} \quad (9)$$

where i = 1, N = 205 countries, t = 1, T = 15 years, and X_{it} is a set of the control variables: real GDP growth, inflation, real interest rate, change of terms of trade, depreciation, and credit growth.

2.4.1 Hypothesis 1

Our first hypothesis states that bank competition reduces financial stability. The thought behind this is that the financial system becomes more fragile with increasing competition among banks. We want to find out whether this statement is applicable on today's countries. Table 3 shows the results of the Arellano & Bond (1991) model with z-score, a financial stability measure, as a dependent variable and the Boone indicator as the main independent variable—representing bank competition. To test our first hypothesis, we use the Boone indicator because it is theoretically a better measure and, furthermore, it is quite new concept and has not been employed in this context much yet. As mentioned above, the independent variables are the following: lag of z-score (l.ZS), the Boone indicator (BI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), and credit growth (CG). We can see that lag of z-score, the Boone indicator, GDP growth, depreciation, and credit growth are statistically significant at 1 percent significance level and change of terms of trade at 5 percent significance level.

As explained above, larger z-score indicates higher stability of the financial system and higher the Boone indicator means weaker bank competition. Therefore, we can reject the hypothesis of reduced financial stability, the *competition-fragility hypothesis*, when the Boone indicator decreases (i.e. higher competition) while z-score increases and the other way around, ceteris paribus. In Table 3, we can see it is the case. While financial stability increases, the Boone indicator decreases, i.e. we can reject the hypothesis of reduced financial stability and we can say the bank competition does not reduce financial stability.

The Arellano & Bond (1991) model is verified by two specification tests as described in 2.1 Methodology section above. They are the Sargan test of over-identified restrictions and second and first autocorrelation tests. The results of these tests are presented in Table 3 as well. In the context of the Arellano & Bond (1991) the p-value of the Sargan test should be over 0.05 so that we cannot reject its zero hypothesis of over-identifying restrictions being valid. In this case, the p-value really is larger than 0.05 which means the Sargan is insignificant and our instruments are valid. This model also satisfies the first and second order autocorrelation conditions of the estimator. These conditions require the first order autocorrelation AR(1) to be significant (not necessarily, as explained in 2.1 Methodology) and, conversely, the

second order autocorrelation AR(2) to be insignificant. Table 3 indicates that AR(1) really is significant and AR(2) truly is insignificant.

Table 3: the Arellano & Bond (1991) estimator results

	Z-Score x BI
l.ZS	0.3406884**
	(22.72)
BI	-0.709555**
	(-2.83)
GDPG	0.0267195**
	(6.37)
l.I	-0.0018612
	(-0.61)
CHTT	-0.0000132*
	(-2.31)
RIR	0.0031599
	(0.99)
D	-0.8709864**
	(-3.74)
CG	-1.001893**
	(-3.15)
constant	6.627989**
	(17.23)
AR(1)	-2.1125**
AR(2)	0.90456
Sargan test	76.74113
Wald test	779.96**

Source: author's computations.
*Notes***:** * 5 percent significance level; ** 1 percent significance level; z statistics shown in parenthesis

2.4.2 Hypothesis 2

Our second hypothesis says that the impact of bank competition on financial stability does not depend on what measures of competition and stability are used. The values of any measures representing bank competition or financial stability should, in general, reflect the same situations, events, states and movements happening in the banking sector and the financial system. Hence, we believe that the selection of proxies does not matter. The key question then is if we are even able to measure bank competition and financial stability. Table 4 – Table 9 show us the results of 18 the Arellano & Bond (1991) models in total. Each of the models includes a different pair of bank competition measure (Boone indicator, the Lerner index, concentration) and financial stability measure (z-score, bank credit to bank deposit, capital adequacy

ratio, non-performing loans, return on assets, and return on equity). It means that we estimated the impact of each bank competition measure on each financial stability measure. We did that while we kept the other independent variables the same for each of the models. Generally, they are the following: lag of financial stability measure, bank competition measure, GDP growth (GDPG), inflation (I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG).

Table 4 contains estimates of 3 the Arellano & Bond (1991) models. All models' dependent variable is **z-score** (ZS) as proxy of financial stability. The difference among the models is bank competition measure. First we comment on the model with the **Lerner index** as the bank competition measure. The independent variables in this case are: lag of z-score (l.ZS), the Lerner index (LI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). The Table 4 shows that lag of z-score, the Lerner index, GDP growth, real interest rate, and credit growth are statistically significant at 1 percent significance level and change of terms of trade at 5 percent significance level.

As mentioned above, higher z-score means larger financial stability and larger the Lerner index means weaker bank competition. The sign of the Lerner index coefficient is positive which means that when the bank competition grows (Lerner index decreases) the financial stability decreases (larger z-score), ceteris paribus. Hence, we infer that we cannot reject the *competition-fragility hypothesis* in this case. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 4. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The results of the model with **z-score** and the **Boone indicator** being the measures of financial stability and bank competition, respectively, are described in detail in the section 2.4.1 2.4.1 aboveHypothesis 1 above. In this case, the results are different because the link between financial stability and bank competition is negative and we reject the *competition-fragility hypothesis.*

The measures of financial stability and bank competition of the third model of Table 4 are **z-score** and **concentration**, respectively. The independent variables in this case are: lag of z-score (l.ZS), concentration (CONC, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). The Table 4 shows that lag of z-

score, concentration, GDP growth, real interest rate, and depreciation are statistically significant at 1 percent significance level and change of terms of trade at 5 percent significance level.

In the section 2.2 Data Description above, we mentioned that larger value of concentration means lower bank competition and higher value of z-score indicates larger financial stability. In the Table 4, we can find a negative coefficient of concentration variable what implies an inverse proportion between the two measures, z-score (financial stability) and concentration (bank competition), but not between financial stability and bank competition. In fact, when concentration grows and causes z-score decrease, ceteris paribus, both bank competition and financial stability, increase. Therefore, we can reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 4. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

Table 4: the Arellano & Bond (1991) estimator results for Z-score

Z-Score x LI		Z-Score x BI		Z-Score x CONC	
l.ZS	0.3301096**	**l.ZS**	0.3406884**	**l.ZS**	0.3678571**
	(52.66)		(22.72)		(22.85)
LI	5.911005**	**BI**	-0.709555**	**CONC**	-0.0279471**
	(20.26)		(-2.83)		(-10.89)
GDPG	0.0198684**	**GDPG**	0.0267195**	**GDPG**	0.0221111**
	(5.82)		(6.37)		(5.07)
l.I	0.0003858	**l.I**	-0.0018612	**l.I**	-0.0022114
	(0.18)		(-0.61)		(-0.86)
CHTT	-0.0000197*	**CHTT**	-0.0000132*	**CHTT**	0.00000692*
	(-1.98)		(-2.31)		(2.49)
RIR	0.0090277**	**RIR**	0.0031599	**RIR**	0.010233**
	(4.68)		(0.99)		(3.4)
D	0.0622083	**D**	-0.8709864**	**D**	-0.9743443**
	(0.49)		(-3.74)		(-3.22)
CG	-1.134774**	**CG**	-1.001893**	**CG**	-0.5349058
	(-5.12)		(-3.15)		(-1.86)
constant	5.475221**	**constant**	6.627989**	**constant**	8.29649**
	(23.66)		(17.23)		(19.86)
AR(1)	-2.0335**	**AR(1)**	-2.1125**	**AR(1)**	-3.1934**
AR(2)	0.45771	**AR(2)**	0.90456	**AR(2)**	0.22776
Sargan test	72.91379	**Sargan test**	76.74113	**Sargan test**	75.64845
Wald test	5670.38**	**Wald test**	779.96**	**Wald test**	880.65**

Source: author's computations.

*Notes***:** * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

In the Table 5 below, we can see results of 3 the Arellano & Bond (1991) models whose dependent variable is **bank credit to bank deposit** (BCTBD) as proxy of financial stability. Various bank competition proxies are employed. In the first model, the **Lerner index** is used to represent bank competition. The independent variables in this case are: lag of bank credit to bank deposit (l.BCTBD), the Lerner index (LI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Lag of bank credit to bank deposit, the Lerner index, GDP growth, lag of inflation, change of terms of trade, real interest rate, credit growth are statistically significant at 1 percent significance level and depreciation at 5 percent significance level.

Above, we explained that bank credit to bank deposit indicator moves in opposite direction than financial stability (the higher it is, the lower financial stability is), as well as the Lerner index in relation to bank competition. Table 5 shows us that the

link between the Lerner index and bank credit to bank deposit is positive. Hence, when bank competition rises (lower the Lerner index) the financial stability increases as well (lower bank credit to bank deposit), ceteris paribus, and the other way around. That leads us to reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 5. The Sargan test is statistically insignificant and AR(1) is significant which is all right. However, there is a problem with AR(2) which should be statistically insignificant but the assumption is not met in this case. Thus, the results of this model can be interpreted only with great care.

The second column of Table 5 contains results of model with **bank credit to bank deposit** as dependent variable and the **Boone indicator** as the independent variable of our main interest. The independent variables in this case are: lag of bank credit to bank deposit (l.BCTBD), the Boone indicator (BI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Statistically significant at 1 percent are: Lag of bank credit to bank deposit, the Boone indicator, GDP growth, lag of inflation, real interest rate, credit growth, and depreciation. Statistically significant at 5 percent significance level is change of terms of trade.

As higher bank credit to bank deposit ratio indicates low level of financial stability, higher the Boone indicator indicates low level of bank competition, and the Boone indicator's coefficient is negative in this model we deduce, that we do not reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 5. The Sargan test is statistically insignificant is significant which is all right. However, there is a problem with AR(1) and AR(2). AR(1) should be statistically significant and AR(2) should be statistically insignificant but the assumptions are not met in this case. Thus, the results of this model can be interpreted only with great care.

The last model of the Table 5 uses **concentration** as bank competition measure. The **bank credit to bank deposit** ratio stays as financial stability measure. The independent variables in this case are: lag of bank credit to bank deposit (l.BCTBD), concentration (CONC, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). The Table 5 shows that lag of bank credit to bank deposit, concentration, GDP growth, change of terms of trade, and credit growth are statistically significant at 1 percent significance level in this model.

As concentration is inverse to bank competition and bank credit to bank deposit is inverse to financial stability we could reject the hypothesis if the sign of concentration coefficient was positive. This is not the case, however, because the relationship between the two measures is negative, and thus we do not reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 5. The Sargan test is statistically insignificant is significant which is all right. However, there is a problem with AR(1) and AR(2). AR(1) should be statistically significant and AR(2) should be statistically insignificant but the assumptions are not met in this case. Thus, the results of this model can be interpreted only with great care.

Table 5: the Arellano & Bond (1991) estimator results for BCTBD

BCTBD x LI		**BCTBD x BI**		**BCTBD x CONC**	
l.BCTBD	0.393947**	**l.BCTBD**	0.5948846**	**l.BCTBD**	0.5320087**
	(61.94)		(109.9)		(109.26)
LI	4.039453**	**BI**	-5.427489**	**CONC**	-0.0436567**
	(5.9)		(-10.89)		(-4.66)
GDPG	-0.0641261**	**GDPG**	-0.0377104**	**GDPG**	-0.0797727**
	(-7.37)		(-3.87)		(-7.19)
l.I	-0.0250092**	**l.I**	-0.0276596**	**l.I**	-0.0240844**
	(-3.42)		(-3.98)		(-3.71)
CHTT	0.0000263**	**CHTT**	0.0000241*	**CHTT**	0.0000249**
	(3.53)		(2.11)		(4.38)
RIR	-0.0342057**	**RIR**	0.0260161**	**RIR**	0.00977
	(-3.53)		(2.62)		(1.05)
D	0.6844675*	**D**	3.155089**	**D**	0.2542027
	(2.02)		(4.9)		(0.61)
CG	15.74044**	**CG**	5.106265**	**CG**	8.539468**
	(12.77)		(3.2)		(5.8)
constant	47.18145**	**constant**	33.59711**	**constant**	40.8946**
	(30.55)		(24.55)		(30.9)
AR(1)	1.9848**	**AR(1)**	0.26671	**AR(1)**	0.82839
AR(2)	-2.0796**	**AR(2)**	-2.6516*	**AR(2)**	-2.419**
Sargan test	77.03207	**Sargan test**	79.67617	**Sargan test**	78.13699
Wald test	15870.1**	**Wald test**	16827.49**	**Wald test**	27627.74**

Source: author's computations.

Notes: * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

In the Table 6 below, we can see results of 3 the Arellano & Bond (1991) models where the dependent variable is capital adequacy ratio (CAR) as measure of financial stability. Various bank competition measures are employed. In the first model, the

Lerner index is used to represent bank competition. The independent variables in this case are: lag of capital adequacy ratio (l.CAR), the Lerner index (LI, bank competition measure), second lag of GDP growth (l2.GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Lag of capital adequacy ratio, the Lerner index, second lag of GDP growth, lag of inflation, change of terms of trade, depreciation, credit growth are statistically significant at 1 percent significance level.

Above, we explained that capital adequacy ratio moves in the same direction as financial stability (the higher it is, the higher financial stability is), the Lerner index, however, moves in the opposite direction in relation to bank competition. Table 6 shows us that the link between the Lerner index and capital adequacy ratio is positive. Hence, when bank competition rises (lower the Lerner index) the financial stability decreases (as well as capital adequacy ratio), ceteris paribus, and the other way around. We deduce that we cannot reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 6. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The second column of Table 6 contains results of model with **capital adequacy ratio** as dependent variable and the **Boone indicator** as the independent variable of our main interest. The independent variables in this case are: lag of capital adequacy ratio (l.CAR), the Boone indicator (BI, bank competition measure), second lag of GDP growth (l2.GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Statistically significant at 1 percent are: Lag of capital adequacy ratio, the Boone indicator, second lag of GDP growth, lag of inflation, change of terms of trade, depreciation, and credit growth. Statistically significant at 5 percent significance level is real interest rate.

As higher capital adequacy ratio indicates higher level of financial stability, higher the Boone indicator indicates lower level of bank competition, and the Boone indicator's coefficient is positive in this model we infer, that we do not reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 6. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied

and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The last model of the Table 6 uses **concentration** as bank competition measure. The **capital adequacy ratio** stays as financial stability measure. The independent variables in this case are: lag of capital adequacy ratio (l.CAR), concentration (CONC, bank competition measure), second lag of GDP growth (l2.GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). The Table 6 shows that lag of capital adequacy ratio, concentration, second lag of GDP growth, lag of inflation, change of terms of trade, real interest rate, depreciation, and credit growth are statistically significant at 1 percent significance level in this model.

Same as with the two previous models, the direct proportion between financial stability and its measure, inverse proportion between bank competition and its measure; and the positive sign of the coefficient of the measure of bank competition lead us to the inference that we cannot reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 6. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano and Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

Table 6: the Arellano & Bond (1991) estimator results for CAR

CAR x LI		CAR x BI		CAR x CONC	
l.CAR	0.5990086**	**l.CAR**	0.5634596**	**l.CAR**	0.5426061**
	(180.85)		(88.61)		(79.47)
LI	3.404246**	**BI**	2.133772**	**CONC**	0.0063302**
	(30.1)		(10.9)		(2.41)
l2.GDPG	0.0735886**	**l2.GDPG**	0.0731125**	**GDPG**	0.0703818**
	(27.2)		(36.75)		(22.9)
l.I	0.0149474**	**l.I**	0.0273356**	**l.I**	0.0241365**
	(12.69)		(12.01)		(12.81)
CHTT	0.0000253**	**CHTT**	0.00000903**	**CHTT**	0.0000118**
	(10.72)		(2.65)		(2.54)
RIR	-0.0031515	**RIR**	-0.0066592**	**RIR**	-0.0064795**
	(-1.61)		(-2.6)		(-3.17)
D	0.9954518**	**D**	0.2083553*	**D**	0.2653913**
	(12.75)		(1.83)		(2.93)
CG	-0.9391283**	**CG**	-0.7959926**	**CG**	-0.8322686**
	(-9.47)		(-3.52)		(-3.94)
constant	5.790529**	**constant**	7.267519**	**constant**	7.055243**
	(58.78)		(42.69)		(30.29)
AR(1)	-2.917**	**AR(1)**	-2.9992**	**AR(1)**	-3.0321**
AR(2)	0.4479	**AR(2)**	0.45492	**AR(2)**	0.4911
Sargan test	77.40318	**Sargan test**	74.10612	**Sargan test**	75.91563
Wald test	107374.54**	**Wald test**	20040.59**	**Wald test**	22087.53**

Source: author's computations.

Notes: * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

In the Table 7 below, we can see results of 3 the Arellano & Bond (1991) models whose dependent variable is **non-performing loans** (NPL) as proxy of financial stability. Various bank competition proxies are employed. In the first model, the **Lerner index** is used to represent bank competition. The independent variables in this case are: lag of **non-performing loans** (l.NPL), the Lerner index (LI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). All variables are significant at 1 percent significance level in this model.

The higher the non-performing loans are, the lower financial stability is and higher the Lerner index is, the larger bank competition. Table 7 shows us that the link between the Lerner index and non-performing loans is positive. Therefore, when bank competition rises (lower the Lerner index) the financial stability increases as well (lower non-performing loans), ceteris paribus, and the other way around. That leads us to reject the *competition-fragility hypothesis*. The results of specification

tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 7. The Sargan test and AR(2) are statistically insignificant. AR(1) is statistically insignificant even though it should be significant. But since it is not crucial assumption and the other two more important conditions of the Arellano & Bond (1991) estimator are satisfied there is no reason to consider the results to be invalid and the estimator provides consistent results.

The second column of Table 7 contains results of model with **non-performing loans** as dependent variable and the **Boone indicator** as the independent variable of our main interest. The independent variables in this case are: lag of **non-performing loans** (l.NPL), the Boone indicator (BI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). All variables are significant at 1 percent significance level in this model.

Since larger non-performing loans ratio means lower financial stability, higher the Boone indicator indicates lower bank competition, and the Boone indicator's coefficient is negative in this model, we infer, that we cannot not reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 7. The Sargan test and AR(2) are statistically insignificant. AR(1) is statistically insignificant even though it should be significant. But since it is not crucial assumption and the other two more important conditions of the Arellano & Bond (1991) estimator are satisfied there is no reason to consider the results to be invalid and the estimator provides consistent results.

The last model of the Table 7 uses **concentration** as bank competition measure. The **non-performing loans** ratio stays as financial stability measure. The independent variables in this case are: lag of **non-performing loans** (l.NPL), concentration (CONC, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). All variables are significant at 1 percent significance level in this model.

In the Table 7, we can see that if the concentration increases (lower bank competition), the non-performing loans ratio decreases (higher financial stability), ceteris paribus. Thus, we do not reject the *competition-fragility hypothesis* in this case. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 7. The Sargan test and AR(2) are statistically insignificant. AR(1) is statistically insignificant even

though it should be significant. But since it is not crucial assumption and the other two more important conditions of the Arellano & Bond (1991) estimator are satisfied there is no reason to consider the results to be invalid and the estimator provides consistent results.

Table 7: the Arellano & Bond (1991) estimator results for NPL

NPL x LI		NPL x BI		NPL x CONC	
l.NPL	0.536392**	**l.NPL**	0.5500278**	**l.NPL**	0.5334928**
	(316.85)		(195.84)		(231.92)
LI	-6.240053**	**BI**	1.302194**	**CONC**	-0.0085779**
	(-31.08)		(12.89)		(-4.4)
GDPG	-0.115036**	**GDPG**	-0.1261579**	**GDPG**	-0.1250232**
	(-64.45)		(-57.75)		(-40.38)
l.I	-0.0242371**	**l.I**	-0.0204958**	**l.I**	-0.0244789**
	(-22.31)		(-6.53)		(-9.96)
CHTT	0.0000425**	**CHTT**	0.0000251**	**CHTT**	-0.0000204**
	(22.37)		(11.42)		(-9.54)
RIR	0.0834906**	**RIR**	0.088538**	**RIR**	0.0918677**
	(39.26)		(23.58)		(30.78)
D	3.27731**	**D**	3.569404**	**D**	3.693315**
	(39.32)		(41.1)		(27.73)
CG	3.442659**	**CG**	3.317598**	**CG**	3.110717**
	(20.45)		(15.01)		(14.62)
constant	2.330829**	**constant**	0.5480552**	**constant**	1.372651**
	(19.38)		(3.16)		(7.88)
AR(1)	-1.7085	**AR(1)**	-1.8042	**AR(1)**	-1.6488
AR(2)	-1.2032	**AR(2)**	-0.86382	**AR(2)**	-0.9739
Sargan test	73.94641	**Sargan test**	74.93411	**Sargan test**	77.63086
Wald test	428829.06**	**Wald test**	264850.14**	**Wald test**	193846**

Source: author's computations.
Notes: * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

In the Table 8 below, we can see results of 3 the Arellano & Bond (1991) models whose dependent variable is **return on assets** (ROA) as proxy of financial stability. Various bank competition proxies are employed. In the first model, the **Lerner index** is used to represent bank competition. The independent variables in this case are: lag of return on assets (l.ROA), the Lerner index (LI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Lag of return on assets, the Lerner index, GDP growth, real interest rate, depreciation, and credit growth are statistically

significant at 1 percent significance level and lag of inflation at 5 percent significance level.

In this case, we cannot reject the *competition-fragility hypothesis.* The logic behind this is the same as in the case of the model with z-score and the Lerner index. Larger return on assets indicates higher financial stability and higher the Lerner index means weaker bank competition. The sign of the Lerner index coefficient is positive, hence with increasing bank competition, financial stability decreases, ceteris paribus. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 8. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The second column of the Table 8 contains results of model with **return on assets** as dependent variable and the **Boone indicator** as the independent variable of our main interest. The independent variables in this case are: lag of return on assets (l.ROA), the Boone indicator (BI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Statistically significant at 1 percent are: Lag of return on assets, the Boone indicator, GDP growth, real interest rate, depreciation, and credit growth.

The result deduction of this model is the same like in the case of the model with z-score and the Boone indicator. Higher return on assets ratio indicates higher level of financial stability, higher the Boone indicator means lower level of bank competition, and the Boone indicator's coefficient is negative in this model. All that lead us to reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 8. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The last model of the Table 8 uses **concentration** as bank competition measure. The **return on assets** ratio stays as financial stability measure. The independent variables in this case are: lag of return on assets (l.ROA), concentration (CONC, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Table 8 shows that lag of return on assets, GDP growth, change of terms of trade,

depreciation, and credit growth are statistically significant at 1 percent significance level in this model.

In this case, the inference of the result is the same like in the case of the model with z-score and concentration. With increasing concentration (declining level of bank competition), decreases return on assets ratio (as well as financial stability), ceteris paribus. The direct proportion of financial stability and bank competition leads us to reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the belowTable 8. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano and Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

Table 8: the Arellano & Bond (1991) estimator results for ROA

ROA x LI		ROA x BI		ROA x CONC	
l.ROA	0.2318801**	**l.ROA**	0.2394454**	**l.ROA**	0.2820953**
	(22.42)		(21.28)		(23.02)
LI	5.560749**	**BI**	-2.052275**	**CONC**	-0.0002749
	(24.2)		(-13.41)		(-0.24)
GDPG	0.0301323**	**GDPG**	0.0333513**	**GDPG**	0.0351077**
	(16.08)		(10.67)		(12.62)
l.I	0.0016495*	**l.I**	-0.0003885	**l.I**	-0.0002458
	(2.03)		(-0.31)		(-0.23)
CHTT	0.00000314	**CHTT**	0.00000961**	**CHTT**	0.00000805**
	(1.66)		(6.11)		(4.28)
RIR	-0.0055573**	**RIR**	-0.009055**	**RIR**	-0.0083033**
	(-5.16)		(-5.25)		(-5.34)
D	-0.8547418**	**D**	-0.7109564**	**D**	-0.9523297**
	(-15.41)		(-9.06)		(-13.83)
CG	0.549659**	**CG**	0.6374578**	**CG**	0.7192566**
	(3.11)		(3.46)		(3.78)
constant	-0.8540168**	**constant**	0.5286791**	**constant**	0.5738915**
	(-8.55)		(5.44)		(4.87)
AR(1)	-3.8643**	**AR(1)**	-4.0066**	**AR(1)**	-4.0057**
AR(2)	0.1981	**AR(2)**	0.13963	**AR(2)**	0.51
Sargan test	79.8743	**Sargan test**	84.14071	**Sargan test**	84.11494
Wald test	5294.37**	**Wald test**	1655.98**	**Wald test**	2859.67**

Source: author's computations.

*Notes***:** * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

In the Table 9 below, we can see results of 3 the Arellano & Bond (1991) models whose dependent variable is **return on equity** (ROE) as proxy of financial stability. Various bank competition proxies are employed. In the first model, the **Lerner index** is used to represent bank competition. The independent variables in this case are: lag of return on equity (l.ROE), the Lerner index (LI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). All variables are statistically significant at 1 percent significance level in this model.

As we explained above, larger return on equity means higher financial stability and higher the Lerner index means weaker bank competition. The sign of the Lerner index coefficient is positive, hence with increasing bank competition, financial stability decreases, ceteris paribus. Based on that, we do not reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 9. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The second column of Table 9 contains results of model with **return on equity** as dependent variable and the **Boone indicator** as the independent variable of our main interest. The independent variables in this case are: lag of return on equity (l.ROE), the Boone indicator (BI, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). Statistically significant at 1 percent are: Lag of return on equity, the Boone indicator, GDP growth, change of terms of trade, real interest rate, depreciation, and credit growth. Statistically significant at 5 percent significance level is lag of inflation.

Since higher return on equity ratio indicates higher level of financial stability, higher the Boone indicator means lower level of bank competition, and the Boone indicator's coefficient is negative in this model we reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 9. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

The third model of the Table 9 uses **concentration** as bank competition measure. The **return on equity** ratio stays as financial stability measure. The independent variables in this case are: lag of return on equity (l.ROE), concentration (CONC, bank competition measure), GDP growth (GDPG), lag of inflation (l.I), change of terms of trade (CHTT), real interest rate (RIR), depreciation (D), credit growth (CG). The Table 9 shows that lag of return on equity, GDP growth, change of terms of trade, real interest rate and depreciation are statistically significant at 1 percent significance level and concentration is statistically significant at 5 percent level in this model.

The sign of concentration coefficient is positive, higher concentration indicates weaker bank competition, and larger return on equity means higher financial stability. Therefore, with increasing bank competition, financial stability decreases, ceteris paribus, and we cannot reject the *competition-fragility hypothesis*. The results of specification tests, the Sargan test and first and second order autocorrelation tests, of this model are also presented in the Table 9. The Sargan test and AR(2) are statistically insignificant and AR(1) is significant, thus, the conditions of the Arellano & Bond (1991) estimator are satisfied and there is no reason to consider the results to be invalid and the estimator provides consistent results.

Table 9: the Arellano & Bond (1991) estimator results for ROE

ROE x LI		ROE x BI		ROE x CONC	
l.ROE	0.2279682**	**l.ROE**	0.3159432**	**l.ROE**	0.3222665**
	(22.45)		(20.9)		(25.76)
LI	35.47104**	**BI**	-14.01589**	**CONC**	0.0390313*
	(24.13)		(-8.1)		(1.99)
GDPG	0.3616453**	**GDPG**	0.3175191**	**GDPG**	0.3993508**
	(19.65)		(7.75)		(10.11)
l.I	0.0237224**	**l.I**	0.0252438*	**l.I**	0.0049928
	(3.01)		(2.02)		(0.39)
CHTT	0.0000764**	**CHTT**	0.0001276**	**CHTT**	0.000111**
	(5.92)		(5.9)		(5.14)
RIR	-0.097834**	**RIR**	-0.1421354**	**RIR**	-0.1151486**
	(-8.07)		(-7.38)		(-6.38)
D	-3.589757**	**D**	-6.803998**	**D**	-4.889189**
	(-7.55)		(-5.65)		(-5.11)
CG	4.960876**	**CG**	6.988124**	**CG**	2.577383
	(4.5)		(5.71)		(1.77)
constant	-2.73865**	**constant**	4.63784**	**constant**	4.681617**
	(-3.49)		(6.24)		(3.09)
AR(1)	-3.1836**	**AR(1)**	-3.6193**	**AR(1)**	-3.9527**
AR(2)	-0.07805	**AR(2)**	-0.23505	**AR(2)**	-1.0862
Sargan test	78.85371	**Sargan test**	79.47288	**Sargan test**	82.18506
Wald test	2635.46**	**Wald test**	722.03**	**Wald test**	870.6**

Source: author's computations.

*Notes***:** * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

We reject the *competition-fragility hypothesis* in 7 out of 18 cases. The conditions of the specification tests of the Arellano & Bond (1991) model are not satisfied in none of the models with the bank credit to bank deposit—financial stability measure. The first order autocorrelation test is not met in none of the models where non-performing loans represent financial stability. Concentration is not even statistically significant in one model (used with return on assets). We can see that the results of the models vary considerably and that different pairs of measures bring different results. We reject our second hypothesis and we can conclude that the results—the effects of bank competition on financial stability—do depend on the measures used to represent financial stability and bank competition in the context of the relationship between them.

2.4.3 Hypothesis 3

Our third hypothesis claims that the effect of bank competition on financial stability changes over time (for example during a crisis). Generally, changes over time, especially during strong events like, for instance, a financial crisis. Hence, it is expected that the effect of bank competition on financial stability is also different over time.

To test this hypothesis, we divide our time period into two. The mid-point is blissfully in the years when the global financial crisis began and this enabled us to compare one period of time before the crisis and second time period of the same length after the crisis when the economies were dealing with it and were healing. We use z-score as the measure of financial stability and three measures of bank competition (the the Lerner index, the Boone indicator, and concentration) thus we estimate three models for each period. The results are presented in Table 10. We can see that, overall, the results of the models of the two halves of the period and of the total period are the same in case of each couple of measures. Therefore, we reject our third hypothesis and we can say that the effect of bank competition on financial stability does not change over time, not even during a crisis.

Table 10: the Arellano & Bond (1991) estimator results for Z-score and BI/LI/CONC in two different periods of time

	BI		LI		CONC	
	2000 – 2007	**2008 – 2014**	**2000 – 2007**	**2008 – 2014**	**2000 – 2007**	**2008 – 2014**
l.ZS	0.3476208**	0.3191749**	0.3221655**	0.2864555**	0.4600779**	0.3327524**
	(5.55)	(10.81)	(8.43)	(12.69)	(5.68)	(11.02)
BI/LI/CONC	-1.561603	-1.332256*	4.756459**	7.159654**	-0.0295315*	-0.0275952**
	(-1.47)	(-2.41)	(3.49)	(9.19)	(-2.14)	(-4.5)
GDPG	0.0167802	0.0493209**	0.0084591	0.045488**	0.0065415	0.0467978**
	(0.47)	(7.6)	(0.22)	(6.42)	(0.17)	(7.49)
l.I	-0.0132856	-0.0016983	-0.0081703	0.0185047**	-0.0123967	0.0028928
	(-1.43)	(-0.47)	(-1.11)	(5.31)	(-1.51)	(0.75)
CHTT	-0.00000763	-3.28E-07	-0.00000447	-3.26E-07	0.0000114*	0.00000457
	(-0.16)	(-0.09)	(-0.13)	(-0.09)	(2.43)	(0.76)
RIR	-0.0158861	0.0197386**	-0.0082359	0.0038923	-0.0128299	0.0200359**
	(-0.89)	(4.59)	(-0.48)	(0.98)	(-0.77)	(3.86)
D	-1.703051**	0.2052677	-1.848898*	0.4885693**	-2.157603**	-0.0161024
	(-3.7)	(0.73)	(-2.47)	(2.72)	(-3.98)	(-0.06)
CG	-1.511716	-1.141549	-1.15832	0.3395913	-0.7723105	-0.9362485
	(-1.75)	(-1.71)	(-1.07)	(0.72)	(-0.86)	(-1.45)
constant	7.58936**	6.681882**	6.388612**	4.309965**	8.365788**	8.444439**
	(6.52)	(10.71)	(6.09)	(8.22)	(5.85)	(10.32)
AR(1)	-2.0067*	-3.495**	-1.8129	-3.4252**	-2.389*	-3.4122**
AR(2)	1.0596	-0.18701	0.47098	-0.42883	0.46368	-0.25674
Sargan test	18.36879	55.33681	13.81716	54.97041	17.56633	57.88974
Wald test	81.87**	204.32**	205.56**	423.94**	61.29**	218.05**

Source: author's computations.

Notes: * 5 percent significance level; ** 1 percent significance level; z-statistics shown in parenthesis

Conclusion

This thesis examined the link between financial stability and bank competition because financial stability is very important for economic growth, unemployment and the process of savings allocation to profitable opportunities for investments; and banks are the key factors for the stability of the financial system. The question of our interest was if the financial market structure, specifically, the competition among banks matters for financial stability.

In the beginning, the theoretical background was presented. Based on that knowledge we formulated our hypothesis. Next, the literature on this topic was reviewed and a discussion about which authors are inclined to the *competition-fragility hypothesis* and which concluded *competition-stability hypothesis* was given. Then the method of the Arellano & Bond (1991), used for the econometrical analysis, was explained in detail. This was followed by the data description where the contribution of this thesis was also presented. We used annual panel data over the period 2000 – 2014 for 205 countries. The uniqueness of this research lies in the use of a new, richer and updated dataset The Global Financial Development Database available at World Bank website. As a result of this, we were able to explore this topic in greater depth and validate the true relationship between financial stability and bank competition. Additionally, the specifics of this dataset enabled us to use new combinations of measures of financial stability and measures of bank stability to investigate their link. Moreover, one of the measures used in this study—bank credit to bank deposit—has, to our knowledge, never been applied in this context before.

In the results section, we looked at each of our hypotheses separately. Analysing the first hypothesis, *Bank competition reduces financial stability*, using the Boone indicator and z-score as our respective measures we discovered that bank competition does not reduce financial stability. Our second hypothesis, *The effect of bank competition on financial stability does not depend on what measures of competition and stability we use*, was tested using a combination of three measures of bank competition and six measures of financial stability. The results of these 18 models yielded mixed results which led us to conclude that it does matter what measures we apply. Testing our final hypothesis, *The effect of bank competition on financial stability changes over time (for example during a crisis)*, we split the full period in two and we estimated three models for each of the two time frames. Our results indicated that the relationship between bank competition and

financial stability remain the same for each of the two frames tested as well as for the full time period. Thus, we were able infer that the relationship does not change over time.

As the models with various couples of measures of financial stability and bank competition bring different results it seems that bank competition and financial stability are not even measured accurately. Thus, we recommend investigating how to measure financial stability and bank competition properly as a potential avenue for future research.

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