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Does Banking Concentration Lead to Banking Stability in the CEE Countries

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Abstract

This paper investigates the relationship between market concentration and banking stability in the Central and Eastern European region. Using data on 196 banks from 10 CEE countries over the period 2003-2012, we find that banks in a higher concentrated market are less vulnerable to risks. The main results hold after controlling for macroeconomic and institutional environments, and stay robust to different models and alternative measurements of key variables. This study provides little evidence for supporting the BDN model of "competition-stability" view, nor the MMR model of U-shape relationships.

Keywords: Bank Concentration; Banking Stability; Risk Level; HHI Index; Z-Score; Charter Value Hypothesis; BDN model; MMR model.

Abstrakt

Tato práce zkoumá vztahy mezi koncentrací trhu a bankovní stabilitou ve střední a východní Evropě. Použitím dat na 196 bank z 10 zemí tohoto regionu v období mezi lety 2003-2012 bylo zjištěno, že banky na koncetrovanějších trzích jsou méně citlivé na rizika. Tento výsledek je dosažen díky kontrole makroekonomického a institucionálního prostředí a příliš se nemění ani při použití jiných modelů či při alternativním měření klíčových proměnných. V neposlední řadě studie přináší důkazy pro podporu BDN modelu konkurence a stability a také MMR modelu s U zakřivením.

Klíčová slova: Bankovní koncentrace; Bankovní stabilita; Úroveň rizika; HHI index; Z-skóre; Charter value hypotéza; BDN model; MMR model

Range of thesis: [143309 symbols]

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague 15/05/2014 **YINGYING YU**

Key Research Questions (20 words)	The relationship between banking concentration and banking stability
Brief Description of Theory (50 words)	"Concentration-stability" supported by CVH, contagion effect model and so on. "Concentration-fragility" is supported by BDN model. MMR model suggests non-monotonic relationship.
Brief Description of Methodology (50 words)	Qualitative and quantitative methodologies. Panel data set, fixed effect model regression
Conclusions (50 words)	We find that banks in a higher concentrated market are less vulnerable to risks. The main results hold after controlling for macroeconomic and institutional environments, and stay robust to different models and alternative measurements of key variables. This study provides little evidence for supporting the BDN model of "competition-stability" view, nor the MMR model of U-shape relationships.

Content:

1. Introduction

It is publicly acknowledged that financial market plays the vital role in all related markets. The financial market provides all the possibilities and opportunities for other industries development. The dysfunction of the financial system is the cause of economic recession and social turmoil. Moreover, the side effect is prolonged and contagious, which can be exemplified in the most financial crises and debt crises.
Even if the bursting point of a financial crisis is not in the banking sector, the consequent banking failures brought by the financial crisis tends to produce the biggest losses. The typical example is that America's Great Depression during the 1930s, which was triggered by the failure of the stock market in 1929. But a series of banking failures from 1933 to 1934 contributed to a large part of losses. The Asian financial crisis also shows that the failure of banking system contributes to the great and continuous recession. To keep the financial system stable, banking stability is believed to be a key part.

During the last two decades, Central and Eastern European countries (CEE) have experienced structural changes because of an initial privatization in the 1990s and the market integration after EU-accession. One of the prominent features established is the high concentration in banking markets. As the Structure-Conduct-Performance (SCP)[1] paradigm indicates, banking market structure is one of the key factors contributing to the banking stability. In order to keep banking stability, it is vital to clear up the relation of banking concentration[2] and banking stability. Especially after recent financial crisis and debt crisis, we may doubt: does the concentrated market promote banking stability in CEE region? This research intends to give an explanation and try to provide some suggestions for post-crisis regulation and legislations amendments.

There is voluminous research on this issue, yet the literature produces conflictive outcomes. Some support that concentrated market reduces the banking vulnerability. Keeley (1990) and Besanko and Thakor（1993）through the Charter Value hypothesis, suggest that concentrated markets with high entry barriers guarantee the high charter value of participants, which reduce the banks risk-taking incentives. Whilst Boyd and De Nicoló (2005) established a BDN model, finding that the opposite result. They argue the lending market is the primary source of banking risks. Loan defaults are not merely dependent on banks, but are more relying on borrowers' investment. Monopolistic banks in an uncompetitive market would charge a higher loan rate, which may cause adverse selection and moral hazards. Other studies further show that there is no clear-cut "concentration-stability" or "competition-stability" linear relationship. The recent research by Martínez-Miera and Repullo (2010) develops a new MMR model, which implies a U shape relationship between banking competition and risk level. When in an extremely concentrated market, the risk-shifting effect dominates. Borrowers would invest in risker projects to shift risks to banks. Whilst in a very competitive market, the margin effect dominates; lower

[1] SCP paradigm is established by Joe S. Bain and Scherer during the 1930s. The approach presumes that the market structure including market concentration determines the companies conducts and as a result influences the firm's performance, including profitability, risk level and its market power.

[2] Competition and concentration in this essay are used to describe different market structures. They express the opposite market situations. In brief, a higher concentration means a lower competition.

profit margin may harm the banking stability. So within the moderate level of concentration, banks keep comparatively stable status.

In the meantime, many scholars using different samples and methodologies attempt to examine the relation from an empirical perspective. Again, these prior empirical studies yield contradictory results. Although there are numerous studies related to this issue, it is not wise to apply their empirical results to the CEE region. First of all, it is arbitrary to apply one of conflicting result to the CEE region. Besides, Haselmann and Wachtel (2007) mention that banks have different performance in responding to dissimilar institutional environments. Transition countries, unlike other European countries, have undergone significant institutional reforms during last two decades and established their own unique institutional environment. Furthermore, regulatory reforms in CEE regions are undertaken qualitatively and quantitatively different from other developed banking systems. For instance, the intention of deregulation in transition countries is for stabilizing industry but other developed countries may use it in an intention of enhancing the competition (Agoraki, 2009). Therefore, this research aims to focus on transition countries and find how CEE market structure influences banking performance, particularly risk levels.

Banking stability in CEE regions along has already been investigated by previous studies. Maechier et al. (2007) based on CEE countries, assess how various financial risks affect aggregated banking stability. Ivicic et al., (2008) further explore the impact of macro-economic and bank-specific variables on banking vulnerability through country-by-country analysis. Their study involves the ration between the concentration level and banking insolvency risk yet finds no uniform result across countries. They used pooled regression for each country over ten years. The small samples and simple regression model may have little access to a comprehensive result. Other researches such as Barjaktarović et al. (2013) assesses the competition level of banking industries in CEE countries, suggesting that majority of CEE countries are situated in moderatly concentrated markets.

The relation of banking risks and competition level seems to be not well documented in previous studies. Indeed, they only focus on one aspect or briefly mention the issue. To provide more ample evidence, this research, unlike the prior studies, would investigate both aspects and focuses on the main relationship of concentration and stability via both qualitative and quantitative analysis.

Our cross-country analysis indicates a negative relationship between banking concentration and risk-taking. Specifically, banks in a more concentrated market are less likely to suffer from the banking failures, retaining higher profitability and lower return volatility. There might be the margin effect in a competitive market leading to fragility. But we do not support the risk-shifting effect mentioned in the BDN model. Additionally, we find little evidence for the MMR model. This main finding stays robust even after controlling for the business and institutional environment.

This research proceeds as follows. Firstly, the CEE regional background will be introduced. Then we would present a detailed literature review including both theoretical and empirical literature, to provide a comprehensive framework for understanding this issue. Next, the description of data and methodology will be illustrated. Then we present the main empirical findings as well as robustness exercises. Finally, a conclusion will be given.

2. Regional Background

In past two decades, Central and Eastern European Countries (CEE) not only have transformed from command economy to market economy, but also have undertaken financial reforms and adjustments toward regional integration and globalization. Despite of different initial conditions, reform order and subsequent policies, most CEE Markets have experienced inherently similar transition process. During this period, CEE countries have undergone turbulence and crises meanwhile raised the awareness of importance of financial stability.

2.1 Establishment of the Dual Banking System (1987-1992)

Banking industry within socialist command economies were featured as mono-bank system. These state-owned banks distribute capital resources under the government instruction instead of market demands. Hence the first step of reform was to create market-oriented financial systems, separating commercial and central banks. Most CEE countries started this reform in the late 1980s. Hungary and Poland are the earliest ones to complete the establishment of the two-tier banking system in 1987 and 1989. Other countries also completed the dual banking system subsequently. New bank emerged reacting to the reform (see table 1, from 1991 to 1993). However, due to the residuals of a planned economy, the financial market was still state-owned and inefficient. A large amount of bad debt and rigid management deteriorated the banking situation. Furthermore, many companies went bankrupt due to economic reforms, which increases more non-performing loans. During the early 1990s, governments tried to rescue banks through injecting direct capital and issuing government bond, but this exposed the whole banking system to higher risks[3]. Overall, the banking industry was considerably vulnerable despite the initial reforms and government interference.

2.2 Privatization of Banks and Market Openness (1992-2003)

Since government remedies was ineffective, privatization was regarded as a further reform method to improve the bad economy. Therefore, in order to improve banking efficiency and lower the governmental expenditure, many CEE countries started to

[3] For example, in1991 and in 1992, the Czech government injected capital to four large banks without improvements. In fact, government failed to rescue banks. It also increases moral hazards.

privatize and restructure the state banks during the middle of the 1990s. In addition, new banks including both foreign and domestic ones were allowed to enter the financial market. Moreover, the related legislation system and regulatory frameworks were updated and improved for supporting arm-length financial transactions and boost the confidence of depositors and creditors. Therefore, the landscape of the banking industry was reshaped thoroughly. Firstly, the total amount of banks decreased steadily with the liberalization and consolidation process. As Table 1 demonstrates, the number of banks started to diminish in all CEE countries around mid 90s. Another important point is the banking consolidation process, which sped up and increased foreign capital flows into the CEE region. Take Czech Republic as an example, foreign capital shares increased from 22.8% of total market in 1995 to 70% in 2001[4]. Meanwhile, foreign banks, on the contrary to the trend of total number of banks, continued to enter the market (Table 1). At the end of 2003, foreign banks occupied the majority of banking industry. In terms of banking performance, non-performing loans have declined, banking efficiency has been promoted, demand for banking services has increased (Fries et al, 2006) and profitability has improved significantly after privatization (EBRD, 1998).

Table 1: Number of banks (Foreign-owned banks) in 10 countries from 1991 to 2003

Year	1991	1993	1995	1997	1999	2001	2003
BRG	75 (0)	41 (0)	41 (3)	28 (7)	34 (22)	35 (26)	35 (25)
HRV	na	50 (na)	54 (1)	61 (7)	53 (13)	43 (24)	41 (19)
CZE	24 (4)	52 (18)	55 (23)	50 (24)	42 (27)	40 (26)	37 (26)
EST	na	21 (1)	18 (4)	12 (3)	7 (3)	7 (4)	7 (4)
HUN	35 (8)	40 (16)	43 (21)	45 (30)	43 (29)	41 (31)	38 (29)
LVA	14 (na)	62 (na)	42 (11)	32 (15)	23 (12)	23 (10)	23 (10)
LTU	na	26 (0)	12 (0)	11 (4)	13 (4)	13 (6)	13 (7)
ROU	na	na	24 (6)	33 (11)	34 (19)	33 (24)	30 (21)
SVK	na	18 (3)	25 (9)	25 (9)	25 (11)	21 (13)	21 (16)
SVN	40 (1)	45 (5)	41 (6)	34 (4)	31 (5)	24 (5)	22 (6)

Note: Foreign-owned bank is a bank where foreign capital ownership exceeds 50%.

Source: Transition Report 1997 and 2004 EBRD

Until the end of 2003, in most CEE countries and particularly in the ten selected countries[5] in this research, at least more than 25 percent of enterprises were in private hands. Also, interest rate was fully liberalized. Related institutional frameworks make substantial progress to regulate participants. Private enterprises can have easy access to loans. Czech Republic, Estonia and Hungary were already close to international standards after privatization (EBRD, 2003).

2.3 EU-Accession (2004-2007)

4 The information is from Czech National Bank (1995) and (2000).

5 Ten countries are Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovak and Slovina.

After 2004, these ten CEE countries joined the EU in sequence. To meet the EU uniform standards, CEE countries further develop their financial system. The law and regulations are improved considerably toward Bank for International Settlements Standards (BIS). Banking competition is fully functioned. Financial deepening is to a significant level. During this period, the CEE region enjoyed a rapid economic growth. Due to the EU common market, CEE markets attract a large amount of FDI. In 2007, half of global investment of emerging markets flowed to the CEE region (IMF). Turning to banking industry, foreign ownership of banking industry is growing to the peak during this period. As shown in Table 2, foreign-owned banks dominate the whole asset market. Seven of ten countries even exceed 80%. According to statistics, foreign ownership is only concentrated in a few Western European countries, such as Austria, Switzerland and Belgium. On the other hand, except the Slovenia, asset share of state-owned banks shrinks to less than 4% averagely. Therefore, we can roughly estimate CEE markets during this period are increasingly concentrated in hands of several foreign banks. However, despite of increasingly concentrated market, the banking industry becomes more stable after EU accession from a short-turn perspective (before financial crisis). Figure 1 extracted from Raiffeisen Research report illustrates the averaged banking non-performing loan ratio in CEE region steadily declines to the bottom out around 2007. Take Czech Republic as an example, the average non-performing loan ratio from 9.5 in 2002 drops to 2.8 in 2007. Additionally, profitability and efficiency increase significantly thanks to FDI spillover benefits. Overall, before crises, EU-accession expands CEE markets and brings more FDI. Foreign banks presence indeed promotes innovation, brings advanced management system, and enhances efficiency to domestic banking industry. It can be interpreted that concentration is related to stability.

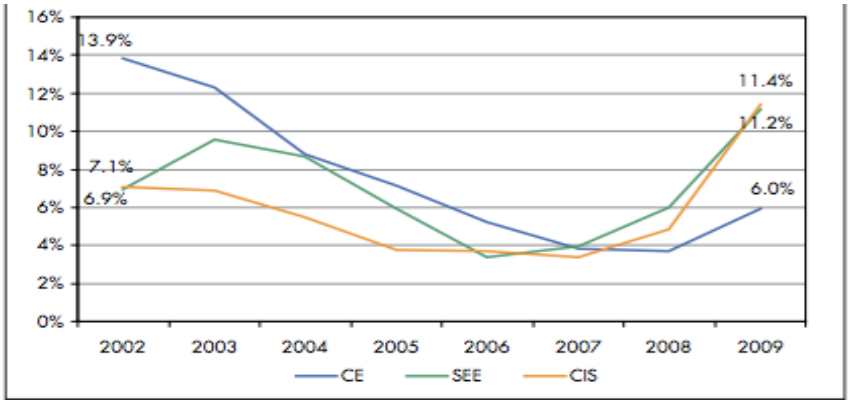
Table 2: asset market share of state-owned and foreign-owned banks in 2007

Country / Market share	BGR	HRV	CZK	EST	HUN	LVA	LTU	ROU	SVK	SVN
State-owned %	2.1	4.7	2.5	0	3.7	4.2	0	5.7	1	14.4
Foreign-owned %	82.3	90.4	96.4	98.7	64.2	63.8	91.7	87.3	99.0	28.8

Note: Foreign-owned bank is a bank where foreign capital ownership exceeds 50%.

Source: Transition Report 2009 EBRD and CEE Banking Sector Report 2012 Raiffeisen Research

Figure 1: Non-performing loan Ratio in CEE banking sector



Note: CE is the Central Europe sub-region consisting of Poland, Hungary, the Czech Republic, Slovenia and Slovakia. SEE is South Eastern Europe, including Romania, Bulgaria and Croatia. CIS is Commonwealth of Independent states.

Source: CEE Banking Sector Report 2010 Raiffeisen Research

2.4 Financial Recession to Recovery (2008-2012)

EU enlargement process fosters CEE and Western European financial markets integration. CEE legal and regulatory frameworks are parallel to BIS standards. Pre-crisis, these new European members were praised for remarkable growth. The financial systems were characterized by high stability. However, the situation turned to an opposite direction when the 2008 financial crisis penetrated into CEE region. Baltic countries, Romania and Bulgaria undergo the largest decline in output. Other countries such as Czech and Hungary are also caught in debt crisis. Because of high external debt, high external financing and high dependency on foreign trade, CEE region is even more vulnerable than other EU members (ECB, July 2010). Besides, since foreign banks control the majority of market, there is an inevitable contagion effect that foreign parent bank would transfer the risks to subsidiary bank and spread to the whole market in CEE region. Moreover, the domestic currency in CEE countries depreciates significantly because of high external indebtedness. For example, the devaluation of Czech currency (CZK) is up to 42%, Estonian currency (EEK) to 24% and Latvian currency (LVL) to 21% within half year from August of 2008 to January of 2009 (Bloomberg CEIC, 2010). The currency depreciation in turn further increases the credit defaults and non-performing loan ratio. Figure 1 demonstrates the non-performing loan rate is rising back to year 2002. Latvia suffers the most serious situation where the non-performing loan ratio in 2009 (0.519) is more than 8 times of that in 2007 (4.355). In terms of market structure, the market is more competitive than before. As Figure 2 shows, the concentration level is slightly declining in most CEE countries except Lithuania, but still remaining high. It is not clear concentration is good for banking stability or not against this background.

3. Research Questions

After twenty years of evolution, the financial system in CEE regions is progressively developing despite of fluctuations and turbulence. Some researchers maintain that a concentrated market, especially a concentrated market that results from an extremely high foreign banks occupation, is significantly linked to the banking vulnerability as well as the whole domestic economy. Therefore, the primary target of this research aims to investigate whether market concentration has an impact on banking stability in CEE countries and how the relationship is shaped. Specifically, we shall answer following questions:

1. Does market concentration/competition have a significant impact on banking stability? Is the relationship positive or negative?
2. How does market structure influence the banking stability? Which component of banking stability (Z-Score) is the main driver of this relationship?
3. Is there any possible non-linear relationship between banking concentration and banking stability, as the MMR model mentioned?
4. How do other bank-specific, country-specific and institutional factors influence the relationship between banking concentration and risks?

4. Theoretical Literature Review

There are three main streams of view resulting from various researches: "concentration-stability" and "concentration-fragility" and non-linear relation of market structure and banking stability.

4.1 Concentration-Stability Hypothesis

Prior economists developed various theoretical models and hold "concentration-stability" view. The earliest theory to support this hypothesis is the charter value model raised by Marcus (1984) and keeley (1990). Allen and Gale (2000b, 2004) use contagion theory to provide new evidence. Some also support this view through analysis of regulation effectiveness. Furthermore, Acharya and Yorulmazer (2007) and other studies employing apagogical methodology, suggest that the related authorities in a competitive market are prone to "Too-many-to-fail" policy that may exacerbate banking vulnerability.

4.11 Charter Value Hypothesis Model（CVH Model）

Early researches based on CVH model, are supportive of high concentrated market reduces risk-taking behaviors. Charter value, also called as Franchise value, is the present value of an enterprise's stream of profits that a firm is expected to earn from the protected market including its reputation, its strong relationship with stakeholders, easy access to information and scale of its economy, according to Guttentag and

Herring (1983). Alternatively, it is can be seen as a bank's intangible assets developed through the market entry barriers (external factor) and its related sources (internal factors) in a long run. High charter value in the less competitive market provides the ability to earn ongoing profit, which offsets the incentive of excessive risk-takings. However, over competition erodes the charter value due to the potential reduction in the expected return. This compels banks to hold less capital and take on risky portfolios, as the opportunity costs of bankruptcy are lower in this case. Generally, a more concentrated market helps develop higher charter value; this in turn plays a better disciplinary role in the market (Guttentag and Herring (1983).

Marcus (1984) through one-period Merton's (1977) model theoretically shows that the risk-taking strategy becomes more attractive for banks only when the charter value declines. Chan, Greenbaum and Thakor (1986) explain that over competitive banking market causes greater volatility of borrowers' credit risk. This undermines the informational surplus and information reusability that are part of charter value[6]. Accordingly, banks with decreased value devote less on asset monitoring and easily select poor quality assets. Besanko and Thakor（1993） detail that the competition jeopardizes informational rents and induces banks to finance low quality borrowers. Informational rent resulted from the relationship lending is defined as one source of charter value in this paper. Marquez (2002) reaches similar conclusion to Besanko and Thakor.

To get a deeper insight on why banks take on risks when the charter value drops, the agency theory should be mentioned here. According to the agency theory (Jensen and Meckling, 1976), there is an agency problem between bank managers/owners and depositors. Since managers/owners have limited liability, they are apt to risk depositors' money for self-interest maximization. If the project is successful they can reap the high rewards; if it is not, then the depositors pay a high price for managers' failure.

According to the Structure-conduct-performance model, a highly concentrated market lowers the cost of collusion and encourages the collusive behaviors in several large companies. Then all firms in the market can earn monopolistic rent (Chamberlin, Edward, 1933; Joe S. Bain, 1941). Likewise, in the concentrated banking sector, banks are more profitable when they collude (Rhoades, 1977). Therefore, they have fewer incentives of risk-taking. However, under the intensified competition, bank managers are under higher pressure to make profit, so they are prone to excessive risks. Thus, the drop of the charter value amplifies the agency problem, inducing mangers to take extra risks.

[6] The informational surplus in this paper means the constant useful information earned in the initial monitoring. Informational surplus would reduce the subsequent monitoring expenditures. Informational reusability means he information durability. The information of borrowers is considered durable if it continues to inform banks over time. Competition and deregulation impair the durability, as the environment is more changeable. Banks also would invest less in informational surplus.

4.12 Model of financial contagion through the interbank market

Financial contagion means that small shocks on a few institutions could spread to the rest of the financial industry and further throughout the larger economy. Allen and Gale (2000b) established a mode of financial contagion through the interbank market. They discover that the contagion probability depends on the degree of completeness and connectedness. If the market is complete and fully connected, then the initial impact of liquidity shortage can be alleviated. There will be little potential of contagion. If the market is incomplete and unconnected, then small shocks could spell contagion. Northcott (2004) points out that a concentrated market with a few banks is more likely to be complete and fully connected than perfectly competitive market. Combining previous research together, it indicates that a concentrated market is more immune against contagion of banking failures the competitive one. Allen and Gale again investigate the relationship between the contagion and financial stability and the competition based on their improved model in 2004. They interpret that under the perfect competition, banks are small and they have weak incentives or ability to provide the liquidity for the problem bank. Also, the coordination problem is getting severe with the increasing number of banks in the market. The troubled bank may have to go bankruptcy and liquidate its asset without assistance. Then the other banks that have relationship with this troubled bank may be forced to liquate their assets and go bankruptcy as well. Finally, all banks are compelled to liquidate the assets at a considerable loss. From the model of contagion, a competitive interbank market may be more vulnerable to banking crises than a less competitive market is.

4.13 The effectiveness of Regulation Theory

Some other scholars support the ”concentration-stability” view in the aspect of regulation effectiveness. They explain that it is more manageable for supervisors when they handle a concentrated industry with a small number of banks.

4.14 “To- Many-To-Fail” Policy

In contrast to “ Too-big-to-fail” policy, Acharya and Yorulmazer (2007) suggest there may be a “too many to fail” policy implemented in competitive markets. “Too big to fail” policy is related to big banks in concentrated market while “Too many to fail” policy is related to small banks in competitive market (Jain and Gupta, 1987). When the amount of troubled banks is low, survived banks can help acquire them through merger and acquisition. When the number of failed banks is increasing, the number of survived banks is decreasing. Therefore the investment capacity of sound banks is decreasing. Many failed banks either have to go bankrupt or are bailed out by regulators. If the number of troubled banks is too large, the regulators will find it is ex-post optimal to rescue them against potential losses. This induces banks to herd ex-ante in order to increase the probability of being bailed out[7]. The herding behavior tends to increase the system-wide banking crisis.

[7] Herding means banks in order to seek the safety purchase the similarity in conducts.

In brief, the authority would adopt "Too many to fail" policy to rescue small troubled banks when facing a competitive market. This would cause bank herding and increases systemic risks.

4.2 Concentration-Fragility Hypothesis

Different from previous literature, some other scholars argue that concentration increases banking fragility. One of classic models raised by Boyd and Nicole points out there is risk-shifting effect in concentrated markets. Mishkin, F. (1999) and other economists from the policy perspective, indicate that the regulators tend to adopt "Too-big-to-fail" policy when facing a concentrated market, which may expose the whole system to more risks. In addition, Beck et al. (2008) disprove the effectiveness of regulation in concentrated market, and find in fact the supervisory burden is heavier when monitoring giant institutions.

4.21 BDN Model

Boyd and Nicole (2005) disagree with previous theoretical research such as contagion model and CVH theory. They firstly point out the lending market plays the key role in the banking stability. In lending market, it is not bankers along who decide the risk level, but borrowers choose the risk of investment projects. Under the uncompetitive lending market, banks with the strong market power can charge higher loan interest rate. However, this high interest rate not only increases the borrowers' bankruptcy probability but also leads to adverse selection and moral hazards. Boot and Thakor in 1993 already reveal that borrowers who possess serious asset-substitution moral hazards prefer bank financing instead of capital market. As a result, there would be more non − performing loans and subsequently greater instability in the entire banking system if the market is highly concentrated.

4.22 "Too-Big-To-Fail" Policy

In a concentrated market, the number of banks is small but the size of them is large. The authorities prefer the "Too big to fail" policy based on two points: firstly, the failure of a large financial conglomerate not only puts the whole system to the systemic risk but also easily spreads the risks throughout the whole economy. Secondly, the failure of the large financial institution has a big social cost. Larger banks contain more depositors and other creditors than smaller banks. If one large bank fails, more stakeholders will get loss, which will cause social turmoil (Mishkin, 1995; Santomero and Hoffman, 1998; Freixas, Parigi and Rochet, 1998). Therefore, considering all the factors, the governments are reluctant to let it fail.

However, many non-interventionists argue that the results of bailout policy may cause more moral hazards. Under the governmental protective umbrella, large banks would take on extra risks (Schwartz, 1995). Besides, this doctrine undermines the monitoring incentives of depositors and creditors and erodes the proper regulation system (Boyd and Runkle, 1993 and Mishkin, F., 1999). Moreover, less external monitoring in turn may reduce the banks' incentives of internal risk management.

Their poorer performance are more prone to bank fragility (Cetorelli et al., 2007). The potential disaster may grow until the authority cannot cover it. Barth et al. (1995) provide the empirical evidence that banks with a higher probability of being bailed out are apt to choose riskier investments. Therefore, monopoly markets make the authorities adopt the "Too big to fail" policy, which in turn aggregates and concentrates the risks.

4.23 The Effectiveness Of Regulation Theory

Previous economist and policy makers have mentioned that the regulators have lower burden if facing the concentrated market with a small number of banks. However, some researchers argue that the large banks in the concentrated markets prefer mixed operation, offering various financial services. These giant financial institutions actually add the supervisory burden. Beck et al. (2008) find that the size of banks is positively related to the organizational complexity because large banks expand geographic markets and business operations. Such high complexity lowers bank's transparency. Therefore the concentrated markets are not easier to reduce the regulation burden or better diversify the risks (Beck, Demirguc-Kunt and Levine, 2003).

4.3 Ambiguous Relationship Between Concentration And Banking Risks

Latest researches however doubt that the "concentration-stability" or "concentration-fragility" may be too naive. They maintain there is no clear-cut monotonic relationship.

4.31 Monitoring Incentives VS Risk-Taking in CM model

Caminal and Matutes (2002)(CM model) investigate the relationship between market structure and banking failures through introducing market power. Their model specifies a connection between market powers and banking failures. They think banks may fail because of project choices. And project choices depend on market structure and market power mentioned in this research. Many previous studies look into the relationship through one major characteristic of banking—profit maximization (Chan et al. 1992, and Matutes and Vives, 2000). However, they overlook another major function of banks—monitoring ability. CM model point out that market power may affect banking risks through affecting monitoring ability. They find that monopoly banks in highly concentrated markets spend more in monitoring firms than those banks from competitive markets. There is an essential assumption in their research that the increase in investment leads to the increase in the aggregate risks. Therefore, monitoring efforts will on the one hand alleviate the current risks, but on the other hand induce investment to grow and thus more potential aggregate risks occurred. Monopolists might go bankrupt because their stronger monitoring incentive translates into bigger investment incentive to take on more risks. As a result, the relationship

depends on the level of monitoring incentives. Is the monitoring incentive too strong that causes more aggregate risks or too weak that cannot cover the risks? So the relationship between market structure related to market power and risks is ambiguous.

4.32 MMR Model Through Risk-Shifting Effect And Margin Effect

Martínez-Miera and Repullo (2010)(MMR) extend Boyd and De Nicolo (2005) model (BDN) and find new theoretical results. BDN model reveals that higher loan interest rate would be charged to borrowers in a concentrated market, leading to higher loan defaults as borrowers are forced to choose risker projects. So the potential firm risks are shifted to bank, causing banking instability. This response is called the risk-shifting effect (David Martinez-Miera and Repullo, 2008; Calbo-Valverde et al., 2013). However, MMR argue that high competition reduces the revenue from non-performing loans and also performing loans. The profit is supposed to provide a buffer to cover the loan loss. Reduced interest revenue would in another direction bring financial instability. This effect is referred to "margin effect". Therefore, MMR maintain that the final impact of market competition on banking stability is different depending on which effect dominates. Specifically, when risk-shifting effect is dominated in an over competitive market, the continuing growing competition will drive down profit, contributing to banking failure. Whilst in very concentrated markets where the risk-shifting impact dominates, the increasing concentration also magnifies failure probability. So within the middle range of concentration degree, banks keep comparatively stable status. Therefore, MMR conclude that there is a U-shape relationship between competition and banking risks.

5. Empirical Literature Review

Theoretical literature gives conflictive results. Similarly, empirical studies using different measurements of competition, dissimilar dimensions of banking stability and various data samples produce paradoxical outcomes. In terms of dimensions of banking stability, empirical literature can be divided into two groups: macro-level stability related to the banking system and micro-level stability embedded in individual banks. Most macro-based studies would consider the stability through the bank crisis or number of bank failures in the market. Micro-based researches from the individual bank or managerial perspective, consider the banking stability as a result of bankers' excessive risk-taking. The latter group of researches uses Z-score, Non-performing loan ratio and so on to measure risks level. Noticeably, most banking crises start with individual banks, although different measurement, there are close connections between macro- and micro- aspects.

5.1 Macro-Level Empirical Literature Review

Demirguc－Kunt and Detragiache（1998）collect the data from 53 countries over the period 1980-1995. The financial liberalization can be seen as a measurement of competition level in the whole sector. The dependent variable, banking crisis is measured by a dummy variable. Crisis is recognized in the situations where emergency measures such as deposit freezes and blanket guarantees to creditors are taken to fix banking system; or large-scale nationalization occurs; or high cost at least 2% of GDP happens; or non-performing asset ratio exceeds10%. This research explains that financial liberalization intensifies competition and erodes the charter value. The lower value contributes to the systemic fragility.

Beck, Demirgüc-Kunt and Levine (2005) assess the relationship between bank concentration and the probability of systemic crises suffered by individual countries based on panel data. They collect annual data from 69 countries from 1980 to 1997. This research proxies concentration by the fraction of assets held by the three largest banks in each country, averaged over time period. Crisis is a dummy variable, and is identified in the circumstances where high cost paid or emergency measurements taken, same identification in previous studies (Demirguc－Kunt and Detragiache, 1998). Their empirical results support "concentration-stability" view.

Schaeck, Cihak and Wolfe (2006) further provide cross-country analysis on macro-level risk. Their data is consisting 38 countries over the period 1980-2003. They use Panzar and Rosse H-Statistic to proxy competition instead of market share held by several largest banks. H-statistic is an accurate measurement as it can capture other banks' competitive behaviors. They find that intense competition reduce the systemic risks. Also this research introduces duration analysis that shows that the surviving time of banks is longer in competitive markets than in concentrated markets. Duration analysis further provides evidence for "concentration-instability" view.

Fungáčová and Weill (2009) adopt quarterly data in Russian private banks from the first quarter of 2001 to the first quarter of 2007. The occurrence of bank failure is measured by a dummy variable that equals 1 if a bank's license is revoked and otherwise is 0. The final sample comprises over 20000 observations. For the key independent variable, both structural and non-structural indices—Herfindahl-Hirschman index (HHI), the share of the three largest banks in total banking assets (concentration level) and Lerner index are used to proxy the competition level. HHI and concentration level measures competition through market structure while Lerner index through analyze of market power in each bank. They find that the higher market power/ concentration attenuates the occurrence of banking failures. So their empirical evidence supports "concentration-stability"/"competition-instability" view.

5.2 Micro-Level Literature Review

Keeley (1990), adopt US bank data from 1970 to 1986 to examine Charter Value hypothesis. This research measures bank competition by market power as reflected in Tobin's q ratio. Default risk is measured by two indexes: a bank's solvency ratio and funding costs for certificates of deposit. Both regression results prove charter value hypothesis. To conclude, the result suggests that intense competition will erode charter value which in turn forces banks to hold less capital and take on more asset risks.

Demsetz, Saidenberg and Strahan (1996) provide further evidence for Charter value hypothesis using the data from US banks during the period 1973 to 1992. The research shows that banks operate more safely and efficient with valuable banking charter when in a less competitive market. In other words, if charter value is high, banks have fewer incentives to take excessive risks and there are fewer conflicts between banks and their supervisors.

Boyd, De Nicoló and Al Jalal (2006) test both CVH model and BDN model through two different data samples. The first one is a cross-sectional sample of around 2500 banks from America in 2003. The second one is a panel dataset consisting of 2600 banks from 134 nonindustrial countries during the period 1993-2004. Z-score is used to measure individual banking risks. HHI is a proxy of competition level. Both samples show that the probability of banking failures is strongly and negatively related to the concentration level. So their empirical evidence supports BDN model and "competition-stability" view instead of CVH model. Besides, trade-off between competition and bank risks is rejected. Furthermore, when De Nicolo and Loukoianova （2007）extend the research for introducing bank ownership, the result shows an even stronger relationship. Uhde and Heimeshoff (2007) select data from more then 2600 banks in the EU－25, including eastern and western countries. Z-score and concentration index[8] are used to measure the risks and competition respectively. After controlling for macroeconomic, regulatory and institutional factors, they obtain the opposite result with Boyd et al. (2007) and De Nicolo and Loukoinova (2007), supporting "concentration-instability" view. Robustness tests further confirm that Eastern European countries with lower level of contestability and diversification opportunities are more likely to be fragile, compared with western counterparts. Capital regulations enhance financial stability across whole Europe. So they agree the effectiveness of regulation theory but against the theoretical result from Hakenes and Schnabel (2011) that maintains the capital regulation may spur the risk-taking incentives.

Many scholars infer the effects of concentration on bank soundness through assessing the impact of bank size on financial stability. They assume the mergers and acquisitions create powerful banks, so size/scale is to some extent related to the

[8]The concentration indexes used here are the fractions of assets of a country's total banking system's assets held by top 5 banks and top three banks respectively, namely C5 and C3.

market power. Therefore these research findings are at least suggestive for explaining the relationship (Boyd, Nicolo, 2006).

Paroush (1995) find from mergers bank scale is enlarged and higher market power improves the stability through diversifying credit risks. Craig and Santos (1997) based on 201 samples in US market, agree that banks become safer after acquisition thanks to diversification benefits. Larger banks with substantial scale economy are better to diversify the portfolio risks. Besides, Hughes and Mester (1998) using capitalization ability to signal banks' risk level, find that managers in banks with substantial scale economies may make big efforts to prevent loss of bank's valuable charter. Managers are risk averse. Hence these researches support the CVH and indirectly agree that "too-many-to-fail" policy implemented in a competitive system would cause the financial fragility.

However, Chong (1991) illustrates the opposite result that based on 22 observations (all of sample data are large interstate banks), large banks will cause the increase in profitability but increase their exposure to systematic risks. He further explains the motives of rapidly growth and potentially ongoing profit drive banks to bear unnecessary risks and overlook hidden loan problems, which overweigh the risk reductions through diversification effects. De Nicoló (2000) based on 21 industrial countries during the period 1988-1998, points out that the insolvency risk increases in size and charter value decreases in size. Both geographical and size-related diversification effects are either absent or offset by higher insolvency risks brought by bank consolidation. De Nicolo, Bartholomew and Zaman (2003) enrich the previous evidence through investigations on 105 countries, indicating that larger and more conglomerate banks exhibiting higher level of risks than the smaller and simpler ones. Consolidation and conglomeration do not necessarily contribute to either safer banks or stable system because large financial conglomerates may stimulate more managerial incentives of risk-taking and exploit more subsidies from the authorities. Finally they confirm higher concentration system brings the higher potential of systemic risk. Therefore, they support inefficiency of regulation in a concentrated industry, and agree that the "too-big-to-fail" policy would lead to financial fragility. To sum up, there is no consensus in the impact of bank competition through individual bank power or size measurement on bank stability.

Jiménez, Lopez and Saurina (2007) followed Keeley's approach, examine the relationship linear or not through the Spanish data from 1988 to 2003. Non-performing loan ratio (NPL) is utilized to proxy banks' distress. The Lerner index is adopted here for testing the BDN and MMR models closely. Besides, HHI and number of banks in the whole industry as proxies of market concentration are presented in the research as well. They evaluate the impact of competition on both deposit and loan markets, but the final result only can supports Charter value paradigm but not risk-shifting effect in the BDN model. Moreover, there is little evidence for U-shape relationship as illustrated in the MMR model. Overall, this

research finds a native relationship between loan market powers and banking risks while market concentration has no significant impact on bank risk-taking.

Beck, Jonghe and Schepens (2011) from a micro point of view, collect data from 79 countries from 1994-2009. Lerner index is as the indicator of competition. The Z-score and NPL ratio are as the index of bank soundness. They examine the cross-country relationship between the market power and bank risks and in the meantime assess how regulation, market structure and other institutional factors influence the relationship. They conclude "greater competition would have a larger impact on bankers' risk-taking incentives in the countries with stricter activity restrictions, more homogenous market structures and more generous deposit insurance and more credit information sharing." In summary, the evidence supports CVH paradigm instead of risk-shifting paradigm.

A large body of studies focuses on the numerical analysis when measuring competition environment, such as Lerner Index, Herfindahl, and H-Statistic. Bushman, Hendricks and Williams (2013) adopt a textured analysis to extract a bankers' perception of external competitive environment. They assume how managers perceive the bank's competitive environment strongly influences operational decisions (Stiroh, 2004, Brunnermeier et al., 2012). This subjective measurement is based on 10-K filings[9], developed by Li, Lundholm and Minnis (2012). This measurement counts the occurrence of reference to competition, such as competitive, competitor, but removes any confused words related to competition that are preceded with "less" "no" "limited" or "few". Then the study calculates the bank's perceived competitive environment (*BPCE*) ratio as the number of references to total number of words in a firm's 10-k filing. They select the data from US market over 1996-2010. To investigate how financial stability, they measure value-at-risk and balance sheet contraction risk at the individual bank level. The study shows that the perceived competition pressures bankers to make riskier operational and accounting decisions. First, banks would lower the underwriting standards; meanwhile, increase the syndicated loans to riskier borrowers which make banks less sensitive to the defaults. The competition perceived also affects banks' accounting choice for example, the recognition of expected loan losses becomes untimely when the competition increases. Overall, higher competition contributes more to systemic risks at the individual bank level.

5.3 Mixed of Micro- and Macro- Level Research

Many studies adopt alternative route through descriptive analysis to compare banking structure and stability in a pair of countries. Normally they used the mixed measurement of both macro and micro index. Bordo et al (1996) compare Canadian and the US banking sector during the period 1920-1980. They combine the macro

[9] A firm 10-k is an annul report required by the U.S. Security and Exchange Commission (SEC), different from the annual report to shareholders. Typically, the 10-K contains more details than the annual report to shareholders. It includes information such as company history, organizational structure, equity, holdings, earnings per share, subsidiaries, etc.

index—the number of failed banks and micro index—ROA and ROE as the measurement of fragility. The number of banks is used as a proxy of competition degree. The evidence proves that fewer banks failed in Canadian market than in the US due to its oligopolistic structure. But US competitive market generates higher profit. Hoggarth et al. (1998) compare British and German market structure and risk level, resulting in the similar conclusion. Staikouras and Wood (2000) make cross-country comparison between Spain and Greece in the 1980s and 1990s. They employ different measurements to gauge the banking stability degree including macro and micro aspects: output fluctuations, inflation rate and profitability volatility. They state the opposite opinion with previous two studies. Spanish banking sector with a more competitive structure are more profitable and stable than Greek one. Staikouras and Wood (2000) are in favor of the competition-stability hypothesis.

6. Methodology and Data

This part is divided into two parts: data and methodology. In terms of data description, we first of all, detail our sample composition and data selection process. Then we explain each variable and variable computation. Finally we give our expectation of potential relationship between the dependent and the independent variables. Referring to methodology, we firstly explain basic model components. Then we clarify how to test the models and how to conduct robustness tests finally.

6.1 sample composition and data selection

This research would employ the data from 10 CEE countries including Czech Republic, Hungary, Slovenia, Latvia, Estonia and Latvia and Lithuania, Bulgaria, Croatia and Romania. The data collected cover the period from 2003 to 2012. We choose the period starting from 2003 as Czechoslovak separates into two independent countries at the beginning of this year, so the potential data confusion is avoided. There are three rules to select the sample countries for our sample. *First*, we exclude CEE countries that have not joined into EU, for example, Albania, Serbia and so on. *Second*, although eastern part of German is included in CEE area, it is hard to separate the whole country data. *Third*, Poland is eliminated as we notice that the data from this country in Bankscope database is fairly incomplete.

Another four filtering rules are applied here in order to get the valid and representative data. *First*, if a bank presents reports at the consolidation level, we exclude subsidiary entities to avoid double accounting. *Second*, we eliminate the outlier data. Notice, we need to distinguish the outliers from the extreme values. Some extreme values may conclude important information. In this research, if a certain value has more than three standard deviations from the mean of its group, then we regard it as an outlier. *Third*, we delete banks that are lacking information of key variables for at least five consecutive years. *Forth*, if there is no basic information for

estimating key variables, the bank-year observations are eliminated. Fifth, we limit our sample to only commercial, saving and cooperative banks, which operate credit business and other commercial services[10]. We finally reduce our data to 196 banks in 10 CEE countries, accounting for around 70% of total financial institutions. All the large and median sized banks are included. So the sample may represent the whole banking industry.

Most of micro-level variables are from the *Bankscope* database provided by Fitch-IBCA[11]. If some basic data stemming from balance sheet or income statement is missing in the Bankscope, we try to look into individual financial statements. Macroeconomic data such as inflation, GDP growth rate and unemployment rate are from the *World Bank*[12]. Other institutional control variables, such as rule of law, control of corruption, regulatory quality are selected from *Worldwide Governance Indicators* (WGI)[13]. The information about foreign bank presence is from European Bank for Reconstruction and Development Transition Report (EBRD)[14]. Since the number of banks and market structure change over sample period, the dataset for the variables used is incomplete, so our sample is reduced to be an unbalanced panel. However, the aim of research is to investigate the effect of market concentration on banking stability. The movements such as mergers and acquisitions cause the changes in market concentration. Hence the unbalanced panel data is suitable and sufficient.
Our dataset consisting of 10 countries can be seen as an international dataset, which has advantage in its sample size, panel dimension and a variety of economies. In this sample, we define the market for each individual bank by the nation. Body et al. (2006) warn us that there is a primary drawback for cross-country sample that the banking market boundary are necessarily ambiguous since there are international banks serving several markets and the economic size in some countries are large. Such problems in our dataset are mitigated since the sample countries have small economic size and have few international banks serving overseas markets.

6.2 Definition, selection and computation of Variables

6.21 Concentration Measurement

From previous researches, normally four indexes Herfindahl-Hirschmann index (HHI), concentration ratio of top k banks in a whole sector (CRk), Lerner index and Rosse-Panzar H-statistic (RP H-statistic) would be used to proxy competition degree of a banking market. The first two measure the competition level of a whole industry through concentration degree while the latter two indicate the market power of each individual competitor in a market.

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10 Credit companies and other specialized lenders are eliminated, as they have no public interest rates. Investment banks and private banks are also not in our list as they are mainly major in consulting services and other financial services.

11 https://bankscope.bvdinfo.com/

12 http://data.worldbank.org/

13 http://info.worldbank.org/governance/wgi/index.aspx#home

14 http://www.ebrd.com/pages/research/publications/flagships/transition/archive.shtml

Sathye (2002) based on previous studies (Stigler, 1964; Hannah and Kay, 1977; Hay and Morris 1991) concludes: "Concentration refers to the degree of economic activity by large firms." Banking concentration reflects the competition degree and control ability of large banks. In this study, the concentration is used as the key measurement of competition, in line with structure-conduct-performance paradigm (Chamberlin, Edward, 1933; Joe S. Bain, 1941)[15]. Specifically, there is an inverse relationship between concentration and competition (Gilbert, 1984).

We may not use Lerner index as a proxy of competition. Lerner index reflects the ability of pricing power to cover the marginal cost. Z-score is the dependent variable for testing risk level of banks in this research. As both Lerner index and Z-score are calculated using the profitability variable, if competition is gauged by Lerner index, the positive correlation between the independent variable and the dependent variable is potentially spurious[16]. Another potential pitfall of the Lerner index is that when we calculate marginal costs, the ratio of interest expenses to deposits is included. Then it may itself embody market power in the deposit market (Berger et al. 2008). Therefore, Lerner index is not used here.

Some other research would use Panzar and Rosse H-statistic. It measures how competitive the bank is by classifying into three groups, ranging from monopoly, competitive to perfectly competitive[17]. But Shaffer (2004) and Boyd and De Nicolo (2006) remind that PR H-statistic is not a good continuous measure of competitive conditions. There is an assumption of H-statistic that the tested market must be in a long-term equilibrium but not in a short-term equilibrium nor in disequilibrium. CEE financial systems seemingly violate this assumption as financial reforms keep reshaping the banking landscape.

For prudence, we therefore would not use PR H-statistic and Lerner Index. HHI and CRk would enter as explanatory variables. HHI will be used for main regressions while CR is only used as an alternative measurement in the robustness test part.

Herfindahl-Hirschmann index (HHI) is defined as the sum of the squares of the market shares. This index of concentration solves some of the problems that arise with the absolute indicators of concentration—CRk. CRk only includes information

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[15] SCP paradigm suggests that the market structure is related to competitors' conducts and market power.

[16] Lerner Index is a proxy for the accrued profit to banks, measuring the competition through the pricing power. $Lerner_{it} = (P_{it} - MC_{it}) / P_{it} = 1 - MC_{it} / P_{it}$. MC_{it} is the marginal cost of the bank i at year t. P denotes the price of assets, defined as the ratio of total revenue to total asset. Therefore, the return is higher, and the Lerner is higher. Z-score is also increase with the return. Therefore, there may be a spurious positively correlation between them.

[17] Rosse and Panzar developed the Rosse-Panzar H-statistic approach in 1987. It is calculated as "the sum of elasticities of gross revenue with respect to input prices". Higher H-statistic implies the higher competition.

of top k banks (regardless of foreign or domestic banks) in the whole market while HHI comprises all the market information including small banks. HHI calculated as follows:

$$HHI_{it} = \sum_{i=1}^{n} MS_{it}^2$$

MS_{it} denotes the market share of bank i at year t. There are three main HHI indexes adopted in this research, namely HHI in the asset market, HHI in the deposit market and HHI in the loan market which reflect the proportion of total assets, deposit, and loans respectively accounted for by each bank in a given market. They are labeled as ***HHId***, ***HHIl*** and ***HHIa***. HHI is within the interval of 0 to 1. The market is assumed to be perfectly competitive when HHI equals 0 and completely monopolistic when equals 1. According to The U.S. Department of Justice[18], HHI is classified into three groups by the absolute value of HHI. If HHI is below 0.15, it indicates that there is a competitive market; if HHI is between 0.15-0.25, moderately concentrated markets; if HHI is above 0.25, highly concentrated market.

Concentration Ratio (CR) is the simplest and index to proxy competition/concentration. It measures the ratio of cumulative market share of the largest k banks to the whole sector (Rose, 1999), denoted as CR_k.

$$CR_k = \sum_{i=1}^{k} S_{it}$$

S_{it} means the market share of bank i at year t. in our research, we measure the proportion of market shares held by the top five banks in terms of deposit and loan markets separately, denoting as *CR5_a, CR5_d* and *CR5_l.*

6.22 Banking Stability Index

There are two main types for banking risk measurement, one is based on a macro perspective and the other is on a micro perspective.

Some of previous studies measure the risks from the macro point of view to count the real episodes of banking crises or number of bankruptcies as a proxy of banking stability, such as Beck et al (2005) and Fungáčová and Weill (2009). These macro data describe the actual failures. However, this measurement would distort the consequence because of four reasons. *Firstly,* different countries adopt different definition of banking crises. Since this research would do cross-country analysis, it might be hard and arbitrary to unify the recognition standards of actual banking crisis. Demirgüç-Kunt and Detragiache (1998) also criticize that the criteria set to define the crisis is somewhat arbitrary. *Besides*, how to pinpoint the start and end year of crisis

[18] HHI classification and definition is in The U.S. Department of Justice: Horizontal Merger Guidelines § 5.2 (2010).

also remains debatable. Thus how to define the duration of a crisis in an objective way remains problematic. Thirdly, a banking failure may be attributed to the regulatory or governmental inefficiency. In such case, a mighty or corrupted authority would disguise its dysfunction through smoothening the banking failure or veiling the severity of the failure. And the authority is competent to intervene the announcement of failures or crisis to keep good reputation. Specifically in term of CEE counties, the related authorities with high level of corruption might be susceptible for potential manipulation in banking failure announcement and duration[19]. *Thirdly*, authorities may adopt the "too-big-to-fail" or "too-important-to-fail" policy to intervene the banking operation explicitly. Bratislava (2007) mentions in most transition countries the political elites could perform their functions only when they obtain the trust from public. Therefore, the authorities in order to get the trust from people and keep good reputation, may try not to make economic failure occur during their tenure. When important banks have problems, the authority may subsidize them and prevent contagion from the systemic crisis. Then, the banking system is already at risk but not enough to describe as an actual crisis. From the macro way, the whole banking system is plausibly sound. The *last* reason we do not accept the macro measurement is that CEE banking industries have little information of financial crises. Hence we cannot collect enough useful data, yet it does not mean banking industries are stable.

Taking all these factors into consideration, we shall adopt the micro-based measurement to proxy banking risks in each individual bank. The most two popular measurements are Non-performing Loan ratio and Z-score (Body and Runkle, 1993; Craig and Santos, 1997; De Nicolo et al., 2004; Beck et al., 2006 etc.).

Non-performing Loan Ratio (NPLR) is the ratio of Non-performing loans to total gross loans. As an ex-post measurement of credit risk, it explains the risk level in loan markets. BDN and MMR emphasize that credit risk is the primary source of potential risks in most banking systems. Therefore, we believe the NPL is an essential index to capture the loan portfolio risk and to exam the BDN model specifically in this research. The NPL ratio formula goes as bellows:

$$NPL_{it} = NPL_{it} / TL_{it}$$

According to the definition provided by paragraph 4.84 of the IMF's Compilation Guide on Financial Soundness Indicators (2006)[20]:

> *"A loan is nonperforming when payments of interest and principal are past due by 90 days or more, or at least 90 days of interest payments have been capitalized,*

[19] The CEE corruption level can be seen in Transparency International Corruption perception index (CPI) http://www.transparency.org/country.

[20] This definition is in chapter 4. Accounting Framework and Sectoral Financial Statements. Available at website: http://www.imf.org/external/pubs/ft/fsi/guide/2006/

refinanced or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons to doubt that payments will be made in full." (P46)

Bloem and Gorter (2001) mention there is no common criteria for the NPL recording and valuation. Mainly there are four ways to record NPL: nominal valuation, adjusted nominal valuation, market valuation and dual recording of valuation. We realize that nominal recording method impedes the accuracy and it does not reflect the impairment on loan, whereas the market valuation is hard for obtaining data. For prudence, we obey the International Accounting Standards 39 (IAS 39) taht the debt impairment should be adjusted to the nominal value. Therefore we choose adjusted nominal valuation by taking impairment allowance into consideration.

Z-Score (ZS) is another index to gauge micro-level risks. It implies the probability of banking failure by measuring bank's overall risks, different from NPL that only indicates loan risks. Z-score is denoted as follows:

$$Z_{it} = \frac{ROAA_{it} + \frac{E_{it}}{A_{it}}}{\sigma(ROAA)_{it}}$$

Z-score represents "the numbers of standard deviations below the mean by which profits have to fall so as to just wipe out equity capital" (Boyd et al., 2006). Specifically, it contains three important points: the individual bank's profitability rate—Return on Averaged Asset (ROAA), bank capitalization level —capital ratio (Equity to Asset ratio) and return volatility (standard deviation of rate of return on averaged assets, $\sigma(ROAA)$). All information used for calculation is from accounting data in Balance sheet and Income statement. Technically, risk measured by Z-score is positively related to profitability and capital ratio but negatively correlated to return volatility. Overall the higher Z-score is, the lower the insolvency risk is and the higher banking stability is.

There is a limitation that both Z-score and NPL ratio cannot measure the actual bank failures since all of information used for calculation is from accounting data rather than from market data (Beck, 2008). Though market data is more relevant, it is hard to obtain.

6.23 Microeconomic Control Variables

As our sample is based on around 200 banks in ten banking markets, across the CEE countries, bank heterogeneity should be taken into consideration. We select seven bank-specific variables to control for the micro-level individual characteristics.

Many economists consider the impact of concentration on financial stability through influence of ***Bank Size***, as the size is to some extent related to market power. Some scholars find a positive relation between bank size and stability (McAllister and McManus, 1993; Hughes and Mester, 1998). Others suggest a negative relation of

bank scale and stability (Chong, 1991; De Nicoló, 2000). Until now, the relationship between bank size and risk is unclear. We would test that whether large scale of banks would better diversify the risk or augment managerial risk-taking motives. It is proxied by total asset size. To avoid skewed distribution, total asset in log transform will be calculated, expressed as ***INTA***.

Body et al. (2006) find a positive relation of loan risk and ***Banking Profitability***. Flannery and Rangan (2007) also discover that the asset risk is positively related to the profitability. Return on Equity (ROE) reflects the return from shareholders' point of view while Return on Assets (ROA) measures the return from the perspectives of shareholders and creditors. Therefore, we combine ***ROE*** and ***ROA*** to control the profitability. We expect negative and significant coefficients of them when regressed with ZS while positive to NPLR

We further include the Capital ratio (***CPTR***) for control the effect of it on risk-taking. Martin (1977) suggests the default risk is directly connected to banks capital holding. Capital is seen as a buffer against the default loans. On the other hand, Hakenes and Schnabel (2011) also find capital ratio affects the risk but in an unstable way. Capital ratio is a ratio of total equity to total assets, calculated with accounting numbers from balance sheet. We anticipate that capital ratio is positively linked to banking stability (ZS) is positive while negative to NPLR.

Each bank is specialized in its own business. Some are excel in the traditional retail intermediation activities and some are in wholesale business. Hanweck et al. (2005) believe different banks with their unique product-line specializations and business model, face different level of risks and competition. W e employ ***Loan Ratio*** (***LR***) of net loans to total assets to control the impact of banking specialization on its risk-taking (Jiménez et al., 2007). We predict the loan ratio affect banking risks, especially asset risks as higher loan ratio means lower liquidity (Demsetz et al, 1996). So a negative relation of LR and ZS is predicted.

Net Interest Margin (NIM) reflects individual bank's asset quality as well as managerial decision process in response to the market variation. Whether the investment successful or not is crucial for banking stability. Angbazo (1997) find NIM in commercial banks is sensitive to credit defaults. Some other empirical research also shows a negative relationship between NIM and credit loss, especially among banks offering commercial-type loans (Hanweck et al., 2005). We predict NIM is negatively linked to NPLR but positive to ZS. ***Cost To Income Ratio (CTI)*** is adopted controlling for banking efficiency, calculated as a rate of operational expenses to operational income. The lower ratio signals the higher efficiency in the bank. A negative sign of coefficient of CPT is expected. Both ratios can be collected from the *Bankscope* database directly.

Finally, ***Foreign Banks Penetration (FP)*** will be taken into consideration. It is measure by the asset share of foreign-owned banks in the market. The higher ratio means the deeper penetration. Foreign bank entry is well acknowledged to have impact on both market structure and system stability. High foreign ownership has been the main feature of CEE banking markets after the privatization reforms and financial liberalization. Detragiache and Gupta (2004) find the foreign bank presence have a stabilizing role before and during the financial crisis. Whilst Levine et al (1998) argue that the high foreign ownership of the banking market is prone to bringing

vulnerability. Some other studies suggest that the degree of foreign penetration is not of major importance (Miklaszewska et al., 2010). For better examining the foreign bank presence influence, the variable is not included into the basic model regression, but added additionally in the robustness part. We expect a positive sign of FP.

6.24 Macroeconomic Control Variables

To examine the relationship between banking risk and competition, macroeconomic factors should be considered as these variables affect bank stability, market structure or both to various extents.

Banking, similar to other industries, is affected by the business cycle. Investment behaviors may be easily affected by the economic situation. For example, the profitability tends to be better during booming times while the non-performing loan problem would be worse during the economic recession. However, some other evidence suggests that occurrence of lending defaults tend to be more frequent during thriving periods than in recession (Jimenez and Saurina, 2006). It may because banks are over optimistic about borrowers' ability when economy growing. To control the business cycle, real GDP growth rate (***GDPG***) are thus introduced. In addition, the economy might have lagged effect to banking industry so one-year lagged GDPG will be included in robustness test but not shown in main regression. We have no clear expectation about the sign of coefficients of GDP growth rates.

Unemployment Rate (UEMP) is also incorporated controlling for the different demand for banking services. The market with a higher unemployment rate indicates the bad economy. We forecast the unemployment rate is inversely related to banking stability.

The fluctuation of ***Inflation Rate (INF)*** would lead to uncertainty and increase the funding cost. The impact of inflation on banking performance is classified into two groups: one is the expected inflation and the other is the unexpected inflation. If banks can predict the inflation, the profitability will show an inverse U shape trend. With inflation growing, banks accelerate risks for pursing profit. The deteriorated credit risks would be exposed to the whole system after the summit of inflation period. If the inflation is unexpected, the interest rate keeps unchanged, which would bring losses to bank. Under this circumstance, high inflation rate is regard as extra "intangible taxation" to banks. The "higher taxation" may lead to risk-taking behaviors (Jeff Madura, 2008). Therefore, to control for inflation influence, INF is incorporated into our regression. The positive relation of INF and ZS is estimated.

6.25 Institutional Control Variables

Institutional environments vary across countries. We believe that good institutional conditions are related to solid supervision. This is beneficial for operating banking business. So we assume there is a positive relation of sound governance and banking stability. The underlying indicators are rule of law, political stability, regulatory quality, control of corruption.

First, we include the variable ***Rule of Law (RL)***. Banks have duty for depositors and hold the claim on the borrowers. A well-developed legal framework empowers the supervisors to regulate the participants' behaviors and the contractual enforcement. La Porta et al. (2008) agree that a developed legislation system protects the creditors' rights and contributes to banking stability.

Regulatory Quality (RQ) is contained for adjusting the variances in regulatory systems. Marc and Michael (2003) research on several case studies, finding that inappropriate supervisory significantly contributes to exacerbation of the systemic banking failures. We assume an independent and qualified regulation would lead to the banking stability.

Thirdly, Bussiere and Mulder (1999) prove that ***Political Stability (PS)*** has strong impact on economic solidity. However, Luděk and Ladislava (2011) based on the examples of CEE countries, argue that political instability is not an obstacle for financial stability. To control the potential influence of politics, we include ***PS*** in this model.

Finally, ***Control of Corruption*** **(*CC*)** is considered, as a higher corruption is believed to hinder the banking performance and stability (Barth, Caprio and Levine, 2009). Since there is agency problem in banking industry, the managers would be easily corrupted to sacrifice creditors' interest for the interest on their behalf.

All four institutional variables are extracted from WGI (Worldwide Governance Indictors). The estimations of indicators are measured on a range -2.5 to 2.5. The higher the score is, the better the governance is. We expect there is positive relationship between the effective governance and banking soundness.

Table 3: Summary of expected sign and source of all the independent variables with ZS as dependent variable

6.3 Description of Statistics

We present the descriptive statistics for all variables in Table 1. After sorting, we

Variabl	Expected sign of ZS	Expected sign of NPLR	Data Sources
HHI/C	Unclear	Unclear	Bankscope
TA	Unclear	Unclear	
ROE/R	-	+	
CPTR	+	-	
NIM	+	-	
CTI	-	+	
LR	-	+	
GDPG	Unclear	Unclear	World Bank
UEMP	-	+	
INF	-	+	
RL/RQ/ CC/PS	+	-	Worldwide Governance Indicator
FP	+	-	EBRD

reduce original 1960 bank-year observations to 1519. Both distributions of risk measurements, Z-score and NPL ratio show a large degree of dispersions across banks, ranging from -7.6 to 110.5 and from 0 to 87.38% respectively. Regarding to concentration level, HHI in assets, deposits and loans exhibit similar mean and standard deviation. HHI indexes present a big diffusion with the highest concentration level up to 0.68 and the lowest one with 0.09. The average of the loan HHI is slightly higher than the average of the deposit HHI, which indicates the loan market risk may be higher than risks related to deposit markets. The asset HHI index measures risks in total market, thus between HHId and HHIl. CRs tell the same story with HHIs. The Profitability ability in CEE countries is generally better performed (39%) than international averaged level (15%). Banking asset quality is averagely positive as shown in NIM (4%). GDP growth rate and inflation rate vary with a big dispersion, which implies there may be an economic recession during this period. In terms of institutional environment, averagely, Control of Corruption governance (0.3) is worse performed than the other three aspects (0.7, 0.9 and 0.6 in Political Stability, Regulatory Quality and Rule of Law respectively) in the CEE area.

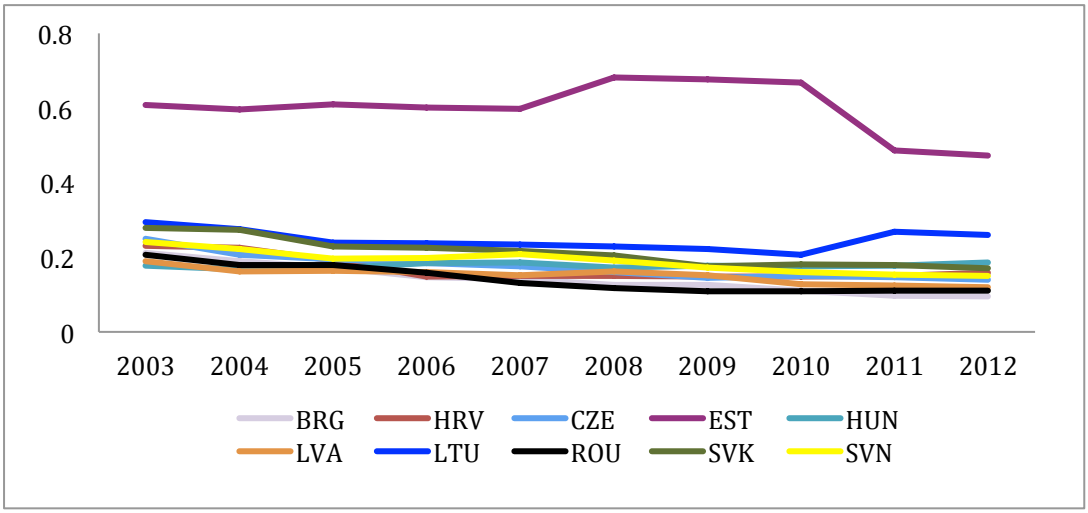
< Insert Table 4: Summary of Descriptive Statistics >

Figure 2 presents the concentration trends measured by HHI in total assets, which in general shows a downward tendency in the concentration level across most countries except Lithuania. The concentration degree of Lithuanian market keeps relatively unchanged, but it has being increasing after the 2009 European debt crisis. Amongst ten countries, Estonia keeps the most concentrated market with the highest volatility. The reality is that two largest commercial banks Swedbank and SEB owned by Swedish bank groups controlled around 70% of market share and the top four banks accounted for approximately 90% of market, according to the publication in Estonia chamber of Commerce and Industry in 2012[21]. The rest countries are situated within the range between 0.1 and 0.3. The graphs imply that Estonia is an exception of exhibiting extremely high concentration[22]. This outlier country may distort the regression results, so we will analyze the sample including Estonia and the subsample without Estonia separately. Overall, the graph shows that concentration level in each country varies with small changes.

Figure 2: Concentration Level in Ten CEE Countries During 2003-2010

[21] See publication in Estonia chamber of Commerce and Industry.
http://www.koda.ee/en/services/banking-finance-and-insurance/banking-system/

[22] This outlier country might distort our regression results. So we would do regressions on both sample with Estonia and the subsample excluding Estonia for future comparison.



Note: HHI index in each country is calculated for representing the concentration level.

Source: self-calculation of raw data from Bankscope database

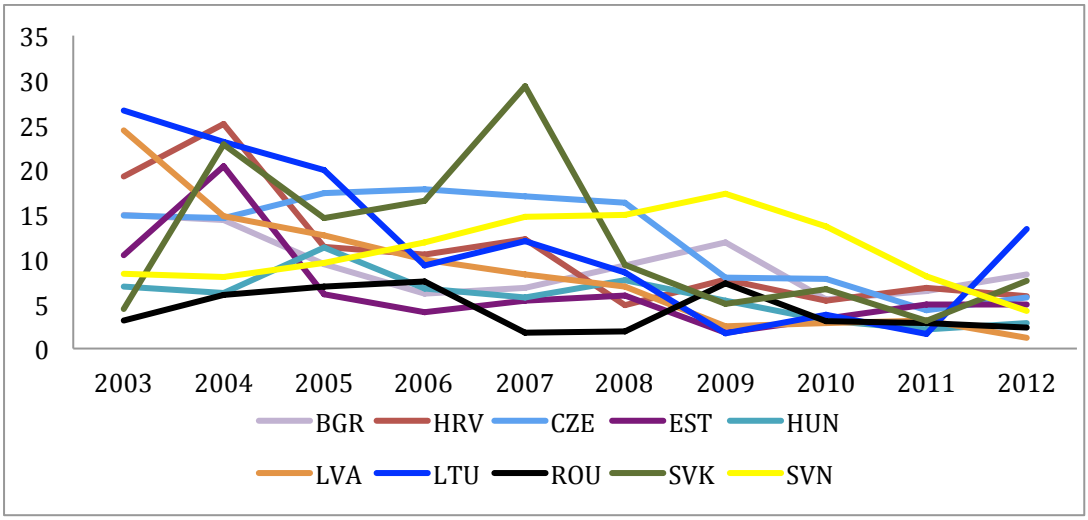
Figure 3 exhibits similar tendency that banking sectors in all countries are undergoing declines but with big waves in the banking stability. Fluctuations during 2007-2009 are particularly vast due to the 2008 financial crisis, seen in all CEE countries. Noticeably, although Estonia shows the highest concentration but its stability level is comparatively low. Lithuanian banks, in response to a post-crisis growth in concentration level, present the continuous growth in the stability after 2011. Slovak undergoes the most stable concentration level but experiences big fluctuations in the banking risks. At the beginning, it exhibits the lowest banking stability. After entering EU, Slovakia banks had experienced a rise in banking soundness before 2008. Probably due to the 2008 financial crisis and the 2009 European sovereign debt crisis, ZS continued to decline after 2008 and to the bottom out in 2011. Other countries also were influenced by the global crises to different extents.

We notice that the CEE countries are very vulnerable to global crises after joining EU possibly because of two reasons: first, they deeply rely on the external financing, external debt and foreign trades (Berglöf, 2009). For example, before the financial crisis, the global investment in emerging market totaled about $ 780 billion. Half of them flowed to CEE region in 2007 (Yang, 2009). Besides, until 2008, total external debt in CEE countries amounts to $ 1.7 trillion, accounting for 80% of local GDP (IMF global financial stability report, 2009). The external debt is Particularly high in Baltic States, Hungary, Croatia and Czech Republic. Second, in most CEE countries except Slovenia[23] around 60%-80% of market shares are foreign-owned and foreign ownership is concentrated in a few Western European countries, according to CEE banking sector Report 2013 by Raiffeisen Research. Most large banks are international banks, which apparently is heavily affected by global situations. The

[23] Slovenia has a very low foreign ownership around 30-35%, according to *CEE banking sector Report 2013* by Raiffeisen Research

risks of parent banks in other countries are easily transferred to the subsidiaries in the CEE region.

Figure 3: Averaged banking stability in 10 CEE Country during 2003-2012



Note: Average ZS of all banks in each country is calculated for representing the national level. And we plot each country-time specific point to shape this graph

Source: self-calculation of raw data from Bankscope database

6.4 Model Description

To examine whether the banking concentration influences banking risks in the CEE region, we generate a general regression as follows:

$Risk_{it} = f$ *(Competition* $Index_{it}$, *Bank Specific* $Variables_{it}$, *Macroeconomic* $Variables_{it}$, *Institutional Control* $Variables_{it}$*)*

All observations are measured with time and individual bank dimensions. This model aims to examine the relationship of concentration and banking stability after controlling for other bank specific, macro-economy cycle, institutional and regulatory environments. Next, the model establishment will be detailed.

6.41 Model and Control Variables Selection

Our regression would contain more than two variables. We choose 12 independent variables to explain risks. It can be possible that two of them are highly correlated. Then we would better to remove one of two highly correlated variables to alleviate multi-collinearity problem in each specification. Hence we shall conduct collinearity detection in order to select the valid variables with lower standard error. Since HHIa, HHId and HHIl are highly correlated (Shown as Table 4), we would put one

concentration index at one time in each regression specification. Also there are high correlations among institutional variables, so PS and RL will be eliminated in the main regression models. Instead, we put them in the robustness part.

The second step is to check whether we need to fix time and entity effects or not. At the first glance, the simple pooled OLS regression seems to be naive for our panel data set as it considers all observations equal. According to the statistically testing consequence, indeed we need to adopt both time and entity effects.

Third, a decision between fixed effects model and random effect model should be made. The outcome of Hausman test suggests the fixed effect model is more suitable. From the reality, each bank is unique for its own characteristics. Therefore the fixed effect methods for the unbalanced panels are usually required (Wooldridge, 2003). Besides, all the selected variables vary with time or entity. Therefore, it is not feasible to adopt the random effect model. In addition, the "clustering" procedure will be added for the fixed effects estimates to account for potential heteroskedasticity or serial correlation in idiosyncratic errors (Wooldridge, 2003).

Noticeably, many researches employ random effect model, as they believe regulatory or supervisory control variables are absent in time variations (Shehzad at el.; Schaeckand Cihak, 2006 and Verbeek, 2004). So as to supplement the research results, the random effect model regression would be incorporated into the robustness part. Besides, some other studies adopting country-specific effect model, suggest that country-specific effect is more appropriate than bank-specific characteristics (Blanchard, 1999). In terms of our study, first, the control for bank-specific effect comprises the control for country-specific effect. Secondly, unlike the research from Uhde and Heimeshoff (2008) that focuses on both Western and Eastern Europe, our sample only consists of the CEE countries. These transition countries exhibit similar historical and cultural patterns. So the bank-specific instead of county-specific effect will be fixed in this paper.

In balance, 13 discussed variables will be included and regressed with time and entity fixed effects. The specific model is explained as below:

$$Risk_{it} = \alpha_i + \mu_t + \beta_1 C_{it} + \sum \emptyset_{it} B_{it}^{(6)} + \sum \gamma_{it} M_{it}^{(3)} + \sum \theta_{it} I_{it}^{(2)} + \varepsilon_{it}$$

Where $Risk_{it}$ represents Z-score or NPL ratio in bank i at year t. C_{it} signifies concentration degree at year t for bank i. $B_{it}^{(6)}$ includes six bank-specific control variables discussed above. $M_{it}^{(3)}$ denotes three macroeconomic control variables. $I_{it}^{(2)}$ is composed of two institutional variables mentioned above. α_i aims to control for time-invariant bank heterogeneity while μ_t controls for time-specific impacts for instance business cycle. ε_{it} is the error term.

6.42 Explanation of Other Model Regressions and The Robustness Tests

To avoid the distortion by extreme observations, we will investigate the U-shape trend

based on a subsample that eliminates some extreme observations. As Estonia contains most of the extreme observations, so we would create a subsample without Estonia[24]. In the subsample, we shall add one more variable C_{it}^2, which denotes the squared HHI. The squared concentration index is included into the regression for examining MMR model or other previous findings that are supportive of a non-monotonic relationship between competition and risks. If the coefficients of C_{it} and C_{it}^2 show the opposite signs at statistically significant level, then there is non-linear relationship. Otherwise, we cannot reject the hypothesis that there is a monotonic relationship.

In addition, the regressions of Z-Score components will be conducted. Each component ROA, Capital ratio and Return Volatility will be served as the dependent variable, in order to see which part plays the principal role in driving the relationship of market structure and banking stability.

The research finally tests whether our results are robust to different regression models and alternative measurement of concentration index. We firstly only consider time-fixed effects in the model. Secondly, the random effect model is chosen for alternative regression. Thirdly, we add one-period lagged GDP growth rate (L.GDPG) for better control of the business environment, and then observe the changes of main results. Fourth, foreign banks penetration (FP) is added to test the strength of the main relationship between market concentration and banking stability. Fifth, HHI index is replaced with another concentration measurement-CRa to check the robustness. Fourthly, we replace the institutional variables RQ and CC with the other two variables PS and RL.

7. Empirical Results

7.1 Correlation of Variables

All the correlations between variables are below 0.5 except that among the concentration variables and among the institutional variables. Specifically, there is an almost perfect collnearity between HHIs. We therefore estimate that the regression of each HHI is likely to produce same outcomes. The CRs are criticized for their neglect of the role of small banks in the previous research. From Table 4, the correlation between HHI and CR is as high as around 0.8, which may suggest that HHI to large extent depends on the market share of largest banks. Hence, the theoretical drawback of CRs may not be as severe as mentioned in the previous studies.

Correlation Matrix A shows that all HHIs are positively connected to ZS while negatively linked to NPLR with small correlation coefficients. HHI indexes illustrate dissimilar correlations to ZS. This suggests that the concentration levels in asset

[24] Section 7 will explain why we use subsample to test MMR model in detail.

market, loan market and deposit market exert different impacts on risks. ZS is more correlated to concentration of asset market (0.1) than of loan markets (0.04). So the separation of markets is necessary. In general, from the correlation matrix A, there is a positive relationship between market concentration and banking stability.

<Insert Table 5: Correlation Matrix A of Key Variables>

The correlations within bank-specific characteristics are shown in Table 6 Matrix B. We observe Profitability (ROA) and Capital Ratio (CPTR) are positive to ZS with high coefficients, 0.3 and 0.4 respectively, which imply higher return and more capital holding contribute to banking stability. However, the CPTR is positive to NPLR. It indicates capital holding increases credit risks, which is opposed to our anticipation and the previous research finding. We may suspect that CPTR as one component of ZS cannot explain the bank risks unquestionably. Bank size (INTA) is positive to ROA but negative to ZS. Two hints can be obtained from these correlations. First, We can interpret that the banks with the larger scale although lead to higher profitability but tend to hold less capital and see more volatile return. It seems that large banking size cannot guarantee banking stability. Second, ROA as one component of ZS may not be able to explain overall risks fully. In summary, from these interlaced correlations, Return volatility ($\sigma(ROAA)_{it}$) of ZS potentially plays the key role in explaining banking stability instead of ROA and CPTR. To apply this to the reality, purchasing profit or hold capital as mush as possible does not guarantee the banking soundness. Stable return might be the main driver of the banking stability.

Bank specialization in loan ratio is positively correlated with ZS and negatively correlated to NPLR. It indicates that higher loan amount does not necessarily lead to higher banking risk. This may because the bank keeps sound risk management, or the institutional regulation plays the role. Cost to income (CTI) is negative to ZS, which indicates that inefficient banks are riskier. Yet the correlation is very weak, only -0.07. Net interest margin (NIM) is positively related to ZS and positive to NPLR without surprise, as better asset quality benefits banking stability. Noticeably, NIM has a higher correlation with NPLR (0.09) than with ZS (0.06). It suggests that NIM is more sensitive to credit loss, consistent with previous research results (Angbazo, 1997; Hanweck et al., 2005). In addition, banks in a concentrated market are more efficient as there is a positive correlation of HHI and NIM.

<Insert Table 6: Correlation Matrix B of Bank-Specific Variables>

Correlation Matrix C describes correlations among country specific variables and dependent variables. As expected, ZS is positive correlated to GDPG and inverse to INF and UEMP. Meanwhile, all institutional variables are positive to ZS, because the sound institutional governance contributes banking stability. Banking risk is most sensitive to political stability (0.25) and then to control of corruption (0.16).

<Insert Table 7: Correlation Matrix C of Country-Specific Variables>

To conclude, correlation matrixes only tell the sign of relation but do not show the significance and joint effects. We need further regressions to reveal the strength of relationships.

7.2 Empirical Regression Results

7.21 Regressions on Overall Sample

The regression outcomes from Table 8 are based on the overall sample including Estonia. All control variables are simultaneously added into six regressions. The first three columns are different from the last three columns in terms of risk measurements. Column 1, 2 and 3 illustrate the regressions with Z-score, all suggesting that higher concentration enhances the banking stability even after controlling for business cycle and institutional environment.

Precisely, all HHIs enter into regression positively and statistically significantly. HHIl (28) has a higher coefficient than HHId (24), which may indicate that the deposit market is less sensitive to banking risks, compared with the loan market. BND (2005) and MMR (2010) also suggest that credit risks are the primary defaults in banking industry instead of deposit risks. Yet, we should not ignore the liability side—the deposit market. As the capacity of deposit market can be assumed to be constant within a country in a short run, a more concentrated deposit market helps a limited amount of participating bank accelerate more deposits, which in turn enhances their ability and ambition to offer more loans. Thus, the market power in loan market will be promoted, causing concentration and monopoly in loan and asset markets. Their connection is also illustrated by high correlation in Table 5.

The profitability variables enter the regression 1, 2 and 3 positively at 5% sig. level. When profitability is positive to banking stability and to concentration degree (see correlation matrix B), there is no need to take on extra risks that may destroy high charter value established in current market. Higher profitability in a more concentrated market serves as a buffer to potential loan defaults, leading to banking stability. So the relationship between profitability and banking stability is suggestive for explaining “concentration-stability” view.

Referring to other control variables, banking size unexpectedly enters negatively into regressions of ZS at 5% sig. level. When bank size increases 1% in total assets, ZS will decrease 0.003 units. Large banks are seemingly more fragile than small sized banks. There is no sign of diversification benefit owned by large banks (Hughes and Mester, 1998), which seems contradictory to our previous finding of “concentration-stability” relationship. Our explanations go as below. Firstly, a market with large banks is not necessarily equal to a concentrated market. US and China are such examples that the banking industries are very competitive meanwhile occupied with many world largest banks. Secondly, Sanjai et al. (2012) find that the

scale-related diversification effects only exist in the banks under a certain threshold. Banks in CEE region may exceed the threshold of banking size, and then the scale effects may be attenuated. Lastly, Allen and Gale (2004) contagion effects may give some explanations. There are around 30 banks existed in each CEE country. Although large banks are risky, a concentrated market structure helps reduce contagion effects, as they are more capable and well informed to save the problematic bank. So it is possible that benefits from reducing contagion more offset risks exhibited by large size in a concentrated market (Allen and Gale, 2004).

CTI as suggested in previous empirical research, shows a negative and significant sign when regressed with ZS. It makes sense that an inefficient bank is more risky than the efficient one. LR enters positively into regressions with 5% sig. level. It indicates that bank specialization enhances the ability of monitoring borrowers and managing risks. High lending opportunities allow banks to better diversify loan portfolios. Another explanation is that although higher loan ratio represents lower liquidity of banks, it signifies higher profitability especially in concentrated markets where loan interest rate is charged high. The liquidity risk is potentially offset by high return. Furthermore, most powerful banks in the CEE region in fact are foreign-owned banks. Therefore their parent banks are capable and are willing to alleviate their potential liquidity problem. Another possible reason is that in a concentrated market, the informational surplus and information reusability as part of charter value is enhanced in a concentrated market. Banks have ability and experience to select high quality borrowers and to monitor them (Chan, Greenbaum and Thakor, 1986). Therefore the probability of impaired loans is low. Overall, our research again agrees with Allen and Gale (2004) that a concentrated market with a limited amount of banks improves the diversification and supervisory role. In our research, LR is even more significantly negative to banking risks when measured by NPLR (1% sig. level), which further confirm our results.

In terms of macro-economic variables, as suggested by theoretical findings, GDP growth rate is strongly positive to banking stability and unemployment rate and inflation rate are negative to ZS. The relationship of UEMP and ZS is not significant so we cannot reject the hypothesis that unemployment rate has no impact on banking stability. Still, we believe that the CEE banking industries develop with business cycle, easily affected by global and regional economic changes.

Turning to institutional variables, both RQ and CC enter positively and insignificantly. The reason may be as follows: first, as suggested by Barth et al. (2001) and Podpiera (2006), institutional environment may have no vital reforms during 2003-2012. Even if there were reforms recently, regulatory and legislation would influence the bank performance subtly and with time lag effects. So it is hard to observe their influence in a short term. Besides, insignificance is possibly due to technical problem of multi-collinearity. When macroeconomic and institutional variables are jointly included in a regression, the statistical significant degree of institutional variables

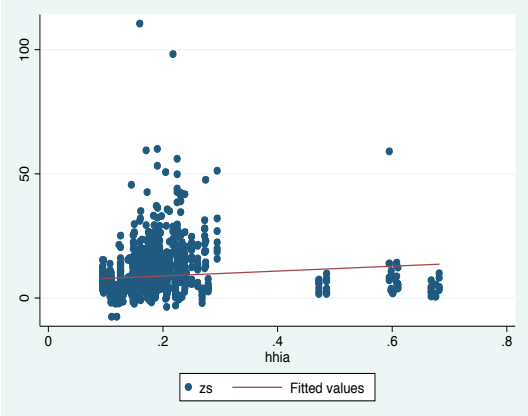
may be eroded. For avoid this problem, we shall put macroeconomic and institutional control variables separately in next subsample analysis.

The columns 4 5 and 6 demonstrate the regressions with non-performing loan ratio. They show similar results but less significant than the regressions with ZS. Particularly, concentrations show no direct impact on credit risks where P value is as high as 89%, 73% and 87% respectively. Other control variables such as profitability (ROA) asset, quality (NIM) and banking efficiency (CTI) also impose no significant influence on credit defaults. The difference of ZS regressions and NPLR regressions may be due to the former index measures the overall insolvency risk instead of only credit defaults. So ZS shows more robust and significant results, which is also more trustable. To some extent it may indirectly support CVH instead of BND or MMR, as latter two models claim credit risk is the key aspect for banking failures while we found concentration indexes are weakly related to loan defaults.

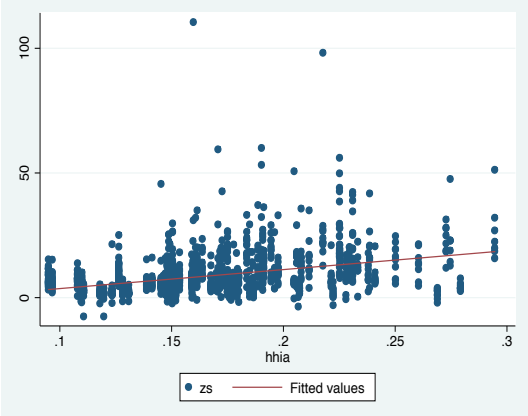
<Insert Table 8: Regressions on the Overall Sample>

As we notice Estonia is an extreme sample country with the highly concentrated market but with low banking stability level, the overall sample might produce inaccurate outcomes. Particularly, if we want to test MMR model that whether there is an inverse U-shape relationship between stability and concentration, the sample including Estonia may show a biased result. As the scatter graph A below shows Estonia is settled on the right side alone, together with other extreme observations on the top, it is easy to mislead us that there is an inverse-U shape with these outliers. After erasing Estonian observations, the scatter graph B visually shows an unclear U shape relationship. For further statistical evidence, we would do regressions on the refined sample in the next section.

Scatter Graph A



Scatter Graph B



7.22 Regressions on Subsample

The subsample would be used to test whether macro-economic control variables and institutional variables affect the relationship in significance and sign. Since NPRL

shows less significant relation with variables and same sign of relations with regressions of ZS in the large sample, we are not going to present specifications of NPLR regressions in next analyses. Also HHIa HHId and HHIl show same results while HHIa can measure entire market, combining both deposit and loan markets, as a result, we only employ asset market concentration as a main explanatory variable for brevity.

The specification 7 in Table 9 presents the baseline result. From the comparison of specification 7 and specification 1, the subsample produces close outcomes to the overall sample. The coefficients present the same direction with slight changes in the absolute value and significance level. It makes sense that the absolute value of coefficient of HHIa increases when the subsample excluding Estonia. When HHI increases 1 unit, the ZS will increase 84 units, double of the previous coefficient.

However, the most interesting finding is that there is a potential non-liner relation between banking stability and market concentration. Specification 8 indicates a negative coefficient of HHI and a positive coefficient of HHI-square at 1% sig. level. Precisely, it means the increasing concentration degree reduces the banking stability until one certain bottom point, and after that, continuing concentration enhances the banking stability.

But when controlling for the macroeconomic influence, the impact of concentration on banking stability is reduced in terms of both significance of and the absolute value of HHI and HHI-square coefficients. It seems that part of influence of concentration on banking risks is due to the changes of macro business environment. As shown in Specification 9, we are not confident about U-shape relation as HHI fails to be significantly related to ZS. Yet, it is not simply linear relation neither, as HHI-square is strongly positive to ZS.

We include institutional variables separately in specification 10 and exclude business cycle variables to avoid the potential insignificance resulted from multi-collinearity. Specification 10 shows the virtually unchanged outcomes under the situation of containing institutional factors.

Other control variables produce similar outcome with Table 8, entering in a same sign but more significant than the previous sample. For brevity, we are not going to discuss details.

Compared with specification 8, institutional and business environmental elements tend to weaken the influence of market structure. Precisely, growing economy and sound governance can offset part of the side effect of competition market. Also economic recession and inefficient governance may undermine the benefits of concentration structure. Given that HHI-square result keeps robust when including the country-specific variables, “concentration-stability” view is supported.

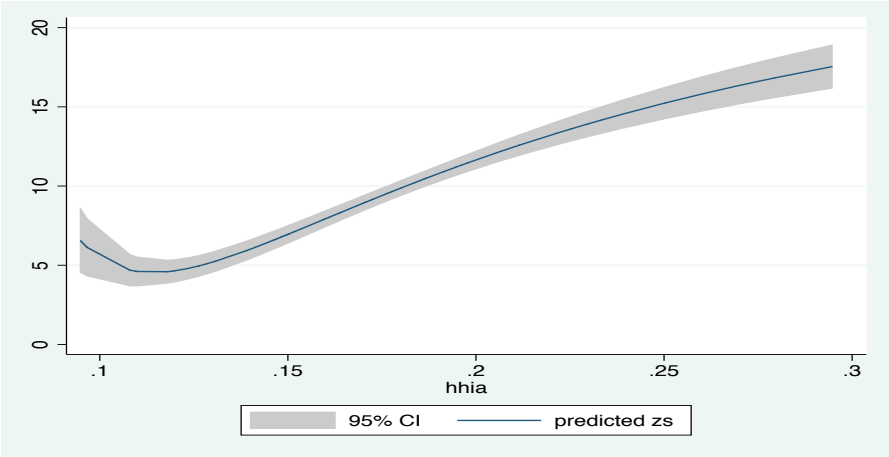
<Insert Table 9: Regressions on the Subsample>

From the specification 9 and 10 based on subsample, we cannot confidently accept the U shape neither the linear relationship between ZS and HHI. We would employ

Fractional Polynomial Regression analysis to provide visual evidence of relationship trend.

Figure 4 below demonstrates a solid regression line shaded 95% confidence interval. It shows an intuitionistic impression that there is a very incomplete and mild U-shape relation, which roughly proves the outcome of specification 8,9 and 10 that there is a non-linear relation. The chart reveals banks are under the most instable phase when HHI falls under 0.15. According to the classification of U.S. Department of Justice, this range is exactly classified into "a competitive market". Despite that lower competition spells more fragility than higher competition (0<HHI<0.1), the competitive market in general is more fragile than the concentrated market. Therefore, the subsample regression and graph analysis to large extent support that concentration raises stability. We have 95% confidence that concentrated markets (moderately concentrated markets (0.15<HHI<0.25) and highly concentrated markets (HHI>0.25)) are more stable than competitive markets (HHI<0.15).

Figure 4: Regressions on the Subsample: Dependent Variable of ZS



HHId and HHIl present the similar shape to HHIa (see appendix Figure 5 and Figure 6). HHIld illustrates the same shape while HHIl shows a more flat line, compared with HHIa. The loan market concentration is positive to banking stability without any turning. For asset and deposit markets, if we categorize the market by HHI classification, the turning point is within competitive market (0<HHI<0.15). The overall concentrated market is more stable than competitive market.

From the analyses of subsample, there is no inverse U shape or negative relation of concentration and stability. We hence reject MMR hypothesis and BDN hypothesis. Instead, a non-linear relation of concentration and stability is found but fail to be significant after controlling for business cycle and institutional environment. The outcomes are similar to the previous estimations from the large sample, bolstering "concentration-stability" view. We can interpret that Competitive markets are more fragile than concentrated markets. If the market is within competitive range, low competition is riskier than high competition.

7.23 Decomposition of Z-Score

Until now, we have confirmed that banking stability increases with concentration. To get a deeper insight of relation between concentration and stability measure by Z-score, we will regress HHI with each single component of Z-Score in Specification 1-3 in Table 10, simultaneously adding all country-specific control variables. All the regressions are based on subsample. As Boyd et.al (2005) mention, regressions of each component can firstly help to explore which part is a main driver of banking stability, and secondly be a robustness test.

The regression 1 adopts ROA as a dependent variable. To avoid perfect collinearity, ROA is eliminated from original control variables. As suggested in previous empirical researches (Body et al., 2005; Beck et al., 2003) and Charter Value theory, banks with larger market power in a less competitive market have higher return. In regression 1, ROA is indeed positive to HHIa, but insignificant. Bank size is positively and significantly related to bank profitability, which indicates higher market power improve profit return, in line with CVH. Meanwhile, CTI enters with the expected sign at 1 percent significance, implicating higher efficiency enhances profitability. Together, Regression 1 plots the positive relationship between concentration and profitability. Meanwhile, positive and significant coefficient of profitability infers "margin effect" existed in the competitive market.

Regression 2 investigates the relationship of concentration and another component—capital ratio. Before regression, CPTR is eliminated from the control variables to prevent perfect collinearity. The result, consistent with prior empirical studies (Bolt and Tieman, 2004;Schaeck et al., 2006) shows that HHIa is strongly negative to capital ratio. Specifically, when concentration degree increases, banks in turn decrease capital holding and increase their investment. According to Z-Score formula, ceteris paribus, the drop of capital ratio actually leads to the banking instability (lower ZS). Noticeably, ROA enters into this regression positively and significantly. It implies more investment is linked to higher profit. Besides, larger bank tends to hold less capital as INTA enters with the positive sign at one percent level. To sum up, these control variables together give some hints why banks in concentrated market hold less capital. There might be two reasons: on the one hand, as Mishkin (1995, 1999) suggests, regulatory authorities are prone to adopt "too big to fail" policy when facing a concentrated market with a limited amount of large institutions. This may consequently encourage participants to pursue high return and hold less capital. On the other hand, large banks in a concentrated market are more capable of portfolio diversification, which enhances their incentives for more investment (Schaeck et al., 2006). Hence, more investment or less capital holding does not necessarily signals more risk-taking if with better diversification.

The previous two specifications have no consensus. To see the complete relation, the final component— return volatility should also be checked as a dependent variable in Regression 3. Capital ratio measures the amount of outstanding loans, while the return volatility measures the loan portfolio quality. Personally, the latter is more sensitive to

banking risks. Surprisingly, we observe a negative impact of concentration on return volatility (standard deviation of ROA) at the most significant level (P=0.000) among three regressions. Banks in a less competitive market are inclined to enjoy more stable profit. Business environment variables show the expected and significant estimates to std (ROA), illustrating that a sounder business environment contributes to steady profit return.

Balancing consequences from three regressions, we cautiously conclude that previous finding of "concentration-stability" is principally driven by the component—return volatility. Banks in a concentrated industry are strongly positive to return stability, and thus are strongly positive to banking stability. On the other hand, concentration is inversely related to capital ratio, but the explanations behind are ambiguous. There might be a trade-off between bank efficiency and capital ratio (Hakenes and Schnabel, 2011). Therefore we cannot assert low capital holding in banks spells instability. Besides, concentration is positively related to high profitability but the estimate is insignificance, which is out of previous expectation. As the profit may not be strongly related to banking concentration, we may interpret that large institutions are devoted to monopoly power and a concentrated market structure is not aiming for higher profit, but for great stability of profit. Whittington. G (1980) researching on UK companies also observes the same results that a concentrated market brings large banks more stable return instead of more profit.

<Insert Table 10: Regressions on ZS Components>

7.3 Robustness Analysis

In the final part of empirical analysis, various robustness checks will be conducted to examine the strength of relationship between banking stability and concentration. Again, all robustness tests are based on the refined sample excluding Estonia. First of all, we employ alternative regression methods and observe no substantial changes. The column 1 only fixes bank-specific effects and the column 2 uses random effect model, they both produce essentially same results although absolute values are slightly higher than previous findings in Table 8 and Table 9.

Secondly, we test alternative measurement of competition via the concentration ratio—CRa, the proportion of market shares held by the top five banks. The column 3 shows a concentration ratio is positive to banking stability but at an insignificant level (P=0.2). It is possibly because this index measurement cannot represent the whole industry. The situation of several large banks thus cannot be equal to the whole market structure. Nevertheless, the positive sign still helps accumulate some evidence for our results.

It is well know that CEE region is featured by the dominance of foreign banks. Foreign-owned banks occupy over half of market share. Column 4 examines whether foreign participation changes the relationship. It shows foreign banks penetration (FP) is strongly positive to banking stability. Also, foreign presence normally leads to less

competitive market (Yeyati et al, 2003). So this outcome provides additional evidence for "concentration-stability" finding. Foreign banks entry may bring FDI spillover benefits, which improve the whole banking system soundness. The main relation keeps the robust when foreign ownership presence enters into the regression.

Column 5 adds a new variable Lagged GDP growth Rate (L.GDPG) for two reasons. First, since accounting recording is time-lagged, accounting data used to calculate the banking stability (ZS) or credit risks (NPLR) is reliable but not relevant. For time consistency, we add one-period L.GDPG to cover actual business activity period. Second, economic environment may affect banks with a lag. For instance, after 2009 European sovereign debt crisis, NPL ratio and unemployment rate climb to the peak in late 2010 in CEE banks (Gunter Deuber, 2010). CEE regions still remain as the most vulnerable area to economic changes due to high financing demands. For controlling the time-lagged effect, L.GDPG will be included here. As expected, L.GDPG together with other two business cycle indicators enters positively and significantly. However, the overall results of regression have no big changes before and after adding this variable.

The column 6 finally checks whether the previous finding is still robust to the two institutional variables— rule of law (RL) and political stability (PS). The previous regressions indicate that with other country-specific variables, institutional variables seem insignificant. To have a closer look at the impact of institutional variables, other country-specific variables are excluded to avoid inter-influence. Rule of law enters the regression positively and significantly at one percent level. After controlling for RL and PS, the coefficients of most bank-specific control variables become more significant. It explains markets with sounder legislation system exhibit higher stability. When compared with Column 3, the absolute value and significance level of loan ratio becomes larger. It shows an improved legal environment encourages banks expand their credit supply, consistent with previous findings by Haselmann et al. (2010). We can further interpret that a better judicial system has better ability to protect the creditors' rights, enforce contractual relationship and regulate participants' behavior (La Porta et al., 2008). HHIa still remains significantly positive to ZS in this alternative regression.

To conclude, our main results have survived through all robustness checks from changing the model regression methods, replacing key measurement of concentration, adding additional foreign penetration and business cycle variables to putting new institutional variables. Together with previous regressions of components of ZS, all these sensitivity tests provide positive evidence for our final findings. Therefore, we are more confident that concentration contributes stability.

<Insert Table 11: Robustness Checks>

7.4 Analysis of Estonia

We mainly stress the issue based on the subsample excluding Estonia, as this country exhibits the extreme values. From Scatter Graph A, this outlier country shows the contradictory finding that the extremely high concentration increases banking fragility. To get the deep insight of this outlier, we may combine its background and give a reasonable explanation.

Estonia has started to release the credit control during 2000-2005. Against this background, there has been a mortgages lending boom over past years. Real estate industry and household mortgage loans have reached over 60% of credit portfolio in 2009 (OECD, 2011). The high amount of mortgage loans exposed the whole banking system to coming financial crisis. The Estonian banking system is highly concentrated. Four largest Nordic banks control 90% of banking market. The same institutions also dominate the rest of financial market through controlling brokerage, pension management and insurance (OECD, 2011). The high foreign presence behind the high concentration causes Estonia banking system more vulnerable, as the financial crisis may spread through parent Nordic banks. As a result, the risk to financial stability is potentially derived from improper deregulation and the external business environment especially after EU accession. The central bank of Estonia (Eesti Pank) in 2013 report also concludes: "the threats of Estonian financial stability are primarily related to the uncertainty caused by the European sovereign debt crisis and the poor growth outlook for the euro area." Therefore, Estonia may not enough to overturn our previous finding.

However, we can observe that high concentrated markets especially in CEE countries where markets are dominated by foreign banks is vulnerable to external environments. This may because their financial markets are integrated into EU market and easily influenced by the financial systems from the home countries of parent banks. Estonia, after recent changes in supervision and legislation[25], the financial system has been more resistant to potential external shocks and strong and solid at present (Eesti Pank, 2013). This may imply that a concentrated market with a limited amount of banks is more manageable for regulation and easier to recover stability (Beck, 2008).

[25] For example, in late 2010, the Financial Supervision Authority Act, the Credit Institutions Act and so on came into force. Other recent regulation and legislation reforms after 2008 financial crisis is detailed in "Review of the Estonian Financial System" by the deputy head of the financial stability department of Eesti Pank. P32-40

8. Conclusion

This study provides the first evidence of relationship between market concentration and banking stability over last ten years for the CEE region. Market concentration is measured by HHI index and banking stability is proxied by Z-Score. This research is based on the sample of around 200 banks from 10 CEE countries including Czech Republic, Hungary, Slovenia, Latvia, Estonia and Latvia and Lithuania, Bulgaria, Croatia and Romania over the period 2003-2012. This cross-country analysis finds that banks in a higher concentrated market are less vulnerable to risks. The main results hold when controlling for macroeconomic and institutional environments. Moreover, our main results have survived through all robustness checks from changing the model regression methods, replacing key measurement of concentration and adding additional variables. However, this study provides little evidence for supporting the BDN model of "competition-stability" view, nor the MMR model of U-shaped relationships between bank competition and risks-takings.

Both our qualitative and quantitative analyses support "concentration-stability" relationship. At the first glance of the rough trends in concentration trend and banking stability tendency (see figure 2 and Figure 3) over 10 years, we expect concentration contributes to banking stability. Then the empirical regression results further confirm this point of view. The interesting finding in our research is that when employing the subsample excluding the outlier country—Estonia, we discover that there is a weak non-linear relationship between banking stability and concentration degree after controlling for business cycle and institutional environments. Nevertheless, we cannot reject the hypothesis that there is a monotonic relationship due to the insignificant coefficient of HHI. For prudence, we provide visual evidence of relationship trend through the Fractional Polynomial Regression analysis. This graph shows the trend to large extent goes with "concentration-stability" theory. Specifically, although lower competition spells more fragility than higher competition ($0<HHI<0.1$), the competitive market is generally more vulnerable than the concentrated market ($HHI>0.1$). Therefore, we agree with CVH and Contagion effect model rather than BND model or MMR model. And we also analyze the impact of other control variables on banking risk, which is suggestive and supportive for our main finding. Finally, we investigate the special case of Estonia, finding that the extreme high foreign presence, deregulation as well as external financial influence together cause the low stability in banking industry. The good news is that the financial system has been more resistant to potential external shocks and strong and solid at present according to the report from Estonia Central bank (Eesti Pank, 2013). This may indicate that a concentrated market with a limited amount of banks is more manageable for regulation and easier to recover stability. However, we also notice that highly concentrated markets especially in CEE countries where banking markets are controlled by foreign banks seem to be more sensitive to external shocks than other European Countries. Hence, we may suggest that some related authorities should build more efficient and effective cross-border cooperation with other countries to set a safeguarding net for this region. Also the regulations and

legislations for the commercial banks should be in place to prevent the potential risks transferred from the parent banks in their countries.

Future research extension: China, as a transition country has similar history and reform processes with the CEE countries. However, it shows an opposite picture of the CEE countries. It now is becoming more competitive with financial liberalization but also becoming more stable than before (Yang and Zhong, 2012). Why facing this issue, the CEE countries and China show the opposite trends? We may be interested in a comparative study in our future research to tackle this question.

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Appendix

Figure 5: Fractional Polynomial Regression Analysis of HHId

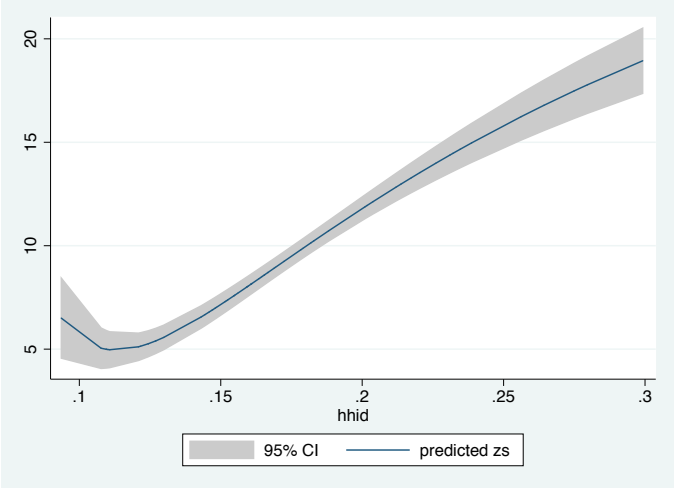

Figure 6. Fractional Polynomial Regression Analysis of HHIl

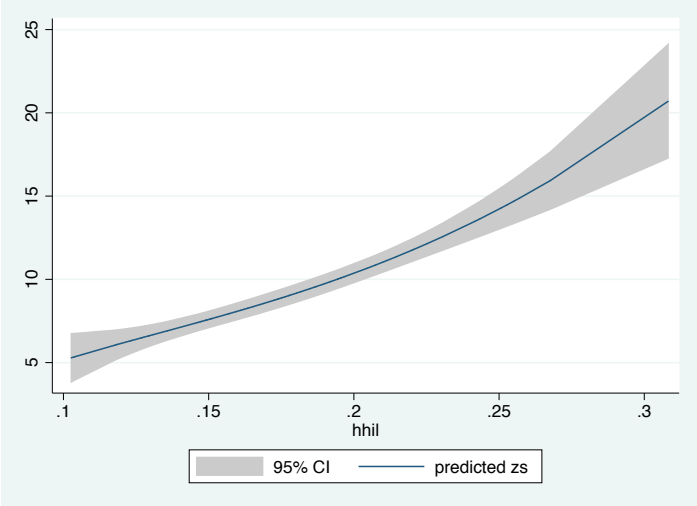

Table 4: Summary of Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
ZS	8.73521	8.476502	-7.619717	110.4612
NPLR	10.50551	11.78947	0	87.38
HHIa	0.1895347	0.0955883	0.0949215	0.6820429
HHId	0.1861845	0.0943051	0.0936261	0.6846188
HHIl	0.1902546	0.0924174	0.1027064	0.684604
CRa	0.6072928	0.1267216	0.3992537	0.9811745
CRd	0.6000214	0.133781	0.3406416	0.9848576
CRl	0.6110227	0.1194091	0.4188123	0.9856051
TA (thou in USD)	4012126	7259844	770.5276	5.19e+07
ROA	0.3914636	3.129164	-43.678	36.607
ROE	6.653542	43.5603	-298.097	900
CTI	72.61383	51.7541	1.023	767.474
NIM	4.013759	2.853757	-4.382	26.139
CPTR	11.61362	8.44327	-23.739	98.664
LR	58.55253	17.38262	0.006	98.093
GDPG	2.764705	5.154531	-17.955	12.2332
UEMP	9.434049	3.450616	4.3	18.7
INF	4.55287	3.082444	-1.14575	15.4032
PS	0.6779383	0.3011736	-0.0210399	1.152391
RQ	0.8613379	0.3165684	-0.0722958	1.426657
RL	0.5582759	0.4018145	-0.2271209	1.163048
CC	0.2987089	0.3707795	-0.3036518	1.023537

Source: Self-calculation base on the data collected from Bankscope.

Table 5: Correlation Matrix A of Key Variables

	ZS	HHIa	HHId	HHIl	CRa	CRd	CRl
ZS	1.0000						
HHIa	0.1039	1.0000					
HHId	0.0972	0.9902	1.0000				
HHIl	0.0618	0.9792	0.9688	1.0000			
CRa	0.2146	0.7964	0.8091	0.7302	1.0000		
CRd	0.1948	0.7498	0.7851	0.6769	0.9733	1.0000	
CRl	0.1931	0.8215	0.8359	0.7898	0.9637	0.9230	1.0000

Source: Self-calculation base on the data collected from Bankscope.

Table 6: Correlation Matrix of Bank-Specific Variables

	ZS	HHIa	HHId	HHIl	INTA	ROA	ROE	CPTR	NIM	CTI	LR	NPRL
ZS	1.0000											
HHIa	0.1003	1.0000										
HHId	0.0825	0.9912	1.0000									
HHIl	0.0429	0.9834	0.9736	1.0000								
INTA	-0.0892	-0.026	-0.037	-0.059	1.0000							
ROA	0.3040	0.0592	0.0519	0.0360	0.2810	1.0000						
ROE	0.1698	0.0360	0.0325	0.0139	0.1499	0.4943	1.0000					
CPTR	0.4035	0.0609	0.0781	0.0653	-0.347	0.0329	-0.054	1.000				
NIM	0.0576	0.0701	0.0863	0.0804	-0.197	0.2279	0.0748	0.409	1.0000			
CTI	-0.0701	-0.028	-0.019	-0.023	-0.359	-0.504	-0.316	0.172	-0.101	1.0000		
LR	0.0521	0.1652	0.1547	0.1455	0.1941	0.0563	-0.018	0.085	0.0953	-0.1306	1.0000	
NPRL	-0.2525	-0.125	-0.112	-0.080	-0.255	-0.412	-0.226	0.111	0.0882	0.1779	-0.065	1.0000

Source: Self-calculation base on the data collected from Bankscope.

Table 7: Correlation Matrix of Country-Specific Variable

	ZS	HHIa	HHId	HHIl	GDPG	UEMP	INF	PS	RQ	RL	CC	NPRL
ZS	1.0000											
HHIa	0.1039	1.0000										
HHId	0.0972	0.9902	1.0000									
HHIl	0.0618	0.9792	0.9688	1.0000								
GDPG	0.2322	0.1508	0.1434	0.1455	1.0000							
UEMP	-0.0257	0.0851	0.1229	0.1240	-0.1829	1.0000						
INF	-0.1526	-0.0237	-0.0347	0.0216	0.2192	-0.3585	1.0000					
PS	0.2483	0.1044	0.0734	0.0330	0.1045	-0.1255	-0.3256	1.0000				
RQ	0.0713	0.3864	0.3561	0.3506	-0.0007	-0.0398	-0.1775	0.5304	1.0000			
RL	0.0399	0.2693	0.2172	0.2405	-0.0867	-0.1181	-0.1885	0.7100	0.7971	1.0000		
CC	0.1552	0.3772	0.3152	0.3301	0.0762	-0.1284	-0.1918	0.7072	0.5000	0.8129	1.0000	
NPRL	-0.2657	-0.1283	-0.1156	-0.0804	-0.2657	0.3032	-0.1069	-0.2456	-0.1499	-0.0372	-0.0932	1.0000

Source: Self-calculation base on the data collected from Bankscope.

Table 8: Regressions on the Overall Sample: Dependent Variables: ZS and NPLR

	ZS (1)	ZS (2)	ZS (3)	NRL (4)	NPLR (5)	NPLR (6)
HHIa	41.498*** P=0.00			-2.063 P=0.89		
	(9.663)			(14.489)		
HHId		24.356*** P=0.00			4.533 P=0.73	
		(8.857)			(12.927)	
HHIl			27.660*** P=0.00			1.757 P=0.87
			(6.499)			(10.720)
Control Variables:						
INTA	-1.915**	-2.011**	-2.007**	-5.066***	-5.079***	-5.074***
	(0.871)	(0.877)	(0.882)	(1.930)	(1.919)	(1.925)
ROA	0.304**	0.303**	0.300**	-0.598	-0.598	-0.595
	(0.141)	(0.143)	(0.142)	(0.739)	(0.739)	(0.742)
ROE	0.004	0.004	0.004	-0.01	-0.005	-0.005
	(0.005)	(0.005)	(0.005)	(.0182)	(0.018)	(0.018)
CPTR	0.579***	0.577***	0.577***	-0.259**	-0.256**	-0.257**
	(0.079)	(0.080)	(0.079)	(0.107)	(0.107)	(0.107)
NIM	-0.340*	-0.324*	-0.317*	-0.248	-0.270	-0.259
	(0.181)	(0.181)	(0.181)	(0.369)	(0.365)	(0.365)
CTI	-0.012**	-0.013**	-0.012**	0.013	0.013	0.013
	(0.005)	(0.005)	(0.005)	(0.012)	(0.012)	(0.002)
LR	0.059**	0.059**	0.063***	-0.157***	-0.156***	-0.156***
	(0.024)	(0.024)	(0.024)	(0.049)	(0.048)	(0.049)
GDPG	0.265***	0.254***	0.242***	-0.369**	-0.362**	-0.366**
	(0.054)	(0.054)	(0.055)	(0.165)	(0.165)	(0.162)
UEMP	-0.050	0.030	-0.004	0.494**	0.470**	0.480**
	(0.100)	(0.104)	(0.096)	(0.199)	(0.193)	(0.192)
INF	-0.574***	-0.517***	-0.549***	-0.229	-0.238	-0.236
	(0.084)	(0.081)	(0.079)	(0.250)	(0.252)	(0.252)
RQ	3.998*	4.520**	4.596**	12.834	12.698	12.752
	(2.132)	(2.075)	(2.128)	(9.460)	(9.399)	(9.333)
CC	1.840	1.705	2.792	(0.301)	0.421	0.403
	(2.577)	(2.640)	(2.659)	(4.419)	(4.461)	(4.490)
Observations	1519	1519	1519	943	943	943
R-square	0.533	0.525	0.529	0.510	0.510	0.510
F statistics (P value)	40.54(<0.000)	36.46(<0.000)	38.66(<0.000)	25.23(<0.000)	25.26(<0.000)	25.46(<0.000)
Time fixed?	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed?	Yes	Yes	Yes	Yes	Yes	Yes

Notes: All p-values are two-tail. Statistical significance based on two-tailed tests at the 1 percent, 5 percent, and 10 percent levels are denoted by ***, **, and *, respectively.

Table 9: Regression on Subsample

	ZS (7)		ZS (8)		ZS (9)		ZS (10)	
HHIa	84.128***	P=0.00	-125.67***	P=0.01	-28.555	P=0.482	-64.151	P=0.188
	(9.417)		(48.264)		(40.538)		(48.472)	
HHIa2			486.734***	P=0.00	318.499***	P=0.003	323.092***	P=0.013
			(127.551)		(107.167)		(129.481)	
INTA	-1.929*		-2.693**		-2.097**		-3.136***	
	(0.994)		(1.081)		(0.994)		(1.071)	
ROA	0.306 **		0.534***		0.317**		0.462***	
	(0.137)		(0.157)		(0.136)		(0.145)	
ROE	0.005		0.005		0.005		0.004	
	(0.004)		(0.006)		(0.004)		(0.005)	
CPTR	0.563***		0.539***		0.552***		0.530***	
	(0.089)		(0.094)		(0.09)		(0.091)	
NIM	-0.295		-0.662***		-0.274		-0.532***	
	(0.186)		(0.199)		(0.184)		(0.191)	
CTI	-0.014***		-0.015***		-0.015***		-0.015***	
	(0.005)		(0.006)		(0.005)		(0.005)	
LR	0.071***		0.074***		0.073***		0.069***	
	(0.023)		(0.024)		(0.023)		(0.025)	
GDPG	0.188***				0.163***			
	0.0493				(0.052)			
INF	-0.746***				-0.307***			
	(0.081)				(0.093)			
UEMP	-0.252***				-0.787***			
	(0.091)				(0.075)			
RQ	2.481579						6.494***	
	(2.295)						(2.300)	
CC	2.502033						3.537	
	(2.556)						(3.007)	
Observations	1463		1463		1463		1463	
R-square	0.5465		0.4925		0.5499		0.5049	
F statistics (P value)	40.17(<0.000)		36.04(<0.000)		38.30(<0.000)		32.92(<0.000)	
Time fixed?	Yes		Yes		Yes		Yes	
Bank fixed?	Yes		Yes		Yes		Yes	

Notes: All p-values are two-tail. Statistical significance based on two-tailed tests at the 1 percent, 5 percent, and 10 percent levels are denoted by ***, **, and *, respectively.

Table 10: Regressions on Decomposition of ZS

	ROA (1)	Capital ratio (2)	Std (ROA) (3)
HHIa	2.411 P=0.395	-19.079** P=0.041	-7.879*** P=0.000
	(2.829)	(9.289)	(1.456))
Control variables:			
INTA	0.796***	-6.052***	0.238**
	(0.299)	(0.913)	(0.113)
ROA		0.520**	-0.030
		(0.226)	(0.020)
ROE	-0.007	-0.015	0.0001
	(0.009)	(0.009)	(0.001)
NIM	0.4011***	0.555***	0.031
	(0.077)	(0.194)	(0.03)
CPTR	0.068*		0.012*
	(0.038)		(0.006)
CTI	-0.015***	-0.002	0.001
	(0.005)	(0.012)	(0.001)
LR	0.017***	-0.027	-0.009***
	0.006	(0.024)	(0.003)
GDPG	0.118***	-0.079	0.030***
	(0.029)	(0.061)	(0.009)
INF	-0.023	0.046	0.032***
	(0.032)	(0.076)	(0.01)
UEMP	-0.027	0.153*	0.130***
	(0.035)	(0.089)	(0.017)
RQ	1.721**	3.999*	-0.202
	(0.793)	(2.324)	(0.350)
CC	-0.144	0.383	0.192
	(0.635)	(1.948)	(0.372)
Observations	1464	1464	1464
R-square	0.4803	0.2900	0.3188
F statistics (P value)	20.85(P<0.000)	6.5(P<0.000)	84.07(P<0.000)
Time fixed?	Yes	Yes	Yes
Bank fixed?	Yes	Yes	Yes

Notes: All p-values are two-tail. Statistical significance based on two-tailed tests at the 1 percent, 5 percent, and 10 percent levels are denoted by ***, **, and *, respectively.

Table 11: Robustness Regressions

	ZS (1)	ZS (2)	ZS (3)	ZS (4)	ZS (5)	ZS (6)
HHIa	94.487***	84.872***		72.561***	76.518***	59.09***
	(9.198)	(5.710)		(9.764)	(9.667)	(10.125)
CR5_a			3.759			
			(4.112)			
INTA	-1.254	-0.481	-2.607***	-2.262**	-1.146	-1.630
	(0.805)	(0.170)	(0.997)	(0.992)	(1.032)	(1.076)
ROA	0.368***	0.481	0.323**	0.30**	0.296**	0.520***
	(0.128)	(0.141)	(0.146)	(0.134)	(0.137)	(0.171)
ROE	0.006	0.004	0.004	0.005	0.004	0.004
	(0.004)	(0.006)	(0.005)	(0.004)	(0.004)	(0.007)
NIM	-0.313*	-0.419	-0.237	-0.271	-0.323*	-0.794***
	(0.187)	(0.122)	(0.193)	(0.182)	(0.180)	(0.206)
CTI	-0.01*	-0.013***	-0.015***	-0.015***	-0.008*	-0.013**
	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.006)
CPTR	0.578***	0.668***	0.544***	(0.565)***	0.502***	0.580***
	(0.087)	(0.052)	(0.088)	(0.089)	(0.089)	(0.095)
LR	0.069***	0.035**	0.064***	0.060**	0.084***	0.069***
	(0.024)	(0.017)	(0.024)	(0.024)	(0.023)	(0.025)
FP				12.014***		
				(2.593)		
GDPG	0.089***	0.161***	0.236***	0.193***	0.154***	
	(0.028)	(0.033)	(0.059)	(0.045)	(0.050)	
L.GDPG					0.233***	
					(0.061)	
INF	-0.654***	-0.641***	-0.515***	-0.626***	-0.446***	
	(0.055)	(0.057)	(0.078)	(0.077)	(0.098)	
UEMP	-0.484***	-0.402***	0.08	-0.279***	0.115	
	(0.062)	(0.0544)	(0.108)	(0.086)	(0.093)	
RQ	2.812	0.027	4.536**	0.46 (2.161)	5.005	
	(1.995)	(0.774)	(2.233)		(2.476)	
CC	5.145**	1.731***	1.549	3.286 (2.834)	-0.337	
	(2.239)	(0.673)	(2.965)		(2.628)	
PS						-2.367
						(2.357)
RL						4.231***
						(1.391)
Observations	1463	1463	1463	1439	1335	1463
R-square	0.5134	0.4977	0.5174	0.5529	0.5187	0.4832
Random effect?	No	Yes	No	No	No	No
Time fixed?	No	No	Yes	Yes	Yes	Yes
Bank fixed?	Yes	No	Yes	Yes	Yes	Yes

Notes: All p-values are two-tail. Statistical significance based on two-tailed tests at the 1 percent, 5 percent, and 10 percent levels are denoted by ***, **, and *, respectively.