**Babeş-Bolyai University**
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**Cluj-Napoca**

# PhD Thesis

## ABSTRACT

## Assessing the contagion risk on the European banking market

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**Key words**
systemic risk, bank contagion, bank failure, Conditional Value at Risk, quantile regression, macro prudential supervision, countercyclical prudential supervision

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## Introduction

Analysts, practitioners as well as researchers of financial markets have come to ask themselves the following question: is the crisis due to financial institutions' too risky actions or is it the result of unwise governmental intervention in the financial markets? Is it a consequence of prudential regulations as in the Austrian economic school spirit or is it due to the Keynes-like actions?

What initially seemed to be a temporary liquidity crisis coupled with the anxious nature of the financial market players has evolved into a profound solvability crisis for the entire financial system, coupled with the sovereign debts crisis. As a consequence of inefficient and too permissive prudential regulations as well as a too shallow inspection from the supervisory authorities, financial institutions have take on way too much debt in their pursuit for revenues. Because the consequences were on par with the assumed risks, banks found themselves playing a dangerous game that jeopardized their stability and the credibility of the entire system.

The collapse from Great Britain (1720), the global financial crisis (1825), the US housing marked panic (1827), the bankers panic (1907), the great depression (1929-1933), the US savings and loans crisis (1990), the Mexican crisis (1994), the Japan housing crisis (1996) and the Asian crisis (1997), the Russian crisis (1998), the US Dot-Com bubble (2000), the Argentinean crisis (1999-2002) are just a few well known examples of crisis in financial history. Still, these were no lessons well learned by financial institutions and governments alike. As Roubini puts it: "Crisis come in many colors and what work in one situation may not work in another".

Financial institutions relied on central banks backing them as last resort lenders and these in turn relied on international financial organizations as last resort lenders for the entire world. This oversight has led to an unprecedented moral hazard and international financial institutions soon became first, last and only resort lenders for the entire financial system.

Interconnections in the banking system are a necessity because institutions are not simultaneously specialized in both the drawing of funds through deposits as well as using these as a credit source for the economy. Some institutions are specialized in deposits while others specialize in lending, both of which are essential to the redistribution of liquidity to the financial system from those banks with a liquidity surplus to banks with a liquidity deficit. These transfers however are bearers of credit risk if they are not adequately managed and must be regulated to prevent the spread of contagion in the case of the counter-parties collapse.

The fact that financial institutions have extended their activity on an international level led to them becoming too large and to inter-connected for them to be allowed to fail. The negative externalities that their collapse would transmit to the entire economy would be colossal and could come in any of the following forms: forced selling of assets, liquidity spirals, haircuts, losses associated with the held positions, undercapitalization, penalizing interest rates or speculative bankruptcies.

The mismanagement of the poorly regulated trading portfolio, the deteriorating quality of the credit portfolio due to economic slowdown along with the poor management of liquidities were the primary causes that banks were extremely vulnerable to the extreme events that the 2008 financial crisis brought on. On an European banking system level, one has to also take into account the subsidiaries dependency on financing from their mother-banks. All of these factors led to an increased vulnerability of European banks as the euro-zone crisis reached new heights.

In trying to find new sources of revenue as well as increasing their assets, the western-European banks participation in banks from the emerging countries from Central and Eastern Europe has increased significantly in the last decade. These banks were apparently safe because their primary activities focused on deposits and loans. However, as the banks interconnections became stronger, so did the systemic risk increase and the contagion effects were becoming more obvious. For almost all banks, the problems regarding the exposure on the international financial markets impose an adequate recapitalization. The effects of this were immediately seen in the mother-banks limiting their subsidiaries access to liquidities and in last resort the selling of their foreign subsidiaries.

It this new context, we can see how the estimation of contagion effects in the banking system becomes of great importance. One also has to note that for the first time the Basel Committee on Banking Supervision has introduced capital adequacy requirements for the systemic-important banks whose collapse would jeopardize the stability of the global financial system.

*The motivation of choosing this theme* resides in the necessity of an in-depth analysis of the European banking system risk, simultaneously with the transmission of the contagion effects within financial institutions. Although there have been recorded a significant number of studies analyzing the systemic risk on the American financial market, not many studies have been done on the European banking market.

*The purpose of this research* is the analysis of the detection, estimation, monitoring and control of systemic risk as well as the effects on banking contamination. A qualitative analysis of the risk factors, systemically important institutions, estimation methodology, and negative externalities has been developed. On the other hand, a quantitative analysis of the European banking sector risk has been performed.

In order to achieve this goal, focus has been shifted towards achieving the following *specific objectives*:

- Analyzing the ability of speculative withdrawals and aggregated liquidity deficit to generate a systemic crisis;
- Analyzing the way in which interbank loans can intensify banking contamination;
- The evaluation of methods and techniques used by supervisory financial organizations in the monitoring and detection of institutions of systemic importance;
- The analysis of the prudential supervision regulations regarding the systemic risk;
- The estimation of systemic risk in the European banking market;
- The impact of the capital adequacy on the systemic risk;
- Assessing the contagion effects spreading among financial institutions;
- Analyzing the possibility of counter-cyclic adjustment of banking contributions to the systemic risk.

*Research methodology.* Observing the extensive methodologies discussed in previous papers we have used the Conditional Value at Risk methodology developed by Adrian and Brunnermeier (2010). Each bank's contribution to systemic risk is determined as the difference between the maximum possible loss of the system conditioned on the event that each bank will face the most severe loss and the maximum possible loss of the system conditioned on the event that each bank register median levels of possible losses. The risk measures were estimated through quantile regression applied directly to the extreme value distributions of the financial variables taken into account.

*Structure-wise,* the thesis is composed of four chapters that detail the specific objectives outlined above while offering a detailed view of the evaluation of contamination risk in the European banking market.

## Chapter 1

## Bank contagion – micro prudential and macro prudential approaches

The first chapter deals with ways in which speculative withdraws, aggregated liquidity deficit, loan relationships in the interbank market as well as contagion through the financial markets can generate systemic events.

Systemic risk is defined as "a systemic event that affects a large number of institutions or financial markets leading to profound dysfunctions in the entire financial sector" (De Bandt & Hartmann, 2002). One of its effects is banking contagion where systemic events propagate at an increased rate from one bank to the other financial institutions. Depending on the way in which they were transmitted, the induced shocks may cause various levels of damage in the banking market, the capital market as well as the payment systems market.

A number of studies were published dealing with the probability that a liquidity crisis that may arise at a certain bank due to massive cash withdraws for example may cause losses to the entire banking sector. Diamond and Dybvig put forward their famous model in 1983 which presents the collapse of a bank under the assumption that there is a single bank in the whole sector. Bhattacarya and Gale (1987) extended the model to the interbank market showing how the collapse of a bank is tied in with the liquidity shocks generated by other bank's clients needs. Diamond and Rajan (2005) showed that the temporary liquidity deficit seen in many banks may cause contagion to the whole banking sector due to common exposures.

The banks collapse may also be caused by a worsening of performance, liquidity, solvability as well as debt indicators. Owning a nonperforming loans portfolio or a value decrease of the assets inside a portfolio may be perceived as a negative signal when considering its solvability. Although it does not face liquidity issues now, holders may wish to withdraw deposits before their maturity date fearing that the worsening of the bank's financial indicators is a sign of its collapse. Depending on the way that this

worsening is judged by the bank's clients, due to the systemic character of information, this may even lead to the bank's collapse even though it is still solvable. The advantage of this type of collapse is that it will sort out the nonperforming banks.

Because volatility shocks may easily be transmitted from one institution to another, negative events in the financial markets, the foreign exchange markets as well as the government bonds markets may affect a large group of participants thus underlining their systemic nature. Compared to other financial sectors, contagion in the banking sector spreads much more rapidly and the negative externalities have a much higher impact. At the same time, a large number of institutions may go bankrupt leading to substantial losses for deponents, investors and other lenders.

Liquidity boots provided by the central bank and other methods to avoid the spread of the contagion are not enough to avoid the systemic risk and may also in some cases be inefficient. Also, these measures are taken ex-port while some measures might need to be implemented ex-ante for them to have an affect. Such measures include a prudential supervisory regulation which forces banks to maintain a level of capital corresponding to the risk generated by their activities.

The recent financial events also lead to a revision of the Basel II Accord by adding an approach that is much more sensible to extreme and unforeseen market variations. The new Basel III Capital Accord pays great attention to the liquidity risk and countercyclical regulations. It is for the first time when BCBS recommends special capital adequacy regulations for the systemically important banks.

## Chapter 2
## Systemic risk identification and quantification

Prudential supervision regulations which are responsible for the efficient monitoring of the systemic risk imply an early on identification of the financial institutions which are of systemic importance. These institutions have an international presence; they handle complex transactions and have a diversified assets and liabilities portfolio. They are too big and too interconnected to be allowed to fail. We consider that the main criterion for identifying these institutions should be the negative externalities they transmit to other banks in the case of a collapse. The negative externalities that their collapse would transmit to the entire economy would be colossal and could come in any of the following forms: forced selling of assets, liquidity spirals, haircuts, losses associated with the held positions, undercapitalization, penalizing interest rates or speculative bankruptcies.

For an efficient systemic risk management, both international as well as national supervisory financial institutions have developed various methods and techniques used to detect, estimate, monitor as well as predict bank contagion. In practice, one can observe a permanent conflict between supervisory authorities and researchers regarding the systemic risk estimation. While the first prefer the account method, the latter propose a much more dynamic approach based on a continuous adjustment of systemic risk with the financial markets evolution. Market risk estimation is a better suited method of risk assessment in the current volatile macroeconomic conditions. On one hand, this estimation gives an instantaneous image of each banks contribution to systemic risk; on the other hand, it reflects all ways in which contagion can occur.

Treating each bank separately led to an incorrect estimation of systemic risk. Therefore, a macroprudential approach and systemic risk measures that account for interdependencies are required. We recommend switching from a microprudential risk approach based on individual calculation of Value at Risk to a macroprudential approach based on the system's Conditional Value at Risk. Developed by Adrian and Brunnermeier (2010), the CoVaR method propose a countercyclical approach of the

capital adequacy prudential supervision requirements. The indicator involves the estimation of the $q^{th}$ quantile from the distribution of the market valued assets growth rates of the entire system at moment t (Value at Risk of the system), conditioned on the probability that each bank face the maximum possible loss of its market valued assets (Value at Risk of bank i).

The Conditional Value at Risk indicator is calculated for the whole banking system, each bank being judged as part of the whole system. This method can be used in a variety of ways: determining the system risk conditioned by one bank's risk, determining one bank's risk conditioned by the system's risk and one bank's risk conditioned by another bank's risk.

The successful implementation of this methodology depends on the accuracy of the empirical model being used. Although the normal distribution method is mostly employed, it may lead to an underestimation of risk and an under allocation of capital. In order to remedy this, we recommend *quantile regression* as a better method of modeling extreme variations.

## Chapter 3
## Evaluations regarding the European banking sector contagion. Empirical study

The European banking sector is characterized by an adequate capitalization level and by generally handling traditional banking activities based on deposits and loans transactions. In spite of this, the debt has significantly increased, the loan-to-deposits ratio has reached new heights and the CEE banks dependency on financing lines from their western mother banks may cause an outbreak of systemic events at any time.

Taking into account these characteristics, we have assessed the contagion risk within the European banking sector through a sample which consists of 53 European banks with international activity. These banks were the subject of the stress testing performed by the European Banking Association in 2010. They are representative banking institutions for 19 European Union member states. The sample consists of both banks that have managed to maintain their rating after the financial crisis has triggered and banks severely hit by the financial transactions performed in distressed areas such Greece, Ireland, Spain, Portugal or Italy. The sample includes both large and small banks. Also, it consists of various banks with subsidiaries in CEE countries.

In our scientific approach, we assume that the reduction of a bank's market valued total assets under a target level in stressed periods generates an increased contribution of the respective bank to systemic risk. The market valued total assets are determined by adjusting the total assets from the balance sheet with the ratio between the market value of equity and the book value of equity. This hypothesis has been extensively studied by Kelly and LeRoy (2005), Allen and Gale (2007), Acharya and Yorulmazer (2007), Adrian and Shin (2010), Shleifer and Vishny (1997).

The analysis was performed for the September 2008 – September 2011 period. The entry data is represented by balance sheet variables extracted from the Quarterly Balance Sheet Reports of Thomson Reuters like the book value of assets and the book value of equity. Also, we have used the daily returns of each bank and the daily market value of

capital. Because the banking market is continuously changing, the systemic risk is time varying. In order to account for the market movements, we have used daily variables that reflect the liquidity, the solvency and the credit risk that affects the European banking institutions.

Due to the deteriorating economic conditions on the international financial markets, the market valued banking assets registered a downturn after September 2008. They have depreciated within one year with more than 15.000 billion euro.

This downward trend of banking assets is closely linked to the evolution of various market indices representative for the interbank market, capital market and governmental bonds market. To capture their impact on the systemic risk we have taken into account the daily evolution of several market indices:

- The Euro area 10-year Government Bonds Benchmark yield (GB10y);
- The index representative for the banks traded on stock exchanges in the region of Central, Eastern and South-eastern Europe (CECE Banking Index);
- The index representing the largest 600 USA companies by market capitalization (STOXX Americans 600 Index);
- The benchmark index of 64 financial institutions frum the Eurozone (EURO STOXX Financials Index);
- The 3-mounth Euro interbank offered rate for unsecured lending transactions (Euribor3M).

Observing the extensive methodologies discussed in previous papers that use the liquidity, the volatility, the undercapitalization or the contamination between financial institutions as systemic risk regressors, we focus on the Conditional Value at Risk methodology developed by Adrian and Brunnermeier (2010). Each bank's contribution to systemic risk will be determined as the difference between the maximum possible loss of the system conditioned on the event that each bank will face the most severe loss and the maximum possible loss of the system conditioned on the event that each bank register median levels of possible losses. We have focused on this method because it provides an answer to the most complex issues encountered in financial risk estimation: extreme variations and procyclicality. Moreover, CoVaR could be estimated on a daily

basis, offering an instantaneously image about the contribution of banks to systemic risk.

The risk measures were estimated through quantile regression applied directly to the extreme value distributions of the financial variables taken into account. Proposed by Bassett and Koenker (1978) the Quantile Regression has increasingly been used in the recent years due to its ability to produce efficient and robust estimates of the quantiles conditioned on extreme events of other variables.

The evaluations regarding the European banking sector contagion implies the following steps:

- estimating the systemic risk in the European banking market;
- the determination of the contribution of individual banks to systemic risk;
- estimating the impact of systemic risk on the too big to fail banks;
- estimating the impact of systemic risk on the too capitalized to fail banks;
- assessing the contagion effects spreading among financial institutions.

## Chapter 4
## Solutions regarding the prudential supervision of risk for the European banking sector

This chapter analyze the instruments used by the supervisory authorities in order to limit the contagion in the banking system. Also, we propose a countercyclical approach regarding the prudential supervision regulations specific for the European banking sector. This approach is based on the previously estimated systemic risk indicators.

In a developed and well regulated banking system, there are several options to avoid the transformation of an isolated banking collapse into a systemic event. The ration behind various interventions is driven by the limitation of the spillover effects that can develop in a vulnerable banking system. The most important actions that can be taken include the followings: deposit withdrawals blocking, limits on interbank lending, constraints regarding the assets portfolio, deposit insurance schemes, lender of last resort rescues, governmental injections, public or private mergers and acquisitions. Also, relaxing the market assessment of assets requirements is also a common practice.

The banking supervision is performed by controlling the individual exposure of each bank to the market risk. Following the Basel II Accord recommendations this is made by setting different limits on the Value at Risk variation. But, this way of treating each bank separately led to an incorrect estimation of the systemic risk. Therefore, a macroprudential approach and systemic risk measures that account for interdependencies are required. It is recommend to switch from a microprudential risk approach based on individual calculation of Value at Risk to a macroprudential approach based on the system's Conditional Value at Risk.

Through a panel estimation approach we have highlighted the relationship between the contribution of banks to systemic risk and different balance sheet indicators specific to banking. The contribution of banks to systemic risk is the one previously determined through the Conditional Value at risk method. The cross-sections are represented by the

53 banks from the sample presented in the previous chapter. The estimation period is 2008-2011.

The banking system specific indicators were calculated based on quarterly balance sheet items extracted from the Thomson Reuters database. They express the following financial statement:

- the indebtedness grade expressed by the Total assets to Total equity ratio *(LVG)*;
- the degree of maturity mismatch of assets and liabilities: (liabilities - cash) / total debt *(nmAP)*;
- the size of banks represented by their total assets *(TA)*;
- the liquidity situation expressed by the Loans to Deposits ratio *(LTD)*.

The panel analysis results show that the balance sheet items have a significant influence on the contribution of banks to systemic risk, for all the periods we have analyzed. Improving the liquidity ratio *(LTD)* and the indebtedness grade *(LVG)* and decreasing the maturity mismatch of assets and liabilities *(nmAP)* will reduce the future contribution of banks to systemic risk.

## Conclusions

Due to its more rapid spreading in the banking sector than in other financial sectors, banking contamination may affect a large number of financial institutions. To be able to identify and limit in a timely fashion its effects one has to perform a much more detailed analysis than in other cases. The negative externalities that may be introduced into the economy must be handled by supervisory authorities with maximum caution as their effects could easily be felt in a variety of markets: interbank market, payment and settlement systems market.

The European banking sector is characterized by an adequate capitalization level and by generally handling traditional banking activities based on deposits and loans transactions. In spite of this, the debt has significantly increased, the loan-to-deposits ratio has reached new heights and the CEE banks dependency on financing lines from their western mother banks may cause an outbreak of systemic events at any time.

Prudential supervision regulations which are responsible for the efficient monitoring of the systemic risk imply an early on identification of the financial institutions which are of systemic importance. These institutions have an international presence; they handle complex transactions and have a diversified assets and liabilities portfolio. They are too big and too interconnected to be allowed to fail. We consider that the main criterion for identifying these institutions should be the negative externalities they transmit to other banks in the case of a collapse. Unforeseen events in the credit market, the capital market or at the macroeconomic level may result in significant losses for a financial institution. The bank is considered of being of systemic importance if, when affected by these extreme events, it would transmits these shocks to the non-financial sector. The level of losses depends on the debt level, the debt structure as well as the loans granted to other financial institutions.

For an efficient systemic risk management, both international as well as national supervisory financial institutions have developed various methods and techniques used to

detect, estimate, monitor as well as predict bank contagion. In practice, one can observe a permanent conflict between supervisory authorities and researchers regarding the systemic risk estimation. While the first prefer the account method, the latter propose a much more dynamic approach based on a continuous adjustment of systemic risk with the financial markets evolution. It is our opinion that market risk estimation is a better suited method of risk assessment in the current volatile macroeconomic conditions. On one hand, this estimation gives an instantaneous image of each banks contribution to systemic risk; on the other hand, it reflects all ways in which contagion can occur.

Treating each bank separately led to an incorrect estimation of systemic risk. Therefore, a macroprudential approach and systemic risk measures that account for interdependencies are required. We recommend switching from a microprudential risk approach based on individual calculation of Value at Risk to a macroprudential approach based on the system's Conditional Value at Risk. The latter is calculated for the whole banking system, each bank being judged as part of the whole system. This method can be used in a variety of ways: determining the system risk conditioned by one bank's risk, determining one bank's risk conditioned by the system's risk and one bank's risk conditioned by another bank's risk.

The successful implementation of this methodology depends on the accuracy of the empirical model being used. Although the normal distribution method is mostly employed, it may lead to an underestimation of risk and an under allocation of capital. In order to remedy this, we recommend quantile regression as a better method of modeling extreme variations.

Because the banking market is continuously changing, one bank's contribution to systemic risk in not constant but is time varying. As systemic risk estimators for the European banking market we recommend variables that reflect the liquidity, volatility capitalization as well as the contamination level of the financial institutions. In order to reflect their variation over time, CoVaR estimation has to be performed using a range of variables that reflect the liquidity and volatility of the interbank market, the capital market and governmental bonds market.

The future contribution of banks to systemic risk and the negative externalities transmitted to other banks in the system can be reduced by countercyclical adjustments of the assets and liabilities portfolio. To this end, we have put forward several financial supervisory models for controlling the contribution of banks to systemic risk. We have used several variables that account for the solvency, liquidity and debt level of financial institutions.

The CoVaR methodology provides an answer to the most complex issues encountered in financial risk estimation: extreme variations and procyclicality. The financial prudential supervision based on this method forces banks to retain higher capital reserves in boom periods, while offering relaxed requirements in crisis periods.

In closing, we would like to highlight that the present research is relevant to the financial supervisory authorities in designing an efficient supervision framework for the European banking market. The analysis proves to be useful to banks to limit the impact of the externalities imposed by the system to its assets and liabilities portfolio. Finally, the research may be used to determine the contagion transmission from mother banks to their subsidiaries and vice-versa.

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