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The effect of capital requirements on the interconnectedness and systemic risk

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Abstract

Financial Institutions play a significant role in the financial world. Hence, regulations have to be set in order to ensure global financial stability. Capital requirements are a tool to keep banking industry solvent. Introduction to higher capital requirements can ensure that financial institutions keep enough equity in their balance sheets, given the underlying risk on their portfolios. However, micro-prudential capital requirements can make banking industry more interconnected and consequently more fragile. In this paper, I find that higher micro-prudential capital requirements can lead to higher interconnectedness and systemic risk in the banking industry. Conversely, my results indicate that tighter macro prudential-capital requirements can decrease the interconnectedness and systemic risk within the banking sector.

1 Introduction

Banking sector plays a critical role in the global financial stability. In order to guarantee that banks are financially healthy, regulations such as Basel have been introduced. Basel has introduced banking guidelines that set out the minimum capital requirements of financial institutions in the form of capital adequacy ratio. This regulatory framework has already been updated three times and the latest reform is known as Basel III.

Until the introduction of Basel III, the regulatory framework has been characterized as micro-prudential. Its goal was to safeguard the solvency of individual financial institutions and did not account for the interconnectedness nor systemic risk. Micro- prudential regulations do not penalized banks with high interdependence that are systematically important. In this paper, I examine the effects of tighter micro-prudential capital requirements in the interconnectedness and systemic risk. To do so, I regress the tier capital ratio to interconnectedness index and SRISK. Tier capital ratio was obtained from Bankfocus. Interconnectedness index has been calculated based on the novel framework of Steffen, using data on the syndicated loan market from Thomson Reuters Dealscan. To reflect systemic risk, the methodology of Acharya (2012) was followed, using data collected from Datasteam. My papers aims to contribute in the existing literature of the effect of micro and macro prudential polices.

Theoretical models have shown that not only do micro-prudential capital require-

ments not mitigate interconnectedness, but they also create incentives to financial institutions for higher linkage. Recent literature have indicated that, banks can end up having similar portfolios either driven by altering their risk management or due to systemic moral hazard (Zhou, 2013 & Acharya, 2009). Moreover, research has shown that increasing micro-prudential capital requirements can increase systemic risk. Weiss (2018) with his empirical results indicates that a micro dimension in the prudential regulatory framework can decrease the stock price of a financial institution and increase the covariance with the market returns, consequently systemic risk rise. My results are consistent with the previous findings. I do find that banks with higher tier capital ratio, are more interconnected with their peers and their systemic risk is greater. An increase of 100 basis points in tier capital ratio can increase interconnectedness and systemic risk by 16.4 and 22.6 basis points, respectively.

In the aftermath of the financial crisis, it seemed clear that further regulations should be set in order to achieve financial health for the whole banking sector. Basel III regulatory framework made significant contribution on the prudential supervision, purposely to extend its dimension from a micro to a macro level. In 2016, the introduction of systemic risk buffer for banks with high interconnectedness is one of the first efforts of regulators to include macro-prudential capital requirements in the banking industry. Macro prudential regulations take into account the possible negative feedback loops of the financial sector to the real economy and the interdependence of financial institutions (Andries,2017)

This paper also aims to investigate the effects of macro prudential capital requirements on interdependence and systemic risk. There is evidence that macro prudential policies can alter the negative effects of the tighter micro-prudential capital requirements (Zhou, 2013). An essential element of macro prudential policies is the pricing of the interconnectedness. Banks that were defined as highly interconnected has to meet stricter capital requirements. Excess systemic risk buffer has been set for systematically important financial institutions in order to increase the resilience of the banking sector and decrease its interconnectedness. Introduction to supplementary surcharges for highly interconnected financial institutions can mitigate the incentive for correlated investments and subsequently decrease the systemic risk. Relevant literature has pointed out that macro prudential regulations can effectively decrease interconnectedness and systemic risk. I find that after the introduction to excess systemic risk buffer there is a negative correlation between tier capital ratio and both interconnectedness and systemic risk, however the results are statistically insignificant.

My results indicate that macro prudential capital requirements, such as excess capital surcharge is an appropriate tool to increase the resilience of the banking industry. Firstly, my findings suggest that systemic risk buffer disincentive banks to be interconnected. Prior regulations did not penalize banks with high asset commonality and consequently financial institutions took advantage of this limitation. This considerably harmed the trust of investors, and lead to lower stock prices of financial institutions (Weiss, 2018). Macro prudential policies can alter the negative effects of the micro-prudential capital requirements, which lead to a potential restore of the trust of investors.

However, the implementation of the excess systemic risk buffer is not applied

equally among the jurisdictions. In USA, interconnectedness premium has been set only for systematically important financial institutions. In Europe, conversely, excess systemic risk buffer has also been set for banks that are domestically important. My results exhibit significant effects of capital requirements in the interconnectedness merely for European banks. Specifically, a rise of tier capital ratio by 100 basis points can decrease interconnectedness by 34.7 basis points. My findings have direct policy implications. The surcharge implementation has been proved that effectively decrease the interconnectedness. Therefore, these policies should be applicable to not only financial institutions that are globally important but also to banks that have significant domestic position.

This paper is organized as follows. Section 2 describes the literature review followed by the theoretical framework in Section 3. In section 4, I formulate my hypotheses. The data and the summary statistics are elaborated in Section 5. Section 6 introduces the empirical framework for interconnectedness and SRISK quantification. Next, in Section 7, I analyze the time trend of interconnectedness. Section 8 and 9 show my results on the effect of capital requirements on interconnectedness and systemic risk, respectively. Section 10 concludes.

2 Literature review

This section provides the literature review on which my hypotheses were based and the contributions of my paper.

Several research has been done to discover the effects of capital requirements in the economy. Kugler (2013) has found that capital requirements can induce an increase in the interest rate of loans. Such regulations imply more equity holdings for banks, which are expensive to be kept in their portfolios. Therefore, banks transfer their higher costs to their borrowers. Meanwhile, increasing loans spread can make companies more risk-taking and therefore the probability of default of these loans will increase. Thus, we might experience financial instability in the banking sector and the economy. (Hakenes and Schnabel, 2013).

Another strand of literature has focused on the effect of micro-prudential capital requirements in the banking industry and its systemic risk. Economists have been interested in the effect of prudential policies in the financial stability of the banking sector. There is a large academic literature that examine whether micro-prudential policies are enough to safeguard the banking industry. Acharya (2009) has developed a multi-period general equilibrium model and discovered that capital requirements induced systemic moral hazard. Banks have the incentive to invest in similar assets based on the theory "too many-to fail" and thus economy-aggregate risk rise. Capital requirements that do not focus on the correlated risk with other banks can lead to higher systemic risk. Specifically, losses from an individual financial institution can be easily transferred to the other connected institutions. Banks prefer to undertake strategies to create overlapping portfolios rather than absorb losses of other institutions. Furthermore, Zhou (2013) used a static model on financial institutions risk taking behavior and found that banks response to capital requirements may enhance linkage within the system and consequently increase systemic risk. Capital requirements overrides the heterogeneity on banks' individual risk aversion and thus banks end up with

more similar portfolios. Moreover, Weiss (2018) with his empirical analysis reveals that micro-prudential capital requirements can lead to lower returns on banks stocks and higher covariance with the market returns, indicating that systemic risk is on a higher level. In his empirical analysis, he reveals that an increase in capital requirements for European banks leads to higher systemic risk. This is the opposite of what was originally intended by the regulators.

The implications of the theoretical models are that macro-prudential regulations are vital to ensure financial stability of the whole system. Zhou (2013) points out the importance of polices that identify systemically important financial institutions to regulate a heterogeneous financial system and mitigate systemic risk. Authors shows that macro prudential policies are effective to reduce bank's contribution to systemic risk (Andries, 2016)

There is growing literature which focus on how systemic risk can be defined. Weiss (2018) used systemic capital shortfall (SRISK) to measure systemic risk in his empirical analysis. Steffen (2018) in his paper used three different market based systemic risk measurements: systemic capital shortfall (SRISK) (Acharya 2017), conditional value-at-risk (COVaR) (Adrian and Brunnermeier, 2016) and distressed insurance premium (DIP) (Huang, 2009). SRISK and DIP show the effects on a specific bank when there is financial crisis in the whole banking sector while COVaR captures how the banking industry is affected when a specific financial institution is under shock. Acharya (2017) developed SRISK as a tool to capture the expected capital shortfall of a financial institution given a significant market decline. Steffen (2018) conclude that interconnectedness and systemic risk, measured through SRISK, DIP and COVaR have a positive correlation in case of recession.

The contribution of this study is two-fold. Firstly, to extend the works both of Steffen (2013) and Weiss (2018). Steffen has investigated the drivers of interconnectedness and consequently of systemic risk. His results indicate that interconnectedness was mainly driven by diversification purposes. My paper will reinforce his results and answer the question whether capital requirements can be a driver of interconnectedness as well. Moreover, Weiss (2018) finds that micro-prudential capital requirements increase systemic risk of European banks. My analysis will expand his research and investigate if the implications are similar for American banks. Furthermore, my analysis contributes to the existing literature on the effects of macro-prudential policies. There is a debate whether macro-prudential polices overcome the drawbacks of the existing micro dimension of the prudential regulation. This paper tries to shed light on such questions.

3 Theoretical framework

In this section, I give an overview to Basel Regulation explain the underlying theory and the motivation of my hypotheses.

Basel is an international regulatory accord which has been designed to improve the regulation, supervision and risk management within the banking industry. These regulations have already been updated three times until now, being the

latest reform the one known as Basel III. Basel has introduced banking regulations that set out the minimum capital requirements of financial institutions in the form of capital adequacy ratio. Purpose of such regulations is to offset losses that might appear in a bank's balance sheet due to exposure to risky assets. The Basel framework is now being followed in 28 jurisdictions. It had been made clear, that there was a need of an universal definition of capital in order to limit potential inequality which might rise from differences in the definition among nations.

Basel I accord, which started to be implemented by the end of 1992, required banks to maintain a minimum amount of 8 % of capital based on their risk-weighted assets. In turn, risk-weighted assets (RWAs) have been calculated by multiplying the face value of credit exposures by a set of risk weights chosen by regulators. Under Basel I, the assignment of assets on risk weights (five distinct risk buckets: 0%, 10%, 20%, 50%, and 100%) were based on the nature of the debtor (e.g. government, financial institutions, corporations).This framework has been introduced to all countries with active international banks. At the end of 1997, an amendment of the accord has been published to incorporate market risk. Financial institutions must maintain enough capital for their market risk as well; however, the calculation can be made with internal models.

In 2004, a revised capital framework has been published, known as Basel II. A main drawback of Basel I was that assets with different risks had the same risk weight. In order to overcome such limitations, in Basel II, risk weights were further defined with focus on the credit rating of the debtor. Moreover, Basel II introduced alternative ways of calculating the RWAs: (1) standardized approach (2) Internal Rating Based (IRB) approach and (3)Advanced Internal Rating Based (AIRB) approach. In the standardized approach, banks are required to calculate their RWAs based on the credit rating from External Credit Rating Agencies while in the other two alternatives credit rating can be calculated with internal models. However, the methodology to compute the internal ratings has to be approved by the regulators. In order to calculate the RWAs of their portfolios, financial institutions are required to quantify four different parameters: (1) Probability of Default (PD), (2) Loss Given Default (LGD), the amount of losses when the counterparty experience default, (3) Exposure at Default (EAD), the amount of exposure to the counterparty and (4) Maturity. The difference between IRB and AIRB is that under the AIRB approach financial institutions can develop their own internal models to calculate all the parameters for their non-retail clients , while in the IRB approach banks are able to calculate only the PD and use the prescribed LGD, EAD and MA from regulators. Furthermore, Basel II has introduced capital requirements related to operational risk; losses that might rise due to failed procedures, systems or policies.

However, a great deal of controversy surrounds the subject whether the Internal Based Rating Approach (IRB) has been applied properly in the banking sector. Banks have incentive to report lower risk, in order to be able to keep less equity, which is expensive to be held in their balance sheets. The use of internal model would make possible for banks to deliver lower RWAs. Therefore, a banks' equity calculated with IRB will be lower than it would have been if it was computed with the standardized approach, making banks more vulnerable.

There has been strong evidence of risk underreporting within the literature. Bruno (2015) indicates that the fifty largest European banking groups had decreasing RWA between 2008 and 2014, while credit risk was rising for the most countries during that period. Moreover, Firestone (2015) investigate the reporting of PD and LGD, which were assigned to the same syndicated loans by nine different American banks and found significant difference among them.

In order to deal with the variability within RWA reporting, Basel proposed three adjustments: (1) the removal of IRB for assets with low PD, (2) constraints on how banks will calculate their RWA and (3) output floors on capital requirements. These policies will prevent banks from under-reporting their risk and therefore regulators will have a clearer view of the financial health of these institutions.

In the aftermath of the financial crisis, Basel III has been introduced in order to strengthen the banking sector. There were many new updates in this reform. For instance, an introduction to tighter capital requirement and the changes that have been made in the definition of capital. Previously, in Basel II, there were three forms of capital that could be used to achieve the minimum capital requirements. Tier 1 capital is the bank's core capital which consists of shareholders equity and retained earnings. Tier 2 capital is the second most reliable form of capital, which includes revaluation reserves, hybrid capital instruments and subordinated term debt. Finally, Tier 3 capital, which consists of short-term subordinated debt. Basel III abolished the use of Tier 3 capital in order to ensure higher quality of capital and focused more on Tier 1 and its components. Furthermore, the revised framework has increased the minimum Tier 1 capital requirements from 4% to 6% and the Core Tier capital requirements from 2% to 4,5%. Basel III framework has introduced as well some additional measurements to safeguard the solvency of the financial institutions; a capital conservation buffer of 2.5% of its common equity tier 1 capital; a counter-cyclical capital buffer, which require banks to have an additional amount of capital in good times in order to be released when economy contracts; a 1% to 3.5% of common equity tier 1 capital global systemically important institutions and ; an other systemically important institutions buffer.

The Basel III regulatory framework made an important change on the prudential supervision, purposely to extend the dimension of prudential supervision to a macro level. A micro-prudential framework consists of bank-level regulations to ensure the financial stability of individual institutions, while macro-prudential policies safeguard the financial system as a whole. The recent financial crisis has shown evidence that the stability of the financial system cannot be achieved by merely setting regulations related to the stability of individual financial institutions. Micro-prudential policies cannot achieve such a goal due to the complexity of the financial system. Hence, a complementary macro-prudential approach had been developed in the framework of Basel III, which takes into account the possible negative feedback loops of the financial sector to the real economy and the interdependence of financial institutions. An important instance of a micro-prudential regulation is the introduction to counter-cyclical capital requirements, which can limit the excessive build up of systemic risk. Counter-cyclical capital buffer has been introduced in order to prevent banks from reducing their lending capacity when there is an economic downturn; hence to reduce the possibility of shock transmission in the real economy. The counter-cyclical component of

the macro-prudential polices can lead to macroeconomic stabilization. Moreover, another element of macro prudential policy is the pricing of the interconnectedness. Systemic risk buffers as Global Systematically Important buffer (GSIB) and Other Systematically Important Buffer (OSIB) have been set in order to increase the resilience of the banking sector and decrease the interconnectedness.

To be precise, the GSIB is mandatory for banks that were defined by regulators as global systemically important institutions (G-SIFI). The systemic importance of a bank is determined according to the G-SIFI criteria agreed by the G-20. The criteria include the bank's size, cross-border activities and interconnectedness. Based on these criteria, a score is computed for each financial institution. SIIs are allocated to specific buckets 1-5 based on their score; 1 to be the less important while 5 to be the most. Each bucket has a different systemic capital requirement, from 1% to 3.5% based on the score of the financial institution .The surcharge (GSIB) has been phased in the beginning of 2016 and from 1st January of 2019 G-SIFIs are also required to hold a minimum amount of Total Loss Absorbency Capacity (TLAC). The TLAC should consist of instruments that can be converted into equity in case of resolution and in order to minimize the risk of a government bailout. The Financial Stability Authority (FSA) updates the list of the GSIBs and the bucket allocation in an annually basis, every November.

Furthermore, the OSIB has been set for financial institutions, which are domestically systemically important institutions (D-SII). D-SIIs are the financial institutions, which are not large enough to be considered G-SIBs, but still with high domestic importance.

There is a great commonality between US and EU capital requirements and how both jurisdictions implement the Basel III regulatory framework. However, there are some divergences. In United States a single regulatory framework has been developed, influenced by Basel III regulatory framework and the Dodd-Frank Act. The Dodd-Frank Act is a United-States federal law that was enforced on July 21, 2010. The law is related to financial regulations and its enforcement made changes in the whole US financial sector. The Act has introduced several capital-related provisions which are harsher than Basel III; stricter definition of capital; remove the references to external credit ratings; capital floor on minimum capital requirements; and amendments in the calculation of RWA. Moreover, Dodd-Frank Act defined D-SIIs, as financial institutions with larger than 50 billion consolidated assets. D-SIIs were not required to have an excess systemic risk buffer but only to participate in stress testing.

Meanwhile in Europe, implementation of Basel has been made through two legislative acts, the Capital requirements regulation and Capital Requirements Directive (CRD IV). The identification of European D-SIIS is under the guideline of the European Banking Authority and the excess requirements for D-SIIs are stricter than the proposal of Basel III framework. Focusing on the macro prudential dimension of the capital requirements, the main disparity between the two jurisdictions is that systemic risk buffer is merely for G-SIIs in US, while in Europe there is implementation of both G-SIBs and D-SIBs. This divergence implies that interconnectedness is only penalized for G-SIBs in US and therefore the disincentive for interlinkage apply only to these banks. Conversely, Europe mitigate systemic risk in an overall basis, as its regulations puts a premium on

interconnectedness for G-SIIs and D-SIIs. Table 1 indicates the criteria for the G-SIB and D-SIB.

Table 1: Framework and Indicators weights for G-SIIs & D-SIIs

Category	Indicator	G-SIIs	D-SIIs
Size	Total exposures	20%	ND*
Interconnecedness	Intra-finanical system assets	6,6%	ND*
	Intra-finanical system liabilities	6,6%	ND*
	Securities outstanding	6,6%	ND*
Substituability	Payment activity	6,6%	ND*
	Assets under custody	6,6%	ND*
	Underwritten transactions in debt and equity markets	6,6%	ND*
Complexity	Notional amount of OTC derivatives	6,6%	ND*
	Trading and AFS sequrities	6,6%	ND*
	Level 3 assets	6,6%	ND*
Cross-jurisdictional activity	Cross-jurisdictional claims	10%	-
	Cross-jurisdictional liabilities	10%	-

*Not determined by regulators. Jurisdictions are free to determine their own weighting system.

Basel III regulatory framework highlighted the importance of the macro-prudential regulation and its power to decrease systemic risk. Interdependence between financial institutions is one of the criteria, which can define a bank as G-SIB. Regulators understood the importance of the interconnectedness in the banking industry and the potential negative effects of high interdependence in the financial stability of the whole economy. As Chair Janet L. Yellen, Chair of the Federal Reserve Board said:

"A key purpose of the capital surcharge is to require the firms themselves to bear the costs that their failure would impose on others. In practice, this final rule will confront these firms with a choice: they must either hold substantially more capital, reducing the likelihood that they will fail, or else they must shrink their systemic footprint, reducing the harm that their failure would do to our financial system. Either outcome would enhance financial stability."

A micro-prudential regulatory framework does not account for the interconnectedness and does not penalized banks with high interdependence. In 2016, the introduction to systemic risk buffer for banks with high interconnectedness is the first effort of regulators to include macro-prudential capital requirements in the banking industry. In this paper, I investigate the effects of a direction towards a dimension of macro-prudential capital requirements. It is worth to mention that micro and macro prudential policies plays an equally important role in the financial stability. Both dimensions of prudential supervision are vital, and they complement each other to ensure the achievement of financially healthy banking sector. While, micro-prudential polices can prevent excess risk-taking at individual bank level, macro prudential supervision takes into account the interactions among banks.

4   Hypothesis Analysis

In this section, I explain the underlying theory and motivation of my hypotheses.

4.1 Interconnectedness and banking regulation

Interconnectedness between financial institutions can be measured though various ways and can take different dimensions. The aftermath of the financial crisis of 2007-2009 made it clear that spillovers can occur due to direct or indirect channels. The literature has established three different channels, through which losses can be spread within the banking industry. The first channel is the direct relationship between banks via inter-bank market, where banks lend to each other. Banks rely heavily on the inter-bank market for their short-term funding and therefore, when it collapses, financial distress can spread among financial institutions. Then, the second channel is information contagion, where the bankruptcy of one bank may leads to distrust for the whole banking industry. Financial institutions have common exposures and are entitled to counter party risk, hence bad news for one bank can be easily translated to others. The last significant channel is through exposure to similar asset holdings. If the price of their common asset declines, financial institution will be simultaneously in financial distress.

It is important to understand the various dimensions of the interconnectedness and how each dimension can affect the financial stability. A regulatory framework should take into account all the aspects of interconnectedness in order to achieve financial stability for the whole banking sector. The first form of capital requirements did not consider the importance of interconnectedness and focus merely on the financial stability of individual banks. Even though, regulators have as an ultimate goal to safeguard bank's solvency, tighter micro-prudential capital requirements might drive to adverse effects of what was originally intended. There is little reason to think that micro-prudential regulation can mitigate interconnectedness. Bank's response to capital requirements can stimulate higher asset commonality and consequently higher interconnected banking system. Recent literature has indicated that banks can end up having similar portfolios either driven by altering their risk management or due to systemic moral hazard (Zhou 2013 and Acharya 2009). Micro-prudential regulations can decrease the idiosyncratic risk of individual financial institutions and consequently decrease systemic risk. Financial institutions have the incentive to invest in less risky assets in order to ensure they meet the capital requirements. However, if risk aversion of financial institutions is aligned, banks will invest in the same assets and therefore banking industry will be more interconnected. Moreover, banks are motivated to invest in similar assets based on the theory "too many to fail". Capital requirements that are based on individual bank's health do not mitigate aggregate risk-shifting incentives towards correlated portfolios.

On one hand, theoretical models have shown that not only do micro-prudential capital requirements not mitigate interconnectedness, but they also create incentives to financial institutions for higher linkage. On the other hand, introduction to macro-prudential capital requirements and punishment for high interdependence disincentive banks to have interdependence. Introduction to supplementary surcharges for highly interconnected financial institutions can mitigate the incentive for correlated investments. It is vital that a regulatory framework addresses both joint risk with other banks as well as bank-specific risk.

In this paper I focus on the interconnectedness, measured by asset holdings

commonality, and I try to investigate the different effects of higher capital requirements in interconnectedness in both micro and macro dimensions of prudential policies. Therefore, my first hypothesis is formulated as follows:

Hypothesis 1a: Tighter micro-prudential capital requirements increase the interconnectedness of financial institutions.

Hypothesis 1b: Tighter macro-prudential capital requirements decrease the interconnectedness of financial institutions.

In order to capture the change towards macro-prudential capital requirements. I split my sample in two periods. I consider as micro-prudential period the years 2012-2016 while macro-prudential period from 2016 to 2019. I measure interconnectedness based on a percentage of bank's balance sheet. their syndicated loans, and potentially extend my findings to other asset classes of financial institutions portfolios. Syndicated loan market is an ideal dataset to study the interconnectedness of financial institutions. It is one of the most significant funding sources of corporations and financial institutions heavily invest in this particular asset class. I focus on the holdings of each participant bank in the syndicated loan market. In a syndicated loan a group of banks finance a single borrower and therefore, participating in the syndication make banks less exposed to a specific borrower. I follow the novel method of Steffen (2013) and I measure interconnectedness based on the exposure of each bank to a specific specialization (industries and countries), by looking at their weights on each bank's syndicated loan portfolio. I expect that my finding will indicate that higher micro-prudential capital requirements increase the interconnectedness of financial institutions, while tighter macro-prudential capital requirements decrease the interdependence of the banking sector. These expectations are in line with the theoretical models which indicate that the micro dimension of prudential regulation incentive banks for overlapping portfolios.

In this paper, I do also investigate whether there are different effects of the macro-prudential capital requirements in the interconnectedness among jurisdictions. Hence, my hypothesis is formulated as:

Hypothesis 2: Tighter macro-prudential capital requirements decrease interconnectedness of European banks on a higher magnitude than USA banks.

In order to do so, I split my sample in financial institutions that have headquarters in USA and in Europe. I assume that European financial institutions will have greater reduction of interconnectedness. My expectations are based on the difference of the policy implementations between the two jurisdictions. On one hand, in USA, they put premium for interconnectedness merely for G-SIIs. On the other hand, in Europe, the pricing of interconnectedness is applicable to D-SIIs as well.

4.2 Systemic risk and banking regulation

In the micro dimension of prudential regulation, systemic risk is not addressed and unintentionally it is possible to rise. Research has shown that increasing micro-prudential capital requirements can increase systemic risk. Weiss (2018) with his empirical results indicate that micro-prudential dimension in the reg-

ulatory framework can decrease the stock price of a financial institution and increase the covariance with the market returns and therefore, systemic risk increases. Specifically, the effects on those variables increase systematic risk, decrease Value at Risk and decrease the market value of a financial institution. On the other hand, macro-prudential regulation can alter the negative effects of tighter capital requirements on the systemic risk.

In addition, this paper investigates the different effects of micro and macro-prudential capital requirements in the systemic risk. Therefore, my third hypothesis is formulated as below:

Hypothesis 3a: Tighter micro-prudential capital requirements increase the systemic risk of financial institutions.

Hypothesis 3b: Tighter macro-prudential capital requirements decrease the systemic of financial institutions.

Systemic risk can be defined as the probability that a series of correlated defaults among financial institutions over a short period, might trigger a withdrawal of liquidity and widespread loss of confidence in the financial system. On one hand, micro-prudential capital requirements focus on the soundness of the individual banks, instead of the banking system. Even though banks appear sufficiently healthy when considered individually, may jointly present a risk to the whole banking sector (Acharya, 2009). Tight micro-prudential capital requirements will not give insight whether the banking industry is financial stable. Many regulatory authorities are announcing higher capital requirements to strengthen bank balance sheets; however, the banking sector remain vulnerable and more prone to macroeconomic shocks. Micro-prudential regulation by its definition does not address to the joint risk of banks and therefore does not mitigate systemic risk. On the other hand, macro prudential regulations, which penalize the high correlation of bank's portfolio can lead to lower systemic risk. Macro-prudential policies can prevent the excessive buildup of systemic risk (Zhou,2013).

Systemic risk can indicate how fragile the banking industry is and whether a financial distress of a bank could spill over to other banks and threaten with contamination the whole financial system. There are various systemic risk measurements, which are proposed in the recent literature. In this paper, I focus on systemic capital shortfall or shortly SRISK, which can give us insight whether a firm is systemically risky. SRISK examines the likelihood to face a capital shortage just when the financial sector itself is weak.

SRISK as systemic risk measurement combine both individual risk and systemic linkage. In case a financial institution's equity falls and its fraction to the outstanding liabilities is low, the firm will need to raise capital, or alternatively will fail. If such an event take place in prosperous times, banks can borrow money from the interbank market. If not, governments must decide whether they will rescue the financial institution. A capital shortfall of a financial institution, when the financial sector is under shock can induce damage to the real economy. SRISK indicates whether a bank is systematically risky the moment there is a financial shock in the economy. Specifically, SRISK give us information of the expected equity loss of a financial institution when there is a financial crisis and whether the banks' current equity market value combined with its liabilities are

enough to cover such equity loss.

I expect that my finding will indicate that higher micro-prudential capital requirements increase the SRISK of financial institutions, while tighter macro-prudential capital requirements decrease the SRISK of the banking sector. These expectations are in line with the theoretical models which indicate that the micro dimension of prudential regulation stimulate an increase in SRISK, by decreasing stock prices of financial institutions and increasing the covariance with the market. Moreover, I believe that introduction to excess systemic risk buffer can restore the low stock prices, creating trust to the investors, and decrease the covariance with the market indexes.

In this paper, I do also examine if there are any different effects of the macro-prudential capital requirements in the systemic risk among jurisdictions. Hence, my hypothesis is formulated as:

Hypothesis 4: Tighter macro-prudential capital requirements decrease systemic risk of European banks on higher magnitude than USA banks.

In order to do so, I split my sample in financial institutions that have headquarters in USA and in Europe. I assume that European financial institutions will have greater reduction of systemic risk. The implementation of excess systemic risk buffer in European D-SIBs, can stimulate a decrease of systemic risk of higher magnitude.

5 Data and Summary statistics

In this section, I discuss the data sources, which has been used for my analysis and I provide the summary statistics.

5.1 Data Sources

There are three main data sources, which have been used in order to analyze the effect of capital requirements in the interconnectedness and the systemic risk of the banking sector.

In order to create the interconnectedness measurement, I download data from Thomson Reuters LPC Dealscan, which gives detailed information related to the syndicated loan market. I use as a sample of 225,535 syndicated loans between 1989 and 2019, on which the lead arranger of the syndicated loan was located either in Europe or USA. The sample accounts for almost 80% of the syndicated loan market of that period. I discard banks with low participation in the syndication market given their total dollar amount invested in this asset class. I build two different interconnectedness measurements, which are based on the borrower's industry and country. Information related to the industry and the region of the borrower for each syndicated loan has been provided from the same dataset. Moreover, each interconnectedness measurement has been calculated based on two methods: (1) asset-weighted and (2) equal weighted. In the former method, I control for the size of the bank, as large banks are more prone to be interconnected. In the latter, every bank has an equal weight. In order to create the asset weighted interconnectedness measurements, I download the assets of

each financial institution included in my sample. Information related to banks assets has been downloaded from DataStream for the period between 1988-2019.

Another important data source for my analysis is Bankfocus, which provides information related to the balance sheets of many banks. I download the yearly tier capital ratio of my sample banks from Bankfocus. There is information available for 139 financial institutions of my sample from 2011 to 2019. I choose tier capital ratio as an indicator to measure the effect of capital requirements in interconnectedness and systemic risk, because regulators set the capital requirements in this form.

Lastly, in order to calculate my systemic risk measurement, Expected Systemic Shortfall (SRISK), I download data from DataStream. For computational purposes of SRISK , the data collected comprises: (1) assets, (2) liabilities, (3) market value and (4) stock price of each institution included in my sample, from 2011 till 2019. Furthermore, in order to calculate the SRISK of individual financial institutions, I need to compute the beta between the market return and bank return. I use MSCI Europe as proxy for the European market and SP500 for the American market. I download MSCI Europe and SP500 daily returns from DataStream.

5.2 Summary statistics

Table 2 provides information for the variables which have been used throughout my analysis, such as distance, interconnectedness, tier capital ratio and systemic risk measurement. Distance and interconnectedness have been summarized for 225,535 syndicated loans and for 138 lead arrangers. Interconnectedness has been calculated with two different methods: equal-weighted and asset-weighted. Distance can take values from 0 to 1, while interconnectedness from 0 to 100. Market-aggregate interconnectedness index has been summarized for the 31 years of my analysis. The interconnectedness on industry level seems higher when it is calculated with the size-weighted method while interdependence on country level is slightly higher with the equal-weighted method. Information related to Tier capital ratio for the 138 banks of my sample for the years 2011-2018 can be found in the table. SRISK has been summarized as well for the 97 matched lead arrangers, displaying an average of 25,8 billion USD.

Table 2: Variables definition

Variable	Definition
Distance	Distance between two banks based on their syndicated loan portfolios
Interconnectedness	Interconnectedness of bank
Tier Capital	Tier Capital Ratio of bank
SRISK	Expected systemic shortfall of bank in billions of U.S. Dollars
Debt	Book value of bank's liabilities in billions of U.S. Dollars
LRMES	Long-run marginal expected short-fall of bank
MV	Market Value of banks in billions of U.S. Dollars
ROA	Return on bank's assets
Assets	Book value of a bank's total assets in billions of U.S. dollars

Table 3: Summary Statistics

	N=	Mean	SD	10th	50th	90th
Distance Measures:						
Distance in 2-digit Borrower SIC	199.800,00	0,342	0,169	0,166	0,294	0,621
Distance in Borrower State	199.800,00	0,390	0,172	0,199	0,358	0,667
Bank-Level Interconnectedness Measures:						
Equal-weighted Interconnectedness:						
Based on 2-digit Borrower	2,444	59,19	13,72	36,39	63,73	72,67
Based on Borrower State	2,444	57 57,94	19,18	26,90	63,08	81,78
Size-weighted Interconnectedness:						
Based on 2-digit Borrower SIC	2,444	65,83	16,87	37,94	70,57	83,41
Based on Borrower State	2,444	59,19	13,72	36,39	63,73	72,67
Market-Aggregate Interconnectedness Measures:						
Equal-weighted Interconnectedness:						
Based on 2-digit Borrower SIC	31	59,15	4,95	53,34	59,67	64,81
Based on Borrower State	31	59,52	10,58	50,91	55,10	78,63
Size-weighted Interconnectedness:						
Based on 2-digit Borrower	31	65,53	5,53	59,57	66,98	70,78
Based on Borrower State	31	62,19	8,31	54,87	59,31	74,56
Capital requirements						
Tier Capital	602	15,91	3,70	12,49	15,09	20,50
Systemic risk measurement						
Systemic Capital Shortfall (SRISK) ($bn)	904	25,8	4,13	5,86	6,16	128

6 Empirical Methodology

In this section I analyze the framework, which has been used to calculate my 2-digit SIC industry and country level interconnectedness as well as my systemic risk measurement, expected systemic shortfall (SRISK).

6.1 Measuring Interconnectedness

In this subsection, I describe the steps which I follow to calculate the distance and subsequently how I create my aggregate-market interconnectedness index from bank-level interconnectedness.

6.1.1 Distance between two banks

In order to develop the interconnectedness measurement for each bank, I examine the overlapping of their syndicated loan portfolios based on two specializations: industry and country. In order to build such a measurement, I firstly analyze the syndicated loan portfolio of each bank in my dataset. Every syndicated loan has been matched to the lead arranger of the facility. In order to examine where each lead arranger invest, I look into the details of the borrowers of the syndicated loans. I follow the novel framework of Steffen (2018) and I focus on the country's and 2 digits' SIC industry information about the borrower. For each year, I aggregate the syndicated loans of every lead arranger in my sample based on the two specializations (country, industry). Next, I create the weights

that each lender invested in each component within a specialization. The total of all weights of a specialization must be equal to one. Afterwards, I compute the distance between two financial institutions. Such measurement indicates how similar are the syndicated loan portfolios between financial institutions in the form of each specialization (e.g. industry)

Specifically, I follow the same steps as Steffen (2013) did in his paper to create the distance measurements. I aggregated the yearly amount of syndicated loans of each lender and then I computed the country and industry weights based on the percentage of investments in a specific country or industry out of the whole syndicated portfolio that year. The weights have been calculated for the period between 1989 to 2019 for the 138 lead arrangers with the highest participation rate in syndicated loan market, based on their amount of investments on that market. These lenders participated in 225,535 syndicated loans, which account for almost 80 percentage of the syndicated loan market in total dollar value. We indicate as $w_{i,j,t}$ the percentage of investments of bank i in country or industry j for the whole year t , with the restriction that $\sum_{j=1}^{J} w_{i,j,t} = 1$

The distance between two banks has been calculated as the Euclidean distance between these banks and it is expressed as

$$Distance_{i,j,t} = \frac{1}{\sqrt{2}} \times \sqrt{\sum_{j=1}^{J} (w_{i,j,t} - w_{k,j,t})^2} \qquad (1)$$

Where $Distance_{i,j,t}$ is the distance between bank i and k in the year t m where $i \neq k$.

$Distance_{i,k,t}$ can have numbers from 0 to 1, where 0 means that the portfolio of the syndicated loans between the two banks have exactly the same weights in the same countries or industries, while 1 indicates that the banks portfolios have full distance and therefore zero overlapping.

6.1.2 Bank level interconnectedness

In order to build a bank level interconnectedness measurement for a specific year, I take the weighted average of the distance between a bank and all the other banks which participated in the syndicated loan market in that particular year. Following the example of Steffen (2018) I normalized the measurement from 0-100 , where number closer to 0 suggest that a bank is less interconnected with the other participants in the syndicated loan market of my sample while a number closer to 100 indicate that a bank is highly interdependent with its peers within my sample. The measurement is calculated through the formula below

$$Interconnectedness_{i,t} = (1 - \sum_{k \neq 1} x_{i,k,t} * Distance_{i,k,t}) \times 100 \qquad (2)$$

Where interconnectedness is the interconnectedness between bank i and bank k in the year t . In the formula, x_{ijt} is the weight which is given to bank i for the calculation of the bank's interconnectedness. I use two different weighting schemes for the calculation of the bank-level interconnectedness index. Firstly, I allocate the same weight in each bank and hence the weight for each bank

is simply w =1/(N -1) where N is the amount of banks which participated in the syndicated loan market in the year i. My second weighting scheme try to capture the difference between banks size hence I use the lagged assets as proxy for each bank size. The weight of each bank in this case is based on the lagged assets value of bank i to the total lagged assets of the banks which participated in the syndicated loan market in the year i and simply it is

$$w_{i,t} = \frac{A_{i,t-1}}{\sum_{i=1}^{N} A_{i,t-1}} \tag{3}$$

6.1.3 Market-aggregate interconnectedness

In order to create my yearly interconnectedness index I aggregated the interconnectedness of all the banks and I take the average. The formula is given below.

$$InterconnectednessIndex_t = \sum_i \frac{1}{N_t} * Interconnectedness_{i,t} \tag{4}$$

These calculation steps will provide us with 4 market-aggregate Interconnectedness indexes, two based on borrower's country interconnectedness (equal and asset weighted) and two based on borrower's 2 digit SIC industry (equal and asset weighted).

6.2 Systemic risk Measurement

In order to analyze whether capital requirements affect the systemic risk of the banking industry I have to calculate the systemic risk measurement. Systemic capital shortfall or SRISK has been developed by Archarya (2019) Brownless and Engle (2013) . It is defined as the expected capital shortfall of a financial institution and is computed as:

$$SRISK = k * D - (1-k) * (1 - LRMES) * MV \tag{5}$$

Where k is the capital requirements, MV is the current market capitalization, D is the book value of debt and LRMES estimates the expected equity loss of the financial institution when the market declines significantly. In this paper, I use SP500 and MSCI Europe to indicate a decline in the American and European market, respectively. LRMES is calculated though the formula:

$$LRMES = 1 - e^{\log(1-d)*beta} \tag{6}$$

where d is the six-month crisis threshold for market decline and is set to be 40% and beta is the financial institutions beta to SP500 or MSCI Europe, depends on the location of lead arranger's headquarters. The beta has been calculated based on a 3-year rolling window. I compute the beta based on the three last year's daily returns of the company and the appropriate market index. I choose to use rolling window betas to control for the time-variance of the coefficients between institutions and the market. Following the novel framework of Steffen (2018) the capital requirements has been set as 5.5% and 8% for European and American banks respectively due to the differences between US-GAAP and IFRS measures.

7 Interconnectedness of banks in loan markets

In this section, I examine the time trend of the market-aggregated interconnectedness index. Also, I analyze my two interconnectedness indexes, which are based on Borrower's State and Industry.

Interconnectedness has been measured with focus on Borrower's Country and Industry following the framework of Steffen (2013). Firstly, I examine for each financial institution the portfolio of their syndicated loans. Next, for every individual loan I get borrower's information; related to the country of the company's principal executive offices and the industry of the issuer based on the Bureau of the Budget Standard Industrial Classifications (SIC) code. I aggregate for every year all the investments which are mapped to a specific component of a specialization. Then, I generate weights based on the total dollar amount that have been invested in the syndicated loan market that particular year. This framework captures the overlapping of banks syndicated loan portfolios. Banks with smaller distance between their portfolio will have higher interconnectedness. Market-aggregated interconnectedness index capture whether many financial institutions have interdependence in their portfolios and consequently the banking sector can be defined as highly interconnected. In my paper, interconnectedness based on Borrower's State has been calculated based on the exposure of banks with high participation in the syndicated loan market to 57 countries. In the figure 1, you can see the trend of Interconnectedness through my sample period.

Figure 1:

Interconnectedness based on Borrower's State
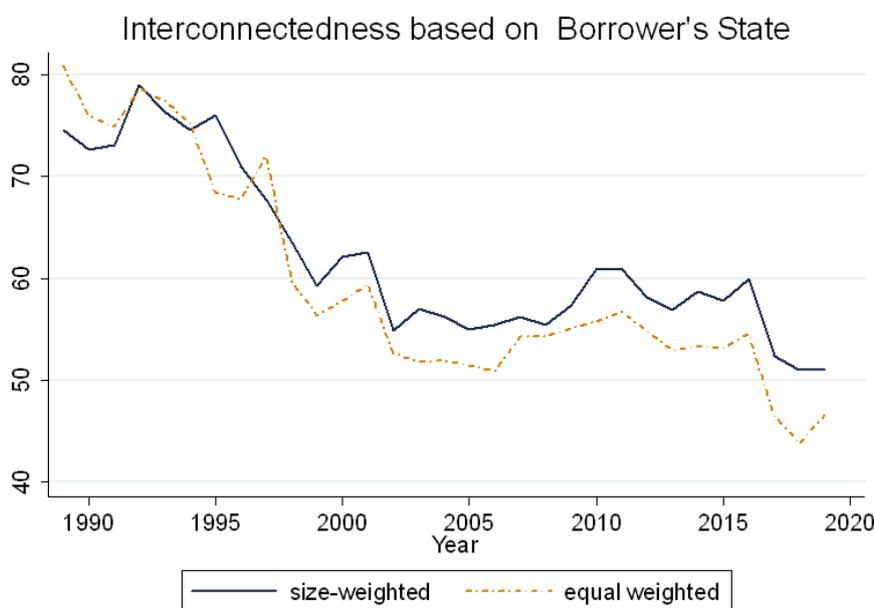
As it can be observed, interdependence among banks was at its highest level

between 1990-1995 and afterwards dropped significantly. Should we focus on the period 2012-2019, which is the epicenter of my analysis, we can observe that from 2012-2016 the market-aggregate interdependence of the banking sector was higher than the 2000s and early 2010s. Moreover, the graph illustrates that after 2016 interconnectedness have a downward trend, and it has dropped to its lowest level in 2019. In the next section, I try to answer whether tighter micro-prudential policies drive the increase in the period between 2012-2016 and if introduction to macro-prudential capital requirements drove the downward trend of interconnectedness after 2016.

A main driver of high level of country level interconnectedness of the banking sector during the period between 1990-1995 might be that banks were less on a country level diversified, because of the early stage of globalization. In the early 1990s there were more constraints for banks to allocate their assets in international investments. Furthermore, lead arrangers of syndicated loans had their headquarters in specific countries and invest in their domestic syndicated loan market; hence there was less possibility for country diversification and consequently banks syndicated loan portfolio were overlapping highly. Moreover, the syndicated loans had mostly taken place in USA during that period and hence banks had a huge weight of exposure to the United States syndicated market. Next, I analyze the interconnectedness based on 2-digit borrower SIC industry. The time trend of the index can be seen in the figure 2 and the division of the industries in the table 4.
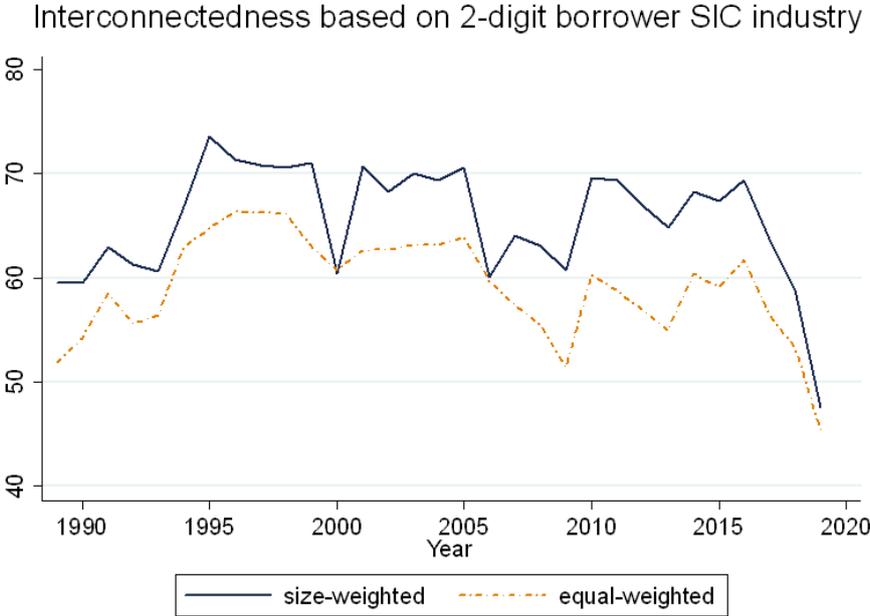
Figure 2:

Interconnectedness based on 2-digit borrower SIC industry

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Table 4: SIC Industry Division

SIC Industry Division	2-digit SIC Industries
Agriculture, Foresty & Fishing	01-09
Mining	10-14
Construction	15-17
Manufacturing	20-39
Transportatin, Communications, Electric, Gas & Sanitary services	40-49
Wholesale Trade	50-51
Retail Trade	52-59
Finance, Insurance & Real Estate	60-67
Services	70-89
Public Administration	91-97

Figure 2 illustrates that industry interconnectedness was on a higher level compared to the prior years of 2005-2009. Moreover, we observe a steep decline after 2016 .The findings are in line with country level interconnectedness. Next, I split my sample to European and USA financial institutions based on the headquarters of each institution to test whether there is a difference between the two jurisdictions. Figure 3, illustrates that American banks are slightly less interconnected than European.

Figure 3:
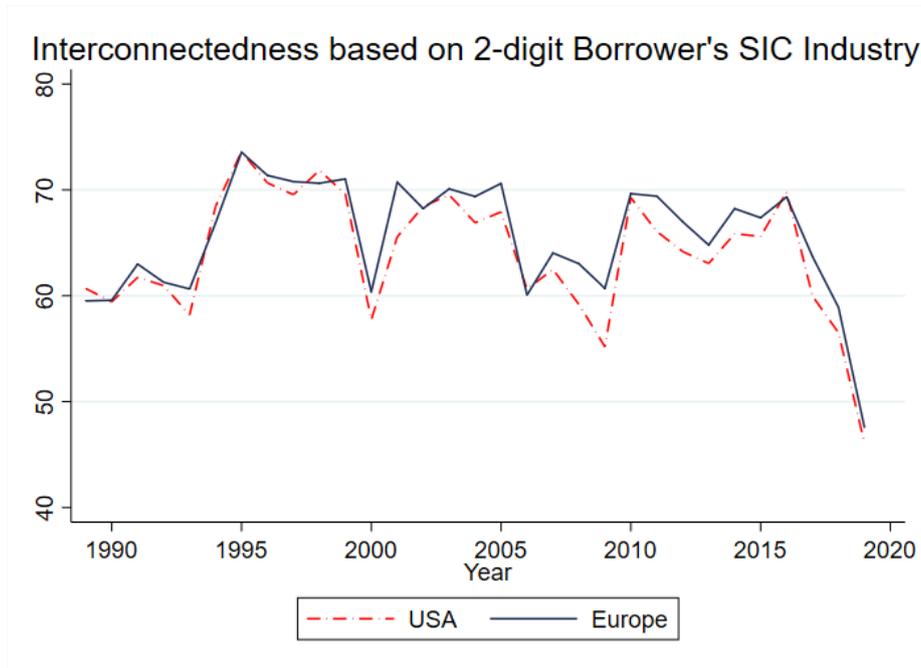
The illustration of both country and industry interconnectedness indexes indicates that interdependence was at a high level between 2012-2016 compared to the previous period 2005-2009. Moreover, we can conclude that larger banks (based

on their asset level) are more interconnected to smaller banks as size-weighted interdependence is higher than the equal weighted interconnectedness in all the cases. Furthermore, interconnectedness index is higher when we look at 2-digit SIC industry. One of the reasons is that country division is bigger than the industry. I disaggregate country specialization in 47 components while industry is decomposed in 10 sub-sectors.

In the next sections, I analyze the effects of tighter capital requirements industry to the interconnectedness and systemic risk. I do differentiate the effects based on the dimension of the prudential regulations to micro and macro level. I focus on the interdependence based on the 2-digit borrowers' SIC and not on the country specialization. The reason is that I would like to ensure that my results are not driven from a flight-to-home effect. In such effect, banks have the motive to participate in syndicated loans in their country in adverse economic conditions. Evidence has shown that increasing capital requirements can decrease the cross-border lending (Wieladek, 2013). Therefore, my bank level interconnectedness index will indicate that the financial institutions is more interconnected with its peers, which have same headquarters. Conversely, industry specialization will not capture the effect of higher interconnectedness because of the capital flights.

8 Interconnectedness and capital requirements

In this section, I examine the effect of the micro and macro capital requirements to my sector level interconnectedness measurement.

8.1 Hypothesis analysis

Micro-prudential regulation focus on making individual banks financial healthy. Regulations until 2016 are in the form of higher tier capital ratio, on which ratio there is not pricing of the interdependence among banks. However, afterwards, macro-prudential regulations have been set and financial institutions are punished when they are systematically important (high interconnectedness). The identification of G-SIIs and D-SIIs puts a premium on interconnectedness. My hypothesis is that macro-prudential regulation disincentive financial institutions to be interconnected, while micro-prudential policies can unintentionally increase the market-aggregated interconnectedness. One one hand, a rise in micro-prudential capital requirements in turn, could involve higher interlinkage within the banking industry. A rise in macro – prudential capital requirements, on the other hand could reduce interconnectedness.

It is not surprising that capital requirements that do not address interconnectedness can lead to higher interdependence. My hypothesis is in line with the theoretical models, which indicate that micro-prudential capital requirements can create motives for overlapping portfolios.
8pt] In order to answer that question, I split my sample in two-time periods: (1) micro-prudential period 2012-2016 and (2) macro -prudential period 2016-2019. The choice of 2016 as the year for change towards a macro dimension of regulations is due to the introduction to excess systemic risk buffer for institutions which were defined as systemically important. Financial institutions with high interconnectedness can be defined as systemically important and therefore

banks have less incentive to create correlated portfolios with their peers. I aim to estimate whether an increase of bank's Tier capital ratio will increase its interconnectedness during the micro-prudential period while it will decrease its interdependence in the macro-prudential period. This time period division will make clear whether such policies can alter the incentive of financial institutions to be less interconnected. Furthermore, I split my sample into European and American banks, based on the headquarters of the institutions. I would like to see whether disparity of implementation of Basel III can drive different effects. Systemic risk buffer has been applied only for G-SIIs in USA, while Europe implement excess buffer for its D-SII as well. The implications for USA financial institutions is that the premium for interconnectedness is merely for the banks, which are identified as G-SIIs. The definition of G-SIIs is based on 12 indicators . Banks will have excess systemic risk buffer if they have a high aggregate score based on those indicators. For instance, a small bank with high interconnectedness do not have to build an excess systemic risk buffer. Specifically, only the globally large financial institutions are disincentivized from being interconnected. On the other hand, European banks puts a premium on any domestic bank that can be highly interconnected and its size is domestically important. The definition of D-SIIS is based on 10 indicators. My hypothesis suggest that tighter European macro prudential capital requirements should have decrease of higher magnitude in the interconnectedness index.

Such division will consequently determine whether excess systemic risk buffer is essential merely for the defined systematically important financial institutions or alternatively for all institutions with overlapping portfolios. Such findings has direct policy implications. It will highlight the importance of interconnectedness premium on financial institutions that are important on domestic level.

8.2 Methodology

The form of the regression, which will give answer to my first hypothesis is as follows:

$$\Delta Interconnectedness_{i,t} = \alpha + \beta_1 \Delta TierCapital_{i,t} + \beta_2 ROA_{i,t} + \beta_3 log(Assets_{i,t}) + e_{i,t} \tag{7}$$

The dependent variable ΔInterconnectedness$_{i,t}$ is the change of bank's i interconnectedness index in year t. The independent variable Δ TierCapital$_{i,t}$ is the change of banks' i Tier capital ratio in year t. In my panel data analysis, I use time fixed effects and I control for bank profitability and size with my variables $_{i,t}$, where is the return on assets of bank i in the year t & log(Assets$_{i,t}$) ,where is the logarithmic value of banks' i assets in the year t

8.3 Results

Table 4 reports the regression results for Interconnectedness based on 86 unique lead arrangers, with yearly data ranging from 2012-2019. During the years 2012-2015 we find positive and economically significant coefficient at 5% confidence interval between $\Delta Interconnectedness_{i,t}$ and $\Delta TierCapital_{i,t}$. Therefore, I accept my hypothesis 1a. An increase of 100 basis points in capital requirements can increase interconnectedness by 16,4 basis points. When, I differentiate my sample based on the region of the bank's headquarters to Europe and America in

Table 5: Tier Capital ratio & Interconnectedness

$\Delta Interonnectedness$	(1)			(2)		
	All Regions	America	Europe	All regions	America	Europe
$\Delta TierCapital$	0,164*	0,077	0,234*	-0,789	0,916	-0,347*
	(1,28)	(0,35)	(1,38)	(-0,40)	(0,24)	(-1,57)
ROA	-0,213	-0,009	-0,039**	0,002	0,004	0,626**
	(-0,98)	(-0,27)	(-1,29)	(0,23)	(0,04)	(1,83)
log(Assets)	-0,141**	-0,008	-0,028**	-0,002	-0,115	0,005
	(-1,74)	(-0,74)	(-1,81)	(-0,24)	(-0,79)	(0,29)
Time Fixed Effects	yes	yes	yes	yes	yes	yes
N=	293	166	127	198	114	84
R^2	0,0215	0,018	0,0481	0,076	0,1128	0,2867

This table reports coefficient estimates from regressions relating a financial institution's $\Delta Interconnectedness$ in the syndicated loan market to its Tier capital ratio; (1) for the time period 2012-2016 and (2) for time period 2016-2019. The independent variable of interest is the change in tier capital ratio. The dependent variable is the change in Interconnectedness of a lead arranger, which is computed based on its distance from all the other lead arrangers with regard to 2-digit borrower SIC industry size-weighted. Control variables include the financial institution's logarithmic assets and return on assets. All regressions include time fixed effects. The hypothesis test's t-value. * indicates that the estimated coefficient is significantly different from zero at the 10% level, ** at the 5% level, and *** at the 1% level.

order to see whether the difference on their regulations matter. The coefficients are positive and of higher magnitude in European banks; economically significant at 5%. In the macro prudential period of my analysis, from 2016 to 2019, I find negative but economically insignificant coefficient between my dependent and independent variable. When I split my sample, I can observe that European banks have negative and economically significant results at 5%. My findings indicate that in Europe, a 100 basis points increase in capital requirements can increase the interdependence of financial institutions by 23.4 basis points during the micro-prudential period, while it is decreased by 34.7 basis points during the macro-prudential period. Furthermore, I find no significant correlation between interconnectedness and prudential capital requirements in American banks.

My results indicate that micro-prudential policies can incentive banks to be more interconnected. The introduction to systemic capital requirements and pricing of the underlying risk of overlapping portfolios, which initiated in 2016, decrease the interconnectedness. My results are not in contrast with the theoretical models. In the micro-prudential period, financial institution takes advantage of the limitations of a framework that do not prohibit interconnectedness. Relevant literature has shown that banks response to micro-prudential capital requirements can alter either the level of their risk aversion (Zhou, 2013) or their investment choices due to the "too many to fail" theory (Acharya, 2012). My empirical analysis suggests that macro-prudential capital requirements lead to changes in the risk management of European banks to less risky or herd-investing to specific assets.

9 Systemic risk and capital requirements

In this section, I examine the effects of capital requirements to my systemic risk measurement, systemic expected shortfall. I investigate the different effects of micro and macro-capital requirements.

9.1 Hypothesis analysis

On one hand, micro-prudential regulation focus on making individual banks financial healthy and they do not address the systemic risk. On the other hand, macro-prudential policies can achieve decrease in the systemic risk. Such policy, by its definition has as main goal to strengthen the financial stability for the whole banking industry. My hypothesis is that tighter capital requirements in a micro-dimension can unintentionally increase systemic risk of the banking sector while a macro-dimension can decrease the systemic risk. My hypothesis is in line with other empirical studies. Weiss has evidence that micro-prudential policies can indirectly lead to lower stock returns for financial institutions and to an increase of their covariance with the market returns. Increasing capital requirements can contain information related to whether a financial institution will pay lower dividends or maintain their returns (Adries,2017). It has been shown that tighter capital requirements incentive banks to decrease their RWAs which consequently leads to less profits. Investors do understand such effects and price the stocks accordingly. On the other hand, macro prudential policies, with its systemic adds on, put a premium on interdependence and consequently banking sector is less fragile. Therefore, investors are more confident for the banking industry and stock prices of financial institution might rise. Individual perception is vital for the stock market.

In order to compare the difference between micro and macro prudential framework, I split my sample in a micro and macro-prudential period. I aim to estimate whether an increase of bank's tier capital ratio will increase its SRISK during the micro-prudential period, while it will decrease its systemic risk in the macro-prudential period. Moreover, I split my sample into European and American banks to explore whether disparity between jurisdictions can drive different effects. It is useful to distinguish whether excess systemic risk buffer for domestically important financial institutions can lead to decrease of higher magnitude in the systemic risk.

9.2 Methodology

The form of the regression, which will give answer to my first hypothesis is as follows:

$$\Delta SRISKi, t = \alpha + \beta_1 \Delta TierCapital_{i,t} + \beta_2 ROA_{i,t} + \beta_3 \log(Assets_{i,t}) + e_{i,t} \quad (8)$$

The dependent variable $\Delta SRISKi, t$ is the yearly change of bank's i SRISK in year t. The independent variable $\Delta TierCapital_{i,t}$ is the yearly change of banks' i Tier capital ratio in year t. In my panel data analysis, I use time fixed effects and I control for bank profitability with my variable $ROA_{i,t}$, where is

the return on assets of bank i in the year t and for banks size with my variable
$\text{Assets}_{i,t}$, the asset of banks i in the year t

9.3 Results

Table 6: Tier Capital ration SRISK

$\Delta SRISK$		(1)			(2)	
	All Regions	America	Europe	All regions	America	Europe
$\Delta TierCapital$	0,226**	0,18	0,249**	-0,223	-0,224	-0,188
	(1,65)	(0,87)	(1,28)	(-0,52)	(-0,27)	(-0,83)
ROA	-0,379**	-0,232	-0,285	0,101***	0,887***	0,801**
	(-2,19)	(-0,77)	(-1,27)	(4,81)	(3,29)	(2,45)
log(Assets)	0,189**	0,133*	0,149	-0,819***	-0,716**	-0,009
	(2,61)	(1,60)	(1,09)	(-4,58)	(-2,74)	(-0,55)
Time Fixed Effects	yes	yes	yes	yes	yes	yes
N=	296	168	128	242	155	87
R^2	0,1073	0,1338	0,1894	0,1615	0,1018	0,1977

This table reports coefficient estimates from regressions relating a financial institution's $\Delta SRISK$ to its interconnectedness in the U.S. syndicated loan market; (1) for the time period 2012-2016 and (2) for time period 2016-2019. The dependent variable is change in systemic capital shortfall (ΔSRISK) .The independent variable of interest is the change in Tier Capital ratio of a lead arranger. Control variables include the financial institution's total assets, (in billion U.S. dollar) and return on assets. All regressions include time fixed effects. The hypothesis test's t-value are in the parentheses. * indicates that the estimated coefficient is significantly different from zero at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 5 reports the regression results for SRISK based on 101 unique lead arrangers, with yearly data ranging from 2012 to 2019. In the micro-prudential period 2012-2016, I find positive and statistically significant coefficients at 5% between $\Delta SRISK i,t$ and $\Delta TierCapital_{i,t}$. A rise of 100 basis points in tier capital ratio stimulate an increase of 22.6 basis points in SRISK. My findings support the hypothesis 3a. When I differentiate my sample based on the region of the bank's headquarters to Europe and USA; the coefficients are positive and economically significant only for European banks. An increase of 100 basis points in tier capital ratio lead to an increase of SRISK by 24.9 basis points. My results are in line with previous empirical analysis, which have shown that banks with higher micro-prudential capital requirements can heightened their systemic risk (Weiss,2017). During the macro-prudential period, I find negative but statistically insignificant coefficients. Looking at the coefficients, we can observe a change in the effects of capital requirements in the macro-prudential period.

In order to understand what effect this change, I have to clarify what can drive changes in $\Delta SRISK$. There are three reasons that can attribute to change in $\Delta SRISK$:

(a) $\Delta(DEBT)$: increasing liabilities of a financial institution can contribute to a positive change in SRISK.

(b) $\Delta(EQUITY)$: decreasing market capitalization of a banks can lead to a positive change in SRISK.

(c) $\Delta(RISK)$: An increase in the risk attributes of a firm, such as the correlation or volatility, also contributes to SRISK.

Previous papers have indicated that attribution to this change is the change in risk and equity. My results are in line with the implications of the empirical analysis of Weiss. He shows that micro-prudential capital requirements can decrease the stocks returns and increase the covariance with the market. I assume that introduction to macro-prudential regulation can boost investors trust and consequently increase the stock price of financial institutions. Moreover, covariance with the market might decrease. My results in my first hypothesis indicate that a macro-dimension on prudential policies can decrease interconnectedness within the banking sector and consequently the covariance of banks with the market. Including policies that can decrease the covariance of institutions with the market can decrease systemic risk of the banks and make them less vulnerable to stock shocks. Even though my results are statistically insignificant for the macro-prudential period, we can see that higher capital requirements do not have a significant effect on the systemic risk of financial institutions.

10 Conclucion

Basel framework plays a vital role for the financial stability of the financial sector. In the beginning, Basel policies had a micro-prudential dimension and focused on the financial stability of individual banks. Micro-prudential policies were able to decrease the idiosyncratic risk of the institutions and indirectly to mitigate the risk of the whole banking sector.

However, a great deal of controversy surrounds the subject whether micro-prudential regulations were enough to safeguard the financial stability of the banking industry. Strong evidence indicates that micro-prudential policies can increase interconnectedness within the financial institutions. Such policies can incentive financial institutions to create similar portfolios based on the theory "too many to fail". Specifically, banks create overlapping portfolios so they will not bailout each other when it is needed. Moreover, micro-prudential policies can alter the risk aversion of institutions to be less risky in order to meet the capital requirements. In case of this effect, banks will end up with asset commonality. Financial institutions are exposed to the same risks, as they invest in the similar non risky assets. Higher interdependence among institutions can lead to a system which banks might be insolvent simultaneously and therefore unable to help each other through the inter-bank market.

Furthermore, micro-prudential framework can increase systemic risk. Evidence suggests that tighter micro-prudential policies increase the expected systemic shortfall of financial institutions. Reason of such effect is that banks stock price decline and covariance with the market increase, which lead to higher expected

systemic shortfall. My findings are in line with such implications and suggest that micro-prudential policies can increase the interconnectedness and systemic risk of the banking sector. In this paper, my results are based on the syndicated loan market and its implications can extended to other asset classes as well.

Next, Basel took a macro-prudential dimension with the introduction to systemic risk buffer and counter-cyclical capital requirements. Systemic risk buffer has been introduced to financial institutions which were defined as systematically important (G-SIIs). A bank can be considered G-SIB based on many criteria, one of them is interconnectedness. The excess systemic risk buffer for institutions with high interdependence with their peers can be considered as a punishment and therefore disincentive institutions for being highly interconnected. In Europe excess systemic risk buffer has been applied to domestic important institutions as well, making macro-prudential regulation stricter than the American jurisdiction. My findings indicate that macro prudential policies decrease interconnectedness within the European banking sector. Regulations based on interconnectedness and pricing of such a risk on banks tier capital ratio achieve to disincentive banks from being interdependent to each other. The implication is not significant for the American financial institutions.

Moreover, my results suggest that the coefficient between macro-prudential capital requirements and systemic risk is negative, however, statistically insignificant. A reason of such an effect can be a decrease to the covariance of banks with the market returns as a result of lower interconnectedness. Moreover, increasing stock price of financial institutions can attribute to that effect.

My analysis indicates the importance of macro prudential policies to achieve financial stability and make banking sector less fragile. My findings indicate the importance of systemic risk buffer. Financial institutions that are highly interconnected with their peers should maintain the excess surcharge, no matter if they are not large enough to achieve a position in G-SII from FSA. Such policy can disincentivize banks from being interconnected and potentially decrease systemic risk.

Furthermore, I suggest to further improve macro prudential policies, in order to be able to disincentive banks to have high interconnectedness with their peers in all the dimensions. Meaning that, regulators can introduce excess systemic risk buffer for banks that have similar portfolios and simultaneously are highly interdependent to each other in the inter-bank market. Banks that have overlapping portfolios and lend to each other in the inter-bank market can impose high risk in the banking industry.

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