The Paradox of Margin Requirements: Systemic liquidity risk and Procyclicality

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Abstract

After the financial crisis of 2008, regulators imposed tight regulations forcing OTC derivatives to be traded through CCP (Central Counter Party). Despite this central institution reduces counterparty credit risk of market participants by means of margin requirements, there is a growing concern which shows that margins requirements could increase procyclicality (Glasserman 2017) and liquidity risk (Bakoush 2018). Regarding procyclicality risk, market participants must cope with margin calls when volatility arises. Although margins serve to avoid that the counterparty fails, margin calls requires participants to add extra liquidity as collateral in a short-time constraint. This circumstance forces market participants to fire sale the assets available in a "thin market" which few buyers and many sellers. Those peculiar conditions affect volatility which could lead again to margin calls. Considering liquidity risk, the study investigates the imbalance of the demand and supply of high-quality collateral overtime. The liquidity risk consists in the collateral scarcity which cannot grow at the same pace of the demand (Levels 2012; Baranova 2016). If the demand of high-quality collateral overcomes the supply, banks and financial institutions could encounter difficulties in finding collateral for backing up their financial transactions with other participants. The interbank market where banks and financial institution lend/borrow liquidity could be severely affected causing funding problems for several entities. The purpose of this study is to investigate whether margin requirements can increase procyclicality and liquidity risk. Firstly, the results of this paper show that higher margin requirements do not lead to higher volatility, increasing procyclicality risk. Secondly, the study reports none liquidity risk underlying that the supply of high-quality collateral overwhelms the demand and that margin requirements have a minimal impact on the imbalance of demand and supply of high-quality collateral.

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1 Introduction

Institutions and governments have long been intrigued by desperately seeking an effective remedy against each financial crisis. On the logical grounds, each crisis results later in tougher laws and regulations than before in an attempting to avoid the same issues again. However, a key aspect which is not investigated accurately revolves around the effectiveness of this new regulation. Indeed, the efforts made for dealing with a problem could lead the way for unintended and disruptive consequences. In fact, after the global financial crisis of 2008, legislators were eager to improve the identification, measurement and management of the counterparty credit risk due to the relevant and pivotal role played in the crisis. "As has been shown in the market events of the last few years, counterparty risk is the most complex form of credit risk with systemic traits and the potential to cause, catalyse or magnify serious disturbance in the financial markets" (Gregory, 2010, p.13). The reform studied by the regulators were tailored for enhancing the over the counter derivatives conditions. In the OTC market financial products are traded with a bilateral negotiation with no formal rules and regulation in the method of trading. Furthermore, products traded in OTC market can be tailored towards the specific needs of the client. Due to this peculiar configuration, participants involved in a trade in the OTC market inherit a counterparty credit risk. Indeed, they must keep in mind that the counterparty could be not able to meet his contractual obligations, producing a risk of insolvency for the other party. In fact, an asset traded on the OTC market, also known as "irregular" market (Sayah,2017), does not exhibit any form of standardization, which results in a risk vulnerable environment (Sayah, 2017). On the basis of the evidence currently available, it seems fair to suggest that this makes sense because in the OTC market the counterparty credit risk burdens on both the parties of the agreements without any mechanism to prevent further consequences.

Secondly, the OTC market had a strong influence in the crisis: "The remainder of the unregulated OTC derivatives market was central to the crisis' causation"(Greenberger, p.18, 2010). The regulation which has taken place in both Europe and the US, concerns forcing OTC derivatives to be centrally cleared through Central Counter Party (CCP) as well as increasing collateral requirements by means of margin requirements. A central counterparty or "clearinghouse" is a financial institution which interposes itself between the participants of a trade exchange to assume their rights and obligations (Gregory, 2014). The main aim of CCP is to minimize the counterparty risk in exchange traded-products and limit the impact that the insolvency of a member of the exchange may have (Gregory, 2014). These financial entities for fulfilling their aims rely on margin requirements as a means of effective insurance against counterparty credit risk. In detail, margins serve to cover the losses of a hypothetical default of a member. Although this system seems stable, there is a foregoing discussion whether the introduction of CCP endangers financial stability, increasing credit risk and systemic liquidity risk. This study is an attempt to address these issues.

1.1 Statement of the Problem

On logical grounds, there is no compelling reason to argue that the introduction of the CCP in the OTC-derivatives market is not beneficial. Indeed, the rule of the CCP allows for a better management and reduction of the counterparty credit risk giving stability and standardizing the OTC derivatives market."In an effort to improve market infrastructure following the crisis, central counterparties (CCPs) are being put forth as the way to make over-the-counter (OTC) derivatives market safer and sounder, and to help mitigate systemic risk." (IMF, 2010, p.1). Despite some relevant benefits due to the introduction of CCP, there are still some unexpected flaws which have been neglected and poorly investigated. (Cecchetti, 2009). The main tool at the

disposal of CCP in coping with counterparty credit risk resides in margin requirements. To put in another way, CCP requires participants to put a collateral as a warranty for avoiding losses. Although this method is quite effective in ensuring a shrinkage of the counterparty credit risk, it could pave the way for devastating consequences. In particular, collateral converts counterparty credit risk into funding liquidity risk through margin calls (Cont, 2017). Indeed, under particular market conditions, participants are called to increase the percentage of collateral hold in their accounts upon request of the CCP. "If counterparties do not have sufficient cash/collateral to meet a margin call, they become distressed"(Bakoush, 2018, p.3). A financial distressed scenario could cause issues in the interbank market. This market regards banks and financial institutions which lend/borrow liquidity among themselves. However, due to a financial distressed scenario banks or financial institutions could refuse to close out its current overnight lending causing liquidity problem to the other institutions. Thus, it transfers its distress to the others, effectively spreading the systemic liquidity risk within the interbank market. (Bakoush, 2018). Furthermore, it is noteworthy to consider that margin requirements are often procyclical. This means that in time of stress, volatility increases, which lead to an increment in margin requirements, which can exacerbate that stress. (Murphy et al., 2014.). Margin requirements are calculated relying on the volatility of the underlying asset as a main input. Consequently, if volatility increase this results in an increase of margin requirements, especially of the aforementioned margin calls which can worsen the situation.

The purpose of this study is to explore the relationship of margin requirements with respect to procyclicality risk. A second purpose is to investigate the strength of the tie between margin requirements and systemic liquidity risk. Finally, data collected for the study provide evidence whether or not the renewed margin requirements regulation in increase procyclicality risk,

through volatility, as well as dramatically boosts the likelihood of spreading a liquidity risk. This study provides an important opportunity to advance the understanding of neglected consequences of new margin requirements regulation, contributing to a successful implementation of the policy-decision tool chosen by the authorities. Indeed, an appropriate change in the current margin regulations could allow: "derivative users to anticipate potential margin call and ensure they have adequate holdings of to access to liquid assets" (Murphy, 2014, p.3). The result of this study may be utilized to develop effective margin requirements regulation to cope with counterparty credit risk, diminishing the possibility of increasing catastrophic aftereffects.

1.2 Structure of the Thesis

This study is presented in five chapters. Chapter I includes the introduction, statement of the problem, and significance of the study, Chapter II presents the theoretical background and the literature review. Chapter III describes the methodology used for this research study. It includes the data collection and data analysis procedures. Chapter IV presents the study's findings including testing the research questions, and results of the data analyses for the two research questions. Chapter V provides a summary of the entire study, discussion of the findings, implications of the findings for theory and practice, and conclusions.

2 Theoretical foundation and literature review

This chapter provides the basis for investigating the cause and effect relationship between margin requirements and systemic liquidity risk. In addition, the logical premise behind the linkage between margin requirements and procyclicality risk will be investigated as well. Although previous research treated intensely these topics, it has not been successful in delivering

a clear answer regarding the consequences of margin requirements with respect to liquidity risk and procyclicality risk. This study sought builds upon this body of research and tries to extend the current knowledge about the flaws which come with margin requirements. The following review of the literature allows to better target and contextualize my research study, with regard to the main key variables, namely liquidity risk and procyclicality risk.

2.1 Derivatives

The global financial crisis in 2008 has encouraged a debate on the role of financial derivatives. Derivatives can be defined as a financial instrument of with the value is derived from one or more underlying assets' performance. The choice of the underlying asset is very variegated, ranging from stocks, futures, currency or an index, to non-financial instruments (For instance, the weather[1]). These financial instruments are extremely sensitive to changes and fluctuations of the underlying asset which determines the value of the derivative itself. More specifically, a derivative can be considered as a contract where the parties specify rights and obligations for payment under, some conditions. For the sake of the discussion, let us consider a futures contract, which is one of the simplest form of a derivative contract, and two parties: a farmer and a miller. The farmer wants to ensure to sell at an acceptable price his commodity while the miller wants to be secure that the commodity will be delivered without overpaying for it. From the point of view of the farmer, the derivative is a protection against a decline in the price of the commodity. On the other hand, the miller is insured against huge increments in the price. Indeed, the farmer has the obligation to deliver the commodity to the miller, upon certain conditions, and the miller has the obligation to pay a certain amount to the farmer. The peculiarity of the future contract resides in the fact that the counterparties must meet these

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[1] A derivative with the weather as underlying asset is called "Weather Derivatives"

obligations at a specific date in the future, previously determined at the beginning of the contract. At a later date, the derivative will determine who has realized a profit and who a loss. In particular, if the price of the commodity at the time of delivering is higher than the price agreed in the future contract, the miller will realize a profit. Whereas, if the price of the commodity is lower than the price agreed in the future contract the farmer will have a profit and the miller a loss. However, it is noteworthy to bear in mind that both from the perspective of the farmer and the miller the hypothetical losses/profits can be deemed as an opportunity cost. In other words, an opportunity cost stands for the alternative given up when a decision took place. To put it more clearly, if the price of the commodity is lower than the price agreed upon in the future contract, the farmer will make a profit because he is selling his goods at a price higher than the market price currently available. By contrast, the miller realized a loss in the sense that he could have bought the commodity at a lower price in the market. In this sense the derivative is affected by changes in price of the underlying asset. This is a straightforward example of a futures contract, a simple derivative contract. In reality, there are a plenty of much more complex derivative contracts which can be tailored depending on parties' needs.

A financial derivative can be essentially traded in two ways:

    i)   OTC (Over the Counter)

    ii)   ETD (Exchange-Traded derivatives)

2.2 Trading derivatives in OTC Market

A derivative traded on the OTC (Over-the counter) is a private contract between two parties, without the supervision of an exchange. There are no standardized contracts and rules. Thus, an OTC derivative could be tailored upon parties' needs. The private agreement

which takes place under this setting is called a forward contract. A forward contract is similar to a future contract. One can say that the latter is a standardized forward contract traded on the market. However, there is a relevant difference between them. Indeed, since the future contract is an exchange-traded, it has clearing houses which guarantee and oversee the transaction. Regarding the forward contract, the absence of the supervision could be seen beneficial in terms of flexibility. However, a closer look at this flexibility hides a huge credit risk. In particular, due to this private trade parties have to bear themselves the counterparty credit risk, which means that if one of the counterparty fail in fulfilling its duties according to the agreement, the other has to bear the loss. On the contrary, future contracts relies on a CCP which effectively reduces this counterparty credit risk by using different methods, such as netting and margining. Indeed, "Multilateral netting allows CCP to offset the amounts it owes and is owed by market participants resulting in what are usually small residual amounts that become single debits or credits between the CCP and each of its clearing member" (Norman, 2011) while margins serve as a guarantee against default losses of a member. In detail, margins comprise securities or cash which participants have to deposit and CCP can easily trade for covering the losses of the default member. Following this line of reasoning, some argue that this poses the basis for a "systemic risk", in which the failure of one entity could generate the chance of a greater collapse. This scenario is exacerbated by the "opaque" conditions of this market. (Darby,1994) To put in another way, the dearth of precise rules hides the real nature of the risk and the real usage of the derivatives in the OTC Market, steering the way for an increased systemic risk.

2.3 Trading Derivatives through CCPs

Exchange -Traded derivatives (ETD) are financial derivatives contracts that are traded through CCPs (Central Counter Party) under standardize regulations. A CCP is an entity that interposes itself between the counterparties to the contracts traded on more or one financial market, becoming the buyer to every seller and the seller to every buyer. (Norman, 2011). Thus, this financial institution acts in a centralized network and as a central player. It is noteworthy to mention that there could be more than one CCP in a network though they provide the same functions. The most relevant advantages of having this centralized structure are:

i)   Notion

ii)   Multilateral Netting

i)   As aforementioned, a contract is split into two parts where the CCP places itself in the middle between the buyer and the seller. Thus, a typical contract between a buyer and a seller will become two bilateral contracts. One involves the CCP and the seller and the other the CCP and the buyer. Due to this particular setting the counterparty credit risk between the buyer and the seller ceases to exist and the risk now lies between each party and the CCP itself. (Gregory, 2010)

ii)   Another crucial characteristic of the CCP is the Multilateral Netting of the exposure. Let us consider 3 entities (A,B,C) . A has an exposure towards B of 100, B has an exposure towards C of 50 and C has an exposure towards A of 120. Consequently, the sum of the bilateral exposure accounts to 270. By introducing the CCP the net exposure amounts to 140, thanks to multilateral netting which can reduce total

counterparty exposures (See *Figure 1).* To summarize, CCP ensures to avoid repeating transactions among market participants, by improving operational efficiency and the credit chain itself.(Anderson et Al, 2013)

Figure 1
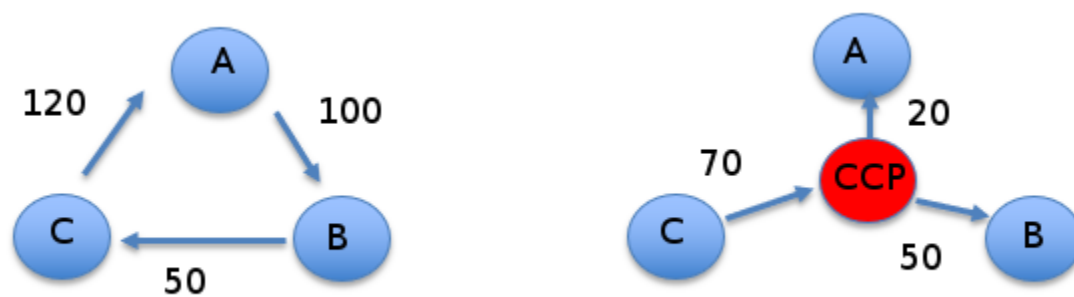
2.4 Functions of a Derivative

The main function of a derivative is to hedge risk and to spread it from one entity to the other. Consequently, derivatives are an effective instrument for risk-management. (Batten et al. 2004). On the other hand, these instruments have been intensively deployed for speculation. Both financial and non-financial firms use them for boosting earnings and turn this speculative manner into a normal routine. (Hodgkins, 2014). In other words, a remarkable amount of companies are bearing the risk and betting on currency or interest rate movements through a derivative, with the expectation to receive a gain. In reality, this can be a very perilous bet if they go wrong resulting in a huge loss rather than a gain. Thus, this "distorted" usage of the derivatives could lie under the huge popularity of this peculiar financial instrument. In particular, the market demand for derivatives trading until 2007 reached an astonishing amount, accounted for €457 trillion in terms of national amount (The Global Derivatives Market: An introduction, 2008).To add fuel to

the fire, the majority of financial derivatives were traded on the OTC at that time, accounting for 95% of the total derivative percentage. (Source: European Commission, Press Release Database) period. On these grounds, there is a consensus in blaming OTC derivatives for the global financial crisis of the 2008. (Bajracharya, 2009). More specifically, as previously mentioned, the OTC Market does not provide a central entity which bears the credit risk of the parties. Thus, there is the potential to create a systemic risk. Current research appear to validate such a view. In particular, empirical findings from 2007 to 2009 linked huge losses by financial institutions from their positions in OTC derivatives resulting from a huge exposure which the institutions were unable to cover. (Hull, 2010). Indeed, during the financial crisis in 2008, investors speculated through credit default swap and other derivatives betting on a possible scenario of the housing market along with the value of mortgage-backed security. (Hodgkins, 2014).

2.5 Regulations Imposed for OTC Derivatives after the crisis

After the adverse consequences of the crisis, legislators urged to oversee and standardize over-the-counter derivatives. Both in America and Europe institutions were prone to shed the light of the OTC market and force derivative to be traded under a CCP platform. As a result, the regulation was tailored for promoting CCPs. In fact, the U.S approved to take effect the Dodd-Frank Wall Street reform and consumer protection act. The main purpose of this act are: limit the risk of the OTC market and limit the consequences caused by the failure of large financial institutions. (Skeel, 2010). The act is able to meet these aims by imposing stricter regulations and the requirement of trading derivatives with a CCP (Central Clearing Counter Party). Along similar lines, the EU introduced a regulation ad-hoc, named EMIR (European Markets Infrastructure Regulation). This European Regulation is keen to increase stability in the OTC derivatives market, by imposing common rules in a derivative contract and clarity in how to deal

with the credit risk. To sum up, both regulations are targeted for channeling the bilateral credit risk of the OTC-derivatives, peculiar of the OTC market, into a centralized model with the CCPs involved in managing counterparty credit risk. To put it differently, the latter target is to avoid that the default of a huge market participant will cause a domino effect on the market. Despite this admirable aim, there have been dissenters to the view that the CCP reduce counterparty credit risk. Indeed, due to the fact that the CCP has an exposure towards the other members, it can be affected by a default risk. This occurs when the losses from a member default exceed the default fund contributions (each participants is obligated to deposit a specified amount into a fund, in order to cover the losses of a member when the participant's margins are not sufficient). As a result, the CCP can be default itself. (Arnsdorf, 2011)

2.6 Margins as a consequence of CCPs

The mandatory introduction of CCPs setting, for trading derivatives, has put the attention on the margin system deployed by these entities. Considering an OTC contract, the credit risk bears totally on the parties of the contract, due to the fact that not any precautions has been taken to tackle the risk of insolvency of the counterparty. Whereas, in a CCP environment margins come to shelter against credit risk. Margin is the minimum amount of a collateral (it can be cash deposit or securities provided) that the holder of the financial instrument has to give to the counterparty to cover the credit risk. Due to the central position of the CCP and the concept of "Notion", previously mentioned, margins serve as a warranty to cover losses if a member defaults and ensure continuity of contracts. (Heckinger, 2016). Thus, margins serve as reducing counterparty credit risk in the financial system. The margin policy of a CCP follows some principles, namely the PFMIs (Principles for Financial Market Infrastructures). These series of standards revolve around 12 key principle. In particular, in the 6th principle is stated: *"A CCP*

should cover its credit exposures to its participant for all product through an effective margin system that it is risk-based and regularly reviewed".

2.7 How Margins are calculated

The main theoretical premise behind this is to take into account three pivotal elements for the margin calculation: Historical Volatility and Time Horizon, Liquidation, Procyclicality.

Historical volatility and Time Horizon: In their methodology CCPs shall ensure to take into account volatility and use a suitable volatility dataset, which must cover at least 12 Months observations. (RTS 153/2013, Art. 25) The volatility is calculated as changes in price of the underlying asset. The methodology deployed by CCPs should cover at least 99% of these changes in price. (Heckinger, 2016).

Liquidation: If a member defaults, the CCP will liquidate the clearing member's position, in order to cover the loss. However, there might be some concerns regarding the financial availability of the other members to absorb the position. Consequently, the liquidation period taken into consideration should be at least 5 days. (RTS 123/ 2013, Art.26)

Procyclicality: A CCP should use prudent margin requirements for limiting procyclicality .Under adverse conditions, spikes in volatility can lead to an amplification of risks, through margins themselves. This phenomenon is known as procyclicality. "Risk-sensitive margin requirements are thus procyclical in the sense that they amplify shock"(Glasserman, et al.,2017,p.2). In particular, when volatility increases, CCPs requires additional margins.(Heckinger, 2016). The guidelines for reducing procyclicality are written in Art.28 of the RTS 123/2013 and stated that the CCP should apply one of the following options:

a) Apply a margin buffer equal to 25% of the calculated margins which it allows to be temporarily exhausted in periods where calculated margin requirements are rising significantly

b) Assign at least 25% weight to stressed observations

c) Ensure that its margin requirements are not lower than those that would be calculated using volatility estimated over a 10 year historical lookback period"

2.8 Adverse Consequences Behind Margins: Liquidity Risk

The main theoretical premise behind margin is that they should get rid of the counterparty credit risk. In reality, margin requirements convert the credit risk into funding liquidity risk, especially through margin calls. For the sake of the discussion it is relevant introduce some different types of margins. Maintenance margin is the minimum amount of cash or securities which customers have to maintain in their account while initial margin revolves around the amount market participants have to deposit in their account as they enter into a futures contract (Kenneth,2011). Variation margin is a payment made by participants to the CCPs which can be settled either on a daily or intra-day basis and depends on the adverse price movements of the contracts these members have. Given these points, the investor is called to meet the requirement of the margin call when the security, used as a collateral, declines under a certain percentage of the market value, which represents the maintenance margin. Thus, in order to maintain his maintenance margin, the investor needs to put cash into its account to reestablish the normal position. In other words, the investor is called to find out this liquidity, which in condition of market stress can be really tough to provide. "Financial institutions may need to obtain and deploy additional liquidity resources to meet margin requirements that exceed current practices."

(Consultative document, Margin Requirements for non-centrally-cleared derivatives, BIS, p.3) Thus, margin calls in a dreadful market situation can lead the way for worsening the consequences rather than avoiding the transmission of losses.(Glasserman et al., 2017). On these grounds, we can argue that, there are broader effects which have been neglected. Indeed, there is further evidence that Margin Requirements could cause a liquidity risk: "We find that distress due to margin procyclicality in the derivatives market can spillover to the interbank market leading to systemic liquidity risk" (Bakoush, et al., 2018, p.1). A clear example of this hypothesis comes from Brexit ,the referendum in the UK for leaving the European Union held on the 24th June 2016. It is argued that "market reaction to the Brexit vote as an example of an event during which heightened volatility led to large variation margin calls"(Lewis, 2016, p.5). Indeed, members were asked to meet high margin calls (estimated in $27 billion[2]), causing funding stress for some members.

2.9 Procyclicality Risk

Another crucial and critical argument revolves around the effectiveness of margin requirements in dealing with procyclicality. As previously mentioned, legislators have already specified some guidelines for diminishing procyclicality. However, it follows that:" any margin system which uses volatility as an input is potentially procyclical"(Heckinger, 2006, p.8). As a result, the procyclicality risk cannot totally disappear. On the logical grounds, an increment in volatility leads the way to an increase in the margin calls. However, for the aforementioned reasons, this results in a liquidity risk which can be perceived as an effective risk, leading to more volatility. Due to the fact that volatility accounts for 90% of margin requirements (Heckinger, 2006), more volatility leads to more margins, resulting in a huge amplification of

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[2] According to the Federal Reserve Bank of Chicago

shocks and risks. Much of the current debate revolves around whether these rules are effective in reducing procyclicality risk. Some argued that: "there is some support for the notion that volatility is reduced by lowering margins."(Ferris et al, 1988,p.254). On the other hand, others claim that there is not a significant relation between margins and volatility in short-term horizon. However, in the long-run margin requirements cause volatility only for speculative stocks (Y.Hsu, 1996). The foregoing discussion implies that there is no general agreement on the real impact of margin requirements on volatility and thus on procyclicality risk, due to the linkage between volatility and procyclicality.

2.9.0 Research Questions

Therefore, the aim of this study is to extend the current state of knowledge by investigating on how margins can lead to systemic liquidity risk and their further effect on procyclicality risk. These concepts can be represented by the following questions:

Research Question 1: Can margin requirements increase procyclicality risk?

Research Question 2: Are margin requirements leading the way for a systemic liquidity risk?

3 Data & Methodology

The dissertation examines the aforementioned research questions: Are margin requirements leading the way for a systemic liquidity risk? Can margin requirements increase procyclicality risk? Given the centrality of these issues, it is essential to investigate the relationship between margin requirements and volatility. Indeed, disentangling this puzzle allows for a clear

understanding of these two variables with the two research questions. First and foremost, margin requirements are a function of volatility. (RTS 153/2013, Art. 25). As a result, the general view rests on the assumption that when volatility increases/decreases it affects margin requirements, which follows the same upward/downward trend. Current research appears to validate such a view (Heckinger 2006). Following this line of reasoning, higher margin requirements results in a soaring request for collaterals, especially through margin calls. For the sake of the discussion, let us consider that the collateral needed is liquidity. Consequently, several entities in the market must come up with additional liquidity in a strict time constraint to meet the margin call. Under this scenario, one of the most-effective way-out could be to sell the assets available. "Investors may choose to sell assets to meet margin calls, causing a further decline in the asset price." (Kahmi, 2009, p.57). This cause a "narrow market" with a low number of buyers and a huge amount of sellers. Considering the disproportion between those who are willing to buy and those who are willing to sell, the price tends to go down due to the high bid-ask spread (Rostek et al., 2008). In fact, due to the massive presence of sellers in comparison with buyers, sellers engage a fire sale characterized with an extremely discounted price. Consequently, the bid price, the price in which the dealer is willing to buy the asset tends to reduce in comparison with the ask price, the price which the dealer ask for selling the asset. The major consequences are that this cause a spike in volatility and, as a result, in margins as wells. (Rostek et al., 2008). The whole cycle starts again without no-way out.

Along similar lines, the same theoretical premise supports the explanation for the tie between the systemic liquidity risk and margin requirements. Considering the scenario previously mentioned when volatility increases margin increases and there is an urgency for meeting margin calls. Consequently, the major effect is that the difference between the demand and the supply of

collateral will widen. According to some studies (Levels 2012; Gorton 2013) there is already a mismatch between the demand and supply of collateral. This holds for low-risk high-liquid collateral. "The increase in collateralized transaction has occurred while the supply of collateral with inherently low credit liquidity risk has not kept the pace" (Committee on the Global Financial System, 2001, p.2). Thus, under disadvantageous scenario with high volatility and margin calls the demand for collateral will experience an increase while the availability of collateral will not grow at the same pace causing a discrepancy.

3.1 Data

This section describes the methodology used for answering to the research questions. First and foremost, an Historical Margin Database from 2009 to 2018 has been taken from the CME (Chicago Mercantile Exchange & Chicago Board of Trade) public dataset. More specifically, the dataset regards the Maintenance margins of options and futures which have as an underlying asset the S&P 500 index. Maintenance margins help to ensure that clearing members can meet their obligations to their customers and to CME Clearing. Moreover, this study relies on the database of the S&P 500 with the same time-range, available through the Data-Stream of Thomson Reuters. Our premise is to use monthly volatility and monthly maintenance margins.

3.2 Research Method Question 1

In this section, the question under discussion is whether margin requirements are an effective tool to cope with Procyclicality Risk.

First and foremost, we want to analyze the relation between margin requirements and volatility. In particular, we investigate the linkage between margin requirements of options and futures having as underling asset the S&P 500 Index and the volatility of the index itself. To put it

differently, if margin requirements are too procyclical we expect that the volatility increase when margin requirements increase. Indeed, since margins requirements are a function of volatility, they tend to increase when volatility rises. As a major consequence, CCPs ask for meeting margin calls which causes a clustered sale of assets, attempting to collect liquidity in a short-time horizon. Due to the practical constraint that data about assets/securities sold when margin calls arise are not available, the study assumes that the asset sold is the S&P 500 itself. According to the European Central Bank, the S&P 500 is regarded as an eligible asset for collateral.

Our regression will take place in the following way:

$$\Delta \sigma_t = \beta_0 + \beta_1 \Delta M_{t-1} + \varepsilon_t \quad (1)$$

In the formula (1) ΔM_{t-1} represents the monthly changes in margin requirements, while $\Delta \sigma_t$ stands for monthly changes in volatility of the S&P 500. ε_t stands for the error term. The methodological approach taken in this study is supported by the theoretical question. The main theoretical premise behind this regression is that the change in volatility of the asset at period t has been caused by the change in margin requirements in the previous period t-1. Indeed, it makes sense including the monthly changes in volatility as dependent variable and the monthly changes in margin requirements in the previous period as independent variable since the study expected that monthly variation in volatility is heavily determined by the previous monthly change in the margin requirements. This idea is in line with the hypothesis that change in margin requirements cause changes in volatility. If changes in margin requirements lead to higher procyclicality risk, this must reflect in terms of changes in volatility in the following period. Thus, this regression allows to infer whether changes in margin requirements play a crucial role in increasing volatility which is a proxy for assessing procyclicality risk. This regression is also

relevant because it has a dynamic interpretation as it dictates the timing of the effect X on Y which makes an appropriate choice when the theory predicts that the effect of X variable persists into future. (Keele 2005). This dynamic regression is supported by the theoretical framework. Indeed, changes in margin requirements does not affect immediately the volatility of the asset because market participants must cope with margin calls and consequently they sell their asset available as a means for collecting liquidity and then volatility arises. Under this assumption, the study rejects the idea of using a classical linear regression and opted for a dynamic regression where the independent variable ΔM_{t-1} is lagged one period before the dependent variable $\Delta \sigma_t$.

Regarding the variable σ_t , the study relies on calculating the monthly volatility from the daily price return of the index retrieved from Thomson-Reuters using the following formula:

$$\sigma_t = \sqrt{\frac{\sum_{i=0}^{N}(PX_i - \overline{PX})^2}{21}} \quad (2)$$

$$\overline{PX} = \frac{1}{21}\sum_{i=1}^{N} PX_i$$

$$\Delta \sigma_t = \sigma_t - \sigma_{t-1}$$

Where:

σ_t= volatility level on the tth month

PX_i= The price return index level of the underlying index on day i

N = Number of trading days in the lookback period (21)

$\overline{PX}$= average price return index level

$\Delta\sigma_t$=Monthly changes in volatility of the index

The study assumes 21 days as a month. This hypothesis is supported by the evidence that the dataset lacks about any data regarding the index (S&P 500) on Saturday and Sunday.

$$M_t = \frac{1}{21}\sum_{i=1}^{N} M_i \quad (3)$$

$$\Delta M_{t-1} = M_{t-1} - M_{t-2}$$

Where:

M_t= Margin Requirements on the tth month

M_i= The Margin Requirements on day i

N = Number of trading days in the lookback period (21)

ΔM_{t-1}=Difference in monthly changes in Margin Requirements delayed by one period

   The advantages of using monthly frequency are easier to model allow to identify better changes in trend though the regression neglects daily changes of the variables. (Miller 1996). In the study is more suitable a monthly frequency because changes in margin requirements does not have an immediate effect on volatility. In fact, market participants are subjected to meet margin requirements and eventually fire sale their assets available which lead to spike in volatility. Consequently, the whole process requires cannot be acknowledge on a daily basis.

3.3 The problem of Stationarity

A stationarity process is one whose statistical properties, such as mean and variance, remain stable over time. (Nason 2006). The premise of stationarity plays a crucial role in forecasting correctly and identifying the driving factors of the regression without leading to inaccurate results. Indeed, a non-stationarity series results in a spurious regression where the hypothesis of the model cannot be tested properly. In essence, in a non-stationarity process it may appear misleading relationships between two or more variables which in reality does not exist, resulting in deceptive conclusions. This is due to the changes in mean, variance and covariance of the non-stationarity data which makes the model unpredictable. Consequently, carrying out non-stationarity regression it is unlikely to produce reliable and consistent results. When it comes to time-series regression is it likely that the variables considered are non-stationarity. As a result, given the importance of a stationarity process, researches have studied several techniques to induce stationarity in the time-series (differencing, transformation of the variables, seasonal adjustments). This study acknowledges the differencing of the variables as a main method for inducing stationarity. The differencing technique consists in subtracting the previous observation from the current observation of the variable considered, which allows for stabilizing the statistical proprieties of the time series (Hyndman 2014). The use of the lagged variable of the dependent $\Delta\sigma_t$ and the independent variable ΔM_{t-1} is not only supported statistically as it helps to transform the regression into a stationarity process, but also theoretically when the dependent variable may not respond immediately to a specific change in the independent variable. (Ostrom 1990). Thus, the differencing technique is used in this analysis considering the independent variable delayed of one period, since the effect of changes in margin requirements is not immediate and require time to have an impact on volatility as previously discussed. For assessing

that the variables $\Delta\sigma_t$ and ΔM_{t-1} are stationary, the study relies on the Dickey-Fuller test. This peculiar test is well known in econometrics to verify whether the variables experience any trends which makes the regression "spurious". In fact, the Dickey-Fuller investigates whether the null hypothesis of a unit root holds. A unit process can be considered as a random process in a time-series and thus, nonstationarity. (Patterson 2012). Consequently, the Dickey-Fuller test is a useful tool for verifying if the time series is stationarity after the transformation.

3.4 The problem of the Correlation

One of the major flaws involved in this type of analysis, regarding margin requirements and volatility of the asset itself, revolves around correlation. On logical grounds, margin requirements are calculated taking into account volatility. To put it differently, the assumption of independence will not hold and the residuals in the equation will be autocorrelated resulting in "spurious" results. In order to face this potential issue, previous studies entrust in a graphical and statistical approach. (Hardouvelis 1988, Hsieh 1990). A similar strategy to overcome and evaluated correlation will be used as well in this research. The method concerns:

1)Scatter-Plot

The primary goal of one of the research questions is to evaluate if there is a relation between margin requirements and volatility. Thus, it is crucial to verify that the assumption of independence is not violated. Following this line of reasoning, it seems fair to suggest that a visual analysis will help the reader in a better comprehension of the problem to understand more clearly the problem of spurious regression (Hsieh 1990).

2) Durbin Watson

For having a statistical test on autocorrelation, a Durbin-Watson test will be run. Nevertheless, margins requirements and volatility are highly correlated, the transformation into $\Delta\sigma_t$ as dependent variable and ΔM_{t-1} as independent variable should deal with correlation. This approach is analogous to the method adopted in similar studies (Hsieh,1990). In Hsieh 1990, the most straightforward method to solve correlation seems to run the regression with the lagged first differences.

3.5 Granger Causality-Test

For a more comprehensive analysis the study acknowledges a Granger-causality test. Thanks to this test the study can investigate whether margin requirements cause volatility or volatility lead to higher margin requirements. Trying to disentangle this issue could help lawmakers in a better understand of the impact in margin requirements through CCP or be aware of the impact of volatility on margin requirements. Indeed, in the first hypothesis lawmakers should be concerned to avoid too much volatility and rise procyclicality risk. While in the second case, the effectiveness of margin requirements is affected by the trend in volatility.

3.6 Research Method Question 2

Regarding the second question, this section is concerned with the issues of margin requirements and systemic liquidity risk. In order to investigate liquidity risk, we analyze the difference between the demand for collateral and the supply of it. First and foremost, we will derive the demand for high-quality collateral[3] and then we will estimate the supply of it. The

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[3] High-quality collateral then comprises 'marketable debt instruments issued or guaranteed by sovereigns, other public sector entities or central banks with a credit rating of AAA to AA- and marketable sovereigns with a credit rating of A+ to BBB-(Levels, 2012)

difference between the demand and the supply allows us to infer about systemic liquidity risk. Indeed, collaterals play a huge role in financial transactions. Thus, changes in the amount of collaterals affect the capability of undergoing in completing financial transactions. In particular, during periods of market stress demand for high-quality collateral may increase, while collateral supply may fall (Baranova, 2016). Thus, this collateral scarcity could impact negatively on the amount of financial transactions. Thus, there is a relation between the difference of the collaterals and the liquidity risk. In particular, if the demand of high-quality collateral overwhelms the supply of high-quality collateral, market participants will encounter difficulties in finding collateral for backing up their financial transactions with the other party., especially in the interbank market. Consequently, if the hypothesis of a systemic liquidity risk holds, we expect that higher margin requirements lead to a wider difference between the demand and the supply of high-quality collateral.

Speaking of the demand for high-quality collateral, we need to incorporate the key concept of *Gross Credit exposure*, which can be considered as the sum of positive (or negative) market value after bilateral netting[4].Under these circumstances, we will retrieve the data of the gross credit exposure from the Bank for International Settlements (BIS) Database. Since the gross credit exposure takes into consideration both derivatives payable and receivable, we can assume that the total amount of collateral needed in the OTC derivatives market is the half of the total Gross Credit Exposure. The main theoretical premise behind this lies in the fact that the BIS data represents the complete market. This approach follows the procedure already used in Levels and Capel (2012). This procedure allows us to come up with the collateral needed in the OTC derivatives market, which reflects the demand.

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[4] Based on the definition of BIS: *https://www.bis.org/publ/qtrpdf/r_qt1109b.pdf*

On the other hand, we can predict the supply of collateral similarly. First, we consider the amounts outstanding of AAA/AA-rate government bonds, retrieved from the BIS International database. However, only a small proportion of those is available for supporting market functions. This is because a large proportion of the total supply of high-quality collateral is encumbered-that is in some sense siloed and used for a purpose that prevents being used to support liquidity. According to Baranova (2016) this amount accounts for US32$ trillion out of the total high-quality collateral supply of US42$ trillion. Consequently, regulatory constraints imply that a large amount of securities will not deployed in transactions, since they are used for fulfilling these regulatory requirements. Based on the evidence currently available, it seems fair to suggest that only a percentage of the total high-quality collateral can be made available in financial transactions. Due to the practical constraint of finding a reliable source for the exact amount of encumbered collateral, the research paper entrusts on the calculation of the European Banking Authority regarding 2014 and 2015. Based on the difference between these two years, the dissertation forecasts the same growth rate for the remaining temporal horizon. Speaking of the period before 2014, the analysis assumes that the amount calculated in 2014 holds for the period considered [5]. Under those hypotheses, we will adjust the amount of the supply of collateral, recognizing that only the un-encumbered amount can effectively underpin financial transactions.

At the end, we will run the regression to assess the relation between margin requirements, as previously calculated, and the difference between the demand and the supply of high-liquid collateral, which mimics liquidity risk. As previously assumed for equation 1, the study acknowledges to use the difference in the margin requirements delayed by 1 period and the

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[5] More information at: *https://www.eba.europa.eu/documents/10180/974844/EBA+Report+on+Asset+Encumbrance-+September+2015.pdf*

difference in the demand and supply of high quality collateral at time t. This regression is consistent with the idea that changes in margin requirements does not affect instantly the difference in the imbalance of the demand and supply high-quality collateral which mimics the liquidity risk. This hypothesis is supported theoretically by the fact that market participants have to deal with margin calls in a certain time range allows them to come up with the liquidity required. Thus, the linkage between change in margin requirements and liquidity risk is not immediate.

$$\Delta SC_t = \beta + \alpha \Delta M_{t-1} \text{ (4)}$$

$$\Delta M_{t-1} = M_{t-1} - M_{t-2}$$

ΔM_{t-1}=*Difference in Changes in Margin Requirements delayed by one period*

ΔSC_t= *Difference in the Demand High Liquid Collateral and Supply High Liquid Collateral*

4 Result

4.1 Introduction

This study is intended to investigate the effect of margin requirements on volatility to analyze whether there could be a procyclicality risk. In addition, another relevant aim is to investigate whether the linkage between margin requirements and volatility can lead to a systemic liquidity. The purposes of this study were achieved by examining the explanatory power of the two variables. This chapter presents the result of the data analysis for the two research questions. To investigate the first research question, a time-series regression was used to evaluate the procyclicality risk. However, the data analysis considers the possibility of correlation. Thus, several visual and statistical instruments will be used for tackling the issue, namely, a scatterplot, Durbin Watson, first differences and granger causality. The second research question was studied

using a regression analysis. The level of significance .05 was used for each statistical analysis

used in this study.

4.2 Research Question One

Research Question 1: Can margin requirements increase procyclicality risk? The first research

question examines the effect of margin requirements on procyclicality risk by means of

volatility. First and foremost, it is essential assess whether the dependent and the independent

variables are stationary. As reported below (*Table 1*) both $\Delta\sigma_t$ and ΔM_{t-1} are stationary since

the approximation of the p-value (MacKinnon approximate p-vaue) is 0 in both cases. This

approximation is consistent with the MacKinnon approximation (1991) which compute the

critical values for all sample size with the estimation of response surface regression (Maddala

1998).[6]Consequently, we reject the null hypothesis of unit root. As a result, both dependent and

independent variables are stationary.

```
. dfuller MonthyDifferenceMarginRequire

Dickey-Fuller test for unit root                        Number of obs   =        108

                                      ———————— Interpolated Dickey-Fuller ————————
                   Test         1% Critical       5% Critical        10% Critical
                 Statistic         Value             Value               Value
────────────────────────────────────────────────────────────────────────────────
 Z(t)             -8.000           -3.507            -2.889              -2.579
────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller DifferenceVolatilty

Dickey-Fuller test for unit root                        Number of obs   =        107

                                      ———————— Interpolated Dickey-Fuller ————————
                   Test         1% Critical       5% Critical        10% Critical
                 Statistic         Value             Value               Value
────────────────────────────────────────────────────────────────────────────────
 Z(t)            -15.709           -3.508            -2.890              -2.580
────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000
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[6] More information ca be found in "Unit Roots, Cointegration and Structural Change,G.SMaddala, In-Moo Kim, Cambridge University press,1998, p.199"

Table 1—Outcome of the Dickey Fuller Test. The table can be interpreted in an alternative form. Indeed, it presents the critical value; namely for 1% level, 5% level and 10% level. If the absolute value of the Test Statistics is greater than the 10% critical value, then we could reject the null hypothesis and claim that the variables are stationary at the 10% level and so on for the other critical levels. Critical values serves as cut-off values which defines regions where the test statistic is unlikely to lie.(Rinat 2013). It is important to remind that our null hypothesis tested is that the unit-root (nonstationarity) is presented in the variable.

Secondly, A scatterplot was used to visually identify if there was any correlation problem. According to Figure 1, From the figure above we can see that the highest value for margin requirements is reported above $2000 while volatility seems to cluster around 0 percentage points accounts around 0.02 percentage points as highest value. Regarding the lowest values, margin requirements account below -$4000 and volatility below -0.01 percentage points. From the figure above we can see that there is none presence of positive correlation in contrast with the hypothesis to find a strong correlation as the research expected. Indeed, the study assumed to find a strong negative or positive relationship from the outcome of the scatterplot. Although the variables used in this analysis are correlated, because margins are tailored using volatility as major in put the transformation into $\Delta\sigma_t$ and ΔM_t of the dependent and independent variable overcome the problem of correlation. Indeed, the graph below (*figure 1*) does not indicate any correlation's issue with the variables. To have a statistical proof of none correlation, the paper acknowledges to utilize a Durbin Watson test to have a statistical proof of correlation between the two variables. The Durbin Watson test is one of the most widely used test for detecting autocorrelation (Patrick et al, 2002). The test is based on a series of critical values which were calculated by Savin and White (1977). The result of the Durbin Watson test was reported in *figure 2*. The study relies on the calculation of the upper and lower significance bounds simulated for 107 observations provided by Stanford University.[7] Under this scenario, the test accepts the null hypothesis of no serial correlation since the Durbin Watson score (2.465975) is

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[7] More information can be found here: https://web.stanford.edu/~clint/bench/dw05b.htm
According to this table the lower bound is 1.66600 and the upper bound is 1.70369

greater than the upper bound (1.70369). As a result, the findings support the idea that using the differences of the independent and depend variable in the model lagged in a different period not only have theoretical foundation, but it proves to be an efficient tool to deal with stationarity and correlation.
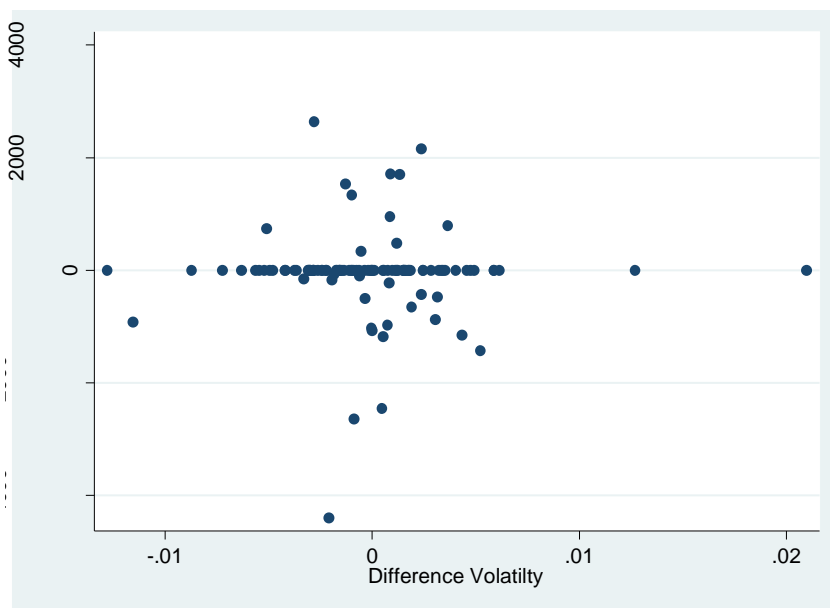

Figure 1- This is a scatterplot of the Monthly Difference in Margin Requirements and Monthly Difference in S&P 500 Volatility

Durbin-Watson d-statistic(2,   107) =   2.465975

Figure 2 Durbin-Watson Test

One straightforward way to solve the issue of correlation is to consider the difference form of both independent and dependent variable. (Micheal et al., 2000). Furthermore, the difference allows for rendering the time-series stationary which maintains a meaningful statistic sample regarding mean, variance and autocorrelation which remain stable over time. This solution is similar to the one already adopted by Hsieh (1990), which relied on the first differences

regression as the best effective way for dealing with correlation and stationarity. For the sake of the discussion, it is important to reminde that the differences regression reduces the number of the observations considered into the model. However, using differences models should have a noticeable impact but not so extreme. (Wooldridge 2013). Although the differences regression diminishes the number of observations, it allows the analysis to cope with both stationary and correlation issues.   Advantages are found in the first difference approach with unchanging predictor variables in the models. (Liker 1985). Consequently, in our model the dynamic differences regression will be effective since the margin requirements are subjected to slow changes overtime.

	(1) ΔM_{t-1}
$\Delta \sigma_t$	-107.6
	(-0.02)
_cons	-1755114.4
	(-0.43)
N	107

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 2- Results of the Regression with First Differences model

Table 2 shows the results of the regression analysis using the difference in changes in volatility and the difference in margin requirements delayed by one period as a modification in the margin requirements does not affect immediately the volatility of the asset. Surprisingly, higher margin requirements do not lead to higher volatility and to increase procyclicality risk as expected. Indeed, the coefficient does not show a significant result at 5% level neither at 10% level. The

negative sign of the ΔM_{t-1} indicates the increment in margin requirements in the previous period lead the way for reducing volatility in the following period. Consequently, higher margin requirements diminish the procyclicality risk though this finding is not significant. These results are partially consistent with the finding of another study (Brumm 2013). The outcome of Table 2 suggests that market participants do not have to fire sale their asset available to meet the requirements of a margin call. Following this line of reasoning, market participants should have access to another form of liquidity, such as borrowing against margin calls. (Brumm 2013).

In many statistical test, when correlation arises it is tempted to say that one variable could cause the other variable. (Hughes, 2004). However, correlation does not mean causation. (Shipley, 2002). "Two variables may be both correlated and related as cause and effect or they may be correlated without being a direct causal relationship. With causation, one event (the cause) is responsible for, or brings about, another event (the effect)." (Hughes, 2004, p.220). Speaking about cause-effect relationship, the issue under scrutiny is now whether one variables affect the other. The hypothetical cause-effect scenarios comprise: volatility affect margins, margins affect volatility, both affect each other, no variables affect the other

As a last remark, the reader must bear in mind that the Granger causality test does not consider any exogenous shock which could explain the cause-effect relationship neither is able to explain how the cause produce the effect. (Lee 2002). However, the concept of Granger causality is one of the most influential, pervasive and important papers in econometrics. (Engle, 1999).

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Granger causality Wald tests
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Equation	Excluded	chi2	df	Prob > chi2
$\Delta\sigma$_t	ΔM_(t-1)	.55655	2	0.757
$\Delta\sigma$_t	ALL	.55655	2	0.757
ΔM_(t-1)	$\Delta\sigma$_t	1.5967	2	0.450
ΔM_(t-1)	ALL	1.5967	2	0.450

Table 3-Granger Causality Test

The Null hypothesis is represented by H_0: The endogenous variable does not granger cause the dependent variable. The table can be read as the excluded variable (right side) does not granger causes the dependent variable (left side). On the last column on the right is presented the p-value which allows to reject or accept the null hypothesis while in the central and left column is presented the degree of freedom and the chi-squared.

The outcome of the Granger Causality test (see table 3) is partially in line with the previous studies. In fact, margins do not lead to volatility (Hsieh 1990, Schwert 1988) but surprisingly volatility does not induce higher margins either at 5% or 10% significance level. Considering the both significance levels, a possible explanation for this result may be the omission of a variable that is Granger causal variable and affects all the variables in the system (Brandt, 2007). This finding has an important implication for developing effective policies which aim to reduce credit risk by means of margin without rise volatility and procyclicality risk. The outcome of the Granger-Causality test seems to suggest that there could be an exogenous variable which affect both margin requirements and volatility. Indeed, the impact of modification in margin requirements plays an insignificant role in changes in volatility, as reported in Table 2. Under this circumstance, policymakers and regulators should be aware of the minimal impact of volatility when they acknowledge any change in the regulation of margin requirements. If market participants have access to other form of liquidity (regulated and non-regulated) to cope with margin calls the default risk can be simply translated from CCP towards other entities, weakening the benefits of the CCP in the financial system.

4.3 Research Question Two

Question 2: Are margin requirements leading the way for a systemic liquidity risk? To answer research question two, the study needs to predict the demand and the supply for high-quality collateral during the time horizon considered. [8]
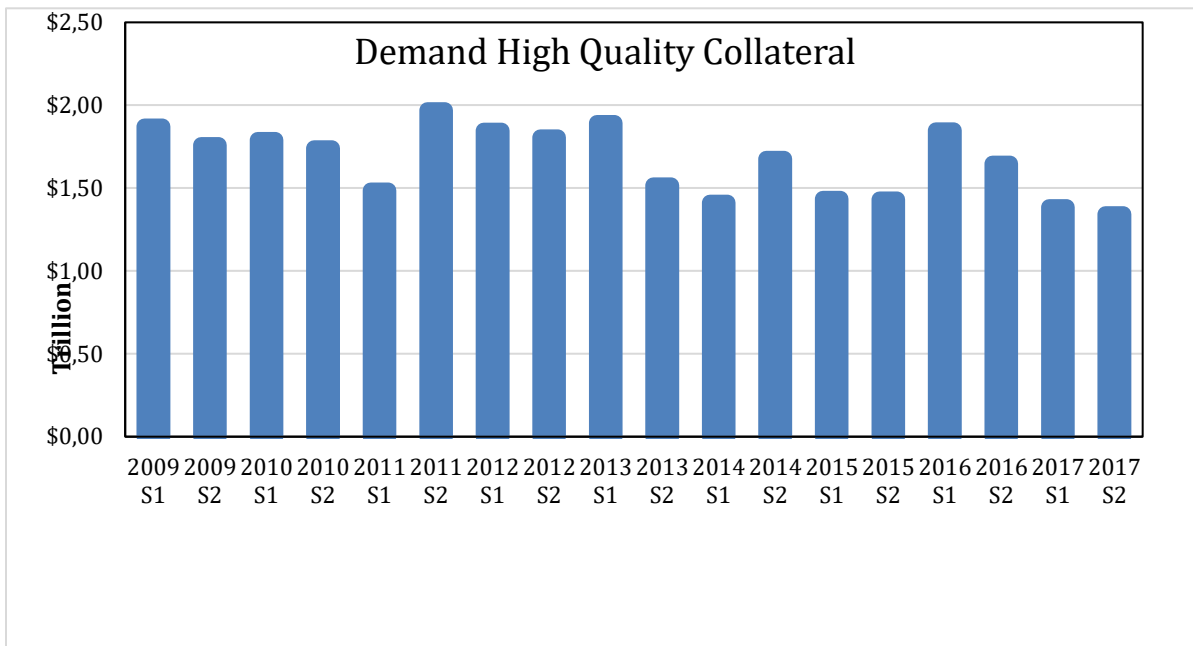

Figure 3- Demand High Quality Collateral

As reported in Figure 4, it is quite challenging try to recognize a trend in the high-quality collateral demanded during the whole period. Indeed, the demand of collateral seems to fluctuate without a clear pattern. A peak is reached at 2 Trillion of US dollars on the second semester of the 2011. A closer look at the bar chart shows that there is a gradual diminishing trend in the demand for collateral from the first semester of 2016 to the second semester of 2017. Surprisingly, after introducing the new regulation (Dodd-Frank Act, 2009) in the U.S. no any

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[8] In the Figure 4 the letter S stands for semester. Unfortunately, the data regarding 2018 are not available yet on Bank for International Settlement Database. Further Information on the dataset here: https://stats.bis.org/#df=BIS:WEBSTATS_OTC_DATAFLOW(1.0);dq=.H............%3FstartPeriod=1998-12-01;pv=2,3,5~14~0,0,0~both

spikes are experienced, as it seemed fair to expect. Along similar lines, introducing the RTS and EMIR[9], namely in 2013 and 2012, did not affect the demand of high-quality collateral.

For estimating the supply of high-quality collateral, the research applied this following strategy: retrieving the data of debt securities statistics[10] from the BIS database[11], filtering the countries government bonds rated AAA and AA according to S&P[12] and adjusted the final quantity considering encumbered collaterals. Due to the lack of data regarding encumbered collaterals, the study assumed that from 2014 until 2017 the amount of encumbered collaterals rose by a steady rate of 1.6%.[13]While for the years previous to 2014, it has considered the amount of encumbered collateral registered in 2014.
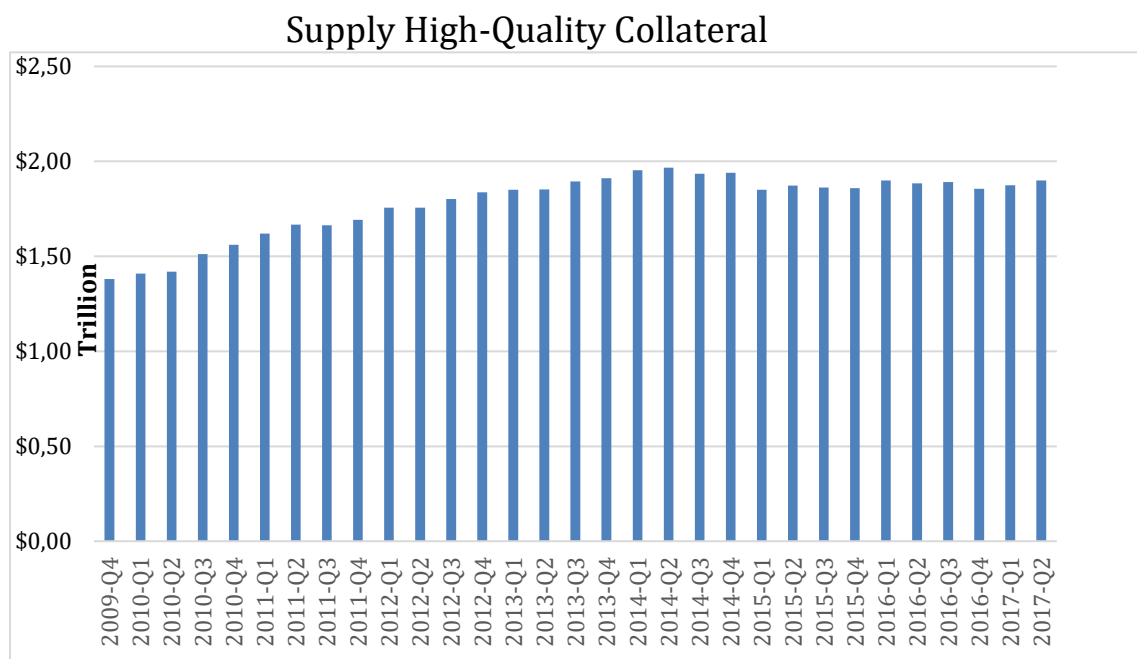

Figure 4- Supply of High-Quality Collateral

[9] For more information about these regulations, the reader should refer to pages 12 and 13 of this dissertation

[10] According to the definition of debt securities statistics referred to foreign bonds and Eurobonds (Bis Statistical Bulletin, 2018, p.194) https://www.bis.org/statistics/bulletin1803.pdf#page=194

[11] The BIS database does not contain any data of Switzerland, Abu Dhabi, South Korea, Kuwait and new Zealand

[12] For more information about the list of countries:
https://www.globalcreditportal.com/ratingsdirect/renderArticle.do?articleId=1780962&SctArtId=412668&from=CM&nsl_code=LIME&sourceObjectId=9636657&sourceRevId=13&fee_ind=N&exp_date=20270106-21:38:13

[13] This rate is the difference between the amount of encumbered collateral in 2015 (27.1% of total collateral) and 2014 (25.1% of total collateral). For more information:
https://www.eba.europa.eu/documents/10180/974844/EBA+Report+on+Asset+Encumbrance-+September+2015.pdf

The Supply of High-Quality Collateral shows a clear trend. In fact, the supplied amount of collaterals rose gradually from 2009 until 2014, reaching a peak around 2 Trillion of US Dollars in the second quarter of 2014 accounting around 2 Trillion of US Dollars. After this increment, the amount started to fluctuate steadily without relevant changes and always account over 1,50 Trillion of US Dollars.

For the sake of the comparison, it is important converting the quarterly data into biannual. Indeed, only having the same unit the study can evaluate whether the difference between the demand and the supply of high quality collateral is symptomatic of a liquidity risk. It has applied the following transformations to the supply quarterly data:

$$\bar{S}_1 = \frac{Q_1 + Q_2}{2}$$

$$\bar{S}_2 = \frac{Q_3 + Q_4}{2}$$

Where:

$\bar{S}_t = the\ period\ expressed\ in\ semester$

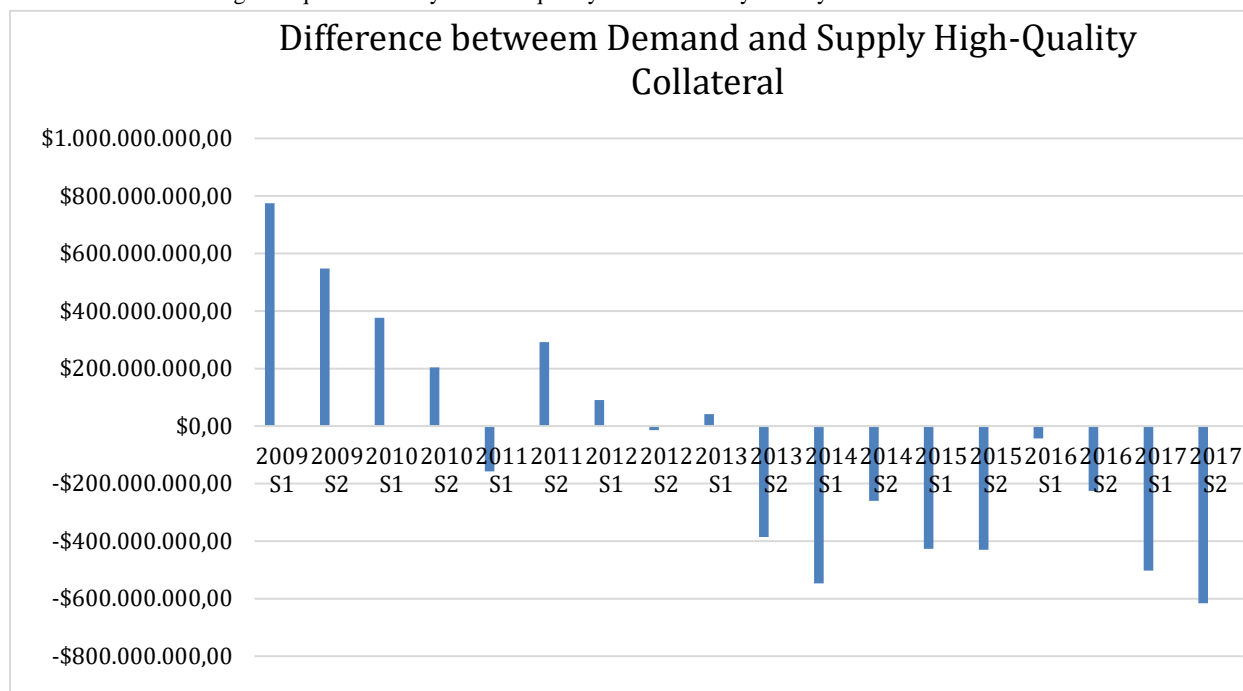$Q_t = the\ period\ expressed\ in\ quarter$

Figure 5-Difference Demand and Supply High-Quality Collateral

The systemic liquidity risk grounded on the logical assumption that if the difference between the demand and the supply of high-quality collateral is positive, then there is a lack of collateral available for satisfy the demand. This means that there is a systemic liquidity risk in the sense of that the market participants will struggle to provide the proper collateral to the counterpart affecting financial transactions. Figure 5 shows that there has been a marked decrease in the difference between the demand and supply of collateral from 2009 to 2011. This can be translated as a noticeable decrease in liquidity risk. Indeed, the imbalance between the demand and supply of high-quality collateral gradually reduce over time. This trend can be partially explained by the fact that after the new regulation took place (Dodd-Frank Act) the financial system was not able to respond properly to satisfy the unusual demand and adapted over time. Although the impact of the refreshed regulation affected the amount of collateral in the financial system, the imbalance between the demand and the supply aligned and the supply becomes greater than the demand around the first semester of 2011. Despite some fluctuation in the

disparity of the demand and supply between the first semester of 2011 and the second semester of 2013, the supply overcome the amount of demanded collateral. As a result, no concrete systemic liquidity risk appeared from the second semester of 2013 until the second semester of 2017. It is noteworthy to mention that the disproportion between the demand and the supply is irrelevant in the second semester of 2012, first semester of 2013 and first semester of 2016.

The issue of having the same data frequency for both variables is particularly relevant into this analysis. The data regarding the difference in the demand and supply of high-quality collateral are expressed semiannually while the raw data regarding changes in margin requirements are expressed on a daily basis thought for the first research question the dataset has been converted into a monthly frequency. Although also for the second research question a time frequency expressed on a monthly basis would be preferred, the conversion of the difference of the demand and supply of high-quality collateral from semiannual to monthly frequency is difficult and involves complicated techniques such as the Cubic Spine Interpolation.[14] Along similar lines, converting the semiannual demand and supply data to a monthly frequency dividing by 6 the amount will result in unreal assumption. For instance, dividing by 6 the semiannual observation implies that the observation for each month is the same. Under those circumstances, the study relies on both variables expressed using semiannual frequency.

Since the data regarding the difference in the demand and supply of high quality collateral are already expressed with semiannual frequency, the study acknowledges to convert the margin requirements data into semiannual data using the following formula.

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[14]   More   information   about   Cubi   Spine   Interpolation   can   be   found   here: http://www.math.ucla.edu/~baker/149.1.02w/handouts/dd_splines.pdf

$$M_s = \frac{\sum_{i=0}^{131} M_i}{132} \qquad 15$$

$$\Delta M_{s_{t-1}} = M_{s_{t-1}} - M_{s_{t-2}}$$

Where:

M_s= The value of Margin Requirements for the semester
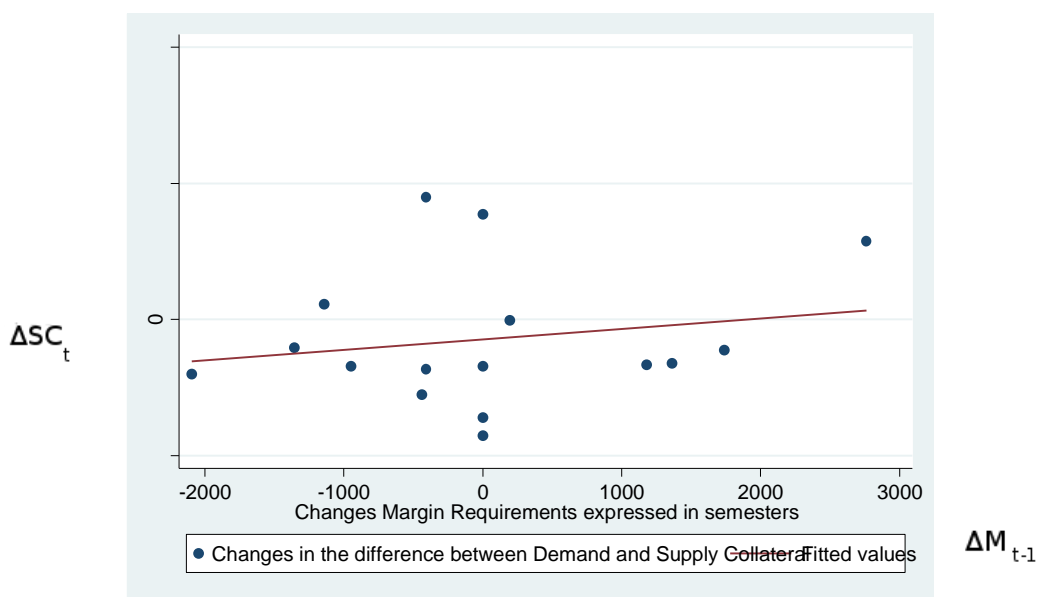M_i = The value of Margin Requirements daily

Figure 6-Plot of the regression between changes in the Difference of demand and supply collateral and difference in the changes of margin requirements

	(1) ΔM_{t-1}
ΔSC_t	38741.5 (0.72)
_cons	-73797358.1 (-1.15)
N	16

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 4-Result of the Regression between changes in the Difference Demand and Supply Collateral and changes in Margin Requirements delayed by one period

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[15] In the denominator is reported 132 because the database does not contain information about margin requirements for Saturday and Sunday of each week.

Figure 6 reveals a weak positive relationship between the dependent and independent variable. This indicates that an increase in the ci margin requirements leads to an increase in the difference between the demand and the supply of collateral. This finding is consistent with the one of previous studies (Baranova 2016; Cumming 2001). This trend can be partially explained with the fact that the during period of financial distress with high volatility market participants can incurred losses downsizing their operations and trimming their risk exposure to preserve capital in an insecure environment and reduce tolerance for bearing the risk. As a result, the demand of high-quality collateral increases due to the rising concerns about the counterparty credit risk. (Cumming 2001). Another theoretical support for this hypothesis can be underlying with the linkage with margin calls. If higher margin requirements lead to higher volatility, market participants must deal with margin calls which require to add an extra amount of collateral with respect to the CCP. On these grounds, the study can argue that an increment in the demand of high-quality collateral is a resulting consequence of stressed market conditions. Despite those considerations, this positive relationship is not marked as it can be seen from the graph. Furthermore, the positive coefficient of the changes in margin requirements (38741.5) is not statistically significant. The evidence presented in this section can be partially explained with the fact that thought the demand of high-quality collateral experiences an upsurge when margin requirements rise; the impact is minimal, and the supply seems to adapt rapidly evidencing a low liquidity risk. This view is supported by Ferrari (2017) and Capel (2014) where the re-use of collateral allows for a noticeable increasing in the supply of collateral and enables market participants to operate in a scenario where the availability of collateral is greater than the demand. The term "re-use" of a collateral or also known as "rehypothecation" means that the parties receiving collateral (collateral taker) may redeploy the collateral for their own purpose.

For instance, trading the collateral for gaining profit or using them as collateral in their transaction. Consequently, the same collateral can underpin several financial transactions at the same time. (Capel 2014). Nevertheless, this form of re-utilization of collateral helps the boost of the supply of high-quality collateral diminishing the systemic liquidity risk, some studies (Financial Stability Board 2017; Capel 2014) argue that this technique poses the basis for financial stability issues. The "re-use" of collateral increases interdependence among financial institutions since the collateral can be traded among several counterparties creating a dependence tie among them. If one of the entities involved in the collateral trade runs into solvency's problem, the risk can be easily spread among the others since it can be problematic for the original owner of the collateral retrieving back its collateral causing a "collateral interruption" which can affect the availability of supporting financial transactions. (Financial Stability Board 2017). Further data collection is required to determine exactly how margin requirements affect the imbalance between the demand and the supply of high-quality collateral since the "re-use" of collateral plays a huge role.

5 Summary and Conclusion

This thesis examines the effect of the introduction of the centralized CCP mechanism for OTC derivatives and the resulting impact of the margin requirements on procyclicality risk and systemic liquidity risk. Although the solution to force OTC derivatives to be centrally traded through CCP serves to minimize the counterparty credit risk by means of margins and collateral and avoiding further consequences for the financial system, some argue that there is a huge risk of amplification of the procyclicality risk (Heckinger 2006, Glasserman 2017) and systemic

liquidity risk (Glasserman 2017, Bakoush 2018, Lewis 2016). Procyclicality risk is defined as "Those fluctuations that cause some of unnecessary amplification of the real economy and damage the soundness of financial system". (Gerlach, 2006). This notion finds concrete example as when under some adverse circumstances of stress, the volatility in the financial system increases which leads to margin calls which intensify stress (Murphy 2014). Margin calls are meant to demand participants to add extra liquidity or securities in their account to maintain a certain margin requirement. The purpose of the margin call is to protect CCP from a failure of clearing members. (Fortune, 2003). In reality, under adverse conditions and high volatility clearing members struggle to meet big margin calls in a stressed market which cause asset sales in a "thin market"(Murphy 2014). On logical grounds, due to the fact that in a "thin market" the number of sellers oversize the number of buyers, it is fair to expect that sellers will engage a downward sale, which cause further price declines. "Volatility rise when the asset price falls" (Harvey, 2015, p.8). Thus, increments in volatility leads the way again for margin calls, causing an endless escalation.

Although these studies do not provide confirmatory evidences that margin requirements lead to higher volatility and widen procyclicality risk, prior studies have found different results (Hsu 1996, Ferris 1988). Thus, the main aim of the thesis is to assess the magnitude of the impact of CCP in OTC derivatives through margin requirements to investigate whether they can amplify a procyclicality risk.

The findings of this thesis expanded the work of previous researchers in the area of margin requirements and the linkage between procyclicality and systemic liquidity risk. This study contradicts the hypothesis that margin requirements leads to higher volatility and higher procyclicality risk. This finding also holds when it comes to causation. According to the Granger

Causality test margins does not cause higher volatility which is line with previous findings (Hsieh 1990, Schwert 1988) and volatility does not seem to induce a change in margins as reported previously. This holds for a 5% significance level and 10% significance level. All thing considered, lead the researcher to suggest that tighter margin requirements does not induce higher volatility but diminish it, though the effect is not statistically significant. This result can be explained with the fact that the regulation on how to calculate margin requirements to avoid procyclicality risk effectively works (Art 28 RTS 123/2013) and stabilize OTC derivatives through CCP at least regarding volatility. However, there could be an omission of a relevant exogenous variable which affects both margin requirements and volatility. In fact, a crucial explanation could be that clearing participants can access to other form of liquidity. This idea found confirmatory evidence in previous studies (Brumm 2013; Fortune 2001). Fortune (2001) pointed out that margin requirements induce leverage strategy increasing the default risk for these clearing members. This result is consisted with the idea that margin calls force members to come up with liquidity by borrowing in regulated or unregulated market. The effect of margin regulation on volatility is ambiguous because there are other relevant factors which play a huge role for which margin requirements in not tailored. (Brumm 2013). On these grounds, the study argues that forcing OTC derivatives to be traded through CCP translate credit risk from the CCP towards other external financial entities, since market participants during margin calls tend to adopt risky-leverage strategies borrowing for meeting the requirements of the margin calls. Thus, limiting the advantages of having a CCP for managing counterparty credit risk and outsourcing this risk. Based on the inadequacies to find reliable database for the data and the lack of relevant confirmatory results, suggestions are made for further research. Further research into this subject should include more detailed information about asset sales in case of margin calls and how

investors find the liquidity for meeting margin calls. Indeed, the datasets which contains this information are private and cannot be accessed for scientific purposes. Consequently, the thesis neglected this relevant variable relying only on the volatility of the underlying asset.

Another crucial point of this thesis was to address whether margin requirements could induce a systemic liquidity risk. Recent studies forecast a mismatch between the demand and the supply of high-quality collateral (Baranova 2016, Levels 2012). The main arguments in favor of this hypothesis are: "the liquidity coverage ratio (requiring bank to hold strictly defined buffer of high liquid assets) and the obligation to clear via central counterparties (CCPs) for standard OTC derivatives contracts (implying that financial institutions need more cash and highly liquid assets to fulfil margin requirements imposed by the CCP). (Jeanette 2015, p.66)". This thesis is an attempt to quantify the effect of CCP and margin requirements on the demand and supply of collateral. Indeed, the availability of high-quality collateral is easy to access in normal conditions, but hypothetically difficult and impossible during adverse times. (Jeanette 2015). This idea is consistent with the fact that during stress periods the volatility tend to be high. Consequently, CCPs are more likely to ask participants to meet margin requirements. Following this line of reasoning, the demand for high-quality collateral will rocket while the supply will struggle to adapt because margin calls should be met in a narrow time-range and regard a noticeable amount of clearing members. Since financial institutions use collateral for their own transactions (Jeanette 2015) a shortage in high-quality collateral could have severe consequences affecting the normal transactions among banks. Given the centrality of this issue, it is pivotal to investigate about the disruptive consequences in the interbank market. The interbank market serves for covering short-fall in liquidity through re-allocation of resources from banks that have a surplus in liquid reserves and those who needs that capital. As a result, the interbank market

plays a pivotal role for the vital functions of banks. (Lee 2012). Since a shortage in the supply of collateral affects the interbank market, banks are not able to reallocate their resources and cover their illiquidity making difficult for them to meet capital requirements imposed by regulation and causing solvency problems. "Liquidity and solvency problems interact and can cause each other through the banking system" (Lee ,2012, p.1) causing a spillover in the interbank market lending which lead to a systemic liquidity risk (Bakoush 2018).

The finding of this study shows that a moderate liquidity risk can be evidenced considering the raw data from 2009 until 2010, as *figure 6* suggests from the imbalance between the demand and the supply of high-quality collateral. However, this liquidity risk tends to diminish steadily as the discrepancy between the demand and the supply of collateral tend to be less relevant and the trend is reverted in the first semester of 2011, where the amount of supplied collateral is greater than the demand. With regard to the period from the second semester of 2013 until 2017, the amount of supply of high-quality collateral overwhelm the demand. This result is in contrast with earlier findings (Levels 2012, Baranova 2016) which founds evidences for a collateral scarcity. Although, the result of this thesis differs from these previous studies the finding is consistent with those of Anderson and Joeveer (2014) in which it is unlikely that there is an overall shortage of collateral. In addition, margin requirements seem to have a minimal impact in influencing the demand and the supply of high-quality collateral. It appears that there is a marginal positive relationship, as reported in *figure 6*, between changes in margin requirements and changes in the difference between the demand and the supply of collateral. This result means that margin requirements tend to increase the demand of high-quality collateral increasing liquidity risk. Although this may be true, the study did not reveal any statistical significance of margin requirements on interfering in the discrepancy between the demand and the supply of

high quality collateral. Overall, there seems to be some clues to indicate that there are other relevant factors which influence the demand and the supply of high-quality collateral more than changes in margin requirements. One possible explanation for this modest impact of margin requirements on the disproportion between the demand and supply of high-quality can reside in the" re-use" of collateral which exponentially increase the availability of collateral when market participants need it.(Ferrari 2017; Capel 2014).

One relevant finding of this thesis is the clear evidence of an overwhelming availability of high-quality collateral. Thus, it is noteworthy investigate about the consequences of this massive supply of high-quality collateral which inundates the financial system. On logical grounds, a huge availability of high-quality collateral makes relatively easy for market participants to get collateral for underpinning their transactions. This means that also potentially dangerous financial transaction can be completed without relevant problems. Consequently, it is worth to analyze whether this oversupplied amount of collateral could lead to more disruptive effects rather than a shortage of collateral.

5.1   Scientific Relevance

This study provided an important opportunity to advance the understanding of hypothetical neglected consequences of new margin requirements regulation, contributing to a successful implementation of the policy-decision tool chosen by the authorities. Indeed, an appropriate change in the current margin regulations could allow: "derivative users to anticipate potential margin call and ensure they have adequate holdings to access to liquid assets" (Murphy ,2014, p.3). The result of this study may be utilized to develop effective margin requirements regulation to cope with counterparty credit risk, diminishing the possibility of increasing catastrophic

aftereffects. The results of this study underlines that there is none risk that the introduction of CCP regarding OTC derivatives will increase procyclicality risk through margin requirements. However, regulators and policy makers must bear in mind that there could be some exogenous variables which affect both margin requirements and volatility and which the study was not able to identify due to the lack of data. Indeed, clearing members seem to have access to an extra form of liquidity to meet the obligation of margin requirements, adopting high-leverage strategy and borrowing against margin calls. (Brumm 2013). Under those circumstances, the counterparty credit risk is translated towards other financial entities which does not belong to the CCP setting. With regard to the second research question, the finding of this thesis points out that margin requirements do not seem to remarkably affect the imbalance between the demand and the supply of collateral. However, this study found out that the issue of a collateral scarcity and a systemic liquidity risk does not hold due to the massive amount of high-quality collateral. This idea is also theoretically supported by the "re-use" of collateral which allows for using the same collateral in different financial transactions. However, this creates a problem of financial stability since an interruption of collateral can be experienced if one of the entities which bought the collateral encounter solvency problems making it difficult for the original owner retrieving the collateral. (Financial Stability Board 2017). Further research should address the issue of having such an overwhelming amount of high-quality collateral in the supply side and the role of "re-use" of collateral.

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