Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER THESIS

Counterparty Risk under Basel III

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Academic Year: **2012/2013**

Declaration of Authorship

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

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Prague, May 13, 2013

Signature

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Abstract

The aim of this thesis is to address the implications of Basel III regulation on counterparty credit risk. We analysed the development of OTC market, we addressed systemic risk and the way how central counterparties could mitigate or spread the contagion among banks. We used simulated data to develop a stress test model to find out the impact of counterparty credit risk on banks' capital requirements, in case the interest rate increased extensively. Six possible scenarios of interest rate levels were developed with ascending order of the IR level. From these scenarios we computed the exposure levels and credit valuation adjustment (CVA) as the market value of counterparty credit risk. We came to the following conclusions: (1) Czech banks have enough capital to withstand any interest rate increase in any scenario. (2) Banks with high exposure to derivatives like Bank of America, Citibank and JP Morgan would face severe problems if the interest rate increased. (3) There is no direct correlation between credit valuation adjustment and interest rate, the CVA increases faster with the increase of the interest rate.

JEL Classification	G21, G28, G32, G33
Keywords	Basel III, counterparty credit risk, central counterparty, exposure, banking capital

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Abstrakt

Cílem této práce je prozkoumat důsledky regulace Basel III na kreditní riziko protistrany. Analyzovali jsme vývoj OTC trhu, rozebrali systémové riziko a způsob, jak centrální protistrany mohou zmírnit nebo rozšířit nákazu mezi bankami. Použili jsme nasimulovaná data, abychom vytvořili stress test model ke zjištění dopadů kreditního rizika protistrany na kapitálové požadavky bank, když výrazně vzroste úroková míra. Bylo vytvořeno šest možných scénářů vývoje úrokové míry se vzrůstající hodnotou. Z těchto scénářů jsme spočítali úroveň expozice a credit valuation adjustment (CVA) jako tržní hodnotu kreditního rizika protistrany. Došli jsme k následujícím závěrům: (1) České banky mají dostatečný kapitál k tomu, aby odolaly jakémukoli vzrůstu úrokové míry v kterémkoli scénáři. (2) Banky s vysokou derivátovou expozicí jako Bank of Amerika, Citibank a JP Morgan by čelily výrazným problémům, pokud by se úroková míra zvýšila. (3) Mezi CVA a úrokovou mírou není přímá úměra, CVA roste rychleji s růstem úrokové míry.

Klasifikace JEL	G21, G28, G32, G33
Klíčová slova	Basel III, kreditní riziko protistrany, centrální protistrana, expozice, bankovní kapitál

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Acronyms

BCBS Basel Committee on Banking Supervision

CCP Central Counterparty

CCR Counterparty Credit Risk

CDS Credit Default Swap

CEM Current Exposure Method

CGFS Committee on the Global Financial System

CPSS Committee on Payment and Settlement Systems

CVA Credit Valuation Adjustment

CS Česká spořitelna

CSOB Československá obchodní banka

D-SIB Domestic Systemically Important Bank

DTD Distance to Default

EAD Exposure at Default

EE Expected Exposure

EMIR European Market Infrastructure Regulation

EPE Expected Positive Exposure

ESMA European Securities and Markets Authority

G-SIB Global Systemically Important Bank

ICMA International Capital Market Association

IOSCO International Organization of Securities Commissions

IM Initial Margin

IMM Internal Model Method

JPM J P Morgan Chase

KB Komerční banka

LGD Loss Given Default

OTC Over the Counter

PD Probability of Default

PFE Potential Future Exposure

RWAs Risk Weighted Assets

SEC Securities and Exchange Commission

SIFI Systemically Important Financial Institutions

SM Standardised Method

T1 Tier 1

T2 Tier 2

VM Variation Margin

Master Thesis Proposal

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Proposed Topic:

Counterparty Risk under Basel III

Topic Characteristics:

The counterparty credit risk proved to be one of the leading sources of losses during the recent financial crisis and thus it is of great importance to deal with it successfully. The shortcoming of Basel I and II was the estimation of counterparty risk, which was based on a computation technique called Value at Risk. The estimation allowed banks to use lower capital charge and also it assessed various assets to be more liquid, hence less risky. This assessment was wrong and so we witnessed for instance the fall of Lehman Brothers. In my thesis I will try to address this challenging problem and investigate the implications that the new regulation rules of Basel III will have on counterparty risk.
The original contribution of this thesis will be the up-to-date revaluation of Basel III with its approach to mitigation and hedging counterparty credit risk and the role of central counterparties as helpful institutions in this matter.

Hypotheses:

1. Counterparty risk is correctly estimated under Basel III
2. There is a negative relationship between risk exposure and counterparty credit quality
3. Central counterparty (CCP) mitigates counterparty risk
4. Hedging the counterparty risk with credit derivatives becomes more difficult for corporations under Basel III

Methodology:

For valuation of counterparty credit risk I shall first use modelling credit exposure utilizing scenario generation and instrument valuation. For the modelling part I will use Monte Carlo simlulation in Stata or EViews. Then I will use credit value adjustment (CVA) formula for calculating market value of counterparty credit risk.
Since my research will mostly incorporate the issues of banking sector, the most challenging part of my work will be the acquisition of data. I will try to utilize data from BIS statistics website and perhaps the database of CSOB, which am currently working for.

Outline:

1. **Theoretical part**
   a) Counterparty risk definition, general terminology
   b) OTC Market
   c) Systemic Risk
   d) Risk Management
   e) Central Counterparty
   f) Counterparty Risk – Pricing
   g) Statistics of Basel
   h) Regulation of Basel II, III

2. **Empirical part (The Model)**
   a) Literature Review
   b) Pricing counterparty credit risk
   c) Scenario Analysis
   d) Credit Value Adjustment

Core Bibliography:

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Author

Supervisor

Chapter 1

Introduction

The regulation of the banking sector is changing once more. Since the beginning of the recent crisis the regulators were focussing on finding the cause of this financial distress. It became obvious that one of the leading causes of the crisis was a weak base of bank capital. That is why stricter rules of Basel III were introduced to ensure that in the future the banks will have a strong capital base to build on. Beside increasing the quality and quantity of regulatory capital, it addresses systemic risk within the global financial system and introduces tools and standards at macroprudential level. But a question rises: Will these measures not just hopefully stop a next crisis to happen but in the same time significantly slow the recovery from the current one?

The OTC market was in the past decade growing rapidly and thus it is important to analyse how Basel III handles counterparty credit risk (CCR). This is a risk of a counterparty going bankrupt, where the exposure of the contract is not known in the future. This happens particularly within the OTC transactions. CCR is supposed to be reduced or eliminated by institutions called central counterparties. These institutions serve as intermediaries in the trade and take on the entire risk for a price. The question is: Does these central counterparties reduce also systemic risk? What would be the consequences if some of these institutions went bankrupt? They are so called SIFIs, systemically important financial institutions and they are too big and too interconnected to fail. Hence the moral hazard of the management should be anticipated and reduced by careful regulations.

The objective of this thesis is to find answers on the questions above with a strong focus on counterparty credit risk, its origin, consequences, management and impact on banks. Three main hypotheses are tested in the thesis. First, Czech banks have enough capital to satisfy capital requirements for CCR in case of the increase of interest rate. Second, there are banks in the USA with high exposure to derivatives that would face severe problems in case of interest rate increase. Third, there is a direct correlation between credit valuation adjustment and interest rate.

The thesis is structured as follows: Chapter 2 describes the theoretical background that is divided into several sections devoted to the following topics: First we talk about OTC market, its development, where is it heading and how is it going to be influenced by regulations Emir and Dodd-Frank Act. Second section analyses the systemic risk and central counterparties are discussed in the third section. In section four we talk about Basel III and its predecessors, how the rules have changed and the particular measures that are taken to fight the crisis. In the last section of the theoretical background there is a theoretical analysis of stress tests. Chapter three contains the actual model. We specify the parameters, set the ground for the computation, compute the exposure of a swap and get to the credit valuation adjustments. We summarize the findings of our computations in Chapter 4.

Chapter 2

Theoretical Background

2.1 OTC Market

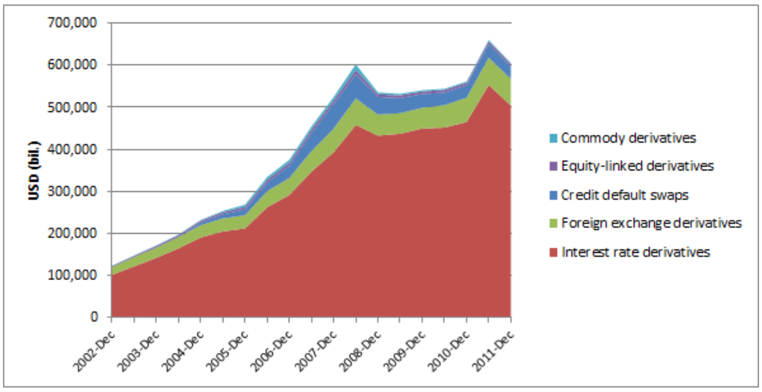
In this section we will discuss the OTC derivatives market. We shall start with the distinction of this particular market based on Kalinowski (2011) and Valiante (2010) then we will devote to its development with respect to existing semiannual data from BIS Statistics (2012). After that we will focus on the regulation of the OTC derivatives market according to Kalinowski (2011) and Mello & Parsons (2012). After that we summarize the EMIR and Dodd-Frank Act as the most important OTC regulations and finally provide possible scenarios of its future evolvement based on Valiante (2010) and Dudley (2012).

2.1.1 Development of OTC Market

The OTC derivatives market is the largest market for derivatives. According to Kalinowski (2011), one of the biggest distinction between OTC market and trading on an exchange is the amount of regulation. OTC market is from a large part unregulated with respect to disclosure of information between the trading parties. Less strict criteria for trading impose higher risk on the investors and particularly on speculators that do not use derivatives to protect their core business but rather use them for high-risk speculative investments.

Valiante (2010) adds two more reasons for trading derivatives apart from hedging and speculation. They are funding and arbitrage. Derivatives can be a tool to redistribute funds between financial or non-financial institutions to provide best way to satisfy financial needs and to redistribute risks in a certain way. The last but not least usage of derivatives as a tool for arbitrage facilitates the mechanism of price formation, for instance CDS spreads are widely used as a tool for risk management that can price credit risk of a specific counterparty.

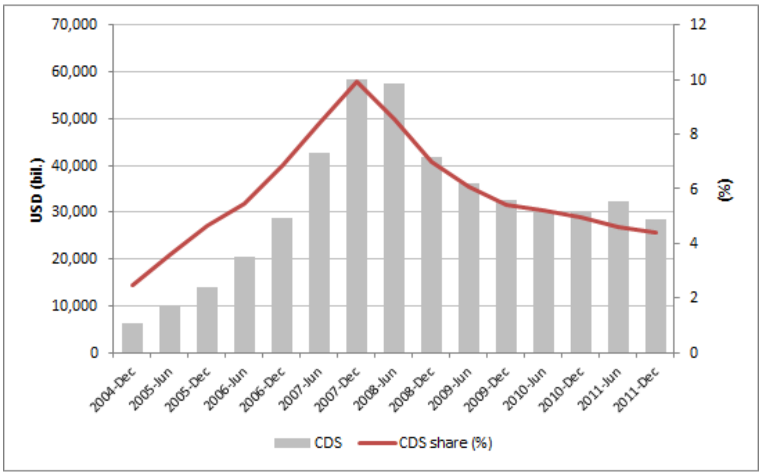
Figure 2.1: OTC derivatives market trends



Source: Author based on BIS Statistics (2012)

Analysing the volume of OTC market using data from BIS Statistics (2012) we found that global OTC derivatives market rose steadily from 127.5 trillion dollars in 2002 to 672 trillion dollars in 2008. The trend can be seen in Figure 2.1. We can see two peaks. The crisis caused the volumes to drop by 13% (2007 to 2009). After the mild growth till 2010 the derivatives market soared again by 15% in June 2011 only to drop by 9% at the end of 2011.

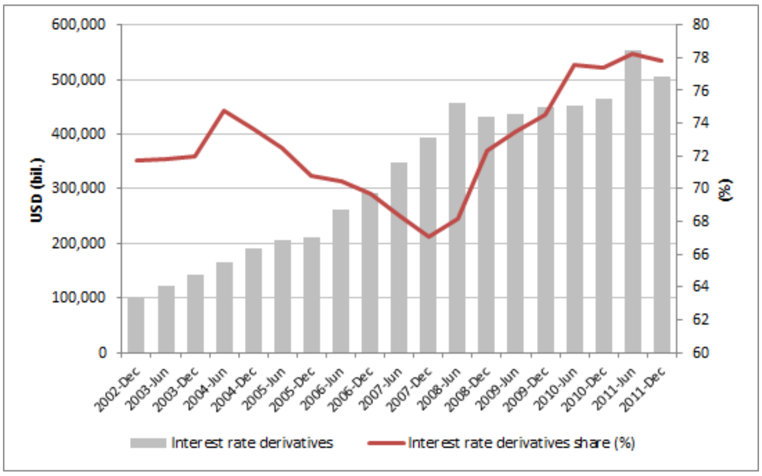
Figure 2.2: CDS - Gross notional amounts outstanding, in billions of USD



Source: Author based on BIS Statistics (2012)

The composition of OTC market changed during the examined period. Two most distinct examples are credit default swaps (CDS) and interest rate derivatives. The former can be seen in Figure 2.2, the latter in Figure 2.3. The CDS rose from 2% in 2004 to 10% in 2008. During and after the crisis the percentage steadily decreased again to 4.4%.

Figure 2.3: Interest rate derivatives - Gross notional amounts outstanding, in billions of USD



Source: Author based on BIS Statistics (2012)

The interest rate derivatives comprise by far the major part of OTC market volume. However it became less popular in pre-crisis period and dropped from 74.8% in 2004 to 67.1% in 2007. During the crisis the rise was substantional and ended up at 77.8% in the end of 2011.

2.1.2 OTC Market Regulation

The financial crisis showed weak points in derivatives markets such as the occurrence of systemic risk. Hence Kalinowski (2011) suggests that a new regulation is needed to manage these weaknesses. After the wave of the crisis there were indeed attempts to introduce surveillance of the OTC market to prevent the situation that came in 2007-2009. Clearing houses were established in the U.S. and in Europe regulations came to force which referred to accountability and reporting of derivative transactions between banks.

One of the possible regulative steps is to ban every derivative transaction from the OTC market to a regulated market, where every transaction is properly recorded. However, there are two purposes the OTC derivatives market is used for. While banks take speculative positions and want to increase profits, non-financial companies just want to hedge their income against currency fluctuation, fuel price fluctuation and other. Thus the incentives are to introduce the obligation to contain derivative transactions on a regulated market with the exception for non-financial firms, which can continue to use OTC derivatives market (Kalinowski 2011).

But does greater use of clearing and hence margining increase costs of hedging for non-financial firms? Mello & Parsons (2012) discuss this question and give the answer, that the cost of hedging is not being increased. They claim, margining does not change the total financing or capital that the non-financial corporation requires to back its hedging. Since a non-margined derivative is equivalent to a package of a margined derivative and a contingent line of credit, a margin mandate merely requires that this package be marketed as two distinct products.

2.1.3 EMIR & Dodd-Frank Act

Regulation of EMIR in the EU and Dodd-Frank Act in the US will significantly change the rules for dealing with OTC derivatives. According to Muehlenbrock (2012), the rules will imply, that all standardized OTC derivatives contracts should be traded on exchanges or electronic trading platform and cleared through central counterparties. Moreover, the contracts should be reported to trade repositories.

The impact of the regulation is expected to be significant to all parties involved in OTC derivative transactions. The common objective of the new regulations of EMIR and Dodd-Frank Act is to mitigate systemic risk and increase transparency in the OTC derivatives market. However, there are distinct differences between the two regulations. Concerning the timeline of the two regulations Dodd-Frank Act came to force already in July 2010, whereas the final text of EMIR was agreed upon in February 2012. The scope of EMIR consists of wide range of OTC derivatives covering different segments of the OTC derivatives market, but is unclear about foreign exchange derivatives. Out of scope of Dodd-Frank Act are spot and forward FX swaps. Considering which transaction should and should not be cleared, EMIR delegates the authority to European Securities and Markets Authority (ESMA), which has the criteria for systemic risk reduction, liquidity of contracts and other. For non-cleared trades there is likely to be introduced higher capital charge and higher rate for exposures toward central counterparties (CCPs). For Dod-Frank Act similar rules are also valid, with the exception of the authority which in this case is Securities and Exchange Commission (SEC). Since the two regulations, the Dodd-Frank Act and EMIR were developed independently, they do not correspond exactly well. One issue may fall into both regulations and is treated differently. There are, however, intentions to harmonize these issues, for example by the OTC Derivatives Regulators' forum, but the practical problems remain still unresolved (Muehlenbrock 2012).

Apart from the regulation stated above, G20 agreed to add margin requirements on non-centrally-cleared derivatives with help of Basel Committee on Banking Supervision (BCBS) and International Organization of Securities Commissions (IOSCO). The introduction of margin requirements for non-centrally-cleared derivatives have two benefits: Reduction of systemic risk and promotion of central clearing. As not all derivatives are suitable for central clearing, be it e.g. for its complexity, margin requirements would be expected to reduce contagion and spillover effects and help to decrease system's vulnerability to procyclicality of uncollateralised exposure. Moreover, because central clearing is costly partially because of the margin that has to be posted by the CCP, introducing margin requirements for non-centrally-cleared derivatives would promote central clearing and hence in turn reduce systemic risk. Importantly, this measure has to be internationally consistent, because otherwise could the trading activity move to regions with lower margin requirements, making the effectiveness of the margin requirement less effective and simultaneously giving competitive advantage to the low-margin locations (BCBS and IOSCO 2012).

The key principles are according to BCBS and IOSCO (2012) following:

- All derivative transactions have to respect the appropriate margining practices.
- The initial and variation margin have to be exchanged by all financial firms and systemically-important non-financial entities.
- The institution have to ensure that the collateral is liquid so it can be in reasonable time period and can serve to cover the losses in case of counterparty default.
- The margin should be immediately available to the collecting party and be subject to arrangements that fully protects the posting party.
- The regulatory regimes should interact and be sufficiently consistent.

According to Miller & Ruane (2012), the Dodd-Frank Act provide exceptions to the clearing requirement for swaps when one of the counterparty is not a financial entity. This is an important point for commercial firms, because they often use OTC derivatives to mitigate its own commercial risk. However it is not enough to be a non-financial firm to become the exception. The swaps must be used for the purpose of hedging or mitigating commercial risk. It must not be used for speculation, investing or trading, and for mitigating the risk of another swap or security-based swap position, unless the position itself is used to mitigate commercial risk.

Concerning the operational implications of EMIR and the Dodd-Frank Act, they will impact both processes as well the parties involved in OTC transactions. Moreover, it affects the infrastructure in general (CCP and trade repositories). The regulations will implement new legal documentation requirements as well as change of IT systems of the institution. There will be different collateral management setup and margin calculation. A duplication of processes due to bifurcation of collateral will increase the complexity of procedures. The funding of collaterals will also change the collateral management. Moreover, if the derivative transactions are not being cleared through central counterparty, EMIR requires the implementation of sound risk management techniques, which implies the appropriate level of capital and an internal evaluation of derivatives (Muehlenbrock 2012).

The Aims of the EMIR and Dodd-Frank Act are as follows.

- Enhanced transparency - reporting all transaction details to the trade repository. The data will be available to regulators and the informations will be centrally stored. Having access to the informations, the regulators will be more equipped to spot any potential problems in advance. Moreover, market participants will have better overview of central derivative transactions, because trade repositories will publish aggregate positions by class of derivatives.

- Mitigation of counterparty credit risk - introduction of a mandatory clearing of the identified OTC derivatives through CCPs. The CCPs will require highly liquid collaterals, stemming from daily margin calls (e.g. initial and variation margin). However, the counterparty credit risk mitigated in this way is likely to transform into concentration risk (collateral will be held only in few places) and higher liquidity risk for the CCPs. This issue takes EMIR into consideration and presents prudential requirements and prudential measures to deal with it.

- Mitigation of operational risk - use of electronic means ensuring accurate execution, timely confirmation as well as proper reconciliation.

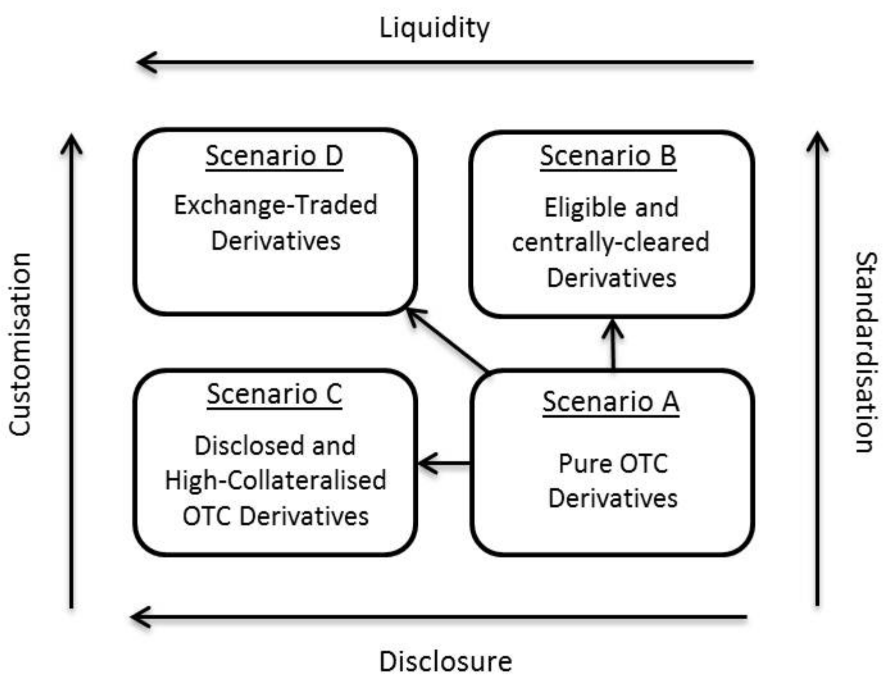
2.1.4 Prospects for the OTC Derivatives Market

Valiante (2010) introduces four different scenarios of potential development in the derivatives market.

- Pure OTC derivatives
- Centrally-cleared OTC derivatives
- Disclosed and highly collateralised bilateral transactions
- Exchange-traded derivatives

They are displayed in the Figure 2.4 with respect to regulation, clearing and other features.

Figure 2.4: OTC derivatives matrix



Source: Author based on Valiante (2010)

Scenario A is according to Valiante (2010) a current scenario, where no regulatory intervention takes place. OTC derivatives are mainly traded on bilateral basis and transaction are highly customized. Disclosure is mainly self-regulated. In Scenario B derivative transaction are cleared on central basis by central counterparties (CCP). These are discussed in a separate chapter. Scenario C attempts to find a compromise between customization and disclosure. Finally, Scenario D deals only with mandatory regulation of derivatives trades with centralized trading and clearing. This scenario would be efficient for flexible, large scale and highly volatile products. Therefore this scenario should not be mandatory and should be limited only to certain kinds of products (Valiante 2010).

In his speech, president and CEO of the Federal Reserve Bank of New York Dudley (2012) gave more shape to the OTC derivatives market development. He addressed the shortcomings of the market, mainly high opacity and liquidity shortage. He created five elements necessary to reform the OTC derivatives market. They are:

- Create strong incentives in the system to provide an impulse for dealers to standardize OTC derivatives trades whenever practical.
- All standardized OTC derivative trades should be mandatorily cleared through CCPs.
- Records for all OTC derivative trades must be reported to trade repositories.
- Two standard-setting bodies — the Committee on Payment and Settlement Systems (CPSS) and the Technical Committee of the International Organization of Securities Commissions (IOSCO) — would strengthen and broaden the principles for financial market infrastructures.
- The Principles would be adopted globally.

These measures would reduce the opaqueness of the OTC derivatives market, improve transparency and price discovery. Furthermore central clearing would reduce the aggregate amount of risk in the system.[1] (Dudley 2012).

2.2 Systemic Risk

This section is devoted to systemic risk, its definition based on Co-Pierre (2011) and Bandt et al. (2011), followed by types of systemic risk where mainly the

[1]For more discussion see sections Systemic Risk and Central Counterparty.

ideas of Co-Pierre (2011), Gai & Kapadia (2010) and Acharya (2009) are introduced. This is followed by a discussion about Systemically Important Financial Institutions and finally a discussion about policies based on Laeven & Valencia (2008).

2.2.1 Introduction to Systemic Risk

Systemic risk is a broadly defined term and the meaning of it has considerably changed in the last few years. Before crisis systemic risk was mostly perceived as probability of contagion effects that cause cascades of defaults. During the crisis, however, it was discovered that systemic risk can occur from two other sources: (i) a common shock which leads to a simultaneous default of several financial institutions at once and (ii) informational spillovers, bad news about one bank can increase the costs of refinancing for all other banks (Co-Pierre 2011).

According to Bandt et al. (2011), there are two categories of systemic risk, broad and narrow. In the narrow sense the systemic risk is understood as contagion effects on interbank markets and in broad sense it is perceived as a common shock to many institutions or markets. The cause of the event could be either a shock from outside the financial system or within it. If the concerned intermediaries fail or concerned markets are dysfunctional then the systemic risk will become great. Because all these dimension are in interaction with each other, that makes systemic risk a very complex phenomenon (Co-Pierre 2011).

2.2.2 Types of Systemic Risk

Contagion of systemic risk appears due to direct linkages between financial institutions mostly in the interbank market. In this setting banks or other financial institutions like hedge funds or insurance companies can be seen as nodes in the net and the connections as edges. This interconnectedness have two major implications. First, it can lead to risk sharing and better liquidity allocation amongst the banks. Second, with regard to systemic risk, it can amplify the contagion effects (Co-Pierre 2011).

This point of view is supported also by Gai & Kapadia (2010). They claim that in a highly connected system, losses of the failing institution can be much more widely dispersed hence there is smaller risk of contagion. But on the other hand, if a systemically important institution fails there is a higher probability of contagious defaults and potential for contagion to spread more widely. In particular, an institution that survive the first wave of defaults is due to high connectivity more vulnerable to a second-round default. Thus effects of any crises can be extremely devastating.

Common shocks are another source of systemic risk. A common shock occurs, when a number of banks hold identical or similar assets. This causes the correlation between their portfolios, which might trigger a fire-sale that can cause significant losses to a large number of banks (Co-Pierre 2011).

Acharya & Yorulmazer (2008) explains why banks can be motivated to increase the correlation between their assets and hence the risk of common shocks. The reason is to prevent costs which arise from potential information spillovers. A bank's last year returns are signals for depositors. If the returns of one bank are low then higher deposit rates are required from depositors. This is the motivation for increasing the correlation between investments, because it increases the probability of joint success resulting in lower costs.

Acharya (2009) analyses another reason for increasing the asset correlation of banks by avoiding negative externalities that arise from a bank failure. These negative effects appear because depositors are not willing or able to lend their money to a bank thus the surviving bank face higher refinancing costs. If this negative externality is not compensated for lower monitoring and information costs that also arise from a bank failure, then the bank will ex ante increase the portfolio correlation to avoid these negative externalities.

Spillovers or informational contagion are according to Acharya & Yorulmazer (2003) another form of systemic risk. The idea behind this is that the insolvent bank can increase the refinancing costs of the surviving banks because of the herding behaviour that usually take place during financial crises.

These different forms of risk are according to Co-Pierre (2011) not independent of each other. They all contribute to stir up the financial crises as during the coming default banks are fire-selling assets, then rumours spread around the market causing tightening liquidity provision and this tightening can lead to a default of the struggling bank. The default can trigger contagion effect and hence spreading systemic crisis to the whole market.

2.2.3 Systemically Important Financial Institutions

Common shocks and contagion effects can be triggered even by one defaulted institution, which was proven by Lehman Brothers and AIG. These institutions are called systemically important financial institutions (SIFI). A failure of such institution may cause not only a financial market distress, but it might negatively effect the economy as a whole. Therefore, macroprudential regulative steps must be taken to impose additional requirements on the systemically important institutions and hence lower the probability of default for these institutions. Such tools may be for example capital surcharges, contingent capital or bail-in debt (Co-Pierre 2011).

BCBS (2011b) conducted in July 2011 a survey focussing on how much loss absorbency potential global systemically important financial institutions (G-SIFIs) need to reduce the probability of failure. To assess what financial institution is considered a global systemically important financial institution or global systemically important bank (G-SIB) an indicator based approach is used. The selected indicators are the size of banks, their interconnectedness, the lack of readily available substitutes for services that they provide, their global (cross-jurisdictional) activity and complexity. Based on the outcome of the indicator-based measurement the banks will be grouped into five buckets. Additional loss absorbency for the highest populated bucket should be 2.5% of risk-weighted assets. There is an initially empty top bucket of 3.5% of RWAs. The rest is structured as follows:

Table 2.1: Bucketing approach

Bucket	Score range	Minimum additional loss absorbency (as a percentage of RWAs)
5 (empty)	D -	3.5%
4	C - D	2.5%
3	B - C	2.0%
2	A - B	1.5%
1	Cut-off point - A	1.0%

Source: Author based on BCBS (2011b)

Risk weighted assets is the sum of different asset classes weighted according to risk they represent. For example a loan secured by a collateral have lower risk then a loan without one, risk free assets have a risk weight of zero. RWAs are based on three types of risk: market risk, operational risk and credit risk. The concepts of RWAs should force banks to have a sound relation between capital and risky positions (Carlsson & Silén 2012).

G-SIFIs are also important from the deleveraging perspective. As Wehinger (2012) indicates, deleveraging of the financial system that was highly leveraged before the crisis should be viewed as necessary process leading to recovery. However, it is having both supply and demand effects, where supply side is also driven by the new regulatory requirements. The effects of the regulation which is mostly welcomed by financial industry might have negative consequences regarding SIFIs. The additional capital requirements as a part of the new regulation might make sense in isolation, but wider negative effects might stem from them. One particular shortcoming is that they do not take into account operational capability, which in many cases was found incomplete, mostly in some of the large, globally active banks. For instance there in no common regulatory framework concerning probability of default.

This opinion is supported by Blundell-Wignall & Atkinson (2012). According to this paper, the capital and liquidity rules set by the new regulations create bias against lending to the enterprise sector. Moreover, the paper shows that movements in the balance sheet of G-SIFIs are dominated by derivatives with varying exposure and netting does not provide the protection against market risk. Another problem stems from collateral and margin calls that are pro-cyclical, which amplifies the liquidity shortage in time of crisis.

Deleveraging may be executed according to Wehinger (2012) in three ways: raising capital, reducing (risk-weighted) assets and restricting lending. As the most preferable way the author perceives raising capital but because of the current market environment the issuance possibilities for banks are limited. Concerning asset reduction, US banks have already got rid of the assets of worse quality in the beginning of the crisis, whereas European banks keep on holding these risky assets (loans) until they are serviced. The third way of deleveraging is restricting lending, which is most unpleasant, but hardly avoidable.

The question is also raised about bank financing. Unsecured bank bonds will under the Basel III Liquidity Coverage Ratio not qualify as high quality liquid assets and so Blundell-Wignall & Atkinson (2012) claim there will be increase of collateralised instruments, specifically covered bonds. These collateralised instruments should be preferred according to the authors because they include recourse to the originator and this should encourage better asset quality than for example asset backed securities. Covered bonds are also generally more liquid then asset backed securities. moreover, covered bonds will be rated as high quality liquid assets. Wehinger (2012) on the other hand argues that apart from the positives, covered bonds have also negative characteristics. They are encumber assets, a single name paper and the amount that the counterparty can hold is limited. Moreover, because they appear on the balance sheet, covered bonds cannot help capital ratios by reduction of the size of the issuer's balance sheet.

Apart from G-SIFIs the regulators also identify domestic systemically important institutions (D-SIFI) and domestic systemically important bank (D-SIB). The Basel Committee on Banking Supervision found appropriate to address the externalities posed by D-SIBs the same way as it addresses the externalities posed by G-SIBs. The externalities are created from the fact that the government cannot afford to let these institutions go bankrupt because they are too interconnected and pose a systemic risk. Moreover, there may emerge direct costs from the moral hazard which is borne by the taxpayers, in particular there may be created competitive distortions and reduced market discipline. All in all this behaviour is likely to increase a probability of distress in the future (BCBS 2012).

The principles of the Basel Committee on Banking Supervision focusses on the higher loss absorbency of the D-SIBs. Apart from that higher degree of supervision is also required for D-SIBs. The regulations will become part of the Basel III regulatory consistency assessment programme. The banks identified as D-SIBs by their national authorities have to comply with the regulatory framework by the January 2016.

2.2.4 Policies

Laeven & Valencia (2008) presents a paper of all systemic banking crises from 1970-2007 and policy responses with appropriate timing and resolution to them. The analysis shows that countries adopted many measures and management strategies with especially frequent use of emergency liquidity support and blanket guarantees to restore confidence. This particular measure was not always met with success.

To successfully handle a systemic crisis, a policymaker must know the nature and the trigger of the crisis. For instance, if unsustainable fiscal policies are the trigger, fiscal tightening may be needed to settle the crisis. However, in most cases this does not happen and the expansionary fiscal policy is used.

If financial market pressures are the trigger, tight monetary policy could help contain them. But if the crisis is caused by liquidity and solvency problems, the central bank should provide liquidity support to the illiquid banks. Moreover, if the liquidity crisis is accompanied with systemic bank runs, government should also provide depositor protection to ensure restored depositor confidence. However these measures tend to be very costly and not necessarily speed up the recovery.

A very important parameter of successful economic policy is timing, the speed of the intervention. As soon as the crisis reach a sufficient level and large part of the financial system is insolvent, bank losses should be recognized, the size of the problem should be established and the appropriate steps should be taken to ensure adequate capitalization of financial institutions. The capital provision should be selective according clear quantifiable rules (Laeven & Valencia 2008).

2.3 Central Counterparty

In this section we discuss the central counterparties (CCPs). We begin with discussing the role of a CCP in financial markets and the tools of CCPs in order to mitigate and reallocate the counterparty credit risk presenting thoughts of Murphy (2012), Pirrong (2011) and Zhu & Pykhtin (2007). We finish the section analysing the advantages and risks of central clearing based on Pirrong (2011) and Milne (2012).

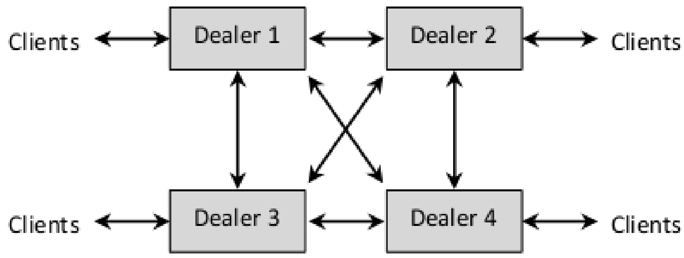
2.3.1 Role of CCPs

Central counterparty (CCP) is a financial entity that is used for clearing derivatives in the OTC market.

The way how two counterparties trade with each other in a traditional OTC transaction is called a 'bilateral trade'. A simple bilateral trade between two counterparties is depicted in Figure 2.5. There is no clearing party involved. Both of the parties are at risk to failure of each other during the life of the contract. In Figure 2.6 works a CCP as an intermediary of the trade. It bears the counterparty credit risk of the transaction hence it must pay all what is owed to the non-defaulting party (Pirrong 2011).

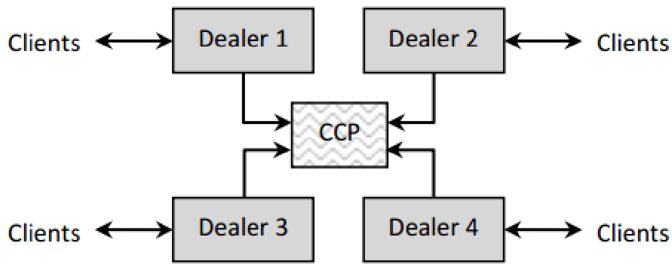
The picture of the trade is however very simplified. Usually more parties are involved and more contracts are being cleared. On top of that some contracts

Figure 2.5: A simple bilateral derivatives market



Source: Murphy (2012)

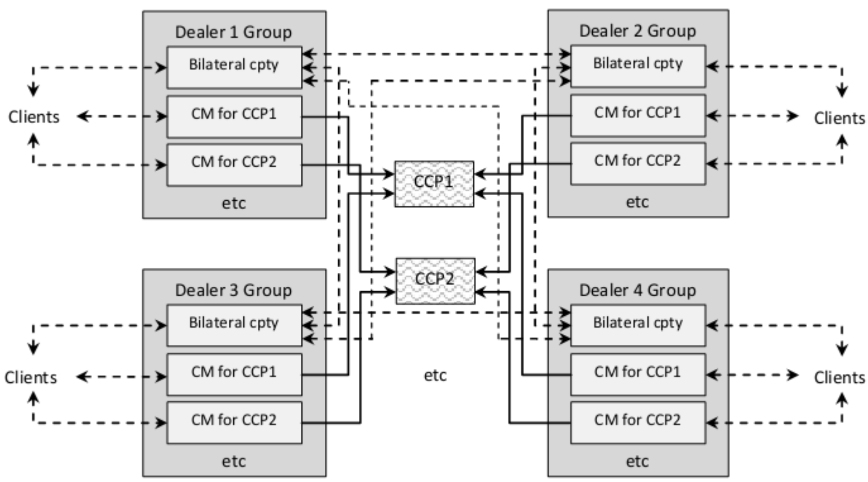
Figure 2.6: A simple central cleared derivatives market



Source: Murphy (2012)

are not subjects of clearing. They are either illiquid or too complicated. This leads to a picture more precise as in Figure 2.7. The dashed lines represent bilateral contracts.

Figure 2.7: A more accurate picture of central cleared market



Source: Murphy (2012)

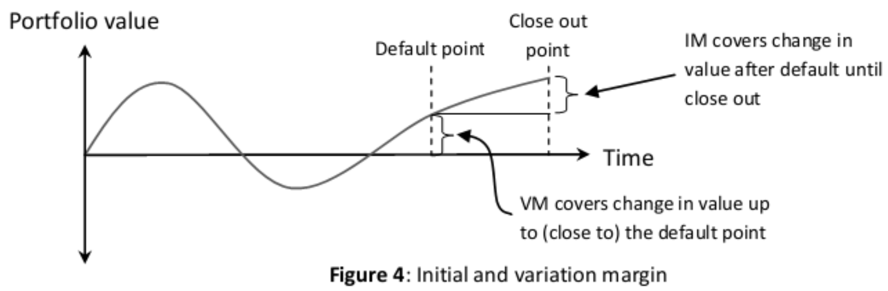
2.3.2 Tools of CCPs

CCP uses variety of mechanisms and tools to mitigate and reallocate counterparty credit risk. According to Pirrong (2011), these are netting, collateralization, insurance, equity, and mutualization. We now take a look at each separately.

Netting is one of the main tools of CCPs. Netting agreement is a legally binding contract between two counterparties that, in the event of default, allows the transactions to be aggregated between two counterparties. In other words, transactions with negative value can be used to off-set the transactions with positive value and only the net positive value represents credit exposure at the time of default (Zhu & Pykhtin 2007).

Collateralization is another useful tool which is widely used. The exchange of collateral is a common issue for a bilateral exchange as well but a problem stems from its informality. Who, how much or when is to rise the collateral is a question that is hard to answer for trades on the bilateral basis. CCP sets the exact rules that answer these questions. There are two types of collateral the CCP requires. At the beginning of each derivative trade the trading parties have to post so called **initial margin** (IM). Because prices of contracts are varying over time, this leads to other collateral requirement called **variation margin** (VM).

Figure 2.8: Initial and variation margin



Source: Murphy (2012)

The initiation and variation margin can be seen in Figure 2.8. IM protects the CCP against the change in value of a portfolio of derivatives in case one of the counterparties defaults. VM reflects changes in value between trade date and the date of a call (Murphy 2012).

Insurance, equity and mutualization are used because they shift the default risk away from the CCP to some other party. Insurance reallocates default losses from derivatives counterparties to the insurer for a nominal fee. CCP equity is essential to be in a first loss position after the resources from the defaulted counterparty (margins, default fund) are exhausted. Mutualization is another way how to shift the default risk. A CCP may have other member firms that are contributing to the default fund and hence agree to absorb some default losses (Pirrong 2011).

2.3.3 Benefits of Central Clearing

A concept of CCP should bring positive effects to financial markets. Pirrong (2011) understands CCPs as organizations that are intended to reduce counterparty credit risk or in other words they should increase the probability that contractually promised payments will be made. CCP can also contribute to the stability of the financial system. By a CCP defaulted positions could be more efficiently replaced and through netting they could be reduced. It can also reduce price volatility and the occurrence of extreme price movements in the case of a defaulted large derivatives trading firm. Moreover, since the default losses are allocated more efficiently, CCPs can mitigate or eliminate potential cascading defaults.

According to Milne (2012), the key benefit of CCPs is not a reduction of counterparty credit risk. That could have been also achieved on the bilateral basis. But the key benefit is reduction of systemic risk. This is done by coordinated management of open positions in case of a default of systemically important financial institution and improved oversight of market participants. However, these benefits are public goods and so some policy interventions are needed to ensure suitable adoption of CCP clearing.

2.3.4 Risks of Central Clearing

According to Milne (2012), the private costs of central clearing are insignificant, important are the social costs to consider. It is necessary to take into account the inefficiency in price discovery, which is caused by collateral management of CCP. A great concern is that the CCPs would become a cause of a systemic risk instead of the cure. A CCP is by default an interconnected financial institution with billions of exposure. If insolvency of illiquidity occurs than a CCP may become the source of systemic risk.

Pirrong (2011) comments on the systemic risk of CCPs too. It is clear that CCPs will not totally eliminate the systemic risk, it will merely reallocate it. The CCPs will be very important systemic nods in the financial system and a failure of one would cause many troubles. There could be a closure on markets where the products are cleared. Furthermore a failure of a CCP stemming from a bankruptcy of one of its counterparties would result to spread of financial contagion.

2.3.5 Current Assessments of International Capital Market Association

In the latest issue of quarterly report, ICMA (2013) brings news about CCP and its impact on the economy, mainly it focuses on the impact on growth. The impact of the regulatory steps both fiscal and monetary is hard to estimate because of the dependence on the qualitative factors as of to what extend they help to restore confidence in the financial system. What the authorities are considering as a potential threat is that the regulatory measures would not just hopefully prevent the next crisis to happen but also they would prevent to recover from the current one. Hence the next questions should be addressed:

1. What will be the impact of overall regulatory measures on growth?
2. Are the proposed measures consistent with one another?
3. Will the regulative measures reduce systemic risk or simply reallocate it from one set of financial institutions to another?
4. In Europe, would closer financial integration in the Euro area affect the integrity of the Single Market across the EU?

The first question depends on the outcome of two contradictory forces. The force that promotes growth is the restoration of market confidence and future lending increase due to recapitalisation of the banks. The force that goes against growth is imposition of austerity as a result of budget cuts that reduces domestic demand. Moreover the increase of costs for the banks mainly due to higher capital charges and increased margin requirements would also push to impede growth. The steps should be taken to encourage capital market financing that in Europe still represents a much smaller proportion of total financing than in the US. If not, at least they should not be taken to discourage it.

The second question is quite an issue in the EU, because new regulatory initiatives are sometimes introduced without proper consideration of the impact of one measure on another. Also consistency between the EU, the US and other countries is important to keep functional. Some countries do not think of adoption important measures because the crisis did not originate with them.

The third question simply considers the fact that if the clearing shifts from bilateral OTC counterparties to multilateral clearing houses, those institutions may become too big and too interconnected to fail, hence there is a threat of concentration of risk in those clearing houses.

The fourth question closely relates to the fact that a lot of euro business is currently conducted outside euro area, especially in London. The point is that to move the business to euro area would increase euro-area liquidity and enhance oversight of euro in euro area. But it is not clear whether the amount of euro business conducted in London prevented in any way the response of euro-area authorities.

2.4 Regulation and Basel

In this section we will discuss the Basel III and its predecessors. First we will acknowledge the shortcomings of Basel I and II based on King & Tarbert (2011) and Byres (2012). Then the focus will be on Basel III and how it deals with counterparty credit risk using articles from Basel Committee on Banking Supervision, Committee on the Global Financial System and Cecchetti (2012). After that we discuss the capital requirements and counterparty credit risk, what is different in Basel III, what are capital buffers and how they influence the bank's regulatory capital. Then we describe the leverage ratio introduced by Basel III. As a last point we will talk about timeline of Basel III.

2.4.1 Shortcomings of Basel I,II

Basel I or Basel Capital Accord was established in 1988 as a response to previous perceived deregulation failures. As the banks wanted larger portion of the market, they were increasing domestic and foreign exposures which were not matched by increasing capital base. To fight the erosion of capital, Basel I was founded as a international standard to introduce a regulatory measures concerning standardized regulatory ratio, defining regulatory capital (Tier 1 and Tier 2) and a uniform process by which banks calculate their regulatory capital ratios. Moreover, to account for different risk levels the concept of Risk-weighting assets was incorporated into Basel I. Particularly, sovereign debt exposures were weighted at zero percent, residential mortgage loans at 50 percent, and unsecured commercial loans at 100 percent (King & Tarbert 2011).

According to King & Tarbert (2011), the achievement of uniform risk-weight categories came up as one of the the framework's greatest flaws. For example, countries such as Greece and Ireland received same zero percent risk weighting for national debt as the United States. The credit standing of corporate debt was also neglected in the computations. Hence banks found out they could seek higher yields at greater risks without increasing its capital base.

Byres (2012) has the same opinion, saying that if risk is mispriced in the regulatory framework, banks will participate in the activities where the restricted capital would yield highest return, in other words, where risk is underpriced. Basel I attempted to price risk within the regulatory framework but for the last twenty years, various derivatives and complex financial products were too sophisticated to Basel I to keep up with. *"We were allowing modern planes to fly, but utilising outdated safety manuals"* (Byres 2012, pg. 3).

Basel II was the revised version of Basel I, mostly in the area of redefining RWAs. The previous calculations were based only on market risk and were conceived too narrow, hence two more components were added: Market risk and operational risk. However, the recent crisis showed that the weaknesses were not completely removed. The definition of Tier 1 capital was left largely intact thus banks could easily took advantage of it by lowering costs of their capital. This lead to an erosion in capital levels leaving banks ill-equipped to absorb significant losses. These insufficient buffers were most crucial in case of systemically important financial institutions (SIFIs) (King & Tarbert 2011).

Byres (2012) adds that since Basel II was introduced after the crisis has been seeded, we cannot find out if the better regulatory system would improve the situation. Moreover the crisis revealed failings in all aspects of the financial system, hence it is unlikely that better capital adequacy regime would avert the crisis altogether.

2.4.2 Basel 2.5

In July 2009 the enhanced capital rules were introduced by the Basel Committee and is now referred to as Basel 2.5 (BCBS 2009). It mainly focused on the area of securitisation, more specifically for dealing with resecuritisation. It strengthened the capital treatment of securitisation and made changes concerning the trading book rules. It supplied the rules with an incremental risk capital charge and a stressed value-at-risk requirement. Also supervisory review process was supplemented with respect to banks' risk management and capital planning processes.

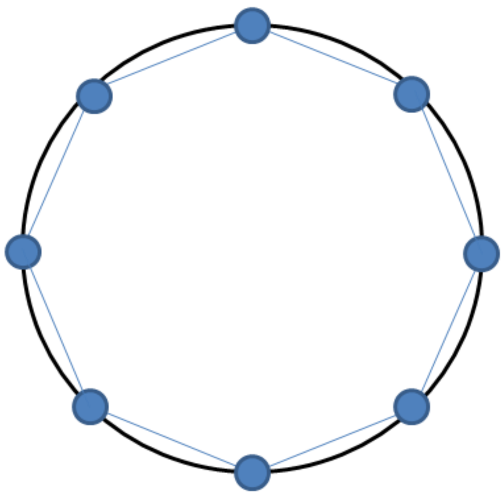
2.4.3 Basel III

Basel III was introduced in 2010 by Basel Committee on Banking Supervision (BCBS 2010b). It is built on the experiences from the recent financial crisis and tries to strengthen the regulatory requirements making them simpler at the same time. The changes are made mainly in the area of increasing quality and quantity of regulatory capital. To address systemic risk within the global financial system, Basel III introduces a set of tools and standards at macroprudential level, such as countercyclical buffer and universal leverage ratio. Question rises, if these measures would not slow the economic recovery. According to BCBS research, they are likely to have a relatively modest impact on growth, particularly, GDP is projected to decrease by 0.22 percentage points below its baseline level in the 35th quarter after the start of implementation process, followed by a recovery of growth towards the baseline (BCBS 2010a).

Blundell-Wignall & Roulet (2012) criticize Basel regulation, particularly its excessive complexity and ineffectiveness. In the paper the authors argue that simple leverage ratio should be the primary regulatory tool for bank capital. The econometric study reveals the determinants of distance-to-default (DTD), measured as a number of standard deviations away from the default point. It was tested on a panel sample of 94 banks, with a special focus on G-SIFI banks. The authors argue that Tier 1 capital ratios do not show any particular influence concerning distance to default of analysed banks. More importantly, Tier 1 ratio came out as statistically insignificant, in contrast to strong significance of the leverage ratio. Concerning the counterparty credit risk, the authors claim that derivatives have a strong direct effect on the DTD. According to the paper, gross market value of derivatives is a key driver of the DTD and high levels are associated with greater vulnerability.

Cecchetti (2012) comments on reduction of counterparty credit risk in the Basel III framework. The new regulation environment should be based on a market capitalist system, where everyone has a right to succeed but on the other hand has an opportunity to fail. In that case firms would treat risk management differently. Moreover, since firms do not take into account risks that they create for others, regulation should be macroprudential so that a failure is affordable for the system. If we imagine 8 institutions engaged in OTC activities in a circle such as in Figure 2.9 that every one has a long position with a partner on the right and same short position with a partner on the left. Everyone in the circle is perfectly hedged, but if on of the counterparties fail, circle is broken and the balance is ruined. Limited counterparty credit risk should stem from centralized clearing. The central counterparties reduce interconnectedness and therefore the possibility of a systemic collapse. The situation can become even more challenging if the counterparties are also connected with one another, not just with the neighbour on either side of the circle. This scenario is very much likely to happen and it increases the possibility of a systemic collapse of even bigger proportion.

Figure 2.9: Connections between counterparties



Source: Author

How does the CCP handle the default of the clearing member? Since the counterparty credit risk is shifted to the CCP, the process of handling this risk is vital for the financial system. The CCP clearing member may fail due to events such as non-payment of margins or the opening of an insolvency procedure. In this case, the CCP has to take the open positions of the defaulting member into its own book and tries to hedge off and close out these positions. To achieve this, the CCP may need the assistance of remaining clearing members, for instance by bidding the defaulted positions. To cover for potential losses, the CCP can access the collateral contributions (variation and initial margin) and the CCP's default fund. If these funds are insufficient, the CCP will use default fund contributions and its own resources if needed (CGFS 2011).

2.4.4 Capital Requirements and Counterparty Credit Risk under Basel III

The capital requirements notion was introduced because every bank faces risks while conducting business. The risks cannot be reduced to zero and every risk that the bank undertakes brings up a potential loss. The bank is not allowed to transfer the losses to its creditors and so it must be capable to cover those losses with its own means (capital).

The different risks are quantified and the possible losses are estimated. The magnitude of this losses becomes the capital requirement. Hence, the sum of capital requirements expresses the amount of risk undertook by the bank. Moreover, the sum of capital requirements has to be smaller or equal than the overall bank capital. The capital requirements are defined as a ratio of capital to risk weighted assets (Zeman 2012).

The regulation of Basel follows these sound principles and requires banks to hold a certain amount of capital to ensure that there is enough means to continue the operations in the period of stress. According to BCBS (2011a), this amount needs to be at least 8% of risk weighted assets (RWA):

$$\frac{\text{Total capital}}{RWA} > 8\%$$

Basel III is looking for a way how to ensure sufficient level of high quality capital, the level of which the preceding crisis revealed as unsatisfactory. The crisis also revealed some inconsistency in definitions of capital across jurisdictions. The definition focuses now on common equity, the highest component of a bank's capital. There are two components of capital: Tier 1 (going-concern capital), Tier 2 (gone-concern capital). Before Basel III existed also Tier 3, capital determined to cover the requirements to market risk, which was abolished (BCBS 2011a).

- **Tier 1** is the highest quality capital and it is divided into core T1 (common equity T1) and hybrid T1. The core T1 has to be at least 4.5% of risk-weighted assets at all times. The T1 capital as a whole must be at least 6% of risk-weighted assets at all times.

- **Tier 2** is a supplementary capital that does not qualify as Tier 1. The volume of T2 cannot be higher than the volume of Tier 1.

The total counterparty credit risk capital charge under Basel III has two components. Default risk capital charge and CVA capital charge:

$$\text{Total CCR Capital Charge} = \text{Default Risk Capital Charge} + \text{CVA Risk Capital Charge}$$

The CVA capital charge is described in detail in the chapter 'Model'.

The default risk capital charge for CCR is based on the risk weights obtained from external rating and multiplying with the outstanding Exposure at Default (EAD). The weights are given in the table below:

Table 2.2: Risk weights based on external ratings

Rating	Weight w_i
AAA	0.7%
AA	0.7%
A	0.8%
BBB	1.0%
BB	2.0%
B	3.0%
CCC	10.0%

Source: Author based on BCBS (2011a)

Concerning exposure at default, BIS specifies three ways to compute EAD for derivatives (BCBS 2005).

- **Internal model method (IMM)** - a bank is allowed to use its own estimates that are developed through internal models in an advanced EAD approach.

- **Current exposure method (CEM)** - used by banks that do not qualify for the use of internal models. To calculate EAD the following equation is used:

$$EAD = (RC + \text{ add-on}) - \text{ volatility adjusted collateral}$$

Where:

- RC = Current Replacement Costs
- Add-on = the estimated amount of potential future exposure

- **Standardised Method (SM)** - used by banks that do not qualify for IMM but would like to adopt a more risk-sensitive method than the CEM. SM is simpler to calculate and has a number of simplifying assumptions compared to IMM but it captures certain key features of IMM.

2.4.5 Capital Buffers

Concerning the additional capital, there are two capital cushions that the banks have to follow: The capital conservation buffer and the countercyclical buffer (Zeman 2012), (BCBS 2011a).

Capital conservation buffer forces the banks to have higher volume of capital than required minimum standard (4.5%, resp. 8%). This serves as an additional capital cushion. It should be created in favourable phases of the cycle so it could used in distress. This buffer has also a microeconomic character because it also protects the bank agains individual troubles. The required minimum standard should be increased by 2.5 percentage points (7% core T1, resp. 10.5% RWA). This buffer ought to consist of the best quality capital, i.e. core T1. If the capital requirements drop below the limit 7%, the bank does not have to limit its functioning but it has a decreased capability of distribution of profit. This affects distribution of dividends, reverse purchase of shares and payment of voluntary bonusses to the employees. The rule applies that the lower the created buffer, the bigger the restriction to profit distribution. The following table clarifies the last point.

Table 2.3: Minimum capital conservation standards

Common Equity Tier 1 Ratio	Minimum Capital Conservation Ratios (expressed as a percentage of earnings)
4.5% - 5.125%	100%
>5.125% - 5.75%	80%
>5.75% - 6.375%	60%
>6.375% - 7.0%	40%
> 7.0% - 0%	0%

Source: BCBS (2011a)

Countercyclical buffer is based on a macroeconomic perspective. It protects the financial sector as a whole in case of a recession and will be created in case of steep rise of loan provision in the national economy. According to the regulator's decision, it would be dissolved in the period of a decline. The bank creates the countercyclical buffer only against the exposures in the respective national economy. For international banks a weighted average for exposures is applied. If a bank fails to create the buffer, it faces a restriction of profit distribution like in the previous case. The size of the buffer is between 0 and 2.5 percentage points.

Figure 2.10 summarizes the capital requirements for banks in the presence of capital buffers.

Figure 2.10: The overview of capital requirements

		Common Equity Tier 1	Tier 1 Capital	Total Capital
Minimum	+ 0%	4.5%	6.0%	8.0%
Min + conservation buffer	+ 2.5%	7.0%	8.5%	10,5%
Min + conservation buffer + Countercyclical buffer (max)	+ 2.5%	9.5%	11.0%	13.0%

Source: Author based on BCBS (2011a)

2.4.6 Leverage Ratio

Another tool that Basel III introduces to prevent future recessions is the leverage ratio. The rationale for this measure is the fact that during the financial crisis the capital requirements were sufficient, but the financial leverage was too big. It had a negative impact on financial system and real economy, because the banks were forced to fire-sell their assets. Hence there is a inclination to restrict the financial leverage and to find a measure which would be simple, transparent and independent. The result is the leverage ratio.

The leverage ratio is the ratio between capital and the size of exposure. The exposure is not risk weighted. The following formula expresses the ratio:

$$LR = \frac{Capital}{Exposure}$$

There is a minimum size of the LR,

$$LR = 3\%$$

. The computation takes into account the three-month average for last quater. In the nominator there is the capital Tier 1 with the same definition as for the capital requirements. If the exposure is deductable from T1, it is deducted from the overall exposure, hence it carries no leverage effect. In the denominator there is a size of the exposure with the components of assets from balance sheet, repo operations, derivatives and off-balance sheet items (BCBS 2011a).

Concerning the time period of the leverage ratio introduction, it is not being enforced immediately, but there is a monitoring period from 1.1.2013 - 1.1.2017. The ratio could be recalibrated in the monitoring period. From 1.1.2017 there is a compulsory limit for leverage ratio.

2.4.7 Timeline

A recent article from Bank for International Settlements BCBS (2013) sets the timeline and implementation of Basel III. According to this report, the timeliness and compactness of the implementation is going to play the key role in building a resilient financial system and restore public confidence in regulatory ratios. The report covers the progress of banks in fulfilling the capital requirements and reinforcing the capital basis. It also points out weak spots and shortcomings that come to surface and require attention.

The time of implementation of Basel III's capital standards was set on 1 January 2013 with the agreement of Basel Committee members. They also agreed to implement the Basel III standards before its date into national laws and regulations. So far, total of 14 members have issued final Basel III-based capital regulations and out of that 11 members have now final Basel III capital rules in force. 13 members missed the deadline and is pressured to issue final versions of the regulations as soon as possible so that the internationally agreed transition periods can be met. Particularly, those members that host global systemically important banks (G-SIBs) are forced to complete the final Basel III regulation issuance. Nevertheless, there are positive news. For the 12 months ending June, large internationally active banks raised capital ratios, e.g. Common Equity Tier 1 capital ratios increased from 7.1% to 8.5% (BCBS 2013).

The basic components of Basel III capital framework were completed in 2011, since then the remaining components were substantially finalised, as can be seen in Table 2.4. The global and domestic systemically important financial institutions (G-SIBs and D-SIBs) framework was published in 2011 and 2012 respectively with a planned implementation in 2016. The framework for Liquidity Coverage Ratio was published in 2013 and is going to be implemented from 1 January 2015. The work on the framework for leverage ratio and Net Stable Funding Ratio is still in progress and under an active development.

Table 2.4: Status of Basel III components and target dates for implementation

Core component of Basel III	**Progress**
Basel III capital adequacy reforms	Published in 2011; implementation from 1 January 2013
G-SIB/D-SIB framework	Published in 2011/2012; implementation 1 January 2016
Liquidity Coverage Ratio	Published in 2013; implementation from 1 January 2015
Leverage ratio	Disclosure starting in 2015 with a view to migrate to Pillar 1 in 2018.
Net Stable Funding Ratio	Under review; minimum standard to be introduced in 2018

Source: BCBS (2013)

2.5 Stress Testing

Stress tests are used to assess the vulnerabilities of financial systems to credit risk. They provide information on potential losses under exceptional but plausible shocks. The policymakers have therefore useful information to detect the predisposition of the financial systems to instability and crises. Stress tests can be focused on an individual institution or a whole sector. The system stress tests good complement those for an individual, because of a forward-looking macroeconomic perspective and a focus on the financial system as a whole (Foglia 2009).

Borio et al. (2012) discuss the usefulness of macro stress testing. They claim, that given current technology, macro stress tests are not suitable as early warning devices and cannot serve as a remedy trigger in a seemingly calm period before crisis. Quite opposite, the stress tests were not part of the solution, but part of the problem. They gave the policy makers false sense of security, claiming that the system is sound. Two limitations have to be taken into account. First, the model used to simulate the stress tests fails to provide a realistic picture of the dynamics of financial distress. Second, considering the context in which the stress tests are run, there is a paradox. The system looks strongest precisely when it is most vulnerable. Hence, unless the limitations are fully understood, the stress test may be a false security indicator in the future.

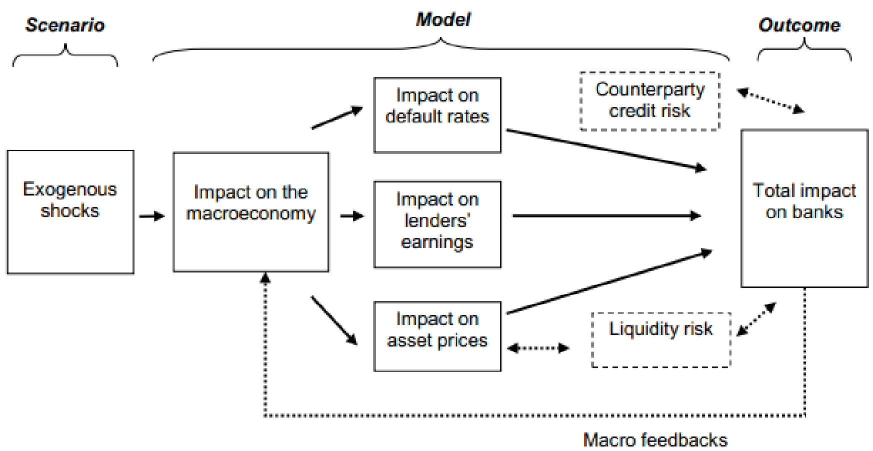
On the other hand, stress test can be used in the crisis as management and resolution tools. In the crisis, when the sources of vulnerability can be clearly observed, the technical limitations of stress test looses the impact. The relevant scenarios are easier to identify. In early stages of the crisis can be identified how much capital should be injected to the financial sector in order to prevent a credit crunch. After all, the objective should be keeping financial sector healthy so it does not constrain or misallocate the supply of credit and ensure long run sustainable profitability.

A typical macro stress test for banks can be seen in Figure 2.11. It starts with a sets of exogenous shocks, that are severe, but plausible. These simulations creates scenarios. Then a model maps scenarios into outcomes. There are two ways how to describe the process: top-down and bottom-up.

- Bottom-up - In a bottom-up case a central authority provides individual institutions with a common scenario, the institution themselves are responsible for estimation of the impact of the shocks and the authority afterwards sums up the results.

- Top-down - In this case the individual institutions are not directly involved, the central authority uses its own internal model(s) to come up with the results.

Figure 2.11: Schematic overview of the structure of macro stress tests



Source: Borio et al. (2012)

The solid lines in Figure 2.11 represent the components captured by the majority of stress tests, whereas the dotted lines show the feedback effects described only by more sophisticated stress test models.

According to Burrows et al. (2012), the most comprehensive approach to macro stress testing is the Risk Assessment Model of Systemic Institutions (RAMSI). It was developed at the Bank of England and it is an example of a top-down model. Its aim is to assess the solvency and liquidity risks faced by banks. It focusses both on individual institutions and on the financial sector as a whole. RAMSI model is structured by equations for each component of each bank's income. The equations use data from each bank's income statement and from the composition of each bank's balance sheet. It is still under development to better capture second-round effects, which are characteristic features of systemic crises.

BCBS (2011a) specifies the enhanced criteria for banks that have to be followed in Basel III:

- Banks have to ensure complete trade capture and exposure aggregation across all forms of counterparty credit risk in a sufficient time period.
- Banks should produce exposure stress testing of principal market risk factors on monthly basis.
- On quarterly basis banks should apply multifactor stress testing scenarios and assess material non-directional risks. Also, stress testing applying stressed conditions to the joint movement of exposures and counterparty creditworthiness is required.
- Stress tests results should be integrated into reports for senior management.
- The stress factors should be severe enough to capture historical extreme market environments and extreme but plausible stressed market conditions.

Chapter 3

The Model

3.1 Literature Review

The cornerstone of literature used for this chapter are the articles from Basel Committee for Banking Supervision. BCBS (2011a) sets the Basel III requirements that the banks have to follow in 2013. Apart from raising the quality and level of capital base, it ensures to capture all material risks, including counterparty credit risk. According to (BCBS 2011a, pg. 29): *"Failure to capture major on- and off-balance sheet risks, as well as derivative related exposures, was a key factor that amplified the crisis."* The computation of statistical measures of exposure are based on BCBS (2005). The CVA computation are based on Zhu & Pykhtin (2007) and Alluve (2012). Insights for the model are also taken from Carlsson & Silén (2012) and Blundell-Wignall & Roulet (2012).

3.2 Model Specification

The following sections are explaining the model which will be used for calculating CVA and testing the hypotheses stated below. As it was mentioned before, the exposure of OTC derivatives are based on future development of the swap value. Hence, the model input will be generated by Monte Carlo simulation.There are naturally some limitations to the model. It is focused only on calculating CVA plain vanilla swaps. Major adjustment would be needed to enable the model to be able to calculate other types of derivatives. Moreover, neither netting nor collateral is allowed. It cannot handle the whole portfolio together but only one counterparty and one contract at the time.

3.2.1 Outline

In order to compute the credit valuation adjustment we need to estimate the swap exposure. This is done by Monte Carlo simulation, where an estimation of interest rate of the swap has to be made. After we arrive to the exposure levels, the outcomes will be depicted in different scenarios, the result of the Monte Carlo approach. After the different path of exposures are modelled we can proceed to find out statistical measures of exposure, namely expected exposure (EE). This measure is the input in the CVA computation. In the model we focus on two other inputs: probability of default and loss given default. Then we insert the inputs in the formula for computing the CVA (based on BCBS (2011a) and finally we check the validity of hypotheses.

3.2.2 Hypotheses

The aim of the model is to asses the impact of the interest rate increase on capital requirements of banks. The hypotheses are as follows:

- The increase of interest rate will have virtually no effect the capital requirements of Czech banks.
- The increase of interest rate will have substantial effect on banks with high exposure to derivatives (Bank of America, Citibank, JP Morgan).
- There is a direct correlation between CVA and interest rate.

3.3 Counterparty Credit Risk - Pricing

Counterparty credit risk is the risk that the counterparty of a derivative contract will default before the contract expires and will not make the agreed contract payments. Since exchange-traded derivatives have guaranteed cash flows, only privately negotiated contracts such as OTC derivatives are subject to the counterparty credit risk. Counterparty credit risk is similar to other forms of credit risk with two exceptions: the uncertainty of exposure and bilateral nature of credit risk (Zhu & Pykhtin 2007). In a typical lender-borrower contract, everyone knows who is the lender and who is the borrower. Moreover the exact exposure is known, which is the borrowed amount. Since the exposure of a derivative contract changes over time, it can easily happen that the roles reverse. In the following sections we will discuss how credit valuation adjustment (CVA) is computed as the price of counterparty credit risk.

3.4 Exposure

Since the credit exposure of a derivative contract is unknown in the future, a modelled framework is necessary to be utilized. The exposure depends on internal factors of the trade (e.g. the amount of collateral) as well as external factors (e.g. the interest rate). The exposure of the bank is zero if the contract value is negative, because the bank has nothing to loose. If, on the other other hand, the contract value is positive, the bank faces a positive exposure. If this is the case in the time of the counterparty default, the three steps the bank undertakes. The bank (i) closes out the position, but receives nothing from the defaulting counterparty, then (ii) enters into a similar contract with another counterparty and pays the market value of the contract and (iii) has a net loss that equals the contract's market value (Zhu & Pykhtin 2007).

Let us now put the counterparty exposure in more exact terms. If there is only a single derivative contract in the bank's portfolio, then the credit exposure is equal to the maximum of the contract's market value and zero. If the value of contract i at time t is denoted as $V_i(t)$, the contract-level exposure is given by:

$$E_i(t) = max\{V_i(t), 0\} \tag{3.1}$$

If there is more than one trade with a defaulted counterparty and the counterparty credit risk is not in any way reduced, then according to Zhu & Pykhtin (2007), the sum of all contract-level credit exposures is equal to the maximum loss for the bank, as in Equation 3.2.

$$E(t) = \sum_i E_i(t) = \sum_i max\{V_i(t), 0\} \tag{3.2}$$

To reduce the credit exposure significantly, the counterparties often use netting agreements. In such contracts transactions with negative value can offset the ones with positive value, thus the credit exposure at default is represented only by the net positive value and the total credit exposure is reduced to the maximum of the net portfolio value and zero:

$$E(t) = max\left\{\sum_i V_i(t), 0\right\} \tag{3.3}$$

However, there can be more netting agreements with one counterparty. Also not every trade is covered by a netting agreement. Denoting the k th netting agreement with a counterparty as NA_k, the counterparty-level exposure is given by:

$$E(t) = \sum_k max\left[\sum_{i \in NA_k} V_i(t), 0\right] + \sum_{i \notin \{NA\}} max\left[V_i(t), 0\right] \tag{3.4}$$

The inner sum of the first term represents the k the netting agreement, the outer one sums exposures over all netting agreements. The second term represents the trades that are not covered by any netting agreement (Zhu & Pykhtin 2007).

3.4.1 Statistical Measures of Exposure

The statistical measures defined in this section are based on BCBS (2005) and Carlsson & Silén (2012). We shall focus on three perhaps most widely used measures of exposure: Expected exposure, potential future exposure and expected positive exposure.

Expected Exposure is the probability-weighted average exposure. It represents the expected loss if the counterparty defaults. EE is the average of the positive MtM-values, hence it is always larger than the average of the MtM-values. The expected exposure is defined by the following formula:

$$EE_t = \frac{1}{N}\sum_{i=1}^{N} max(0, V_{ti}) \tag{3.5}$$

Where

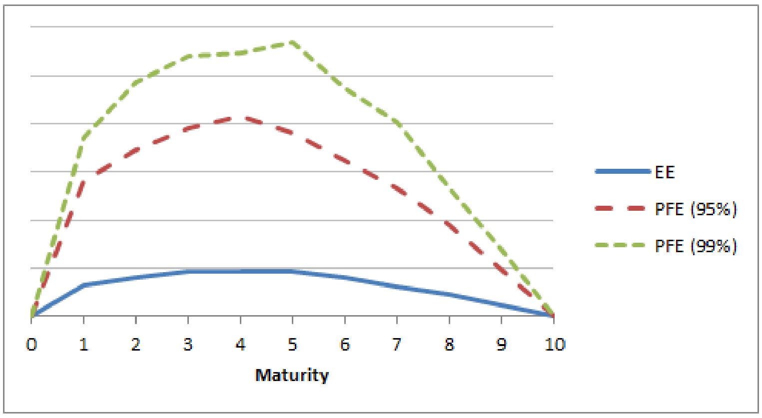
- i=1,...,N is the number of the scenario
- V_{ti} is the swap value for ith scenario in time t

Potential future exposure measures the worst possible exposure. It is the maximum exposure estimated to occur on a future date at a high level of statistical confidence (BCBS 2005). The confidence level could be e.g. 99%.

This means, that with a 99% probability the exposure will not exceed the PFE level. This measure reminds of value at risk (VaR). One of the difference between PFE and VaR is, that for PFE the time horizon is generally longer.

In Figure 3.1 we can see the difference between expected exposure and potential future exposure. PFE is always greater than EE, because it takes only the greatest 95 of 99 percent, whereas EE takes the average of swap exposures.

Figure 3.1: Statistical measures of exposure - EE, PFE



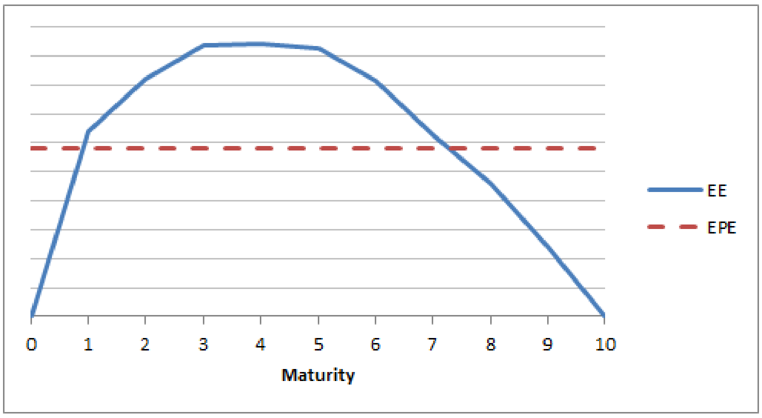
Source: Author

Expected positive exposure is the time-weighted average of individual expected exposures in given time horizon. Technically we take the values of EE_t and compute the average with respect to time periods:

$$EPE = \frac{1}{M} \sum_{t=1}^{M} max(0, EE_t) \tag{3.6}$$

Expected positive exposure can be seen in Figure 3.2. It is the average throughout the life of the swap.

Figure 3.2: Statistical measures of exposure - EPE, EE

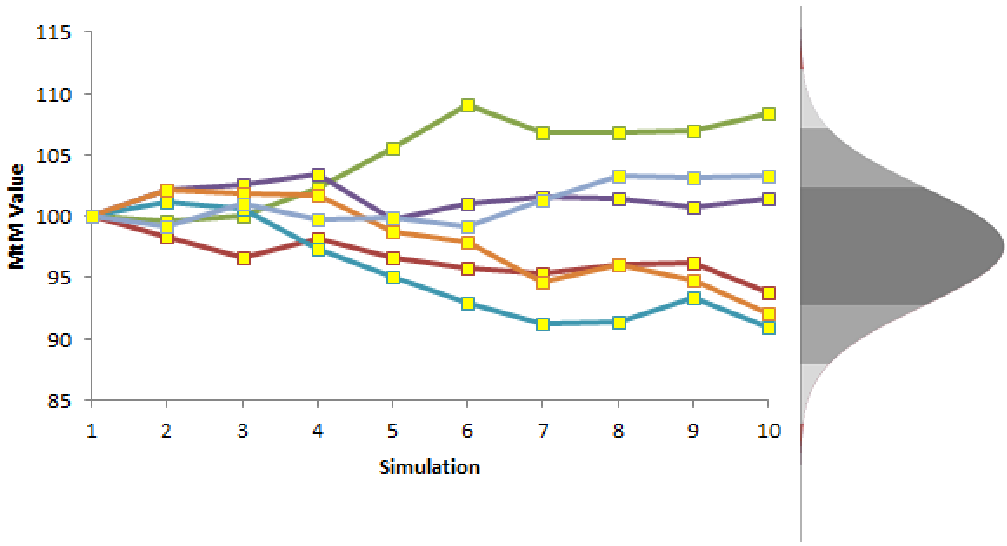


Source: Author

3.5 Scenario Analysis

Scenario analysis is the process of creating set of realizations of counterparty-level exposure, where each realization corresponds to one market scenario at each simulation date. The scheme of the process can be seen in Figure 3.3.

Figure 3.3: Scheme of simulations for credit exposure



Source: Author

We can observe the different exposure for each simulation date. We start with $PV = 100$ and see how it evolves over time. In the end we can see the distribution of outcomes. It is not exactly right because we use only six different scenarios. Normally we use the Monte Carlo approach to generate thousands of scenarios, then the distribution would be as presented.

The periods between the simulation dates are called 'time buckets'. The number of simulation dates are usually restricted because of the computational intensity required to calculate counterparty exposures. This holds mostly for banks, while they have a large portfolio of derivatives. Therefore simulation dates used by most banks usually comprise daily or weekly intervals up to a month, monthly up to a year and yearly up to five years, etc. (Zhu & Pykhtin 2007).

3.6 Credit Valuation Adjustment

Credit valuation adjustment (CVA) is by definition the difference between the risk-free portfolio value and the true portfolio value that takes into account the possibility of the counterparty's default (Zhu & Pykhtin 2007). Put it differently, the CVA is the market value of counterparty credit risk. First we clarify two important concepts: Probability of default and loss given default.

3.6.1 Probability of Default

In building a credit risk model one of the core inputs is probability of default (PD). The accuracy of PD measurement has a great impact on the quality of the results of credit risk model. PD is the probability that an institution defaults during a specified period of time. It is based on macroeconomic as well as microeconomic factors. Generally in a crisis, when the potential of liquidity provision is low, PD gets higher across all institutions. However, it is the question of each specific counterparty to deal with the economic downturn.

There are, however, obstacles to accurately compute PD estimations. One of them is low number of defaults especially in high rating grades. Due to relatively low number of borrowers a high degree of volatility is observed even if some defaults take place in a given year. The usual banking practice for obtaining PD values consist of qualitative mapping mechanism to bank-wide master scales or external ratings (Engelmann & Ranhmeier 2011).

The approach that will be used in this model is based on BCBS (2011a).

$$PD(t_i) - PD(t_{i-1}) = exp\left(-\frac{s(t_{i-1})t_{i-1}}{LGD}\right) - exp\left(-\frac{s(t_i)t_i}{LGD}\right) \tag{3.7}$$

Where

- $(PD(t_i) - PD(t_{i-1})$ is the probability that the counterparty defaults between t_{i-1} and t_i
- s_t is the credits spread of the counterparty at time t_i, used to calculate the CVA of the counterparty
- LGD is the loss given default of the counterparty, defined in the following section

Generally under Basel III the banks that have internal models for credit risk have to use this formula as a component of the overall CVA valuation. If some variables are not available, for example credit spread of the counterparty, then a proxy has to be used. In the case of credit spread there is a substitution in the form of a proxy spread based on the rating, industry and region of the counterparty (BCBS 2011a).

3.6.2 Loss Given Default

Loss given default (LGD) is the credit loss incurred if a debtor of the financial institution defaults. More precisely it is the ratio of losses to exposure at default. Three kinds of losses can occur: (i) the loss of principal, (ii) the carrying costs of non-performing loans, and (iii) workout expenses. Three ways can be used to measure LGD for an instrument. Market LGD is observed from the market prices of defaulted bonds or marketable loans soon after the default actually happens. Workout LGD is based on set of estimated discounted cash flows resulting from workout (loan repayment) and estimated exposure. Finally, implied market LGD is derived from risky but not defaulted prices of bonds, where a theoretical asset pricing model is used (Schuermann 2004).

Where the lack of statistical data on defaults prevents from utilizing the objective approaches of estimation, it is advised to use subjective approaches based on expert judgement as a source of information. Interviews with experts, using comparables (e.g. similar portfolios) or scenario techniques should be incorporated into evaluation. Basically all kinds of available loss related information should be an input to achieve the most accurate results (Engelmann & Ranhmeier 2011).

According to BCBS (2011a), LGD should be based on the spread of a market instrument of the counterparty, or if not possible use a proxy spread based on the rating, industry and region of the counterparty.

3.6.3 CVA

According to Vodička (2012), the basic definition of CVA can be written as:

$$CVA = PD * LGD * EAD \tag{3.8}$$

In the Equation 3.8 the PD represents the probability of the counterparty's default. LGD is the loss given default, hence the percentage of what is lost if the counterparty defaults. EAD is exposure at default.
BCBS (2011a) specifies 2 ways how to compute CVA capital requirement: Advanced CVA approach and Specified CVA Approach.

Standardized approach is defined for the banks that do not qualify for the internal EPE model. It is based on the following formula:

$$K = 2.33\sqrt{h}\sqrt{\begin{aligned}&\left(\sum_i 0.5 \cdot w_i(M_i \cdot EAD_i^{total} - M_i^{hedge}B_i) - \sum_{ind} w_{ind} \cdot M_{ind} \cdot B_{ind}\right)^2 + \\ &+ \sum_i 0.75 \cdot w_i^2(M_i \cdot EAD_i^{total} - M_i^{hedge}B_i)^2\end{aligned}} \tag{3.9}$$

Where

- 2.33 is the standard deviation for the 99% confidence interval
- h is the one-year risk horizon, h = 1
- EAD_i^{total} is the exposure at default of counterparty across all netting sets
- B_i is the notional amount of purchased single name CDS hedge, which is used to hedge CVA risk
- M_i is the notional weighted average maturity
- w_i is the weight allocated to the counterparty according to external rating
- B^{ind} is the notional value of purchased index CDS

- M^{ind} is the maturity of the index hedged 'ind'
- w_{ind} is the weight applicable to index hedges

Advanced approach is applicable to the banks with EPE model and VaR model for specific credit risk and will be used in the model. BCBS (2011a) defines this CVA capital charge as follows:

$$CVA = LGD \int_0^T P(t)EE(t)dPD(0,t) \tag{3.10}$$

P(t) is the risk-free discount factor for t, $EE(t)$ is the risk-neutral expectation of the exposure to the counterparty at time t.

The integral can be approximated by a following sum (Alluve 2012).

$$CVA = LGD \sum_{i=1}^{k} \left\{ \frac{EE(t_{i-1})P(t_{i-1}) + EE(t_i)P(t_i)}{2} \right\} (PD(t_i) - PD(t_{i-1}) \tag{3.11}$$

Here, $(PD(t_i) - PD(t_{i-1})$ is defined in the chapter devoted to probability of default.

3.7 Interest Rate Simulation

To simulate the interest rate movements a Monte Carlo model in excel was used. The model comprised 1000 simulations, each simulation started at the 2% interest rate and increased randomly in the predefined fashion by changing the range of random numbers. We cosider six different scenarios, from the mildest increase to the most severe increase of the interest rate.

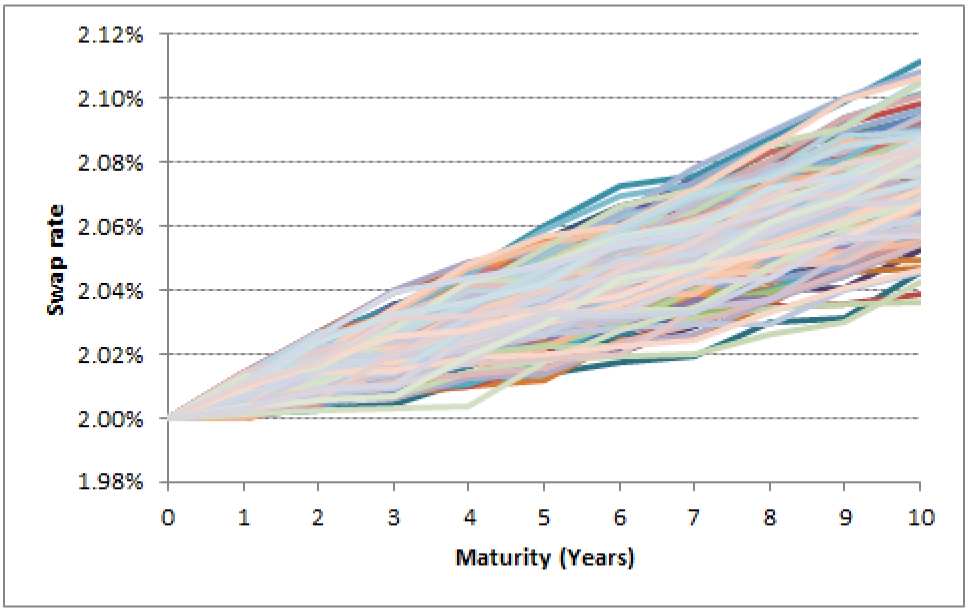
The cases are summarized in the Table 3.1.

Table 3.1: Simulation of the interest rates

	95% confidence interval of IR in Year 10
Scenario 1	2.05% - 2.10%
Scenario 2	2.5% - 3.0%
Scenario 3	3.0% - 4.0%
Scenario 4	3.4% - 5.0%
Scenario 5	4.4% - 7.0%
Scenario 6	6.0% - 10.0%

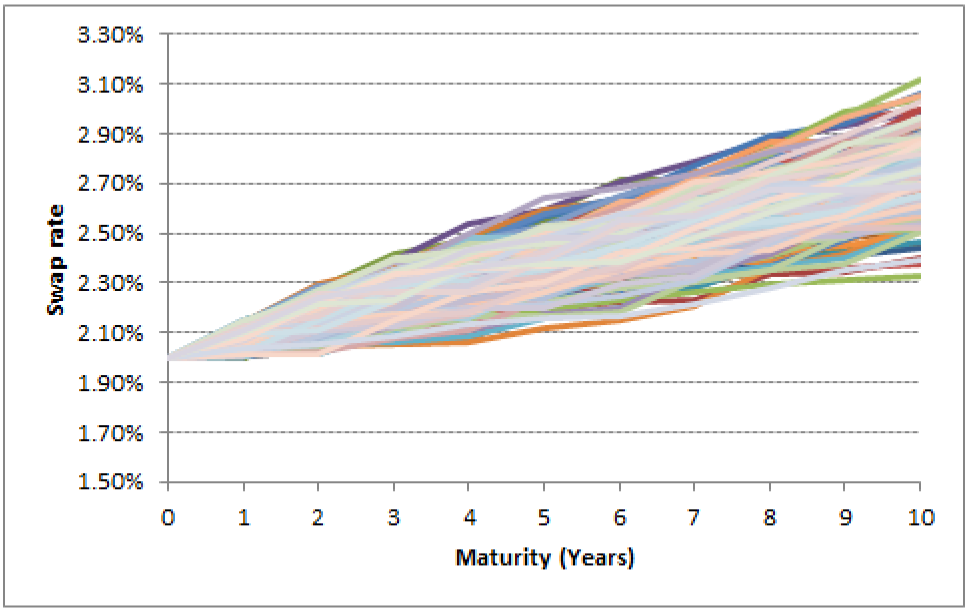
Source: Author

Figure 3.4: Swap rate simulation; 1st case



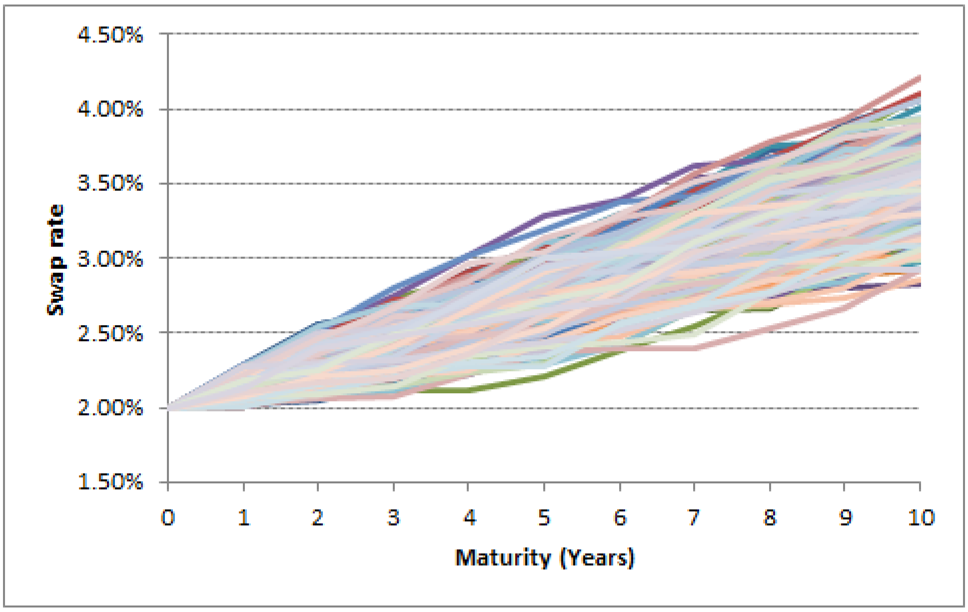
Source: Author

Figure 3.5: Swap rate simulation; 2nd case



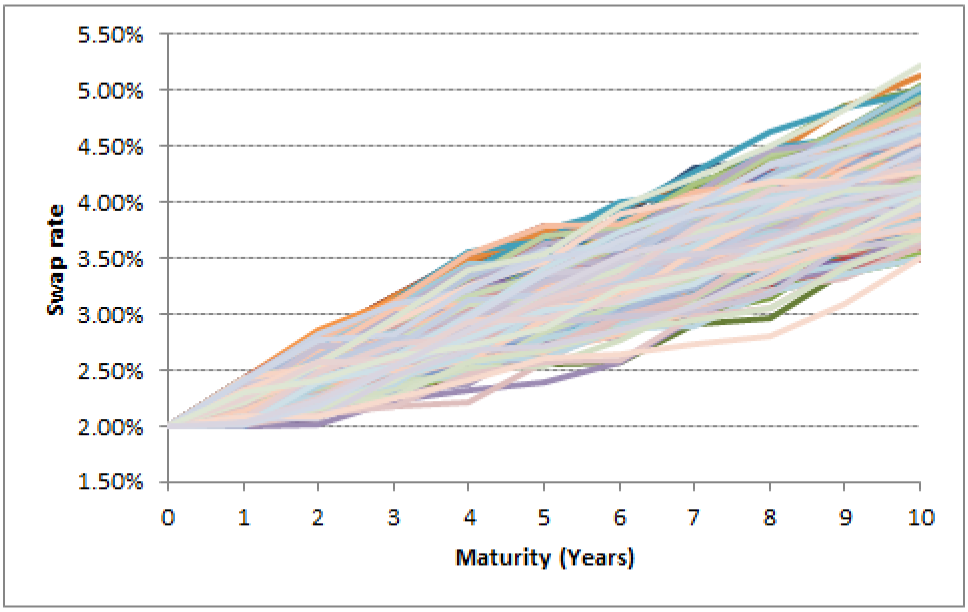
Source: Author

Figure 3.6: Swap rate simulation; 3rd case



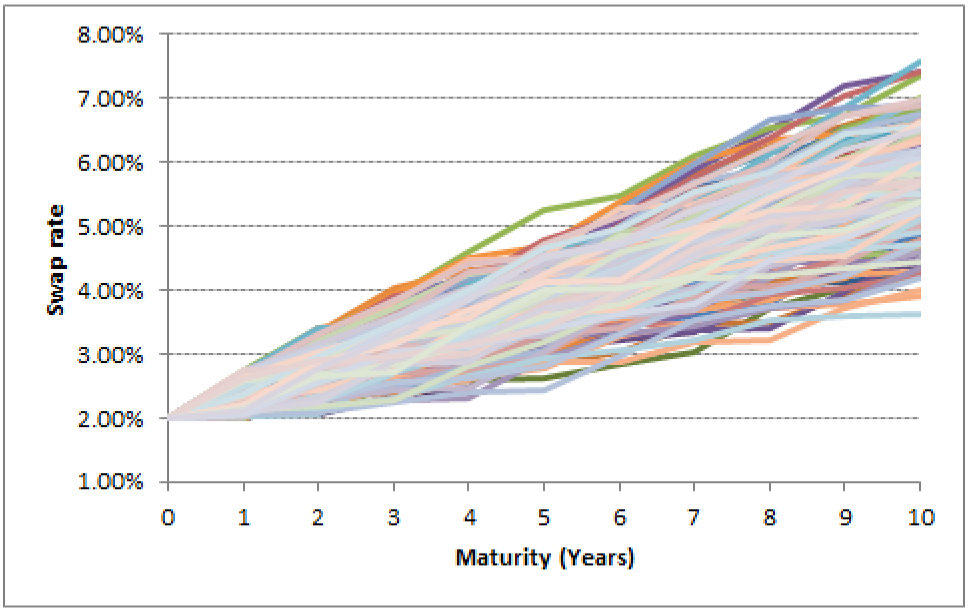
Source: Author

Figure 3.7: Swap rate simulation; 4th case



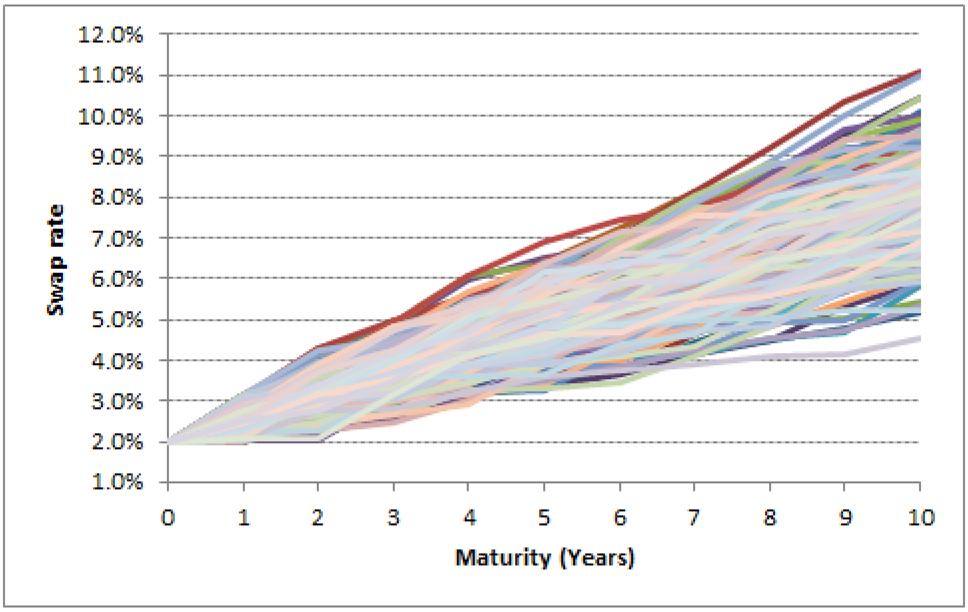
Source: Author

Figure 3.8: Swap rate simulation; 5th case



Source: Author

Figure 3.9: Swap rate simulation; 6th case



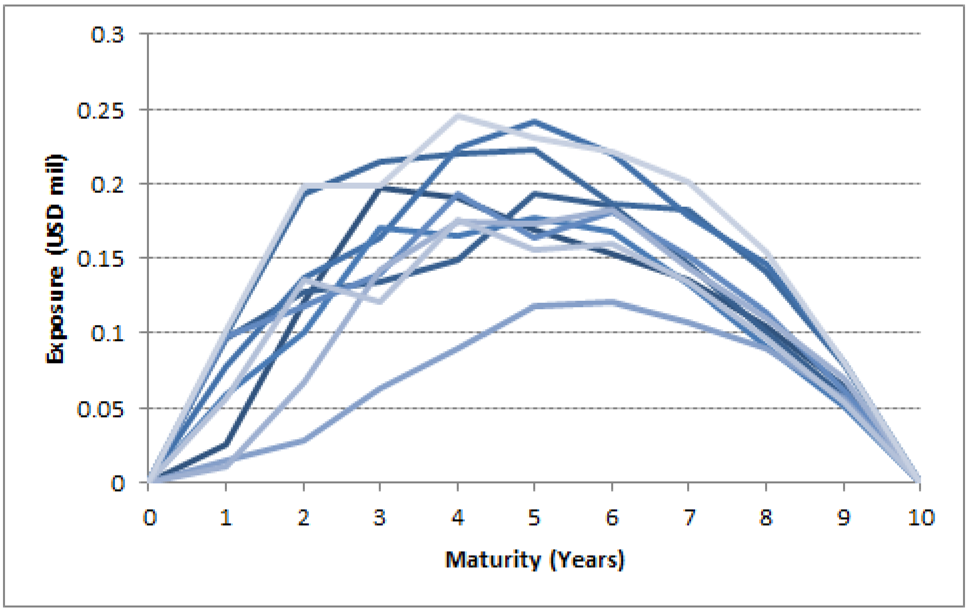
Source: Author

3.8 Swap Exposure Computation

We suppose a swap contract between two banks. We will call them Bank A and Bank B. Bank A is paying a fixed rate of 2%, Bank B is paying a floating rate based on the market conditions. We assume the notional value of the swap being USD 100 million. To compute the exposure of the swap we use the simulated interest rates of the previous six cases. For simplification, we can look at the swap as it were 2 bonds. Since Bank A is paying the fixed interest rate of 2%, then according to the assumption of rising interest rates in all cases it will be always in the money. Hence Bank A will always have a positive exposure and therefore faces the counterparty credit risk.

If we compute the market value of the swap in all the years of the swap's existence, we will automatically know the exposure of Bank A. Moreover we assume the maturity of the swap 10 Years, USD 2 million coupon paid annually. The following Figures show 10 (out of 1000) simulated exposures for the 6 scenarios.

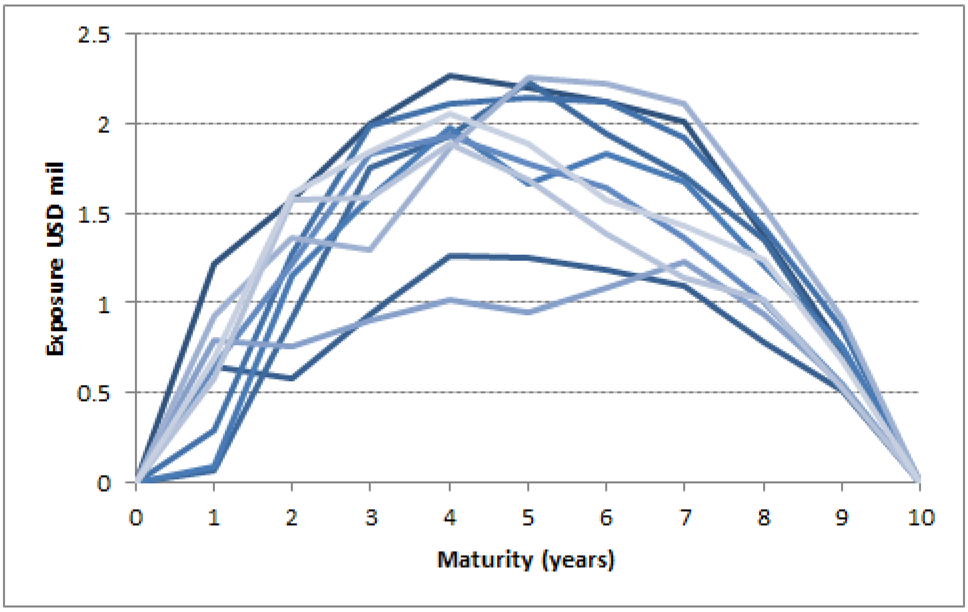
Figure 3.10: Swap exposure simulation; 1st case



Source: Author

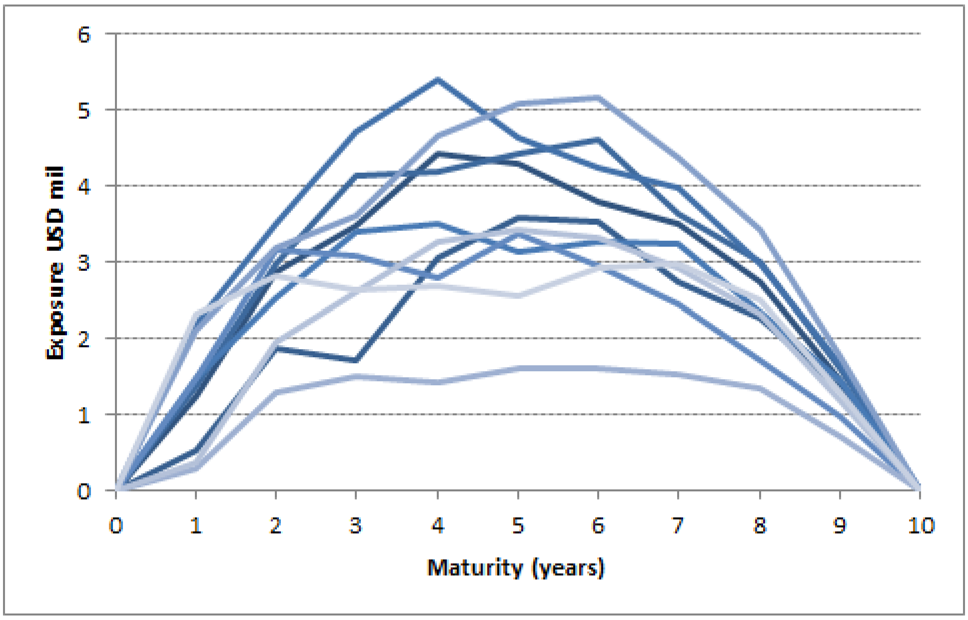
The exposure profile has a 'hill shape', it starts at zero and ends at zero. This is logical, because there is no uncertainty in the initiation and expiration of the swap. Somewhere in the middle of the swap life the exposure is the greatest, because of the highest uncertainty. As the projected interest rates are rising, the exposures rises with them. The highest exposure in Figure 3.10 is

Figure 3.11: Swap exposure simulation; 2nd case



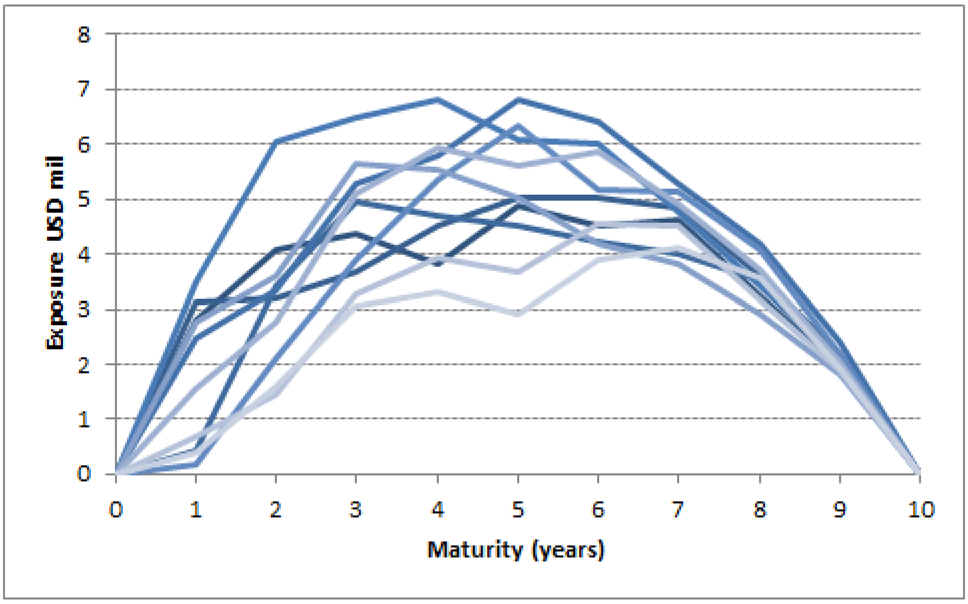
Source: Author

Figure 3.12: Swap exposure simulation; 3rd case



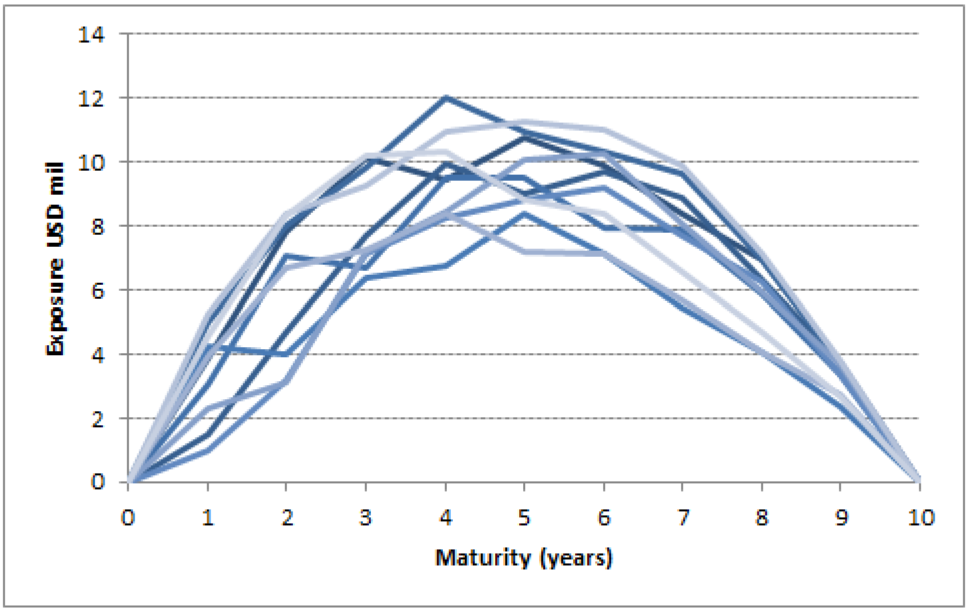
Source: Author

Figure 3.13: Swap exposure simulation; 4th case



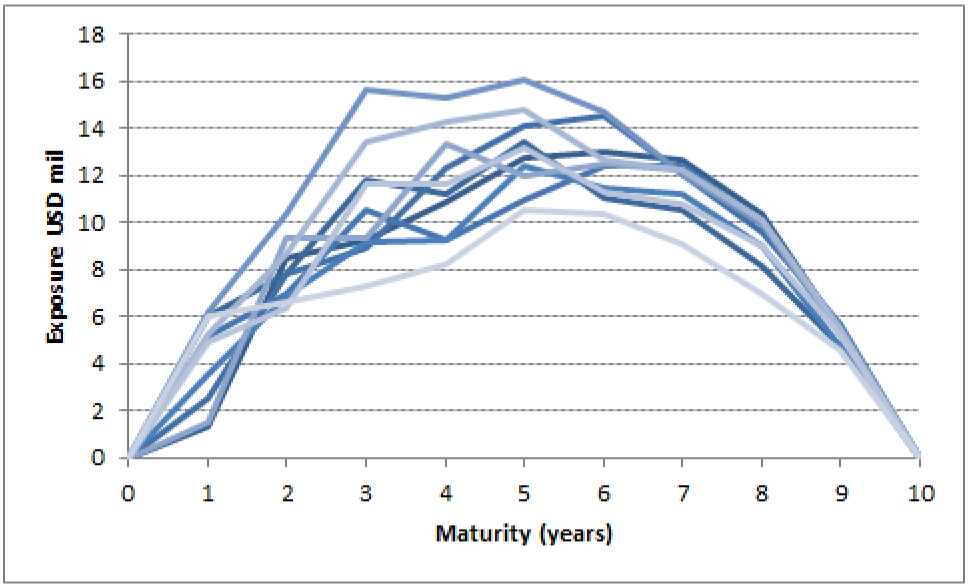
Source: Author

Figure 3.14: Swap exposure simulation; 5th case



Source: Author

Figure 3.15: Swap exposure simulation; 6th case



Source: Author

just USD 0.25 million, whereas in Figure 3.15 is about USD 16 million. Hence rising interest rate have a great impact on the exposure profiles.

In Table 3.2 we can see the expected exposure of our swap in different scenarios. For reminder, expected exposure is computed as the average exposure in given years, in our case from the 1000 simulations.

Table 3.2: Expected exposure of the swap

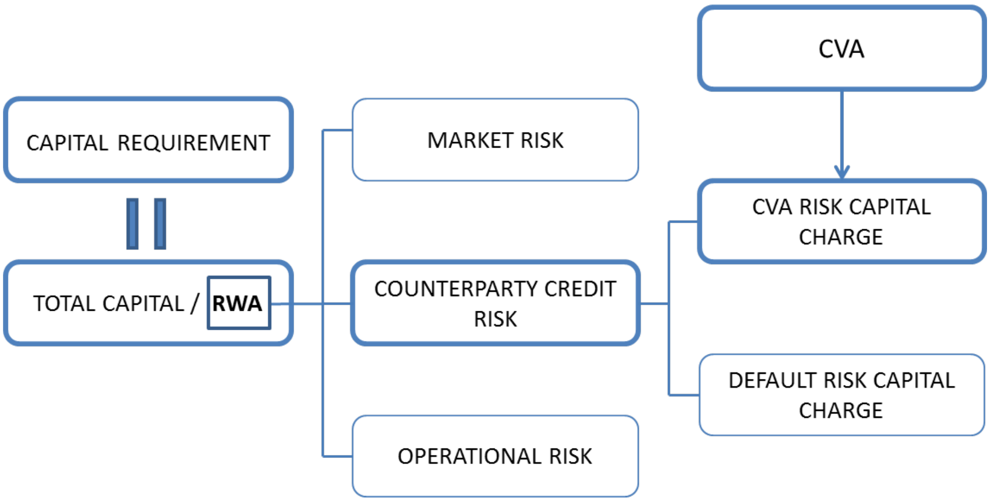
Maturity	0	1	2	3	4	5	6	7	8	9	10
Scenario 1	0.00	0.06	0.11	0.14	0.16	0.17	0.17	0.15	0.11	0.07	0.00
Scenario 2	0.00	0.62	1.09	1.45	1.65	1.73	1.67	1.48	1.14	0.65	0.00
Scenario 3	0.00	1.19	2.12	2.77	3.22	3.37	3.24	2.87	2.23	1.27	0.00
Scenario 4	0.00	1.77	3.17	4.18	4.78	5.04	4.92	4.35	3.36	1.92	0.00
Scenario 5	0.00	2.92	5.19	6.80	7.84	8.18	7.98	7.08	5.51	3.17	0.00
Scenario 6	0.00	4.70	8.20	10.76	12.22	12.74	12.35	10.99	8.56	4.94	0.00

Source: Author

3.9 CVA Modelling

First, to see the big picture, let us explain the relationship between capital requirements and the CVA. This relationship is depicted in Figure 3.16. The capital requirements is computed as the total capital of a bank over risk weighted assets for three kinds of risk - market risk, operational risk and counterparty credit risk. Counterparty credit risk has two components - default risk capital charge, which is the credit risk for conventional loans and CVA risk capital charge for OTC transactions with unstable credit exposure.

Figure 3.16: How is capital requirements connected to CVA



Source: Author based on Carlsson & Silén (2012)

The expected exposures for the six scenarios computed in the previous section forms the basic increment in the CVA formula. However, additional inputs are needed to compute the CVA according to Equation 3.11 and Equation 3.7. They are summarized in Table 3.3.

Table 3.3: Parameters to the CVA model

Parameter	Value
Risk-free discount factor (P_t)	2%
Loss given default (LGD)	60%
CDS spread	0.1

Source: Author

The risk-free discount factor was set to 2%, Loss given default to 60% and CDS spread to 0.1.

We can see in Table 3.4 that with increasing interest rates the CVA is increasing more or less proportionally. In the mildest increase in scenario 1 the CVA is negligible. It sums up to 0.001% of the notional which makes approximately USD 1,000. In the most severe scenario 6, however, the CVA value is 0.078% of the notional USD 100 million, which makes USD 78,000. Supposing a bank has in its portfolio more of these swaps and the total CVA is

Table 3.4: CVA results in percentages

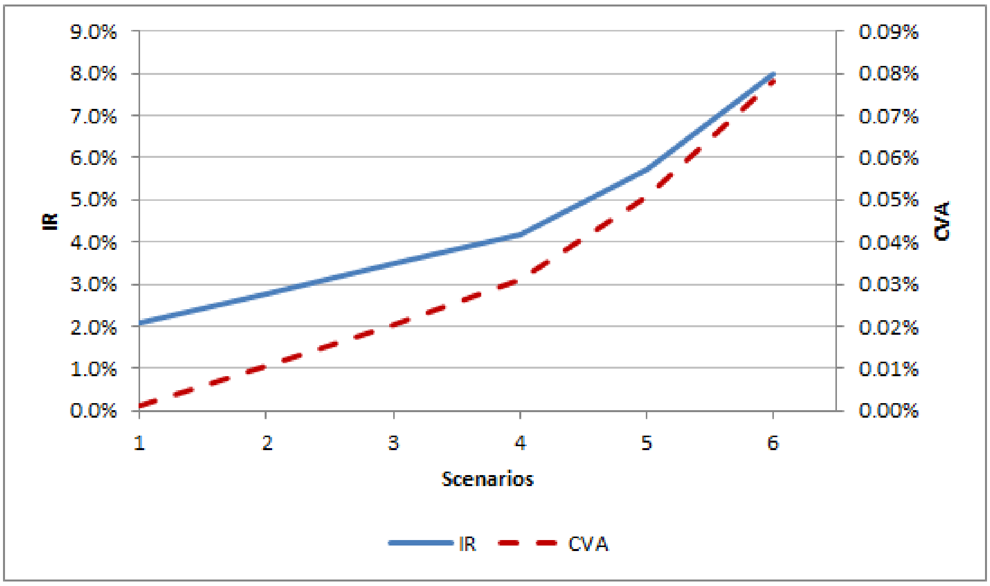
	IR	CVA
Scenario 1	2.05% - 2.10%	0.001%
Scenario 2	2.5% - 3.0%	0.011%
Scenario 3	3.0% - 4.0%	0.020%
Scenario 4	3.4% - 5.0%	0.031%
Scenario 5	4.4% - 7.0%	0.051%
Scenario 6	6.0% - 10.0%	0.078%

Source: Author

computed as a sum of each swap, then the overall CVA value is not something that should be overlooked.

Let us more closely analyse the relationship between CVA and interest rate. Since the simulated interest rate is in a range, the average of the two boarder values was made. The outcome can be seen in the Figure 3.17. With the increase of interest rate the CVA increases not linearly, but more rapidly. To further specify the rate of increase a more profound analysis would be needed. But we can reject the hypothesis the there is a linear relationship between CVA and interest rate.

Figure 3.17: The development of CVA with increase of interest rate



Source: Author

To make the example more to the point, we can asses how the CVA would impact the three Czech biggest banks: Komerční banka (KB), Česká spořitelna

(CS) and Československá obchodní banka (CSOB). The input values are displayed in the Table 3.5.

Table 3.5: CVA inputs for KB, CS and CSOB

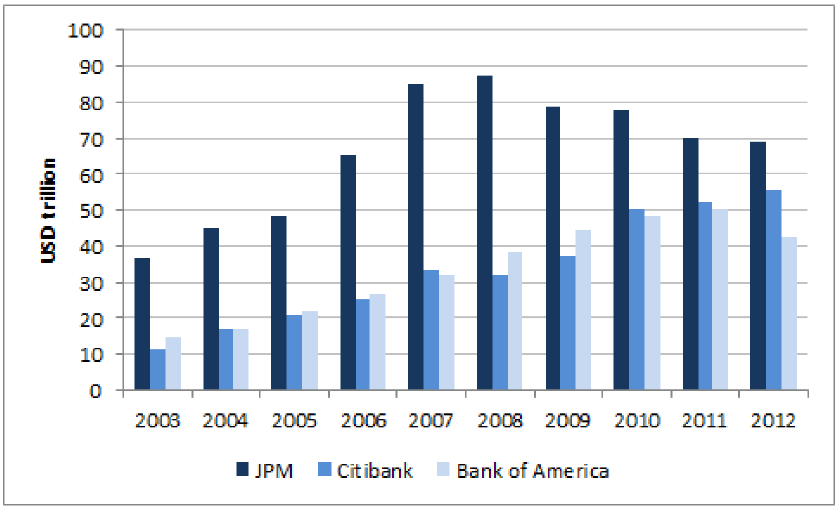
	CAD %	Capital (bn)	RWA (bn)	Derivatives (bn)
KB	14.6%	81.85	560.62	795.09
CS	13.1%	75.56	576.80	721.05
CSOB	13.6%	60.30	443.08	663.20

Source: Author based on Annual reports (2012)

If we apply the CVA percentages of our model case to the volume of each banks derivatives, we get the results that are displayed in Table 3.6.

We can see that even in the most severe scenario 6 the CVA forms only around 0.6 percent of the banks' capital. We can conclude that in the Czech Republic the banks have a solid capital base in proportion to derivatives hence Basel III CVA capital charge will have a small impact on the capital requirements. Thus the policy recommendation should follow that the use of CCPs should be limited in the Czech Republic. Nevertheless there are banks that use derivatives more abundantly and the analysis should reveal potential threat to them. We will focus on three of those banks that have the highest derivative exposure: JP Morgan Chase (JPM), Citibank and Bank of America. The exposure of the preceding banks can be seen in Figure 3.18.

Figure 3.18: Exposure to derivatives of JPM, Citibank and Bank of America



Source: Author based on Call Reports RC-L (2012)

Table 3.6: CVA for each scenario for Czech banks

Scenario 1	CVA (in bn CZK)	in % of capital
KB	0.0083	0.008%
CS	0.0070	0.007%
CSOB	0.0068	0.009%
Scenario 2		
KB	0.083	0.082%
CS	0.0698	0.075%
CSOB	0.0681	0.092%
Scenario 3		
KB	0.15693	0.158%
CS	0.1340	0.144%
CSOB	0.1307	0.176%
Scenario 4		
KB	0.2406	0.239%
CS	0.2023	0.217%
CSOB	0.1974	0.266%
Scenario 5		
KB	0.3961	0.394%
CS	0.3331	0.357%
CSOB	0.3251	0.439%
Scenario 6		
KB	0.6085	0.605%
CS	0.5117	0.548%
CSOB	0.4994	0.674%

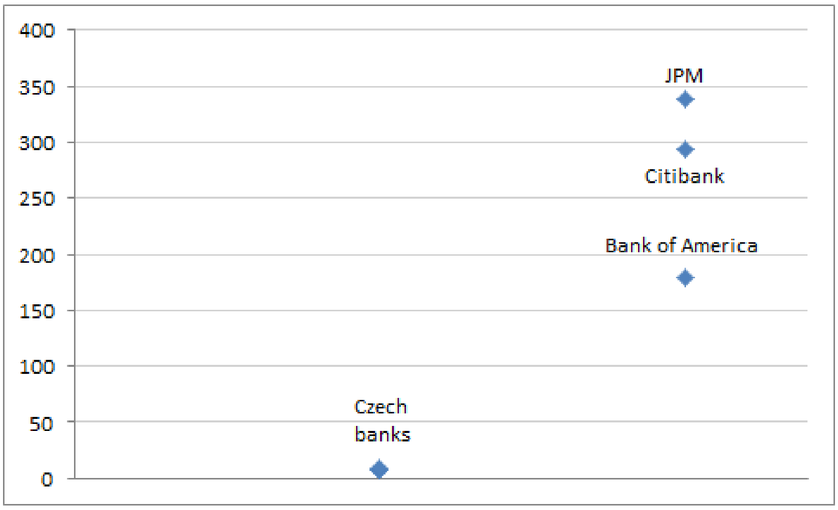
Source: Author

As can be seen, the highest exposure has the investment bank JPM, almost USD 70 trillion in 2012. There has been a massive reduction since 2008, where the exposure exceeded USD 87 trillion. Nevertheless the exposure remains still the highest among all US banks. The second place takes for the last three years (2010-2012) Citibank, currently with the exposure over USD 55 trillion and the third bank is Bank of America with exposure exceeding 42 trillion. Bank of America also greatly reduced the exposure since the year 2011 by USD 7.7 trillion.

Comparing Czech banks' exposure to derivatives, as can be seen the Table 3.5, with their American counterparts, we can conclude that on average the exposure of JPM, Citibank and Bank of America is more than 1,670 times higher than the average exposure of Česká Spořitelna, Komerční banka and CSOB. This is of course an impressive number, but we have to take into account the size of the bank, mainly its capital base. If the proportion of exposure to derivatives and capital would be the same as in case of Czech banks, then the exposure in the absolute numbers would be of a small importance.

The comparison of the Czech and American banks concerning the ratio of exposure to capital can be seen in Figure 3.19. The numbers are for the year 2012.

Figure 3.19: Exposure to Capital ratio



Source: Author

The difference is very clear. The Czech banks have their exposure to derivatives on average 8 times higher than their overall capital. Bank of America, Citibank and JPM have their ratios 179, 293 and 338 respectively. Hence the demand for capital would be a lot more than in Czech banks in case of the increase of interest rate. The summary Table 3.7 is an analogy of Table 3.6, but instead of Czech banks we analyse Bank of America, Citibank and JP Morgan. In the mild Scenario 1 the banks are not facing any troubles. The CVA represents only a fraction of percentages of the for-mentioned banks' capital. However, in Scenario 2 the percentage rises significantly, for JPM it is 3.6%, for Citibank it is 3.1% and 1.9% for Bank of America. The percentages grows as the interest rate grow and in the most severe Scenario 6, the CVA in percentages of capital increases to the threatening 26.5% for JP Morgan, 22.9% for Citibank and 14.0% for Bank of America. If the interest rate increased to fulfill this scenario, the banks would face severe deleveraging and the problems of great proportions.

The results are supported by Blundell-Wignall & Roulet (2012). The authors found a significant relationship between derivative exposure and distance to default. Specifically, among three analysed US banks, the worst came out Bank of America with distance to default (DTD) of 1.67 standard deviations. Citibank had the DTD 1.86 and surprisingly, as the most safe bank came out JP Morgan with DTD 2.55. The authors commented on this outcome, stating that JPM received a guarantee for $29bn of the $30bn less-liquid mortgage backed securities issued by Bear Stearns that was taken over be JPM. In this respect, some negative DTD attributes were ameliorated.

Table 3.7: CVA for each scenario for JP Morgan, Citibank and Bank of America

Scenario 1	CVA (in bn USD)	CVA in % of capital
JP Morgan	0.7	0.4%
Citibank	0.6	0.3%
Bank of America	0.5	0.2%
Scenario 2		
JP Morgan	7.4	3.6%
Citibank	5.9	3.1%
Bank of America	4.5	1.9%
Scenario 3		
JP Morgan	14.1	6.9%
Citibank	11.3	6.0%
Bank of America	8.7	3.7%
Scenario 4		
JP Morgan	21.3	10.5%
Citibank	17.1	9.1%
Bank of America	13.1	5.5%
Scenario 5		
JP Morgan	35.1	17.2%
Citibank	28.2	14.9%
Bank of America	21.6	9.1%
Scenario 6		
JP Morgan	54.0	26.5%
Citibank	43.3	22.9%
Bank of America	33.2	14.0%

Source: Author

3.10 Sensitivity Analysis

In this sections we will examine the sensitivity of parameters LGD, CDS spread and Pt. To perform the sensitivity analysis we chose 10 different values of respected variables and run the model with each of them. The results tell us how sensitive the CVA is to our selected variables. All the variables are held constant during the life of the swap. The results below are computed for the most severe 6th scenario.

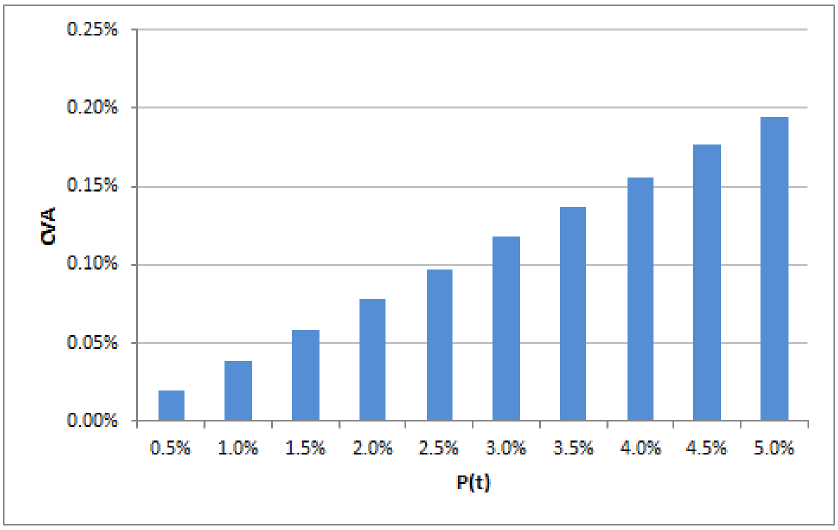
In Table 3.8 we can see the development of the variable P(t), i.e. the risk-free discount factor. To make the result more visible, it is also displayed in Figure 3.20. The values are linearly increasing from 0.5% to 5%. The value of CVA rises as the P(t) rises which is logical. The risk-free discount factor determinates how much of the exposure forms the CVA. The higher P(t), the higher CVA.

Table 3.8: Sensitivity of P(t)

P(t)	0.50%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%
CVA	0.020%	0.039%	0.059%	0.078%	0.097%	0.118%	0.137%	0.156%	0.177%	0.194%

Source: Author

Figure 3.20: Sensitivity of P(t)



Source: Author

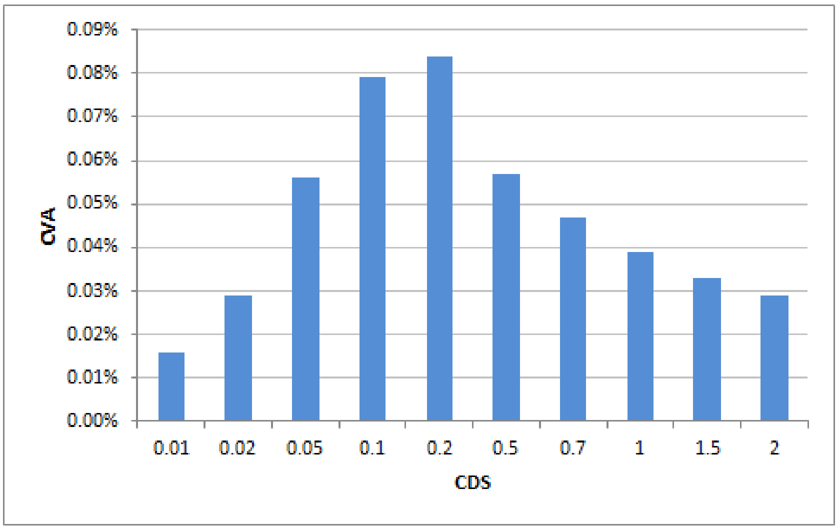
The values for the CDS spread were chosen from 0.01 to 2 (or 100 to 2000 bps). CVA rises up to the value 0.2, where it breaks even and is declining thereafter. The process can be seen in Table 3.9 and Figure 3.21. This is an unusual development, it would be more sensible to expect the rising CVA as the CDS rises without any cap. This abnormality would suggest to extend our research to find out the reasons for the CVA decline.

Table 3.9: Sensitivity of CDS spread

CDS	0.01	0.02	0.05	0.1	0.2	0.5	0.7	1	1.5	2
CVA	0.016%	0.029%	0.056%	0.079%	0.084%	0.057%	0.047%	0.039%	0.033%	0.029%

Source: Author

Figure 3.21: Sensitivity of CDS



Source: Author

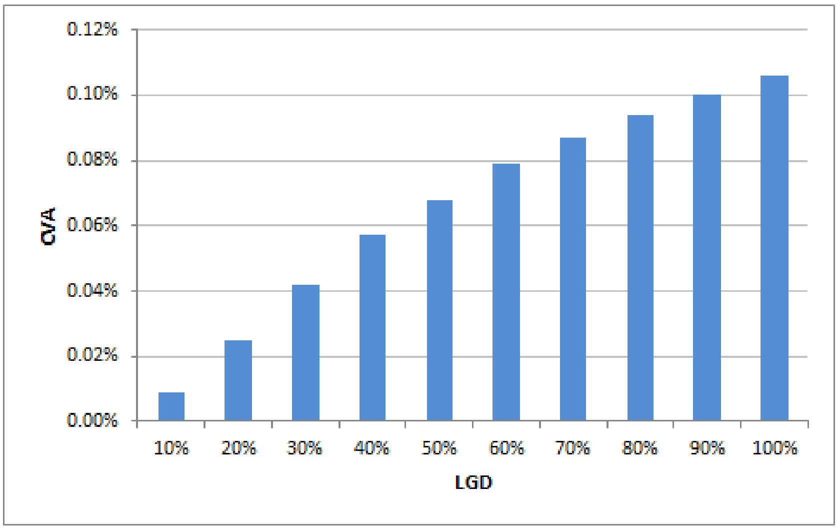
The final variable is LGD, i.e. loss given default. It covers percentages from 10% to 100%. Logicaly, the CVA is rising with the rise of LGD, as can be seen in Table 3.10 and Figure 3.22. CVA is expressing the value of counterparty credit risk, which is dependent on the variable of how much cannot be saved after the default of the counterparty. That is why the CVA rises when the LGD is increaring, hence increasing the cost of default.

Table 3.10: Sensitivity of LGD

LGD	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
CVA	0.009%	0.025%	0.042%	0.057%	0.068%	0.079%	0.087%	0.094%	0.100%	0.106%

Source: Author

Figure 3.22: Sensitivity of LGD



Source: Author

Chapter 4

Conclusion

In the thesis we presented a model for assessing what would be the impact of counterparty credit risk on capital requirements of banks, if interest rate suddenly increased. Our first hypothesis regarded the Czech banking sector. We came to conclusion that Czech banks have enough capital concerning potential interest rate increase to withstand any analysed scenario. The second hypothesis related to the US banks. We concluded that Bank of America, Citibank and JP Morgan do not have the capital base that would protect them form the increase of the IR. This founding was supported by the OECD research, Blundell-Wignall & Roulet (2012). In this OECD research paper the authors confirmed the significantly positive relationship between distance-to-default (DTD) and exposure to derivatives. Bank of America and Citibank belonged to the more threatened with Distance-to-Default less than 2 (1.86 and 1.67 respectively). JP-Morgan's relative high DTD (2.55) was ameliorated due to guarantee stemming from takeover of Bear Stearns. The third hypothesis referred to the relationship between interest rate and CVA, where we did not find a direct correlation.

The focus was also aimed at central counterparties, whether the centralized clearing would help to mitigate counterparty credit risk. The CCPs are inherently too big too fail and systemically important institutions. They handle a tremendous amount of counterparty credit risk. There is a very strong fear that the contagion would spread further if a central counterparty defaults. Hence the moral hazard of the management should be anticipated and reduced by careful regulations.

The future research will be focused on improvement of the model and deepening the knowledge about Basel III impact on banks' capital requirements and overall financial stability. The rigorousness of the model will be upgraded so that it will be able to capture more than just plain vanilla swaps and to compute with netting and collateral agreements that are most common in an OTC trade. Another issue is that the model produces outcomes for unilateral counterparty credit risk. This means it neglects the fact that the institution may default before its counterparty. In this case the default of the latter counterparty would become irrelevant or even profitable; it would pay only a fraction of the contract's value.

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Appendix

Figure 4.1: Overview of progress in implementation of the Basel capital framework by Basel Committee member jurisdictions

	As of October 2012			*As of end-March 2013*		
	Basel II	**Basel 2.5**	**Basel III**	**Basel II**	**Basel 2.5**	**Basel III**
Number of countries which have issued final rules and implemented them	22	20	0	24	22	11
Number of countries which have issued final rules, but have not yet implemented them	1	0	6	1	0	3
Number of countries which are at various stages of finalisation of rules	4	4	19	2	3	13
Number of countries which have not initiated any significant action to put in place the rules	0	3	2	0	2	0
Total	27	27	27	27	27	27

Source: BCBS (2013)

Figure 4.2: Phase-in arrangements

	2011	2012	2013	2014	2015	2016	2017	2018	As of 1 January 2019
Leverage Ratio	Supervisory monitoring		Parallel run 1 Jan 2013 – 1 Jan 2017 Disclosure starts 1 Jan 2015					Migration to Pillar 1	
Minimum Common Equity Capital Ratio			3.5%	4.0%	4.5%	4.5%	4.5%	4.5%	4.5%
Capital Conservation Buffer						0.625%	1.25%	1.875%	2.50%
Minimum common equity plus capital conservation buffer			3.5%	4.0%	4.5%	5.125%	5.75%	6.375%	7.0%
Phase-in of deductions from CET1 (including amounts exceeding the limit for DTAs, MSRs and financials)				20%	40%	60%	80%	100%	100%
Minimum Tier 1 Capital			4.5%	5.5%	6.0%	6.0%	6.0%	6.0%	6.0%
Minimum Total Capital			8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Minimum Total Capital plus conservation buffer			8.0%	8.0%	8.0%	8.625%	9.25%	9.875%	10.5%
Capital instruments that no longer qualify as non-core Tier 1 capital or Tier 2 capital			Phased out over 10 year horizon beginning 2013						
Liquidity coverage ratio	Observation period begins				Introduce minimum standard				
Net stable funding ratio	Observation period begins							Introduce minimum standard	

Source: BCBS (2011a)