School of Management

Financial Risk Management
In An Integrated Framework

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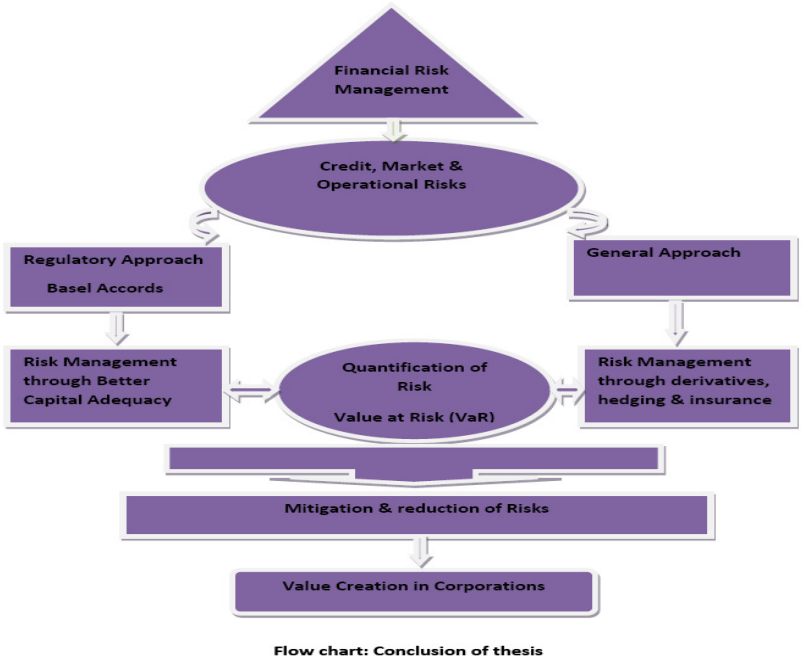

Flow chart: Conclusion of thesis

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Abstract

Statement of Topic

In modern business world of today, financial risk management is an important discipline for corporations, financial and public institutions. In this thesis, we have examined how different approaches of financial risk management interact in an integrated risk-management process for financial and business corporations separately. We have also elaborated risk mitigation in a corporation that are based on Basel accords and conventional risk reducing or mitigations approaches of hedging, derivatives & insurance and VaR.

Findings from our thesis

From our thesis, we have concluded that any corporation can generate value creation by mitigating and reducing the impacts of losses associated with financial risks. This can be done by implementing three steps of measuring, controlling and managing corporate-wide risks with applications of better capital adequacy regulations of Basel Accord & conventional practices of VaR, insurance, hedging and derivative in an integrated framework. From theoretical books, journals, we explored the value of using Basel Accords & Value at Risk (VaR) tool for Financial Risk Management and analyzed its pros and cons. The Basel Accord provides the guidelines and regulations for all the banks of world for better capital adequacy. It is apparent that Value at Risk has developed as a successful financial risk assessment methodology of corporations in the last decade. There are three methodologies in which Value at Risk can be measured. Danske Bank and Maersk - A.P Moller Group also use VaR for financial risk management.

Insurance is valuable to corporations in the context of mitigating the impacts of operational risk. Hedging against various kinds of risks is a common practice in financial institutions. Normally hedging is exercised in banks with derivatives. Corporate risk management through hedging against risks with derivatives minimizes the risks and thereby increasing the efficiency and worthiness of banks. Through our case study to Maersk - A.P Moller Group, we can observe that Hedging and Derivatives are commonly used to mitigate their interest rate and rate of exchange risks.

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Chapter 1: Summary and Introduction

1.1) Introduction

In 20th century, insurance was source of managing risks. Risk managers were primarily responsible for managing "pure" risks through the purchase of insurance. However the concept of risk management soon became associated with financial risk management with the use of derivative financial products.

Gustav Hamilton of Sweden's Statsforetag in early 1970s proposed the "risk management circle" to describe the interaction of all elements in the risk management process (assessment, control, financing and communication)[1]. This was a concept of holistic approach that made basis for modern risk management.

Financial risk management is the quality control of finance. It's a broad term used for different senses for different businesses or things but basically it involves identification, analyzing, and taking measures to reduce or eliminate the exposures to loss by an organization or individual. The practice of risk management includes some techniques such as insurance, hedge, derivative contracts, auditing, swaps.etc and some popular risk measuring methodologies like VaR to manage a wide variety of risks. Every business faces risk, some are predictable and under management's control and some are unpredictable and hence uncontrolled. We can take risks as an opportunity to get higher returns because higher risks are associated with higher returns. The climate of world's economy and markets can be affected very quickly by changes in exchange rates, interest rates, and commodity prices. Counterparties can rapidly become problematic. For instance, it is important to ensure financial risks are identified and managed appropriately.

1.2) Context of the study

"Corporate risk management' (CRM) seeks to identify, assess, and control sometimes through insurance, swaps more often through other means all of the risks faced by the business enterprise, especially those created by growth," (Griffith). Luis Ramiro Hernandez wrote in Risk Management.

[1] http://www.soa.org/ & http://www.soa.org/files/pdf/news-erm-fact-sheet.pdf

"The executives of a company can institute the processes that enable people and resources across the company to participate in identifying and assessing risks, and tracking the actions taken to mitigate or eliminate those risks''[2]

In corporate risk management, a risk is defined as a possible event or circumstance that can have negative influences on the corporation in question. It could have huge impacts that can be on the very existence, the resources (human and capital), the products and services, or the customers of the corporation, as well as external impacts on society, markets, or the environment. However for a financial institution, corporate risk management is normally thought as the combination of credit risk, interest rate risk or asset liability management, market risk, and operational risk.

There are two general approaches to financial risk management. First is risk decomposition, which involves managing risks one by one. Second is risk aggregation, that involves to rely on the strength if diversification to reduce risks. Normally, banks use both approaches to tackle with the problem of managing market risk. Where as the credit risks are normally by tradition are managed by using risk aggregation, but now with the passage of rapidly changing market techniques and advent of credit derivatives the risk decomposition approach can also be used.[3]

The case of Rosklide Bank of Denmark[4], highlights the significance of better risk management as in the mid of July, 2008 it fell as much as 82 kroner and was down 49 percent at 73 kroner in Copenhagenthe stock market. Because bank is highly exposed in real estate[5] and has to accept that its credit portfolio is more risky than before[6].

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[2] Risk managers….The new Emperors of Wall Street. (Risk Magazine, March 1999)

[3] John Hull C 2007, page 23

[4] http://www.bloomberg.com/apps/news?pid=20601213&refer=home&sid=agxUn22XGZMA and http://www.cphpost.dk/get/41288.html

5 According to Svenska Handelsbanken AB's Danish Chief Economist Jes Asmussen ''Danish house prices will drop as much as 10 percent this year and next because of rising borrowing costs and too much supply''

6 Roskilde Bank has a solvency ratio of 11.5 percent, somewhat higher than the legal requirement that a bank's capital base must be at least eight percent of its investments, loans and other business where financial risks lies. The regulatory requirements of capital for risks are discussed in details in coming chapters.

According to Philippe Jorion[7], ***'Corporate/Enterprise-wide risk management, or integrated Risk Management, aims at measuring, controlling, and managing the overall risk of the institution across all risk categories and business lines'.***

Financial Risk Management: In our thesis we will focus on financial risk management in an integrated framework or under broader concept of corporate risk management.

According to Banking Business review latest news[8], Northern Trust has launched a daily integrated risk reporting tool to consolidate predictive risk management, performance evaluation, and compliance analysis on the company's fundamentals dashboard. The newly integrated reporting dashboard, refreshed daily, is appropriate for institutional clients, such as pension funds, insurance companies, foundations and endowments, as well as some ultra high net worth clients, and fund managers across the globe. The solution is tailored to client needs and is much more welcomed by the customers. This also reveals the importance of an Integrated Financial Risk Management.

Normally credit risk, market risk and operation risk related to financial matters are dealt with under financial risk management. According to financial dictionary 'financial risk is a risk that a firm will be unable to meet its financial obligations. This risk is primarily a function of the relative amount of debt that the firm uses to finance its assets. A higher proportion of debt increases the likelihood that at some point the firm will be unable to make the required interest and principal payments. Examples include default risk of a credit, markets risks of interest rate, foreign exchange rate, equity price and commodity etc. All this should be made possible by a convergence in methods used to quantify financial risk.

Objective of the Study

Business/financial corporation should take risks as an opportunity because in our point of view higher risks are associated with higher returns. Preparation is a key component of financial risk management.

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[7] Philippe Jorion 2006, 3rd Ed, page 521
[8] Banking Business Review, Risk Management, http://riskmanagemnet.banking-business-review.com

The objective of the study is to see how businesses can be prepared & cope with financial risks that are possible to control or mitigate for value creation.

1.3) Problem Formulation

Our purpose is to examine and see that how different approaches of financial risk management interact in an integrated risk-management process separately for financial and business corporations. We will base our thesis mainly on literature review in which a theoretical framework will be sought out for an integrated/corporate/ enterprise risk management framework. For this purpose, we would answer the following questions,

1) For better corporate risk management, which checks & controls should be applied and what are currently available approaches that are most qualified?

2) How the net worth of a corporation either a financial or business can be increased by minimizing the risks and losses associated with different departments of the corporation?

3) How important we should cope with risks of a financial corporation by mixing general approach with Basel accords in an integrated framework? As well as, why these risks and controls are important to a Corporation?

Risk management in an Integrated Framework

For the purpose of answering the above research questions we did study of relevant literature and analysed cases of some companies. This enabled us to develop the following framework for better financial risk management. It is based on three steps of integrated risk management. We have argued in following chapters that what should be done under what step to reap the maximum benefits for value creation in any corporation.

Risk management in an Integrated Framework

Corporate/Integrated Risk Management process	Financial Risks
Measurement of corporate wide risks	Basel Accord & Value at Risk (VaR)
Controlling Corporate-wide Risk	Hedging derivatives & Insurance etc
Managing Corporate-wide Risk	Properly offsetting & managing risks
Result: Mitigation of risks	Value creation

(Philippe Jorion, 2006)[9]recommended following three steps for integrated risk management that we have further analyzed and elaborated in the context of the framework that we developed as well as for the purpose of this paper.

1.3.1) Measuring Corporation-wide Risk

This first step involves the measurement of overall risks. If a capital charges have been set up once for the various classes of risk, the overall charge can be totted up from the various components. And we think Basel Accord provides solid guidelines for the allocation of capital charges for coping risks. For instance, a main result is that the overall charge will be less than the total, due to diversification effects of breaking down risks of market, credit and operations. In this step we recommend Basel accords and VaR to be used for financial risk measurements in certain situations of corporations. This is comprehensively discussed in following chapters.

1.3.2) Controlling Corporate-wide Risk

[9] Philippe Jorion 2006, 3rd Ed page 521-527

In the modern business world of today businesses are becoming more complex, with more products that reach across various risk categories. Therefore, there is a need to have a better control over global risks. Particularly financial institutions are discovering complex and unanticipated interactions between their risks. Moreover, it seems that risk has a way of moving toward areas where it is not well measured and some times attempts at controlling one type of risk often end up creating another one. For example, an increasing number of instruments now mix different types of risks. For instance, credit derivatives involve both market and credit risk and so do tradable loans. All these types of risk interactions create a need for integrated risk-management systems.

Conventional risk management approaches of insurance and hedging through derivatives are handy to corporations in controlling risks.

1.3.3) Managing Corporate-wide Risk

Corporate risk-management systems should allow institutions to manage their risk much better. However, in some of the cases where some risks are difficult to quantify, the process itself creates insights into a company's overall risk. So, this will create a better allocation of capital. Besides, better allocation of capital, hedging against risks with derivatives is also very useful. As some financial corporations have discovered that some risks offset each other.

Furthermore, the most tangible benefit of corporate risk management is cost reduction for insurance against corporation-wide risks. Financial institutions do not need to buy separate insurance against each type of risk by treating their risks as part of a single portfolio, thereby taking advantage of diversification benefits.

Corporate risk management can also help to save transactions costs. For instance, by the mid-1990s, hedging systems consisted of focusing on sources of risk one at a time and perhaps covering risks individually. That's how; most of the multinationals would evaluate their transaction risks in various currencies and hedge them individually. This approach has a problem that it is inefficient because it ignores correlations that exist among financial variables. However, transaction costs can be saved if the hedging problem is viewed on a company-wide basis.

Contribution to the Research

We recommend to financial institutions to follow corporate risk management by following capital allocation procedure of Basel Accords with some generally accepted useful risk management techniques like Value at Risk (VaR), hedging, insurances and derivatives etc. The basis on which, we are suggesting so are thoroughly discussed in details in coming chapters of the thesis.

Our contribution in this thesis would be to merge internationally accepted CRM's of Basel accords with the general literature of CRM and important risks including some own suggestions learned during our studies of literature and case studies of Danske bank & Maersk. However our major focus will be on the financial risks and their measurements, methodologies & techniques like value at risk (VaR).

1.4) Organization of Thesis

Discussing corporate risk management is always difficult because each corporation is different. Certainly there are many areas about that risk management can deal with, for example Investments, trading and business firms but for our own interest and convenience we will focus our thesis with respect to corporate finance. Which will cover different areas as whole and that could bring about some reductions in risks and resultantly maximize the worth of corporation.

We can see the case of the risk management organizational structure of Danske Bank in appendix A, which has a hierarchal division of risk managing and controlling responsibilities among different units of the Group. This set-up of the Group uses most of the approaches as we have discussed in the paper and is quite successful in risk management. The whole set up of the group for risk management is using the integrated risk management steps at different levels, which can also be attributed to our personally developed framework.

For our purpose of the thesis, we will use four chapters which will cover each of the steps of the Corporate/Integrated Risk Management process mentioned in above Chapter 1.3.

1) First of all, we will focus on the most important step of Corporate Risk Management in Chapter 2 and 3, which is its tools and measurement of corporate wide risks. Measurement of corporate wide risks is taken as the core of the Corporate Risk Management and we will put more pages on it.

2) Chapter 2 will be descriptive illustration of Basel Accords and our own analysis of its importance and criticism.

3) Chapter 3 will combine literature review and some case analysis from Danish Banks to elaborate Value at Risk (VaR).

4) Chapter 4 will be the second step of controlling corporate-wide risk, which is Insurance, hedging & derivatives. In this Chapter, the major methodology will be also quantitative analysis from literature with our case study from Danske Bank.

5) Chapter 5 will explain how Business Enterprises manage corporate-wide risk by case study from Maersk-A.P. Moller Group.

6) Chapter 6 is our conclusion and findings.

1.5) Methodology

The research methodologies of the thesis include a combination of a theoretical analysis through a critical perspective to the Corporate Risk Management literature and an empirical case study from Maersk-A.P. Moller Group and a few Danish Banks illustrations.

The data presented were collected both from primary and secondary sources. The primary sources were retrieved through interviews and first hand document from Maersk-A.P Moller Group and Danske Bank. The secondary sources were retrieved from annual reports, books, journals, internet and magazines. The case of Danske Bank is inserted in chapter 3 and chapter 4 together with the theoretical analysis by the method of quantitative analysis. The case study of Maersk A.P Moller Group has been chosen because this company is one of the largest companies in Denmark and Risk Management is their important task to prevent the group from losses. Interviews have been conducted within Maersk-A.P. Moller Group by meeting with two senior management people of Risk Management team from their Group Finance and Maersk Line Finance. The case study of Maersk is using the method of qualitative analysis.

When we selected the risk measurement for the purpose of the topic, we chose VaR (Value at Risk). Value at risk is a quantitative tool to measure the market risk and it is mostly used in banks and for

financial risk management of nonfinancial institutions. The thesis also includes a descriptive and critical analysis of VaR (Value at Risk).

1.5.1) Quantitative tool_ Value at Risk (VaR) Model

Value at risk is a quantitative tool to measure the market risk. VaR is widely used by almost all the famous financial institutions including banks, hedge funds and private equity firms to measure risk. There are three basic approaches that are used to compute Value at Risk, though there are numerous variations within each approach. The measure can be computed analytically by making assumptions about return distributions for market risks, and by using the **variances in and co-variances** across these risks. It can also be estimated by running hypothetical portfolios through **historical data** or from **Monte Carlo simulations**. We have chapter 3 specially using quantitative tool of VaR model to measure market risk.

1.5.2) Case Study Research methods

In addition to quantitative analysis, qualitative analysis has also been used for this thesis. Qualitative inquiry employs different knowledge claims, strategies of inquiry, and methods of data collection and analysis.[10] It then could provide a deeper understanding of the research. Qualitative analysis prioritizes the study of "perception, meanings and emotions" as well as "behaviour" which aims to "figure out authentic insights" and "study how phenomena are constructed".[11] Qualitative research includes interviews, observation, texts, audio or video recordings and so on. In this project, we mainly used interviews and audio recordings and secondary material such as company website, presentation, annual report etc.

1.5.2.1) Interview

The best way to learn people's subjective experience is to ask them about it and listen carefully to what they say. That is also a powerful method of producing knowledge. In this case study, we chose

[10] Creswell, 2003, Page 181
[11] Silverman, 2005,Page 134

interview as our major research method and conducted two formal interviews with the head from Maersk Group Finance Risk Management team and the leader of Maersk Line Risk Management.

The interviews were carried out in English, a foreign language for both interviewers and interviewees. The interviews took place in case company's meeting rooms. Prior to interview, a short introduction of us and our research topic was presented to interviewees and as agreed, we took record for each conversation. Based on Creswell (2003), [12]qualitative research is emergent rather than prefigured, interview questions could be changed for situated purpose. Even though the interview questions are well prepared, according to Creswell (2003), our strategy is to "control over the line of questions", evoking or guiding participants to involve as much as possible rather than insisting on specific questions. Therefore, some non-prepared questions were asked and some valuable answers were received. After interview, we took some time on transcribing two interviews for detailed analysis.

1.5.2.2) Secondary material

Using secondary material is a quick method to get to the point, it saves the time and expenses of transcribing. It enables us to find out historical data, and provides the opportunities for participants to directly share the resources. For the secondary material, we mainly focused on the company website, some presentation slides and 2009 Annul Report posted in April. However, there could be some limitation on the secondary materials as it might be out-dated for some presentations or website.

1.5.3) Conclusion of methodologies

Quantitative methods involve the processes of collecting, analyzing, interpreting, and writing the results of the study. [13] The specific methods are commonly used for financial analysis of modelling, calculating and presenting the results. In chapter 3, the VaR modelling applied the quantitative methods.

[12] Creswell, 2003, Page 183
[13] Creswell, 2003, Page 120

Qualitative analysis is a "socially constructed nature of reality" and "one can not escape the personal interpretation brought to qualitative data analysis"[14]. Interview and secondary material, none of them could be always objective, accurate. We cannot rank them or choose the best, no method of research is intrinsically better than others; everything depends upon what we are trying to find out. Choosing a "method that is appropriate to what you are trying to find out" is needed[15]. Therefore, we combined two research methods together to serve for the purposes of case study.

For our purpose of the thesis, we have collected information from Maersk-A.P Moller of Denmark and Danske Bank. We got information of currency exchange and interest risks involving derivatives of Maersk under market risk. For banks, we analyzed credit risk of Danish banks under historical simulation of VaR and derivatives being used by Danske Bank. For some desired information which we could not get access to due to being confidential, we have supported our theoretical analysis and methodology with instances and examples of these corporation's practices of VaR with the help of available public information.

[14] Creswell, 2003 Page 185
[15] Silverman, 2005 Page 136

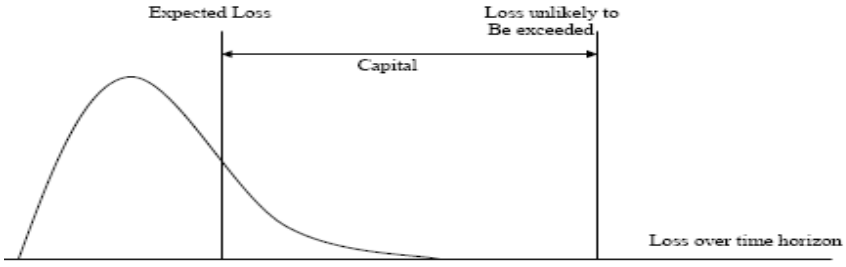
Chapter 2: Basel Accords

2.1) Introduction

Basel Accords are the banking capital framework, which is sponsored by the central banks of the world. These accords are designed to promote uniformity, make regulatory capital more risk sensitive, and promote enhanced risk management among large, internationally active banking organizations. Basel Committee on Bank Supervision (BCBS) provides a set of agreements by giving recommendations on banking regulations in regard to credit risk, market risk and operational risk.

Capital requirement is of great importance under the Basel Accords and these set the guide lines for the financial institutions. It is internationally accepted that a financial institutions should have capital that could cover the difference between expected losses over some time horizon and worst case losses over the same time horizon. Here the worst case loss is the loss that should not be expected to exceed with the some high degree of confidence. This higher degree of confidence might be 99% or 99.9%.The reason behind this idea is that expected losses are normally covered by the way a financial institution prices its products. For instance, the interest charged by a bank is designed to recover expected loan losses. However the capital is a mitigating tool to protect the bank from an extremely unfavourable outcome. All this is depicted in the following figure 2.1.[16]

Figure 2.1: The loss probability density function and the capital required by a financial institution



[16] John Hull C 2007, Page 166

Source: John Hull C 2007, p 166

2.2) the Basel Committee

The Basel Committee is made from the representatives of central banks and regulatory authorities of the G10 countries, and some others (specifically Luxembourg and Spain). The committee can not enforce recommendations because it does not have the authority; however most of the member countries (and others) tend to implement the Committee's policies. Simply, we can say that the recommendations are enforced through national (or EU-wide) laws and regulations, rather than as a result of the committee's recommendations - thus some time may pass between recommendations and implementation as law at the national level.

2.3) Basel I

Basel I which is the first Basel Accord, was issued in 1988 and focuses on the capital adequacy of financial institutions. This accord mainly talks about the capital adequacy risk, which is the risk that a financial institution will be hurt by an unexpected loss. It categorizes the assets of financial institution into five risk categories i.e. 0%, 10%, 20%, 50%, and 100%. Normally the Banks that operate internationally are required to have a risk weight of 8% or less[17].

This accord had created capital requirements for credit risk which is the loss arising from the default by a creditor or counterparty in banking assets.

Risk weighted assets (RWA) are the result of risk weights multiplied with the respective exposures.

This Basel I accord requires that a bank should hold at least 8 % of the RWA as a capital charge or a minimum capital requirement (MCR) for the safety against credit risk. For the claims on banks there is a 20 % risk weight; however it can be transacted into a charge of 1.6% of the value of claim. For instance, we can say that an exposure of $1 million will be equivalent to RWA of $200.000 and to MCR of $16.000 as a result of the following calculations,[18]

[17] http://www.answers.com/basel+accord?cat=biz-fin
[18] Bol, Nakhaeizadeh, Rachev, Ridder Vollmer 2003, page 2-3

$$RWA = Exposure \times Risk\ Weight = 1\ Million\ \$ \times 20\ \% = 200{,}000\ \$\ MCR$$

$$= RWA \times Minimum\ Requirement\ of\ 8\ \%$$

$$= 200{,}000\ \$ \times 8\ \% = 16{,}000\ \$$$

But if we compare with the minimum capital requirements for claims on corporate of $1 Million would be,

$$MCR = RWA \times Minimum\ Requirement\ of\ 8\ \% = 1\ Millions\ \$ \times 8\ \% = 80{,}000\ \$$$

After the first Basel Accord there was felt a need to have better regulations for financial institutions especially that could lay down the rules for other types of risks.

Roskilde Bank has a solvency ratio of 11.5 percent, somewhat higher than the legal requirement that a bank's capital base must be at least eight percent of its investments, loans and other business where financial risks lies. Because this bank is highly exposed in real estate and has to accept that its credit portfolio is more risky than the basic risk to meet regulatory requirements of capital.

2.4) Basel II

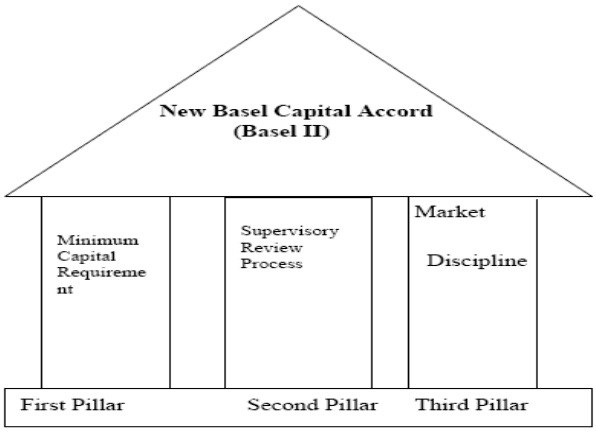
The Basel II accord almost completely overhauls the Basel Accord I .This accord is based on three mutually supporting "pillars" of capital adequacy. The firs pillar is an explicitly defined regulatory capital requirement, a minimum capital-to-asset ratio equal to at least 8% of risk-weighted assets. Second pillar is about the bank supervisory agencies like the Comptroller of the Currency, have authority to adjust capital levels for individual banks above the 8% minimum when necessary. And the third supporting pillar calls upon market discipline to supplement reviews by banking agencies.

The Basel II is to be fully implemented by 2015. This accord has focus on three main areas, including minimum capital requirements, supervisory review and market discipline. The purpose of Basel II is to strengthen international banking requirements as well as to supervise and enforce these requirements, for instance to ensure that financial institutions have enough capital on account to meet obligations and

absorb unexpected losses[19]. The main aims of the second Basel can be defined to make it sure that capital allocation is more risk sensitive. There was an attempt to separate operational risk from credit risk. However quantifying both, there should be an attempt to align economic and regulatory capital more closely to reduce the scope for regulatory arbitrage.

In fact Basel II does not change the question of how to actually define bank capital, which diverges from accounting equity in important respects. Nevertheless, the Basel I definition still remains in place.

Basel II has three pillars. This is a concept that could be analysed as (1) having minimum capital requirements which addresses risk, (2) a supervisory review and (3) discussing market discipline in order to have greater stability in the financial system.



Source: Bol, Nakhaeizadeh, Rachev, Ridder Vollmer (2003, page 6)

However the Basel I accord discussed only some parts of each of these pillars. For example, if we compare the Basel II with respect to the first, only credit risk was dealt with in a simple manner while market risk was an afterthought; operational risk was not dealt with at all.

2.4.1) First pillar

[19] http://en.wikipedia.org/wiki/Basel_II

This pillar mainly discusses with maintenance of regulatory capital calculated for main risks types that a bank faces, which are, **Credit risk/ Operational risk/ Market risk**

The first pillar has provided three different ways of calculating credit risk components with varying degree of sophistication, which are standardized approach, Foundation IRB (Internal Rating-Based Approach) and Advanced IRB. Similarly operational risk has also three different approaches, first basic indicator approach or BIA, Standardized Approach or STA, and advanced measurement approach or AMA. However for the market risk the preferred approach is Value at risk (VaR).

Minimum Capital Requirement:

The first pillar provides the MCR (Minimum Capital Requirement) and also defines the minimum ratio of capital to RWA. It's very necessary to know about the total capital requirement and its measurement for the banks. The new framework also maintains the current definition of total capital and minimum requirement of at least 8 % of the bank's capital to RWA[20.]

Capital Ratio: $\dfrac{\text{Total Capital}}{\text{Credit Risk + Market Risk + Operational Risk}}$

(John Hull C 2007)[21] describes in details risk weighted asset for operational risk a risk which is defined as 12.5 times the calculated operational risk capital as in the following equation,

Total capital = 0.08 * (credit risk RWA + Market risk RWA + Operational risk RWA)

The calculation of the denominator of the capital ratio is dependent on three different types of risks, credit risk, market risk and operational risk. However the credit risk measurement methods are discussed in details than those in current Accord whereas the market risk measures remains unchanged. Nevertheless, the new framework proposes for the first time a measure for operational risk. (Bol, Naskhaeizadeh, Rachev, Ridder, Vollmer 2003, page 6-7)

[20] Bol, Nakhaeizadeh, Rachev, Ridder Vollmer 2003, page 6 & 3-11
[21] John Hull C 2007, Page 179

Table2.1. Rationale for a new accord

Basel 1 Accord	Basel 2 Accord
Focus on a single risk measure	Emphasis bank's own internal methodologies, supervisory review and market discipline
One size fits all	Flexibility, menu of approaches, incentives for better risk management
Broad brush structure	More risk sensitive

2.4.2) Second pillar

The second pillar of Basel II discusses the regulatory response to the first pillar. It gives regulators improved 'tools' as compare to the ones available to them under Basel I by providing a framework. This framework deals with all the other risks a bank may face, for example pension risk ,systemic risk, concentration risk, strategic risk, reputation risk, liquidity risk and legal risk, which the accord combines under the title of residual risk.

2.4.3) Third pillar

The third pillar of Basel II has increased the disclosures that the bank must have to make. The reason behind this is to allow the market to have a better clarity of the overall risk position of the bank besides to allow the counterparties of the bank to price and deal appropriately.

2.5) Criticisms

There are few criticisms about Basel II. For example the larger banks and developed countries have advantages over smaller banks and developing countries. Because they can use more sophisticated risk measures while smaller banks cannot implement those easily and developing countries doesn't have more much larger and advanced banks. Another criticism is this that the better credit risks will be

advantaged as banks move towards true pricing for risk[22]. Based on the experience of United States and the United Kingdom system it is shown that the improved risk sensitivity means that banks are more willing to lend to higher risk borrowers, just with higher prices. And borrowers who are previously 'locked out' of the banking system have a chance to establish a good credit history.

We can summarize the critical points of the Basel II as follows,

1. The Basel II accord is full of complexities.

2. In accord the risk is endogenous and hence VaR can destabilize an economy or a financial system[23].

3. The Basel II accord doesn't use the best available risk measures[24].

4. One of the drawbacks is also that the operation of Basel II will lead to a more pronounced business cycle, because the credit models used for pillar compliance typically use a one year time horizon. For instance this would mean that during a downturn in the business cycle, banks will be in a need to reduce lending as their models forecast increased losses, increasing the magnitude of the downturn. Therefore, Basel II is procyclical and hence counteracts its purpose to reduce systemic crises.

5. The Basel II IRB approach enables inconsistent views of creditworthiness[25].

One of the drawbacks is also that the operation of Basel II will lead to a more pronounced business cycle, because the credit models used for pillar compliance typically use a one year time horizon. For instance this would mean that during a downturn in the business cycle, banks will be in a need to reduce lending as their models forecast increased losses, increasing the magnitude of the downturn.

Nordea Bank Case: Credit risk comprises 92% of the risk in Nordea Bank. By the implementation of Basel regulations the requirements for the capital are now more supportive to curb risks. Another leading Danish Bank Nordea is also following regulations of Basel. In June 2007, the Nordea was

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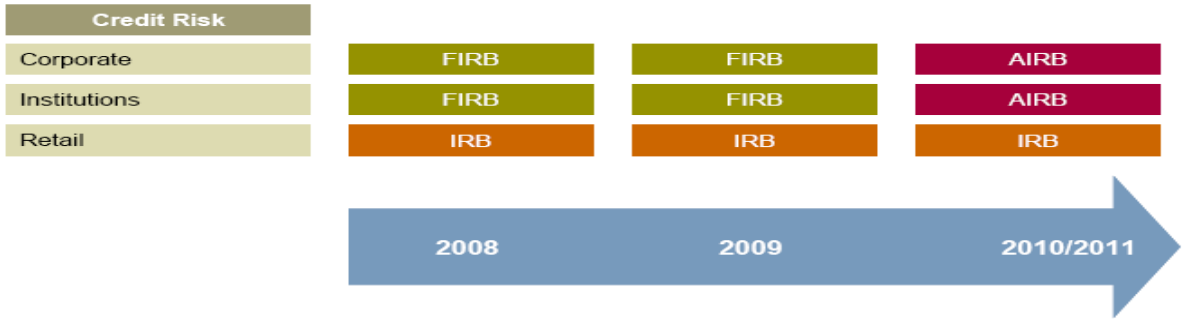
[22] http://www.answers.com/topic/basel-ii
[23] H.Keiding: Economics of Banking (Prel.version:November 2009, page 5)
[24] Timmy Przybyla, Christian Bengtsson GÖTEBORGS UNIVERSITET (2009) 'Basel II International Convergence of Capital Measurement and Capital Standards' page 5
[25] Timmy Przybyla, Christian Bengtsson GÖTEBORGS UNIVERSITET (2009) 'Basel II International Convergence of Capital Measurement and Capital Standards' page 5

approved by the Financial Supervisory Authorities to use FIRB approach for corporate and institution portfolios except for foreign branches and subsidiaries. The Bank aims to gradually implement the IRB approach for the retail portfolio and other portfolios before the year end 2009, as depicted in the following figure. However the standardised approach will continue to be used for new portfolios and smaller portfolios for which approved internal models are not yet in place.

Figure: Roll out plan



Source: Nordea Bank (Capital adequacy & risks Management (pillar 3) report, 2007 page 10)

2.6) Future of Basel Accord

We can see more work in the future on Basel accords because Basel III is already in progress, at least in a preliminary sense. The goals of this accord are to improve the definition of bank capital, further improvement of the sensitivity of the risk measures and quantify further classification of risk.

2.7) Conclusion

Basel Accords are the bank capital framework which is sponsored by the world's central banks and these are designed to promote uniformity, make regulatory capital more risk sensitive, and promote enhanced risk management among large, internationally active banking organizations. Basel I accord mainly talks about the capital adequacy risk, which is the risk that a financial institution will be hurt by an unexpected loss. The Basel II accord almost completely overhauls the Basel Accord1 .This accord is based on three mutually supporting "pillars" of capital adequacy. The firs pillar discusses the maintenance of regulatory capital calculated for main risks types that a bank faces, which are, Credit

risk, Operational risk and Market risk. Second pillar is about the bank supervisory agencies like the Comptroller of the Currency, have authority to adjust capital levels for individual banks above the 8% minimum when necessary. And the third supporting pillar calls upon market discipline to supplement reviews by banking agencies. The Basel II deals with three approaches that banks and regulators of the world has to choose, 1) Standardized, 2) The Foundation Model Internal Ratings-Based Approach (Foundation) and 3) The Advanced Internal Ratings-Based Approach (Advanced or A-IRB). However, Basel Accords does have some limitations, but to overcome these, work on third accord is in progress. Nevertheless, Basel Accords still provide solid capital regulatory recommendations that are certainly helping in coping with financial risks of credit and markets risks of banks. Basel Accord is ‘‘the right way to forward’’ that provides solid capital regulatory recommendations. However, the success lies in the fact that how well the gradual implementation of complex rules on capital adequacy is conducted. Regulations should be focused more on setting principles baked with supervisory review in the future of financial market innovations rather than expanding rules further in Basel III.

Chapter 3: Value at Risk (VaR)

3.1) Introduction

Value at risk is a quantitative tool to measure the market risk .VaR is widely used by almost all the famous financial institutions including banks, hedge funds and private equity firms to measure risk. We will investigate what are the assumptions, drawbacks and effectiveness of the traditional models.

By the early 1990s, many financial service firms had developed rudimentary measures of Value at Risk, with wide variations on how it was measured. In the aftermath of numerous disastrous losses associated with the use of derivatives and leverage between 1993 and 1995, culminating with the failure of Barings, the British investment bank, as a result of unauthorized trading in Nikkei futures and options by Nick Leeson, a young trader in Singapore, firms were ready for more comprehensive risk measures. In 1995, J.P. Morgan provided public access to data on the variances of and co variances across various security and asset classes, that it had used internally for almost a decade to manage risk, and allowed software makers to develop software to measure risk. It titled the service "Risk Metrics" and used the term Value at Risk to describe the risk measure that emerged from the data.[26] The measure found a ready audience with commercial and investment banks, and the regulatory authorities overseeing them, who warned to its intuitive appeal. In the last decade, VaR has becomes the established measure of risk exposure in financial service firms and has even begun to find acceptance in non-financial service firms. Although there are also some other risk measuring techniques, but VaR is one of the best risk measurement tools.

To understand VaR in depth, we shall try to find answers of some important questions for the risk measurement of financial institutions. These questions are worth of asking as the end product of all three approaches is the Value at Risk,

1. First is to see how different are the estimates of Value at Risk that emerges from the three approaches?

[26] http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/VAR.pdf

2. Secondly, which approach of VaR is best suitable in which task of a financial institution like banks? So that these institutions could have a better risk management.
3. VaR approaches do have some pros and cons, but questions arise that whether pros can outweigh the cons or not? So that we could regard VaR as a best risk measuring method.
4. What could be the best way to overcome the limitations of VaR and to get the most reliable estimates?

3.2) Measuring Value at Risk

There are three basic approaches that are used to compute Value at Risk, though there are numerous variations within each approach. The measure can be computed analytically by making assumptions about return distributions for market risks, and by using the **variances in and co-variances** across these risks. It can also be estimated by running hypothetical portfolios through **historical data** or from **Monte Carlo simulations**.

3.3) Variance-Covariance Method

The first method of VaR calculation is variance-covariance, or delta-normal methodology. This model was popularized by J.P Morgan (now J.P. Morgan Chase) in the early 1990s when they published the Risk Metrics Technical Document. As Value at Risk measures the probability that the value of an asset or portfolio will drop below a specified value in a particular time period, it should be relatively simple to compute in a case if we can derive a probability distribution of potential values. Basically this is what we do in the variance-covariance method, an approach that has the benefit of simplicity but is limited by the difficulties associated with deriving probability distributions[27].

We take a simple case[28], where the only risk factor for the portfolio is the value of the assets themselves. Moreover the following two assumptions allow translating the VaR estimation problem into a linear algebraic problem:

[27] http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/VAR.pdf
[28] http://www.answers.com/value+at+risk?cat=biz-fin

- The first is that the portfolio is composed of assets whose deltas are linear; more exactly: the change in the value of the portfolio is linearly dependent on (i.e., is a linear combination of) all the changes in the values of the assets, so that also the portfolio return is linearly dependent on all the asset returns.
- The second assumption is that the asset returns are jointly normally distributed.

The implication of these assumptions is that the portfolio return is normally distributed, simply because it always holds that a linear combination of jointly normally distributed variables is itself normally distributed.

The following notation will be used in Variance Covariance methodology,

- i means "of the return on asset i" (for σ and μ) and "of asset i" (otherwise)
- p means "of the return on the portfolio" (for σ and μ) and "of the portfolio" (otherwise)
- all returns are returns over the holding period
- there are N assets
- μ= expected value; i.e., mean
- σ = standard deviation
- V = initial value (in currency units)
- $\omega_i = V_i / V_p$
- $\boldsymbol{\omega}$ = vector of all ω_i (T means transposed)
- $\boldsymbol{\Sigma}$ = covariance matrix = matrix of co-variances between all N asset returns; i.e., an NxN matrix

All the calculation then goes as follows:

(i) $$\mu_p = \sum_{i=1}^{N} \omega_i \mu_i,$$

(ii) $$\sigma_p = \sqrt{\boldsymbol{\omega}^T \boldsymbol{\Sigma} \boldsymbol{\omega}}$$

Here the assumption of normality permits us to z-scale the calculated portfolio standard deviation to the appropriate confidence level. So for the 95% confidence level VaR we get:

(iii) $$VaR = V_p - (\mu_p - 1.645\sigma_p)$$

However the Variance-Covariance Method also assumes that stock returns are normally distributed. We can say it in other words that it requires that we estimate only two factors - an expected (or average) return and a standard deviation – this allows us to plot a normal distribution curve.

3.3.1) Criticism of the method

The main benefit of the Variance-Covariance approach is that the Value at Risk is simple to compute, after a financial institution have made an assumption about the distribution of returns and inputted the means, variances and covariance's of returns. [29]

1) However there are three main weaknesses of the approach in the estimation process,

A) **Wrong assumption:** in a case where conditional returns are not normally distributed, the computed VaR will understate the true VaR. Additionally, if there are far more outliers in the actual return distribution than would be expected given the normality assumption, the actual Value at Risk will be much higher than the computed Value at Risk.

B) **Input error**: Even in a case where the standardized return distribution assumption holds up, the VaR can still be wrong if the variances and co-variances that are used to estimate it are incorrect. However to the extent that these numbers are estimated using historical data, there is a standard error associated with each of the estimates. In other words, the variance-covariance matrix that is input to the VaR measure we can say is a collection of estimates, some of which have very large error terms.

C) **Non-stationary variables**: Another related problem occurs when the variances and co-variances across assets change over time. This type of non stationary in values is not uncommon because the fundamentals driving these numbers do change over time. That's why the correlation between the U.S. dollar and the Japanese yen may change if oil prices increase by 15%, it can in turn lead to a breakdown in the computed VaR.

[29] http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/VAR.pdf

2) Much of the work that has been done to revitalize the approach has been directed at dealing with these critiques.

First, some researches have been directed at bettering the estimation techniques to yield more reliable variance and covariance values to use in the VaR calculations. Some of the researchers suggest refinements on sampling methods and data innovations that allow for better estimates of variances and co-variances looking forward. But some others posit that statistical innovations can yield better estimates from existing data. So conventional estimates of VaR are based upon the assumption that the standard deviation in returns does not change over time (homoskedasticity), Here Engle argues that we get much better estimates by using models that explicitly allow the standard deviation to change of time (heteroskedasticity). Actually he suggests two variants Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) that provide better forecasts of variance and, by extension, better measures of Value at Risk.

Another critique against the variance-covariance estimate of VaR is that, it is designed for portfolios where there is a linear relationship between risk and portfolio positions. As a result, it can break down when the portfolio includes options, since the payoffs on an option are not linear. In an attempt to deal with options and other non-linear instruments in portfolios, some researchers have developed Quadratic Value at Risk measures. However, these quadratic measures, sometimes categorized as delta-gamma models (to contrast with the more conventional linear models which are called delta-normal), permit researchers to estimate the VaR for complicated portfolios that include options and option-like securities such as convertible bonds. For instance, the cost though, is that the mathematics associated with deriving the VaR becomes much complicated and that some of the intuition will be lost along the way.

Table 3.1: Pros and Cons of Variance Co-variance Methodology

Pros	Cons
• Value at risk is easy & fast to compute by this method.[30] • It takes into account explicitly all correlation.	• This method is only suitable for linear portfolios • And in this method covariance does capture all temporal dependence[31] (Ref; Power point) • Assumption of normal distribution of risk factors

3.4) Historical Simulation

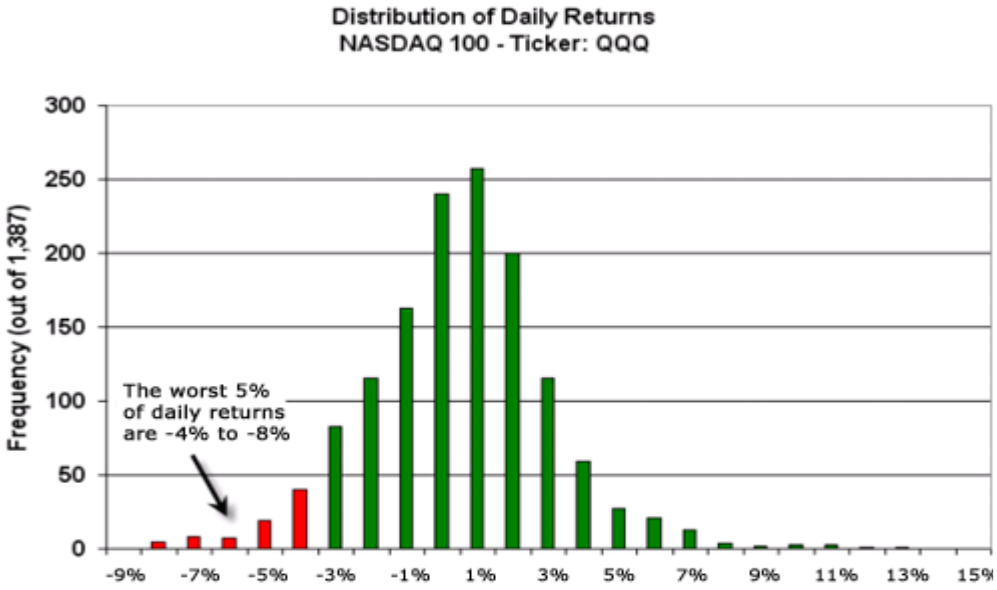
Historical simulation is the simplest way of estimating the Value at Risk for many portfolios. According to this approach, the VaR for a portfolio is estimated by creating a hypothetical time series of returns on that portfolio, obtained by running the portfolio through actual historical data and then computing the changes that would have occurred in each period. Danske Bank used this method from mid-2007, and the Group replaced its parametric VaR model with a historical simulation model. Because the major advantages of the historical simulation model are that it uses full revaluation and makes no assumptions regarding the loss distribution. Resultantly it leads to more accurate results for non-linear products than other methods would give.

We can say that the historical method simply re-organizes actual historical returns, putting them in order from worst to best. This approach assumes that history will repeat itself, from a risk perspective. Now we explain the historical approach with an example. We can see any explanation by

[30] Wing Lon Ng University of Essex - CCFEA
[31] Wing Lon Ng University of Essex - CCFEA

investopedia[32]. In March 1999 the QQQ started trading and if we calculate each daily return, we produce a rich data set of almost 1,400 points. If we put them in a histogram that compares the frequency of return "buckets", then for example, at the highest point of the histogram (the highest bar), there were more than 250 days when the daily return was between 0% and 1%. Then at the far right, we can barely see a tiny bar at 13% which represents the one single day (in Jan 2000) within a period of five plus years when the daily return for the QQQ was a stunning 12.4%.

Figure : 3.2[33]



We can notice the red bars that compose the "left tail" of the histogram. Moreover these are the lowest 5% of daily returns (since the returns are ordered from left to right, the worst be always the "left tail"). However the red bars run from daily losses of 4% to 8%. Simply because of the reason that these are the worst 5% of all daily returns, we can say with 95% confidence that the worst daily loss will not exceed 4%. And if put another way, we expect with 95% confidence that our gain will exceed -4%. And that is VAR in a nutshell. Now, we re-phrase the statistic into both percentage and dollar terms:

- In case of 95% confidence, we expect that our worst daily loss will not exceed 4%.

[32] http://www.investopedia.com/articles/04/092904.asp
[33] http://www.investopedia.com/articles/04/092904.asp

- And if we invest $100, we are 95% confident that our worst daily loss will not exceed $4 ($100 x -4%).

We can see that VAR indeed allows for an outcome that is worse than a return of -4% and it does not express absolute certainty but instead makes a probabilistic estimate. However if we want to increase our confidence, we need only to "move to the left" on the same histogram, to where the first two red bars, at -8% and -7% represent the worst 1% of daily returns:

- In case of 99% confidence, we expect that the worst daily loss will not exceed 7%.
- Or, if we invest $100, we are 99% confident that our worst daily loss will not exceed $7.

That's why Historical simulation approach seems to be the easiest full-valuation procedure. This approach is built on the assumption that the market will be stationary in the future. Furthermore, its main idea is to follow the historical changes of price (P) of all assets (N). In addition, for every scenario a hypothetical price P is simulated as the today price plus the change of prices in the past. If we evaluate the whole portfolio through simulated prices and portfolio values are ranked from smallest to largest and the designated risk tolerance level becomes the VaR estimate (Manfredo1997).

Now we explain further this approach with the help of work done by John Hull C. The following tables 1 and 2 illustrate the methodology of historical simulation. There are observations on market variables over the last 500 days that are shown in Table 1. The observations are taken at some particular point in time during the day which is normally the close of trading. Here we assumed that there total of 1000 market variables. **Table 3.2: Data for VaR historical simulation calculation**

Day	Market Variable 1	Market Variable 2	...	Market Variable 1,000
0	20.33	0.1132	....	65.37
1	20.78	0.1159	....	64.91
2	21.44	0.1162	....	65.02
3	20.97	0.1184	....	64.90
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
498	25.72	0.1312	....	62.22
499	25.75	0.1323	....	61.99
500	25.85	0.1343	....	62.10

Source: John Hull C 2007[34]

Moreover table 2 shows the values of the market variables tomorrow if their percentage changes between today and tomorrow are the same as they were between Day i-1 and Day for $1 \leq i \leq 500$. In table 2 the first row shows the value of market variables tomorrow assuming their percentage changes between today and tomorrow are the same as they were between Day 0 and Day 1. And the second row shows the value of market variables tomorrow between Day 1 and Day 2 and so on. In table 2 all the 500 rows are the 500 scenarios considered.

Table 3.3: Scenarios generated for tomorrow (Day 501) using data in Table 3.2

Value of portfolio on Day 500 is $23.50 million

Scenario number	Market variable 1	Market variable 2		Market variable 1000	Portfolio value ($ M)	Change in value ($ M)
1	26.42	0.1375	....	61.66	23.71	0.21
2	26.67	0.1346	....	62.21	23.12	-0.38
3	25.28	0.1368	....	61.99	22.94	-0.56
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
499	25.88	0.1354	....	61.87	23.63	0.13
500	25.95	0.1363	....	62.21	22.87	-0.63

Source: John Hull C (2007, 219)

Now we define here vi as the value of a Market variable on Day i and suppose that today is Day n. The i^{th} scenario assumes that the value of the market variable tomorrow will be, $v_n \frac{v_i}{v_i - 1}$

[34] John Hull C 2007, Page 218-219

In this example, n = 500. Here for the first variable the value today $v500$ is 25.85. In addition $v0 =$ 20.33 and $vi = 20.78$. All this follows that the value of the first Market variable in the first scenario is,

$$25.85 \times \frac{20.78}{20.33} = 26.42$$

In this example the penultimate column of table 2 shows the value of the portfolio tomorrow for each of the 500 scenarios. And we suppose that the value of the portfolio today is $23.50 million. All this leads to the numbers in the final column for the change in the value between today and tomorrow for all the different scenarios. For the first scenario the change in value is +$ 210,000 for scenario 2 it is -$380,000 and so on.

In this case we are interested in the one percentile point of the distribution of changes in the portfolio values. As discussed earlier because there are a total of 500 scenarios in table 2, we can estimate this as the fifth worst number in the final column of the table. But alternatively we can also use extreme value theory which I have discussed in coming sections. In this case John Hull (2007, P 220) has taken 10 day VaR for a 99 % confidence level is usually calculated as $\sqrt{10}$ times the one day VaR.

Furthermore, in this example each day the VaR estimate would be updated using the most recent 500 days of the data. For example if we consider what happen on Day 501, we find out new values for all the market variable and are able to calculate a new value for our portfolio. However the rest of the procedure will be the same as explained above to calculate new VaR. Then we use data on the market variables from Day 1 to Day 501. It will give us the required 500 observations on percentage changes in market variables: the Day 0 values of the market variables are no longer used. Same will be the case of Day 502 that we use data from Day 2 to Day to 502 to determine VaR and so on.

According to Jorion (1997), this full-estimated model is more set forth to the estimation error since it has larger standard errors than parametric methods that use estimates of standard deviation. Historical simulation method is very easy to use if we have daily data. It's simple to understand that the more observations we have, the more accurate estimation we will receive, because the old data will not have a great influence on the new tendency on the market.

3.4.1) Assessment

There is no doubt that historical simulations are popular and relatively easy to run, but they do come with baggage. Particularly, the underlying assumptions of the model generate give rise to its weaknesses.

All the three approaches to estimating VaR use historical data, historical simulations are much more reliant on them than the other two approaches for the simple reason that the Value at Risk is computed entirely from historical price changes. And also there is little room to overlay distributional assumptions (as we do with the Variance-covariance approach) or to bring in subjective information (as we can with Monte Carlo simulations). For example a corporation or portfolio manager that determined its oil price VaR, based upon 1992 to 1998 data, would have been exposed to much larger losses than expected over the 1999 to 2004 period as a long period of oil price stability came to an end and price volatility increased.

Furthermore, there are many economists argue that history is not a good predictor of the future events. Still, all VaR methods rely on historical data, at least to some extent. (Damodaran, 2007[35]). Additionally, every VaR model is based on some kinds of assumptions which are not necessarily valid in any circumstances. Therefore because of these factors, VaR is not a foolproof method. Another economist Tsai (2004)[36] emphasizes that VaR estimates should therefore always be accompanied by other risk management techniques, such as stress testing, sensitivity analysis and scenario analysis in order to obtain a wider view of surrounding risks.´

Another related argument is about the way in which we compute Value at Risk, using historical data, where all data points are weighted equally. For example the price changes from trading days in 1992 affect the VaR in exactly the same proportion as price changes from trading days in 1998. For instance to the extent that there is a trend of increasing volatility even within the historical time period, we will understate the Value at Risk[37].

3.4.2) Pros and Cons of Historical Simulation

[35] Damodaran, A. (2007), Strategic Risk Taking: A Framework for Risk Management, Pearson Education, New Jersey.
[36] Tsai, K.-T. (2004) Risk Management Via Value at Risk, ICSA Bulletin, January 2004, page 22

[37] http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/VAR.pdf

Pros of Historical Simulation: Rogov (2001)[38] considers Historical simulation is much easier for the calculation of VaR and has some advantages which are as follows, in this approach

- This approach permits non-normal distribution;
- Historical simulation is very good for non-linear instruments;
- The entire estimation can be achieved by the easiest way through the past data;
- This approach is applicable for all types of price risk;
- In this approach the presence of the model risk (estimating an inadequate model) is almost impossible;
- This approach is very easy and the Basel Committee chose it in 1993 as the fundamental method for estimating VaR.

Cons of Historical Simulation

Although historical simulation is much easier for the calculation of VaR and but still it has some disadvantages which are as follows,

- In this approach the assumption that the past can show the future is wrong, but this method is based on such assumption;
- The computation periods are too small and there is a big possibility of making the mistakes of dimension;
- This approach does not give information about correlation with risk factors;

Historical simulation has both pros and cons but actually the drawbacks can lead to higher possibility of picking up more extreme market events associated with the "fat tails" of the probability distribution; and this causes the overestimation of the VaR. Besides the assumption that the returns are distributed identically and independently, during the long period may be violated (Manfredo1997). In order to overcome the problem of extreme market event's measurement Extreme Value Theory is used, which is discussed in coming sections.

3.5) Monte Carlo Simulation

[38] Also quoted by Olha Venchak (2005)

Monte Carlo Simulations or the bootstrapping technique also happen to be useful in assessing Value at Risk, with the focus on the probabilities of losses exceeding a specified value rather than on the entire distribution. We can see that this simulation method is quite similar to the Variance Co-variance method as the first two steps in a Monte Carlo simulation mirror the first two steps in the Variance-covariance method where we identify the markets risks that affect the asset or assets in a portfolio and convert individual assets into positions in standardized instruments. But it is in the third step that the differences emerge. Here in this method rather than computing the variances and co-variances across the market risk factors, we take the simulation route, where we specify probability distributions for each of the market risk factors and specify how these market risk factors move together.[39]

According to David Harper Monte Carlo simulation (MCS) is one of the most common ways to estimate risk. If we take an example, to calculate the value at risk (VaR) of a portfolio, we can run a Monte Carlo simulation that attempts to predict the worst likely loss for a portfolio given a confidence interval over a specified time horizon . But we always need to specify two conditions for VaR: first confidence and second is horizon.

In the article of Monte Carlo Simulation with GBM by David Harper, CFA, FRM, we can review a basic MCS applied to a stock price. In this article the author described a model to specify the behaviour of the stock price, and we'll use one of the most common models in finance: geometric Brownian motion (GBM). We know that Monte Carlo simulation is an attempt to predict the future many times over. And at the end of the simulation, thousands or millions of "random trials" produce a distribution of outcomes that can be analyzed. But the following steps are basics,

1. We need to specify a model (e.g. geometric Brownian motion)
2. Then Generate random trials
3. And finally process the output

Step1. Specify a Model (e.g. GBM)

David Harper has used the geometric Brownian motion (GBM), which is technically a Markov process.

[39] http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/VAR.pdf

So in this first step it means that the stock price follows a random walk and is consistent with (at the very least) the weak form of the efficient market hypothesis (EMH) like past price information is already incorporated and the next price movement is "conditionally independent" of past price movements.

GBM has the following formula, where "S" is the stock price, "m" (the Greek mu) is the expected return, "t" is time, and "e" (Greek epsilon) is the random variable, and "s" (Greek sigma) is the standard deviation of returns,

$$\frac{\Delta S}{S} = \mu \Delta t + \sigma \varepsilon \sqrt{\Delta t}$$

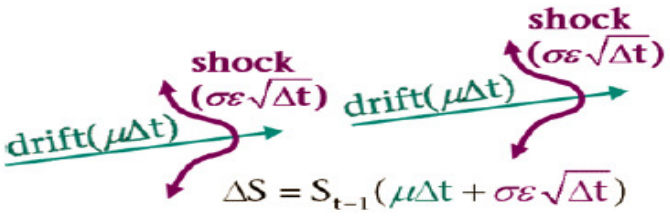
However, in case the formula is rearranged to solve just for the change in stock price, we see that GMB says the change in stock price is the stock price "S" multiplied by the two terms found inside the parenthesis below:

$$\Delta S = S(\mu \Delta t + \sigma \varepsilon \sqrt{\Delta t})$$

Here there are two terms are used the first term is a "drift" and the second term is a "shock". Furthermore for each time period, the model assumes the price will "drift" up by the expected return. However, the drift will be shocked (added or subtracted) by a random shock. But the random shock will be the standard deviation "s" multiplied by a random number "e".

GBM actually has this essence as illustrated in Figure 3.3. The price of stock follows a series of steps, where each step is a drift plus/minus a random shock (itself a function of the stock's standard deviation): **Figure 3.3[40]:**

[40] http://www.investopedia.com/articles/07/montecarlo.asp



Step 2: Generate Random Trials:

Now after having a model specification, we then proceed to run random trials which are the second step. For illustration, Microsoft Excel has been used to run 40 trials. But this is an unrealistically small sample, because most simulations or "sims" run at least several thousand trials. But for this case, let's assume that the stock begins on day zero with a price of $10. The following is a chart of the outcome where each time step (or interval) is one day and the series runs for ten days (in summary: forty trials with daily steps over ten days):

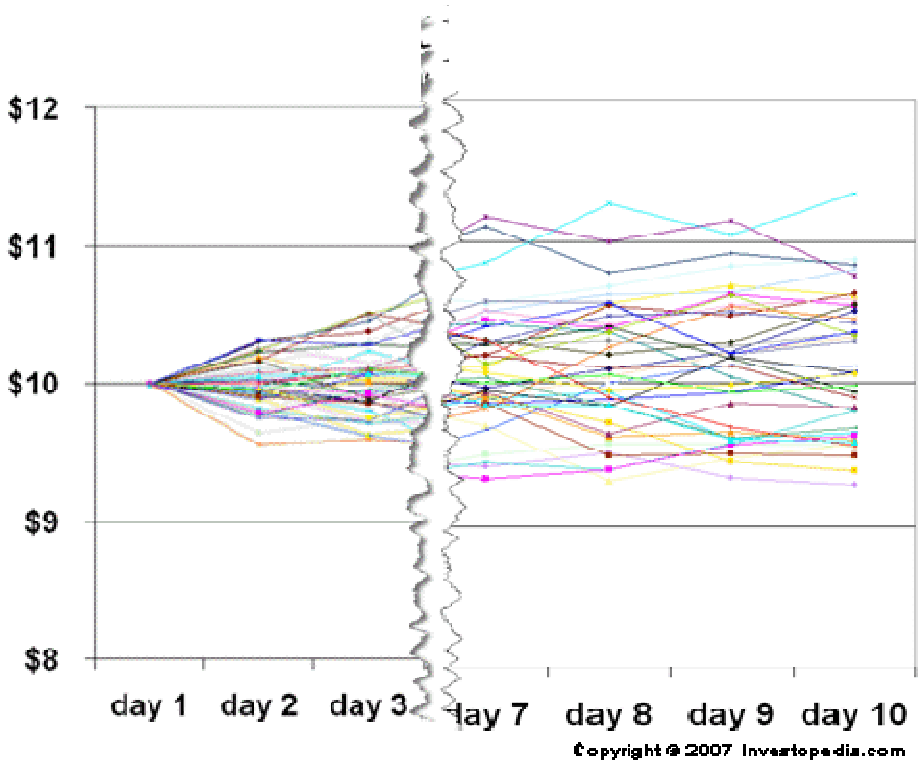


Figure 3.4[41]: Geometric Brownian Motion

We can clearly see that the result is forty simulated stock prices at the end of 10 days and none has happened to fall below $9, and one is above $11.

Step **3: Process the Output:** Now at the third step the simulation produced a distribution of hypothetical future outcomes. And at this step we could do several things with the output. For example, if we want to estimate VaR with 95% confidence, then we only need to locate the thirty-eighth-ranked outcome (the third-worst outcome). And that's because of the reason that 2/40 equals 5%, so the two worst outcomes are in the lowest 5%.We will get the following histogram if we stack the illustrated outcomes into bins (each bin is one-third of $1, so three bins covers the interval from $9 to $10),

Figure 3.5[42]

[41] http://www.investopedia.com/articles/07/montecarlo.asp
[42] http://www.investopedia.com/articles/07/montecarlo.asp

But here we need to remember that our GBM model assumes normality: price returns are normally distributed with expected return (mean) "m" and standard deviation "s". And more interestingly, our histogram isn't looking normal. Actually with more trials, it will not tend toward normality. But instead, it will tend toward a lognormal distribution: a sharp drop off to the left of mean and a highly skewed "long tail" to the right of the mean and all this often leads to a potentially confusing dynamic some times:

- Price *returns* are normally distributed.
- Price *levels* are log-normally distributed.

But we can also consider it in another way such as, if a stock can return up or down 5% or 10%, but after a certain period of time, the stock price cannot be negative. Moreover, price increases on the upside have a compounding effect, while price decreases on the downside reduce the base: lose 10% and you are left with less to lose the next time. The David Harper explains further with a chart of the lognormal distribution superimposed on our illustrated assumptions (e.g. starting price of $10):

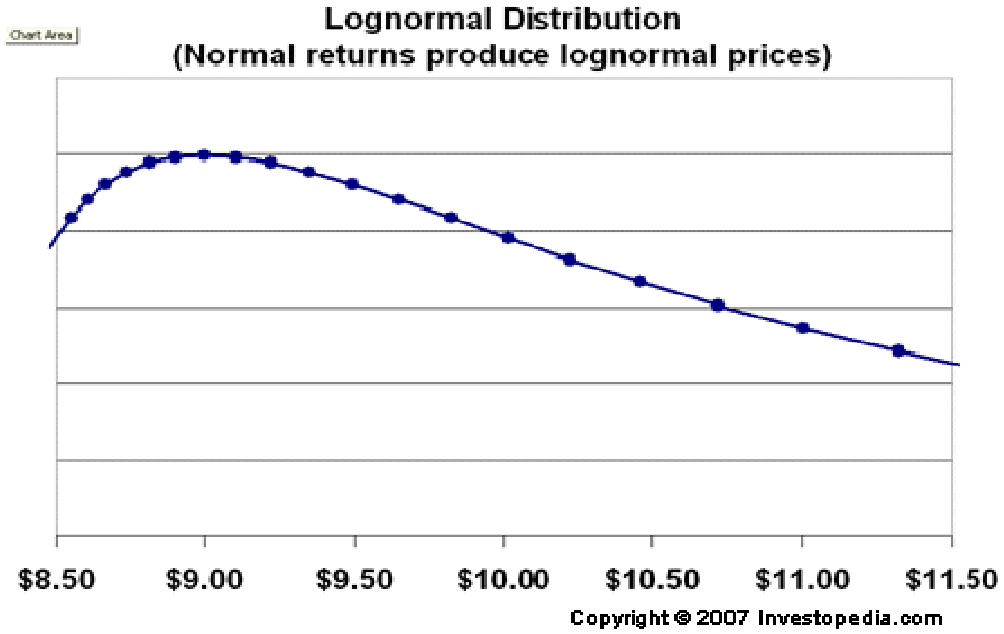


Figure 3.6

Actually a Monte Carlo simulation applies a selected model (a model that specifies the behaviour of an instrument) to a large set of random trials in an attempt to produce a plausible set of possible future outcomes. And if we take the example of simulating stock prices in a case of portfolio investment by financial institution in finance, the most common model is geometric Brownian motion (GBM). This model assumes that a constant drift is accompanied by random shocks and while the period returns under GBM are normally distributed, the consequent multi-period (for example, ten days) price levels are log normally distributed.

Danske Bank Group's internal credit risk model is a portfolio model that calculates all credit exposures in the Group's portfolio across business segments and countries. These calculations include all loans, advances, bonds and derivatives. And importantly the Group has the portfolio model that uses a Monte Carlo simulation, which is a general procedure for approximating the value of a future cash flow. Moreover, the individual losses calculated in each simulation are ranked according to size. At the Group level economic capital is calculated as Value at Risk at a confidence level of 99.97%. But the largest customer exposures are entered individually in the simulation, while small customers are divided into homogeneous groups with shared credit risk characteristics. All this is done to measure the actual risk on a 12-month horizon as accurately as possible. Danske Bank Group allocates economic capital at the facility level on the basis of an internally developed allocation model. The concentrations of individual customers as well as country concentrations are taken into account. Moreover economic capital at the facility level is used for risk based pricing and for performance measurements. For instance Monte Carlo Simulation is a helpful tool for the Group to cope with the risk based pricing problems and resultantly to have a better performance.[43]

In Nordea Bank Market risk for the banking business is based on scenario simulation and Value-at-Risk (VaR) models tailor-made for Economic Capital. However the asset and liability management (ALM) for the life insurance business model is used, which is based on scenarios generated by Monte-

[43] Risk Report of Danske Bank 2007

Carlo simulation. Similarly like many other famous banks the market risk in Nordea's internal defined benefit plans is based on VaR models.[44]

Table 3.4: Pros and Cons of Monte Carlo Simulation

Pros	Cons
➢ This method is statistically "clean" method. ➢ Monte Carlo Simulation is the most flexible of all estimation techniques.	➢ This method requires a lot of calculations or specific computer software. ➢ This method has the assumption about the normality of distribution

3.5.1) Assessment

In fact Monte Carlo simulation is difficult to run for two reasons. First reason is that we have to estimate the probability distributions for hundreds of market risk variables rather than just the handful that we talked about in the context of analyzing a single project or asset. Second reason is that the number of simulations that we need to run to obtain reasonable estimate of Value at Risk will have to increase substantially (to the tens of thousands from the thousands). According to Jorion (2001), Monte Carlo simulation can handle credit risks to some extent.

However the advantages of Monte Carlo simulations can be seen when compared to the other two approaches for computing Value at Risk. For example unlike the variance-covariance approach, we do not have to make unrealistic assumptions about normality in returns. Importantly, the approach of Monte Carlo simulations can be used to assess the Value at Risk for any type of portfolio and are flexible enough to cover options and option-like securities.

[44] Nordea Bank Report, Capital adequacy & Risk Management pillar 3, 2007, page 24

3.6) Comparison of approaches

All the three approaches have their own pros and cons as discussed before. The first approach of variance-covariance, with its delta normal and delta gamma variations, requires us to make strong assumptions about the return distributions of standardized assets, but is simple to compute, once those assumptions have been made. Besides, this approach gives the fastest results and is more suitable for measuring VaR of options. The second approach of historical simulation requires no assumptions about the nature of return distributions but implicitly assumes that the data used in the simulation is a representative sample of the risks looking forward. Moreover, this approach is faster in giving results than Monte Carlo Simulation and more suitable for short sampling. And the third approach of Monte Carlo simulation allows for the most flexibility in terms of choosing distributions for returns and bringing in subjective judgments and external data, but is the most demanding from a computational standpoint. But this approach is slow in giving end products and is suitable for modeling risk. It's up to the needs of banks and nature of its data that determines to chose the best suitable approach for measuring VaR. However (Philippe Jorion, 2006)[45] has described some of comparisons that we are listing down in the table with some precise changes relevant to our purpose.

Table 3.5: Comparison of VaR Approaches

	Variance Covariance	**Historical Simulation**	**Monte Carlo Simulation**
Valuation:	Linear	Non Linear	Non Linear
Distribution	Normal time varying	Actual	General

[45] Philippe Jorion 2006, 3rd Ed, page 270

Speed	Fastest	Fast	Slow
Drawbacks	Options, Fat tails	Short Sample	Model Risk, Sampling Error

3.7) Limitations of value at risk

VaR has become a very important risk measurement technique in the world of finance these days. Actually VaR tells us what the maximum potential loss will be at a given confidence level e.g. of 95% or 99% and therefore VaR is a tail measure. That's why it's the biggest limitation of it that it does not tell us what the loss can be beyond VaR. It ignores the tail risk. Similarly what will be the potential loss be in extreme outcome namely in the 1% case?

VaR normally is best suitable to use in under normal market conditions to give a good estimate. Basically the risks unseen in events with probabilities lower than considered confidence level are neglected. Another reason for that risk measure could be the, to have good description of the tail behavior namely a distribution function that model the risk most realistically for the asset in mind. Simply for the reason to have a good description of the tail any risk measure of the tail will provide wrong estimates of risk. For these reasons we will study Extreme Value theory in next section.

Another limitation of VaR is that it considers the result in the end of the period. It doesn't give any answer to what can or will happen during the holding period of a certain asset or portfolio etc. Another drawback also arises here that VaR assumes that the current position invested stays constant in the holding period, but that what a general shortcoming of most of the risk measures. Therefore we can also say that the VaR is a static risk measure, for dynamic risk measurement we see the next section of EVT.

3.8) Extreme Value Theory (EVT)

Basically risk managers are agreed with the risk of low-probability events that could lead to catastrophic losses. The traditional VaR methods normally ignore extreme events and focus on risk measures that accommodate the whole empirical distribution of returns. Basically this kind of problem is not exclusive to risk management, researchers and practitioners in the world of finance and businesses grip this problem by using Extreme Value Theory (EVT), which is a specialist branch of statistics that attempts to make the best possible use of what little information we have about the extremes of the distributions in which we are interested.

We will focus on the extreme value theorem which is a key to EVT. This theorem is known as a cousin of the better-known central limit theorem. It tells us what the distribution of extreme values should look like in the limit, as our sample size increases. Now here we suppose that we have some return observations but do not know the density function from which they are drawn. However, under some certain relatively innocuous conditions, this theorem of EVT tells us that the distribution of extreme returns converges asymptotically to,

$$H_{\xi,\sigma,\mu}(x) = \begin{matrix}\exp(-[1+\xi(x-\mu)/\sigma]^{-1/\xi}) \\ \exp(-e^{-(x-\mu)/\sigma})\end{matrix} \quad \begin{matrix}if\ \xi \neq 0 \\ \xi = 0\end{matrix}$$

In the equation above the parameters μ and σ correspond to the mean and standard deviation, moreover the third parameter; ξ gives an indication of the heaviness of the tails i.e. the bigger ξ, the heavier the tail. We can call this parameter as the tail index, and the case of most interest in finance is where ξ > O, which corresponds to the fat tails commonly founded in financial return data. Simply in this case, our asymptotic distribution takes the form of a Freshet distribution.

Basically this theorem describes that the limiting distribution of extreme returns always has the same form, whatever the distribution of the parent returns from which our extreme returns are drawn. This is very significant because it allows us to estimate extreme probabilities as well as extreme quantities, including VaR, without having to make strong assumptions about an unknown parent distribution.

3.8.1) Comparison of EV-VAR with traditional VaR approaches

The EV approach has several advantages over traditional parametric and nonparametric approaches to VaR. Parametric approaches of VaR like Monte Carlo simulation estimate VaR by fitting some distribution to a set of observed returns. However, since most observations lie close to the centre of any empirical distribution, so traditional parametric approaches usually tend to fit curves that accommodate the mass of central observations, rather than accommodate the tail observations that are more important for VaR purposes. These Traditional approaches also suffer from the drawback that they impose distributions that make no sense for tail estimation and fly in the face of EV theory. For instance if we compare, the EV approach is free of these problems and specifically designed for tail estimation. On other hand Non-parametric or historical simulation approaches estimate VaR by reading off the VaR from an appropriate histogram of returns. But these approaches lead to less efficient VaR estimates than EV approaches, simply because of the reason they make no use of the EV theory that gives us some indication of what the tails should look like. And above all, these approaches of VaR also have the very serious limitation that they can tell us nothing whatever about VaRs beyond our sample range.

Certainly as with every other tool in risk management, the successful use of EVT demands an appreciation of strengths and limitations. For instance, it depends more on judgment and experience, and EVT is not an exercise in mechanical number crunching. Nevertheless, cautiously used, EVT can be very useful indeed.

3.9) Conclusion

It is obvious that Value at Risk has developed as a successful risk assessment tool at banks and other financial service firms in the last decade. The use of VaR is the firms has been driven by the failure of the risk tracking systems used until the early 1990s to detect dangerous risk taking on the part of traders.

There are three approaches in which Value at Risk can be measured, which are Variance-Covariance Method, Historical Simulations and Monte Carlo Simulations. All the three approaches have their own pros and cons. Therefore these are used according to the best suited tasks.

Let's answer our three questions raised in the beginning. As far as first question is concerned, about how different are the estimates of Value at Risk that emerges from the three approaches? We have to recognize that the answers we obtain with all three approaches are a function of the inputs. For example, the methods of historical simulation and variance-covariance will yield the same Value at Risk if the historical returns data is normally distributed and is used to estimate the variance-covariance matrix. Likewise, the variance-covariance approach and Monte Carlo simulations will yield approximately the same values if all of the inputs in the latter are assumed to be normally distributed with consistent means and variances. So we can say that as the assumptions diverge, so will the answers. Lastly, the methods of historical and Monte Carlo simulation will converge if the distributions we use in the latter are entirely based upon historical data.

Precisely the question of which VaR approach is best can be answered by looking at the task at hand. In a case where we are assessing the Value at Risk for portfolios, that do not include options, over very short time periods (a day or a week), the variance-covariance approach does a logically good job, notwithstanding its heroic assumptions of normality. Likewise if the Value at Risk is being computed for a risk source that is stable and where there is substantial historical data, historical simulations provide good estimates. And finally the most general case of computing VaR for nonlinear portfolios (which include options) over longer time periods, in a situation where the historical data is volatile and non-stationary and the normality assumption is questionable, Monte Carlo simulations do best. For instance, this is what some Danish banks like Danske Bank and Nordea Bank are doing and using these techniques according to the nature of their tasks.

The third questions is easy to answer, as its obvious that pros of VaR approaches can outweigh the cons and some of the cons can be cope with use of EVT. That's why VaR is being used across the globe by all type of financial institutions for better risk management and is regarded as a best risk measuring method.

As far as the fourth question is concerned, we would suggest using EVT to supplement VaR methods, which have become a standard for measuring market risk in order to overcome the limitation of VaR. Basically EVT deals with the frequency and magnitude of very low probability events and gives good results about extreme risk. Therefore, EVT makes the best out of an inherently difficult problem, and hence symbols a significant step forward in better VaR estimation.

We can see an illustration of VaR calculation & role Danske bank's risk management in appendix B. The illustration supports the findings of this chapter that VaR is the best risk measurement tool and thereby it helps in making accurate decisions of risk management.

Chapter4: Risk Management through Insurance, Hedging & Derivatives

As mentioned in Chapter 1, Insurance, Hedging& Derivatives are the ways of controlling corporate wide risk. In this chapter, we will explain what are those options and how do they work for Corporate Risk Management. We will take the order by Insurance, Hedging and Derivatives separately.

4.1) Insurance

4.1.1) Introduction

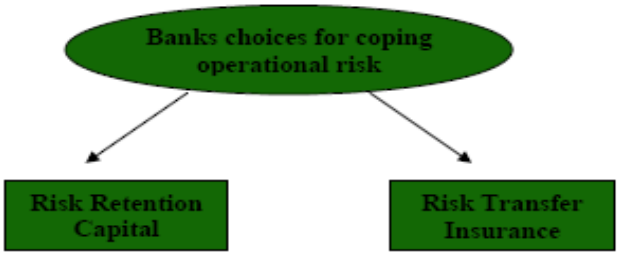
Insurance is an important part of risk management for operational risk. Banks have two options to tackle the operational risk, besides having stricter implementation of auditing and check & balance systems 1) One is reserving capital 2) To buy insurance

However, the bank should purchase insurance to the extent that the cost of insurance is lower than the cost of reserving capital. We can say in other words that the marginal benefit of an increase in insurance cover should be compared to its marginal cost. *For instance, once it is established for a bank that insurance is better than reserving capital, it should buy insurance for minimizing the risks of operations.*

The Danske Bank Group also uses insurance policy for better operational risk areas with an outsourcing policy and an auditing policy. But each business area is in charge of the day-to-day monitoring of operational risks and is responsible for mitigating losses resulting from such risks.[46]

However, all risks cannot be eliminated, either because they are outside of the bank's control or because it would just be too expensive. If the bank still would like to continue the activity that causes the risk it faces a choice between retaining and transferring the risk. In retaining the risk the bank has to reserve capital for future losses.

[46] Danske Bank Annual Report 2007, page 68



Financial institutions like banks can have a better risk management by transferring risk through insurance. According to Wendy Dowd (2001) Risk Transfer is 'Exchange unknown financial impact of specified events to a third party for a known financial cost' and that cost can be premium for insurance. In the following table the objective and strategy to cope with operational risk is clearly illustrated.

Table 4.1: Operational Risk Mitigation/Management Objectives

Objective	Reduce Probability of Event (**Frequency**)	Reduce Economic Impact of Event (**Severity**)
Strategies	Internal Controls	Internal Controls Recovery/Continuity Planning Risk Transfer (Insurance)

Source Wendy Dowd (2001)[47]

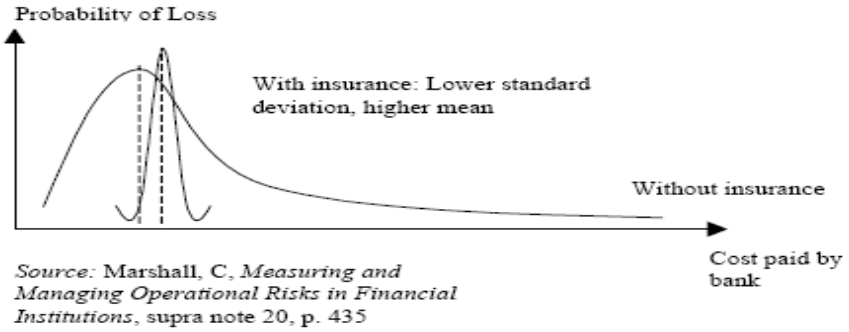
4.1.2) Value of Insurance

How and why insurance is valuable to banks will be much clear from this part of the chapter[48]. We have to understand that the value of insurance is important to realize that risk transfer does not actually involve transfer of the actual risk, but of the economic impact and the timing of loss data may have to be collected from more than one bank impact. For instance we can say that the bank purchasing insurance cover for its buildings still runs the risk of having a building burn down, but the economic

[47] http://www.bos.frb.org/bankinfo/conevent/oprisk/dowd.pdf
[48] Aino Bunge 2002, Page 115

impact of the fire will not be faced by the bank at that time, assuming that it is fully insured. And certainly it will have been paid for through insurance premiums.

Figure 4.1: Effect of Insurance on Loss Distribution[49]



Source: Marshall, C, *Measuring and Managing Operational Risks in Financial Institutions*, supra note 20, p. 435

The above Figure 4.1 clearly illustrates the effect insurance may have on the loss distribution curve for the bank. In fact we can say that insurance has the effect of decreasing the standard deviation (unexpected losses) on individual claims, as the cost for the bank in the form of insurance premium is predetermined.

As depicted in Figure 4.1, insurance reduces the uncertainty of loss, thereby making cash flows smoother for the bank. And this can have several benefits, for example it permits the bank to undertake value adding reinvestment opportunities that may otherwise be lost. Some times after experiencing an operational risk loss it may be hard for the bank to raise new capital, and the insurance payment makes sure that there are funds available. In a situation in which the bank is subject to a tax system with increasing marginal taxes there may also be a tax benefit to smoothing tax flow over several years.

4.1.3) Limitations on Insurance

We know there are many theoretical benefits of insurance, but still it may be surprising to learn that insurance coverage only exists for approximately 20-30 % of the total operational risk in banks. There are different reasons for why coverage is limited.

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[49] Aino Bunge 2002, Page 120

A, Risk of nonpayment and delays

One of the limitations of insurance is that it also exposes the bank to counter-party risk in that the bank cannot be certain that the insurance company will be able to make the payment in the event of loss. However, the credit risk should not be exaggerated though, as the insurance industry has proven to be able to incorporate massive losses. Banks have to consider that even when insurance payments will be made, they might not work as a perfect substitute for capital. But with the availability of capital to the bank immediately, the process form loss to an insurance payment can be lengthy. Therefore some times, many claims are not settled in the same fiscal year as the loss occurred. So bank will have to show losses on the balance sheet and income statement. One solution which has been tried is to guarantee the bank an up-front payment as soon as a claim is made. But it can in turn expose the insurance company to the risk that the bank would be unwilling or unable to pay back the money in the case the claim was unfounded. Consequently, such up-front payments are only likely to be available to larger banks with high credit ratings.

B, Non availability of insurance for very large losses

Normally it is perceived from the theory that banks should be able to profit the most from the transfer of low-frequency, high-impact losses, in reality coverage for very large losses has not been available. In fact some of the possible operational losses for large banks can amount to billions of dollars, which may threaten the soundness of even a large insurance company. However, the market of reinsurance has proven to be able to accommodate even very sizeable losses, but still for the very low-likelihood, catastrophic, events the collection of data has not been sufficient. Basically, the newly developed coverage for rogue trading based on the events at Barings has not become popular, probably that's because of the reason that banks tend to rely on internal controls and do not find the level of premiums appealing. Even we can see in the case of widespread Bankers Blanket Bond that usually only provides coverage for losses up to $100–200 million, even though larger losses are quite probable for a big bank.

4.1.4) Conclusion of Insurance

Insurance is valuable to banks because it reduces the impacts of unexpected losses and helps banks to have better risk management. However, the bank should purchase insurance to the extent that the cost of insurance is lower than the cost of reserving capital.

This is not certain that the managers of banks will get the level of insurance and capital right, however we can be sure of that capital charges changes the parameters of the decision. But decision makers in banks and regulators should not forget the benefits of insurance, both from existing forms of insurance coverage, and from new developments while looking for problems associated with insurance. In fact, as it's clear from the above sections that insurance is part of sensible operational risk management for all banks, small as well as large. However, for operational risks that arise because of frauds and negligence, should be curtailed through better auditing and internal control systems of check and balances. Banks should be more optimistic as the market for operational risk management is developing, and there are interesting products are being developed to cure many of the deficiencies of insurance compared to capital, such as delayed payments. For instance, we would say that insurance is very valuable in better risk management and thereby reducing the uncertainty and increasing worth of the financial as well as business concerns.

4.2 Hedging and Derivatives

4.2.1) Hedging Introduction

Hedging is the method of transferring Risk to permit the Risk Bearer to assume two offsetting positions at the same time so that, regardless of the outcome of an event, the risk bearer is left in a no win/no lose position. For example, in the options market, a stock owner of an underlying stock can write calls or buy puts. In the same options market, the short sellers of the underlying stock can buy calls or write puts.

Hedging has a significant role in risk management and we can say that there are two alternative objectives of hedging policies[50].

- Taking the advantage of opportunity and take risks.

[50] Mark Grinblatt, Sheridan Titman 2002, Page 55

- Having a prudent management aimed at hedging risks, totally or partially (for avoiding adverse market movements and benefit others)

Second case is that where policies aim to,

- Have locks in interest rate over a given horizon using derivatives or forward contracts.
- Hedge against adverse movements only, having the option to benefit from other favorable market movements on the other hand.

For any corporation the financial distress can be costly. These distress costs consists of costs arising from some conflicts between debt holders and equity holders and also arising from the reluctance of many of the firms most important stakeholders (like suppliers and customers) to do business with a firm having financial difficulties. In fact, if any firm hedges its risks, then it can increase its value by reducing its probability of facing financial distress in the future. Different studies[51] showed that hedging firms have, on average, market values that are 4.9 percent higher than others.

4.2.2) Advantages of Hedging

The reasons of hedging against risks can be realized by the following benefits of it,

1) ***Hedging helps in decreasing firms expected tax payments.*** According to (Philippe Jorion, 2006)[52] greater earnings stability also can reduce average taxes paid when the firm's tax function is convex. Normally, tax rates start at zero for negative incomes and then grow positive and higher for increasing levels of income. However, the schedule of the tax authority is akin to a perpetual call option on profits. Therefore, by lowering volatility, the firm can lower the value of this option, thereby enhancing firm value.

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[51] There is now tentative evidence that this is the case. Allayannis and Weston (2000) find that market valuations are higher for firms that make use of foreign currency derivatives to hedge. The value added is significant: Hedging firms have, on average, market values that are 4.9 percent higher than others. With a median market capitalization of $4 billion in their sample, this translates into an average value added of $200 million for each firm with a risk-management program. This is powerful evidence that risk management does increase value. Quoted by Philippe Jorion (2006, page 531)

[52] Philippe Jorion 2006, 3rd Ed, p. 530

2) ***Hedging can lower agency costs.*** In any corporation, due to the fact that the agents interests (management) are not aligned with those of the shareholders. So we can say that some managers may be incompetent, wasting firm value. Certainly shareholders are perfectly aware of this situation and are continually trying to assess the performance of managers, by watching earnings, for example. However, the problem is that earnings can fluctuate due to factors outside the control of the firm. For instance, we make earnings less volatile through hedging; risk management makes earnings more informative, which should lead to better performance assessment.[53]
3) Hedging helps in reducing the costs of financial distress[54].
4) Hedging also benefits firms to better plan for their future capital needs and reduce their need to gain access to outside capital markets.
5) Hedging also benefits by improving the design of management compensation contracts and it allows firms to evaluate their top executives more accurately.
6) Hedging benefits by improving the quality of the investment and operating decisions.

4.2.3) Limitations of Hedging

However hedging does not always reduce the probability of financial distress. In a case where the cost of hedging is adequately large and if hedging reduces the variance very little, then hedging may actually increase the probability of financial distress. Furthermore instances where this would occur are very unusual. But if it is costly then hedging may not be worthwhile for firms with very low financial distress costs.

4.2.4) Derivatives

Derivatives can be very useful as these can alter the interest rate exposures and allow us to hedger exposures and make interest income independent of rates. But this does not eliminate risk; however,

[53] Philippe Jorion 2006, 3rd Ed, page 530
[54] Mark Grinblatt, Sheridan Titman 2002, Page 59

since hedging might have opportunity costs because they set the interest at lower levels than rates could permit.[55]

Derivatives have two main types: ***Forward instruments*** are forward rate agreements or swaps; while ***option instruments*** allow capping the interest rate (caps) or setting a minimum guaranteed rate (floors). Moreover, forward instruments permit us to change and reverse exposures, such as turning a floating rate exposure into a fixed rate one, so that the bank can turn an adverse scenario into a favorable one. Nevertheless, in case of hedging with forward instruments implies a bet on the future and still leaves the bank unprotected against adverse interest rate movements if the bet goes wrong, While optional instruments allow us to capture the best of both worlds: one getting the upside of favorable interest rate movements and protection against the downside of adverse deviation, with a cost commensurable with such benefits. For instance, we can say that the derivatives serve to alter the exposure, to resize or reverse it and to modify the risk-return profile of the balance sheet as a whole. However, futures are instruments traded on organized markets and these perform the similar functions.

4.2.5) Danske Bank case

In the case of Danske bank, the Group enters into derivative contracts with personal customers only if it has ascertained that the customer has the right understanding of the risk profile of the products and the ability to meet realized losses. Moreover, for establishing derivatives transactions with businesses and institutions, the Group endeavors to ascertain whether the customer has adequate knowledge of the risks entailed in the transactions.

Additionally, the Group often requires collateral for derivative contracts with personal customers. In case of professional counterparties in the market, mutual collateral agreements are becoming customary. The policy of the Group is to promote such collateral management agreements in order to reduce the counterparty risk. However, the Group's collateral management agreements are monitored separately. The Group sets separate limits for the risk it is prepared to take on, for each customer. But because of reason that the exposures are normally hedged, the risk will arise only if market fluctuations occur at a time when the counterparty is unable to meet an obligation to provide cover. The following

[55] Joel Bessis 2004, page 180

table shows the net exposure to derivatives with positive fair value. (Danske Bank Annual report 2007, page 31)

Table 4.2:

COUNTERPARTY RISK (DKr m)	2007	2006
Derivatives with positive fair value	224,616	149,529
Netting benefits	181,237	116,814
Current net exposure	43,379	32,715

Now, in following sections of the chapter, we will see how hedging is done with derivatives and how it helps in curbing various kinds of risks.

4.2.6) Conclusion for Hedging and Derivatives

Hedging against various kinds of risks is common practice in financial institutions. Normally hedging is done in banks with derivatives.

Hedges and derivatives plays a vital role with coping and reducing the danger of various kinds of risks like, interest rate risk, foreign exchange risk and market risks etc. Thereby, hedging reduces the probability of financial distress. Corporate risk management through hedging against risks with derivatives minimizes the risks and thereby increases the efficiency and worthiness of corporations.

Chapter 5: Case Study of Maersk-A.P. Moller Group

This chapter consists of three parts. It begins with the introduction of case company Maersk- A.P. Moller Group and the reason why we decided to do the research there. It will be followed up by the main body of who we interviewed, what are the questions asked and what coincides with our topic. The last part will be our conclusions and findings.

5.1) Case Company Introduction

5.1.1) Case Company background

The Maersk-A.P. Moller Group (Maersk) is a multinational conglomerate with business operating in some 130 countries and it has a workforce of some 120,000 employees.[56] In addition to owning one of the world's largest shipping companies, they're involved in a wide range of activities in the terminal, energy, logistics, retail and manufacturing industries.

Based on Maersk 2009 Annual Report,[57] the group comprises approximately 1,100 companies. Its business areas can be categorized as container shipping and related activities, APM Terminals, Tankers, offshore and other shipping activities, oil and gas activities, retail activities and Shipyards, other industrial companies, interest in Danske Bank A/S, etc. In 2009, it generated revenue of USD48.5 billion and it was USD61.2billion in 2008.

5.1.2) Why A.P. Moller Maersk – Group

A.P. Moller Maersk - Group is a famous international company with a good reputation in the market. It is a giant in Denmark contributing big portion of the country's GDP and tax income. The group has various business entities and its function of risk management is significantly important for the group to forecast the risk and manage the cash flow.

Another reason of choosing this company is because one of the researchers Moli has been working for this company for almost 7 years. She is an International Trainee from Maersk and right now is working in Maersk in Copenhagen headquarter. Therefore she could get access to company resources easily

[56] www. maersk.com

[57] Maersk –A.P. Moller Group 2009 Annual Report, Page 14

such as website and internal report and also have chance to interview its senior management people in Risk Management field.

5.2) Interview process

5.2.1) Interview background

According to Maersk 2009 Annual Report, there is a specific chapter about Risks. [58] The Maersk-A.P. Moller group is exposed to various types of risks as a consequence of the Group's activities. Risk Management is anchored in the Group's management. In 2009, the organization of the Group's risk monitoring was changed and implementation of an improved risk management tool was initiated. The Group's risks can be divided into Strategic Risks, Financial Risks, Operational Risks and Regulatory Risks. We will mainly target on the Financial Risks.

Risk Management is existing in most of the business enterprises with no exception to Maersk. What is interesting to us is that it shows much awareness of the Risk monitoring and uses a plenty of tools to monitor the risk. With the curiosity to know what improvement they are doing, we conducted our interviews with some prepared questions.

5.2.2) Interviewees introduction

Thomas, Skytte – Senior Director, Head of Risk Management in Group Finance and Risk Management

Thomas has been in the Maersk Group for 10 years and he holds a degree in Master of Economics. He is now heading the whole Risk Management Department of four people in Maersk Group Finance. Their Risk Management covers every business areas from the Group including Strategic Risks, Financial Risks, Operational Risks and Regulatory Risks.

Kasper, Andreasen Mahon – Director, Head of Investment and Risk Management in Maersk Line Centre Finance

[58] Maersk –A.P. Moller Group 2009 Annual Report, Page 48

Kasper is the head of the Investment and Risk Management team of three people in Maersk Line, which is only the shipping unit from the Group. His field for Risk Management only lies on managing Currency Risk by reporting to the group and assets risk management including purchasing fleet, chartering and reviewing long term deployment plan.

5.2.3) Interview questions

We have prepared some questions which served the purpose of our thesis question. However, during our conversations, there were some new findings and some valuable points were got from un-prepared questions. The following questions covering our interviews:

- How does their Corporate Risk Management work? What type of risks they are managing?
- How do they manage their currency risk and interest rate risk?
- Which tools are they using and do they use VaR and other financial measurement?
- How do they feel their risk management compared to the industry?

5.3) Maersk Risk Management

The interview was conducted very successfully. We got most of the questions answered and there are still some more interesting findings. The findings can be linked to our thesis in the following aspects.

5.3.1) Corporate Risk Management in Maersk Introduction

Thomas, Skytte is the author of the Risks part in Maersk 2009 Annul Report. His answers to this coincided with their 2009 Annual Report. The Risk Management is centralized by a dedicated Risk Management team under Group Finance, which is heading by Thomas. Each business areas also have Risk Management section but it only contains strategic risk management, reporting of currency demand to Group Finance or any other business specific risk management.

Apart from the dedicated Risk Management team, the Group has many activities and organisational support with the primary purpose of helping to identify, monitor and manage the most material risks.

Most risks are managed in the various business areas. The day-to-day management and the Board of Directors regularly access material risks and take the required initiatives to manage such risks satisfactorily.[59] It is reflected in Kasper's team as his job is only an iceberg of the risk management in Maersk Line, which is just reporting the currency demand to Group Finance and manage non-current asset like our fleet purchasing and chartering activities. The awareness of giving more risk management work to each business areas is increasing from the talk with Thomas in group risk management. Because only four people of the team can't cover well various types of risks.

5.3.2) Financial Risks in Maersk

The Group's risks can be categorized to Strategic Risks, Financial Risks, Operational Risks and Regulatory Risks. As our thesis focus on Financial Risk Management, we just concentrated our discussion in the Financial Risks field. Maersk Financial Risks include foreign currency risks, interest rate risks, oil price risks, credit risks and liquidity risks. Among all of those, currency risks, interest rate risks and oil price risks are the most popular and important ones. For the A.P. Moller - Maersk Group, the development in the crack (the difference between the prices of crude oil and bunker oil) is a significant risk factor. A widened crack (i.e. the price of crude oil increase more than the price of bunker oil) will bring the result that income from oil and gas activities increases faster than the costs incurred by shipping activities. This will have a positive effect on the earnings of the A.P. Moller - Maersk Group, while a narrowed crack will have a negative effect.

Hedging and derivatives are commonly used in Maersk

Currency risk and interest risk are hedged to transfer the risks. Maersk Group's income from shipping and oil-related activities is mainly dominated in USA, while the related expense are incurred in both USA and a wide range of other currencies such as DKK, EUR, CNY and GBP. Income from other activities such as terminal activities and retail activities, are often locally based, so that income and expenses are mainly derived from same currency, thus reducing the Group's exposure to the currency

[59] Maersk –A.P. Moller Group 2009 Annual Report, Page 48

risk. [60] So that, based on Thomas, the Group hedges the none-USD value of the Group's net cash flow and reduce the fluctuations in the Group's earnings.

The Group uses various financial derivatives, including forward and option contracts, to hedge these risks. The key aspects of the currency hedging policy are as follows:

- Net cash flows in none-USD currencies are partly hedged with a 12-month horizon
- Future significant investment commitments in none-USD currencies are hedged
- Net receivables in other currencies than USD are partly hedged

Maersk Group has some loans mostly in USD with some part in other currencies. And some loads are at fixed interest rates, while others are at floating interest rates. The interest on floating rate loans is partly hedges through interest rate swaps that fix the interest rate for a certain period. According to its 2009 Annual report, the interest during of the Groups debt portfolio was 3.1 years.

The way they manage interest risk is mainly standard swap, which is to lock the interest rate on 12-month duration and within 3% to 6%. Kasper commented it is not an aggressive approach but in a defensive way.

Risk Management Tools

As a business enterprise, Maersk Group also has their tools and modelling of Risk Management. Unlike the financial institutions, not too much scientific Risk Modelling is used. The basic financial measurements of the investment are:

NPV (Net Present Value)

IRR (Internal Rate of Return)

CFROI (Cash Flow Return on Investment)

[60] Maersk –A.P. Moller Group 2009 Annual Report, Page 98

VaR (Value at Risk) is one of the important tools for them to check the maximum loss the company can suffer from, under normal market conditions, over the given period of a time at the given probability level. Variance and Covariance are largely used in the analysis of the hedging data. And for the group portfolio of currency, the Sensitivity Delta is used by colouring the risk alert.

When we mentioned Basel Accords of minimum capital reservation, even it is irrelevant to the business enterprise like Maersk Group. Thomas still introduced to us that the Group is using the same concept as Basel Accords by their internal Financial Rule, under which they should maintain certain equity ratio to manage the liquidity risks.

It was also mentioned the Group actually have very advanced financial tool and modelling for Oil price risk while they are using Simulation methods (often called Monte Carlo methods). However, we don't have access to the relative statistics and people. So we didn't dig it out further.

5.3.3) Case Study Conclusion

The case study for Maersk-A.P. Moller Group is conducted by interviews and using secondary materials from its website and annual report. Even though much information can be acquired from its annual report but interviews with two different people did give us an in-dept understanding of how they manage their Corporate Risk Management, what kind of tools they are using for Risk Measurement and controlling and how they feel compared with industry.

In general, Maersk Group has a dedicated Risk Management team with very experienced and knowledgeable people in economics and risk management field. However, as they also pointed out, they should still increase the awareness of the risk management by adding more man power doing it. The risk types mainly lie on Currency Risks, Interest Rate Risks and Oil Price Risks. While the Group Risk Management team well use hedging and derivatives to avoid the risk and increase the net worth of the company and net value of cash flow. They do use some financial tools and risk modelling to measure the risk like VaR (Vale at Risk) and Simulation methods for Maersk Oil Trading. However, an improved risk management tool should be adopted by taking more financial modelling.

Compared with peer companies in the same industry, for instance shipping companies, they feel their risk management ranks at the middle level, which is not very aggressive approach but in defensive way.

The company's style is aligned with the approach. However, they may learn some practices from financial institutions to use the Risk Management Tool to increase the net worth of the company.

Chapter 6: Conclusion

Financial risk management in an integrated framework is the focus of this thesis. Risk management in businesses supports to implement risk based policies and practices. The risks that a bank or in some other business concern currently faces are tomorrow's potential losses. However, these risks are not visible as tangible revenues and costs are. In fact, sensitivity and visibility to risks is inevitable for a corporations' management. For banks, simply because of the reason that the *banks are 'risk machines': banks take risk, transform them and embed them in banking products and services*. The purpose of implementing risk based practices is to provide a balanced view of risk and returns from a management point of view, to develop competitive advantage and to comply with increasingly stringent regulations. *The 'capital adequacy' principle is very significant for risk management in banks; it states that the bank's capital should match its risks*.

By the mid-1990s, the major financial & business corporations have learned rich lessons for risk management. A piecemeal approach to corporate risk management can miss significant risks or even worse, push risks into places less visible, creating a misleading sense of safety.

Now major corporations are embarking on ambitious programs to quantify their financial risks systematically and comprehensively. Because of the implementation of Basel Accord regulations, now the tendency is towards combined capital charges for market, credit, and operational risks. The corporate risk management brings substantial benefits for banks and business corporations. Many of the studies that we read during the writing of this paper gave us evidence that corporate risk management can increase shareholder value substantially. We have seen the case of the risk management organizational structure of Danske Bank in appendix A, which has a hierarchal division of risk managing and controlling responsibilities among different units of the Group. This set-up of the Group uses most of the approaches as we have discussed in the paper and is quite successful in risk management.

Integrated/corporate risk management is a broad field. It involves financial risks which need to be curtailed. There are three major financial risks that are credit risk, market risk and operational risks. The Basel Accord provides the guidelines and regulations for all the banks of world for risk

management of these three main financial risks. The Accord, gives the rules for better capital adequacy for the three risks. These risks can be dealt with any of the three methods of capital adequacy laid down by the Accord. The Accord is based on three mutually supporting "pillars" of capital adequacy. The first pillar discusses the maintenance of regulatory capital calculated for main risks types that a bank faces, namely, credit risk, market risk and operational risk. The second pillar and the third pillars are basically new initiatives on stronger supervisory review and market discipline, this makes up promising complements to the capital adequacy. Under the second pillar, the bank supervisory agencies, like the Comptroller of the Currency, have the authority to adjust capital levels for individual banks above the 8 % minimum when necessary.

The Basel Accord provides comprehensive approaches for banks to tackle with credit risk, which is the most important risk for banks, for example credit risk for Nordea bank of Denmark comprises 92% of total risk (Nordea Bank annual report 2007). Briefly, Basel Accord still provides solid capital regulatory recommendations that are certainly helping in coping with financial risks of credit and markets of banks. Basel Accord is ‘‘the right way to forward’’ that provides solid capital regulatory recommendations. However, the success lies in the fact that how well the gradual implementation of complex rules on capital adequacy is conducted. Regulations should be focused more on setting principles baked with supervisory review in the future of financial market innovations rather than expanding rules further

It is apparent that Value at Risk has developed as a successful financial risk assessment methodology of corporations in the last decade. There are three methodologies in which Value at Risk can be measured. However all the three methodologies have their pros and cons. Nevertheless, the total pros of VaR outweigh the cons, making it a best risk management methodology. That’s why it is widely used for risk measurement around the world and is very effective risk management methodology. Danske Group and A.P Møller Maersk of Denmark also uses VaR for financial risk management.

The traditional VaR methods normally ignore extreme events and focus on risk measures that accommodate the whole empirical distribution of returns. Basically this kind of problem is not exclusive to risk management, researchers and practitioners in the world of finance and businesses

solve this problem by using Extreme Value Theory (EVT) that attempts to make the best possible use of what little information we have about the extremes of the distributions in which we are interested.

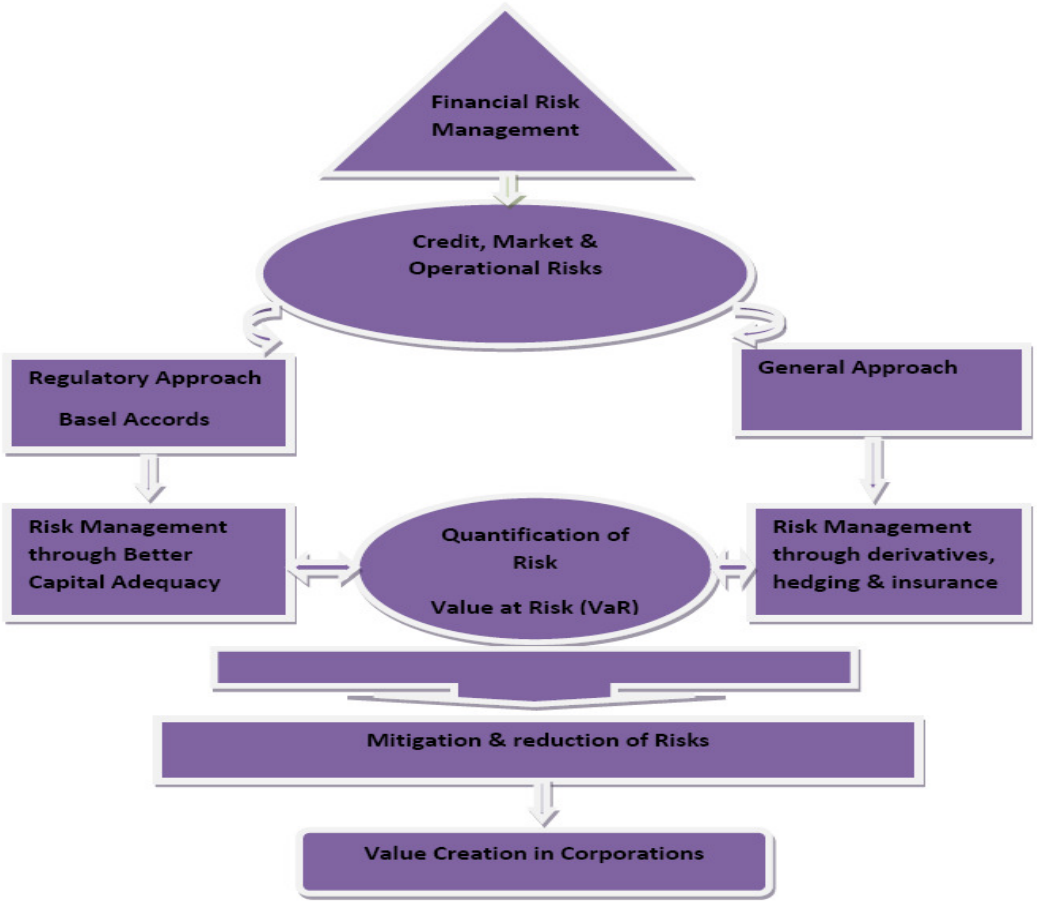
In fact, EVT deals with the frequency and magnitude of very low probability events and gives good results about extreme risk. Therefore, EVT makes the best out of an inherently difficult problem, and hence symbols a significant step forward in better VaR estimation. *For instance, we would say that VaR methodology is the best to use with EVT for better risk management*.

Insurance is valuable to corporations in the context of mitigating the impacts of operational risk. Insurance reduces the impacts of unexpected losses and thereby reducing uncertainty which is valuable. However, the corporations should only purchase insurance to the extent that the cost of insurance is lower than the cost of reserving capital. We can say in other words that the marginal benefit of an increase in insurance cover should be compared to its marginal cost. For instance, we would say that insurance is very valuable in better risk management and thereby reducing the uncertainty and increasing worth of the corporations.

Hedging against various kinds of risks is a common practice in financial institutions. Normally hedging is exercised in banks with derivatives.We have two types of derivative instruments. First is Forward Hedge, it locks in future rates but its disadvantage lies in giving up the possibility of benefiting from the upside of favourable movements in rates (opportunity cost or risk). Second is Optional Hedge that provides protection against adverse moves and allows us to take advantage of favourable market movements (no opportunity cost). However, its cost the premium to pay when buying an option is much higher. Corporate risk management through hedging against risks with derivatives minimizes the risks and thereby increasing the efficiency and worthiness of banks. Hedging and derivatives play a vital role with coping and reducing the danger of various kinds of risks like, interest rate risk, foreign exchange risk and market risks etc. The findings of some studies showed that hedging firms have, on average, market values that are 4.9 percent higher than others

For instance, any corporation can generate value creation by mitigating and reducing the impacts of losses associated with financial risks. This can be done by implementing three steps of measuring, controlling and managing corporate-wide risks with applications of better capital adequacy regulations

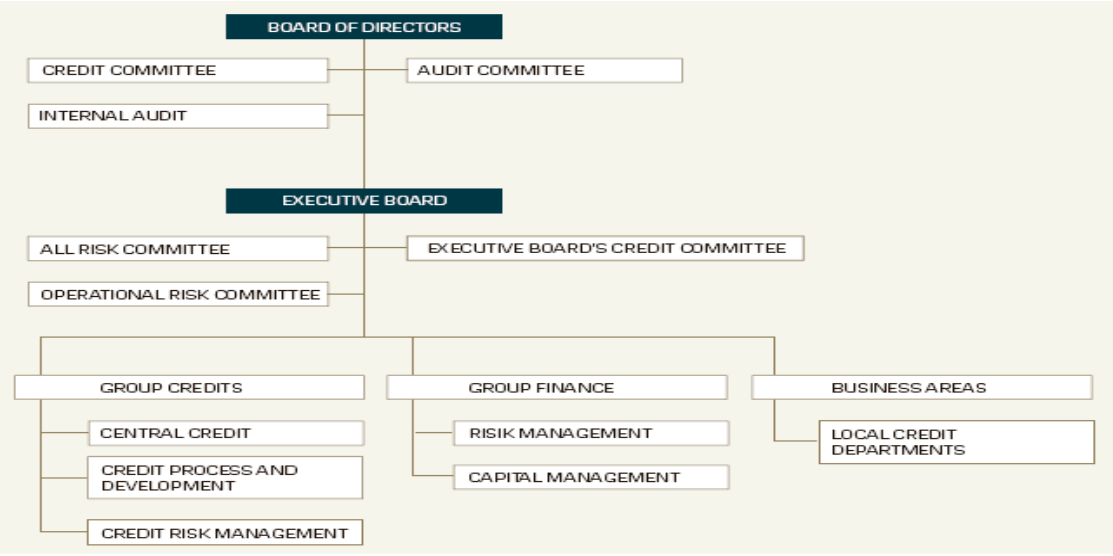
of Basel Accord & conventional practices of VaR, insurance, hedging and derivative in an integrated framework.



Flow chart: Conclusion of thesis

Appendix (A) ‘‘Risk Management Organization of the Danske Bank Group’’

The Danske Group of Denmark is the biggest national banking institution of Denmark. It has established a functional separation between units that enter into business transactions with customers or otherwise expose the Group to risk on the one hand, and units in charge of overall risk management on the other. Overall risk management is centralized under Group Credits and Group Finance, where Risk Management, the Group’s department for general risk monitoring, is located. Each business area is responsible for the business transactions it enters into. A number of responsibilities, including day-to-day risk management and monitoring, have therefore been delegated to each business area. To optimize the division of duties between business areas and support functions, the Group has developed the Danske Banking Concept, which is based on the principle of a uniform customer segmentation and service strategy across the business areas. The Concept also includes a uniform organization and uniform processes in the business areas. To a great extent, the processes are based on the shared IT platform implemented over the past few years. The Concept serves to optimize the control measures carried out at the Group level by Group Credits and Group Finance, among others. (Danske Bank Report 2007, pages 9)



Board of Directors: Under the Group's two-tier management structure, the Board of Directors lays down overall policies, while the Executive Board is in charge of the Group's day-to-day management and reports to the Board of Directors. None of the executives of the Group is on the Board of Directors of the parent company The Board of Directors lays down the overall risk policies and limits. The largest credit facilities are submitted to the Board of Directors for approval, and the Board has defined overall limits for market risks. Important elements of the risk management framework are approved by the Board. Regular reporting enables the Board of Directors to monitor whether the risk management policies and systems are complied with and match the Group's needs.

The Board of Directors has set up a number of committees to supervise specific areas or to prepare cases that are later considered by the full Board. Under Danish law, board committees do not have independent decision-making authorities. The committees include the Credit Committee and the Audit Committee. The Credit Committee operates as a hearing panel for major credit exposures and monitors trends in the credit quality of the Group's loan portfolio as well as special renewal applications and facilities. The Audit Committee examines accounting, auditing and security issues. These are issues that the Board of Directors, the Audit Committee itself, the group chief auditor or the external auditors believe deserve attention before they are brought before the full Board. The Committee also reviews the internal control and risk management systems.

Executive Board

The Executive Board is responsible for the day-to-day management of the Group as laid down by the rules of procedure of the Board of Directors and the Executive Board.

The Executive Board sets forth operational risk policies and supervises the risk management of the Group. It reports to the Board of Directors on the Group's risk exposures and approves material business transactions, including credit applications up to a defined limit. The Executive Board has established three committees that are in charge of ongoing risk management.

Group Credits

The Group's credit organization is led by the head of the central credit department, Group Credits. Group Credits has overall responsibility for the credit process in all of the Group's business areas. This

includes the responsibility for developing rating and score models and for applying them in day-today credit processing in the local units. Credit approval authorities specific to customer segments and products have been granted to the individual business areas. In addition, Group Credits rates customers with facilities exceeding DKr100m. Group Credits is in charge of recording the utilization of portfolio limits within industries and countries and of the quarterly process of calculating impairment of exposures.

Group Finance

Group Finance oversees the Group's financial reporting and strategic business analysis, including the performance and analytic tools used by the business units. The department is also in charge of the Group's investor relations, corporate governance, capital structure, M&A and relations with rating agencies. Risk Management is also part of Group Finance. As the Group's risk monitoring unit, Risk Management has overall responsibility for the Group's implementation of the rules of the Capital Requirements Directive (CRD), risk models and risk analysis.

Business areas

The business areas carry out the fundamental tasks required for optimal risk management. They enter the necessary registrations about customers that are used in risk management tools and models, and they maintain and follow up on customer relationships. Each business area is responsible for preparing carefully drafted documentation before business transactions are undertaken and for properly recording the transaction. Each business area is also required to update information on customer relations and other issues as may be necessary.

Reporting

The Group allocates considerable resources to ensuring the ongoing compliance with approved credit limits and to monitoring its credit portfolio. It has a fixed reporting cycle to ensure that the relevant management bodies, including the Board of Directors and the Executive Board, are kept informed on an ongoing basis of developments in the credit portfolio, non-performing loans and the like. Reporting includes the annual reporting and quarterly reporting of the Group. (Danske Bank Report 2007, pages 9 to 14)

Appendix (B) VaR in Danske Bank

The Danske Group applies Value at Risk (VaR) in the management of its interest rate, exchange rate and equity market risk. Value at Risk measures the maximum loss that the Group may, under normal market conditions, incur over a certain period of time at a certain confidence level. The group for example, takes a 95% 10-day VaR of DKr1,000 that means that there is a 95% probability that the Group will not lose more than DKr1,000 within the next ten days or we can say that there is a 5% probability that the Group will incur a loss exceeding DKr 1,000. One of the benefits of VaR is that it provides an aggregate measure of all risk types that factors in the correlation structure of the financial market .For example, equity prices often go up when bond prices fall and vice versa. However in practice, this means that the VaR of a portfolio containing bonds and shares will be lower than the sum of the VaRs of comparable separate bond and share portfolios.

The following table (Danske Bank Annual report 2007, page 51) shows the Group's market risk at the end of 2006 and 2007 calculated according to conventional risk measures.

MARKET RISK, CONVENTIONAL RISK MEASURES		
At December 31 (DKr m)	2007	2006
Interest rate risk	2,417	946
Equity market risk, listed shares	1,105	1,611
Equity market risk, unlisted shares	3,340	3,185
Credit spread risk on corporate bonds	3	4
Commodity risk	3	-
Exchange rate risk, Value at Risk	7	8

From 2007, the Group had replaced its parametric VaR model with a historical simulation model. The main benefit of the historical simulation model is that it uses full revaluation and makes no assumptions regarding the loss distribution. This leads to more accurate results for non-linear products than other methods would give. The Danske Group's VaR model is based on two years' historical market data. For instance each calculation is based on 1,000 scenarios representing possible future outcomes of the risk

factors. On that basis, an empirical loss distribution is calculated, and it is used to determine the VaR. A confidence level of 95% corresponds to the fiftieth-largest loss in the distribution.

There are 1,000 scenarios that are generated by means of a bootstrap method (a variation of historical simulation). For the construction of a 10-day scenario, 10 independent drawings are made from a dataset of two years' historical daily returns. These outcomes are generated at random and are always equally likely and each outcome contains all risk factors in order to maintain the correlation. The risk factors that are applied include interest rates, equity indices and exchange rates. For the purpose of ensuring that the model input for daily calculations is correct, a number of reconciliations are run. The reconciliations cover the market data used for the calculations and the scenarios generated, as well as the portfolios included. However the internal VaR model is used for both risk monitoring and for the calculation of capital requirements. The former employs a confidence level of 95%, and the latter, a level of 99%. The following table 6.3 shows the VaR used in internal risk monitoring. This table is broken down by risk type and also shows the diversification benefit from using VaR as a total risk measure rather than looking at each risk type separately. The figures cover all the Group's risk portfolios. The 2006 VaR was calculated with the previous model as the minimum and maximum for the risk types that do not occur on the same days, so these values are not shown under the diversification benefit. (Danske Bank Annual report 2007)

For instance, we can conclude from this illustration of the bank that VaR plays a vital role in quantification of risk and it should be a used in an integrated framework to curb losses

Table[61]

[61] Danske Bank Annual report 2007, page 56

VALUE AT RISK (10-DAY HORIZON, CONFIDENCE LEVEL OF 95%)

	2007				2006			
At December 31 (DKr m) By risk category	Avg. VaR	Minimum VaR	Maximum VaR	Dec. 31	Avg. VaR	Minimum VaR	Maximum VaR	Dec. 31
Interest rate	239	68	694	584	121	66	238	66
Exchange rate	10	3	20	4	10	4	28	7
Equity market	73	47	138	84	93	45	181	65
Diversification benefit	-74			-107	-66			-46
Total VaR	248	90	655	565	158	92	247	92

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