9
Risk Management

9.1 Introduction to Risk Management

We will now give a short introduction of how to measure risk and how to define limits on risks for a portfolio with many different instruments. Such limits are used by financial institutions to control and minimize risks. There have been more and more focus on risk management, especially after the financial crises in 2007–2008.

Financial risk management is the practice of creating economic value in a firm by using financial instruments to manage exposure to risk, particularly **Counterparty Credit risk** and **Market risk**. Here we will focus on market risk. Market risks includes:

- **Equity risk**, the risk that stock or stock indices prices and/or their implied volatility will change.
- **Interest rate risk**, the risk that interest rates and/or their implied volatility will change.
- **Currency risk**, the risk that foreign exchange rates and/or their implied volatility will change.
- **Commodity risk**, the risk that commodity prices and/or their implied volatility will change.

Some other sources of risk have been discussed in other sections of these lecture notes. Such risks include foreign exchange risk, liquidity risk, inflation risk, model risk, settlement risk, correlation risk, operational risk etc.

In order to ensure the survival of the financial firm and to comply with the provisions of the regulators, firms must have methods in place

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to regularly measure and maintain sufficient Capital to cover the nature and level of the risks to which the firm is or may be exposed to. The firm has both an obligation and an opportunity to design appropriate risk management systems that are tailored to their unique business requirements. Financial risk management can be both qualitative and quantitative.

In the banking sector, worldwide regulations are developed, such as the Basel Accords which are generally adopted by internationally active banks for tracking, reporting and exposing operational, credit and market risks.

The companies' systems for managing market risks should fulfil two general purposes. First, from a general risk management perspective, the systems should sufficiently provide the companies with a good understanding of the size of the market risk. Secondly, the systems should allow the companies to take risk mitigation measures that will ensure that their balance sheets are not exhausted. These systems can also form the basis for the companies' Capital requirement calculations.

The recent financial crisis has demonstrated numerous weaknesses in the global regulatory framework and in banks' risk management practices. In response, regulatory authorities have considered various measures to increase the stability of the financial markets and to prevent future negative impact on the economy. One major focus is on strengthening global Capital and liquidity rules.

Perhaps, the most important risk to measure is the potential loss due to the market and credit risk. As with all forms of risk, the loss amount may be measured in a number of ways or conventions. Traditionally, one convention is to use **Value-at-Risk** (VaR). The use of VaR is well established and accepted in the short-term risk management practice.

However, traditional VaR contains a number of limiting assumptions that constrain its accuracy. The first assumption is that the composition of the measured portfolio remains unchanged over the specified period in time. Over a short time horizon, this limiting assumption is often reasonable. However, over longer time horizons, many of the positions in the portfolio may have been changed and the VaR of the initially measured portfolio is no longer relevant. Another assumption is that changes are normally distributed which excludes fat tails and black swans. This has caused extensions of traditional CaR such as stressed VaR or credit VaR.

The Variance-Covariance and Historical Simulation approach to calculating VaR also assumes that historical correlations are stable and will not change in the future or breakdown under times of market stress.

In addition, care has to be taken regarding the intervening cash flows, embedded options, changes in floating interest rates etc. in the portfolio. These features cannot be ignored since their impact might be large.

9.1.1 Capital Requirement

One critical question is how much, and what type of, Capital a bank needs to hold so that it has adequate protection from losses due to future events.

In its simplest form, Capital represents the portion of the bank's liabilities, which does not have to be repaid, and therefore is available as a buffer in case the value of the bank's assets decline. If banks always made profits, there would be no need for Capital.

Unfortunately, such an ideal world does not exist, so Capital is necessary to act as a cushion when banks are impacted by large losses. In the event that the bank's asset value is lower than its total liabilities, the bank becomes insolvent and equity holders are likely to choose to default on the bank's obligations.

Naturally, regulators would hold the view that banks should hold as much Capital as possible, in order to ensure that insolvency risk and the consequent system disruptions are minimised. On the other hand, banks would wish to hold the minimum level of Capital that supplies adequate protection, since Capital is an expensive form of funding, and it dilutes earnings.

There are three views on what a bank's minimum Capital requirement should be.

First, in the **regulatory view**, the minimum Capital requirement as demanded by the regulators; it is the amount a bank must hold in order to operate. A regulator's primary concern is to ensure that there is sufficient Capital in order to buffer a bank against large losses. Regulatory Capital could be seen as the minimum Capital requirement in a "liquidation" view, whereby all liabilities can be paid. Recently regulators have introduced the concept of survival horizon for banks whereby its capital should be enough to sustain its business during a time period of 30 days in case markets break down.

Regulatory Capital is a standardised calculation for all banks, although, there are differences to various regulatory regimes and countries.

Second, in the **economic view** there is a theoretical view on minimum Capital requirement based on the underlying risks of the bank's assets and operations. Economic Capital could be seen as the minimum Capital requirement so that the bank is in continual operation. Here we are only concerned to hold enough Capital to survive.

Economic Capital was originally developed by banks as a tool for Capital allocation and performance assessment. For these purposes, it did not need to measure risk in an absolute, but only in the relative sense.

Over time, with advances in risk quantification methodologies, the concept of economic Capital has been extended to applications that require accuracy in the measurement of risk. This is evident in the ICAAP, whereby banks are required to quantify the absolute level of internal Capital.

Finally, in the **rating agency view** the minimum Capital a bank needs to hold is the amount it needs in order to meet a certain credit rating. The amount and type of Capital a bank holds in relation to its total risk weighted assets (RWA) is a crucial input to the reviewing mechanisms used to determine its credit rating. In addition, since credit ratings provide important signals to the market about the financial strength of the bank, they can have significant downstream impact on a bank's ability to raise funds, and the cost at which the funds can be raised. Therefore, having sufficient Capital to meet the requirements of the rating agencies becomes an important consideration for senior management.

A key part of bank regulations is to make sure that firms operating in the industry are **prudently managed**. The aim is to protect the firms themselves, their customers and the economy, by establishing rules to make sure that these institutions hold enough Capital to ensure continuation of a safe and efficient market and that the banks are able to withstand any foreseeable problems.

The main international effort to establish rules around Capital requirements has been the Basel Accords, published by the **Basel Committee on Banking Supervision** housed at the **Bank for International Settlements**. This sets a framework for how banks and depository institutions must calculate their Capital. In 1988, the Committee decided to introduce a Capital measurement system commonly referred to as Basel I. This framework has been replaced by a significantly more complex Capital adequacy framework commonly known as Basel II. This is currently being replaced by Basel III.

The Capital ratio, the percentage of a bank's Capital to its risk-weighted assets is dictated under the relevant Accord, Basel II. It requires that the total Capital ratio must be no lower than 8 per cent.

Each national regulator normally has a slightly different way of calculating bank Capital, designed to meet the common requirements within their individual national legal framework.

In the European Union, member states have enacted Capital requirements based on the Capital Adequacy Directive CAD1 issued in 1993 and CAD2 issued in 1998. In the United States, depository institutions are subject to risk-based Capital guidelines issued by the Board of Governors of the Federal Reserve System (FRB).

9.1.1.1 Regulatory Capital

According to Basel II, the bank Capital was divided into two "tiers", each with some subdivisions.

Tier 1 Capital

Tier 1 Capital, the more important of the two, consists largely of shareholders' equity and disclosed reserves. This is the amount paid up to originally purchase the stock (or shares) of the Bank, retained profits subtracting accumulated losses, and other qualifiable Tier 1 Capital securities. In simple terms, if the original stockholders contributed $100 to buy their stock and the Bank has made $10 in retained earnings each year since, paid out no dividends, had no other forms of Capital and made no losses, after 10 years the Bank's Tier 1 Capital would be $200. Shareholders equity and retained earnings are now commonly referred to as "Core" Tier 1 Capital, whereas Tier 1 is core Tier 1 together with other qualifying Tier 1 Capital securities.

Tier 2 (Supplementary) Capital

Tier 2 Capital, or supplementary Capital, comprises undisclosed reserves, revaluation reserves, general provisions, hybrid debt capital instruments and subordinated term debt. Undisclosed reserves are not common, but are accepted by some regulators where a Bank has made a profit but this has not appeared in normal retained profits or in general reserves.

A *revaluation reserve* is a reserve created when a company has an asset revalued and an increase in value is brought to account. A simple example may be where a bank owns the land and building of its headquarters and bought them for $100 a century ago. A current revaluation is very likely to show a large increase in value. The increase would be added to a revaluation reserve.

A *general provision* is created when a company is aware that a loss has occurred, but is not certain of the exact nature of that loss. Under pre-IFRS accounting standards, general provisions were commonly created to provide for losses that were expected in the future. As these did not represent incurred losses, regulators tended to allow them to be counted as Capital.

Hybrid debt Capital instruments consist of instruments, which combine certain characteristics of equity as well as debt. They can be included in supplementary Capital if they are able to support losses on an ongoing basis without triggering liquidation. Sometimes, it includes instruments, which were initially issued with interest obligation (e.g. debentures), but the same can later be converted into Capital.

Subordinated debt is classed as Lower Tier 2 debt, it usually has a maturity of at least 10 years and ranks senior to Tier 1 debt, but is subordinate to senior debt.

9.1.2 Risk Measurement and Risk Limits

To measure and control the risk, financial institutions in general use risk matrices, VaR calculations and other methods. The risk calculated using such models is then analysed each day and compared with the limits. The management and the board of directors decide these limits. We will next give a description of the most common models.

9.1.2.1 Risk Matrices

Risk matrices are used to measure, control and report risks. A risk matrix is an outcome analysis of a scenario in which two risk factors are stressed at different intensities. The factors that are altered are usually the price of the underlying asset (delta and gamma risk) and expected volatilities (Vega risk). An example of a risk matrix is presented in Table 9.1.

The aforementioned matrix shows gains or losses for different pre-specified scenarios in which volatilities and underlying prices fluctuate within an interval of +/–30 per cent and +/–20 per cent, respectively.

Table 9.1 An example of a risk matrix

	–20 %	–10 %	–5 %	0 %	5 %	10 %	20 %
–30 %	–33 480 000	–29 430 000	–26 955 000	–24 180 000	–21 105 000	–17 730 000	–10 080 000
–20 %	–25 420 000	–21 370 000	–18 895 000	–16 120 000	–13 045 000	–9 670 000	–2 020 000
–10 %	–17 360 000	–13 310 000	–10 835 000	–8 060 000	–4 985 000	–1 610 000	6 040 000
0 %	–9 300 000	–5 250 000	–2 775 000	–	3 075 000	6 450 000	14 100 000
10 %	–1 240 000	2 810 000	5 285 000	8 060 000	11 135 000	14 510 000	22 160 000
20 %	6 820 000	10 870 000	13 345 000	16 120 000	19 195 000	22 570 000	30 220 000
30 %	14 880 000	18 930 000	21 405 000	24 180 000	27 255 000	30 630 000	38 280 000

Many companies use risk matrices to set limits for the level of the largest acceptable loss. Another alternative is to define a subsection within the matrix and set the limit where the greatest loss may occur within this subsection.

Risk matrices have both strengths and weaknesses due to their simplicity. A strong point is that they offer an extremely clear and comprehensible method in which to place potential outcomes in direct relation to changes in relevant market variables, which is attractive for traders as well as risk functions and senior management.

Their weaknesses are that they do not Capture **basis risks**, (see next) between different maturities, exercise prices and underlying assets and they completely ignore risk factors other than price and volatility. Many times, the degree of stress that is tested, in particular with regard to volatilities, is not high enough. We will show an example of this subsequently (see the HQ Bank section).

Basis Risk

Risk matrices ignore basis risks between different underlying assets, maturities and the exercise prices of options. This basis risk is the risk that opposite positions in a hedging strategy do not move as expected in relation to one another. This risk does not appear in the risk matrix because the risk matrix calculations simply adds all positions in the trading portfolio without any regard for correlation of prices or volatilities. Note here, exercise prices refer exclusively to option exercise prices.

Many financial firms and fund managers are not sufficiently aware of the consequences of this weakness. By calculating the sum of their positions, two strong assumptions are implicitly made:

- The market prices of all assets and liabilities in the portfolio are assumed to be perfectly correlated. In other words, for example, it is assumed that if the price of an asset increases 1 per cent, all other underlying assets in the portfolio will also increase by 1 per cent. This means that a negative position and a positive position in two assets would cancel one another out and as a result the risk (expressed as delta and gamma) can appear to be very small or non-existent.
- With regard to options, it is assumed that implied volatilities for different maturities and different exercise prices are perfectly correlated. For example, if the volatility of an option maturing in three months increases by 5 per cent, it is assumed that volatilities of all

other options in the portfolio with different maturities and exercise prices will also rise by 5 per cent. This implies that negative and positive positions in different maturities could completely cancel out one another in which case the risk (expressed as Vega) could appear to be small or non-existent in the risk matrix.

It is worth noting that it was this exclusion of basis risks between both different underlying assets and different maturities that to a large extent contributed to the failure of the Swedish HQ Bank. It did not identify the enormous risks in its trading portfolio. The HQ Bank case therefore represents a good example of the danger of risk matrices.[1]

Example 9.1.2.1

HQ Bank in Sweden

HQ Bank's main market risk measure for its trading portfolio was a risk matrix as described earlier. The bank simulated a worst-case scenario within the matrix and set its limits based on this measure.

The absolute largest exposures in HQ Bank's trading portfolio were index linked options on the German DAX index and the Swedish OMX index. The following table shows the exposures expressed as delta and Vega at 18 May 2010. The table also shows the exposures broken down by underlying asset and maturity (which the risk matrix calculations do not include).

Position date	2010-05-18		
		Data	
Underlying	Exp.date	Sum of Vega	Sum of Delta
ODAX	2010-05-21	–259 069	–4 317 526
	2010-06-18	11 136 970	–37 881 767
	2010-12-17	51 855 354	82 996 030
	2010-12-17	–53 655 171	–67 476 377
ODAX Total		9 078 084	–26 679 640
OMXS30	2010-05-21	742 152	15 725 210
	2010-06-18	–581 817	–3 214 468
	2010-07-16	–3 272 317	–10 597 947
	2010-10-15	–4 174 850	–1 880 670
	2011-01-21	–6 019 420	133 047
OMXS30 Total		–13 306 252	–165 172
Total		–4 228 168	–26 514 468

[1] See the report by the Swedish FSA (Finansinspektionen).

Vega in the table is expressed as the change given an increase in implicit volatilities of one percentage point.

Delta is expressed as the change given an increase in the underlying asset price of one percent.

Several important events are evident from the previous table.

The bank had a negative Vega exposure in OMX and DAX for long maturities (primarily December 2010) and an opposite exposure for short maturities (primarily June and September 2010).

The total exposure in DAX was positive in terms of Vega and negative in terms of delta, while the total exposure in OMX had the opposite signs. The aggregate exposure (Swedish Krona (SEK) -4.2 million in Vega and SEK -26.5 million in delta) appears to be relatively small compared to the sub exposures per maturity and underlying asset.

When the risk in these exposures is transferred to a risk matrix, the implicit assumption is made, as mentioned before, that all maturities and underlying assets are perfectly correlated. Given this assumption, the exposures in HQ Bank, at least in terms of Vega, undeniably appeared to be relatively small. In Vega, the December outcome in DAX seemed to eliminate the September outcome and the total exposures in both Vega and delta in OMX seemed to compensate for the opposite exposures in DAX. As a result, only the total exposure of SEK -4.2 million in Vega and SEK -26.5 million in delta were visible in the matrix. This was naturally a gross simplification of the risk profile.

The table shows that if all underlying prices would remain unchanged and if the volatility would increase by 1 percentage point in the DAX December outcome at the same time as the volatility would remain unchanged for all other maturities and underlying prices (which was not an improbable scenario), HQ Bank would have lost SEK 53.6 million at the same time as the risk matrix would have indicated a loss of SEK 4.2 million.

This example illustrates how the risk matrix's underlying simplified assumptions regarding basis risks can lead to a gross underestimation of risks.

One conclusion that can be drawn from the HQ example is that if a portfolio contains significant positions which cannot be assumed to have a particularly strong correlation and/or significant option positions with different maturities and exercise prices that are not proven to be strongly correlated, the basis risks are likely to be significant t. These risks, therefore, must be measured and controlled, which an aggregate risk matrix does not do.

There are several ways to improve risk matrices so that they Capture basis risks:

1. Lower aggregate levels: For example, it is conceivable that the correlation between two shares in one country is greater than

the correlation between two shares in different countries. It is therefore possible to form several groups, one for each country, and then construct a risk matrix for each of these groups. This will ensure that correlation within the groups is actually high in order to ensure that significant basis risks are not underestimated.

2. Other correlation assumptions: The basic (implicit) assumption in the risk matrix is that there is perfect correlation between underlying assets, maturities and exercise prices, which may be viewed as an extreme assumption. In order to examine what would happen in the presence of imperfect correlation, it is helpful to simulate the matrix under other assumptions. The most common alternative is to test the opposite extreme scenario – the total absence of any correlation – but other correlation assumptions may also need to be tested. Simulating two extreme cases can be a good exercise since the results provide an interval of outcomes for comparison. This type of simulation also illustrates what could happen if correlations drastically change, which is important information since correlation patterns are not constant over time.
3. Combinations with other risk measures: This is the absolute most common and the most robust way to manage basis risks. For maturities, it is common to measure Vega in time buckets, which are often also subject to limits. For basis risks between underlying assets, scenario analyses in which the largest positions in individual assets are stressed under an assumption that the correlation is zero are often used. For financial firms that use VaR models, these models usually function as a good complement, provided that the same correlation assumptions are not made between the risk factors in the VaR model as in the risk matrix.

Exclusion of Risks

As described previously, risk matrices measure the exposure to two types of risk:

- Change in price of underlying assets (delta and gamma risks).
- Change in expected volatility in underlying assets (Vega).

These two definitely qualify as significant risks for, for example, an equity portfolio with optionality. However, the portfolio may be exposed to other significant risks which might need to be analysed and measured outside of the matrices like:

- Sensitivity to changes in maturity (theta) is one factor that is often excluded from risk measurements. One possible explanation for why theta is often excluded is that it is questionable if it is a "risk" in the true meaning of the word since it is not directly affected by market risk factors. Because theta is the gain/loss arising due to the additional passage of time, it is relatively predictable. Theta may still need to be measured in order to be able to derive the origin of the results.
- If the portfolio contains optionality, the interest rate sensitivity (rho) can be a significant risk factor.
- For some asset classes there are also other types of risks that are difficult to measure with risk matrices, for example credit spread risks and twist risks in bond portfolios or dividend risks for equity derivatives.

Volatility Stress in the Risk Matrices

Asset prices and volatility might be stressed differently. For share portfolios, the price dimension is stressed by +/–10 – 15 per cent while the volatility dimension is stressed by +/–20 – 30 per cent. A 10 – 15 per cent fluctuation in a share portfolio is an extreme stress scenario over a short period of time, particularly since the stress is often applied to a diversified portfolio and not to individual share. However, it is not particularly unusual for implicit volatilities to fluctuate in considerable excess of 20 – 30 per cent. In other words, the model to a stress scenarios can be too weak. For example, the VIX index rose by more than 50 per cent in one day during the Lehman crash in 2008. In 2011 alone there were two trading days during which the volatility in VIX fluctuated by more than 30 per cent in just one day. The stress on volatility is therefore not proportionate to the stress on price for many companies. Similar differences can also be observed for asset classes other than equities.

9.1.2.2 VaR Models

VaR in general is a probability-based risk measure that is statistically created by a model. The measure should be interpreted as a loss that with a specified probability is not expected to be exceeded during a certain period of time. Companies normally use a VaR with a probability of 99 per cent or 95 per cent and a 10-day time horizon. For example, a VaR measure of -200 million, 99 per cent and 10 days would mean that, at the date of measurement, a company could expect with 99 per cent probability not to exceed losses of more than 200 million over a period of 10 days. However, VaR does not say anything about what the losses could be in extreme cases. VaR is also almost always based on historic market fluctuations, and forward-looking hypothetical market fluctuations and correlation patterns are not captured in the model.

VaR models are a globally accepted method for measuring and controlling risk. This method is primarily used by the larger companies, but also by some of the smaller companies. VaR models are good supplements to risk matrices and other sensitivity measures since they contain a probability aspect that is not found in these methods. The VaR measure is also more comprehensive than, for example, risk matrices since it takes into account many more risk factors than only price and volatility. A VaR model is relatively intuitive and easy to understand as a concept and it also enables comparisons of risk-taking between different parts of a company's business.

It is important to understand the function of the VaR model in order to be able to understand its limitations. A VaR model rapidly becomes more complex as more asset classes and types of instruments are included. A number of assumptions and simplifications must be made in the model to simulate the risk of loss. The most important, is to ensure that these simplifications are not so significant as to render the VaR measure unrealistic. Therefore back-testing of the VaR model on historic data is important in order to verify that losses are neither over- nor underestimated.

There exist a number of common methods for simulating a distribution of losses. These methods can be divided into three groups, **Parametric VaR**, **Monte-Carlo Simulated VaR** and **Historically Simulated VaR**.

Parametric VaR – This method is the least robust of the three. The reason for this is that an assumption is made about the underlying probability distribution and a full revaluation of the financial instruments is not carried out. This type of model can be used for areas with low complexity (e.g. isolated parts of an organization that handle simpler instruments). If this model is to be used for risk control with well-defined limits, it should be supplemented with additional limits on well-planned and robust risk measurement methodologies, such as stress tests and scenario analyses that reflect extreme fluctuations in risk factors.

According to this method, an assumption is made about the probability distribution of the daily returns. Input data required by the model includes standard deviations, means and correlations between the various risk factors. Instruments are not fully revalued individually, rather the model's calculations are based on sensitivity measures. The most common assumption is normal distribution, even if other distribution assumptions could be possible.

For linear instruments (i.e. instruments where the prices do not depend non-linear on another underlying instrument), a method based on delta should be sufficient but if optionality or convexity is present in the portfolio, a delta/gamma method should be used. The obvious disadvantage of this type of VaR model is the distribution assumption. After a number of financial crises, it has become generally accepted that few financial markets are characterised by normally distributed prices. Extreme fluctuations are much more common than what is indicated by a normal distribution. The true probability of observing a loss greater than the one predicted by the VaR model is therefore greater than the chosen degree of confidence.

Monte-Carlo Simulated VaR – Provided that a full revaluation of financial instruments is carried out, this model is better suited for complex, non-linear instruments than parametric VaR. Therefore, this model can be used for risk control and risk measurement when such instruments are included. However, since a distribution assumption is made in the simulation of risk factors (often normal distribution), extreme fluctuations, just like for parametric VaR, should be taken into account separately via scenario analyses and stress tests.

This method simulates time series for various risk factors via a stochastic process. The "Geometric Brownian Motion" or a similar process is often used in the simulation. For each simulated outcome, every instrument in the portfolio is fully revaluated in order to identify effects on profit. The advantage of this method is that its simulation of exotic financial instruments is more accurate and therefore also more appropriate for portfolios containing many complex instruments. The disadvantage of this model is that it also makes an assumption about distribution since the stochastic process must follow a probability distribution.

Historically Simulated VaR – The advantage of this VaR model is that it does not require any explicit distribution assumption while, at the same time, a full revaluation of the instruments is carried out. The disadvantage of this model is that the simulation is strongly dependent on the model being based on a "representative" historical period of time (more on this later).

This method uses actual historical time series to identify changes in risk factors to which the portfolio is sensitive. The exposures are simulated by actual historical scenarios, which occurred within the historical period. A result is simulated for each day during the historical period and thus builds the distribution. The loss amount that corresponds to the degree of confidence chosen by the company is then sorted out and represents the VaR measure. This method does not require any explicit assumptions about the distribution, which is a clear advantage. Full revaluation means that the model can also be used to simulate very complex instruments. The disadvantages are that this method requires considerable computer power to simulate large portfolios with complex instruments and it can be difficult or impossible to obtain sufficient historical data for certain instruments. This method is also particularly sensitive to the span of the historical period. The most common period of time consists of the most recent one-year period. Some banks uses a two-year period and other shorter periods was 17 days.

Irrespective of the analytical structure, a number of assumptions must be made to estimate the parameters used to construct the probability distribution. The parameters are usually estimated using actual data from a past period in time. The VaR models have proved to be extremely sensitive to the period that was chosen, which in particular applies to historically simulated models. For example, a company's VaR value more than doubled if the historical period included the financial crisis in 2008.

Companies using VaR models to calculate Capital requirements for market risks need historical data for a period of at least one year. A shorter historical period of data makes the VaR value more sensitive to new data, while a longer historical period of data makes the value less sensitive.

Choice of Risk Factors for the VaR Model

A VaR model selected as a risk measurement method for specific operations should include all significant risk factors associated with such operations. However, if the firm's operations in a specific market are very small, or if the risks are negligible, some risk factors may be estimated or even completely excluded from the model.

It is relatively common for risk factors to be excluded or for risk factors that cannot be assumed to have a reasonable correlation with the actual risk to be included in the estimations. Many companies do not have any ongoing validation of this process in order to regularly monitor how accurate the estimates are.

9.1.3 Risk Control in Treasury Operations

The main responsibility of treasury operations is to manage the company's borrowing and lending transactions and to identify any differences in maturity and currency between cash flows. Also the treasury operations usually include management of the financial firm's liquidity reserves. In general, the treasury operations often represent a significant portion of the firms' total market risk, primarily in the form of interest rate risks, credit spread risks and cross currency basis swap spread risks.

In general, the treasury operations are separate from other areas of the company that generate market risk. This is evident in that both methods for and of reporting market risk often differ significantly from other areas of the company. Treasury operations can have a considerable less transparency in terms of risk than other areas of the companies. Less sophisticated methods and fewer risk measures are used, and as a result, several significant risks are generally not identified.

9.1.3.1 Cross Currency Basis Swap Risk

These risks arise in companies, which borrow funds in a different currency than they lend funds. The interest rate risk that arises is normally hedged with an interest rate swap and the currency risk with a cross currency basis swap. The Fig. 9.1 shows such a typical arrangement

Explanation of the model

- Bank A issues a five-year fixed interest rate bond in EUR. However, the bank's lending is primarily in SEK with three-month maturities.
- To neutralise this discrepancy in maturity between borrowing and lending, Bank A enters into an interest rate swap in EUR where the fixed interest rate for the issued bond is transformed to a variable EURIBOR-based interest rate.

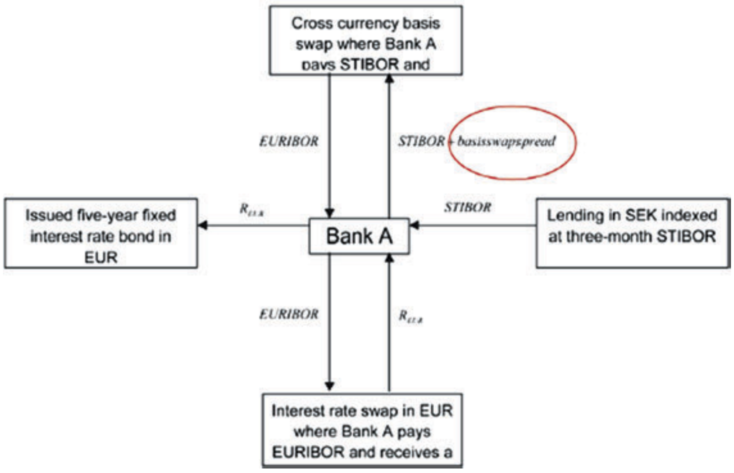

Fig. 9.1

- The currency discrepancy is neutralised via a cross currency basis swap where Bank A pays STIBOR and receives EURIBOR. In the previous example, Bank A pays a spread in addition to STIBOR in the basis swap (encircled in previous instance).

In the example, all transactions are made to maturity (i.e. to five years). From a risk perspective, it therefore appears that borrowing and lending are fully hedged. At maturity, Bank A will receive the interest rate margin it locked in via swaps related to its borrowing and lending. However, changes in basis swap spreads result in gain/loss effects during the term of the hedge. According to applicable accounting rules, changes in market value attributable to changes in basis swap spreads have a direct effect on Bank A's profit/loss and often on its Capital adequacy as well. The investigation demonstrated that the incurred profit/loss risk is often significant.

9.1.3.2 Credit Spread Risk

Credit spread from a specific bond is defined as the difference between the bond's market rate and the rate of a risk-free bond with the same maturity. Credit spread risk is the risk of loss in the form of a change in value of the bond when the credit spread changes. The credit spread is, as implied by its name, primarily attributable to the creditworthiness of the issuer. Credit spread risks are not unique to treasury operations; they are also found in many other areas of the companies. However, they are often of considerable size in the treasury operations, particularly in liquidity portfolios which often hold large amounts of bonds, notes and bills.

A normal procedure within treasury operations is to use interest rate swaps for liquidity portfolios in order to lower the maturity of the portfolio (often under three months) and thereby decrease the sensitivity to changes in interest rates. Credit spread risk, however, remains unchanged after such a procedure. The treasury operations focus in most cases specifically on the interest rate risk in the portfolio, which is often sharply reduced after hedging with swaps. Companies might place considerably less importance on the credit risk spreads, which in some cases actually are larger than the interest rate risks.