WORLD 4 / CHAPTER 1

RISK AND RISKMANAGEMENT

RISK AND RISKMANAGEMENT

During the past years, the state of risk management in the banking world has undergone dramatic changes. This is the result of the tremendous growth in the trade of derivatives, the development of modern approaches within finance theory. Moreover, it is understood that classic accounting approaches can not adequately describe the risks involved in complex trading and hedging strategies. Today, the bank departments of strategic planning, system support, and controlling try to evaluate the impact of these new possibilities on the overall strategy of the banks, on the role of the management, and on the optimum allocation of the company´s capital. With the help of risk measurement, risk evaluation, and risk monitoring banks try to develop methods to estimate market, credit and liquidity risks adequately. Furthermore, it is tried to establish a clear limit system in a bank , that allows the bank´s overall risks to stay between the given limits.

At present, the legislation favours statistical methods such as the value-at-risk (VAR) approach to quantify the respective risks of banks. These VAR approaches take several factors into account: Possible fluctuations of individual risk positions, correlations between different positions (both within the same risk category but also between different categories), liquidity risks, and default risk regarding credits. The role of the bank management is to guarantee that the methods in use match the risks that are taken by the bank.

A very important source of bank revenues stems from the presence of risk. However, most risks should not to be seen in a negative way. Though, on the one hand, risks must be limited, banks have to establish a risk management system that allows them also to earn money on risks. In order to achieve these two aims, risks must be measurable and, thereby, made estimable.

The majority of bank risks are controlled within trading and treasury. Since trading is one of the of a bank´s core business, it is strongly affected by the question of limiting and measuring risks.

Risks are always linked to a specific uncertainty. Modern approaches of risk measurement try to quantify these uncertainties in order to compare different risk positions, and consequently the returns on risk.
Another important aspect of the modern risk measurement methods is the idea that the total risk is lower than the sum of the single risks involved. This idea is based on the portfolio theory, where the total risk may be reduced by diversification. In the context of the FX trade, this means that a single position (e.g. short USD position) bears a higher risk than a position that is composed of different individual positions (e.g. the same amount composed of short positions in USD, GBP, JPY, and SFR). The probability that each position turns negative is lower than the probability that only one single position will lead to a loss.

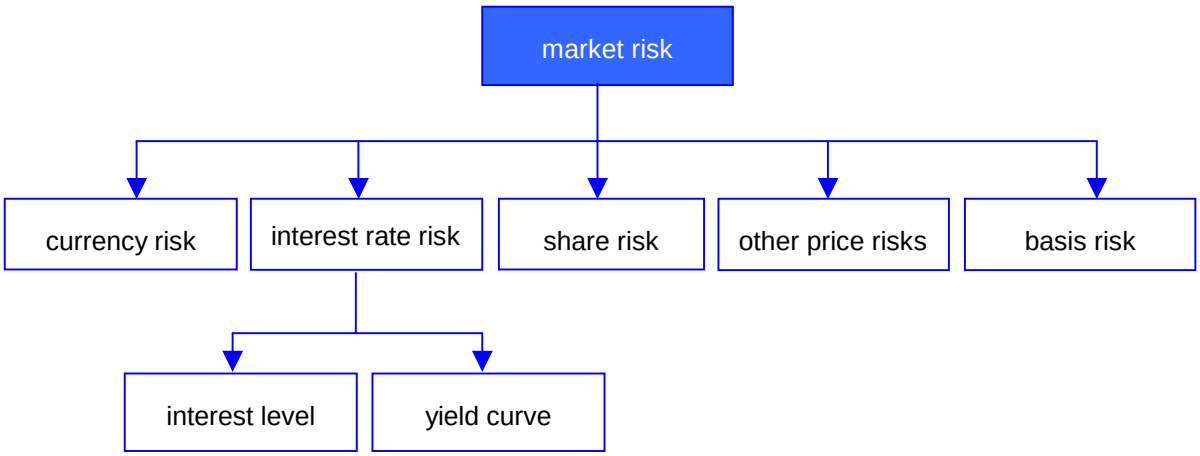
The same ideas apply also to the credit risk, where the risk of a single credit is higher than a comparable risk that is based on a variety of borrowers (with comparable creditworthiness).

1. Types of risk trading

1.1. Market risk

Market risk (also called price risk) is the risk that the bank suffers losses on its open positions due to unfavorable market movements. Especially in the trading section, market risks must be taken into account, since most open positions are found there.

Overview: Market risks



On the following pages, we want to focus on the determination of currency-, interest rate-, and basis-risk.

Determination of open FX positions

Classic determination

The most simple method to determine open FX positions is:

Example

	assets
-	liabilities
+/-	hedged interest
+/-	spot positions
+/-	forward positions
=	open FX position

A simple example shall show the problems involved in such a calculation.

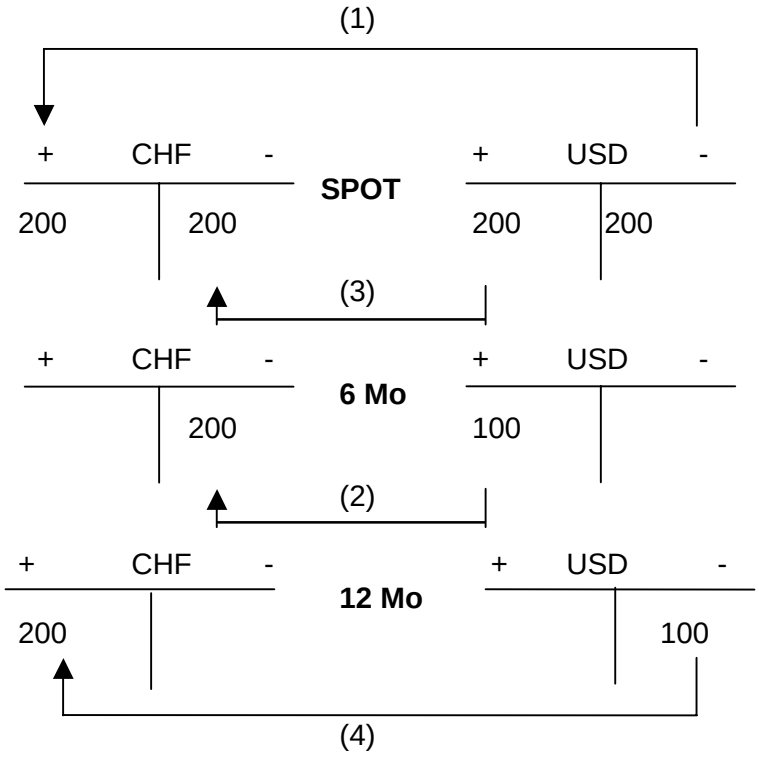
Example

USD/CHF	2.0000
interest rates	
USD, 6-month	5.00 % (182 days)
USD, 12-month	5.00 % (365 days)
CHF, 6-month	5.00 % (182 days)
CHF, 12-month	5.00 % (365 days)
FX swap:	
6-month	0 BP (neither premium nor discount)
12-month	0 BP (neither premium nor discount)

Since the swap dealer is convinced that USD interest rates will rise and CHF interest rates will fall, he decides to settle the following positions:

Buy a 6-month USD-CHF FX-swap [sell spot (1), buy forward (2)]
Sell a 12-month USD-CHF FX-swap [buy spot (3), sell forward (4)]

Using T-accounts, you get the following positions:



By simultaneously buying and selling spot, the spot position is balanced. You have a 6-month forward purchase on the one side, and a 12-month forward sale on the same amount of USD on the other side. If you used the method described above to determine the open position, your result would be a closed USD-position. If there were no open USD position, the result would not be influenced if the USD rate would change. We assume that the interest rates stay unchanged while the USD spot rate changes.

Example

Assumption:

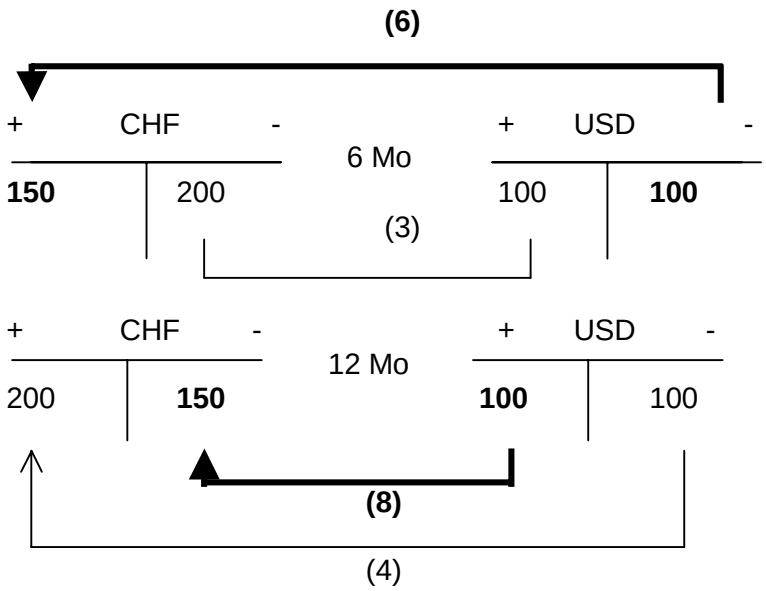
USD/CHF 1.5000

Unchanged interest rates and therefore unchanged forward points. Our position may be closed with the following transactions:

Sell 6-month USD-CHF FX-swap [buy spot (5), sell forward (6)]
Buy 12-month USD-CHF FX-swap [sell spot (7), buy forward (8)]

Using T-accounts, you get the following positions:

Since the spot position is balanced by buying and selling spot, we do not describe it for reasons of clarity.



Since the USD positions are balanced, you have a loss of CHF 50 in 6 months and a profit of CHF 50 in 12 months.

Example

As shown in chapter 2 (financial mathematics), two cash-flows that occur at different times cannot be compared directly. Thus, you have to determine their respective present values.

Doing this for our example, we have:

Present value of CHF -50 in 6 months

$$\frac{-50}{1+\left(0.05\cdot\frac{182}{360}\right)} = -48.767$$

Present value of CHF +50 in 12 months

$$\frac{+50}{1+\left(0.05\cdot\frac{365}{360}\right)} = 47.588$$

The total return on our transactions adds up to CHF - 1.179 (CHF 47.588 — CHF 48.767).

Despite the fact that the interest rates have not changed in our example, the dealer still suffers a loss in this position. Since the only change that took place, was in the USD/CHF rate, this loss must be due to a change in the exchange rate. Therefore, the view that this position does not run an FX-risk must be put in perspective.

The problem with the classic determination of open FX positions is that positions occurring at different times are simply added up.

Because of this problem, a more modern approach for determining open positions has gained acceptance recently.

Calculation of open FX positions by using present values

Open FX position = total of the present values of all future cash-flows

Example

For the above example, we get the following open FX position:

spot - 100

+100

6 month +97.535

$$\frac{100}{1+\left(0.05\cdot\frac{182}{360}\right)}$$

12 month - 95.175

$$\frac{100}{1+\left(0.05\cdot\frac{365}{360}\right)}$$

total position + USD 2.360

By selling USD 2.360, you could hedge against the FX risk that is involved in these transactions.

Check: If the spot rate falls by 50 Rappen, we would get a return of CHF 1.180 on the sold USD 2.360. This would exactly compensate the negative result at a spot rate of 1.50.

Interest rate risk

The GAP-analysis

The GAP-analysis determines the capital surplus of different terms and measures the sensitivity of end-year results due to an assumed change in interest rates. Interest rates can undergo a parallel shift, but also the whole interest rate structure can change (change of interest rate level and yield curve).

For reasons of clarity, GAP-analysis divides individual positions into different time intervals where they are balanced. A possible partition of an interest rate portfolio could look like the following:

Range of interest rate terms
0-7 days
7-30 days
1-3 months
3-6 months
6-12 months
1-2 years
2-5 years
5-10 years
above 10 years

Such a presentation and risk measurement has the advantage that it is very clear and is easy to interpret. But there are also some disadvantages:

- When dividing the interest terms, it is possible that positions that seem to be closed now (and are therefore not taking into account by GAP) may later be regarded as open positions. For example, a 6-year swap that is combined with a 7-year swap (one of them being a fixed-rate payer swap, and the other the fixed-rate receiver swap) is totally neglected during the first presentation. After a year has passed, the 6-year swap enters the range of 2-5 years while the 7-year swap remains in the original range.

- The GAP-method only reflects amounts of capital. Different price sensitivities of the underlying instruments (e.g. zeros, fixed-rate interest transactions with non-annual interest payments) are neglected.

The following improvement of the GAP-method has gained acceptance in recent times:

- The representation of open interest rate positions within the single terms are based not only on amounts of capital, but also on the interest payments involved.

Basis risk

Basis risk commonly refers to the risk of different price developments of two positions (that show almost the same terms). Basis risk occurs with positions of different instruments (e.g. interest rate swap/bond) as well as with positions that are based on the same yield curve but that bear some remaining risks due to differences in liquidity or due to imperfect markets (e.g. structured bonds where each part is hedged separately).

1.2. Credit risk

Classic credit risk (counterparty risk)

The classic credit risk refers to the loss of the total capital amount (or parts of it) due to the partner´s inability to pay. This classic credit risk exists for banks with all asset deals, since all receiveables are booked in the balance sheet with the capital amount. The same risk occurs with warranties that the bank has given.
With derivatives (off-balance sheet products), this classic credit risk is per se eliminated.

Example

Consider, that the borrower defaults after the credit has been given but before it is paid back. This would mean, that the bank loses the total amount of capital and the accrued interest.

With an interest rate swap, the bank does not risk losing the underlying amount of capital in case of a default.

Settlement risk

The settlement risk represents a type of credit risk that occurs with all exchange transactions: The bank has already completed its part of the transaction while the partner default foils the completion of the transaction. Therefore, the extent of the settlement risk equals the total value of the transaction. The risk is inherent from the time, that the bank has done the transaction until the completion of the transaction by the counterparty.

Particularly, settlement risk has to be considered if the payment arrangements differ due to different time zones. If, for example, a EUR/USD spot transaction is settled, the payer of the USD may complete his payment a couple of hours before he will get the EUR in return.

The settlement risk should be particularly considered in the case of FX transactions. There, the respective volumes tend to get bigger while almost all transactions are settled over the counter. Settlement risk hit the headlines in 1974 with the bankruptcy of the Herstatt Bank; since then settlement risk is also known as "Herstatt risk".

Position risk

The position risk (replacement risk) refers to a bank´s risk that due to counterparty´s default the position must be replaced at an extra cost in the market.

If the bank enters an interest rate swap and the counterparty defaults during the term, the bank has to arrange a new interest rate swap at current market rates for the rest of the term, in order to create the same interest position as before the default. Due to this new deal, additional costs can occur.

Today, banks make use of two common methods to estimate this position risk:

Maturity method

Depending on the transaction(and the product) term, a percentage of the nominal amount is taken as risk value. The internal measurement for an interest rate swap could be as follows: charge 1 % per year of the term; this would mean that the position risk for a 4-year interest rate swap would be 5 % of the underlying principal. One, thereby, assumes that interest rates might change by 1 %.

Mark-to market approach

With the mark-to-market approach, the position risk is determined on the basis of the current market value of each position. All of the - from the bank´s point of view - positive market values (since only in this case will the bank incur a loss caused by the partner default) are considered in the calculation of the position risk.
In order to take the risk, that these market values may change in the future, into account, margins are added to the current market values. These margins are determined in a way similar to the term method, whereas the margin rate must be accordingly lower. It has become more popular to calculate the margin for the replacement value with methods like the VAR-approach (see next chapter).

1.3. Other risks

Operational risk

Operational risks represent all those risks that are caused by a malfunctioning system in the banks. These may be computer shutdowns as well as inadequate organizational prerequisites within the banks.

Legal risks and risks of statutory regulations

Some risks can not be influenced by banks, but could still play a role for the total risk of the bank. These risks could be legal uncertainties during the treaty´s drafting as well as risks that are a result of possible changes in statutory regulations.

Political risks

Changes of the political landscape may have influences on the bank´s possible trading as well as on the frameworks that the bank´s current partners are facing.

Image risks

Due to the fact that banks are operating in a highly sensitive area (managing someone else´s money), their business connections are very susceptible to possible image loss. Rumours and/or scandals may lead to greater business losses, although the economic effects might be headed off easily by the bank.

Criminal risks

Even when the bank tries to avoid all of the risks mentioned above, there is still the risk that individuals deliberately try to bypass the established procedures in a criminal way.

2. Risk Management

In the previous section, we looked at methods to assess risk positions. In this section, we want to focus on the determination of risks. Moreover, we want to concentrate on market risk.

2.1. FX position keeping

Position keeping is a procedure where all transactions in a currency pair are recorded (e.g. GBP/USD) and the open balance is valued at the end of each time interval. This way, a bank gets an impression about its open position and the risks it is currently running.

Three ways are necessary in order to calculate and evaluate an open FX – position:

I. Calculation of the net position in the quoted currency

The net position in a currency is the amount by which a dealer is short or long of that currency after balancing out all deals. Long positions bear positive signs, short positions negative signs. If long and short positions cancel each other out the position is said to be closed.

II. Calculation of the net position in the variable currency

The volume of the quoted currency is multiplied by the price in order to get the volume of the variable currency. After, the volumes are added up.

III. Valuation at the average rate

The open net position is valued at the average rate. In order to calculate the average rate, the net position in the variable currency is divided by the net position in the quoted currency. The net position reflects the volume of the open position in the quoted currency. The average rate takes all transactions inta account and can therefore be interpreted as brek-even rate. This means that if the position is closed at that rate you have neither a profit nor a loss. If the position is closed (or valued) at a better rate you can realize a dealing (or valuation) profit.

Example

You made the following USD / CHF transactions:

Sell USD 10 mio at 1.4020

Sell USD 10 mio at 1.4025

Buy USD 15 mio at 1.4023

Buy USD 10 mio at 1.4018

Your position looks as follows:

Position quoted currency rate	*Rate*	*Position variable currency*	*Total position*	*Average*
- 10.000.000	1,4020	+ 14.020.000	- 10.000.000	1,40200
- 10.000.000	1,4025	+ 14.025.000	- 20.000.000	1,40225
+ 15.000.000	1,4023	- 21.034.500	- 5.000.000	1,40210
+ 10.000.000	1,4018	- 14.018.000	+ 5.000.000	1,40150
+ 5.000.000		- 7.007.500		1,4015

You have a long position of USD 5 mio at 1.4015.

By comparing your position with the current rate you can determine if the position is a profit of loss.

The following principles apply:

- In the case of long positions the average rate is compared with the bid rate. The question is if the quoted currency was bought cheaper than it can be sold now.

- In the case of short positions the average rate is compared with the offered rate. The question is if the amount sold can be repurchased cheaper.

In practice, the valuation of the position is done at the mid rate, though a valuation at the bid/offer rates is theoretically correct.

Example

Your net position is USD 5 mio long at an USD / CHF average rate of 1.4015. The closing rate is 1.4017 – 19. Did you make a profit or loss ?

You are USD 5 mio long which you can sell at 1.4017. Since you have paid on average 1.4015 CHF per USD you cash in a profit of 0.0002 CHF per USD, i.e. CHF 1,000 (5,000,000 x 0.0002).

If you revalue the position at the mid rate (1.4018) your result is CHF 1,500 (5,000,000 x 0.0003).

Keeping a position – the day after

If a revalued position shall be valued again you can choose between two possibilites:

a) You continue with the average rate of the net position

b) The open net position is valued and the profit/loss booked. The starting point for next day's valuation is then the net position at the **valuation rate**.

Example

We continue with the USD / CHF example calculated above. You are USD 5 mio long at 1.4015, valuation against 1.4017. Your next deal is the sale of USD 7 mio at 1.4017. Value the position if the closing rate is 1.4016.

Way 1:

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average rate*
+ 5.000.000	1,4015	- 7.007.500	+ 5.000.000	1,40150
- 7.000.000	1,4016	+ 9.811.200	- 2.000.000	1,40185
- 2.000.000		+ 2.803.700		1,40185

Closing rate: 1.40185

Result: Profit 500 CHF (2 mio x (1.40185-1.4016)

Way 2:

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average rate*
+ 5.000.000	1,4017	- 7.008.500	+ 5.000.000	1,40170
- 7.000.000	1,4016	+ 9.811.200	- 2.000.000	1,40135
- 2.000.000		+ 2.802.700		1,40135

Closing rate: 1.40135

Result:	Profit	1,000 (Valuation Day 1)
	Loss	500 (Valuation Day 2)
Total:	**Profit**	**500**

Note: In way 1 all profits/losses of the past are incorporated in the average rate.
In the second possibility the result is locked in and the next average rate reflects the break-even for the new deals.

Position keeping if the quoted currency is the domestic currency

In continental Europe, the switch to the Euro poses the problem that the positions are kept and valued in the domestic currency. Thus, the position in the quoted currency is no longer automatically the open FX – position. The open FX – position is now the position in the quoted currency or profits/losses which incur if the valuation is done at the valuation rate in the domestic currency.

Example

You buy EURO / USD 10 mio at 1.1835 and buy EURO / USD 12 mio at 1.1837. You sell EURO / USD 22 mio at 1.1838. Furthermore, you buy EURO / USD 10 mio at 1.1840 and sell EURO / USD 5 mio at 1.1842. What is your position and result at the end of the day if you revalue your position against a Euro / USD closing rate of 1.1837?

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average Rate*
+ 10.000.000	1,1835	- 11.835.000	+ 10.000.000	1,18350
+ 10.000.000	1,1837	- 14.204.400	+ 22.000.000	1,18360
+ 10.000.000	1,1840	- 11.840.000	+ 32.000.000	1,18370
- 22.000.000	1,1838	+ 26.043.600	+ 10.000.000	1,18350
- 5.000.000	1,1842	+ 5.921.000	+ 5.000.000	1,18296
+ 5.000.000		- 5.914.800		1,18296

You are Euro 5 mio long at a EURO / USD rate of 1.18296. You earn a profit of 0.00074 Euro per USD (1.1837 – 1.18296). With 5 mio Euro, that is 3,700 USD or 3,125.79 Euro.

Keeping a closed position

Usually, positions are kept in the quoted currency. If the position in the quoted currency is closed you have two possibilities to continue your position keeping:

a) You fix the result of the closed position and start with a new calculation of the average rate. In the final valuation the result of the closed position must be taken into account separately.

b) You skip the transaction that would close your position and re-insert it for valuation later. This way, you can calculate an average rate covering all transactions.

Example

In the morning you buy EURO / USD 10 mio at 1,1835 and EURO / USD 12 mio at 1,1837. You sell EURO / USD 22 mio at 1.1838. In the afternoon, you buy EURO / USD 10 mio at 1.1840 and sell EURO / USD 5 mio at 1.1842.

What is your position and result at the end of the day if you revalue your position at a EURO/ USD closing rat of 1.1837?

Way 1:

Step 1:

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average Rate*
+ 10.000.000	1,1835	- 11.835.000	+ 10.000.000	1,1835
+ 12.000.000	1,1837	- 14.204.400	+ 22.000.000	1,18360909
- 22.000.000	1,1838	+ 26.043.600	0	
0		+ 4.200		

Step 2:

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average rate*
+ 10.000.000	1,1840	+ 11.840.000	+ 10.000.000	1,1840
- 5.000.000	1,1842	- 5.921.000	+ 5.000.000	1,1838
+ 5.000.000		+ 5.919.000		1,1838

You have a loss of 500 USD (5,000,000 x (1.1837 – 1.1838). If you add the profit of USD 4,200 from the first transaction, the total result is a profit of USD 3,700 or 3,700 / 1.1837 = 3125.79 Euro.

Way 2:

Position quoted currency	*Rate*	*Position variable currency*	*Total position*	*Average rate*
+ 10.000.000	1,1835	- 11.835.000	+ 10.000.000	1,18350
+ 12.000.000	1,1837	- 14.204.400	+ 22.000.000	1,18360
+ 10.000.000	1,1840	- 11.840.000	+ 32.000.000	1,18370
- 22.000.000	1,1838	+ 26.043.600	+ 10.000.000	1,18350
- 5.000.000	1,1842	+ 5.921.000	+ 5.000.000	1,18296
+ 5.000.000		- 5.914.800		1,182960

Your profit is 5 mio x 0.00074 = USD 3,700.

Independently of the calculation you receive the same result.

2.2. Traditional risk management methods

Asset-and-liability risk management

Risk measurement using the GAP method

With the GAP method, the change p.a. in the P/L is calculated for an assumed change in interest rates. Thereby, the assumption is made that positions are not closed before maturity. Therefore, the annual calculation of interest returns and expenditures can only be influenced by interest rate changes. The assumed change in the interest rate can be caused by either a parallel shift of the yield curve or by a completely different interest rate structure.

With the increasing use of interest rate derivatives and their mark-to-market evaluation, the use of the GAP method to calculate risks of the trading book has become more and more obsolete.

Risk measurement using the duration method

Instead of calculating the change in the p.a interest rate position, the mark-to market change due to new interest rates is used for the determination of the risk position. For this, the method of Modified Duration is employed.

The modified duration measures the price sensitivity of each position. On the basis of an assumed interest rate structure, the effects of changing interest rates on the total value of the portfolio are simulated. Similar to the GAP method, either a parallel shift of the yield curve or different interest rate scenarios can be simulated to measure the risks.

The concept of Modified Duration assumes a flat yield curve, what is the main disadvantage of this method.

Risk measurement using the present value of a basis point

Like the duration method, risk measurement using the present value of a basis point (PVBP) makes no use of the p.a. change in the P/L but it is rather based on the mark-to-market change of the total position. The cash flows of the positions (capital and interest) are fixed for each date (mapping) and the change of value due to an interest rate change by 1 basis point is calculated using the zero yield curve (see chapter 4).

The computed risk values can then be used on either an aggregated basis (all positions and terms) or for individual terms to measure the risk. The risk is measured either by shifting the yield curve or by assuming different interest rate scenarios.

2.3. Modern risk management methods

All of the above mentioned risk measurement methods have the disadvantage that they focus only on individual types of risk. Therefore, the total risk can only be determined by adding these individual risks. Possible effects of diversification are not taken into account by these risk measurement methods. In risk measurement, the value-at-risk approach(VAR) is currently seriously discussed. Large banks are testing/using this approach mainly to quantify the price risks of their trading positions. Since it can also be used to determine the capital requirements (capital adequacy directive), the banks are becoming ever more interested in these methods.

The outstanding characteristic of all methods employed is to cover different types of risk - e.g. share risks, FX risks and interest rate risks – by a standard measurement instruction in order to consider diversification effects at the aggregation of risks.

Generally, the value-at-risk approach refers to the negative change in value (measured in absolute terms) of an individual position or of a portfolio which is not exceeded during a certain time with a certain probability.

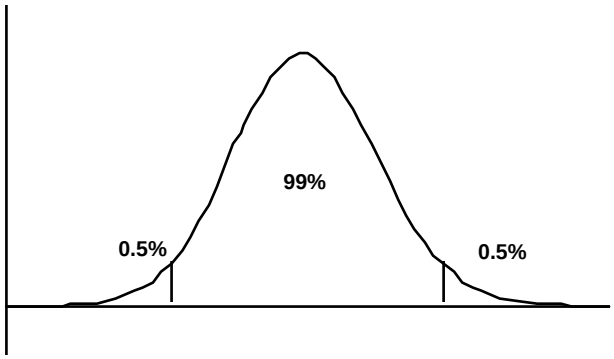
Excursus: Probability theory

To calculate future price risks, future price changes are assumed to be distributed normally. Thereby, standard statistical instruments can be employed.

A variable that randomly takes on different values is called random variable. The average value (result of a great number of observations) of such a random variable is called expected value or mean.

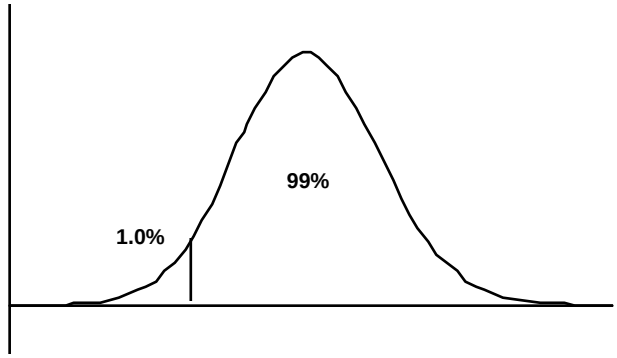
The variance is a measure of the extent by which a variable can swing. The variance is defined as the mean square deviation from the mean and is symbolized by s^2. The standard deviation (s) - also called the values volatility - equals the square root of the variance.

The confidence interval of a variable is that interval within the random variable falls with a certain probability. A confidence interval of, e.g., 95% means that the probability is just 5% that the value will fall outside this interval. If you are interested in the variation around the mean, you talk about a so-called symmetric confidence interval.



Graph 1: symmetric confidence interval

While calculating price risks - if the risk can only be found on one side so-called one-sided confidence intervals are used.



Graph 2: one-sided confidence interval

Assuming that the observed variables follow the normal distribution, and the standard deviation (volatility) is known, you can calculate the risk for a given one-sided confidence interval. The most common intervals in risk measurement are 95 % or 99 %. The relative change of prices for the desired confidence interval can be estimated from a given standard deviation as follows:

confidence interval 95 % = 1.65 σ

confidence interval 99 % = 2.33 σ

In order to take possible correlations between two variables into consideration, the risk measurement uses the so-called correlation coefficient. Correlation coefficients have values between +1 and -1. If the coefficient is +1 , both variables behave in exactly the same way; a coefficient of -1 means that they move in opposite directions. A correlation coefficient of 0 means that the variables are completely independent from each another.

The variance-covariance method

If the variance - covariance method is used to calculate the market risk, it is assumed that the relative variations of the positions follow the normal distribution.

The calculation of market risk using the variance-covariance method can be done with the following steps:

I. **Calculation of the historic variation of the individual terms and instruments.**

II. **Fixing the period for which a position is held. The question that must be dealt** with in this case is, how fast the trading section can close existing positions This assumed period is influenced by the largeness of the position and market liquidity.

III. **Setting the confidence interval.** Which percentage of all historic cases should the risk management take into account?

IV. **Consideration of possible correlation coefficients between the variables.** If, for example, we have a 4-year swap (purchase) and a 5-year swap (sale) in our books, the risks of both positions should not simply be added since there is a certain (historic) probability that if the rate of a 4-year swap rises, then the rate of 5-year swaps will not fall. Taking into consideration the correlation effects, the risk of such a position could be clearly reduced and it would not be comparable to the risk of two sold (bought) interest rate swaps. If the correlation effects are ignored, it can happen that each risk must be considered. Thus, you would have to add up all risks. Depending on the trading strategy, this would lead to a gross overestimation of the total risk.

The great advantage of the variance-covariance method lies in its simplicity as well as the free availability of the data (historic volatilities and correlation coefficients are freely available on the Internet / risk metrics).

Historic simulations

If you want to avoid the assumption of the normal distribution, the so-called historic simulation represents a method which is independent of models.

When using historic simulation, no assumptions regarding the distribution, volatility, or correlations are made. In order make a historic simulation, you need the time – series of the market prices of all underlyings that are in the portfolio. For example, if you have all closing prices of the last 500 days, you determine the results of the portfolio for every day. The setting of a confidence interval decides whether one of these days is eliminated from the risk calculation or not. If, in our example, the confidence interval is fixed at 99%, it means that those five days are neglected that constitute the worst results for our portfolio (500 • 0.01). The sixth-worst day therefore serves as the basis for the portfolio risk measurement. Thereby, all historic correlation effects are automatically taken into consideration.

The advantage of this method lies in its independence from any models and that it takes automatically all correlations into account. It is a disadvantage, that each time the portfolio composition changes, a completely new simulation has to be done. This may lead to a situation where a different scenario with less risk has been expected although the new position has actually increased the total risk.

Monte-Carlo simulation

If over time, the value of a variable changes randomly we call the process a stochastic process. A stochastic process, where only the current value has an influence on the following value, but not the way in which the current value has been reached, is called a Markov process.

Applying this principle to the development of market prices, this means that the next price depends only on the current price(and possible external influences). Monte-Carlo simulations assume that the development of prices follows the principle of Markov processes.

Principle: On the basis of the current historic volatilities and correlations the portfolio´s future development is simulated by means of a random generator. Each of the simulations will be different, but the total of all simulations fit the given statistical parameters. After finishing all simulations, the maximum loss is determined by choosing a desired confidence interval.

By changing volatilities and correlation coefficients, the risk manager is able to gain a higher flexibility than with other methods Complex and calculations as well as the required computer resources pose disadvantges.

None of the risk measurement methods quoted above work without limitations and assumptions. Therefore, it is important and necessary to understand the consequences if one or more of the underlying assumptions do not apply. The term **stress testing** refers to methods that simulate the effects of extreme market conditions and changes in assumptions. With stress testing, no particular procedure is laid down.

The term back testing refers to a reality test; where the predicted VAR values are - in retrospect - compared to the actually realised losses.

2.4. Limits

An efficient risk monitoring needs an adequate risk measurement as well as some necessary internal prerequisites. The following points should be considered:

- back office support
- internal and external risk monitoring
- mark-to-market developments of the trading positions
- implementation of limit systems for trading

In this section, we want to discuss several types of limits. As far as the other prerequisites are concerned, we refer to the appendix that deals with internal surveillance requirements and the minimum requirements for trading operations.

Banks must not only measure, but also limit the risks that they are taking. How much risk is appropriate for a bank depends on the bank´s risk-bearing capacity which is closely linked to the bank´s equity and equity structure, but also on the strategies and the general risk attitude of the shareholders. Generally, we distinguish between limits that deal with credit risk, the market risk, and the liquidity risk of banks. It should be noted that in practice there are a number of limits and systems. Therefore, we only want to discuss some of the limits and their possible forms.

2.4.1 Credit risk limits

Counterparty limits

Typically, counterparty limits want to limit the total position. They deal with class risk, position risks of derivatives and settlement risk. Within banks, counterparty limits have to be allocated in the individual departments. In practice, there are rigid systems that allot the total risk to individual products and departments, as well as systems that set the total risk, which is accessible to everyone on a first come first served basis. Both systems have advantages and disadvantages. With the rigid allotment, some departments do not strain their limits while others have to turn down profitable transactions due to their strained limits. The flexible system does not guarantee that the most profitable transactions eventually get carried out. If, in the extreme case, one negative credit transaction uses up the bank´s total limit, none of the other departments is able to carry out any transactions whatsoever. Usually, banks make use of rigid systems, which are however watered down internally , so that departments are able to pass on limits internally to others.

Industry limits

Regardless of the individual customer, the total credit risk that a bank is willing to take is limited by industry as well. In addition to the counterparty risk, industry limits can be added depending on the risk in a particular industry. This way, it could become impossible to make a deal due to industry limits, though the counterparty limit would still allow it.

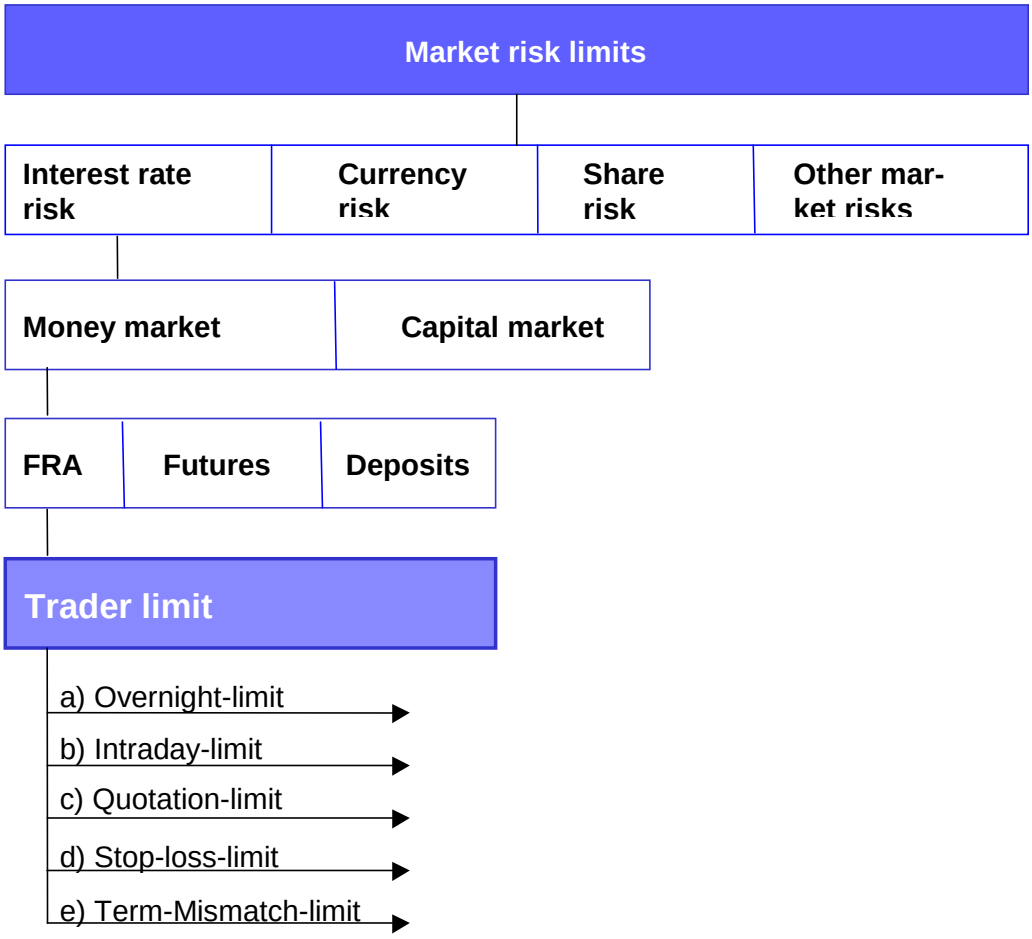
Country limits

The country limits work in a similar way to the industry limits.

2.4.2 Market risk limits

Limit of the bank's total positions

When determining market risk, the aim should be to take all the risks of the bank into account. To make this limit operational, it must be allocated to the individual organizational units: Depending on the organizational structure of the bank, one might - as a first step - divide the total risk limit into interest rate risks, currency risks, share risks and other risks. Within the interest rate risk, risks in the money market and the capital market could be differentiated; and within the capital market one could further distinguish between single products or individual dealers.



Trading limits

Overnight limit

The limit on the open positions at the end of a day. The overnight limit is equal to the position limit, i.e. the risk limit for the individual dealer. Depending on the market risk, the risk can be calculated per dealer by using a scenario analysis (e.g. 1 % change in the interest rate, 5 % change in exchange rate) or by using complex methods (e.g. the value-at-risk approach).

Intraday limit

Even if a dealer is not allowed to have any open overnight positions, he still must be allowed to have open positions during the day. This intraday limit is fixed usually according to the dealer´s qualification and position and depends on the market liquidity of the instrument. Besides, the limit will also depend on the position of the bank in the market, i.e. if it is market-maker for the instrument or not.

Quotation limit

The quotation limit limits the volume for which a dealer is allowed to quote. Similar to the intraday limit, the quotation limit depends on the dealer´s qualification and position, on the market liquidity for this instrument, and on the position of the bank in this market. For example, a DEM dealer might have a quotation limit of 100 Mio, i.e. this dealer has the right to make FRA-quotations up to DEM 100 Mio per call.

Stop-loss limit

In addition to the overnight limit, there is the possibility of having a stop-loss limit. A stop-loss limit restricts the maximum loss that the bank might be willing to accept on a particular position. If this limit is exceeded, the dealer must close his position even if he has not exceeded his own position limit yet.

Term-mismatch limit

In addition to the position´s total limit, a limit on open positions can be fixed for individual terms. A FRA dealer´s maximum open position can be limited, for example, in such a way that he can hold an open position of 1,000 Mio for a term of six months, while for a term of one year the open position is limited to 500 Mio. A similar limit may be implemented for an FX dealer, too.

Additional restrictions can be levied either by **instrument limits** that limit the liquidity risk in the individual markets, or by **term limits** that limit the maximum term of an instrument.

3. The capital adequacy directive

Until the end of 1995, the statutory regulations were mainly in terms of the credit risk. In some countries, the interest rate risk and currency risk were limited by further regulations (e.g. Grundsatz 1a in Germany, § 26 BWG in Austria).

In 1993, the EU published the Capital Adequacy Directive (CAD), which was to be gradually established in all EU countries from 1995 onwards. The Capital Adequacy Directive intends to create a uniform regulation for banks and financial institutions in all EU member states. Hereby, the determination of the equity requirement is based on market risks as well as on credit risks. Thus, CAD can be seen as an addition to the existing regulations for determining equity requirements in order to cover credit risks. Since the market risk is usually found in trading, the most important consequences of this new regulation are in the trading departments of the banks. Open positions that were taken by trading departments - as mentioned above, were already restricted in some countries - but did not lead to higher equity requirements till today. Due to these new regulations, trading departments can expect higher equity requirements, which will lead to additional profit expectations within the trading departments.

A new feature of CAD is the differentiation between a bank book (strategic positions) and a trading book. In the trading book, an equity cover for the market risks (interest risk, share risk, and other market risks), credit risks, and settlement risks is required. Both the books have in common that they require a cover for currency risks. Within the bank book, the credit risk must separately be covered by equity.

Components of the trading book

The trading book of a financial institution consists of:

- the bank´s own trading of financial instruments
  - for re-selling
  - to take advantage of differences in selling and retail prices
  - to take advantage of short-term fluctuations in prices and interest rates
- derivatives in combination with transactions in the trading book
- other positions connected with the trading of financial instruments
- stocks and operations to hedge or re-finance positions of the bond trading book
- sale and repurchase agreements (repos), reverse repos, bond-lending operations, and bond-borrowing operations of the trading book
- collateral for securities
- claims on pending transactions and advance payments for transactions in the bond's trading book

With the trading book, the following requirements have to be met:

- setting the bond trading book must follow internal criteria
- these internal criteria must be set in a way which is objectively comprehensible to third parties; the criteria should apply in general
- organizational precautions (trading room, "dealing table") are an indication for the trading book
- bonds that are part of the trading stock come under the trading book
- transfers are to be clearly documented and accounted for
- internal transactions to avoid risks in the bank book come under the trading book

Though national authorities have some freedom regarding the directive implementation; the regulations may therefore vary between the different EU countries. In this section, however, we present the most important and common elements of the CAD.

We focus on the following aspects:

- determination and use of the capital

- determination of the credit risk
  - credit risk for positions of the balance sheet
  - position risk
  - settlement risk

- methods to determine the market risk for
  - currency risk
  - interest rate risk
  - stock risk

- limits on large scale loans

3.1. Determining the equity cover and the use of equity

Under CAD, there has been a slight expansion in the definition of capital. CAD differentiates between three tiers of capital:

Tier 1

The core capital consists mainly of the equity, and free reserves minus possible losses or carried forward losses.

Tier 2

The supplementary capital is made up of shares without voting rights, subordinate debt with terms of more than five years.

Tier 3

The additional supplement capital consists of subordinate debt with terms of more than 2 years, and the not yet realized net trading profits.

In addition to this, there are some more limits when determining the equity cover for risks:

- At least 50 % of the required capital cover required for the credit risk has be covered by the core capital.

- At least 28.5 % (the percentage may differ in some EU countries) of the required capital cover for the market risks must be covered by the remaining core capital (after having covered the credit risk).

3.2. Determination of the credit risk

Almost all of the existing regulations on solvency were taken over by the CAD, but some aspects were refined, especially to take into account the requirements of the trading book. The required capital cover for credit risk - also called specific risk in combination with the positions of the trading book - depends on the creditworthiness of the partner (counterparty weighting) as well as on the delivery risk that depends itself on the particular instrument (risk factor).

required capital cover = counterparty weighting · risk factor · 8 %

The counterparty weighting depends on the creditworthiness of the partner. The risk reflects the current value of the product credit risk.

Counterparty weighting

The counterparty weighting uses pre-defined, different weighting rates, that express credit risk in per cent. With possible guarantees or mortgages, the lower weighting rate applies to those parts that are covered by the guarantee or mortgage. There are five different weighting rates applied:

Weighting 0 %:

Claims against (or guaranteed claims from) central governments and central banks as well as regional and local authorities of the so-called zone A (all the OECD member countries)

Weighting 10 %:

Claims against or sale-and-repurchase agreements from credit institutions of zone A if they are covered by corresponding securities (e.g. bonds in Germany)

Weighting 20 %:

Claims against and debentures from credit institutions of zone A

Weighting 50 %:

Claims that are covered totally by residential property mortgages, as well as those derivative instruments where the partner belongs to the 100 % weighting category.

Weighting 100 %

All remaining assets of the bank

Risk factors

With the help of the risk factor, you can distinguish between

- risks of balance sheet instruments
- position risk
- settlement/delivery risk

Netting agreements

The counterparty risk in OTC – derivatives deals can be reduced by netting agreements. In this case receivable and liabilities are netted out. There is the so called Novation-Netting and the Liquidation Netting.

Novation – Netting is the subsumation of all receivables and liabilities individual from swap, outhright or option deals under one **treaty**. Since all claims are already netted at the date of origin, Novation – Netting requires rather big administrative efforts. shalb wird in In practice Liquidation – Netting (close-out Netting) is prefered. In case of certain events (cancelation or insolvency) all open claims from forward deals are summed up at market value to one position. The balance, expressed as the net market value, belongs to the counterparty with a positive balance.

Liquidation – Netting enables to transfer counterparty risks of OTC – derivatives in all currencies if

- the deals were concluded with one partner and
- if the directives of the banking supervision allow for these deals netting agreements.

Risks of instruments in the balance sheet

All positions in the balance sheet that are part of the banking book have a risk factor of 100 %.

There are some exceptions for those positions that are part of the trading book.

Shares

The share positions of the trading book bear a specific risk (credit risk), that is 4 % equity capital on the gross total position but only 2 % equity capital on those shares

- whose issuers don't have a specific risk of 8 % for bonds
- that are highly liquid (e.g. DAX)
- where the individual positions are no more than 5 % of the stock portfolio

Qualified assets

The CAD introduces to the securities trading book of a bank the term "qualified assets". For these, there is a reduced cover of the risk (specific risk). Qualified assets are, for example:

- buying and selling positions on assets that bear a counterparty weighting of 20 %.
- bonds with a counterparty weighting of 100 %, if
- they are accepted for trading at an recognised stock market
- the respective bonds market is liquid
- the partner´s creditworthiness is considered satisfactory

Depending on the time to maturity and regardless of the original counterparty weighting, the following total capital cover is required:

term to maturity	*cover*
up to 6 months	0.25 %
from 6 to 24 months	1.00 %
more than 24 months	1.60 %

Position risk

Normally, for balance sheet instruments, the total nominal amount of capital is taken as the credit risk. For derivatives, a credit equivalent to the position risk needs to be determined. This means, that all claims in the balance sheet are weighted with 100%; while for derivatives, there are two different possibilities of evaluation: the market evaluation method and the maturity method.

The market evaluation method

The measurement of credit risk in the derivatives business is done in three steps:

Step 1

You determine the replacement value of contracts that have a positive value.

Step 2

The nominal amounts of all contracts are multiplied by the following %-rates (to include all possible risks in the future)

term to maturity	*contracts on interest rates*	*FX-contracts*	*contracts on shares*	*contracts on precious metals except gold*	*contracts on commodities except gold*
up to 1 year	0 %	1 %	6 %	7 %	10 %
more than 1 year and no longer than 5 years	0.5 %	5 %	8 %	7 %	12 %
more than 5 years	1.5 %	7.5 %	10 %	8 %	15 %

Exception: This additional calculation does not apply for basis swaps.

Step 3

The risks that are determined by steps 1 and 2 are each multiplied by the counterparty weighting of the partner.

The maturity method

With the maturity method, the credit risk for derivatives is calculated in two steps.

Step 1

First, all nominal amounts of each instrument are multiplied by the following %-rates:

original term	*contracts on interest rates*	*FX-rates contracts*
up to 1 year	0.5 %	2 %
more than 1 year and no longer than 2 years	1 %	5 %
for each additional year	1 %	3 %

Note: With interest rate contracts, also the time to maturity can be chosen. All other derivatives fall in the category of FX contracts.

Step 2

The risk that is determined by step 1 is multiplied by the counterparty weighting of the partner.

Excursus: Netting and novation

The CAD offers for derivatives the possibility of a reduced equity cover for the credit risk (position risk) in case of existing novations (bilateral contracts that allow to replace legal agreements by new obligations) or nettings (setting off matching sales and purchases against one other).

Acknowledged **bilateral novation contracts** allow

- a calculation that is based on the market evaluation method where within steps 1 and 2 one makes use of net values per partner instead of gross values per contract
- a calculation that is based on the maturity method where the assumed nominal amount per partner takes into account the effects of the novation contract.

Authorities accept **offset agreements** if

- step 1 of the market evaluation method is based only on the net values of those contracts that are agreed upon. The possible future risk which is calculated in step 2 is reduced by the following formula:

$$\text{spread} = 40\% \cdot \text{gross spread} + 60\% \left(\text{gross spread} \cdot \frac{\text{net} - \text{MVM}}{\text{gross} - \text{MVM}} \right)$$

If the term method is used, one may reduce the %-rates that are applied in step 1. The following table shows the reduced %-rates.

original term	*contracts on interest rates*	*FX-rate contracts and contracts on gold*
up to 1 year	0.35 %	1.5 %
more than 1 year and no longer than 2 years	0.75 %	3.75 %
for each additional year	0.75 %	2.25 %

Settlement risks and delivery risks on trading stock

To cover the settlement risks on trading stock, the CAD provides an additional equity cover. It differentiates according to the following criteria:

- **Transactions that were not settled by the counterparty until the agreed date**
  Equity cover: fixed %-rate (depending on the number of days between the agreed date and the current date) on the difference between current market rate and the agreed rate, or on the overall amount due

- **Advance transaction**
  (e.g. payment of bonds before delivery)
  Equity cover required: cover similar to that for a credit (counterparty weighting · risk factor (100 %) · 8 %)

- **Repos, reverse repos, bond-lending and bond-borrowing operations**
  Equity cover: in case of repos and bond-borrowing operations, the current market value is calculated including the securities and accrued interest. The required capital for these positive market values are 8% of the market value multiplied by the counterparty risk of the partner.

- **Other risks**

  (e.g. claims in the form of fees and commissions)

  Equity cover: further claims based on trading operations are weighted by the respective counterparty risk and are covered with 8%.

3.3. Methods to determine the market risk

The CAD´s fundamental innovations are mostly relevant for measuring and limiting the market risks. There, you can differentiate between FX risk, interest rate risk, and stock risk.

3.3.1. FX risk

The CAD defines a system to measure the FX risk from the total business of the bank. (bank book and trading book) as well as the required equity cover for this risk.

Standard method

The calculation of the required equity cover for the FX risk follows three steps:

Step 1

Calculation of the open net position per currency. There a two methods for calculating this net position:

Alternative 1: net spot position (including accrued interest)
+ net forward position
+ irrevocable guarantees that are certain to be called
+ unrealized income and expenditures (optional)
+ stock of FX options (delta-weighted)
+ market value of further options on FX positions

Alternative 2: present value of all future FX cash-flows

Step 2

Calculation of the overall net position, whereas the net-long positions and net-short positions (exception: the currency of the balance sheet) are transferred into the balance sheet currency at the current spot rate. Then, these positions are added separately in order to arrive at the overall net amount of long positions and short positions. The larger of these amounts is taken as the overall net position of the institution´s foreign currencies.

Step 3

Calculation of the required equity cover. This calculation includes an allowance of 2 % of the overall capital available. This amount may be subtracted from the overall net position. The remaining position is weighted at 8 %; the result is the required equity cover.

Note: under certain circumstances, the local authorities can reduce the required equity cover for combinations of certain currencies, e.g. if there are bilateral agreements or if the historic variation of two currencies are within a given band.

Statistic methods

Financial institutions may calculate the FX risk with the help of statistical methods, too. Anyhow, there are some parameters given:

- an assumed holding term of 10 trading days for the positions
- in only 5 % of the historic cases, the losses may be greater than the calculated risk (taking into account data from the last five years, or 1 % if taking into account the last three years)

3.3.2. Interest rate risk

Under CAD´s definition, the equity cover for interest rate risks is restricted to the positions in the trading book. Therefore, open interest rate risks of the bank book do not require any equity cover. As far as the risk calculation is concerned, financial institutions are allowed to choose from different methods. All these methods divide the interest rate risk into three different categories.

- basis risk: different instruments, coupons, and terms within a given maturity band
- yield curve risk: different changes of interest rates within the single terms
- interest level risk: the risk of a parallel shift of the yield curve

There are two standard methods (maturity band method and duration method) and the so-called sensitivity models that are allowed by the CAD to cover the interest rate risk.

The two standard methods differ mainly in the complexity of the calculation. With the maturity band method, average risk factors are given for each term; with the duration method, the true risk factors of the positions are used for the calculation. Since the duration method is more precise, the CAD demands a lower equity cover.

The maturity band method

Step 1

First, you calculate the net position of each instrument, where

- only trading book positions are taken into account
- derivatives are treated like positions in their underlyings
- option positions are weighted with their delta
- the term to maturity is taken into account

Positions may be treated as closed if all of the following criteria apply at the same time:

- they are denominated in the same currency
- their reference interest rate (e.g. LIBOR) is closely matched
- roughly the same coupon (+/- 15 BP)
- same term to maturity (7 - 30 days, depending on the total term)

Step 2

The determined net positions are grouped according to their maturity band:

zone	*maturity band **	*weighting*
1	0 - 1 month	0 %
	1 - 3 months	0.20 %
	3 - 6 months	0.40 %
	6 - 12 months	0.70 %
2	1 - 2 years	1.25 %
	2 - 3 years	1.75 %
	3 - 4 years	2.25 %
3	4 - 5 years	2.75 %
	5 - 7 years	3.25 %
	7 - 10 years	3.75 %
	10 - 15 years	4.50 %
	15 - 20 years	5.25 %
	> 20 years	6.00 %

Since lower coupons are more sensitive to changes in interest rates, there is a slightly different calculation for coupons of less than 3%.

The result of multiplying the volume by the weighting is a net-long position or net-short position for each maturity band.

Note: Fixed-rate instruments are classified according to their time to maturity, floating rate instruments according to the remaining time to the next fixing date.

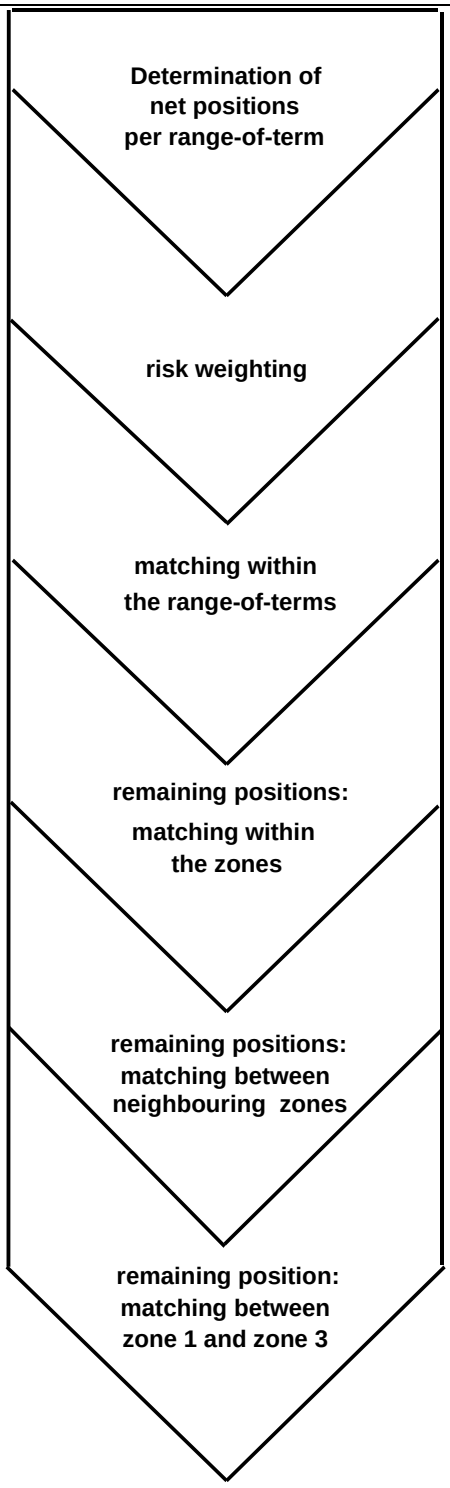
Step 3

In the third step, the equity cover required is calculated as follows:

a) 10 % of the amount of matched weighted positions in all maturity bands
b) 40 % of the matched weighted positions of zone 1
c) 30 % " " " " of zone 2
d) 30 % " " " " of zone 3
e) 40 % of the matched weighted positions between zones 1 and 2
40 % " " " " " zones 2 and 3
f) 150 % " " " " " zones 1 and 3
g) 100 % of the residual unmatched weighted positions

Note: the risk of point a) represents the basis risk, the risk as calculated by points b) to f) represents the interest yield curve risk, and the risk of point g) represents the interest level risk.

Maturity Band Method – Implementation



matched positions within the maturity band
10 %

+ matched position	zone 1	40 %
+	zone 2	30 %
+	zone 3	30 %

+ matched position	zone 1 and 2	40 %
+	zone 2 and 3	40 %

+ matched position	zone 1 and 3	150 %

+ remaining positions 100 %

= required equity cover

The duration method

Step 1

Analogous to the maturity band method

Step 2

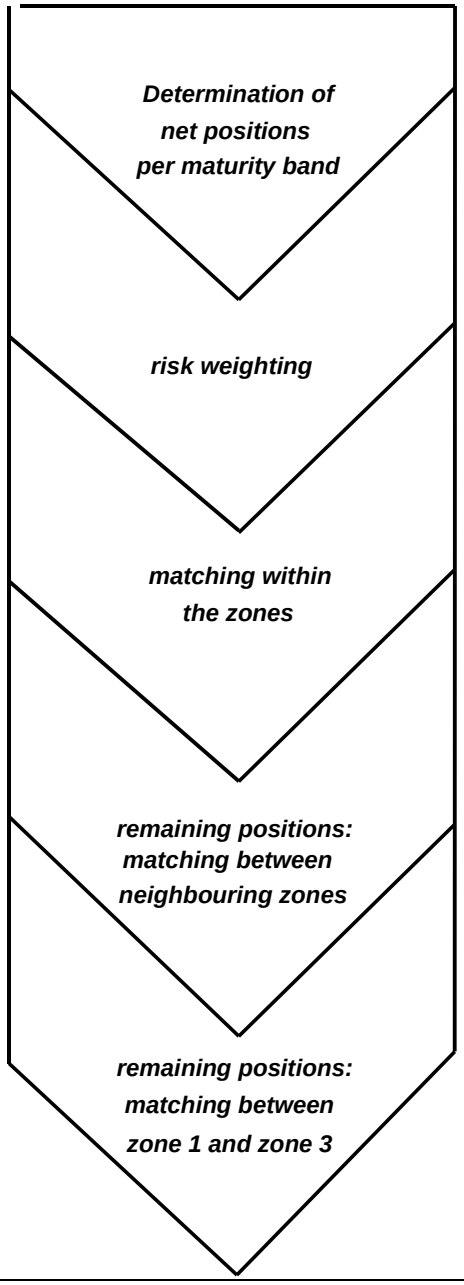
Instead of multiplying the determined amounts by a given weighting rate, the duration method makes use of the modified duration for each individual position. The assumed change in interest rates is given: 1.0 % within zone 1, 0.85 % within zone 2, and 0.70 % within zone 3.

Step 3

The required equity cover is calculated as follows:

a) 2 % of the matched, duration-weighted positions for each zone
b) 40 % of the matched, duration-weighted positions between zones 1 and 2, and respectively between zones 2 and 3
c) 150 % of the matched, duration-weighted positions between zones 1 and 3
d) 100 % of the residual positions

Duration method - Implementation



matched position within the zone 2 %

\+ matched position zone 1 and 2 40 %
\+ zone 2 and 3 40 %

\+ matched position zone 1 and 3 150 %

\+ remaining position 100 %

= required equity cover

Sensitivity models

The standard methods in CAD have the disadvantage that cash-flows of each interest rate instrument are evaluated with the same yield. This implicitly assumes a flat yield curve. For this reason, CAD also allows sensitivity models. The main characteristic of sensitivity models is the evaluation of all cash-flows on the basis of the so-called zero-yield curve. The methods in use must meet the following criteria:

- the respective supervisory authority must grant an approval
- the maturity bands of the maturity method must be used
- interest and capital amounts must be presented
- at least the same maturity bands as with the maturity method must be classified
- the price sensitivities of the individual maturity bands are given

The calculation of the required equity cover is completed in the same way as step 3 of the maturity method.

3.3.3 Stock risk

Stocks in this context are considered to be common shares, preference shares, convertible issues, participating preference shares, and all derivatives that are influenced by price changes in the above mentioned shares.

In this section, we discuss the cover for positions in the trading book. If certain shares are part of the bank book, the cover is calculated like for an ordinary loan. In contrast, positions in the trading book need only a reduced cover for the credit risk (specific risk) but at the same time an additional cover for the market risk.

Step 1

First, you calculate the net positions for each instrument. The net positions are converted into the balance sheet currency according to the prevailing FX spot rates.

- positions on indices are either split up into single positions according to the index composition or they are treated as an individual title
- derivatives are treated as positions in the underlying title
- options have to be taken into account with their delta
- sales and purchases (also spot and forward transactions) may be balanced if the papers are issued by the same issuing party, have the same conditions and are issued in the same currency.

Step 2

Secondly, the overall gross position and the overall net position are determined. The overall gross position is the sum of all net-long positions and net-short positions, ignoring the sign of the positions. The difference between the sum of net-long positions and the sum of net-short positions is the overall net position.

Step 3

Calculation of the required equity cover

general position risk (market risk) = 8 % of the overall net position

3.4. Limits on large scale loans

To limit the risks of individual transactions, the legislative body has introduced the following limitations:

- the overall credit risk of an individual client (or a group of connected clients) is limited to 25 % of the institution´s resources

- the overall credit risk of the parent company (or the bank´s own subsidiaries and all its parent´s subsidiaries) is limited to 20 % of the institution´s resources

- the amount of all large scale loans (credit risk to a client which come to 10% of the bank´s resources) may not be more than eight times the institution´s resources

3.5. Excursus: Suggestion of the Basle committee concerning equity cover of market risks

With its proposal in January 1996, the Basle committee of bank supervision, explicitly allows internal risk models to be used in determining market risks. This proposal was the result of interventions of banks and financial market participants who strove for a more precise description of the risks involved in more complex trading strategies. With the proposed models, the CAD does take into account indirect correlation effects between positions but only if these positions are taken with the same market risk and in the same currency.

Internal models depend on the approval of the responsible authority. With internal models, banks may use historic volatilities and correlations to quantify their market risks. Thereby, correlations within the individual risk categories (e.g. 5-year interest rate position/ 10-year interest rate positio) as well as adequately reliable correlations between the risk categories (e.g. USD interest position/ USD currency position; interest position/ share position) can be considered.

The use of internal models must follow the following quantitative parameters:

- assuming that the positions are held for 10 trading days
- a historic point of view of at least one year
- a one-sided confidence interval of 99 % (1 % probability that the loss is greater than the descried risk)

With regard to the qualitative criteria, the following requirements apply:

- independent department of risk management
- independent controls by the internal audit
- existing internal risk limits
- regular tests
- active participation of the management

The required equity cover for market risks is the larger of the two following values:

- average risk value of the last 60 days multiplied by a factor of 3
- risk value of the previous day

In addition to the above mentioned factor of 3, the Basle Committee favors the introduction of a spread that depends on the individual reliability of the model in use.

When implementing the CAD, banks will be allowed to use the suggested internal models of risk measurement. Since Brussels currently recommends that the risk measured with internal models must meet at least the risk as measured by the CAD, banks can hardly reduce their equity cover by employing internal models The banks would thus have the single advantage that the internal risk measurement methods would then meet the statutory requirements.