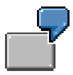
Market Risk Management (TR-MRM)

HELP.TRMRM

Release 4.6C

Copyright

Icons

Icon	Meaning
	Caution
	Example
	Note
	Recommendation
	Syntax
	Tip

Contents

Market Risk Management (TR-MRM)

Purpose

The *Market Risk Management* component (TR-MRM) in the *Treasury* (TR) area helps treasurers to plan, manage and control the market risks a company is exposed to.

Market risks result from the danger of negative market developments (changes in the money and capital markets), which affect a company's financial assets. As such, we can distinguish between the risks associated with changes to stock prices, interest rates, and exchange rates.

Implementation considerations

In order to use the *Market Risk Management* (TR-MRM) functions, you must first make the necessary Customizing settings (IMG: *Treasury* → *Market Risk*).

Integration

Access to all current operative cash flows and to all financial transactions is indispensable for comprehensive risk management. In order to determine and control risks, the information from these two sources needs to be brought to together.

The components *Treasury Management* (TR-TM) and *Cash Management* (TR-CM) provide you with a decision-making basis for daily financial planning in the short and medium term, and for long-term financial budgeting.

The *Market Risk Management* component (TR-MRM) builds on *Cash Management* (TR-CM), which contains all the payment flows from other operating areas such as *Sales and Distribution* (SD) or *Purchasing* (MM-PUR). This means that all cash flows arising from business operations in any division of your company can be accessed for the purposes of risk management.

All financial transactions managed in *Treasury Management* (TR-TM) can also be selected from *Market Risk Management,* and evaluated and controlled together with cash flows from operating business.

Scope of functions

Market Risk Management allows you to carry out the following functions:

- Create and maintain the market data required to value financial instruments (both real data and fictitious data in scenarios)
- Select financial instruments, including transactions from operating business, according to various criteria
- Value the following transactions on the basis of real and fictitious data:
  - Forward exchange transactions
  - Currency options
  - Bonds
  - Loans
  - Money market transactions
  - Forward rate agreements

  - Interest rate guarantees
  - Interest rate/cross-currency interest rate swaps
  - Swaptions
  - Futures
  - Bond options
  - Options on futures
- Calculate the following key figures:
  - Market values and differences to market values
  - Future values for any horizon
  - Effective prices and effective interest rates
  - Currency and interest exposures
  - Sensitivities to changes in interest rates, exchange rates and volatilities
  - Value at risk
  - Cash flows of variable and option instruments
- Analyze the above figures interactively

System Requirements for Market Risk Management

The market risk control process consists of a complex cycle of continually compiling business-relevant data, and then interpreting these data, taking into account future developments (measuring, analyzing, and simulating risk). All of this is then used to make decisions regarding actual finance instruments. This process is inextricably linked with other Treasury and company-wide functions (financial accounting, controlling, payment transactions). The complexity of the control process and its interaction demands a sophisticated support tool.

The following are required of a system if it is to be used for controlling market risk:

- **Integration**

  Available information and data about underlying and hedging transactions from different business areas within one system

- **Analytical and Methodical Capability**

  Possibility of making comprehensive position and risk valuations; constant situation and deviation analyses are necessary.

- **Flexibility**

  Possibility of selecting data according to different criteria, and representing the result both in a detailed as well as in a condensed way.

Planning/Analysis

Features

This part of the application offers you the following planning and analysis possibilities to aid in the risk control of your company:

- Calculation of the key figures such as cash flow, currency exposure, interest rate exposure, etc.
- Incorporation of fictitious transactions in the real position of financial transactions and transactions from operating business.

  In this way you can represent the impact of different trading and hedging alternatives on the net present value, the effective interest rate/effective rate/price of the real positions of finance and underlying transactions.
- Calculation of key figures under particular assumptions about future market developments (simulation)

Planning and analysis functions are divided into two sections:

- Planning and analysis of **only financial transactions**

  In this part, you find the functions which cover financial transactions in your **Treasury position**.

  The planning/analysis of financial transactions checks both **currency** and **interest rate** risk.

  You can calculate the net present value of your current position, as well as net present values related to future points in time. You can enter both forward data and scenario data as market data for the dates in the future.

  In addition to the net present value, interest rate risk analysis allows you to determine the effective interest rate for any future period of time.
- Planning/analysis of **financial and underlying transactions**

  The functions in this part cover the transactions in your Treasury position in addition to the transactions resulting from your company's everyday operating business.

  The planning/analysis of financial and underlying transactions only checks currency risk.

  You can calculate the net present value of your current position as well as net present values related to future points in time. You can enter both forward data and scenario data as market data for the dates in the future.

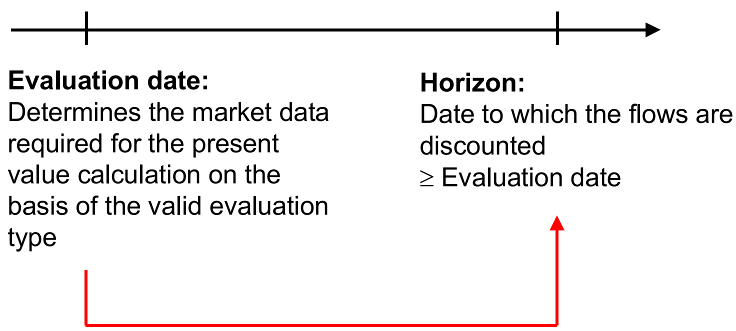
  The currency risk analysis functions determine the effective rate on the review date for any period of time.

Analyzing Currency Risk of Financial Transactions

1. Choose *Financial Accounting* → *Treasury* → *Market Risk* → *Analysis/Simulation* → *Finance Transactions Only* → *Currency Risk.*

   The *Currency Risk Analysis: NPV Forex Transactions* selection screen appears (report program RFTVSK20).

2. You can use selection criteria (such as company code, portfolio, security account, transaction type, trader, etc.) to restrict the transactions to be analyzed all the way down to the single transaction level.
3. In the data group *Program control*, choose a *Transaction currency* for selecting the transaction, and a *Reference currency* which will be used to display the results of the analysis.
4. Choose an *evaluation type*.
5. Choose a valuation date in the field *Valuation from.*
6. Choose a *horizon*.



7. In the fields *Scenario 1, Scenario 2,* and *Scenario 3*, you can enter scenarios upon which the NPV calculation should be based.
8. Choose *execute.*

   The system calculates the NPVs of the selected financial transactions. These NPVs then appear on the *NPV Analysis Cash Management* screen.

9. You can now make further changes, and see how they affect the NPV:

   – Change the horizon

   – Apply scenarios

   – Create fictitious transactions [Ext.]

   You can use the following functions:

Function	Menu path	Result

Recalculate NPV	*Net present value → Calculate*	Recalculates the NPV.
Display absolute NPV	*Net present value → Display → Absolute*	Displays the absolute NPV.
Display NPV difference	*Net present value → Display → Diff. to current*	Displays the NPV difference to the current NPV.
NPV calculation with current market data	*Net present value → Calculate using refresh*	Calculates the NPV on the basis of current market data.
Maintain details of fictitious transactions	*Edit → Fictitious transactions → Detail*	Lets you maintain additional data for fictitious transactions. If you maintain detail data, you can only change the fictitious transactions using the detail maintenance function.
Delete fictitious transactions	*Edit → Fictitious transactions → Delete*	Deletes the selected fictitious transactions.
Display calculation basis	*Goto → Calculation basis*	Displays the scenario data and market data used in the NPV calculation. For the interest rate display, the system interpolates the yearly rates between the grid points.
Display cash flow	*Goto → Cash flow*	Displays the cash flows from all transactions between the *Evaluation from* date and the horizon, including conditional payments.
Display exposure	*Goto → Exposure*	Displays the volume (balance) of transactions exposed to a risk resulting from the transaction currency.
Graphical display	*Goto →Graphic*	Displays all NPVs using SAP presentation graphics.

Result

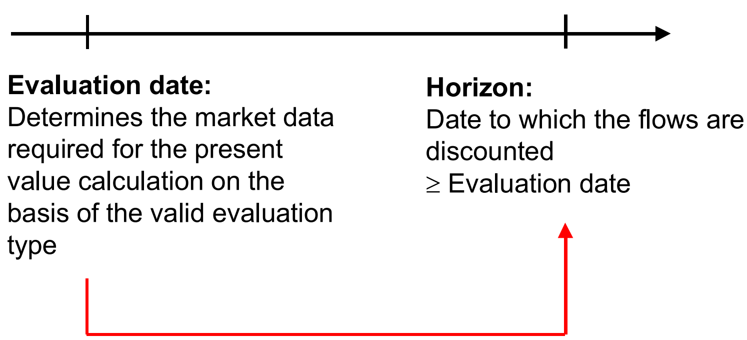
You have analyzed the current NPV of your transactions, or the effect of fictitious transactions or scenarios.

Analyzing Interest Rate Risk of Financial Transactions

1. Choose *Financial Accounting → Treasury → Market Risk → Analysis/Simulation → Finance Transactions Only → Interest Rate Risk.*

    The *Interest Risk Analysis: Effective Interest Rate and Net Present Value* selection screen appears (report program RFTVIRR1).

2. You can use selection criteria (such as company code, portfolio, security account, transaction type, trader) to restrict the transactions to be analyzed all the way down to the single transaction level.
3. In the data group *Program control*, choose the *Display currency* for the results of the analysis.
4. Choose an *evaluation type*.
5. Choose an evaluation date in the *Evaluation per* field.
6. Choose the *period start* and a *horizon/period end*.



For the effective interest calculation, the system assumes that the evaluation date and horizon are identical. The effective interest rate calculation is based on the dates *Period start* and *Period end.*

7. On the *valuation parameters* tab, you can enter scenarios upon which the NPV and effective rate calculations should be based.
8. Choose *Execute.*

    The *NPV Analysis* selection screen appears.

9. You can now make further changes, and see what effects they produce.
    - Change the horizon
    - Apply scenarios
    - Create fictitious transactions [Ext.]

    You can use the following functions:

Function	Menu path	Result
Recalculate NPV	*Net present value → Calculate*	Recalculates the NPV.
Display absolute NPV	*Net present value → Display → Absolute*	Displays the absolute NPV.
Display NPV difference	*Net present value → Display → Diff. to current*	Displays the NPV difference to the current NPV.
NPV calculation with current market data	*Net present value → Calculate using refresh*	Calculates the NPV on the basis of current market data.
Maintain details of fictitious transactions	*Edit → Fictitious transactions → Detail*	Lets you maintain additional data for fictitious transactions. If you maintain detail data, you can only change the fictitious transactions using the detail maintenance function.
Delete fictitious transactions	*Edit → Fictitious transactions → Delete*	Deletes the selected fictitious transactions.
Display calculation basis	*Goto → Calculation basis*	Displays the scenario data and market data used in the NPV and effective interest rate calculations. For the interest rate display, the system interpolates the yearly rates between the grid points.
Calculate the effective interest rate	*Goto →Effective int. rate*	Calculates the effective interest rate.
Calculate total return	*Goto → Total return*	On the basis of the imputed interest rate you specify, the system calculates the return resulting from the interest on the payments up to the horizon.
Display cash flow	*Goto → Cash flow*	Displays the cash flows from all transactions between the *Evaluation from* date and the horizon, including conditional payments.
Display exposure	*Goto → Exposure*	Displays the volume (balance) of transactions exposed to a risk resulting from the transaction currency.
Graphical display	*Goto →Graphic*	All results are presented to you with SAP presentation graphics.

Result

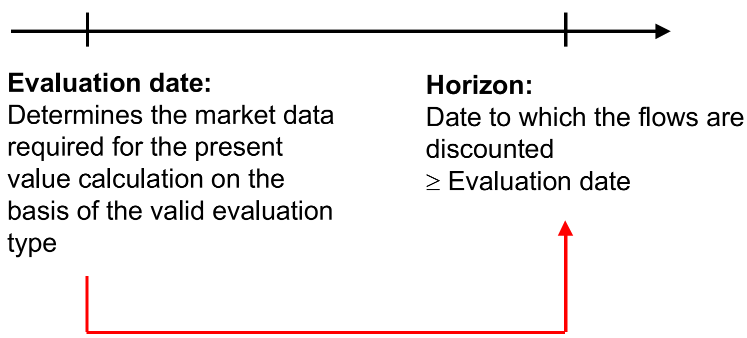
You have analyzed the current NPV and effective interest rates of your transactions, and/or the effect of fictitious transactions and/or scenarios.

Analyzing Currency Risks in Fin./Underlying Transactions

1. Choose *Financial Accounting* → *Treasury* → *Market Risk* → *Planning/Analysis* → *With Underlyings* → *Currency Risk.*

   The Forex Risk Analysis: Effective Rate and NPV Forex Transactions selection screen appears (report program RFTVSK21).

2. Choose an *evaluation type*.
3. Choose an evaluation date in the *Evaluation per* field.
4. Choose a *horizon*.



5. Choose a *Transaction currency* for selecting the transactions, and a *Reference currency* for displaying the results of the analysis.
6. You can restrict the financial transactions to be analyzed by making *General selections* (company code, portfolio, product type and transaction currency).
7. You can narrow the selection down to individual transactions on the *Money/forex/deriv.* and *Securities/loans* tabs.
8. In order to select underlying transactions (in addition to the financial transactions), choose the *Cash management* tab, and enter *grouping,* a *business area,* and *summarization date*, as necessary.

   In the *Date from* field, enter the date from which cash flows from the selected operative transactions are to be incorporated in the effective rate calculation.

   In the *Date to* field, enter the date up to which payments from the selected transactions are to be incorporated in the effective rate calculation.

   Specify the *summarization date* between the *Date from* and the *Date to.* The system projects the payments from the underlying transactions to this date by calculating a simple balance. This balance is then discounted/compounded to the horizon date, and thus represents the present value of the underlying transactions for that date.

The *summarization date* must come after the *Evaluation per* date. It is a good idea to fix the *summarization date* between or on the dates *Date from* and *Date to*.

9. On the *Valuation parameters* tab, you can enter scenarios upon which the NPV calculation should be based.

10. Choose *Execute.*

    The system calculates the NPVs and effective rates of the selected financial transactions. The *NPV Analysis Cash Management* screen appears.

    The **effective rate** is calculated as the quotient of the present value of financial transactions at the *horizon* and the present value of the summarized value of the underlying transactions at the *horizon.* The payments realized between the evaluation date and the horizon (such as option premiums and flows due from forward transactions) are included in the calculation as compounded values up to the horizon.

    – The **future value of the financial transactions** is valid on the horizon. In other words, the present value of the cash flow resulting from financial transactions up to the *horizon* is calculated for this date and the financial transactions are valued using the market value.

    – The **summarized value** is the balance of cash flows arising from underlying transactions, projected to the *summarization date*.

11. You can now make further changes, and see how they affect the NPV.

    – Change the horizon

    – Apply scenarios

    – Create fictitious transactions [Ext.]

    You can use the following functions:

Function	Menu path	Result
Recalculate NPV	*Net present value → Calculate*	Recalculates the NPV.
Display absolute NPV	*Net present value → Display → Absolute*	Displays the absolute NPV.
Display NPV difference	*Net present value → Display → Diff. to current*	Displays the NPV difference to the current NPV.
NPV calculation with current market data	*Net present value → Calculate using refresh*	Calculates the NPV on the basis of current market data.

Maintain details of fictitious transactions	*Edit → Fictitious transactions → Detail*	Lets you maintain additional data for fictitious transactions. If you maintain detail data, you can only change the fictitious transactions using the detail maintenance function.
Delete fictitious transactions	*Edit → Fictitious transactions → Delete*	Deletes the selected fictitious transactions.
Display calculation basis	*Goto → Calculation basis*	Displays the scenario data and market data used in the NPV calculation. For the interest rate display, the system interpolates the yearly rates between the grid points.
Display cash flow	*Goto → Cash flow*	Displays the cash flows from all transactions between the *Evaluation from* date and the horizon, including conditional payments.
Display exposure	*Goto → Exposure*	Displays the volume (balance) of transactions exposed to a risk resulting from the transaction currency. Hedging transactions, underlying transactions, and total exposure are disclosed separately.
Graphical display	*Goto →Graphic*	The calculated values are presented to you with SAP presentation graphics.

Result

You have analyzed the current NPV of your transactions, or the effect of fictitious transactions or scenarios.

Information System

Use

The information system in the *Market Risk Management* (TR-MRM) component offers you a range of valuation options.

Scope of functions

To access the information system functions, choose *Market Risk → Information System.* This part of the menu contains evaluation reports for calculating the following:

- Market values
- Sensitivities
- Interest and currency exposures
- Cash flow data
- Value at risk figures
- Crash scenarios

You can maintain the area menus and report structures by choosing the IMG activity *Structure Report Selection*. From here, you can change the report structure for Market Risk Management that was delivered with the system (TRTM), or create your own report structure and assign it to the application menu for the Market Risk Management area (TVM1) instead of the report structure delivered with the system.

For more information, see the documentation for the IMG activity *Structure Report Selection.*

Mark-to-Market Valuations

Definition

Mark-to-market value is the actual market value of a portfolio.

Use

For financial planning decisions made with a view to risk management, an accurate valuation of all positions on the basis of current market data is an absolute necessity.

This means that all financial assets must be valued with the amount which could be realized on the market and all financial liabilities must be valued with the repurchase value asked on the market.

The *Market Risk Management* component can value financial instruments using the bid/ask spreads quoted on the market. All related transaction costs incurred are taken into account. Transactions which are traded in different markets, e.g. German Federal bonds or mortgage bonds, are valued in Market Risk Management using different market-specific yield curves. Likewise, the premiums for standard options and for exotic options are calculated on the basis of different volatility curves.

Integration

The correct valuation of positions is very important for many other tasks. Risk controlling, for instance, is required to perform position valuations independently of trading. For disclosure purposes (e.g. balance sheet notes), position lists are required and commitments per single counterparties need to be checked on a mark-to-market basis. This information needs to be able to be summarized flexibly for various hierarchy levels. It is sensible to value a financial transaction when either creating one or closing one. This allows you to check your partner's quotation, for example, or to vary conditions. You can do all of these things using mark-to-market valuation.

Structure

The R/3 system offers the following mark-to-market valuation variants:

- Calculation of market values

  In mark-to-market valuation for the current date, all future cash flows are discounted to the current date using current market data.

- Calculation of future value based on current market data

  In mark-to-market valuation for a future date, all cash flows arising with effect from the future date are discounted back to it, using forward data projected from current market data.

- Evaluation in the future based on scenario data

  In mark-to-market valuation for a future date using scenario data, all cash flows arising with effect from the future date are discounted to this future date using the scenario data.

Position Valuation

Position valuation determines the market value of your current financial position(s). The system uses bid quotations for long positions and ask quotations for short positions. The mark-to-market values can be displayed at single transaction or summarized levels.

Procedure

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Information system* → *Mark-to-market* → *Position evaluation*

   The selection screen for report RVTVBW00 appears.

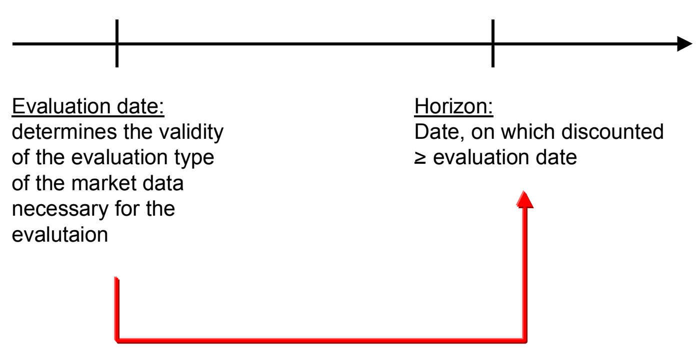
2. Select the financial transactions to be analyzed. You can select any level down to single transaction.

3. Specify the NPV valuation within the data group *Program control* by entering the following values:

   a. Currency

   b. Valuation from

   c. Horizon



   d. Display currency

   e. Indicator, whether cash flow on the horizon is taken into account

   f. Evaluation type

4. Specify the access to market price tables in the data group *Program control* by entering the following:

   a. In the field *Use price table*, indicate in which form you want to access the stored prices.

   b. Set the exchange rate indicator for the price table.

   c. Specify the earliest search date in the price table.

d. If need be, define a scenario.

5. Choose the *Sorting order* of the calculated values and the *Summarization level* in the data group *Output control*.

   Use the sort sequence to determine the characteristics and the related sequence for displaying the results. Use the summarization level to select the level at which the system is to display the cumulative results.

6. Choose *execute.*

Result

You will see the mark-to-market value of the selected transactions. The net present value at the horizon is always revealed using forward data.

Choose *Goto* → *Display transaction* to call up the transactions used in the net present value analysis. At transaction level, you can also access the financial transaction data.

Choose *Goto* → *Calculation basis* to display the market data (or scenario data) used in the valuation.

Matrix Valuation

When you run a matrix valuation, a position valuation is made several times using slightly different input parameters each time. A position value is calculated for every input parameter combination. In this way, you can identify the sensitivity of selected financial transactions to changes of one or two variables, e.g. exchange rate and currency interest rate.

The matrix evaluation differs from a scenario analysis, since no complete scenarios are defined, and only selected variables are gradually changed.

Procedure

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Information system* → *Mark-to-market* → *Matrix evaluation*

   The selection screen for report RVTVBW11 appears.

2. Select the financial transactions to be analyzed. You can select any level down to single transaction.

3. Specify the NPV valuation within the data group *Program control* by entering the following values:

   a. Currency

   b. Valuation from

   c. Display currency

   d. Indicator, whether cash flow on the horizon is taken into account

   e. Scenario

   f. Evaluation type

4. Choose *execute.*

   You will get the dialog box *Grid axis definition.*

   With the grid axis definition, you vary the market data of the evaluation type or of the scenario.

5. Set the values for both the X and the Y axis, whose values you wish to vary. You have the following choices:

   – Yield curve, specified by currency and yield curve type

   – Currency, specified by from and to currencies

   – Volatility, specified by volatility type and maturity

6. Also enter the incremental change of the number in the field *Percent* and the number of steps in the field *Disp.*

   For reasons dealing with display, the maximum number of steps is limited to three.

7. Choose *continue.*

Result

You will see the mark-to-market value of the selected transactions, when two influential figures have been changed.

Choose *Goto* → *Calculation basis* to display the market data (or scenario data) used in the valuation.

Profit/Loss Evaluation

Profit and loss evaluation displays the realized incoming and outgoing payments for forex transactions and forex options for a given period as well as the net present value of financial transactions at the start and the end of the period. The realized payments can be translated into the display currency using either the exchange rate valid on the due date of the payment or the rate valid on the posting date. Payments made on the key dates are incorporated in the evaluation of realized payments.

Options which have lapsed or have been exercised, lose their value on the expiration date or the exercise date. Options with cash settlement are an exception; the cash settlement is shown as a realized payment.

Procedure

1. Choose *Financial accounting → Treasury → Treasury management → Market risk → Information system → Mark-to-market → P/L evaluation.*

   The selection screen for report RVTVPL00 appears.

2. Select the financial transactions to be analyzed. You can select any level down to single transaction.

3. Specify the NPV valuation within the data group *Program control* by entering the following values:

   a) Period begin

   b) Period end

   c) Display currency

   d) Evaluation type

   e) Indicator whether conversion on due date

      The parameter *Conversion on due date* determines how payments which are not made in the display currency are to be translated. If you set this indicator, the system uses the exchange rate valid on the due date of the payment. If you do not set this indicator, the system uses the exchange rate valid on the posting date. If this rate is not available or if the payment has not been posted, the system uses the exchange rate valid on the current date (system date).

   f) Scenario

4. Specify a further display variant in the data group *Output control.*

5. Choose *execute.*

Result

You will see the mark-to-market value of the selected transactions for single transactions. The output can be summarized according to various criteria.

Choose *Goto → Calculation basis* to display the market data (or scenario data) used in the valuation.

Value at Risk

Definition

Value at risk (VaR) represents the potential loss in value of a position (expressed as NPV) which could (with a certain probability) be realized before the position is hedged or liquidated. VaR is thus an extension of NPV analysis, leading to uniform risk quantification. The difference being, that VaR takes into account the uncertainty of future market developments.

Use

Uniform application of the NPV approach within VaR allows for a consolidation of VaR over every part of a company. You can aggregate risks arising from products, currencies and organizational units in any way you like and aggregate the results to represent the total risk. Value at risk analysis therefore plays an important role in controlling global risk for the entire company.

Within the framework of Risk Management, value at risk is a key value for controlling. VaR also provides the basis for the internal risk controlling models proposed by the **Basel Committee on Banking Supervision**. Keep in mind that the final decision about which operative controlling measures are appropriate has to be made by the risk controlling department of your company. As a key figure, VaR only has a warning function.

Risk/return control represents a further use of VaR analysis. Within modern portfolio management, expected yields are viewed in relation to committed risks.

Structure

The value at risk is determined by the value of the committed position and the volatility of market prices. It is also influenced by the average retention period of the position, until the position is hedged or liquidated. The following calculation methods are used for VaR:

- **Historical simulation of change in NPV, based on historical changes in market prices**

  In the historical simulation, *n* comparative NPV calculations are carried out. This involves calculating *n* net present values resulting from the current market data modified by *n* historical market data changes. The changes to the historical market data are included in the NPV simulation as relative changes. These simulated NPVs are compared with the NPV calculated from current market data. This produces *n* potential gains/losses.

  The correlations of the individual market prices and the dependencies between the positions are implicitly taken into account.

  The historical simulation can be carried out using one of the following approaches:

  - **Full valuation**

    If you use the full approach, *n* NPV calculations are carried out for all market data records valid in the past and compared with the NPV of the current market data. This produces *n* potential gains/losses.

  - **Delta valuation**

    If you use the delta approach, the system estimates the elasticity of the price function to the various parameters that affect the price. The NPV differences result from weighting the sensitivity with the price differences from the historical market data. As for the full valuation, this produces *n* potential gains/losses.

- **Variance/covariance approach for determining change in NPV based on the volatility of each individual market price**

  In the variance/covariance approach, potential loss is calculated from the volatility of the risk factors. The volatility of the risk factors can be estimated from historical market data from each of the respective risk factors (standard deviation), or imported from external sources (datafeed, market data file).

  The resulting risks are aggregated via correlation matrices, taking any interdependencies into account.

Historical Simulation: Full vs. Delta Valuation

The purpose of historical simulation is to determine what gains or losses would be incurred if a market price development from the past were to occur today. Broadly speaking, there are two calculation methods, full valuation and delta valuation:

Full valuation:

If you use the full valuation method for historical simulation, *n* comparative NPV calculations are made with the market data changes over the historical period. In this case, the system calculates fictitious present values for all the flows in the historical period on the basis of the valid market data.

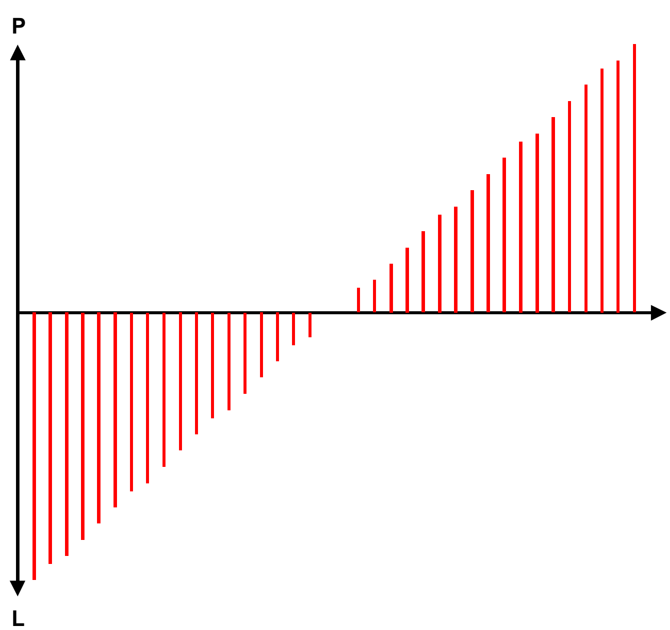
In order to simulate the present value changes, the current present value is multiplied *n* times by the market data that has been adjusted for the historical changes.

These simulated NPVs are compared with the NPV calculated from current market data. This produces *n* potential gains/losses.

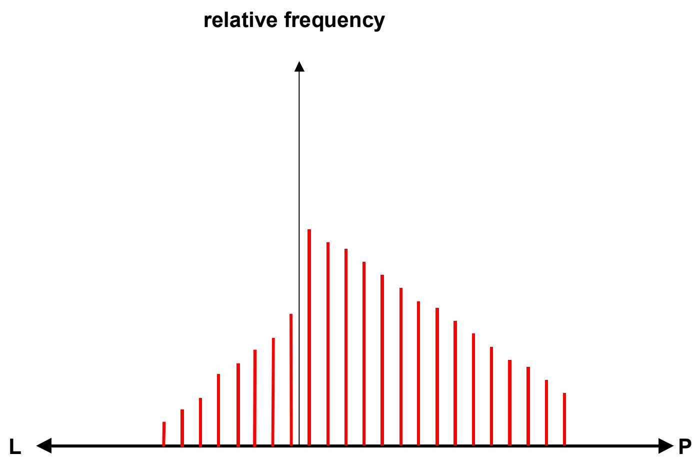
The calculation is carried out for the historical changes to each risk factor in the risk hierarchy. In other words, the values are recalculated for each node in the risk hierarchy, taking into account all the historical changes to the risk factors under that node.

The correlation of individual market prices and the relation between positions is implicitly taken into account, as the NPVs for every business event in the historical period are calculated based on **all** market data currently available.

Gains and losses are sorted by amount.

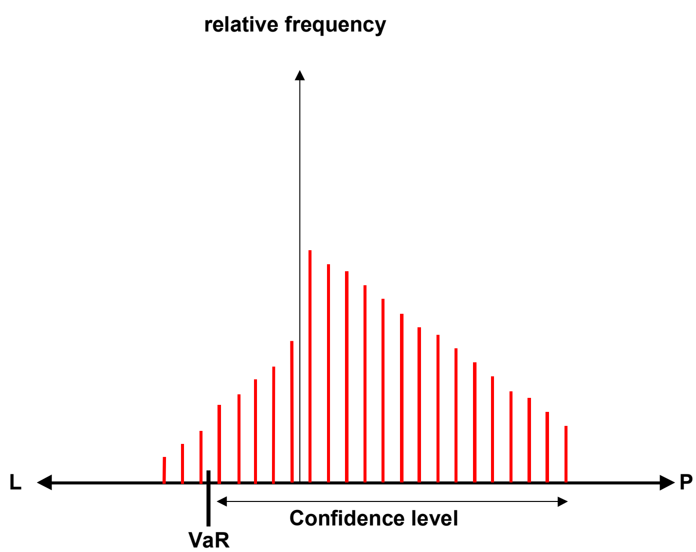


The relative frequency of the profits and losses is calculated. If there is a large enough sample (n), the distribution will represent an actual frequency distribution of profits and losses.



By entering a confidence level, a VaR is calculated from the distribution of gains and losses. This VaR represents a particular amount, which nothing, with a certain probability, will drop below.

With 200 checked values and a confidence level of 99%, the third largest loss represents the VaR.



Delta valuation:

With the delta valuation, the NPV is not calculated for every business event in the historical period. Instead, the elasticity of the price function is estimated for the different price parameters, independent of historical market prices. The NPV differences result from weighting the sensitivity with the price differences from the historical market data. As with full valuation, this results in *n*

Historical Simulation: Full vs. Delta Valuation

potential profits/losses, whose relative frequency distribution can be represented using full valuation.

At the heart of this approach is the assumption that the NPV function is linear. This assumption also lessens the number of calculations necessary to perform the valuation.

Historical Simulation

Use

Using historical simulation, you can calculate the VaR on the basis of full or delta valuations.

Historical market price changes are stored in simulation scenarios. A simulation scenario is created for every risk consolidation level for every day in the time series. In this scenario, the system only changes the market prices for which the risk is to be calculated in the particular risk consolidation level.

To determine the interest rate risk, for example, scenarios are created in which only the zero coupon yields are changed.

The system uses these simulation scenarios to value the position and calculates the value at risk on the basis of the resulting gains and losses.

By generating simulation scenarios, the system is able to consider all price changes and the probability of their common, simultaneous occurrence. As a result, the historical simulation takes all the price changes for a given day into account at the same time. This means that the correlations between the individual risk factors are already included.

This procedure enables you to map complex price changes that cannot be modeled using the variance/covariance approach.

Integration

VaR values are displayed on the basis of the risk hierarchy [Page 75].

With the **full valuation approach**, each position on each risk hierarchy is revalued using the historical market data for the respective risk factor. The positions are not aggregated for the risk hierarchy.

With the **delta approach**, it is assumed that the NPV differences can be added (taking the respective +/- signs into account) to aggregate the positions for the risk hierarchy.

Scope of functions

Fictitious profits and losses from the full and delta valuations form the basis for VaR. VaR can be calculated by the R/3 system in the following ways using the distribution of profits and losses:

- **From simulated profits and losses**

  The simulated profits and losses calculated for each day in the historical period are sorted by size taking into account the +/- sign.

  The value at risk ($VaR_{confidence}$) for a confidence level is **k-the nth smallest profit/loss**, where:

  k = ((1 - confidence level) * No. of simulation days) + 1

  The value at risk is displayed as a **positive** or **negative** value.

For 200 days the $VaR_{95\%}$ is the 11^{th} smallest profit/loss value, since

k = ((1-0.95) * 200) + 1 = 10 + 1

- **From simulated profits and losses**

  The simulated profits and losses determined for each day in the historical period are transformed into **absolute** amounts and sorted by size without taking into account the +/- sign.

  The value at risk ($VaR_{confidence}$) for a confidence level is the **2k-largest profit/loss**, where:

  k = ((1 - confidence level) * No. of simulation days) + 1

  The value at risk is always displayed as a **negative** value. If k is larger than the number of simulation values (where the confidence level is very low), the value at risk is displayed as zero.

  For 200 days the $VaR_{95\%}$ is the 22^{nd} largest profit/loss value, since

  k = [(1-0.95) * 200] +1 = 11

  and therefore 2k = 22

- **From absolute profits and losses (double the number of values)**

  The simulated profits and losses determined for each day in the historical period are transformed into **absolute** amounts and sorted by size without taking into account the +/- sign. However, twice the number of sample values are used.

  The value at risk ($VaR_{confidence}$) for a confidence level is the **k-largest profit/loss**, where:

  k = ((1 - confidence level) * 2 * No. of simulation days) +1

  The value at risk is always displayed as a **negative** value. If k is larger than the number of simulation values (where the confidence level is very low), the value at risk is displayed as zero.

  For 200 days the $VaR_{95\%}$ is the 21^{st} largest profit/loss value, since

  k = [(1-0.95) * 400] +1 = 21

- **Assuming a normal distribution**

  The simulated profits and losses are assumed to be values in a sample which has an expected value of zero with normal distribution. The standard deviation is calculated using a statistical estimation procedure. The value at risk is then determined by multiplying the variance by the confidence level.

  The value at risk is always displayed as a **negative** value.

Executing Historical Simulation

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Information system* → *Value at risk* → *Hist. simulation - delta.*

   The selection screen for report RFTVVAR4 appears.

2. Enter the selection criteria for the financial transactions. You can use the single transaction level.
3. Enter the selection criteria for the financial transactions in the data group *Cash Management*.
4. Enter the *Value from* date in the data group *Value at risk calculation*.
5. Choose a *Display currency.*
6. Choose an *Evaluation type*.
7. Enter the *Historical period* or the *Start of history.*

   The system determines market price changes as base values for the historical simulation and the variance/covariance approach on the basis of the market data for the day in the historical period which is furthest back in the past upto the *Start of history*.

8. Choose a *Holding period.*
9. To choose the exact days on which the market data should be read, choose a calendar.
10. Enter in the field *Miss level* the maximum number of values which can be missing before the calculation is stopped.

    If there is no market data for historical dates (no quotation, no delivery via datafeed) the system has a replacement strategy. This involves using market rates from further in the past. Since this leads to a distorted statistical picture, you can use the error tolerance to determine the maximum number of such replacements allowed in an historical time sequence.

11. Choose a *Confidence level.* This confidence level expresses (within the probability distribution of the VaR) what level of risk you are prepared to take.
12. In order to choose a calculation method for the historical simulation, you have to choose an entry in the field *VaR sample definition*.
13. Choose a *Risk hierarchy.*

    To display risk in the framework of Value at Risk evaluations, it is important that the risk hierarchy and the evaluation type match. The evaluation type determines the yield curve types which are used to value financial instruments. The risk hierarchy determines for which yield curve types historical time sequences are formed. A risk can therefore only be output if the yield curve type of the evaluation type is the same as the yield curve type of the risk hierarchy.

14. If you want to run a full valuation instead of a delta valuation, mark the *Full valuation* indicator.
15. Choose the *Sorting order* and the *Summarization level* in the data group *Output control*.

16. Choose *execute.*

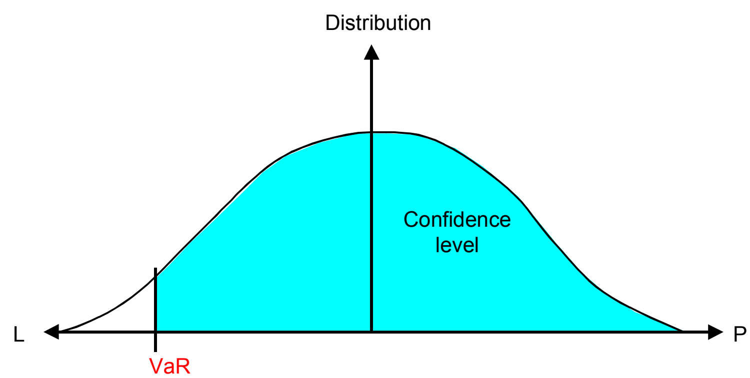
Result

You will get the VaR of the selected transactions based on a historical simulation.

Variance/Covariance Approach Theoretical Basis

The variance/covariance approach is an analytical procedure for determining the value at risk. The approach is based on the classic assumption from financial theory regarding normally distributed position and price changes. The value at risk is determined in the individual risk factors via the volatilities of these factors and aggregated to the respective risk consolidation level using the correlation matrix.

As in the historical simulation (normal distribution assumption), the system determines the value at risk as a quantile of the position distribution. If a variance/covariance approach is assumed, the position value changes are normally distributed. The value at risk can therefore be determined as a multiple of the standard deviation.



Variance/Covariance Approach

Prerequisites

In order to calculate VaR using the variance/covariance approach, you need the volatilities and correlations of the risk factors. These can be determined from historical price changes or imported to the system from third party vendors via datafeed. In addition to calculation by the system using the statistics calculator, the RiskMetrics™ data record from JP Morgan can be imported via datafeed.

The variances are determined from the historical data. Variances are estimated for a particular holding period.

If you want to determine the VaR for a holding period which is different to the holding period for the estimated variance, you can use the *t-root method* to carry out adjustments to the holding period (only applies if logarithmic changes are calculated).

You can, for example, transform a one day standard deviation into a ten day standard deviation by multiplying it by the root of 10.

Features

- Value at risk in a risk factor

  The system determines the value at risk for a risk factor by calculating the value change of the position which occurs with an isolated price change of this risk factor.

  The value change of the position is calculated by determining the delta position in the risk factor and multiplying it by the standard deviation of the risk factor. The delta position is calculated by the price calculators.

  The sign of the VaR for risk factors is the same as the sign of the delta.

- Value at Risk for Risk Hierarchy Levels

  The aggregation of VaR along the risk hierarchy is controlled by the aggregation type of the risk hierarchy. The following aggregation types are available:

Aggregation type	Meaning
summated (with +/- sign)	For each consolidation level in the risk hierarchy, the value at risk is determined using the sum of individual risk factors (positive and negative values).
summated (absolute amounts)	For each consolidation level in the risk hierarchy, the value at risk is determined using the sum of the absolute amounts of individual risk factors (positive value).
differentiated	The values at risk of the underlying risk factors are added together separately according to whether they are positive or negative amounts. The larger of the two values represents the value at risk as a positive value.

correlated	For each consolidation level in the risk hierarchy, the value at risk is determined using the sum of the absolute amounts of individual risk factors (positive value).

Executing Variance/Covariance Approach

1. Choose *Financial accounting → Treasury → Market risk → Information system → Value at risk → Variance/Covariance.*

   The selection screen for report RFTVVAR3 appears.

2. Enter the selection criteria for the financial transactions. You can use the single transaction level.
3. Enter the selection criteria for the financial transactions in the data group *Cash Management*.
4. Enter the *Value from* date in the data group *Value at risk calculation*.
5. Choose a *Display currency.*
6. Choose an *Evaluation type*.
7. Enter the *Historical period* or the *Beginning of history.*
8. Choose a *Holding period.*
9. Choose a *Confidence level.* This confidence level expresses (within the probability distribution of the VaR) what level of risk you are prepared to take.
10. Choose a *Risk hierarchy.*

    To display risk in the framework of Value at Risk evaluations, it is important that the risk hierarchy and the evaluation type match. The evaluation type determines the yield curve types which are used to value financial instruments. The risk hierarchy determines for which yield curve types historical time sequences are formed. A risk can therefore only be output if the yield curve type of the evaluation type is the same as the yield curve type of the risk hierarchy.

11. Choose an *Volatility type*.
12. Choose an *Correlation type*.
13. Choose the *Sorting order* and the *Summarization level* in the data group *Output control*.
14. Choose *execute.*

Result

You will get the VaR of the selected transactions based on the variance/covariance approach.

Exposure

Definition

In market risk management, exposure is understood as all future payments from a financial position, distinguished according to the risk factors which affect them.

Volatility exposure is, for example, the future conditional payment of an option, as the payment amount depends on the volatility of the rate of the underlying for the corresponding period.

Structure

Exposure can be differentiated according to relevant risk factors:

- **Forex Exposure**

  Forex exposure is the balance of foreign currency payments in planned currency from underlying transactions (underlying transaction exposure) and the future value of the financial transactions (hedging transaction exposure) at the horizon in planned currency.

  The balance of these two variables is the total exposure or the open position on the date the financial transactions are valued.

- **Interest Exposure**

  Interest rate exposure offers you the following options for examining how your financial transactions react to interest rate changes:

  – Value of 1 basis point

    This value shows you the change in net present value of a position if the entire yield curve rises or falls by one basis point.

  – Reaction volume of position

    The reaction volume is a different way of presenting the interest rate risk, independent of a specific yield curve shift. The value is the quotient of the net present value change and the change in the yield curve in basis points.

    Underlying transactions from Cash Management are not yet supported in interest rate exposure calculation at present.

    Until Cash Management is connected, loans, money market transactions and securities are understood to be underlying transactions, which create risks. Derivatives and foreign exchange transactions are the hedging transactions which can be used to manage risk.

Calculating Currency Exposure

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Information system* → *Exposure* → *Currency exposure.*

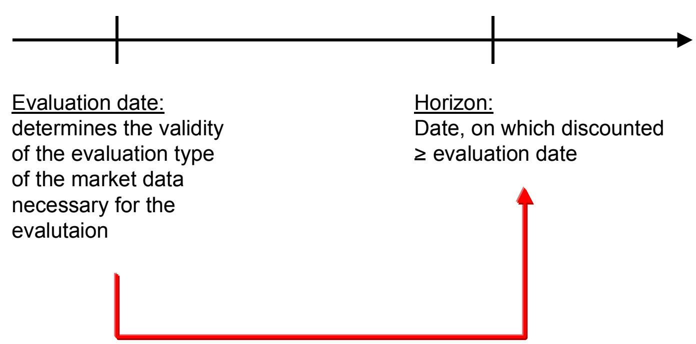
   The selection screen for report RFTVEX00 appears.

2. Select the financial transactions and underlying transactions to be analyzed. You can select any level down to single transactions.

3. In selecting financial transactions, you can additionally select the marker *Discount financial transactions* in the data group *Cash Management.*

   By doing this, the NPVs of the financial transactions will be calculated to the horizon (instead of their balances merely being displayed).

4. Choose a *Horizon* and the date for *Valuation from.*



5. To stop posted transactions from being selected, mark the indicator *Don't include posted trans.*

6. Choose an *Evaluation type*.

7. If need be, define a *scenario*.

8. Set the *increment* for the output of the amount columns.

   The future value of the financial transactions is divided up into sub-periods according to the increment you set. The prorated future value is assigned to the subperiod from which the payments have come.

9. Choose *execute.*

Result

Underlying and hedging transaction exposures are calculated. As a balance, total exposure is displayed to you as an *open position* in the planned currency.

Choose *Forex exposure* → *Term view* to display the results in shorter time intervals.

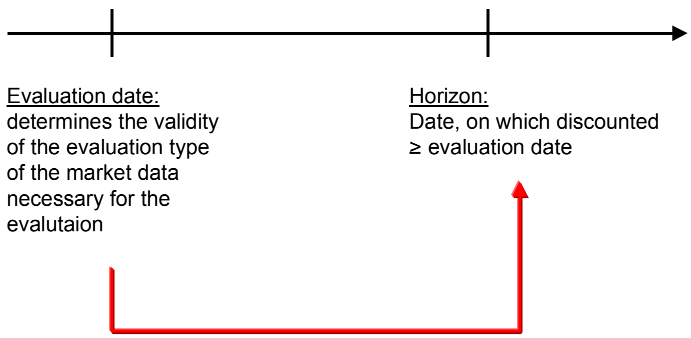
Choose *Goto* → *Calculation basis* to list the market or scenario data used in the valuation.

Calculating Interest Rate Exposure

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Information system* → *Exposure* → *Interest exposure.*

   The selection screen for report RFTVZX00 appears.

2. Select the financial transactions to be analyzed. You can select any level down to single transactions.
3. Choose a *Horizon* and the date for *Valuation from.*



4. Choose an *Evaluation type.*
5. Choose the number of basis points by which the yield curve should be shifted.
6. In the field *Shift linear/Effective at horizon*, choose when the yield curve shift should take effect.

This data is relevant if the dates entered for *Evaluation per* and *Horizon* are not identical.

7. Choose the *Display type* of the interest exposure. You can choose among the following possibilities:
   - Display as modified duration
   - Display as value of x basis points
   - Display as reaction volume
8. Choose a *currency.*
9. Choose the *Date from* and the *Date upto.*
10. Set the *increment* for the output of the amount columns.

    The future value of the financial transactions is divided up into sub-periods according to the increment you set. The prorated future value is assigned to the subperiod from which the payments have come.

11. If need be, define a *scenario*.
12. Choose *execute.*

Result

Interest exposure is calculated and displayed according to chosen display type.

Choose *Forex exposure* → *Term view* to display the results in shorter time intervals.

Choose *Goto* → *Calculation basis* to list the market or scenario data used in the valuation.

Calculating the Cash Flow

1. Choose *Accounting* → *Treasury* → *Market Risk* → *Information System* → *Cash Flow* → *Global Evaluation of Cash Flow*.

   The *Cash Flow Analysis* selection screen appears (report program RFTVCF00).

2. Select the financial transactions and underlying transactions to be analyzed. You can narrow the selection right down to single transactions.
3. Choose the *Date from* and the *Date to.*
4. Choose an *evaluation type*.
5. To stop posted transactions from being selected, mark the indicator *Don't include posted trans.*
6. You can also specify a *scenario*.
7. Choose *Execute.*

Result

The cash flow contains all payments which are generated from the *Date from* until the *Date to (horizon)* by the selected financial transactions and underlying transactions.

The cash flows are assigned to five equal subperiods and totaled for each period.

In addition to fixed payments, you also see the conditional payments. The conditional payments are derived from the conditional transactions by using the market data for the *date from* and the forward/scenario data at the *period end/horizon.*

Price Parameters

Use

Price parameters comprise all information needed for the fair valuation of financial instruments. This can involve both information available on the market, such as money market interest rates and capital market interest rates, as well as internal calculation bases. The price parameters are used particularly in the Treasury component and in the industry solution SAP Banking.

You can enter the following information as price parameters in the SAP system:

- Reference interest rates
- Forex rates
- Security prices
- Index statuses
- Interest volatilities
- Forex rate volatilities
- Security price volatilities
- Index volatilities
- Correlations
- ß factors

Integration

You have the following alternatives to choose from when entering price parameters:

- Manual Maintenance [Ext.] of the parameters
- Importing the parameters from a file using the File Interface [Page 70]
- Automatic import of the parameters per Datafeed [Page 65]

Interest Tables

Definition

The reference interest rates and yield curve types defined in Customizing are stored in interest tables. The maintenance of the reference interest rates also belongs to the area of interest tables. The function currency replacement for yield curve type is also part of the interest tables.

Use

The reference interest rates serve to save money market and capital market rates or internal financing or refinancing rates. The values maintained in the **reference interest rate table** form the basis for calculations in the application component *Market Risk Management* and also for the structure-congruent determination of the opportunity interest rates in *Profitability Analysis* of the industry solution SAP Banking. An interest rate structure curve is established for every currency using a yield curve type by the assignment of reference interest rates. With the function currency replacement for yield curve type it is possible to replace a currency that is to be replaced (EURO participating currencies, for example) with a replacement currency (EURO, for example).

Structure

In the **reference interest rate table** you enter the interest rates as par rates or zero coupon rates, depending on the yield category you selected when creating the reference interest rate. From the par rates the system calculates zero coupon rates and zero bond discounting factors for the dependent yield curves and zero bond discounting factors from the zero coupon rates. These yield curve values are stored on the data base in the form of an 'extended interest table'.

Structure of the Yield Curve

Use

With the help of this function the system calculates the yield curve.

Scope of functions

The system performs the following steps:

1. All the grid points (= reference interest rates) are used as framework. Access to the reference interest rates is governed by the reading procedure parameter that you define for the yield curve type. We make a distinction for the reading procedure to be performed between read back, read directly and read back directly.
   - In the case of **read back**, the system uses the last maintained interest rate for every grid point of a yield curve, meaning the system reads back in the interest table up to the most recent entry. For this reason, under certain circumstances the validity of the interest rates used can be different points in time.
   - In the case of **read directly**, the system reads the interest rate valid precisely on the yield curve date for every grid point of the yield curve, meaning there is no reading back in the interest table.
   - **Read back directly** means that the system reads back in the interest table until at least one interest rate is maintained. On this date, the system reads directly. Consequently, for this procedure the validity of all interest rates used is identical.
2. For the calculation of curves of the yield category par rate, the system at least requires grid points at yearly intervals. If no reference interest rates are defined on these annual grid points, interpolation takes place. The system performs interpolation of the annual grid values up to the last reference interest rate defined in the yield curve.
3. The system makes the following calculations:
   - Zero coupon rates and zero bond discounting factors are calculated for the yield category **par rate**. Calculation of the zero coupon rates takes place in the same way as calculation of the forward rate. The zero bond discounting factor that applies for the discounting from t_1 to t_0 is ZBDF $_{t_1}$ = 1. The zero coupons are used, among other things, as base amounts for the creation of payment flows.
   - Zero bond discounting factors are calculated for the yield category **zero coupon yield**. In this case, par rates are not calculated.
4. If you have defined a different interest calculation method for the reference interest rate from that of the yield curve, the system converts the concrete interest rates to the interest calculation method of the yield curve.
5. The interest rate is shifted accordingly to the markups or markdowns.
6.

Interpolation

Use

Interpolation serves to determine a value for an interest term of a yield curve (for which no interest rate exists) from the existing interest rates. The interpolation function is used in the following cases:

- Interpolation of **annual** grid values from the grid values of a yield curve type of the yield category *par rate* for the structuring of the yield curve.

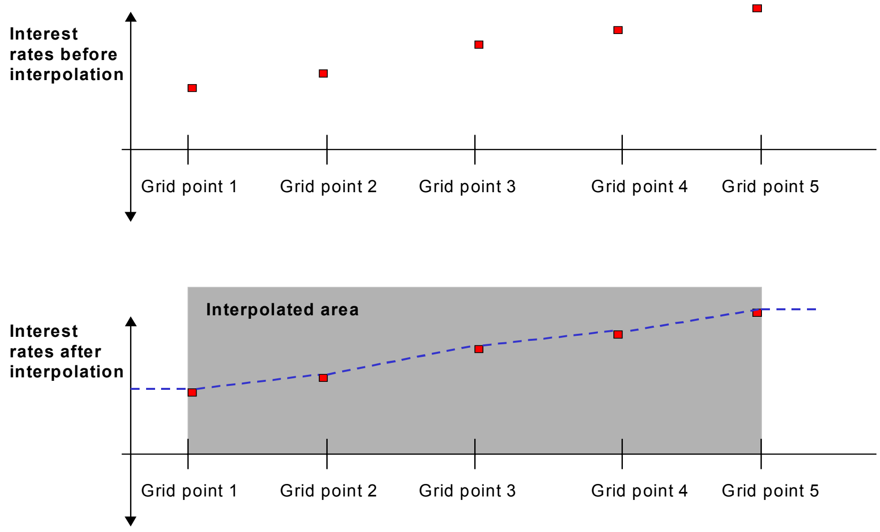
    Annual grid values, meaning grid points such as 1 year, 2 years that are not defined as reference interest rate (grid point) of the yield curve are needed for the calculation of the zero bond discounting factors.

- Interpolation of interest rates with an **interest date different from that of the grid points** of a yield curve type when accessing the yield curve.

For the yield category **par rate**, the par rate is interpolated on the required interest date according to the chosen interpolation procedure of the yield curve type and calculated from the interpolated par rate of the zero coupon and the zero bond discounting factor. For the yield category **zero bond yield**, first the zero bond rate is interpolated according to the interpolation procedure and from this, the zero bond discounting factor is calculated. In this case there is no calculation of a par rate.

Scope of functions

If the term of a required interest rate is before the first or after the last grid point, the first or the last grid point is transferred (extrapolation). If the required interest date is between two grid points of the yield curve, depending on the *interpolation* parameter of the yield curve type, either **linear interpolation** or **cubic spline interpolation** is performed.



1. Linear interpolation calculates a required value on the basis of two given values on the line between the two given values.

   The interpolation is performed as follows:

   P_t: interpolated interest rate at time t

   P_{t-1}: lower grid value at time t-1

   P_{t+1}: upper grid value at time t+1

   d_t : term of the required interest rate in days

   d_{t-1} : term of the lower grid value in days

   d_{t+1}: term of the upper grid value in days

   $$P_t = P_{t-1} + (P_{t+1} - P_{t-1}) \frac{d_t - d_{t-1}}{d_{t+1} - d_{t-1}}$$

   Calculation of the number of days is always based on the interest calculation method of the yield curve.

2. The **cubic spline interpolation** is used along with linear interpolation to achieve "smoother" yield curves. "Smooth" means that with cubic spline interpolation for the procedure implemented here, there is constant differentiability, whereas with linear interpolation, the resulting curve is constant. The yield curve resulting from the cubic spline interpolation retains the feature that in the case of monotonous initial data (for example, a normal yield curve), the monotony remains.

   The cubic spline interpolation procedure uses parts of third degree polynomials that are linked to the grid points by suitable conditions in such a way that continuous differentiability of the yield curve is ensured. Contrary to linear interpolation, in the case of cubic spline interpolation, all grid points are included in the calculation of an interpolated value.

The cubic spline interpolation procedure provides better interpolation values than linear interpolation. This means, however, that cubic spline interpolation is more complex, more extensive and, therefore, requires longer terms than linear interpolation.

For the graphical display of a yield curve the grid points are linked independently of the interpolation category of the yield curve. This means it is not possible to view cubic spline interpolation graphically.

Example

Interest rates of the grid values:

Days	Grid values
1	5.0 %
30	5.3 %
90	5.6 %
365	6,.0 %
1096	6.4 %

Validity date: 04/01/1994
Interest calculation method: act/360
Interpolated annual grid value for the term of 2 years (731 days):

- Linear interpolation:

$$P_{731} = 0.06 + (0.064 - 0.06)\frac{731 - 365}{1096 - 365} = 0.062002736$$

- Cubic spline interpolation:

  P_{731} = 0.062503419

Zero Bond Discounting Factors

Use

The zero bond discounting factors (ZBDFs) are used, among other things, for the following purposes:

- Base amount for calculation of the margin net present value
- Base amount for calculation of the structure-congruent opportunity interest rate

You use zero bond discounting factors especially when the yield structure curve is not flat. The ZBDFs are determined from interest rates sequentially, meaning from the cumulated ZBDFs of the previous years. The structure-congruent valuation of a cash flow requires duplication of the cash flow course of a financial instrument (specified by the payment amount and time) using a bundle of other financial instruments.

Zero coupon bonds, for example, can be used as duplication financial instruments as their use avoids the reinvestment problems of return flows. The classic effective interest methods work on the assumption that the cash return flows are reinvested at the effective interest rate, though this is only realistic if the course of the interest structure curve is horizontal. The use of yields from zero coupon bonds or the zero coupon structure curve (yields - zero bonds = f (term)) relates directly to the current interest structure.

Calculation is as follows:

Terms in days in accordance with the chosen interest calculation method
j_t : days in the year of year t in accordance with the interest calculation method
b_t : annual **base** days of the term of the $ZBDF_t$ in accordance with the interest calculation method
$ZBDF_{cumulated}$: cumulated ZBDF of the previous **annual** grid values

$$ZBDF_{cumulated} = ZBDF_1 * \frac{j_1}{b_1} + ZBDF_2 * \frac{j_2}{b_2} + ZBDF_3 * \frac{j_3}{b_3} + \ldots$$

P_t: interest rate for the term of the required zero bond discounting factor
d_t : term of the required zero bond discounting factor
d_{t-1} : term of the previous **annual** grid value

$$ZBDF_t = \frac{1}{1 + P_t * \frac{d_t}{b_t}}$$

where $d_t \leq 1$ year

$$ZBDF_t = \frac{1}{1 + P_t * \frac{d_t - d_{t-1}}{b_t}} \left(1 - P_t * ZBDF_{cumulated}\right)$$

where $d_t > 1$ year

Example

Example for Zero Bond Discounting Factors [Ext.]

Forward Rates

Definition

Forward rates or implied forward rates are interest rates for transactions that are in the future but that are determined by a current yield structure curve.

Use

Taking interest incurring up until the start of the term into account, the system calculates interest rates for terms in the future, an interest rate for the term of 6 months, for example, with a term starting 3 months from the current date.

Calculation of the forward rates is based on the zero bond discounting factors of a current yield structure curve. This can be identified by the yield curve type and the currency and depends on the respective type of the interest rates (par rates as opposed to zero bond rates). No forward par rates are calculated for yield curves of the yield category zero bond yield.

$t_0 < t_1 < t_2$

d : days between t_1 and t_2 according to the interest calculation method, where $d = t_2 - t_1$

b : annual base days according to the interest calculation method

d_t: term of the annual grid value before t_1

FR_{t0}: forward zero bond rate for the period t_1 to t_2 based on the yield structure curve valid in t_0

$ZBDF_{t1}$: the zero bond discounting factor that applies for the discounting of t_1 to t_0

$ZBDF_{t2}$: the zero bond discounting factor that applies for the discounting of t_2 to t_0

Calculation of the forward **zero bond rates** results from the following formula:

$$FR_{t0} = \left(\frac{ZBDF_{t1}}{ZBDF_{t2}} - 1\right) * \frac{b}{d}$$

where $d \leq 1$ year

$$FR_{t0} = \left(\frac{ZBDF_{t1}}{ZBDF_{t2}}\right)^{\frac{b}{d}} - 1$$

where $d > 1$ year

The forward zero bond discounting factors are determined from these forward zero bond rates:

$$FZBDF = \left(\frac{ZBDF_{t2}}{ZBDF_{t1}}\right)$$

Calculation of the forward **par rates** (only for yield curves of the yield category par rate) results from the following formula:

Forward Rates

$$FP_{t0} = \frac{1 - FZBDF}{\frac{d}{b} FZBDF}$$

where d ≤ 1 year

$$FP_{t0} = \frac{1 - FZBDF}{\frac{(d - d_t)}{b} FZBDF + FZBDF_{kum}}$$

where d > 1 year

Example

Forward zero bond rate for the term 180 days in 90 days
t_0 = 0 : calculation time
t_1 = 90 days
t_2= 270 days
Interest calculation method: 30/360
FR_{t0}: Forward rate for the period t_1- t_2 based on the yield structure curve valid in t_0
$ZBDF_{t1}$ = 0,98619: the zero bond discounting factor that applies for the discounting of t_1 to t_0
$ZBDF_{t2}$= 0,95790: the zero bond discounting factor that applies for the discounting of t_2 to t_0

$$FR_{t0} = (\frac{0.98619}{0.95790} - 1) * \frac{360}{180} = 5.9066$$

Evaluation of Yield Curves

To use this function, choose *Treasury → Market risk → Market data → Manual market data entry → Interest → Evaluate yield curve.*

Use

Using this function provides you with an overview of the calculability of the selected curves and also of the percentage shares of the interest rates entered for the curve or for the date. Additionally, you can have the interest rates and zero bond discounting factors for a certain yield curve displayed or the yield curve depicted graphically. You can also directly enter missing reference interest rates for the selected combination of yield curve type, currency and date.

Integration

For the evaluation of yield curves, the system reads the interest rates and zero bond discounting factors from the interest tables.

Prerequisites

In Customizing you must have defined and assigned the currency of the yield curve type for which you wish to have the interest rates displayed. You can also create or edit the yield curve type directly from the overview screen or from the detail screen by choosing *Environment → Set up yield curve.*

Scope of functions

1. **Initial screen**

   Use the initial screen to enter the selection criteria (yield curve type, currency, date). From here you can call up the overview screen or the detail screen directly.

2. **Overview screen - yield curve list**

   The yield curve list contains the following details:

- Information on the calculability of the yield curve. The yield curve can be calculated ( ) if at least one reference interest rate has been entered for the yield curve in accordance with the reading procedure.
- Percentage rate specification of the reference interest rates already maintained for the yield curve (%AC) or for the date (%AD).
- Details on the redemption currency if this has been maintained in Customizing or directly by means of *Environment → Currency redemption*.

   From here you can call up the functions *Display yield curve values* and *Display calculation basis* for the yield curves you selected by choosing *Goto*. In addition, by choosing you can branch to the detail screen of the selected yield curve.

3. **Detail screen**

   Two tab pages are displayed on the detail screen:

- On the *yield curve values* tab page you can see the interest rates used in the yield curve in the form of par and zero coupon rates and also the corresponding zero bond discounting factors for the interest date.

- On the *calculation basis* tab page you see the reference interest rates always without markup or markdown according to the interest calculation method of the reference interest rates. *Interpolation* appears under *reference interest* if an annual grid value enhanced by interpolation is involved. Choosing brings you back to the overview screen.

This function also offers you the following other options:

Function	Result
Maintain curve interest rates	Here you can enter or change the reference interest rates on the yield curve date.
Environment → Display interest rates graphically	All interest rates of the selected reference interest existing in the selected period are displayed graphically.
Environment → Display average curve	The average interest rates (par and zero coupon rates) and zero bond discounting factors are listed for the selected period.
Environment → Display average curve graphically	The average yield curve is displayed graphically.

For the calculation of the average yield curve:

All interest rates in the selected period of the reference rate in question are used and weighted with the number of validity days in accordance with the interest calculation method of the reference interest rate.

Example

Reference interest rate: DEM_02_Y_M
Selected period: 01/01/1999 - 01/31/1999
Interest rates valid in this area:
from 12/15/1998: 3 %
from 01/11/1999: 4 %
from 01/21/1999: 5 %
Interest calculation method of the reference interest: act/365
The average reference interest rate is calculated with this as follows:
(10 * 3 % + 10 * 4 % + 11 * 5 %) / 31 = 4.03 %
The average yield curve is structured on the basis of the average reference interest rates.

Volatilities

Definition

Volatilities describe as a risk measure the fluctuation range of a price parameter during a certain time period and, consequently, both the positive and negative deviation of market parameters from their expected value.

We make a distinction for calculation between **historical** and **implicit** volatilities:

- **Historical volatilities**

  Historical volatilities are determined on the basis of data from the past. Sample standard deviation is used as a reliable estimation function for the volatility. If you have daily volatilities, you can convert these to annual values as follows:

  – logarithmic changes: $V_{year} = V_{day} * \sqrt{days}$

  – other changes: linear interpolation

- **Implicit volatilities**

  It is frequently not the historical volatility that is measured, but the volatility resulting from an option price. This implicit volatility is an estimation of the market on the volatility of the market parameter. This comprises both historical information and also market expectations regarding the future.

Use and origin

You can use historical volatilities both for the value at risk approach and also for the option price calculator. In the R/3 system, implicit volatilities are only used in the option price calculators.

Before you can use volatilities for value at risk, they need to be linked to a statistic type in Customizing.

Historical volatilities and implicit volatilities are usually transferred to the system from external sources. Additionally, you have the option of calculating historical volatilities directly in the R/3 system by means of the statistic calculator. Since calculation using the statistic calculator involves scaling with the confidence factor of the statistic type, it is advisable to only use such volatilities for the value at risk approach.

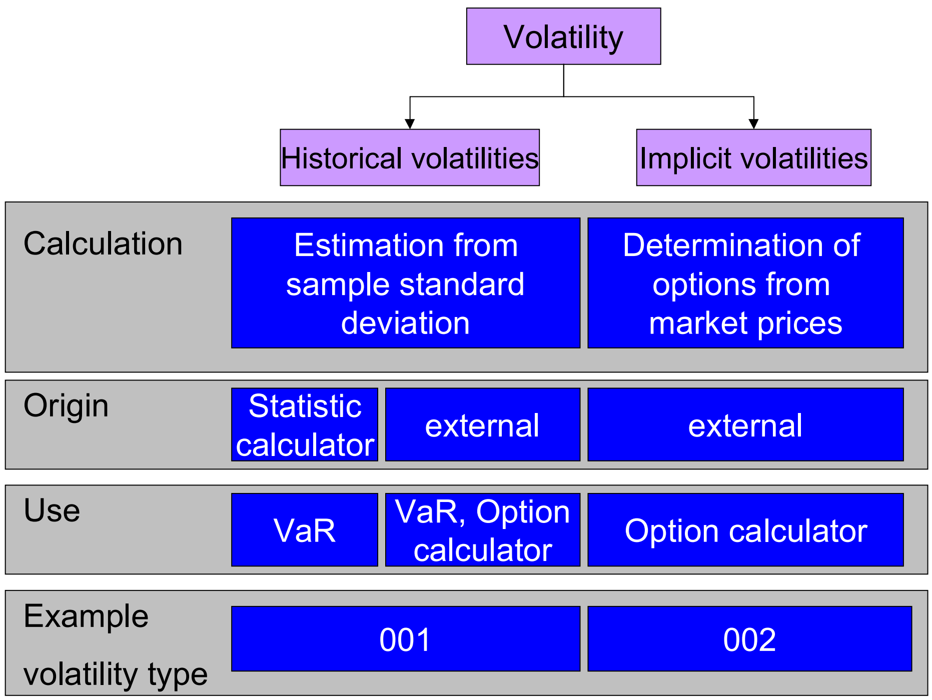
Structure

The clear and unmistakable determination of the volatilities in the volatility table is different, depending on the market parameter on which they are based. The following information must be stored in the volatility table:

Volatility	Required parameters for clear and unmistakable definition
Interest volatility	Volatility type, reference interest rate, date, term
Exchange rate volatility	Volatility type, currencies, date, term
Security volatility	Volatility type, class, date, term
Index volatility	Volatility type, index, date, term

Volatilities

In the statistic calculator, volatilities for interest are usually calculated based on zero coupon rates to ensure consistency with the net present value calculation with zero coupon rates. If you wish to determine volatilities for the variance/co-variance approach in value at risk evaluation from par coupon curves, you will need the interest rate volatility curve in addition to the definition of an interest volatility, which defines an assignment of the interest volatility to an interest rate structure curve. Using this assignment, the par rates can be calculated into corresponding zero rates and from these, the volatilities.



The following examples of volatility types serve to clarify the definition in the system:

Volatility type	**Volatility description**	**Volatility rate category**	**Single / average volatility**	**Statistic type**
002	Forex volatility	Average		
001	Risk metrics			2

Scenario

Definition

A scenario is a complete set of market data in the same form as the current market data.

You are the one who creates the scenario. In this way you define what you consider to be a possible or probable market situation (high interest rate scenario with inverse interest structure, for example).

Use

In Market Risk Management you can use scenarios to analyze the effects of market price changes on the risk situation of a company. This means that scenarios play a significant role in the planning and controlling of a company's risk situation.

Structure

You can define forex rates, yield curves, security prices and indices and also their volatilities in a scenario.

To depict a historical market situation you can define a scenario into which you can import historical market data.

In the case of NPV evaluations in market risk management, a scenario is defined by just a subset of the selected market data within the current market data. The last market data available on the horizon is used for valuation for market data not found within the specified scenario.

Integration

You do not specify a validity period for the scenario. When starting an evaluation of market risk management, by specifying the *horizon* you define the calendar date that is to apply for the evaluation of the scenario in question.

For the evaluations, the system only reads the scenario values whose rate category or volatility type matches the evaluation type in the settings. Otherwise the current market data applies. Exception: Provided they are defined in the scenario, the system reads forex rates and security indices from there, irrespective of the rate category or index type. In this case, interpretation of the scenario values is determined by the evaluation type.

Editing a Scenario

1. Choose *Market data → Scenarios → Change.*

   This brings you to the screen *Scenario administration: Initial screen*.

2. Enter the (or a new) description for the scenario. To edit, choose *Create, Change, Display* or *Delete.*

   To speed up the process of creating an entirely new scenario, you have the option of copying an existing scenario and simply making the necessary changes to it. The scenario data is transferred from the template.

3. To create a scenario, enter a *scenario long text* for the F4 help and a *scenario short text* for the drilldown.

4. If you wish to activate an additional authorization check for the individual scenario, assign an *authorization group* to this scenario on the tab page *administrative data.* You define the authorization group in Customizing of *Treasury* by choosing *Market risk management → Authorization administration → Maintain authorization group.*

5. Enter the required data by choosing the appropriate tab page. To enter new details, choose *insert line*.

   – Forex rates:

     Always specify a *reference currency* and choose *Continue.* In the currency field, enter for which (foreign) currency you wish to define a currency rate scenario. Enter a *bid rate* and an *ask rate*. When you choose *Continue*, the system automatically enters the fields *from currency* and *to currency* on the basis of the settings you have made in Customizing of Treasury by choosing *Treasury Management → Basic functions → Transaction management → Currencies → Leading currency.*

   – Yield curves:

     Before you can enter interest rates for yield curves, you need to enter a currency and a yield curve type (YCtype) and choose *Continue.* To maintain interest rates, select the line and choose . On the screen that now appears (*Create grid points for yield curves*), enter the scenario rates. The system offers you all the reference interest rates of the specified yield curve.

     By choosing you can have a look at and change the selected yield curve. Choosing the *help* pushbutton provides you with general information on how to use the graphic. Double clicking on a grid point allows you to change the yield curve when in graphic mode. You have the following options for changing the yield curve in the SAP presentation graphic:

Function	Procedure	Result
Interpolation	Choose *Interpolation*, select the 2 grid points by dragging the mouse (the grid points' text changes to ***), choose the interpolation type *Polynomial, Spline or Linear.*	The yield curve is interpolated between the two selected grid points.

Mirror image	Choose *Mirror image,* double click on a grid point.	The yield curve is mirrored at the chosen grid point.
Total shift	Choose *Total shift* and move a grid point with your mouse.	All grid points are "shifted" by the chosen amount.
Rotation	Choose Rotation, double click on a grid point as axis (the grid point's text changes to ***), choose *with angle* or *with shift*. For a rotation with angle you can explicitly define the angle of rotation. Note that a 100% change is defined as a rotation angle of 0,3%.	The yield curve is rotated round the chosen grid point.
Single shift	Choose *Single shift* and move a grid point with your mouse.	The chosen grid point is "shifted" by the chosen amount.

To "shift" yield curves directly by a certain number of percentage points, choose *Shift.* This brings you to the screen *Shifting yield curves.* Enter for the yield curve you wish to "shift" the respective percentage by which it is to be shifted. The effect of the shift is that the zero coupon curve of the scenario is moved by the value entered. Then the system determines the grid points (reference interest rates) from the shifted yield curve.

The shifts are applied to the reference interest rates. If you choose *Shift* again, the previous shift will no longer be visible to you. Then you can define a new shift, this, however, again being based on the current market data.

6. If you wish to use current or historical market data as scenario values, choose *Import market data* and choose the desired *Evaluation type*, (which must already have been defined in Customizing), the date of the market data and the price parameters.

7. Choose .

Market Data Shift

Definition

Using the market data shift (also called external rules) you can modify both current and scenario market prices. A market data shift can comprise several risk factor shifts, which are distinguished from one another in the system by the assignment of a rule index.

A market data shift refers to one or more price-determining factors. You can effect a fictitious change of the values of the following factors with the market data shift:

- Forex rate
- Yield curve
- Security index
- Security class
- Volatility

For each of the factors you can define an absolute or a percentage risk factor shift.

Use

Market data shifts are used as characteristic for net present value evaluation. They serve to simply represent the effects of price changes on the net present values. Net present value evaluation then displays all fictitious net present values per risk factor shift in addition to the current net present value. This can provide the basis for calculating further key figures.

Creating Market Data Shifts

Note that shifting factors can also result in invalid parameter values (negative time deposit rates, for example). Make sure you carefully check the plausibility of your shifts.

Procedure

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Master data* → *Market data shifts*. This brings you to the initial screen *Market data shifts: Maintain*.
2. Enter a 10-digit (maximum) numerical value for the market data shift and choose *Create.* This brings you to the screen *Market data shifts: Definition*.
3. Enter a *short* and a *long description*.
4. If you wish to specify an additional authorization check for the individual market data shift, assign an *authorization group* to this market data shift. You define the authorization group in Customizing of *Treasury* by choosing *Market risk management* → *Authorization administration* → *Maintain authorization group.*
5. To create a risk factor *shift*, choose *Create RF shift.*

This brings you to a dialog box in which you specify the *risk category* and the *shift category*. Choose *Continue.* This brings you to a new dialog box. Enter a *shift description* and in the field *risk factor shift* the amount of the shift (positive values only). Depending on the risk category chosen, also enter the following specifications or restrictions:

Risk category	Specifications or restrictions
Forex rate	Enter a *target currency.* If you do not enter a *starting currency*, the system assigns the respective transaction currency valid at the time of the run.
Yield curve	When you choose *Selection*, if you decide upon *All yield curves per currency, Shift one yield curve* or *Shift reference interest rate*, choose *Reference object*. Under *Reference object*, enter the required data in the fields that are now ready for input.
Security index	When you choose *Selection*, if you decide upon *Shift one security index*, enter this index.
Security class	When you choose *Selection*, if you decide upon *Shift one security rate*, enter a *security class*.
Volatility	When you choose *Selection*, if you decide upon *Shift one volatility type* or *Shift one volatility*, choose *Reference object*. Under *Reference object*, enter the required data in the fields that are now ready for input.

Choose ✔.

The system distinguishes between the individual risk factor shifts by means of a rule index. This is designed as consecutive numbers. To renumber the risk factor shifts (after the repeated deletion of risk factor shifts, for example), you can choose *Edit → Reorg. RF shifts.* The risk factors shifts are then renumbered consecutively by the system.

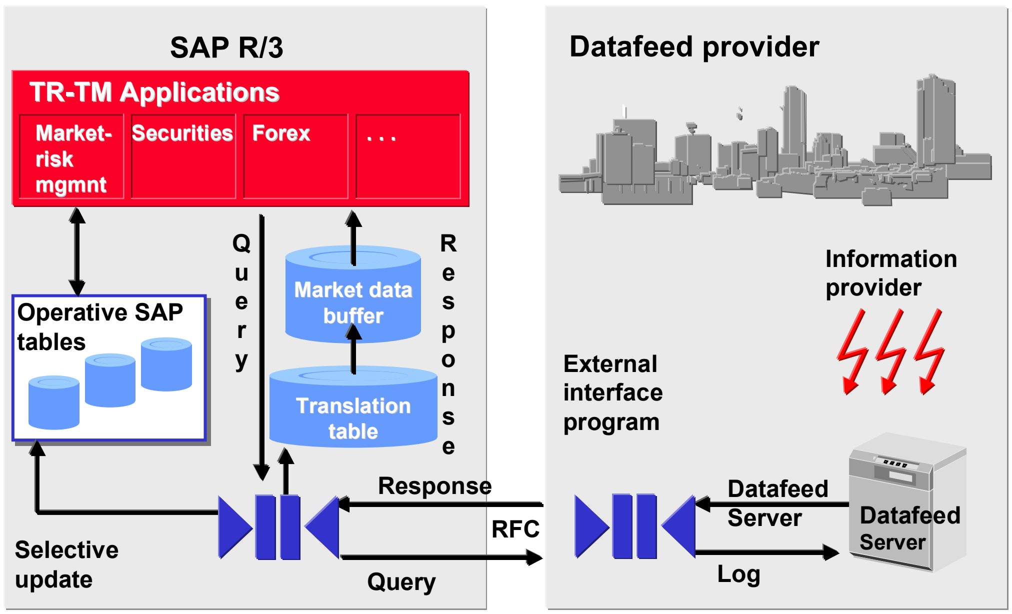
To change the details on the risk factor shifts, choose *Change RF shift.*

6. Choose .
7.

Datafeed

Use

You can use the R/3 Treasury datafeed to incorporate current market data in your financial transactions via an open interface. The following graphic provides an overview of the use of datafeed in the SAP R/3 System.



Prerequisites

- You have a real-time datafeed in operation in your company.
- The system platform of your real-time datafeed provider supports the R/3 datafeed.

Features

- Market data buffer containing current market price information
- Standardized communication structures compatible for all providers
- Reports to request and receive price information from datafeed providers
- Reports for directly evaluating the market data buffer and for saving information on exchange rates, interest rates and securities in the relevant SAP standard tables
- Flexible conversion of financial instrument names
- Query log to document access to the data buffer
- Datafeed Workflow - Handling Errors

  The workflow recognizes transfer errors or Customizing errors and informs the relevant processor who can then deal with the error.

- User Exit for Rate/Price Calculations

  To calculate average rates/prices, invert rates/prices, etc, you can use TRTMDF01. You have access to rates/prices that are permanently in R/3 and can calculate new ones if necessary.

- Rates/prices via the Internet Make the necessary settings in Customizing via *Internet Settings for the External Partner Program* such as Universal Resource Indicator (URI), user and password (coded).

  Note that you can only use this functionality if you connect to the WEB server of a SAP certified partner whose certificate is also valid for internet access.

You can transfer the following types of market data via the datafeed interface:

- Exchange rates
- Security prices
- Reference interest rates (e.g. LIBOR, FIBOR)
- Indexes
- Forex swap rates (Forwards)
- Currency volatilities
- Securities volatilities
- Index volatilities
- Interest rate volatilities
- Commodities (not used in Treasury but in SAP Oil & Gas)

Displaying Market Data

Use

Depending on the selection criteria you define, the *Display market data* function generates a list of the most recently imported market data and of any errors by calling up report RFTBDF00.

You can select, display or print out market data from this list.

Activities

1. Choose *Tools* → *Datafeed* → *Display market data.*

   The system displays the screen headed *Datafeed: Market data management.*

2. Enter your selection data for the market data you wish to display.
3. Choose *Program* → *Execute*.

   The SAP R/3 System lists the market data you selected.

4. You can now select or flag the market data to view detailed information.
5. You can print out the list of market data via the menu path *Market data* → *Print.*

Requesting Current Market Data

Use

Current market data is requested using report RFTBDF07. The selected market data is obtained via the datafeed interface and written to a market data buffer.

Features

The R/3 master data table (Exchange rates, securities prices,etc.) is only updated with this report if an update is explicitly asked for in the selection. To do this, you must select *Save market data in R/3 permanently, if defined in Customizing.* The SAP R/3 System only updates market data if you set the *Refresh* indicator during Customizing. All others are updated in the market data buffer only.

You can generate an error log and/or a market data list as required.

Prerequisites

- The link with the partner system/coupling program is working
- Customizing settings are maintained in datafeed
- At the start of the report, ensure that you have the following RFC authorizations:
  - Authorization object S_RFC with field attributes RFC-TYPE='FUGR', RFC_NAME='TBDF' and ACTVT=16 (Execute) and
  - Authorization object F_T_FBNAME for asynchronous calling up with field attributes ACTVT=01 (add or generate) and FNMA='TB_DATAFEED_RATE_R'.

    These authorization objects are contained in the F_DTFEED_ALL profile.
- To maintain the rates/prices in the operative SAP tables, you need the following authorization groups:
  - FC32 (Currencies)
  - FC16 (Interest rates)
  - TRZ (Indexes)
  - FC00 (Currency volatilities)
  - TRMK (Interest rate volatilities).

Features

Report RFTBDF07 generates an R/3 inquiry on one occasion that leads to a delivery of rates/prices.

If your external datafeed supports realtime rate/price provision, you can initialize a Real-time-rate/price provision [Ext.] with report RFTBDF14. In this case, the market data buffer and, if necessary, the R/3 master data table is updated then and several times via the external datafeed.

Activities

1. Choose *Market data management → Datafeed →Market data → Request current market data.*

    This takes you to the screen entitled *Datafeed: Refresh Market Data and R/3 Tables.*

2. Enter the data necessary for your selection.

3. Choose *Program → Execute*.

    The SAP R/3 System calls up the market data management basic list generated according to your selection criteria.

4. You can now select or flag the market data to view detailed information.

5. You can print out the list of market data via the menu path *Market data → Print.*

File Interfaces

Refer to:

Rates and prices [Page 71]

Statistical data [Page 73]

Rates and Prices

The *Import market data* function allows you to import the market data you need to the SAP R/3 System.

Make sure you have the correct market data file format.

To call up a selection list in which you can specify the market data you require, you use the *Generate requirements list* function. You can save the list in file format.

See also:

Importing market data [Ext.]

Generate requirements list [Page 72]

Generate Requirements List

1. Choose *Market data management* → *File interfaces* → *Rates and prices* → *Generate requirements list.*

   The screen entitled *File Interface: Generate Requirements List* appears.

2. Under the heading *Output,* in the field marked *File name,* enter the directory path and the file name of the file in which the requirements list is to be output. The directory path must already exist on the application server.

   You can restrict the requirements list to be generated by selecting the following *Instrument classes:*

   a. *Currencies*

   b. *Securities*

   c. *Interest rates*

   d. *Indexes*

   Under *Selection,* you can enter further restrictions for the requirements list by entering master data and instrument properties.

3. Choose *Program* → *Execute*.

   The SAP R/3 System displays a selection list for requesting market data. You select the requested market data by marking the relevant entries in the column marked *OK.*

4. Choose *Market data* → *Save* to save the requirements list to the output file.

Importing Statistical Data

Procedure

1. Choose *Tools → Market data file → Statistical data.*
2. Make the following entries on the selection screen:
   – Specify the file name for the data you wish to import.
   – If you want to import the data from a diskette or hard disk, select the *PC upload* field.
   – If you want to simulate a data import run, mark the *Test run* field.
3. To start the import procedure, choose *Execute*.

Master Data

Risk Hierarchy

The market risk of a company or credit institute is the result of a combination of risk factors. For example, interest changes, exchange rate or stock price fluctuations can all affect the value of a company's financial assets. Market risk represents potential loss(es) due to market price changes. It can thus be used as a key figure in making decisions about equity capital adequacy, the limiting of positions, or the desired minimum yield of a portfolio.

Definition

For more extensive control, you need to split market risk into its component factors. Market risk is broken down into the following risk categories:

- Interest Rate Risk
- Currency risk
- Index risk
- Volatility risk
- Exchange rate risk

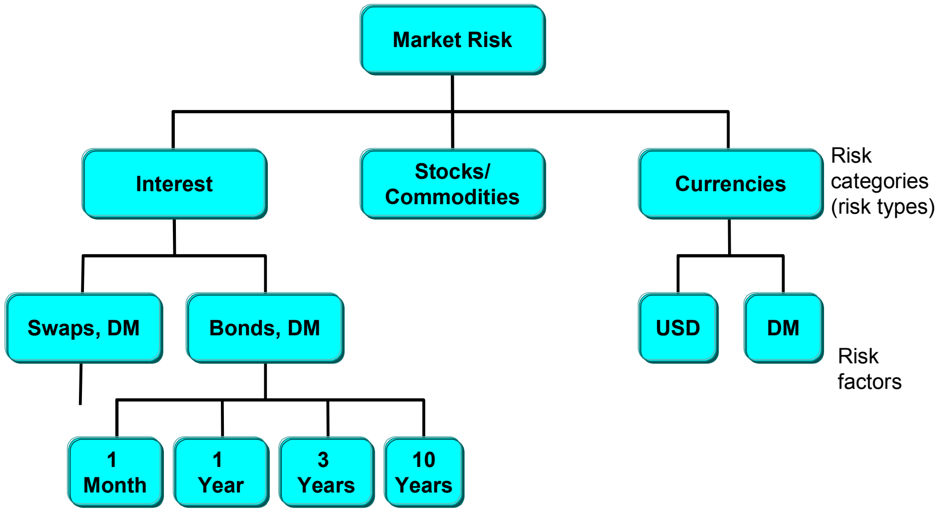
Each risk category can then be divided into further sub-risks. In the interest area, for example, there are swaps, bonds and debentures, money market transactions, etc. For these sub-markets, there are corresponding sub-risks. These sub-markets are usually different for each currency area.

In the **risk hierarchy** you define the break-down of market risk into its components. The risk factors provide the basis for the risk hierarchy. By definition, a risk factor cannot be broken down into further components. The risk factors also represent the price-determining elements for the instruments in the portfolio.

In the interest area, **key rates** are defined as risk factors. The idea with key rates is to define the progress of the yield curve over time using the interest rates for several terms, whereby the key rates are modeled as zero coupon rates. The interest rates for remaining terms are directly determined from the key rates. Since the key rates are implicitly selected when the interest structure is selected, it is **not** necessary to explicitly define the interest structure in the risk hierarchy. This only occurs in cases where an evaluation is desired for the key rates defined in the risk hierarchy.

In the case of stocks, the stock price is shown in a market index. The assumption with this is that the price development of the stock is directly dependent on the market index.

Risk Hierarchy



Use

Risk hierarchies make possible a detailed representation of the influence of different risk factors when valuing. The risks defined in the risk hierarchy are revealed in evaluations.

Structure

Each level in the risk hierarchy is described as a **consolidation level**. The market risk is the consolidation level at the very top of the risk hierarchy.

The risk hierarchy is constructed starting with the market risk and moving down to the individual risk factors. Its composition is determined by the user via a structure.

At the higher levels, risks are divided into risk categories. Aggregation of risks, starting from risk factors all the way up to the market risk, is usually not additive, as risks actually influence each other. An additive linking of individual risk factors is thus merely an assumption to make it easier to examine the isolated influences of risk factors. In the R/3 system, you have the following aggregation types for each consolidation level:

- **summated** (with +/- sign)

  Risk on a hierarchy level is calculated as the sum of the risks from the lower risk hierarchy levels.

- **summated** (absolute amounts)

  Risk on a hierarchy level is calculated as the sum of the absolute risks from the lower risk hierarchy levels. By using absolute amounts, you create a worst case.

- **differentiated**

  On a risk hierarchy level, risks for all lower risk hierarchy levels are separated according to positive and negative amounts and added together. The larger of the two values represents the value at risk as a positive value.

- **correlated**

Risk on a particular risk hierarchy level comes from the risks at all lower risk hierarchy levels, taking into account how they influence on one another (correlation).

Maintaining Risk Hierarchies

1. Choose *Financial accounting* → *Treasury* → *Market risk* → *Master data* → *Risk hierarchy*.

   The initial screen for maintaining risk hierarchies appears.

2. Select or assign a key for a risk hierarchy.

3. Choose *Edit.*

   When **creating** a new risk hierarchy, the maintenance screen for the header data of the hierarchy will appear.

   a. Enter a short and long description for the risk hierarchy.

   b. Decide how the risk factors are determined in the interest area control.

      Here you specify whether the risk factors in the interest area are freely defined or whether they are determined automatically by the selected yield curve type in the form of reference interest rates.

      The default sets reference interest rates as risk factors.

      If you want to define interest rates, choose *Edit* → *Control. Interest area* →*Freely defined term.*

      Once risk factors have been set to be freely definable, you can not reverse the setting.

   c. Choose an aggregation type to be the default for the risk hierarchy. This will determine the type of aggregation for the entire hierarchy. At the level of single hierarchy node, however, the default setting can be overridden.

      To maintain the hierarchy, choose *Goto* → *Hierarchy tree.*

      With a new hierarchy, there will be a node with the preassigned name ROOT. This node can be changed, but not deleted. You can build the tree up, starting from this root node.

   d. To create successor nodes, select the root node and choose *Edit* → *Create node.*

      You can now enter names for the successor nodes.

   e. If for a risk hierarchy you want to use the interest area risk factors determined by the system from the set reference interest rates, choose *Goto* → *Create ref. int. rate node.*

      You get the dialog box *Create risk factor node for reference interest rates*, and can specify the currency and yield curve type for the new node here.

      By choosing *Continue*, the reference interest rate node will be created.

   f. To rebuild all of the risk factor nodes (under the node representing a reference interest rate) congruent to the current definition of yield curve types, choose → *Edit Reorg. ref. int. node.*

   g. You can still specify each existing node by assigning a text to it. To do this, select the node and choose *Goto* → *Node texts.*

h. If the node is an **end node** (lowest level), go to the detail screen to select a risk type. To do this, choose *Goto → Risk factor.*

The following risk types can be assigned.

Risk Type	Additional Necessary Entries
Yield curve	Currency, yield curve type, term
Interest volatility	Volatility type, term, reference interest rate
Exchange rate	Base currency; exchange currency
Exchange rate volatility	Volatility type (base currency); volatility type (exchange currency)
Security price	Security class
Security volatility	Volatility type, term, security class
Stock index	Security index
Stock index volatility	Volatility type, term, security index

i. If the node is a **summarization node** (superordinate level), go to the detail screen to select an aggregation type. To do this, choose *Goto → Aggregation type (node)..*

– The following aggregation types can be assigned.

– similar to risk hierarchy aggregation type

– summated (with +/- sign)

– summated (absolute amounts)

– differentiated

– correlated

When **creating/changing**, the maintenance screen for the chosen hierarchy will appear. Do as described above.

4. Choose *Risk hierarchy → Save.*

Before saving, you should check whether risk types were also created for all bottom nodes. Choose *Risk hierarchy → Check consistency.*

Result

You have edited the chosen risk hierarchy.

Tools

Saving OTC NPVs

Use

You can use this function to save present values for money market, forex and derivative transactions in the OTC NPV table.

When you run a key date valuation in the money market and forex areas of Treasury Management, you can also select derivatives transactions (at present, only options are supported) and specify an NPV type. The NPV type allows you to access the NPVs stored in Market Risk Management.

These NPVs are used when you write up/write down or create provisions for the premiums that have been capitalized (long positions) or entered on the liabilities side (short positions) according to the defined valuation rules. When you run a new valuation, the system resets the valuation flows for a previous key date valuation run.

Prerequisites

In Customizing for Market Risk Management, you must have defined a price/NPV type for OTC transactions (*Rate and Price Tables → Define Price/NPV Type for OTC Transactions*).

If you want to calculate NPVs with different evaluation types, we recommend that you define different price/NPV types.

Procedure

1. Choose *Accounting → Treasury → Market Risk → Tools → Storage → OTC NPVs.*

   The *RiskM: Store from mark-to-market evaluation finance transactions* selection screen appears (report program RFTVBW50).

2. Select the financial transactions.
3. In the data group *Program control*, choose the *evaluation per* date, the *display currency*, and the *evaluation type.*
4. In the data group *output control*, you can specify a *variant*, an *NPV type*, and whether a *Test run* should be carried out.
5. Choose *Execute.*

Result

The system calculates the OTC net present values and saves them to the OTC NPV table.

Calculating Bond Prices

Use

The system saves the prices calculated by this function in the R/3 price/rate table under the selected rate/price type. You can then use these prices in Treasury Management (for example, to value securities positions or for evaluations).

Procedure

1. Choose *Accounting* → *Treasury* → *Market Risk* → *Tools* → *Storage* → *Calculated Bond Prices.*

   The *Price Calculation for Securities (Bonds)* selection screen appears (report program RFTVBW29).

2. Select the securities by entering the *product type* and *class.*
3. In the *Calculation control* section, choose the *current date* and *evaluation type.*
4. In the *Control of save function* section, choose the *price type* and the *exchange* under which you want to store the calculated values. You can use the *test run* indicator to simulate the calculation.
5. Choose *Execute.*

Result

The system calculates the prices for the bonds you have selected and saves them to the price/rate table.

Option Price Calculator

Use

The option price calculator calculates premiums on standard and exotic currency options and premiums for OTC options.

For the exact calculations, see the following sections of the documentation for the MRM price calculator:

Option Price Calculator [Page 112]:

- European Standard Options (OTC) [Page 113]
- European Barrier Options (OTC) [Page 115]
- American Standard Options (OTC) [Page 120]

Integration

For more information about the option price calculator, see *Foreign Exchange/Derivatives* in the *Treasury* section of the SAP Library.

Scope of functions

You make the following entries to calculate the premium on a currency option:

- *Currency pair*
- *Term/days*

In the *Market data* section, you can make the following entries (or, alternatively, import the data from the market data table by choosing *Edit → Get market data)*:

- *Spot*

  Enter the exchange rate for the currency pair you specified in the *Currency pair* field. This rate is used to calculate the option premium.

- *Swap*

  In this field, you enter the forward premiums/discounts. Alternatively, you can let the system calculate them on the basis of the interest rates for the currencies in the currency pair. In this case, you leave the *Swap* field empty, enter the interest rates for the first and second currencies, and choose *Calculate → Swap/forward rates*.

- *Forward*

  This field shows the sum of spot and swap rates as the forward exchange rate - both bid and ask sides.

- *Interest 1st currency*

  Enter the bid and ask values of the interest rate corresponding to the option period for the currency named first in the currency pair. If this interest rate is not consistent with the specified swap rate and the interest rate of the second currency, it is calculated and adjusted.

- *Interest 2nd currency*

Enter the bid and ask values of the interest rate corresponding to the option period for the currency named second in the currency pair. If you do not enter a value in this field, the interest rate is calculated using the swap and interest rates for the first currency.

- *Volatility*

  Enter both bid and ask values of the volatility corresponding to the option period, as a volatility.

In the *Premiums* section, enter the basis prices of the options for which you want to calculate the premiums. By choosing *Calculate* → *Calculate premiums* you can display the currency option premiums as bid and ask quotes.

You can also calculate the sensitivities of a premium. To calculate the sensitivities of one premium, select the premium and choose *Calculate* → *Implied volatility.* To calculate the sensitivities of all the premiums, choose *Edit* → *List of results.*

You can calculate the premiums for European exotic currency options by choosing *Goto* → *Exotic options.* You then need to specify the following values in the *Premiums* section:

- The *Type* specifies the product type to which the option is allocated.
- In the *Barrier* field, enter the value which must be reached for the option condition to be met.
- In the column marked *Rebate,* enter the amount payable if the option conditions are not met (in units of the 2nd currency).

Interest Calculator

Use

The interest calculator converts interest rates from one interest calculation method to another.

Activities and Scope of Functions

The interest calculator offers two main functions, which can be used together.

- You can convert an interest rate from one **interest calculation method** to another.

    To perform this function, you have to specify a source interest rate and an interest calculation method. To calculate a spot rate, you must enter the *Effective from* date of the source interest rate for the target interest rate.

    An interest rate entry has priority over a *curve type* or *currency*.

    Choose *Calculate* → *Calculate interest* to start the conversion.

- Calculating a **forward interest rate** or a **forward yield curve** from a given yield curve.

    To perform this function, you have to specify a curve type source and currency source. To calculate the forward rate/curve you must enter the forward date in the *Effective from* field for the target forward rate/target curve.

    The system ignores any entry made in the fields for interest rate or interest calculation method.

    Choose *Calculate* → *Calculate curve* to start the forward calculation for a curve.

    To display the source and results curves after calculation, choose *Goto* → *Display yield curve.*

Statistics Calculator

Use

You use the statistics calculator to estimate volatilities and correlations on the basis of historical market data.

The statistics calculator only calculates the volatilities and correlations of risk factors in **one** risk hierarchy (currency and interest rate risks only). These volatilities and correlations are used, for example, in the variance/covariance approach.

At present only second sampling moments ($E(X-EX)^2$) and transformed second sampling moments can be estimated for interest and exchange rates.

Scope of functions

The market prices per risk factor and the correlations between the market prices form the data basis for the variance/covariance approach. You can calculate these statistical parameters using the various methods offered by the statistics calculator.

- Risk factors

  A risk factor affects the price of an instrument and is included in the valuation of a transaction. The following should be regarded as risk factors:

  – Grid points of yield curves (reference interest rates)

  – Exchange rate pairs

- Calculation of price/rate changes

  $P_{i,t}$ is the value of the i^{th} risk factor on the date *t.*

  T is the retention period, then

  $R_{i,t} = \dfrac{P_{i,t} - P_{i,t-T}}{P_{i,t-T}}$ is the relative change in value of the i^{th} risk factor,

  $D_{i,t} = P_{i,t} - P_{i,t-T}$ is the absolute change in value of the i^{th} risk factor,

  $E_{i,t} = \ln\left(\dfrac{P_{i,t}}{P_{i,t-T}}\right)$ is the logarithmed value change in the i^{th} risk factor, for the day *t*,

  whereby *t-T* is *T* days older than *t.*

- Calculation of the variances and correlation coefficients

  You can use the statistics calculator to calculate the necessary statistical parameters using the classical standard deviation and correlation coefficient methods.

  The statistics calculator uses the following formulas:

  $\varepsilon_{i,t}$ is the change in the rate/price (absolute/relative/logarithmed) of the i^{th} risk factor at time *t.*

$\varepsilon_{j,t}$ is the change in the rate/price (absolute/relative/logarithmed) of the j[th] risk factor at time *t.*

The formula for the classical standard deviation of the i[th] risk factor is:

$$\sigma_{i,t}^2 = \frac{\sum_{k=1}^{N} \varepsilon_{i,t-k}^2}{N-1}$$

The formula for the classical correlation between the i[th] risk factor and the j[th] risk factor is:

$$\sigma_{ij,t}^2 = \frac{\sum_{k=1}^{t} \varepsilon_{i,t-k}\varepsilon_{j,t-k}}{N-1}$$

This is the basis for calculating the correlation coefficient

$$\rho_{ij,t} = \frac{\sigma_{ij,t}}{\sigma_{i,t}\sigma_{j,t}} \text{ with } (-1 \le \rho_{ij,t} \le 1)$$

Executing Statistics Calculation

1. Choose *Financial accounting → Treasury → Market risk → Tools → Statistics calculator.*

   The initial screen for calculating volatilities and correlations appears.

2. Choose a *Risk hierarchy.*
3. To restrict the calculation to one node on the risk hierarchy, choose *Nodes.*
4. Choose a *Reference currency*.
5. Choose a *Volatility type*.
6. Choose a *Correlation type*.

   The correlation type and volatility type are assigned a statistics type in Customizing. This describes the statistical calculation type and sets the parameters and basic estimation functions (sample range, confidence level, etc.).

7. Choose a *Calendar.*. In doing this, all historical days are selected for which market data will be read.
8. Choose the *Start date* (the date from which the market data should be imported).
9. Choose a *Holding period* (in days). For this period, the volatilities and correlations are estimated. More precisely, by comparing the market data at the beginning of the holding period with the market data at the end, the system determines the market price changes.

   If the holding period which you want to use for an evaluation is different to the holding period with which the statistic data is estimated, an adjustment is made. You define the type of adjustment in the *Retention period calculation category* parameter, which you use to define a statistics type. These settings are made in Customizing under *Treasury → Market data admin. → Master data → Define stat. type* At present, statistic data based on price change logarithms is transformed using the root method. Statistic data based on relative or absolute price changes is transformed into the required retention period of the evaluation using interpolation.

   Historical days are determined starting from the *Start of history* date and continuing backwards.

   Say the beginning of the history is 03 March 1997 (Monday). With a holding period of one day, the market price change is the change from 28 February 1997 to 03 March 1997. The second price change is figured to be the change from 27 February to 28 February, and so on. The historical period reveals the number of examined market price changes.

10. Enter the error tolerance (*No. of missing rates allowed*) to control the reaction of the system when data is missing.

    If there is no market data for historical dates (no quotation, no delivery via datafeed) the system has a replacement strategy. This involves using market rates from further in the past. Since this leads to a distorted statistical picture, you can use the error tolerance to determine the maximum number of such replacements allowed in an historical time sequence.

11. You can make the following alternative calculations:
    - Calculate volatilities only
    - Calculate correlations only
    - Calculate volatilities and correlations
    - Choose specific volatilities and/or correlations
12. With the indicator *Test run (batch mode only)*, you can control whether the data is written to the database.
13. Choose *execute.*

Result

Volatilities and correlations are calculated. The calculated values are output as a list, and in an update run they are stored in the database tables.

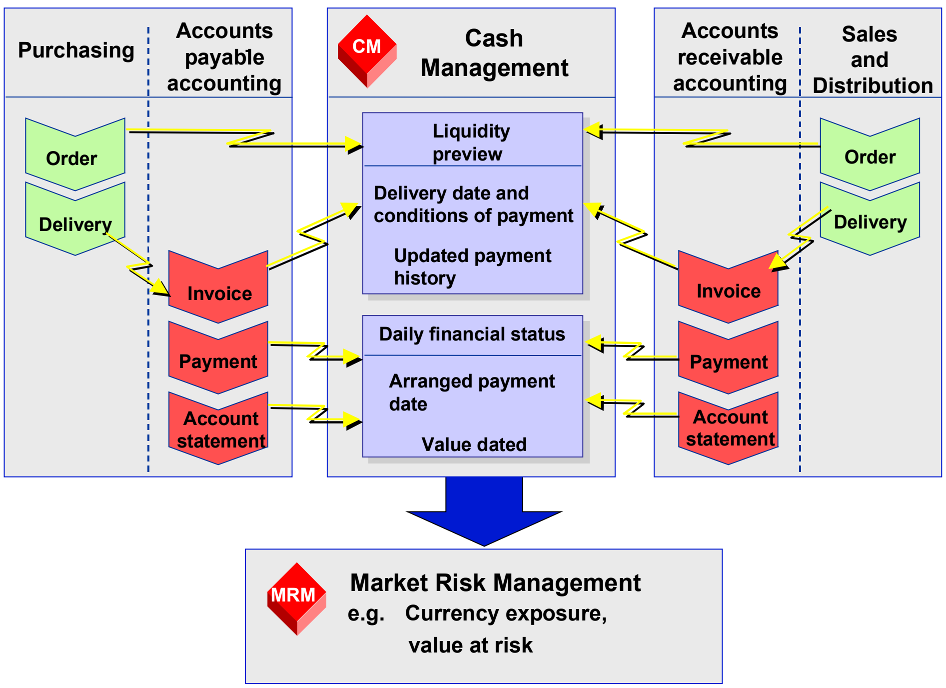
MRM Price Calculator

Description of the instruments which can be valuated in Market Risk Management

The main goal of Treasury - Market Risk Management is to analyze and valuate the interest rate and currency risks of an enterprise. The evaluation takes operative cash flows from SAP's Cash Management into account, as well as financial transactions created in Treasury Management.

Operative cash flows (e.g. transactions in materials management or from sales and distribution) are accessed in MRM reports directly via Cash Management using a special hierarchy. All of the data which flows into daily financial status or liquidity estimate are accessible by MRM.

Example for the integration of operative cash flows in evaluations in MRM:



NPV determination for these operative cash flows is based on the same methods as for financial transactions (see, for example, forward currency transactions): For each value date, cash flows are discounted to the horizon using zero bond discounting factors.

Financial transactions can be closed and created in Treasury Management for liquidity control, financing, or risk transformation. Financial information created in Treasury Management is always available in MRM (exceptions: transactions created as *orders*, and undisbursed loans).

You can valuate the following financial instruments in MRM:

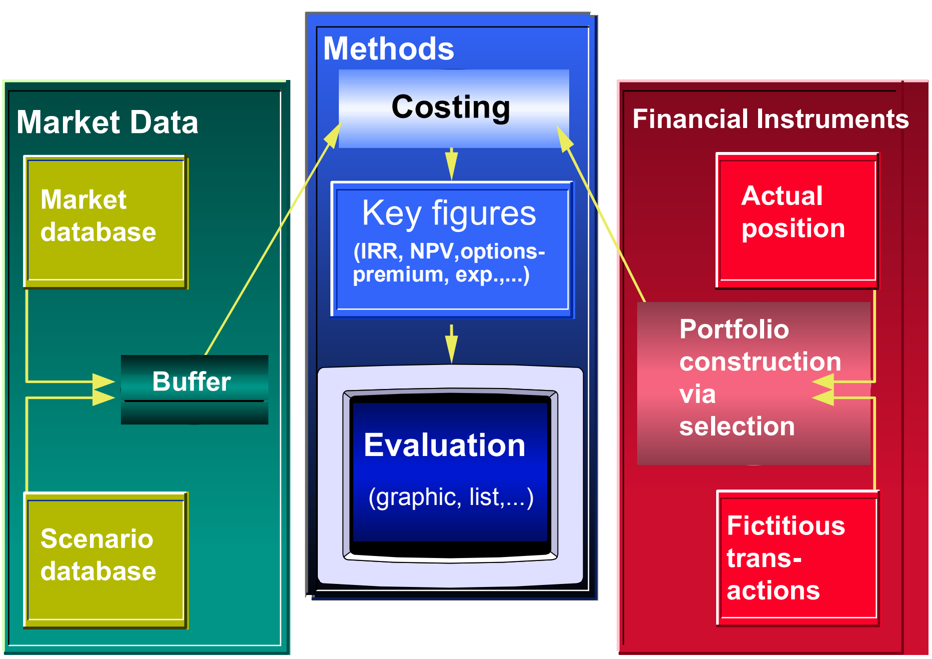
- Forward exchange transactions
- Currency options (European, American, barrier)
- Bonds (fixed-interest, floating rate, zero bonds) with price info or using yield curves

- Loans (fixed-interest, floating rate)
- Cash transactions (besides deposits at notice)
- Forward rate agreements (FRAs)
- Interest rate guarantees (European)
- Interest rate swaps/cross currency interest rate swaps (also exotic structures such as rollercoasters)
- Swaptions (European)
- Caps, floors
- OTC bond options (European)

Note that formula-based conditions (e.g. 2 x LIBOR - *x*%) can not currently be valuated in Market Risk Management. Spreads on reference interest rates are taken into account in determining NPV. You can determine the market value for securities which are not bonds (i.e. not product category 040 - things such as warrant bonds, convertible bonds, stocks, warrants, certificates of investment) using mark-to-market valuation.

When calculating NPVs and derived key figures, the system can use both real data (market database and actual position) and simulated data (scenarios and fictitious transactions). The way in which the price calculator calculated prices is not influenced by this.

Linking real and fictitious market data and financial transactions to MRM calculations.



Price Calculator for Financial Instruments

The price calculator documentation describes the market price calculators for different financial instruments.

There is price calculator documentation for every financial instrument. It contains product-specific information, and links to subroutines (e.g. calculating forward rates or zero bond discounting factors) needed to calculate several financial instruments. The subroutine documentation contains links to descriptions of the price calculators which use that particular subroutine.

Price calculator documentation for each financial instrument consists of the following parts:

Use

This part contains information on the financial instruments and variants which can be created and valuated in the system. If anything other than market price can be calculated, this will be indicated here.

Integration/Calculation Basis

In addition to the transaction data, the market data necessary for valuation are listed here.

Prerequisites

This part determines the calculation basis by listing all of the input parameters for determining market price.

This part also contains links to descriptions of subroutines necessary for calculating certain input parameters. The subroutine descriptions usually don't contain product-specific information, as these routines are used for several financial instruments.

Features / Valuation

This part contains descriptions of valuation procedures. The formulae for market price valuation are depicted here. There are also links here to descriptions of standardized valuation procedures (subroutines). The complete description of the valuation steps is contained in the subroutines.

Loan Transactions

Use

The market price calculator for loan transactions calculates current market values. It also calculates market values and time values for a future point in time (horizon).

You can valuate both loans given and loans taken. You can create and valuate both fixed rate and floating rate (variable) interest payments. As principal repayments, you can create and value final repayments, installments, and annuities. Discounts and premiums can be taken into account. A distinction is made between disbursed and undisbursed loans.

Integration/Calculation Basis

To valuate a loan, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition to the yield curve necessary to discount a generated cash flow, you may also have to specify a yield curve for calculating forward rates for floating interest payments (see Input Parameters).

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites / Calculation Basis

Treasury Management automatically generates a cash flow for you when a loan is created. The cash flow consists of interest payments and principal payments which fall on certain dates. If the interest rate is fixed, the amount of the interest payments is known. If the interest rate is floating, only the reference interest rate is known. In the case of disbursed loans, the cash flows are summarized in accordance with the Customizing settings for the summarization rule.

Zero bond discounting factors are needed to discount cash flows. You can use the zero coupon or the par coupon calculation method for calculating zero bond discounting factors.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

First, the entire cash flow is reduced to those payments which come after the horizon. For floating rate loans, the forward interest rates for the reference interest rate are also calculated. The resulting interest payments are placed into the cash flow, which only contains payments whose amount and time are set. Depending on the calculation routine, the NPVs of the individual payments are calculated in the transaction currency on the horizon. The value of the loan (in transaction currency) is then the sum of the NPVs of the cash flows.

Note the following definitions:

- t_i: Due dates of the cash flows (i=1...n)
- C_i: Cash flow at time t_i
- $BW(C_i)$: NPV of the cash flow Ci on the horizon, due in t_i

- NPV: Net present value

$$NPV = \sum_{i=1}^{n} BW\left(C_i\right)$$

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Money Market Transactions

Use

Money market transactions are **fixed-term deposits (time deposits)** and transactions concerning **commercial paper**.

The market price calculator for money market transactions calculates current market values. It also calculates market values and time values for a future point in time (horizon).

Time deposits can be created with the transaction types investment made (asset transaction) and investment taken (liability transaction). The term and the beginning of the term can be variable. For fixed interest agreements, the frequency of interest payments can be determined individually. You can even process several fixed interest rates over time.

Commercial paper transactions are created with a term beginning and a term end, as are time deposits. In contrast to time deposits, though, interest is only paid at maturity. The nominal amount is then the amount of the entire payment at the end, composed of the principal and interest payment together. The nominal volume (= principal payment) is smaller than the nominal amount. Instead of an interest rate, you can specify a call or put price. This means that commercial paper can be handled and valuated like zero bonds (see calculation of the theoretical price of spot security transactions).

Integration/Calculation Basis

To valuate a time deposit, you need to enter transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

Treasury Management automatically generates a cash flow for you when a time deposit is created. The cash flow consists of interest payments which fall on certain dates, and a principal payment. As the interest rate is fixed, the amount of the interest payments is known.

Zero bond discounting factors are needed to discount cash flows. You can use the zero coupon or the par coupon calculation method for calculating zero bond discounting factors.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

First, the entire cash flow is reduced to those payments which come after the horizon. Depending on the calculation routine, the NPVs of the individual payments are calculated in the transaction currency on the horizon. The value of the money market transaction (in transaction currency) is then the sum of the NPVs of the cash flows.

Note the following definitions:

- t_i: Due dates of the cash flows (i=1...n)
- C_i: Cash flow at time t_i
- $BW(C_i)$: NPV of the cash flow Ci on the horizon, due in t_i
- NPV: Net present value

$$NPV = \sum_{i=1}^{n} BW(C_i)$$

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Spot Stock Transactions (on an Exchange)

Use

The market price calculator for spot stock transactions calculates current market values. It also calculates market values and time values for a future point in time (horizon).

Spot stock transactions of the same security class are put together to form a position and valuated as such.

The market value of a position on an evaluation date (horizon) is calculated as the product of the number of stocks in the position (for short positions, multiply by *-1*) and the stock price on the evaluation date (forward stock price on the horizon).

The future price of the stock on the horizon is not known. What we want, however, is that the stock is in our position on the horizon of the transaction. To do this, you can either purchase the stock at the price on the evaluation date and hold it till the horizon (and get the dividend payments), or buy the stock on horizon at the forward price. Assuming there is no arbitrage, both transactions have the same value, and the forward price on the horizon is calculated as follows:

$$NPV(forward\ price) = ACT + \sum_{i=1}^{n} NPV(DIV_i)$$

with:

- Forward value: Stock price on due date of transaction
- NPV (forward price): NPV of forward price on evaluation date
- ACT: Current (actual) price of stock
- DIVi: Expected dividend

NPV(DIVi): NPV of expected dividend on evaluation date. This is not calculated for the current release. Instead, the forward price is set to the current price.

Integration/Calculation Basis

To valuate a spot stock transaction, the transaction data and the stock price have to be specified for the evaluation date.

If the horizon comes after the evaluation data, a parcoupon or zero coupon yield curve has to be entered for the evaluation date in the transaction currency.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

If the horizon comes after the evaluation date, you will need zero bond discounting factors to determine the forward stock price.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

You use the function module for calculating Zero Bond Discounting Factors [Page 51] for input parameters.

Features / Valuation

The NPV of the stock position (in transaction currency) is the product of the forward price on the horizon and the number of stocks in the position (multiplied by -1 for short positions).

Note the following definitions:

- No.: Number of stocks to be bought/sold on due date.
- DIVi: i^{th} expected dividend payment *(not used in current release).*
- NPV(DIVi): NPV of the dividend payments on the horizon.
- ACT: Stock price on evaluation date.
- ZW(ACT): Stock price valid on horizon
- B: Buy/sell indicator
- NPV: Net present value

$$NPV = B * No * \left[ZW(ACT) + \sum_{i=1}^{n} NPV(DIV_i) \right]$$

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Bonds (Listed)

Use

The market price calculator for bonds calculates current market values. It also calculates market values and time values for a future point in time (horizon).

You can create and valuate fixed rate bonds, zero bonds, and floaters as standard or foreign currency bonds. You can have up to two transaction currencies - one for interest and one for principal. You can create fixed or floating interest rate agreements.

In SAP Banking Risk Management, you can create positions from security transactions, and valuate them.

Depending on the Customizing settings, the valuation uses the NPV as the theoretical price (by calculating the NPV of interest and principal payments), or it is the market price (by including the security price and accrued interest). The NPV always contains accrued interest and is thus always a dirty price. If the horizon comes after the evaluation date, the theoretical price of the bond is always calculated as the NPV on the horizon.

Integration/Calculation Basis

Depending on Customizing settings, two types of valuation are possible for spot security transactions.

- **The NPV is the market price of the bond:**

  The current price of the bond on the evaluation date has to be specified. The specified ID number is the number of the security class.

- **The NPV is the theoretical price of the bond:**

  You need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition to the yield curves necessary to discount a generated cash flow, you may also have to specify yield curves for calculating forward rates for floating interest payments (see Input Parameters).

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and one of the transaction currencies differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

Depending on Customizing settings, two types of valuation are possible for spot security transactions.

- **The NPV is the market price of the bond:**

  The amount of the cash flows resulting from accrued interest on the horizon is generated.

- **The NPV is the theoretical price of the bond:**

  Treasury Management automatically generates a cash flow for you when a bond is created. The cash flow consists of interest payments and principal payments which fall on certain dates, and are normed to a nominal amount of 100,000. If the interest rate is fixed, the amount of the interest payments is known. If the interest rate is floating, only the reference interest rate is known. The cash flows are summarized into a security according to the position data of the position object.

Zero bond discounting factors are needed to discount cash flows.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

Depending on the Customizing settings, there are two types of valuation for a security position:

- **The NPV is the market price of the bond:**

  The NPV is the sum of the current price of the bond in the transaction currency (multiplied by the nominal volume of the security position) and the accrued interest on the horizon.

  Note the following definitions:

  – ACT: Current (actual) price of stock
  – NV: Nominal volume of security position
  – W(ACT): Currency of current price of security (issuing currency)
  – C: Cash flow for accrued interest
  – W(C): Currency of cash flow C
  – DC: Display currency
  – WK(W(ACT)/W(C) ; DC): Currency W(ACT)/DC or W(Ci)/AZ (bid or ask rate) on horizon
  – B: Long/short indicator
  – NPV: Net present value

$$NPV = B * \left[AK * NV * WK\left(W\left(C\right); DC\right)\right]$$

- **The NPV is the theoretical price of the bond:**

  First, the entire cash flow is reduced to those payments which come after the horizon. For security positions with variable interest rates, the forward reference interest rates are also calculated. The calculated interest payments are put into the cash flow, which only contains flows whose size and payment date are certain. The cash flows are then standardized according to the nominal volume of the security position. Depending on the method of calculation (par or zero coupon method), the NPV of the individual cash flows is calculated for the horizon, using the yield curve of the transaction currency. The value of the security position (in the display currency) is the NPV of the sum of the cash flows. These cash flows are standardized to the nominal volume of the position, and converted to the display currency using the appropriate (forward) exchange rate. For short positions, the whole calculation is multiplied by negative one (-1).

  The following abbreviations/definitions are used:

Bonds (Listed)

- t_i: Due dates of cash flows
- NV: nominal volume of the security position
- Ci: Cash flow on date ti (with NV/100,000 standardized to the nominal volume)
- $BW(C_i)$: Net present value on the horizon of the cash flow Ci due on ti
- Wi: currency of cash flow Ci
- WK(Wi;AZ): (forward) currency rate (ask or bid) Wi/AZ
- K: Long/Short indicator
- NPV: Net present value

$$NPV = K * \left[\sum_{i=1}^{n} BW(C_i) * WK(W_i;AZ) \right]$$

Spot Exchange Transactions (OTC)

Use

Spot currency transactions can only be valued as balances in two different currency accounts. They are then valued similarly to account transactions.

Forward Exchange Transactions (OTC)

Use

The market price calculator for forward exchange transactions calculates current market values, time values, and future market values (the future point in time is the horizon).

With a forward exchange transaction one currency is exchanged against another on a key date in the future at an agreed upon rate.

If the settlement date of the transaction comes before the horizon, the forward exchange transaction has a value of zero on the horizon. The currency payments don't flow into a currency position in the Risk Management component.

If the settlement date of the transaction comes after the horizon, a value can be calculated. In valuing the transaction, the NPV on the horizon is calculated for both cash flows which flow on the settlement date. The calculation uses the appropriate yield curves from the transaction currencies. The NPV is the difference between the NPVs of the two cash flows, which have been converted to the display currency using the appropriate exchange rate (ask or bid price).

Integration / Calculation Basis

In order to value a forward exchange, you need the transaction data, and alternatively a par coupon or zero coupon yield curve in the transaction currency (ask or bid rate) for the evaluation date.

The currency rates (bid and ask rates) of both transaction currencies in relation to the display currency are needed. If the horizon comes after the evaluation date when calculating a forward exchange rate (bid or ask rate) on the horizon, a yield curve will have to be entered in the display currency.

Prerequisites / Calculation of the Input Parameters

With the help of the Treasury Management component, a cash flow is generated when a forward exchange transaction is created. The payment flow consists of both exchange payments in both transaction currencies, which flow on the settlement date of the transaction.

Zero bond discounting factors are needed as further input parameters in order to discount the cash flow. The zero and par coupon calculation methods are available for defining zero bond discounting factors.

If the horizon is later than the evaluation date, the corresponding forward currency rates (bid or ask price) of the transaction currencies are calculated for the evaluation date using the yield curves from the transaction and display currencies.

Scope of Functions / Valuation

The modeled cash flow only contains payments, whose amount and payment date are known. Depending on the method of calculation (par or zero coupon method), the NPV of the individual cash flows is calculated for the horizon, using the yield curve of the transaction currency. The value of the forward exchange (in the display currency) is the difference between the NPVs of the two cash flows. The value is converted to the display currency using the (forward) currency rates (bid or ask).

The following abbreviations/definitions are used:

- C: Cash flow of the call side of the forward exchange.
- D: Cash flow of the put side of the forward exchange.
- BW(C/D): NPV of the cash flow C/D on the horizon
- W(C/D): currency of cash flow C/D
- DC: display currency
- WK (W(C);AZ): (forward) exchange rate W(C)/AZ (bid or ask rate)
- NPV: net present value

$$NPV = BW(C) * WK(W(C); DC) - BW(C) * WK(W(D); DC)$$

Currency Options / Currency Barrier Options (OTC)

Use

The market price calculator for currency options / currency barrier options calculates current market values, time values, and future market values (the future point in time is the horizon).

A currency option is an option on a forward exchange transaction. There are both call and put options. A currency barrier option is a currency option, for which there is an additional condition known as a barrier Currency barrier options also come in both the call and put variety. We distinguish between four main types of barrier options:

- The “up & in”, which means that a currency option becomes valid only when the currency rate in the underlying rises above a certain level (barrier).
- The “up & out”, which means that a currency option becomes invalid when the currency rate in the underlying rises above a certain level.
- The “down & in”, which is where a currency option becomes valid when the currency rate in the underlying falls below a certain level.
- The “down & out”, which is where a currency option becomes invalid when the currency rate in the underlying falls below a certain level.

Both the American and the European types of currency and currency barrier options can be created. The buyer has the right to exchange one currency for another at a price agreed upon earlier (with a currency barrier option, this assumes that the currency option is valid). The optional exchange takes place on a particular date (when exercised according to European standards), or during a specified period up to the expiration date (when exercised according to American standards). Only those currency and currency barrier options whose expiration date is after the horizon will be valued.

The future currency rate is modeled in the valuation. Currency options, like other types of options, are calculated using the option price formulae: Black for European options, and the binomial tree (using 30 or 31 periods) for American options. These formulae require the strike price (the agreed upon exchange rate in the case of currency options), the spot rate (the current or forward exchange rate), the term of the option, and the volatility. In addition, currency options also require two risk free interest rates (corresponding to the two transaction currencies).

Integration / Calculation Basis (currency options only)

In order to value a currency option, you need the transaction data, and alternatively a par coupon or zero coupon yield curve in the transaction currency (ask or bid rate) for the evaluation date.

You will also need a currency volatility curve for the term of the option. The given currencies represent the two transaction currencies (currencies of the call and put sides of the underlying transactions).

The currency rates (bid and ask rates) of both transaction currencies in relation to the display currency are needed. If the horizon comes after the evaluation date and the transaction currency differs from the display currency when calculating a forward currency rate on the horizon (currency of the put side of the underlying / display currency), a par or zero coupon yield curve structure will have to be entered in the display currency (ask or bid rate).

Prerequisites / Calculation of the Input Parameters (currency

options only)

You need zero coupon rates and zero bond discounting factors for use in later determining the risk free interest rates (both of which go into the price formula).

If the horizon is later than the evaluation date, the corresponding forward currency rates (bid or ask price) of the transaction currencies (currency on the put side of the underlying) are calculated for the evaluation date using the yield curves from the transaction and display currencies. The relevant forward currency rate (bid or ask price) of the transaction currency on the horizon is calculated using the yield curve from the transaction currency, based on the exchange rate on the evaluation date.

Scope of Functions / Valuation (currency options only)

Depending on the type of option (American or European), the option price calculator uses the Black Scholes formula (for European options) or the binomial tree (for American options), along with the following parameters (some of which are taken from the input parameters):

- Call/Put: Call/Put:
- Term: term of the option in days (expiration date of the option to the horizon)
- Spot: current currency rate or forward currency rate on the horizon of the two transaction currencies (currencies on the call and put sides of the underlying transaction)
- Strike: fixed currency rates of both transaction currencies in the underlying transaction of the option (currencies of the call and put sides of the underlying transaction)
- Interest rate 1: risk free interest of the call side of the underlying transaction = zero interest rate of the given yield curve corresponding to the currency of the call side of the underlying transaction and the option term
- Interest rate 2: risk free interest of the put side of the underlying transaction = zero interest rate of the given yield curve corresponding to the currency of the put side of the underlying transaction and the option term
- Volatility: currency volatility of both transaction currencies from a volatility curve with a term corresponding to the option term

The result calculated will be the NPV (on the horizon) of the currency difference (DZ) between the currency rate and the currency rate fixed in the underlying transaction on the exercise date of the option. This difference (DZ) is standardized to the nominal volume of the put side of the underlying transaction, and has a lower limit of zero.

The NPV of the currency option (in the currency of the put side of the underlying transaction) is the nominal volume (NV) of the put side of the underlying transaction multiplied by the currency difference (DZ).

Along with the symbols given already, the following are also used:

$$NPV = K * NV * DZ$$

where:

K: call/put-marker

If the display currency differs from the put side of the underlying transaction of the currency option/currency barrier option, the NPV is calculated using the (forward) currency (bid/ask) rate.

Options on Bonds (OTC)

Use

The market price calculator for options on bonds calculates current market values, time values, and future market values (the future point in time is the horizon).

Options on bonds have two variants, call and put. At the moment, only the European type can be dealt with. The buyer has the possibility to either buy (call) or sell (put) a bond on a particular date at an agreed-upon strike price (clean price of the bond in the issuing currency). Only options whose horizon is before the expiration date will be valued.

In valuing the option, the NPV of the payment flows (interest and principal) from the underlying after the expiration date is calculated, which will be used to determine the theoretical price of the option on the expiration date. After deducting accrued interest, the theoretical clean price of the bond goes into the option price formula as the spot, along with the strike price, term, risk free interest rate, and the price volatility. You can either enter the price volatility of the (forward) bond price yourself, or it can be calculated for you using the duration and yield taken from the interest volatility.

Underlying:

All securities can be used as underlyings that can be set up in the SAP system.

Integration / Calculation Basis

In order to value an option on a bond, you need the transaction data, and alternatively a par coupon or zero coupon yield curve in the transaction currency (ask or bid rate) for the evaluation date. In addition to the yield curves necessary for discounting generated cash flows (see input parameters), it is possible that additional yield curves will be necessary to calculate forward interest rates for variable interest payments.

In addition, you need a price volatility curve for the bond in the underlying over the term of the option. If this isn’t available, you can use an interest volatility curve for the term of the option. The reference interest rate you give is the one closest to the reference interest rate in the yield curve, whose term most closely parallels that of the bond. For example, if the term of the fixed side of the swap is 4.25 years, the term for the reference interest rate in a yield curve has to be set to four years.

If the display currency is different from the transaction currency in the underlying of the loan, the relevant currency rates (ask or bid rate) are needed. If the horizon comes after the valuation date and the transaction currency differs from the display currency when calculating a forward transaction on the horizon, a par or zero coupon yield curve structure will have to be entered in the display currency (ask or bid rate).

Prerequisites / Calculation of the Input Parameters

Depending on the calculation procedure, the following input parameters are calculated for later determining the risk free interest rate and the spot rate (both of which go into the price formula):

- Zero coupon rates and zero bond discounting factors

  If the underlying bond contains more than one currency when determining the spot rate, the currencies will be converted into the call or put currency using the appropriate ask / bid rates. If the horizon is later than the evaluation date, the corresponding forward currency rate (bid or ask price) is calculated for the horizon using the yield curve from the transaction currency on the evaluation date.

- **Spot**

The spot is the NPV of the clean price (standardized to the nominal volume) of the bond on the expiration date of the option. Using the Treasury Management component, a cash flow is generated when a bond is created. The payment flow consists of principal and interest payments, which flow on particular dates, and are standardized to a nominal amount of 100,000. The amount of the interest payments is known for fixed interest rates. For variable interest rates, only the reference interest rate is known. It is gradually calculated using the forward calculator. For interest rate agreements whose fixed and variable interest rates are tied to formulae, the amount of the resulting interest rates are calculated using the calculated forward rates (possibly taking interest floors and caps into consideration). The amount of the resulting interest payments are also given. On the one hand, payment flows are reduced by those cash flows whose due date is before the expiration date of the option. On the other hand, they are increased by the cash flows from the accrued interest, which is calculated using the accrued interest calculator. The cash flow from the accrued interest goes until the expiration date of the option. The NPV of the individual cash flows is calculated on the horizon according either to the par or zero coupon calculation methods. This is done using the yield curves, dependent on the transaction currency. It is the equivalent of the NPV of the individual cash flows first on the expiration date of the option, and again on the horizon. The value of the spot is the NPV of the sum of the cash flows, which have been changed into the transaction currency of the call or put price, using forward currency rates (ask or bid). The sum is standardized to the nominal volume of the bond

The following abbreviations/definitions are used:

- ti: Due dates of cash flows
- Ci: Cash-flow at time point ti (including accrued interest payments)
- BW(C_i): Net present value on the horizon of the cash flow due on ti
- Wi: currency of cash flow Ci
- Wk: currency of the call or put rate (issuing currency)
- NV: nominal volume of the bond = 100,000
- WK(Wi;Wk): (forward) currency rate (ask or bid) Wi/Wk on the horizon
- NPV: market value

$$NPV = \frac{\sum_{i=1}^{n} BW(C_i) * WK(W_i; W_k)}{NV}$$

- **Volatility**

If a price volatility curve is available, then the volatility which goes into the option price formula is the one from the curve with a validity period the same as the one representative of the difference between the expiration date of the option and the horizon.

If no price volatility curve is available, the interest volatility is determined for the term according to the difference between the expiration date and horizon of the option (possibly linearly interpolated from the values of neighboring option terms). The price volatility calculator then converts it to a price volatility using the modified duration (based on the interest and principal payment flows from the bond after the expiration date of the option), and the forward zero yield. The yield is calculated from the given zero bond discounting factors and, is calculated for the remainder of the term of the bond (in relation to the expiration date of the option).

If the transaction currency differs from the display currency of the option (or the currency of the call or put sides), the transaction currency is changed into the display currency using the ask or bid rate from the horizon. If the horizon is later than the evaluation date, the corresponding forward currency rate (bid or ask price) is calculated for the horizon using the yield curves from the transaction and display currencies from the evaluation date.

Scope of Functions / Valuation

The option price calculator uses the following parameters (some of which are taken from the input parameters) when pricing European options (Black Scholes formula):

- Call/Put: Call/Put:
- Term: term of the option in days (expiration date of the option to the horizon)
- Spot: see input parameters
- Strike: agreed upon call or put price of the security standardized to 1
- Interest rate 1: 0 (no currency option)
- Interest rate 2: risk-free interest rate = zero interest rate of the interest yield curve with a term equivalent to the option term.
- Volatility: see input parameters

The difference (DZ) between the price of the bond and its call or put price on the expiration date of the option is standardized to the nominal volume of the bond, with a lower limit of zero. The NPV of the simulated DZ is then calculated.

The net present value of the interest option is the nominal volume (NV) multiplied by the interest difference DZ.

Along with the symbols given already, the following are also used:

$$BW = K * NV * LZ$$

where:

K: call/put-marker

If the display currency differs from the issuing currency (i.e. the currency of the call or put price), the NPV is calculated using the (forward) currency (bid/ask) rate.

Option Price Calculator

Use

The option price calculator calculates the NPV of an option on a transaction (bond, swap, FRA, stock) as well as the option delta.

Features

The following option categories can be valuated:

- Standard European
- Barrier (Up&Out, Up&In, Down&Out, Down&In)
- Hit at end Binary (Digital)
- One Touch Binary (Digital)
- Standard American

American options on swaps and bonds can not be valuated at present. For all other underlyings, they can be (American standard options only).

We first differentiate between exercise category (European, American), and then among option category.

The price calculator for European standard options gives you the option delta directly in addition to the option price.

The price calculator for digital hit-at-end binary options and digital one-touch binary options calculates the option price.

The option price calculator calculates the delta as the difference quotient: The price calculator is called up a second time with a price delta of (0.001).

The price calculator for European barrier options calculates the option price. The option delta is approximated using a difference quotient. The option calculator is called up a second time using a spot price shifted by (0.001).

In determining the price of an American standard option, the price calculator is called up twice - once with thirty steps and once with thirty-one. The option price is then the arithmetic mean of the two values. To calculate the option delta, the above procedure is repeated using a spot price shifted by (0.001). The option delta is then the difference quotient.

European Standard Options (OTC)

Use

European standard buy (call) and sell (put) options are valued using the Merton Procedure. Both the option price and the delta are calculated. The category of the underlying is only of interest for valuing the delta.

Prerequisites / Calculating the Input Parameters

The price calculator for European standard options has the following parameters:

- Term: Remaining term of the option in days

  The option price calculator [Page 83] calculates the term as follows:

  Exercise date
  - Contract date
  - Value dated days
  = Remaining term of the option in days

- Domrate (domestic rate): Interest rate_1 in percent
- Forrate (foreign rate): Interest rate_2 in percent
- Spot: Spot amount
- Strike: Strike amount
- UL cat.: Category of the underlying
- Vola: Volatility
- Put/Call: Indicates whether the option is a put or call option

Features / Valuation

If the expiration date of the option is reached, the internal value of the option (difference between spot and strike) is used.

If the value for the option term is positive, the option price is calculated as follows:

$$\text{lograte} = \log(1 + \text{domrate}/100)$$

$$\text{logfor} = -\log(1 + \text{forrate}/100)$$

$$\text{yearfrac} = \text{term}/365$$

$$\text{volaroot} = \frac{\text{Vola} * \sqrt{\text{yearfrac}}}{100}$$

$$d1 = \frac{\log(\text{spot}/\text{strike}) + (\text{logfor} - \text{lograte}) * \text{yearfrac}}{\text{volaroot}} + \frac{\text{volaroot}}{2}$$

$d2 = d1 - volaroot$

$price\_call = spot * exp(logfor * yearfrac) * N(d1) - strike * exp(lograte * yearfrac) * N(d2)$

$delta\_call = N(d1)$	(if underlying = stock)
$N(d1) * exp(logfor * yearfrac)$	(otherwise)

$price\_put = price\_call - spot * exp(logfor * yearfrac) + strike * exp(lograte * yearfrac)$

$delta\_put = N(d1) - 1$	(if underlying = stock)
$(N(d1) - 1) * exp(logfor * yearfrac)$	(otherwise)

N(x) is the value of the cumulative distribution function for standard distribution at x.

European Barrier Options (OTC)

Use

European barrier buy (call) and sell (put) options are valuated using the Rubinstein Procedure. Four situations can occur:

- Up & In
- Up & Out
- Down & In
- Down & Out

In addition, a rebate can be paid. This is a fixed amount which is paid based on reaching or not reaching the barrier when the option is not exercised. For an Up & Out option, a fixed amount is paid as soon as the price reaches or exceeds the Up & Out point. For a Down & In, a fixed amount is paid if the price does not reach the *in point* before the option expires.

Prerequisites/Calculating the Input Parameters

The price calculator for European barrier options has the following parameters:

- Term: Remaining option term in days
- Domrate: Interest rate_1 in percent
- Forrate: Interest rate_2 in percent
- Rebate: Rebate amount
- Rebate sign: +/- sign of the rebate
- Spot: Spot amount
- Strike: Strike
- Barrier: Barrier
- Cat UL: Category of the underlying
- Vola: Volatility
- In/Out: Indicator whether category in/out
- Up/Down: Indicator whether upper/lower barrier
- Put/call: Indicator whether call or put option

Features / Valuation

If the expiration date of the option is reached, the internal value of the option (rebate amount) is shown.

For an unexpired option, the option price is calculated as follows:

lograte = log(1 + opt_domestic_rate / 100).

logforeign = log(1 + opt_foreign_rate / 100).

European Barrier Options (OTC)

yearfrac = opt_days / 365.

dom_disc = exp(lograte * -1 * yearfrac).

for_disc = exp(logforeign * -1 * yearfrac).

adjvola = opt_vola / 100.

volaroot = adjvola * sqrt(yearfrac).

lambda = (lograte - logforeign + ($adjvola^2$ / 2)) / $adjvola^2$).

eta = -1 for up options

eta = 1 for down options

phi = -1 for puts

phi = 1 for calls

N(x) = standard distribution of x

resign = + for positive rebates

+ for negative rebates

The prices of the barrier options are consist of 6 summands:

res1:

ex = phi * ((log(spot / strike) / volaroot) +
(lambda * volaroot)).

ex2 = ex - (phi * volaroot).

res1 = phi * spot * for_disc * N(ex) -
phi * strike * dom_disc * N(ex2).

res2:

ex = phi * ((log(spot / barrier) / volaroot) +
(lambda * volaroot)).

ex2 = ex - (phi * volaroot).

res2 = phi * spot * for_disc * N(ex) -
phi * strike * dom_disc * N(ex2)

res3:

yps = eta * ((log($barrier^2$ / spot / strike) /
volaroot) + (lambda * volaroot)).

yps2 = yps - (eta * volaroot).

```
res3 = phi * spot * for_disc *
    exp( log( barrier / spot) * 2 * lambda) * N(yps) -
    phi * strike * dom_disc *
    exp( log( barrier / spot) * ( 2 * lambda - 2)) * N(yps2)
```

res4:

```
yps = eta * ( ( log( barrier / spot  /
        volaroot) + ( lambda * volaroot)).
yps2 = yps - ( eta * volaroot).
res3 = phi * spot * for_disc *
    exp( log( barrier / spot) * 2 * lambda) * N(yps) -
    phi * strike * dom_disc *
    exp( log( barrier / spot) * ( 2 * lambda - 2)) * N(yps2)
```

res5 (Rebate summand for *in options*):

```
ex1 = eta * ( ( log( spot / barrier) /
        volaroot) + ( ( lambda - 1) * volaroot)).
yps1 = eta * ( ( log( barrier / spot) /
        volaroot) + ( ( lambda - 1) * volaroot)).
if resign = '-'.
  res5 = -1 * rebate * dom_disc * ( N(ex1) -
   exp( log( barrier / spot) * ( 2 * lambda - 2)) * N(yps1)).
else.
  res5 = rebate * dom_disc * ( N(ex1) -
   exp( log( barrier / spot) * ( 2 * lambda - 2)) * N(yps1)).
endif.
```

res6 (Rebate summand for *out options*):

This component is the same as a one-touch option (see the documentation for one-touch options)

Runtime > 0

24 constellations have to be differentiated between for this valuation:

In - Option

Up - Option

Put (**Up&In Put**)

Spot < Barrier

Strike >= Barrier

Price = res1 - res2 + res4 + res5

Strike < Barrier

Price = res3 + res5

Spot > Barrier

Standard option, as already knocked

Call (**Up&In Call**)

Spot < Barrier

Strike >= Barrier

Price = res1 + res5

Strike < Barrier

Price = res2 - res3 + res4 + res5

Spot > Barrier

Standard option, as already knocked

Down - Option

Put (**Down&In Put**)

Spot > Barrier

Strike >= Barrier

Price = res2 - res3 + res4 + res5

Strike < Barrier

Price = res1 + res5

Spot < Barrier

Standard option, as already knocked

Call (**Down&In Call**)

Spot > Barrier

Strike >= Barrier

Price = res3 + res5

Strike < Barrier

Price = res1 - res2 + res4 + res5

Spot < Barrier

Standard option, as already knocked

Out - Option

Up - Option

Put (**Up&Out Put**)

Spot < Barrier

Strike >= Barrier

Price = res2 - res4 + res6

Strike < Barrier

Price = res1 - res3 + res6

Spot > Barrier

Price = res6

Call (**Up&Out Call**)

Spot < Barrier

Strike >= Barrier

Price = res6

Strike < Barrier

Price = res1 - res2 + res3 - res4 + res6

Spot > Barrier

Price = res6

Down - Option

Put (**Down&Out Put**)

Spot > Barrier

Strike >= Barrier

Price = res1 - res2 + res3 - res4 + res6

Strike < Barrier

Price = res6

Spot < Barrier

Price = res6

Call (**Down&Out Call**)

Spot > Barrier

Strike >= Barrier

Price = res1 - res3 + res6

Strike < Barrier

Price = res2 - res4 + res6

Spot < Barrier

Price = res6

American Standard Options (OTC)

Use

American standard options are valuated using the binomial procedure.

Prerequisites/Calculating the Input Parameters

The price calculator for American standard options has the following parameters:

- Term: Remaining option term in days
- Domrate: Interest rate_1 in percent
- Forrate: Interest rate_2 in percent
- Spot: Spot amount
- Strike: Strike amount
- Steps: Number of steps in binomial tree
- Cat UL: Category of the underlying
- Vola: Volatility
- Put/call: Indicator whether call or put option

Features / Valuation

If the expiration date of the option is reached, the internal value of the option (difference between spot and strike) is used.

For a positive value for an option, the option price is calculated as follows:

Starting from the root node and working backwards, the exercise value and the holding value of each option is calculated for each node. The greater of the two prices is the option price for each node. The node value is the sum of the previous node values weighted with the probability of occurrence.

lograte = log(1 + domestic_rate / 100).

logforeign = log(1 + foreign_rate / 100).

d_time = days / 365 / steps. " time in years per step

disc = 1 / exp(lograte * d_time).

up = exp(vola * sqrt(d_time) / 100).

uplog = log(up).

down = 1 / up

ha = exp((lograte - logforeign) * d_time).

prob = (ha - down) / (up - down).

Holding value$_{ij}$ = (Price of largest predecessor * probability of upward movement + price of smaller predecessor * probability of downward movement) * discounting factor for a unit of time

$= (P_{i+1,j} * prob + P_{i+1,j+1} * (1 - prob)) * disc.$

exercise value$_{ij}$ = price of underlying at time period i - Strike

= spot * exp(uplog * (2 * i - j)) - strike

P_{ij} = Max(exercise value$_{ij}$ | holding value$_{ij}$)

P_{01} = price of the option

The price of an American option is calculated as the average value of the price with the prespecified number of time units and the price for one unit more. It has been determined that the price for an even number of time units and the price for an uneven number of time units converge on the correct price from above and below (respectively).

Caps (OTC)

Use

The market price calculator for caps calculates current market values. It also calculates market values and time values for a future point in time (horizon).

A cap contains a number of ways to guard against a reference interest rate R_k from increasing above a fixed value R_x (strike). If the cap's term begin comes before the horizon, the cap contains an existing fixed-interest transaction on the horizon. The value of the reference interest rate R_k is set at fixed intervals of length τ (e.g. every six months). If at time point $k\tau$ the value of the reference interest rate R_k is above the agreed upon interest rate R_x, the buyer of the cap is paid the difference at time point $(k + 1)\ \tau$.

Generally for caps with

- R_x: Cap rate
- L: Nominal value
- Z: interest payments at time points τ, 2τ, …, $n\tau$,

it is the case that the seller of the cap has to make the following payment at time point $(k+1)\tau$:

$$\tau L \max(R_k - R_x,\ 0)$$

Assuming that F_k is the forward rate for the time frame between $k\tau$ and $(k+1)\tau$, and that interest rates R_x, R_k and F_k are all expressly related to compounding frequency τ, you can assume an approximation of F_k as the discount rate for the time frame between $k\tau$ and $(k + 1)\tau$. This would mean that the above described payment at time point $(k+t)\tau$ is equivalent to the payment of

$$\frac{\tau L}{1 + F_k} \max(R_k - R_x, 0)$$

at time point $K\tau$. The advantage to this way of looking at things is that it allows every caplet to be viewed as a call on a τ-periodic interest rate, where payment is made when the option expires and not a period later. The nominal value of the underlying for every option is:

$$\frac{\tau L}{1 + \tau F_k}$$

Integration/Calculation Basis

To valuate a cap or an individual caplets, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date.

In addition, a yield curve also has to be specified for calculating the forward rates F_k. If the term begin of the cap related to the evaluation day is in the past, then interest rate Rf for the fixing has to be specified for the current caplet. If this interest rate is not available, the value of the interest rate is set to 0.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the observed reference interest rate Rk.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

To valuate a cap or an individual caplets, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date.

In addition, a yield curve also has to be specified for calculating the forward rates F_k. If the term begin of the cap related to the evaluation day is in the past, then interest rate Rf for the fixing has to be specified for the current caplet. If this interest rate is not available, the value of the interest rate is set to 0.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the observed reference interest rate Rk.

Prerequisites/Calculating the Input Parameters

First, the cap is reduced to the individual caplets which expire after the horizon.

Zero bond interest rates and zero bond discounting facts are calculated from the yield curve of the transaction currency to later determine risk-free interest rates (the ones used in option price formulae for individual caplets), and to determine the discounting factors of the current caplet on the horizon.

The spot rate is calculated for each caplet, and later flows into the option price formula. To calculate the spot, the forward rate F_k of the agreed-upon reference interest rate R_k is calculated in the forward calculator. The run-up period is the time up to the beginning of the individual caplet (the term of the option).

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

For each caplet whose term begin comes after the horizon, the option price calculator for pricing European options (Black-Scholes formula) is called up with the following parameters:

- Call/put: Call
- Term: Term to the beginning of the caplets (is the term of the corresponding option) in days (beginning of the caplet - horizon)
- Spot: see input parameters
- Strike: Comparative interest rate R_x in cap
- Interest rate 1: 0 (no currency option)
- Interest rate 1: Risk-free interest rate = zero bond interest rate from the specified yield curve (calculated with the zero coupon method), where the term corresponds to the option term.
- Volatility: Interest volatility of reference interest rate R_k from the volatility curve with term equal to that of the caplet.

Caps (OTC)

The result is simulated. It is the NPV on the horizon of the difference (DZ) between the reference interest rate R_k an the strike R_x on the date the option expires (i.e. at the start of the caplet).

The NPV of the caplet (in transaction currency) is then the DZ multiplied by the nominal volume.

We end up with the following formula:

$$NPV(caplet(i)) = B\frac{DZ}{100} * \frac{\tau L}{1 + \tau F_k}$$

with:

B: Buy/sell indicator

The NPV of the caplet current on the horizon is also calculated (in transaction currency). If the term begin of the caplet comes before the evaluation day, the NPV of interest difference (minimum = 0) from the fixed interest rate and the cap rate is calculated on the horizon (using transaction currency of current caplet), and multiplied with the nominal volume (NV) and compounding frequency (t). If the term start of the caplet comes after the evaluation date, the forward rate F_k will be calculated from the reference interest rate R_k using the forward calculator. The NPV of interest difference (minimum = 0) between the calculated forward rate F_k and the cap rate is calculated on the horizon (using transaction currency of current caplet), and multiplied with the nominal volume (NV) and compounding frequency (t).

We end up with the following formula:

- If the term begin of the caplet < evaluation date:

$$NPV(caplet(current)) = K * BW(\max(R_f - R_x, 0)) * NV * t$$

- If the term begin of the caplet > evaluation date:

$$NPV(caplet(current)) = K * BW(\max(F_k - R_x, 0)) * NV * t$$

with:

B: Buy/sell indicator

The NPV of the cap is then the sum of the NPVs of the individual caplets. We end up with the following formula:

$$NPV = \sum_{i=1}^{n} NPV(caplet(i)) + NPV(caplet(current))$$

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Floors (OTC)

Use

The market price calculator for floors calculates current market values. It also calculates market values and time values for a future point in time (horizon).

A floor contains a number of ways to guard against a reference interest rate R_x from falling below a fixed value R_x (strike). If the floor's term begin comes before the horizon, it contains an existing fixed-interest transaction on the horizon. The value of the reference interest rate R_k is set at fixed intervals of length τ (e.g. every six months). If at time point $k\tau$ the value of the reference interest rate R_k is below the agreed upon interest rate R_x, the buyer of the cap is paid the difference at time point $(k + 1)\ \tau$.

Generally for floors where

- R_x: Floor rate
- L: Nominal value
- Z: interest payments at time points τ, 2τ, …, $n\tau$,

it is the case that the seller of the floor has to make the following payment at time point $(k+1)\tau$:

$$\tau L \max(R_k - R_x,\ 0)$$

Assuming that F_k is the forward rate for the time frame between $k\tau$ and $(k+1)\tau$, and that interest rates R_x, R_k and F_k are all expressly related to compounding frequency τ, you can assume an approximation of F_k as the discount rate for the time frame between $k\tau$ and $(k + 1)\tau$. This would mean that the above described payment at time point $(k+t)\tau$ is equivalent to the payment of

$$\frac{\tau L}{1 + F_k} \max(R_k - R_x, 0)$$

at time point $K\tau$. The advantage to this way of looking at things is that it allows every floorlet to be viewed as a call on a τ-periodic interest rate, where payment is made when the option expires and not a period later. The nominal value of the underlying for every option is:

$$\frac{\tau L}{1 + \tau F_k}$$

Integration/Calculation Basis

To valuate a floor or an individual floorlets, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition, a yield curve also has to be specified for calculating the forward rates F_k. If the term begin of the floor related to the evaluation day is in the past, then interest rate Rf for the fixing has to be specified for the current floorlet. If this interest rate is not available, the value of the interest rate is set to 0.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the observed reference interest rate Rk.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

To valuate a floor or an individual floorlets, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition, a yield curve also has to be specified for calculating the forward rates F_k. If the term begin of the floor related to the evaluation day is in the past, then interest rate Rf for the fixing has to be specified for the current floorlet. If this interest rate is not available, the value of the interest rate is set to 0.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the observed reference interest rate Rk.

Prerequisites/Calculating the Input Parameters

First, the floor is reduced to the individual floorlets which expire after the horizon.

Zero bond interest rates and zero bond discounting facts are calculated from the yield curve of the transaction currency to later determine risk-free interest rates (the ones used in option price formulae for individual floorlet), and to determine the discounting factors of the current floorlet on the horizon.

The spot rate is calculated for each floorlet, and later flows into the option price formula.

The forward rate F_k of the agreed-upon reference interest rate R_k is calculated in the forward calculator.

The run-up period is the time up to the beginning of the individual floorlet (the term of the option).

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

For each floorlet whose term begin comes after the horizon, the option price calculator for pricing European options (Black-Scholes formula) is called up with the following parameters:

- Call/put: Call
- Term: Term to the beginning of the caplets (is the term of the corresponding option) in days (beginning of the caplet - horizon)
- Spot: see input parameters
- Strike: Comparative interest rate R_x in cap
- Interest rate 1: 0 (no currency option)
- Interest rate 2: risk-free = zero bond interest rate of the given yield curve structure with term equal to the beginning of the floorlet.
- Volatility: Interest volatility of reference interest rate R_k from the volatility curve with term equal to that of the caplet.

The following procedure is used to calculate the option value:

The result is simulated. It is the NPV on the horizon of the difference (DZ) between the reference interest rate R_k an the strike R_x on the date the option expires (i.e. at the start of the floorlet).

The NPV of the floorlet (in transaction currency) is then the DZ multiplied by the nominal volume.

We end up with the following formula:

$$BW\left(Floorlet(i)\right) = K\frac{DZ}{100} * \frac{\tau L}{1+\tau F_k}$$

with:

B: Buy/sell indicator

The NPV of the floorlet current on the horizon is also calculated (in transaction currency). If the term begin of the floorlet comes before the evaluation day, the NPV of interest difference (minimum = 0) from the fixed interest rate and the floor rate is calculated on the horizon (using transaction currency of current floorlet), and multiplied with the nominal volume (NV) and compounding frequency (t). If the term start of the floorlet comes after the evaluation date, the forward rate F_k will be calculated from the reference interest rate R_k using the forward calculator. The NPV of interest difference (minimum = 0) between the calculated forward rate F_k and the floor rate is calculated on the horizon (using transaction currency of current floorlet), and multiplied with the nominal volume (NV) and compounding frequency (t).

We end up with the following formula:

- If the term begin of the floorlet < evaluation date:

$$BW\left(Floorlet(current)\right) = K * BW\left(\max\left(R_{\mathrm{f}} - R_x, 0\right)\right) * NV * t$$

- If the term begin of the floorlet > evaluation date:

$$BW\left(Floorlet(current)\right) = K * BW\left(\max\left(R_x - F_{\mathrm{k}}, 0\right)\right) * NV * t$$

with:

B: Buy/sell indicator

The NPV of the floor is then the sum of the NPVs of the individual floorlets. We end up with the following formula:

$$NPV = \sum_{i=1}^{n} NPV\left(floorlet(i)\right) + NPV\left(floorlet(current)\right)$$

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Swaps (OTC)

Use

The market price calculator for swaps calculates current market values. It also calculates market values and time values for a future point in time (horizon).

Swaps are agreements for swapping fixed and/or variable interest rates. The system allows you to map the individual variations of almost all forms of swap. Besides interest swaps (one transaction currency), you can represent currency swaps and cross-currency interest rate swaps (two transaction currencies). A capital swap can be processed at the beginning and/or end of the term. Flexible condition items allow you to structure interest rate agreements as you wish. In addition to fixed-rate payer and receiver swaps (swap of fixed for floating rate), you can also process basis swaps (floating rate swap). You can also create amortization and step-up swaps. Floating interest rate spreads and the interest payment frequency are flexible.

Integration / Calculation Basis

To value a swap, you need to enter transaction data and either a par coupon or zero coupon yield curve in the transaction currencies (bid or ask rates) for the evaluation date. In addition to the yield curves necessary to discount a generated cash flow, you may also have to specify yield curves for calculating forward rates for variable interest payments (see Input Parameters).

If the display currency differs from the transaction currency (currencies) of the swap, you will need the relevant exchange rate (bid or ask rate). If the horizon comes after the evaluation date and a transaction currency differs from the display currency, then you have to enter a par coupon or zero coupon yield curve in the display currency (bid or ask rates) to calculate the forward exchange rate for the horizon.

Prerequisites / Calculating the Input Parameters

- *Treasury Management* automatically generates cash flows for each side of a swap when a swap is created. The cash flow consists of interest payments and principal payments which fall on certain dates. If the interest rate is fixed, the amount of the interest payment is known. In the case of floating interest rates, only the reference interest rate is known.
- Zero bond discounting factors are needed to discount the cash flows.
- If the display currency differs from the transaction currency (currencies) of the swap, the system uses the exchange rate on the horizon (bid or ask rate) to translate the transaction currency into the display currency. If the horizon comes after the evaluation date, the system calculates the corresponding forward exchange rate (bid or ask rate) at the horizon on the basis of the exchange rate on the evaluation date using the yield curves for the transaction and display currencies.

Features / Valuation

First, the entire cash flow is reduced to the payments due after the horizon. The forward reference interest rates are then calculated for swaps with variable interest payments (on one or both sides). The resulting interest payments are included in the cash flow, which only contains payments with set amounts and payment dates.

If the first payment flow after the horizon is not fixed when you run the valuation, and the corresponding fixing run was due before the evaluation date, the system assumes that the first cash flow for the variable side is zero ('0') and enters zero in the detail log under the fixed cash flows.

Depending on the calculation routine (par or zero coupon method), the NPVs of the individual cash flows (each side) at the horizon are calculated using the yield curves for the transaction currencies. The value of both sides of the swap (in the transaction currencies) is then the sum of the NPVs of the cash flows from both sides. The NPV of the swap in display currency is the difference between the display currency values of both sides of the swap (translated into display currency using (forward) exchange rates (bid or ask)).

The following definitions apply:

- t_i: Due dates of the cash flows
- C_i: Cash flow of the receiver side of the swap at date t_i, i=1,..n
- D_i: Cash flow of the payer side of the swap at date t_i, i=1,..m
- $PV(C_i / D_i)$: Present value of the cash flow C_i or D_i due on t_i at the horizon
- TC (RS): Transaction currency of the receiver side of the swap
- TC (PS): Transaction currency of the payer side of the swap
- DC: Display currency
- BR(TC(RS);DC): (Forward) bid exchange rate TC (RS) / DC at horizon
- AR(TC(PS);DC): (Forward) ask exchange rate TC (PS) / DC at horizon
- NPV: Net present value

$$NPV = \sum_{i-1}^{n} PV(C_i) * BR(TC(RS);DC) - \sum_{i-1}^{m} PV(D_i) * AR(TC(PS);DC)$$

Swaptions (OTC)

Use

The market price calculator for swaptions calculates current market values. It also calculates market values and time values for a future point in time (horizon).

A swaption, depending on the underlying transaction, is usually an option on an interest rate swap with a purely fixed side and a purely floating side. It comes in the varieties call and put. Currently, only the European type can be processed. Under the conditions for a European swap, the buyer has the right to make a swap on a given date. Only swaptions will be valuated whose expiration comes after the horizon.

To valuate a swaption, the swap is divided into a fixed-rate bond (fixed side) and a floating-rate bond (floating side). The swaption is then valuated like an option on the fixed-rate side with a strike of 1 using the option price formula from Black (for European type). The price volatility of the fixed side of the swap is approximated from the interest volatility using the duration and the yield.

Underlying:

Currently, it is only possible to use an interest rate swap with a purely fixed side and a purely floating side as the underlying security. You can have a swap as an underlying with the charateristics fixed rate payer and fixed rate receiver swaps.

Integration/Calculation Basis

To valuate a swaption, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the reference interest rate from the yield curve (set up in the evaluation type) whose term is closest to the term of the fixed side of the swap.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

Depending on the calculation routine, the following input parameters are calculated for later use in determining the risk-free interest rate and for calculating the spot (both go into the option price formula).

- Zero coupon rates and zero bond discounting factors
- **Spot**:

  The spot is the NPV (on the horizon) of the absolute price (standardized to nominal volume) of the fixed side of the swap at expiration. *Treasury Management* automatically generates a cash flow for the fixed side of the swap when it is created. The cash flow consists of interest payments and principal payments which fall on certain dates. Both the due dates and amounts of the individual cash flows is known. Depending on the calculation method (par or zero coupon method), the NPVs of the individual cash flows are calculated on the horizon using the yield curves corresponding to the transaction currency of the fixed side. The value of the money market transaction (in transaction currency) is then the sum of the NPVs of the cash flows.

Note the following definitions:

– t_i: Expected cash flow dates

– C_i: Cash flow at time t_i

– $NPV(C_i)$: NPV of the cash flow on the horizon, due in t_i

– NV: Nominal volume of swap

$$Spot = \left[\sum_{i=1}^{n} \frac{NPV(C_i)}{NV} \right]$$

- **Volatility**:

  The interest volatility is calculated from the interest volatility curve according to the difference between the term of the option and the horizon (possibly linearly interpolated). Then, using the modified duration (related to interest and principal cash flows from the fixed side of the forward swap) and the forward zero yield for the term of the swap (calculated from given zero bond discounting factors), the interest volatility is converted to a price volatility by the price volatility calculator.

- **Call/put indicator**:

  If the swap in the underlying transaction of the swaption is a fixed-rate receiver swap, the swaption can be viewed as a call on the fixed side of the swap. The call/put indicator is set to call. If the swap in the underlying transaction of the swaption is a fixed-rate payer swap, the swaption can be viewed as a put on the fixed side of the swap. The call/put indicator is set to put.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

The option price calculator for pricing European options (Black-Scholes formula) is called up with the following parameters:

- Call/put: see input parameters
- Term: Term of the option in days (expiration of the option - horizon)
- Spot: see input parameters
- Strike: 1 (the value of the variable side of the swap approximating the nominal volume)
- Interest rate 1: 0 (no currency option)
- Interest rate 2: risk-free interest rate = zero interest rate of the given yield curve term which is the same as the option term.
- Volatility: see input parameters

The NPV of the swaption (in transaction currency) is the interest difference (DZ) multiplied by the nominal volume (NV).

Swaptions (OTC)

We end up with the following formula:

$$NPV = B * NV * DZ$$

with:

B: Buy/sell indicator

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Forward Rate Agreements (OTC)

Use

The market price calculator for forward rate agreements calculates current market values. It also calculates market values and time values for a future point in time (horizon).

A forward rate agreement is an agreement to secure against rising (call) or falling (put) interest rates by fixing an interest rate for a period of time in the future. This interest rate is compared to a reference interest rate R_k (e.g. LIBOR) when the FRA is fixed.

A settlement payment is due on the settlement date (beginning for the interest rate hedge period). The settlement payment is NPV of *X* on the settlement date, where *X* is the product of the nominal amount and the difference between the contracted FRA rate and the value of the reference interest rate on the fixing date.

The NPV of the FRA is then the NPV of the settlement payment on the horizon if the horizon comes before the settlement date, or zero, if the horizon comes after the settlement date.

Integration/Calculation Basis

Depending on the time relationship between the horizon and the evaluation date, the following parameters need to be specified:

1. **Evaluation date <= horizon < fixing date < settlement date or evaluation date < fixing date < horizon < settlement date**

   To valuate, you need to enter transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition to the yield curve necessary to discount a generated cash flow, you may also have to specify a yield curve for calculating forward rates for floating interest payments (see Input Parameters).

2. **Fixing date < evaluation date <= horizon < settlement date**

   To valuate, you need to enter transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. The interest rate R_f (fixing for the reference interest rate) also has to be specified. If this interest rate is not available, the value of the interest rate is set to 0.

3. **Fixing date < settlement date < horizon**

   No entries necessary.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

Depending on the time relationship between the horizon and the evaluation date, the following parameters are used in the valuation:

1. **Evaluation date <= horizon < fixing date < settlement date or evaluation date < fixing date < horizon < settlement date**

Treasury Management automatically generates a cash flow for you when an FRA is created. The cash flow consists of both interest payments which come at the end of the term of the FRA. If the interest rate is fixed, the amount of the interest payments is known. If the interest rate is floating, only the reference interest rate is known.

2. **Fixing date < evaluation date <= horizon < settlement date**

   Treasury Management automatically generates a cash flow for you when an FRA is created. The cash flow consists of both interest payments which come at the end of the term of the FRA.

3. **Fixing date < settlement data < horizon**

   No other parameters flow into the valuation.

Zero bond discounting factors are needed to discount cash flows.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

Depending on the time relationship between the horizon and the evaluation date, the NPV of the FRA is calculated as follows:

1. **Evaluation date <= horizon < fixing date < settlement date or evaluation date < fixing date < horizon < settlement date**

   First, the forward reference interest rate is calculated. The resulting interest payment is placed into the cash flow, which only contains payments whose amount and time are set. Depending on the calculation routine (par or zero coupon method), the NPVs of the cash flows (from each side) are calculated (in transaction currency) on the settlement date (see Input Parameters). The value of the settlement payment (in transaction currency) is then the difference between the NPVs of the two cash flows.

   Note the following definitions:

   C: Cash flow resulting from the interest rate fixed in the FRA

   D: Cash flow resulting from the forward reference interest rate

   NPV(C/D): The NPV of the cash flow C/D on the settlement date

   K: Long/short indicator

   SP: Settlement payment

   $$SP = K * (NPV(C) - NPV(D))$$

   The NPV of the FRA is then the NPV of the settlement payment on the horizon (depending on calculation method - par or coupon).

   If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

2. **Fixing date < evaluation date <= horizon < settlement date**

   In this case, the cash flow only contains flows whose amount and time of payment are fixed. Depending on the calculation routine (par or zero coupon method), the NPVs of the cash flows (from each side) are calculated (in transaction currency) on the settlement date (see Input Parameters). The value of the settlement payment (in transaction currency) is then the difference between the NPVs of the two cash flows.

Note the following definitions:

C: Cash flow resulting from the interest rate fixed in the FRA

D: Cash flow resulting from the fixed forward reference interest rate

NPV(C/D): The NPV of the cash flow C/D on the end of the waiting period.

B: Long/short indicator

SP: Settlement payment

$$SP = B * \left(NPV\left(C\right) - NPV\left(D\right)\right)$$

The NPV of the FRA is then the NPV of the settlement payment on the horizon (depending on calculation method - par or coupon).

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

3. **Fixing date < settlement date < horizon**

The NPV of the forward rate agreements is 0.

Interest Rate Guarantees (OTC)

Use

The market price calculator for interest rate guarantees calculates current market values. It also calculates market values and time values for a future point in time (horizon).

IRGs are options on forward rate agreements. They come in the call and put varieties. You can create both the European and the American type of IRG. In an IRG, the buyer has the right to take up an FRA on a particular date (European type), or at any time up to a certain date (American type). If the horizon comes after the end of the option term (perhaps on the fixing date), no valuation of the IRG takes place.

In the valuation, the fixed interest rate R_f of the FRA is seen as the strike for the option. The IRG is regarded as an option on a forward interest rate R_x (with term fixed in FRA) with a strike price of fixed interest rate R_f (set in FRA). The user must specify a volatility.

European IRGs are valuated using the Black formula. American IRGs are valuated using a binomial tree (with 30 and 31 periods).

Underlying:

You can set up the FRA in the underlying any way you'd like, but only "classic IRGs" can be valuated. That is where the fixing date of the FRA in the underlying comes before or on the expiration date. The option always ends on the fixing date of the reference interest rate of the FRA.

Calculation basis:

To valuate a swaption, you need to enter the transaction data and either a par coupon or zero coupon yield curve in the transaction currency (bid or ask rate) for the evaluation date. In addition, a yield curve also has to be specified for calculating the forward rates.

You will also need an interest rate volatility curve for the option terms. The specified reference interest rate is the observed reference interest rate R_x.

If the display currency differs from that of the transaction currency, you will need the relevant exchange rate. If the horizon comes after the evaluation date and the transaction currency differs from the display currency, then you have to enter a parcoupon or zero coupon yield curve so that the forward exchange rate can be calculated for the horizon.

Prerequisites/Calculating the Input Parameters

Zero interest rates and zero bond discounting factors are calculated from the transaction currency yield curve to be used later for determining risk-free interest rates and discounting factors.

The spot rate is also determined for later use in the option price formula. The forward rate of the agreed-upon reference interest rate R_k is calculated by the forward calculator.

If the display currency differs from that of the transaction currency, the exchange rate on the horizon is used to convert from the transaction currency into the display currency. If the horizon comes after the evaluation date, the forward exchange rate will be calculated from the exchange rate on the evaluation date using the yield curves from the transaction and display currencies.

Features / Valuation

Depending on the exercise type, the option price calculator for European options (Black-Scholes formula) or the option price calculator for American options (binomial tree) is called up with the following parameters:

- Call/put: Call/put
- Term: Term of the option in days (expiration of the option - horizon)
- Spot: see input parameters
- Strike: Comparative interest rate fixed in FRA of underlying
- Interest rate 1: 0 (no currency option)
- Interest rate 2: risk-free interest rate = zero interest rate of the given yield curve which has the same term as the option.
- Volatility: Interest volatility of forward interest rate for R_x from the volatility curve with term same as option term
- NPV: Net present value

The result is simulated. It is the NPV on the horizon of the difference (DZ) between the forward rate of the reference interest rate R_x of the FRA and the strike on the date the option expires.

The NPV of the IRG is the interest difference (DZ) multiplied by the term (T) of the reference interest rate Rx (in years) and the nominal volume (NV).

We end up with the following formula:

$$NPV = B\frac{DZ}{100}NV * T$$

with:

B: Buy/sell indicator

If the display currency differs from the transaction currency, the NPV is converted using the (forward) exchange rate.

Function Modules

Accrued Interest

Use

The accrued interest calculator calculates accrued interest for existing interest flows on a particular evaluation date.

Features

The accrued interest calculator uses linear interpolation to make its calculations.

Calc. Cumulative Dist. Fnct. for Stnd. Norm. Dist.

Features

The value N(x) of the cumulative distribution function for a normal distribution at point x is approximated as follows:

$$N(x) = \begin{cases} 1 & , if \quad x > 10 \\ y * k_2 * \exp(-0,5x^2) * \left(\left(\left(\left(k_3 * y - k_4 \right) y + k_5 \right) y - k_6 \right) y + k_7 \right) & , if \quad 0 \leq x \leq 10 \\ 1 - N(-x) & , if \quad x < 0 \end{cases}$$

with:

$$y = \frac{1}{1 + k_1 * |x|}$$
$$k_1 = 0.2316419$$
$$k_2 = 0.39894228$$
$$k_3 = 1.33027443$$
$$k_4 = 1.82125598$$
$$k_5 = 1.78147794$$
$$k_6 = 0.35656378$$
$$k_7 = 0.31938153$$

Convexity Adjustment

Use

For interest transactions with variable components (swaps, caps, floors, floating rate notes) where the term of the interest rate reference differs from that of the period for which the calculated rate is to be applied, it is necessary to make a correction in calculating the relevant forward rate. An example of this type of transaction is a constant maturity swap (for example, a swap which pays a fixed rate every six months against the rate of a 10 year bond).

Prerequisites/Calculating the Input Parameters

Input parameters:

- Current date
- Evaluation date
- Fixing date, date interest rate is set
- Reference interest rate name
- Uncorrected forward interest rate
- Term of the reference interest rate in days
- Volatility to be used for adjustment (volatility of the reference interest rate for time from valuation to fixing - can be left empty, in which case it will be filled by the system)

Features / Valuation

To calculate the adjustment, you calculate the convexity and modified duration of a bond with the same term as the reference interest rate.

First, the term of the reference interest rate is determined in years.

Then, a fictitious bond with the same term and annual interest payments in the amount of the forward rates is generated.

Difference quotients are used on this to calculate the modified duration and convexity.

The adjustment is then calculated using the following formula:

$$Adjusted\ Rate = \frac{Forward\ Rate - 0.5 * Forward\ Rate^2 * Vola^2 * Term * Convexity}{1{,}000{,}000 * Duration}$$