Liquidity Management and Cash flow/Earning at Risk

1. Introduction

This document describes the Liquidity Management application, as well as the calculation of Cash flow/Earnings at Risk of liquidity plans, via multi-dimensional Monte Carlo simulations. The application is implemented in the C# language using .Net environment and operates on the database‘s data model.

A number of .Net modules ensure the required functionality:

- The database is accessed via a COM interface, which activates one IOS instance during each usage and ensures the reading and writing of data from .Net applications, via a C# wrapper. All database types, that are supported by IOS, are also supported by the Liquidity Management application.
- Tabular and graphical outputs are created using the new Component Studio One module for .Net.
- Reports from the .Net application are generated via a .Net interface from the Crystal Reporter. Reports that are usually run from C++ applications can also be generated from this .Net application.
- Internal data management and communication with the database are based on .Net record sets, as well as on tree structures, using XMLDOM.

Functionalities Cash flow and Earnings at Risk have been implemented as an extension of the Liquidity Management application.

1.1. Strategic Liquidity Management

Strategic liquidity management is an essential part of ALM, as the planning and management of future cash flows can have a decisive effect on the stability of the company. Strategic liquidity management takes into consideration the long-term liquidity of a company and evaluates possible, unexpected, and in many cases, unfavorable developments of business conditions and their effect on the company‘s solvency.

1.1.1. The Concept of Liquidity

Liquidity is defined as the availability of credit or the securing of future credit, that is required in order to meet all payment obligations, on and off-balance sheet, at due date. Obligations are generally covered by payment receipts, by assets that can be converted into cash, or by taking out loans. Liquidity risk increases if expenditure and income do not correspond to one another over time.

1.1.1.1. Liquidity Management Objectives

Liquidity management is a fundamental component of the management of a safe and reliable company. A reliable liquidity management includes the targeted management of assets and liabilities which, based on the balance sheet, secures the necessary payment income that is in accordance with the payment expenses.

Liquidity management is supported by upstream liquidity planning that takes into account probable economic changes, as well as political, regulatory and other business conditions (internal or external) including market conditions. Liquidity planning is based on the analysis and identification of known, expected or potential outflows, and evaluates the company’s alternative business strategies in order to ensure that adequate incoming payments (inflows) are available to cover the outgoing payments.

The objectives of liquidity management are:

- Timely payment of all payment obligations, on and off balance sheet;
- Avoidance of financing costs for shortfalls, which can arise through, for example, financing on the money market at market conditions or through the compulsory sale of assets;
- Compliance with regulatory liquidity requirements.

Despite the differences in liquidity management, businesses require an effective liquidity management program that is based on the nature and complexity of their business operations and risk profiles:

- Establishing and implementing reliable and targeted policies for liquidity management, and
- Developing and implementing effective technologies and procedures for monitoring, measuring and controlling the company‘s liquidity requirements and liquidity positions.

1.1.2. Liqudity Policy

A reliable liquidity policy defines liquidity sources and volumes that are necessary for the continuation of business operations and is in compliance with applicable regulatory liquidity requirements. Liquidity policy mainly concerns strategic liquidity management and is supported by effective procedures for measuring, attaining and maintaining liquidity.

Due to the long-term nature of insurance business, strategic liquidity management must take into account long-term obligations. Liquidity policy considers future liquidity needs by taking into account current or future developments in the business environment, e.g.:

- Economic and market conditions;
- Regulatory legislation and political environment;
- Customer opinion on positive or negative developments in the industry and company;
- Steadfastness of the company and its ability to finance itself if necessary;
- Strategies for managing assets and liabilities;
- Design of products, as well as of productive and administrative processes, and
- Concentration of risk.

Liquidity policy should focus on the company's ability to be steadfast when it comes to payment requests. The company‘s steadfastness can be achieved by securing liquid assets that are sufficient to cover potential payment shortfalls in the event of unfavorable conditions. Liquidity policy must ensure that the liquidity plan can be met in case of a liquidity risk. It must establish procedures for the financing and management of unexpected cash flow failures, where the financing at a particular time point is not possible or can be obtained on very unfavorable terms.

Liquid assets also include assets whose cash flows, even while taking losses, can easily be converted into cash. Obligations should also be checked for their liquidity properties. Some products can include payment privileges, customization options or settlement periods. The company's liquidity position, tested under various conditions, should be monitored regularly and reported to management.

1.1.3. Liquidity Management and Controlling

Every company should develop and apply effective and comprehensive procedures and information systems for managing and controlling liquidity, that is in accordance with their liquidity policies. Such procedures should match the volume and complexity of the business. Internal audits should examine

the following points:

- Ensuring compliance with liquidity policies and processes,
- Ensuring effective liquidity control, and
- Review the content and accuracy of management reports.

The assessment of liquidity management and procedures must be made available to the management on an ongoing basis.

1.2. Cash flow/Earning at Risk

Companies apply the principles of Value-at-Risk (VaR), which has primarily been developed for the management of market risk in the financial world and in corporate environments. Important aspects in the measurement process and management of corporate risks include: longer risk horizons, periodical risk assessments, definition of corporate equations to describe balancing and aggregation of balance sheet and plan items, modeling exposures for future periods and evaluating risks against plan or budget specifications. Market risks periodically include the calculation of cash flows (Cash flow at Risk - CfaR) and earnings of plan item performances (Earning at Risk - EaR). Evaluation of CfaR/EaR is based on stochastic market models (simulation markets) with a distinctive "mean reversion" characteristic, which can be simulated using the Monte Carlo method.

- **Market and Business Risk:**

The management of risks in a corporate environments is more complex than in financial environments. The reason for that is that companies, on the one hand, have to deal with market risks that can be hedged (goods, currencies, interest rates, etc.), but on the other hand they deal with business risks that cannot be hedged (when implementing specific products or services). The management of business risk implies the integration of risk measurements into planning and budgeting processes.

- **Financial Results and Company Value:**

Financial managers (portfolio managers, treasurers) measure the values of assets and liabilities and their short-term changes at the valuation point. In contrast, managers of companies are more likely to measure periodic financial results – such as cash flows and income, as well as their changes and volatility – and thus show performance indicators and contributions to the company value.

- **Short- and Long-term Risk Management:**

As opposed to financial institutions, that can bear risks for short periods of time in order to produce trading profits, companies have to plan long-term and bear risks for longer periods (monthly, quarterly).

- **Application of CfaR/EaR in Financial Institutions:**

The simulation and measurement of CfaR/EaR are of great importance to financial institutions that take on long-term risks. This primarily includes credit institutions that take on long-term credit risks and are exposed to their effects. The periodical evaluation of CfaR/EaR can be used as a natural extension of common ALM analyzes – Cash Flow Analysis, Interest Income Analysis, Maturity Transformation, etc. – as these analyzes include periodical calculation of average amounts of for cash flows, interests, incomes and contributions.

Economic Benefits of CfaR and EaR

The economic benefits of CfaR and EaR can be viewed at the following application levels: operational,

management, supervision. Some benefits include:

- Increase in risk transparency and risk limitation

  The effect of market volatility on financial results must ensure a better representation of economic risks within the organization and should lead to the establishment of systems for risk limitation for CfaR and EaR.

- Communication and standardization of risk measures

  Applying CfaR and EaR as risk measures improves the communication between business unites, management, senior management, board of directors, shareholders, rating agencies, and regulatory bodies.

- Hedging, capital allocation and performance evaluation

  The integration of risk and income analysis leads to the establishment of effective hedging strategies, capital allocation and optimization of risk performances.

2. Definition of Liquidity Plans

2.1. Example of a Liquidity Plan

Liquidity plans include a periodic presentation of cash flows and balance sheet developments along the time axis, that are hierarchically aggregated according to balance sheet items. An example of a liquidity plan for three historical and three forecasted periods is given in the table below. Historical periods belong to the actual data, while future periods belong to plan data. Items from A. Financial assets and B. Financial liabilities represent balance sheet developments that are aggregated to item C. Financial status.

		Actual data			Planned data		
	Year	2004	2004	2004	2004	2004	2004
	Month	2	3	4	5	6	7
	I. Loans from banks (short-term)	100.000	130.000	140.000	160.000	110.000	70.000
	II. Group loans	20.000	30.000	40.000	50.000	50.000	30.000
	III. Other loans	5.000	10.000	10.000	10.000	0	10.000
A	**FINANCIAL ASSETS (I.+II.+III.)**	125.000	170.000	190.000	220.000	160.000	110.000
	I. Liabilities to banks (short-term)	-250.000	-206.000	-106.000	-96.000	-116.000	-126.000
	II. Group liabilities	-10.000	-10.000	-10.000	0	-10.000	-10.000
B	**FINANCIAL LIABILITIES (I.+II.)**	-260.000	-216.000	-116.000	-96.000	-126.000	-136.000
C	**FINANCIAL STATUS (A+B)**	-135.000	-46.000	74.000	124.000	34.000	-26.000
	I. Customer payments (incl. VAT)	250.000	200.000	100.000	150.000	50.000	100.000
	II. Group incoming payments (incl. VAT)	50.000	20.000	0	0	10.000	10.000
D	**OPERATING INCOMING PAYMENTS (I.+II.)**	300.000	220.000	100.000	150.000	60.000	110.000
	I. Supplier payments (incl. VAT)	-200.000	-100.000	-50.000	-200.000	-100.000	-50.000
	II. Group output payments (incl. VAT)	-50.000	0	0	-20.000	-10.000	0
E	**OPERATING OUTPUT PAYMENTS (I.+II.)**	-250.000	-100.000	-50.000	-220.000	-110.000	-50.000
F	**OPERATING UNDER-/OVER-COVERAGE (D.+E.)**	50.000	120.000	50.000	-70.000	-50.000	60.000
	I. Divestments	50.000	0	0	0	0	0
	II. Received dividends /Other inputs	0	0	0	0	0	0
G	**NON-OPERATING INCOMING PAYMENTS (I.+II.)**	50.000	0	0	0	0	0
	I. Investments	-10.000	0	0	-20.000	-10.000	-10.000
	II. Paid dividends/Other outputs	-1.000	0	0	0	0	0
H	**NON-OPERATING OUTPUT PAYMENTS (I.+II.)**	-11.000	0	0	-20.000	-10.000	-10.000
I	**NON-OPERATING UNDER-/OVER-COVERAGE (G.+H.)**	39.000	0	0	-20.000	-10.000	-10.000
J	**TOTAL UNDER-/OVER-COVERAGE (F.+I.)**	89.000	120.000	50.000	-90.000	-60.000	50.000
K	**FINANCIAL STATUS (C.+J.)**	-46.000	74.000	124.000	34.000	-26.000	24.000
	I. Bank balances => A I.	-30.000	-10.000	-20.000	50.000	40.000	-60.000
	II. Group loans => A II.	-10.000	-10.000	-10.000	0	20.000	-10.000
	III. Other loans => A III.	-5.000	0	0	10.000	-10.000	10.000
	IV. Liabilities to banks => B I.	-44.000	-100.000	-10.000	20.000	10.000	-10.000
	V. Group liabilities => B II.	0	0	-10.000	10.000	0	20.000
L	**FINANCIAL MEASURES (I.+II.+III.+IV.+V.)**	-89.000	-120.000	-50.000	90.000	60.000	-50.000
	I. Unavailable financial assets	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
	II. Available credit lines in total	100.000	100.000	150.000	100.000	50.000	50.000
	III. Current usage of credit lines	-35.000	-35.000	-50.000	-50.000	-50.000	-50.000
M	**AVAILABLE LIQUIDITY RESERVES (I.+II.+III.)**	64.000	64.000	99.000	49.000	-1.000	-1.000
N	**TOTAL AVAILABLE LIQUIDITY (A-L I.-L II.-L III.+M)**	**234.000**	**254.000**	**319.000**	**209.000**	**109.000**	**169.000**

2.1.1. Liquidity Management Requirements

The requirements of Liquidity management can be derived from experience of liquidity planning and liquidity management, as well as from the example considered in the previous section:

- Balance sheet structures should be freely definable and stored with an ID and time stamp. They represent tree-like, hierarchical constructions and include basis items that can be

hierarchically aggregated into item groups. A balance sheet structure can contain several dependent or independent item hierarchies. Balance sheet structures can be copied.

- The aggregation of balance sheet values can be performed automatically, by using the balance sheet hierarchy, or explicitly, via aggregation formulas. Aggregation formulas contain arithmetic expressions with brackets and functions for sum, mean and if statements. Balance sheet items represent operands in the formulas, where operands from different plan periods (with an absolute or relative index) can occur. An identifier for plan periods can be used in the formulas for period navigation.

- Liquidity plans represent instances of balance sheet structures that inherit balance sheet hierarchies and contain periodic development of balance sheet values (cash flows or balances) for each balance sheet item. A periodic development can be freely defined by determining the start and end date, and frequency. Liquidity plans can be copied and saved with a time stamp. They can also be added and/or subtracted, which enables plans from subsidiaries to be aggregated into group plans, or plan differences to be formed when analyzing scenarios.

- The storage of balance sheet structures and liquidity plans is in compliance with user rights regarding creating, changing, confirming and deleting. These operations are historized in the database under a time stamp.

- Cash flow sources for base items can originate from reports, transactions or from manual entries. On the start date of the liquidity planning, starting balances are specified manually or are taken from accounts. Cash flows or account balances are taken from position compositions. Positions for each base item can be defined statically via a position list, or dynamically using queries.

- Liquidity plans are displayed as tables in the browser. Browser rows correspond to the balance sheet structure and can be extended and narrowed using the tree-shaped balance sheet structure. It is possible to display aggregation results along the time axis along with period differences (absolute and in %), as well as scroll the browser vertically and horizontally.

- Liquidity plans can also be displayed graphically. 2D and 3D charts show plan developments over time, on a period basis.

- Liquidity plan reports can be generated from the database using Crystal Reporter standard reports. Context-dependent reporting enables the reporting of individual plans or entire plan groups from the balance sheet structure. Liquidity plans can be copied to the clipboard and exported to CSV files.

- Liquidity plans can be calculated using scenarios, which can be created or generated using scenario plans.

3. Liquidiy Management Structure

3.1. Hierarchical Representation of Balances

In the Liquidity Management application, balance sheet items are arranged hierarchically into tree-shaped structures (see Figure 1). This creates basis positions or balance sheet items that represent leaves on the tree-shaped structures (e.g. balance sheet items A1.credits at banks, A2.groups or L2.groups → A2). Such balance sheet items receive cash flows from various configurable sources: positions, transactions, balances from accounts or manually entered data. Data that is added manually can also be inserted via clipboard.

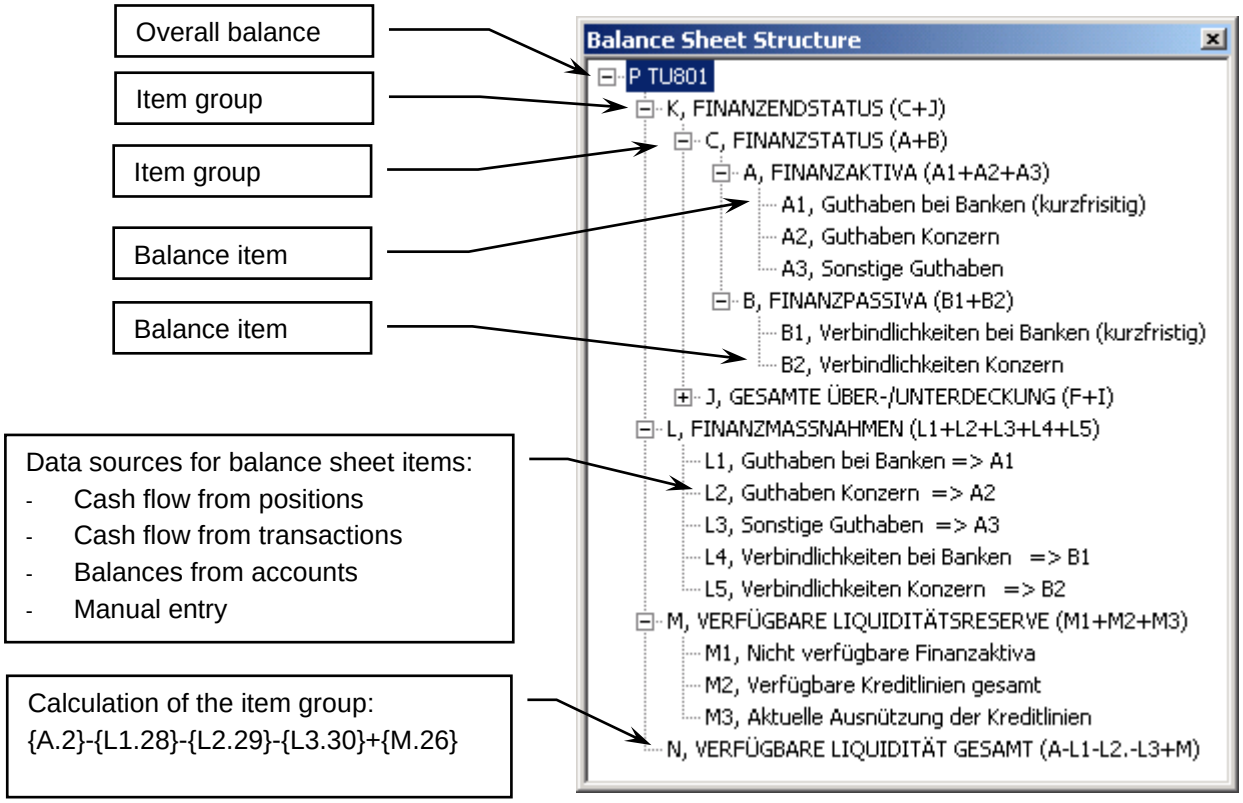


Figure 1: Hierarchical presentation of balance sheet structures

Balance sheet items from higher levels of the tree structure create hierarchical item groups (see K.Financial status (C+J) or C.Financial status (A+B) in Figure 1). The item group data for each time period is calculated from subordinate basis items or item groups, using calculation formulas. In the simplest case, calculation formulas consist of sums or differences. For example, item group A. Financial assets (A1 + A2 + A3) results from the sum of basis items A1, A2 and A3. Other items can be defined outside the item hierarchy, accessing data of items within the overall balance sheet via the valuation formulas. Item N, total available liquidity (A1-L1-L2-L3 + M), which is actually defined as a basis item, results from the arithmetic formula A1 - L1 - L2 - L3 + M, that accesses item values from the balance sheet tree (see Figure 1).

3.2. Organizational Structure of Balance Sheets and Plans

Balance sheets are illustrated using balance sheet structures, where cash flow data sources are being assigned to the lowest node in the structure. Calculation formulas are used for the aggregation of balance sheet items.

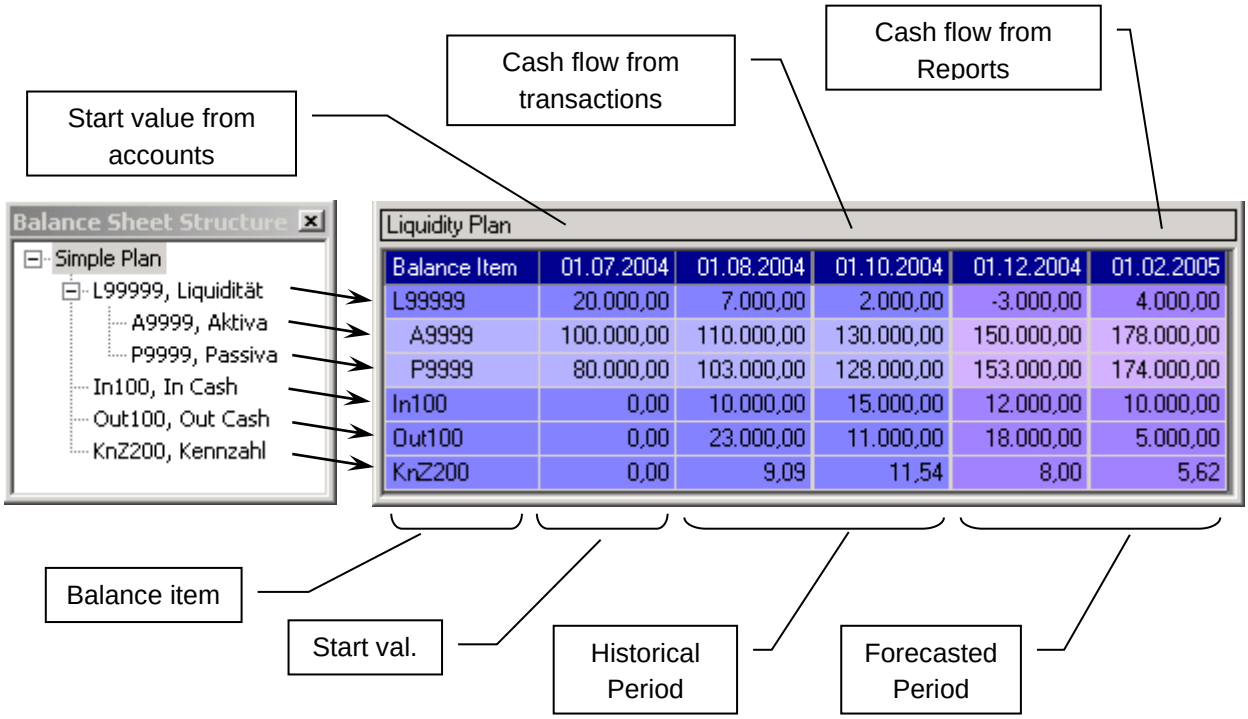


Figure 2: Allocation of balance sheet items and planning rows

A liquidity plans represents balance sheet entities with a periodic development (see Figure 2). In the liquidity plan, a row is assigned to each balance sheet item. As a result, some rows become basic rows and require cash flow sources or manual entries (e.g. the rows In100 and Out100). Other rows correspond to item groups and are calculated using calculation formulas (e.g. A9999, assets or L9999, liquidity). Certain calculation formulas access data from the same column (e.g. line L9999, liquidity results from the difference between rows A9999, assets and P9999, liabilities), while others can take data from other columns (e.g. from the previous period).

Periodical developments can be divided into three segments (see Figure 2):

- Start value (Start balance): Start values represent cumulative results from the past history and can be inserted manually or taken from accounts.
- Historical periods: Historical periods contain data of actual historical liquidity developments; such data can be taken from transactions or entered manually.
- Forecasted periods: The aim of liquidity planning and liquidity management is a well-balanced development over time; planned cash flows for financial items can be taken from reports or entered manually.

4. Operating the Liquidity Management

4.1. User Log In

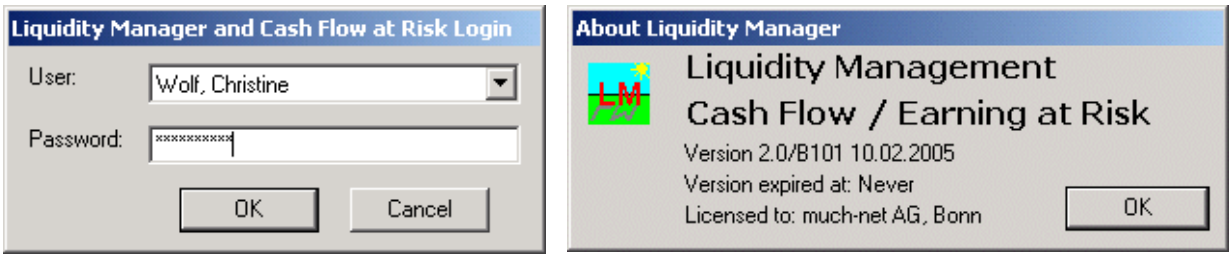


Figure 3: User log-in and application information dialogue

Figure 3. shows the Liquidity Management information dialogue with the user login, that includes user name and password. The application interprets the licenses and user rights. User rights imply the possibility of creating, modifying, confirming and deleting balance sheet structures and liquidity plans per time stamp. The deleting can ensue physically or logically. In the case of the logical deletion, the data are only stated as deleted, but do remain in the data base.

4.1.1. Balance Sheet Structures and Liquidity Plans

The liquidity management application is comprised of menu items in the menu bar, menu items in context-dependent pop-up menus and buttons in context-dependent bars. The context-dependent pop-up menus and buttons require that elements – such as nodes in the tree-shaped structures or rows in the browser – are being selected in an active window. The menus and buttons are then individualized for each selected element. To open a pop-up menu, one must position the mouse in an active window and press its left button. The mouse pointer will display the desired element.

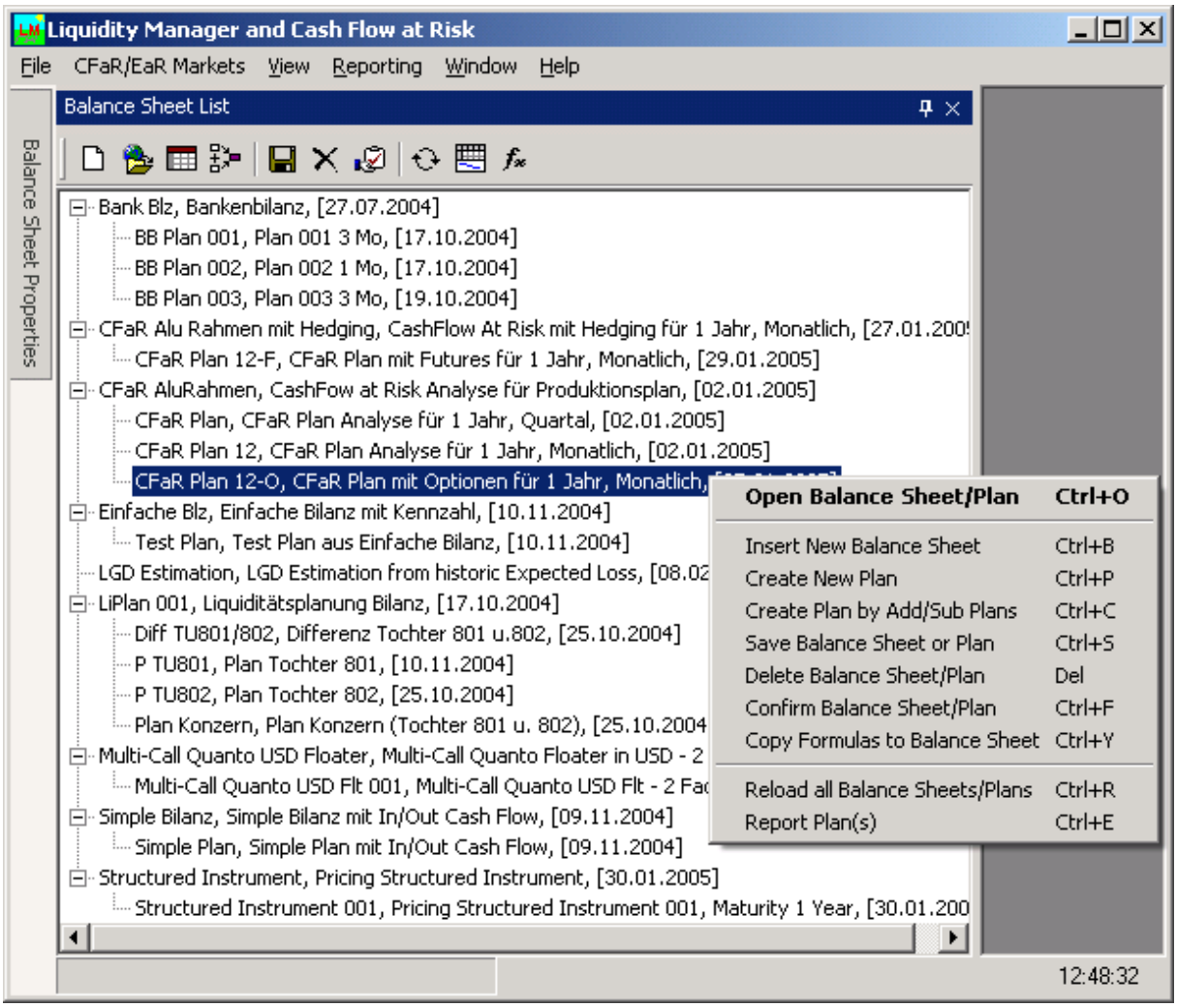


Figure 4: List of balance sheet structures and liquidity plans

Description of the menu items in the window Liquidity management application (see Figure 4) are shown in the table below:

Button, Menu Item	Description
File	Menu Item: File
Cash Flow Type	Opens a browser for the specification of cash flow and transaction types per instrument. Such information is required in order to extract cash flows from positions and transactions, as well as balances from accounts for liquidity management.
Exit	Closes the Liquidity Management application
CfaR/EaR Markets	Menu Item: Cash flow/Earnings at Risk
Define Market	Definition of simulation markets and risk variables (risk factors); assignment of risk variables to simulation markets; definition of historical time series from the database, as data sources for risk variables.
Volatility and Correlation	Calculation of daily volatilities and correlations of historical time series for 1 year for risk variables of a simulation market. Daily volatility and correlation are required in the Monte Carlo simulation for the construction of the “Volatility Bridge”.

Button, Menu Item	Description
Forecasted Value and Volatility	Definition of performance and volatility of risk variables for a simulation market for future time periods. Auto- and cross-correlation of risk variables is calculated via a Monte Carlo simulation, using historical data, as well as future performance and volatility.
View	Menu Item: View
Balance Sheet List	Opens the window with the balance sheet tree, for the management of balance sheet structures and liquidity plans, if it was previously closed.
Balance Sheet Properties	Opens the window with the properties of balance sheet structures and liquidity plans, if it was previously closed.
Balance Sheet Structure	Opens the window where balance sheet structure is defined and cash flow sources are assigned to balance sheet items, if it was previously closed.
Balance Item Properties	Opens the window for balance item properties, if it was previously closed.
Liquidity Chart	Opens the window for liquidity plan charts, if it was previously closed.
Status Bar	Turns the application status bar on or off
Reporting	Menu Item: Reporting
Show Report	Liquidity plan reports for all balance sheet structures in the application, that are stored in the database.
Window	Menu Item: Window All windows for balance sheet structures and liquidity plans that are opened are entered as submenu items. These windows can then be activated via submenu items.
Help	Menu Item: Help
Help	Opens the Help file for the liquidity management application
About	Open the Information dialogue for the liquidity management application

The following table contains the description of context-dependent buttons and corresponding context-dependent pop-up menu items in the window Management of Balance Sheet Structures and Liquidity Plans (see Figure 4):

Button, Menu Item	Description
Open Balance Sheet/Plan	Opens a previously selected balance sheet structure from the tree, or a previously selected liquidity plan. “View” rights are required for this operation.
Insert New Balance Sheet	Inserts a new balance sheet structure or copies one from an existing balance sheet structure. “Add” rights are required for this operation.
Create New Plan	Creates a new liquidity plan based on the balance sheet structure that has been previously selected from the tree, or cops from an existing liquidity plan within the same balance sheet structure. “Add” rights are required for this operation.
Create Plan by Add/Sub Plans	Creates a new liquidity plan based on a previously selected balance sheet structure from the tree. The new liquidity plan is calculated using sums and/or differences of other plans in the selected balance sheet structure. “Add” rights are required for this operation.

Button, Menu Item	Description
Save Balance Sheet or Plan	Stores a balance sheet structure or a liquidity plan, that has previously been selected in the tree, into a data base. “Update” rights are required for this operation.
Delete Balance Sheet/Plan	Deletes a balance sheet structure with all its associated liquidity plans – that has previously been selected in the tree – from the database. It also deletes all selected liquidity plans from the data base. The deleting is either logical (marked as deleted) or physical (removed from the database), depending on the user rights. “Remove” rights are required for logical removal, while “exclusive” rights are required for physical removal.
Confirm Balance Sheet/Plan	A balance sheet structure or plan are confirmed. This balance sheet structure or plan can then no longer be modified. “Confirm” rights are required for this operation.
Copy Formulas to Balance Sheet	All formulas of a plan are transferred into the superordinate balance sheet structure.
Reload all Balance Sheets/Plans	Reloads all balance sheet structures and their associated liquidity plans from the database. Changes that have not be saved are ignored.
Report Plan(s)	Reports of balance sheet structures or liquidity plans that have previously been selected in the tree. The reporting includes only liquidity plans that are stored in the database.

To navigate the tree-shaped balance sheet structure, one uses the left mouse button on the tree branch marked with “+” or “-” to open and close the branch. In this way, a balance sheet structure can be expanded to display subordinate liquidity plans.

The first step in creating a liquidity plan is defining a new balance sheet structure. It is possible to create balance sheet structures from existing balance sheet structure templates by copying them, with or without transferring assigned cash flow sources (see Figure 5). By pressing the menu option Open Balance Sheet/Plan, one can define balance sheet items, their hierarchy and cash flow sources (see Figure 10).

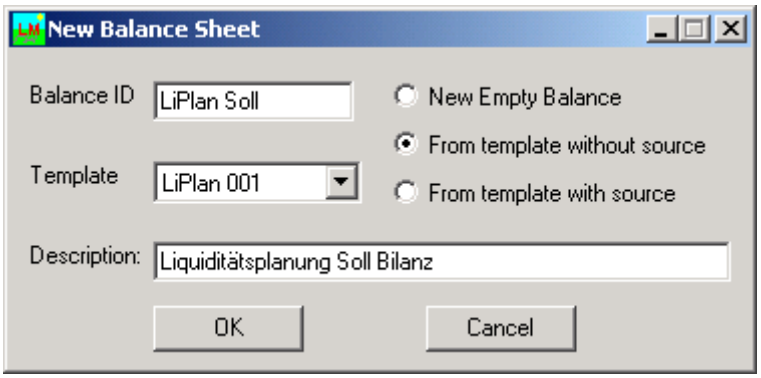


Figure 5: Definition of a Balance Sheet Structure

Descriptions of the fields and buttons in the window Definition of a Balance Sheet Structure (see Figure 5) are shown in the table below:

Field, Button	Description
Balance ID	Unique ID of the balance sheet structure (up to 30 characters)
Template	Uses an existing balance sheet structure as the model for a new one

Field, Button	Description
Description	Description of the balance sheet structure (up to 50 characters)
New Empty Balance	Creates a new balance sheet structure
From template without source	Creates a balance sheet structure from a set of templates without cash flow sources; creates a copy of an existing balance sheet structure
From template with source	Creates a balance sheet structure from a set of templates with cash flow sources; creates a copy of an existing balance sheet structure
OK	Closes the window and confirms the definition of the balance sheet structure
Cancel	Closes the window without defining the balance sheet structure

The second essential step in creating liquidity plans is the definition of a new liquidity plan. It is possible to create liquidity plans from existing liquidity plan templates by copying them (see Figure 5). By pressing the menu option Open Balance Sheet/Plan, one can view the definition of parameters and plan periods (see Figure 19).

Figure 6: Definition of a Liquidity Plan

Descriptions of the fields and buttons in the window Definition of a Liquidity Plan (see Figure 6) are shown in the table below:

Field, Button	Description
Plan ID	Unique ID of the liquidity plan (up to 30 characters)
Template	Uses an existing liquidity plan as a model for the new one
Description	Description of the liquidity plan (up to 50 characters)
New Plan	Creates a new liquidity plan
From Template	Creates a liquidity plan from a set of templates; creates a copy of an existing liquidity plan
OK	Closes the window and confirms the creation of the liquidity plan
Cancel	Closes the window without creating the liquidity plan

Every plan can be constructed from existing plans within the same balance sheet, by using plan operations (addition and subtraction). For example:

- The sum of all plans of a subsidiary company results in a group plan.
- The difference between plans is used for the comparison of plans between subsidiary companies, or between different scenarios.

- In the illustration below (see Figure 7), the total plan represents the difference between the group plan and the plan of the subsidiary P TU801 of 19.10.2004.

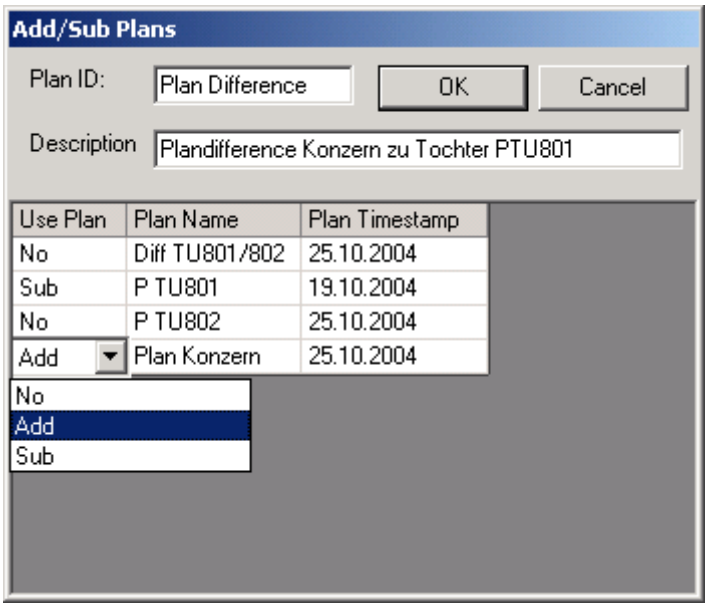


Figure 7: Definition of Plan Operations

Descriptions of the fields and buttons in the window Definition of Plan Operations (see Figure 7) are shown in the table below:

Field, Button	Description
Plan ID	Unique ID of the new liquidity plan (up to 30 characters)
Description	Description of the new liquidity plan (up to 50 characters)
Browser columns for plan operations	
Use Plan	Selects plan operations: No: no consideration, Add: add plan, Sub: subtract plan
Plan Name	Unique plan ID
Plan Timestamp	Timestamp of the plan
OK	Closes the window and confirms the definition of the liquidity plan
Cancel	Closes the window without creating the liquidity plan

4.1.2. Balance Sheet and Liquidity Plan Properties

Each balance sheet structure has its own properties. Important properties (see Figure 8) represent automatically supported data for the historization, that conform to the corresponding user rights (Date and User ID for creating, modifying, confirming and deleting balance sheet structures).

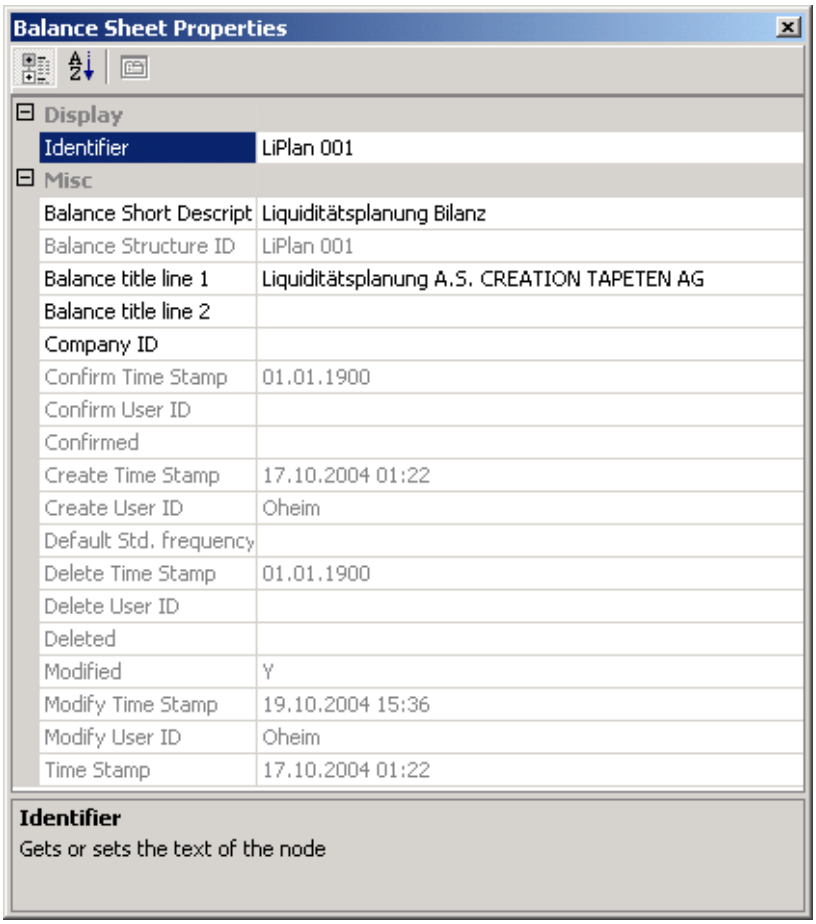


Figure 8: Balance Sheet Structure Properties

Descriptions of the fields within the window Balance Sheet Structure Properties (see Figure 8) are shown in the table below:

Feld	Description
Identifier	Unique ID of the balance sheet structure (up to 30 characters)
Balance Short Description	Description of the balance sheet structure (up to 50 characters), editable
Balance Structure Id	Unique ID of the balance sheet structure (up to 30 characters), editable
Balance title line 1	Extended description 1 (100 characters) of the balance sheet structure, can be displayed when reporting, editable
Balance title line 2	Extended description 2 (100 characters) of the balance sheet structure, can be displayed when reporting, editable
Company Id	Unique ID of the company (partner), selection from a list available
Created, Create User, Create Time Stamp	Creates the balance sheet structure: Status (Y/N), User ID, Date of creation
Modified, Modify User, Modify Time Stamp	Modifies the balance sheet structure: Status (Y/N), User ID, Date of modification
Confirmed, Confirm User, Confirm Time Satamp	Confirms the balance sheet structure: Status (Y/N), User ID, Date of confirmation
Deleted, Delete User, Delete Time Stamp	Deletes the balance sheet structure: Status (Y/N), User ID, Date of deletion

Feld	Description
Default Std. Frequency	Standard frequency of the plan structure, inherited from the balance sheet structure when creating liquidity plans
Time Stamp	Time stamp of the last saved liquidity plan

Each liquidity plan has its own properties (see Figure 9), and has the same automatically supported data for historization as has the balance sheet structure (Date and User ID for creating, changing, confirming and deleting balance sheet structures).

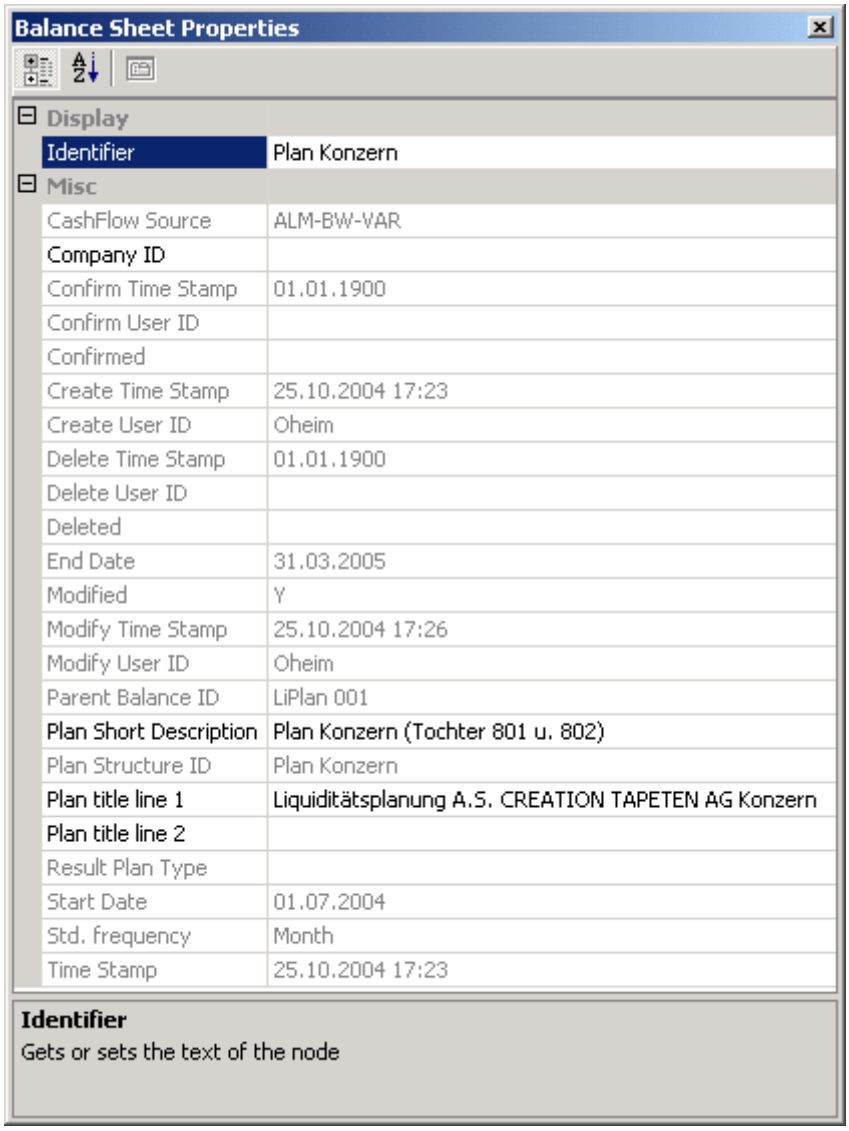


Figure 9: Liquity Plan Properties

Descriptions of the fields within the window Liquidity Plan Properties (see Figure 9) are shown in the table below:

Field	Description
Identifier	Unique ID of the liquidity plan (up to 30 characters)
Plan Short Description	Description of the liquidity plan (up to 50 characters), editable
Plan Structure Id	Unique ID of the liquidity plan (up to 30 characters)

Field	Description
Plan title line 1	Extended description 1 (100 characters) of the liquidity plan, can be displayed when reporting, can be editable
Plan title line 2	Extended description 2 (100 characters) of the liquidity plan, can be displayed when reporting, editable
Company ID	Unique ID of the company (partner), selection from a list is available
Parent Balance ID	Unique ID (up to 30 characters) of the superordinate balance sheet structure of the plan
Cash flow Source	Unique ID of the report from which the cash flows pour in into the liquidity plan
Result Plan Type	Not supported
Start Date	Start date of the liquidity plan
End Date	End date of the liquidity plan
Created, Create User, Create Time Stamp	Creates the liquidity plan: Status (Y/N), User ID, Date of creation
Modified, Modify User, Modify Time Stamp	Modifies the liquidity plan: Status (Y/N), User ID, Date of modification
Confirmed, Confirm User, Confirm Time Satamp	Confirms the liquidity plan: Status (Y/N), User ID, Date of confirmation
Deleted, Delete User, Delete Time Stamp	Deletes the liquidity plan: Status (Y/N), User ID, Date of deletion
Default Std. Frequency	Standard frequency of the plan structure
Time Stamp	Time stamp of the last saved liquidity plan

4.1.3. Definition of the Balance Sheet

The liquidity management application enables a freely definable balance sheet structure, that consist of hierarchically arranged basis items and groups. Multiple hierarchies can be defined within a balance sheet structure, although they must be attached to the start node (the balance sheet structure itself). Items are entered, deleted and moved within the tree structure using context-dependent pop-up menus and buttons (see Figure 10). Options Move Selected Row Up and Move Selected Row Down, that are located in the menu, enable the shifting of items. A shift along the entire hierarchy – e.g. inserting a new subtree at a higher level – is possible by using the option Drag&Drop and moving a selected element with the mouse. In this way, when creating a new balance sheet structure, items can first be inserted to the start node and afterwards arranged hierarchically using Drag&Drop

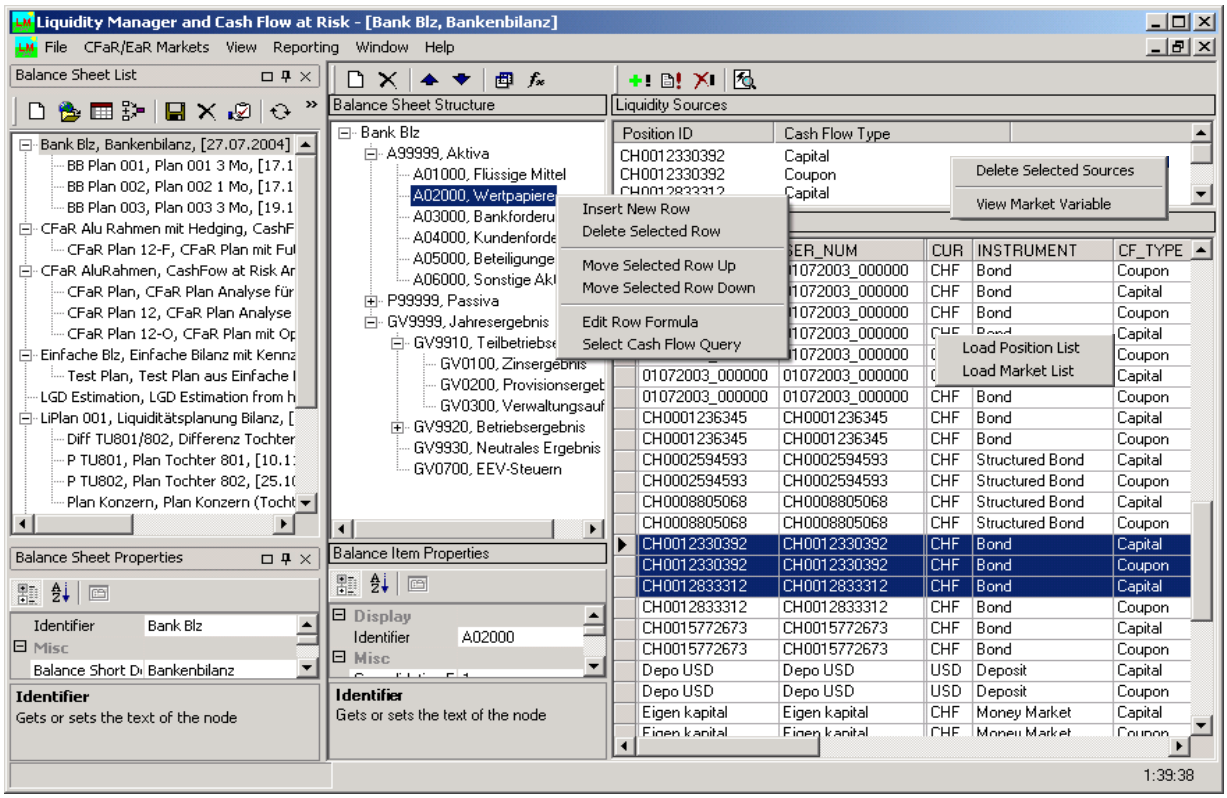


Figure 10: Definition of the structure and data delivery for the balance sheet structure

The following table contains the descriptions of buttons and their corresponding pop-up menu items in the window Definition of a Balance Sheet Structure, as well as fields in the browser Liquidity Source and Positions (see Figure 10):

Button, Menu Item	Description
Insert New Row	Inserts a new row (balance sheet item) that represents a subordinate row of the previously selected row (balance sheet item)
Delete Selected Row	Deletes a previously selected row (balance sheet item)
Move Selected Row Up	Moves the previously selected row (balance sheet item) up
Move Selected Row Down	Moves the previously selected row (balance sheet item) down
Edit Row Formula	Opens the window for the definition of row formulas for the previously selected row
Select Cash flow Query	Opens a browser for the selection of a dynamic item composition as a cash flow source for the previously selected row (balance sheet item)

Button, Menu Item	Description
Save Cash flow Sources	Stores all selected statistical positions that serve as cash flow sources for liquidity items
Delete Selected Sources	Deletes all previously selected static positions that serve as cash flow sources for liquidity items. The pop-up menu opens by pressing the left mouse button in the Liquidity Sources browser (see Figure 10)
Load Position List	Opens the browser for the selection of a report as a static source for cash flows. The pop-up menu opens by pressing the left mouse button in the browser Positions (see Figure 10)
Browser Liquidity Source	
Position ID	Unique ID of positions that serves as a static cash flow source for the balance sheet items
Cash flow Type	Cash flow type (Coupon: interest payment, amortization: capital payment)
Browser Positions	Browser fields correspond to position fields (see documentation)

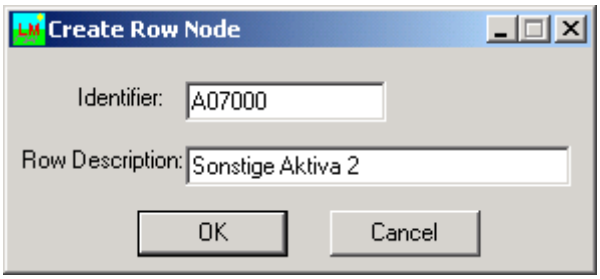


Figure 11: Definition of a new balance item

As illustrated in Figure 11, a new item is defined by choosing the option Insert New Row in the menu. The following table contains descriptions of the fields and buttons in the window Definition of a new Balance Sheet Structure (see Figure 11):

Field, Button	Description
Identifier	Unique ID (up to 30 characters) of the new row (balance sheet item)
Row Description	Description (up to 50 characters) of the new row (balance sheet item)
OK	Closes the window and confirms the definition of the new row (balance sheet item)
Cancel	Closes the mask without creating a new row

Each balance sheet item has specific properties (see Figure 12) that vary depending on its hierarchical position in the balance sheet structure tree. Important properties include data for cash flow sources (query ID for dynamic cash flow sources) for base items, as well as aggregation formulas (row formula), for group items or computable basic items. The Consolidation Factor (negative or positive decimal number) is used for the automatic aggregation of item values along the hierarchy structure. This means that the value of a parent item is calculated from the sum of the values of subsidiary items, weighted by the consolidation factor.

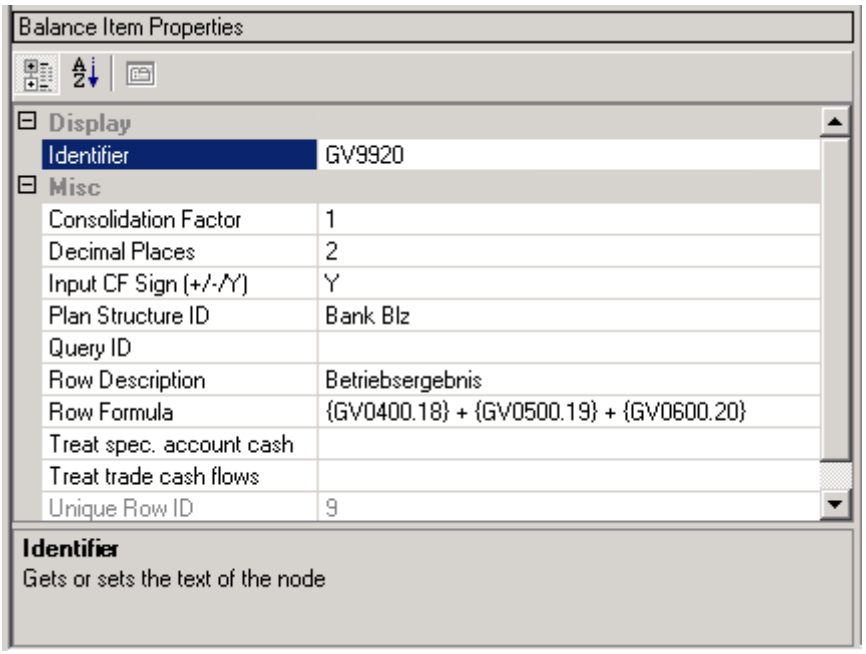


Figure 12: Balance sheet item properties

The following table contains the descriptions of the fields in the window Properties of Balance Sheet Items (see Figure 12):

Field	Description
Identifier	Unique ID of the liquidity plan (up to 30 characters)
Consolidation Factor	The factor with which each subordinate item, during the aggregation, is multiplied to the higher-level item without a calculation form
Decimal Places	The number of decimal positions after the comma when displaying numbers in the browser
Input CF Sign (+/-/Y)	Setting for the entering of numbers in the plan browser ("+" only positive numbers; "-" only negative numbers; "Y" positive or negative numbers)
Plan Structure ID	Unique ID of the balance sheet structure
Query Id	Unique ID of the query
Row Description	Description of the row (up to 50 characters), editable
Row Formula	Calculates the formula for the row (balance sheet position)
Treat spec. account cash	Not supported on a position basis
Treat trade Cash flow	Not supported on a position basis
Unique Row ID	Unique ID of the row (balance sheet position)

4.1.4. Cash Flow Sources

Statistical Cash Flow Sources

Cash flow sources for the lowest balance nodes (base items) in the tree structure can be periods from reports. The report is selected in the browser (see Figure 13) and items from the report are assigned to the lowest balance node. To achieve that, go to the Positions area, select the positions on the leftmost column and then use the Drag&Drop option to move them into the Liquidity Sources area (see Figure 10).

The window presented in Figure 13 is opened by positioning the mouse in the Position area, pressing the right mouse button to open the pop-up menu, and selecting the option Load Position from the list.

To completely or partly delete statistical cash flow sources, position the mouse in the area Liquidity source, press the right mouse button to open the pop-up menu and select the option Delete Selected Sources (see Figure 10). Item groups are selected using the standard Windows technique (Shift or Ctrl keys + left mouse button and mouse drag).

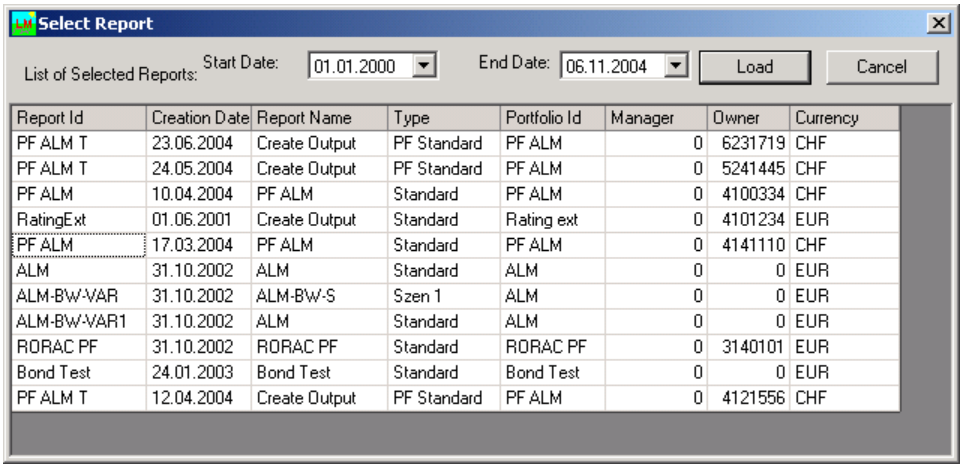


Figure 13: Selection of reports as a statistical source of cash flows

The following table contains the descriptions of buttons and fields in the window Selection of Reports (see Figure 13):

Field, Button	Description
Start Date	Start date of the filter for the selection of reports
End Date	End date of the filter for the selection of reports
Load	Loads the selected report
Cancel	Aborts the operation
Report Selection Browser	
Report ID	Unique ID of the report
Creation Date	Creation date of the report
Report Name	Description of the report
Type	Report type
Portfolio ID	Unique ID of the reported portfolio
Manager	Not supported
Owner	Owner of the report
Currency	Currency used in the report

Dynamic Cash Flow Sources

For the lowest balance nodes in the tree structure, cash flow sources can also be periods from items in the reports that are dynamically selected using query statements. For example, the portfolio PF ALM – from the below illustrated Query List Name (see Figure 14) – represents a query statement that is otherwise used for the loading of portfolios (use Select method).

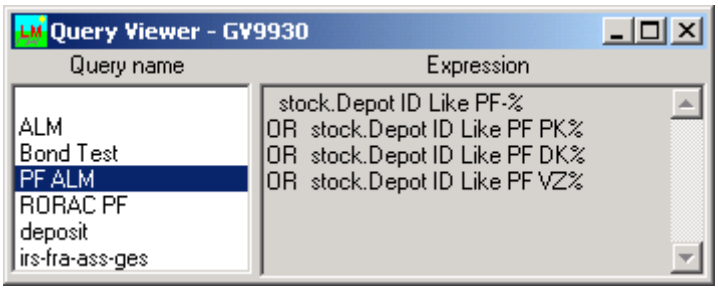


Figure 14: Selection of queries as the dynamical source of cash flows

The table below contains the description of fields in the window Selection of a Query (see Figure 14):

Field, Button	Description
Query Selection Browser	
Query Name	Unique ID of the query
Expression	Query expression
	A query is selected by positioning the mouse on an ID in the column Query Name and then double-clicking it. To delete it, double-click the empty line in the column Query Name (non-dynamic items as cash flow sources)

Cash Flow Input

If no static or dynamic cash flow sources are specified, the cash flow must be entered manually (see Figure 15). Cash flows can also be transferred by inserting a clipboard into the input line.

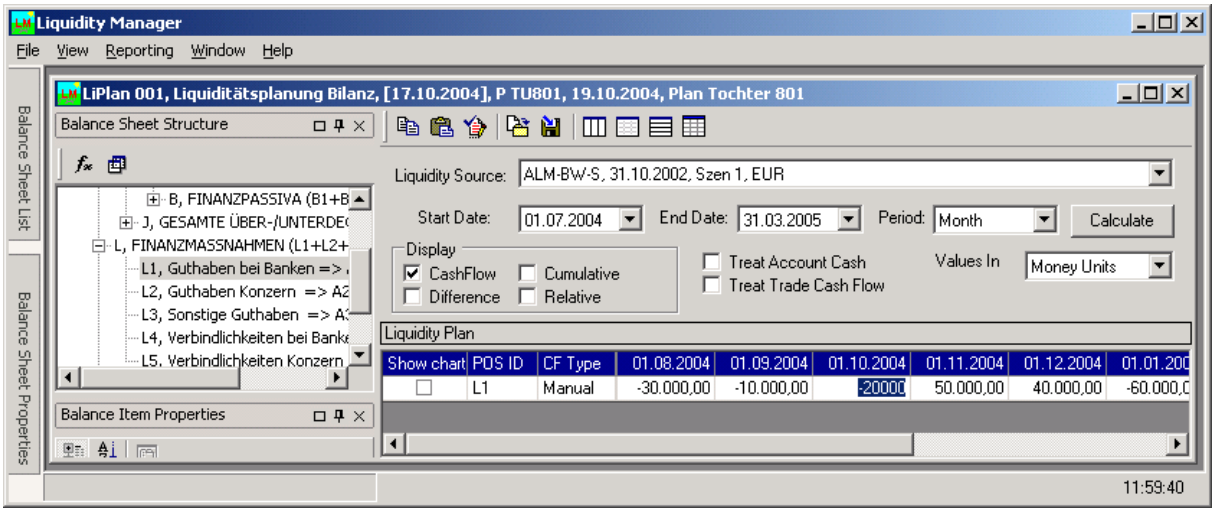


Figure 15: Manual input of cash flows for balance items L1

Definition of Cash Flow and Transaction Types

Access to cash flows from reports and transactions requires information about the cash flow and transaction types, which are specified and recorded in a nomenclature table (see Figure 16). In this way when assigning positions to balance sheet items, only the interest cash flows or only the capital cash flows, depending on the type of instrument, can be selected. When accessed, transaction types are searched for in transaction tables according to transaction type and to liquidity period.

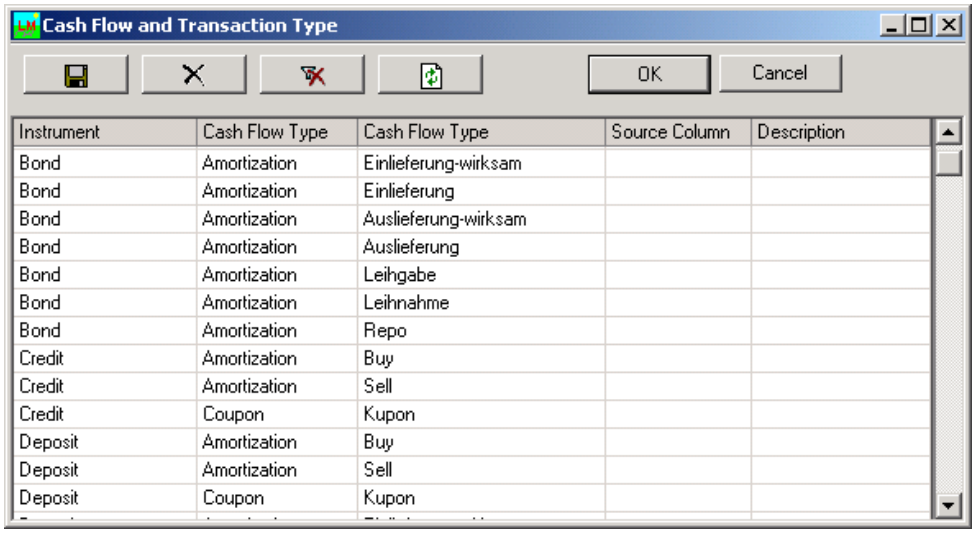


Figure 16: Tabullar input of cash flow and transaction types for instruments

The table below contains the descriptions of fields and buttons in the window Cash Flow and Trasaction types (see Figure 16):

Field, Button	Description
Save Records	Saves browser data
Delete Records	Deletes the previously selected browser rows
Remove Filter	Removes the column filter; a column filter can be set to the first row of each column by selecting the column content
Reload	Reloads data, ignoring all the modification that have not been saved
OK	Closes the window and saves all data
Cancel	Closes the window without saving the data
Browserspalten	
Instrument	Instrument type
Cash flow Type	Type of cash flow of each instrument
Transaction Type	Type of transaction of instrument
Source Column	Column in the transaction table, for the extraction of transaction cash flows
Description	Description of the row

4.1.5. Aggregation of Balance Sheet Positions

The aggregation of cash flows along the balance sheet structure is performed via freely definable formulas. The following options are possible:

- No formula is defined for an aggregation node: An arithmetic aggregation of child nodes takes

place automatically, whereby one signed factor (Consolidation factor from the node properties) multiplies the values of child nodes.

- One formula is defined for one aggregation node (see Figure 17): This formula is then used for the aggregation, whereby all nodes can appear in the formula (not just the child nodes). Due to the free definition of the formulas, all key figures – such as return, ROI, etc. – can be calculated as well.

Node names are transferred to the formula by selecting a node in the balance sheet structure and double-clicking it with the mouse. Arithmetic operators and functions can be inserted into the formula window via function keys or entered directly with the keyboard.

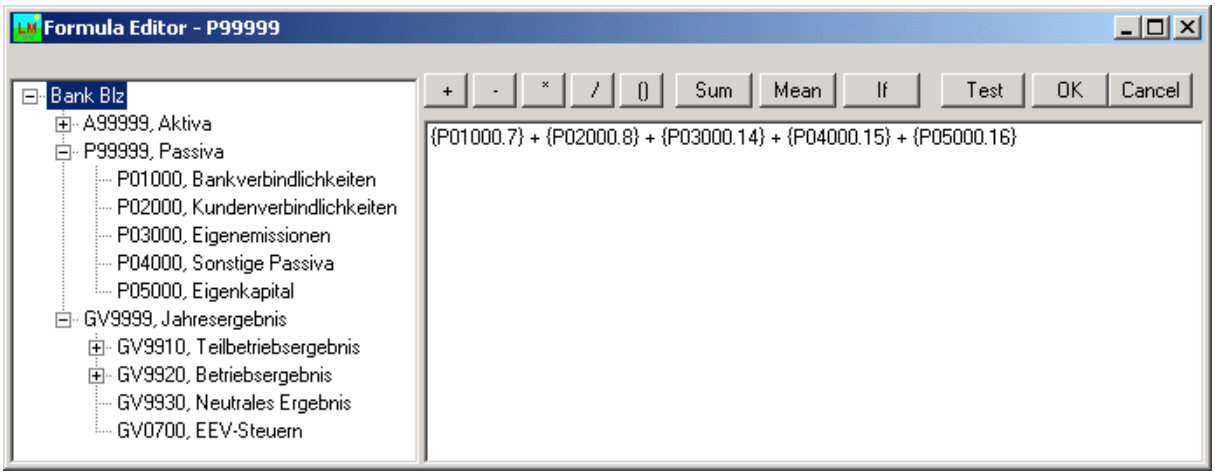


Figure 17: Calculation formulas for balance items

The table below contains the descriptions of fields and buttons within the window Calculation Formulas (see Figure 17):

Field, Button	Description
+, -, *, /, ()	Arithmetic operators and brackets for arithmetic expressions
Sum, Mean, IF	Functions: Sum (X) – the sum of all subordinate nodes of node X Mean (X) – the mean of all subordinate nodes of node X IF (Condition; Expression1; Expression2) – if the condition is met, Expression1 is performed; otherwise Expression2 is performed
Test	Verification of the formula for syntactic correctness
OK	Closes the window and applies the inserted formula
Cancel	Closes the window without applying the formula
Browser Columns	
Balance Sheet Structure	Structure of the balance sheet
Window Formula	The calculation formula is entered by using operator and function buttons. Node names are transferred to the formula by selecting a node in the balance sheet structure and double-clicking it with the mouse (see syntactic rules below)

The aggregation formulas (calculation formulas) follow the standard syntactic rules for arithmetic expressions, which consist of sums or differences of terms, that in turn contain products or quotients of factors. Given below is the established formula definition via syntactic rules. The rules are similar to

the ones commonly used in MS Excel.

Syntactic Rules:

Expression => Term ('+' | '-') Expression | Term

Term => Factor ('*' | '/') Term | Factor

Factor => '(' Expression ')' | NumberConst | Node | Sum | Mean | IF | 'n'

NumberConst => // an unsigned decimal number, e.g.. 6; 90; 0.25

NumberConst => 'Last' **//** number of the last column

Node => '{' NodeId.NodeNr'}' // node in the balance sheet structure

Node => '{' NodeId.NodeNr'['Column']''}' // node in the balance sheet structure
// with column input for the liquidity plan

Column => Integer // absolute number of the plan column

Column => 'n-' Integer | 'n+' Integer // plan column relative to the current column

NodeId.NodeNr // ID and internal number of the node

Sum => 'Sum' '(' Node ')' // sum of all child nodes

Mean => 'Mean' '(' Node ')' // mean of all child nodes

IF => 'If' '(' Condition ';' Expression ';' Expression ')'

'n' => // 'n' the current column number

Condition => Expression CompareOp Expression

CompareOp => '>' | '>=' | '=' | '<' | '<=' | '<>'

Examples of Calculation Formulas

Examples of calculation formulas contain different variations of the formula definition, along with the corresponding explanations:

{**P01000.7} + {P02000.8}**	Sum of two positions (the formula applies to all columns)
{A.2} -{L1.28}-{L2.29}-{L3.30}+{M.26}	Arithmetical expression of several positions (the formula applies to all columns)
sum({In100.7})	Sum of all positions subordinate to **{In100.7}** (the formula applies to all columns)
mean({In100.7})	Mean of all positions subordinate to **{In100.7}** (the formula applies to all columns)
if(n>0;{In100.7} + {A9999.2[n-1]};{A9999.2})	For all column numbers greater than 0, a sum is formed for the position **{In100.7}** from the current period, as well as for position **{A9999.2[n-1]}** from the previous period; for the first column, one uses the content from the first column;

if(n>0;100 * {In100.7} / {A9999.2};0)	For all column numbers greater than 0, an index is created; the first column is set to 0;
if({A9999.2} >0;100 * {In100.7}/ {A9999.2} ;0)	When the position **{A9999.2}** is positive, the index is calculated; in other cases it is set to 0;
if(n>0; {P010.7} - {P010.7[0]}; {P010.7})	For all column numbers greater than 0, a difference to the first column is defined (with the absolute number equal to 0); the current column content is used for the first column;

Tabulla and Graphical Demonstration of Cash Flows

After opening an existing or calculating a new plan, cash flows or balance performances of a liquidity plan are displayed in tabular and graphical form.

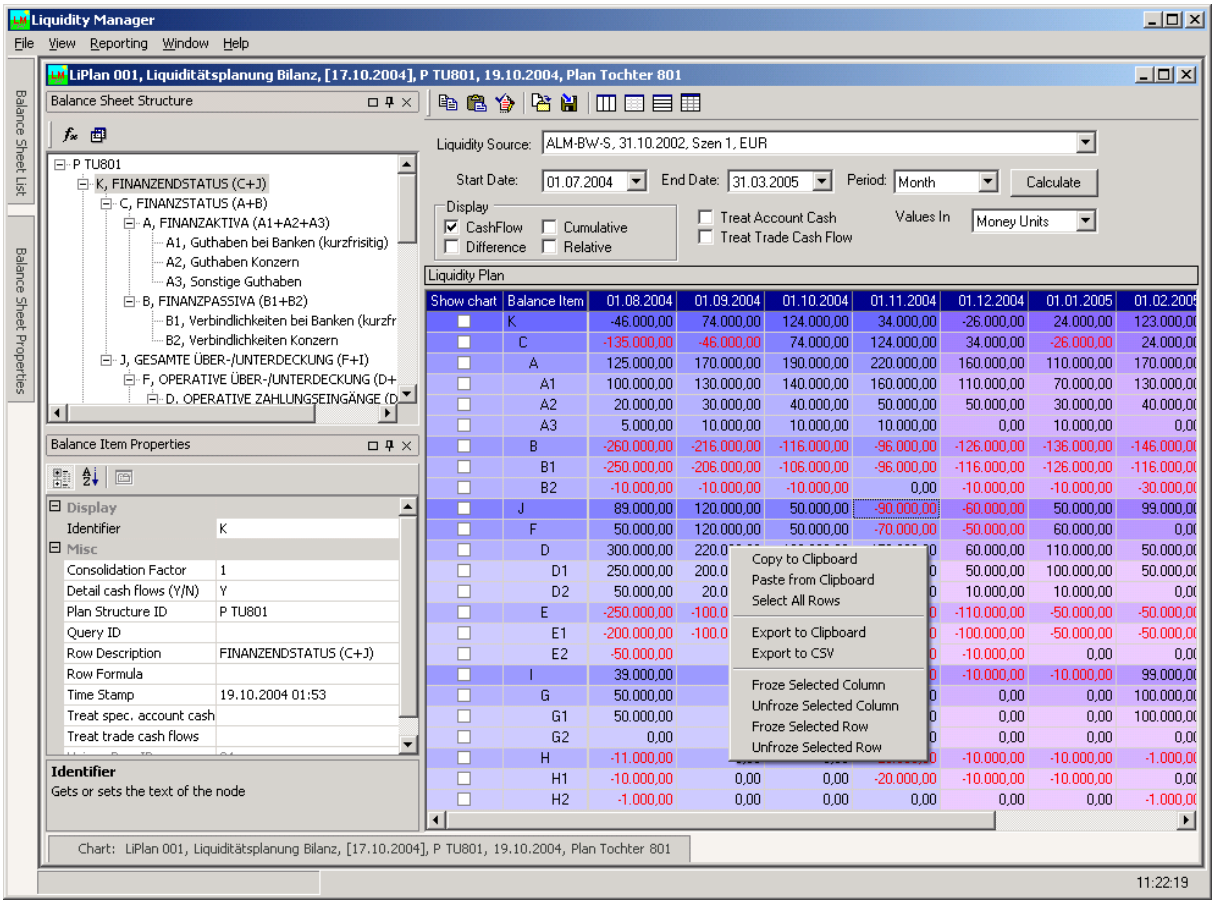


Figure 18: Tabullar and graphical demonstration of cash flows

The following table contains descriptions of buttons and their corresponding pop-up menu items in the window Cash Flow (see Figure 18):

Button, Menu Item	Description
Copy to Clipboard	The previously selected area in the browser is copied into the clipboard
Paste from Clipboard	The content of the clipboard is copied into the browser. The copied information is applied only to the rows of base positions after Recalc, all other rows are overwritten by the calculation formula.
Select All Rows	Selects all rows and columns of the browser. This is usually performed prior to operations Copy to Clipboard, Export to Clipboard, or Export to CSV.
Export to Clipboard	The previously selected area in the browser, as well as the fields in the dialogue, are exported (copied) to clipboard.
Export to CSV	The previously selected area in the browser, as well as the fields in the dialogue, are exported (copied) to a CSV file. The file name is selected or entered into a window prior to the export.
Freeze Selected Column	All columns that are located before a selected cell are captured when scrolling the columns.
Unfreeze Selected Column	Stops the freezing of columns when scrolling.

Button, Menu Item	Description
Freeze Selected Row	All cells that are located before a selected cell are captured when scrolling.
Unfreeze Selected Row	Stops the freezing of cells when scrolling.

Items are opened and closed in the tree structure depending on whether they have been selected or not. All future periods are marked with a slightly purple color. The data in the tables can be selected, copied and inserted. Export to clipboard and CSV files ensures the export to MS products (MS Excel, MS Word, ect.).

4.1.6. Tabular and Graphical Illustration of Cash flows, Diff, Sum and %

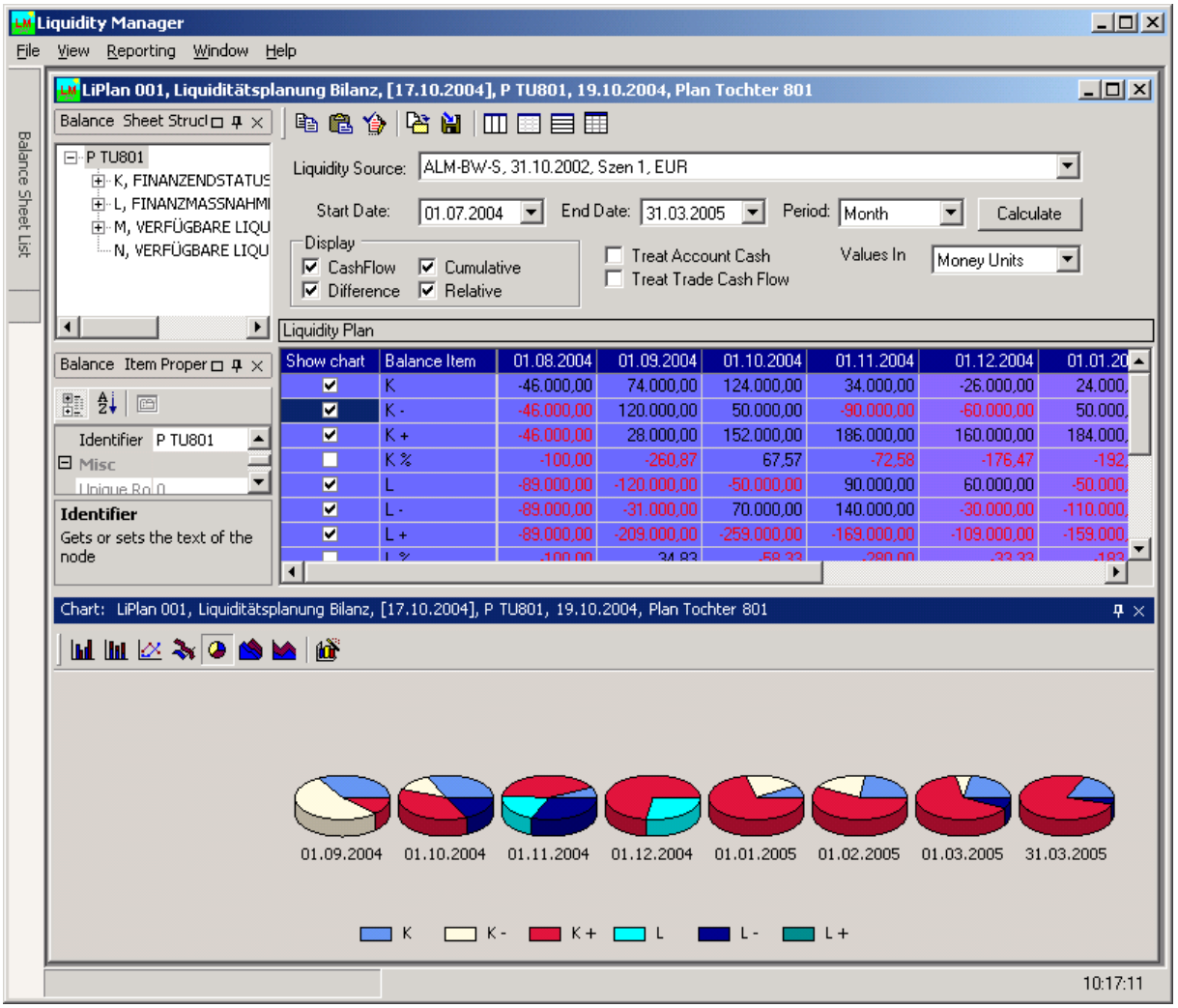


Figure 19: Tabular and graphical illustration of cash flows, differences and sums

Cash flow differs from period to period and accumulated cash flows can be switched on via check boxes. When the checkbox Treat Trade Cash flows is checked, cash flows from transactions of previous periods are collected. When the checkbox Treat Account Cash is selected, balance sheet values are taken from accounts at the start of the period. “Values in” (Money units, thousands, billions) determines in which form the cash flows will be expressed.

The table below contains the descriptions of buttons in the window shown in Figure 19:

Button, Menu Item	Description
Liquidity Source	Selects a report as a cash flow source
Start Date	Start date of the liquidity plan
End Date	End date of the liquidity plan
Period	Time period of the liquidity plan
Display	Check boxes in the display group
Cash flow	Cash flows or balance development
Cummulative	Current sum of periods from Cash flow rows
Difference	Difference between the value of the current period and the value from a previous period from Cash flow rows
Relative	Current differences (in %) between the period value and the value from the previous period, based on the previous period value from the cash flow row
Treat Account Cash Checkbox	Balances from accounts at the start of the liquidity planning are interpreted as start values (in the first column)
Treat Trade Cash flow Checkbox	Transactions are used as cash flow sources for historical periods
Values in	Determines how period amounts will be expressed: in monetary units, in thousands, in millions

4.1.7. Tabular and Graphical Demonstrations of Cash Flows and Positions

Individual cash flows for each balance sheet item can be displayed in tables and graphics. Cash flow positions are accumulated to the respective balance sheet items, taking into account short/long positions (see Figure 20).

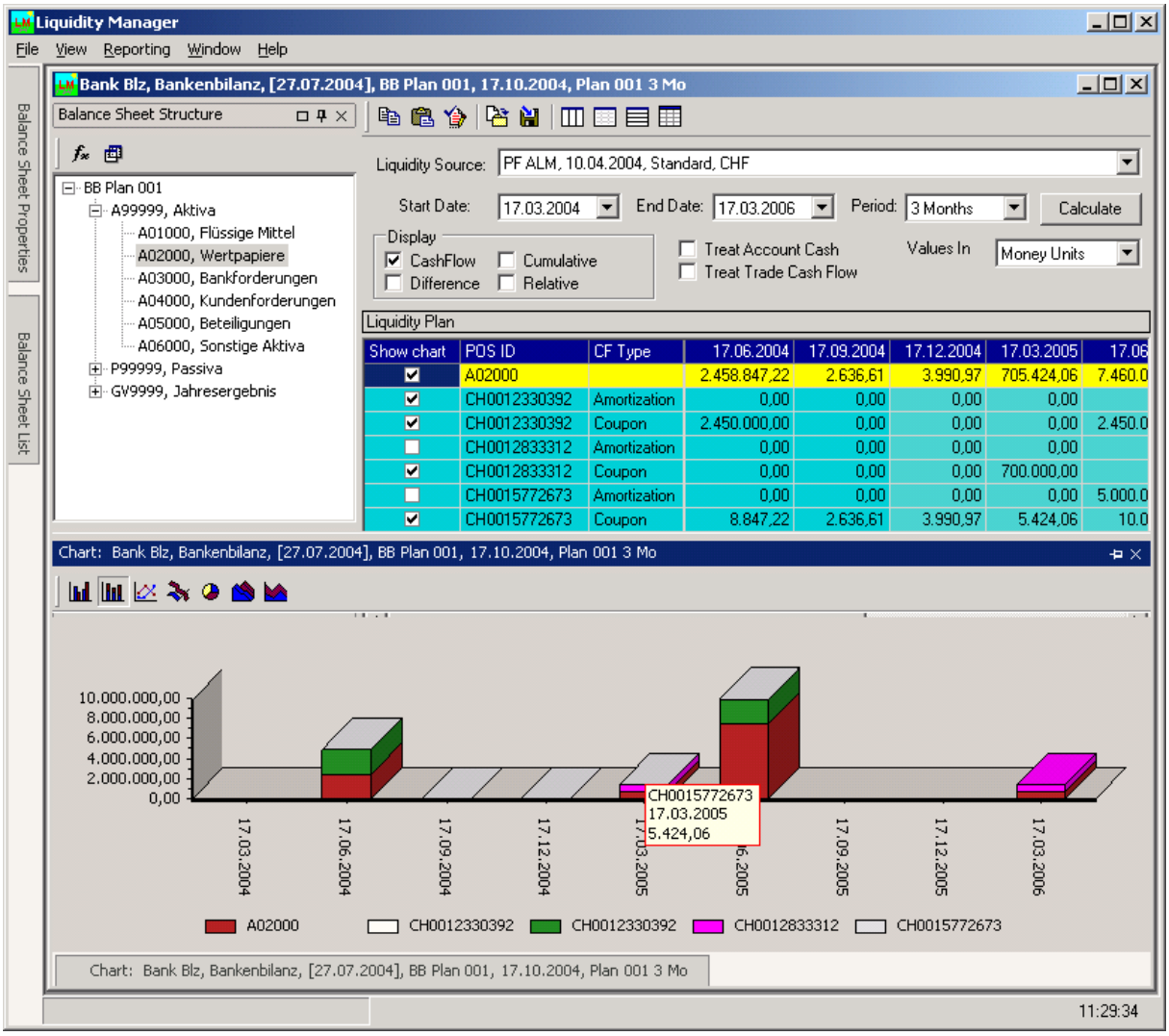


Figure 20: Tabular and graphical illustration of cash flows from positions

4.1.8. Navigation through the Graphical Interface

The graphical illustration of the period development is connected to the representation in tabular form. The chart can be locked in the upper corner using the window control, as well as opened in a new window by positioning the mouse on the title row and then moving it. All other windows have the same feature as well.

The Component One Graphic for .Net can be moved, scaled and rotated. In order to achieve that one must position the mouse in the graphical area of the window and press the left mouse button to use the Drag&Drop feature:

- without keyboard: rotate
- with Shift key: move

- with Ctrl key: scale

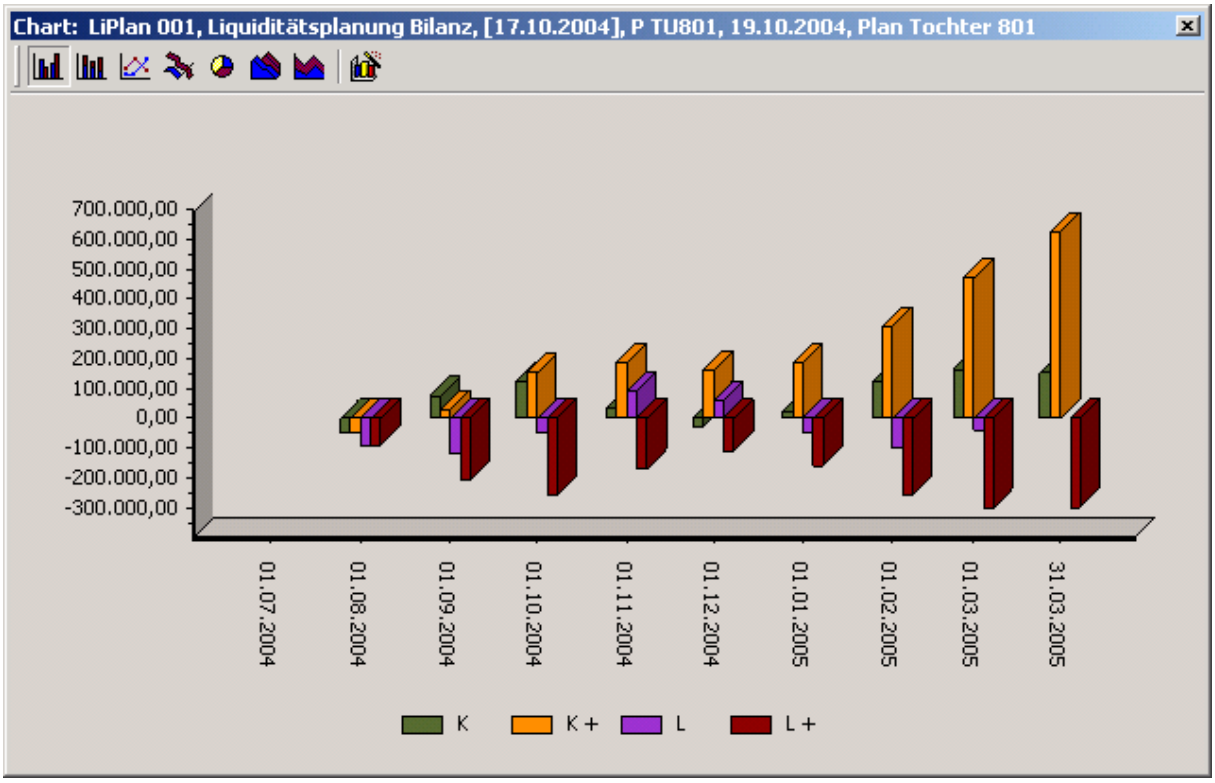


Figure 21: 3D bar chart for cash flows

The table below contains the descriptions of buttons and pop-up menu items shown in Figure 19:

Button, Menu item	Description
Bar	2D or 3D bar chart
Stacked Bar	2D or 3D stacked bar chart
Line	2D or 3D line chart
Stacked Line	2D or 3D stacked line chart
Pie	2D or 3D pie chart
Area	2D or 3D area chart
Stacked Area	2D or 3D stacked area chart
2D Graph	Switching between 2D and 3D charts
Hide Toolbar	Shows or deletes the bar via graphic buttons

Figures 21, 22, 23 and 24 show various 2D and 3D charts. The different chart types can be selected in each chart dialogue via buttons and their corresponding pop-up menu items.

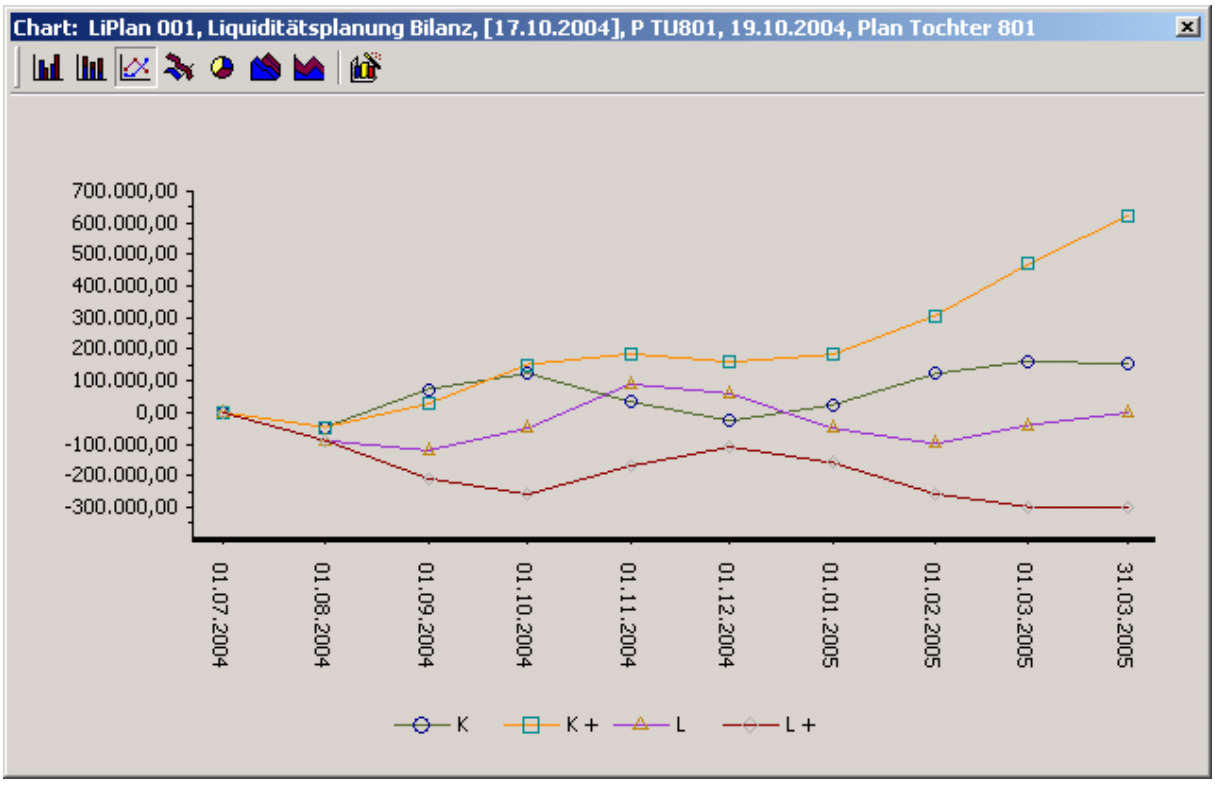


Figure 22: 2D Line chart for cash flows

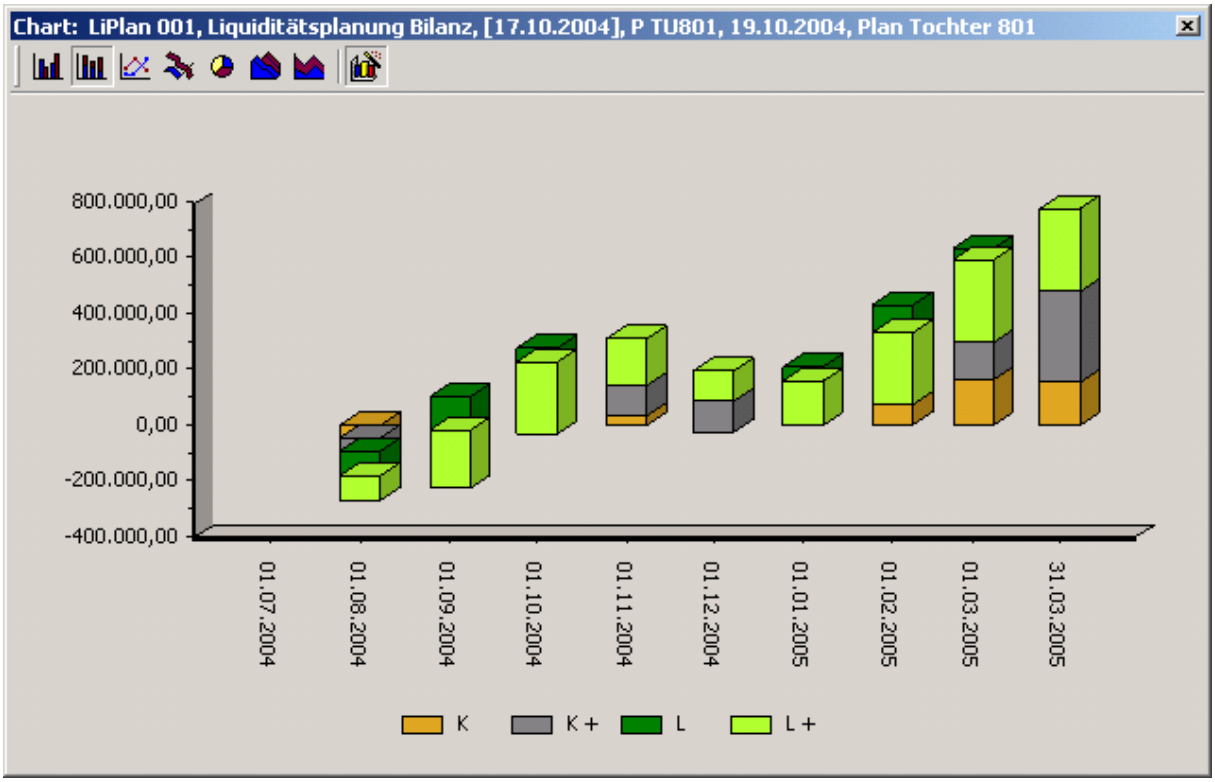


Figure 23: 3D Stacked bar chart for cash flows

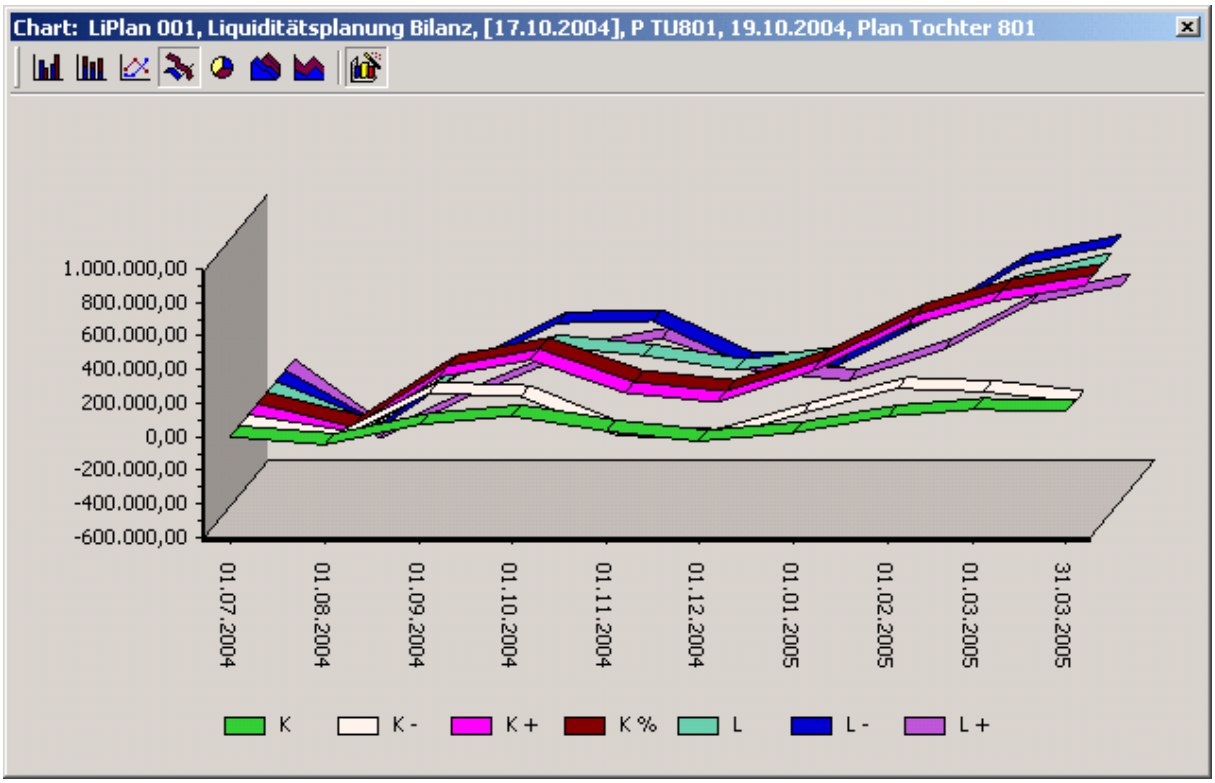


Figure 24: 3D Line chart for cash flows

4.1.9. Navigating the Graphical Interface

All windows in the graphical user interface can be docked, moved and navigated separately (see Figure 25). Several balance sheets or plans can be called up and appear on the screen for comparison. Multiple charts can be displayed at the same time.

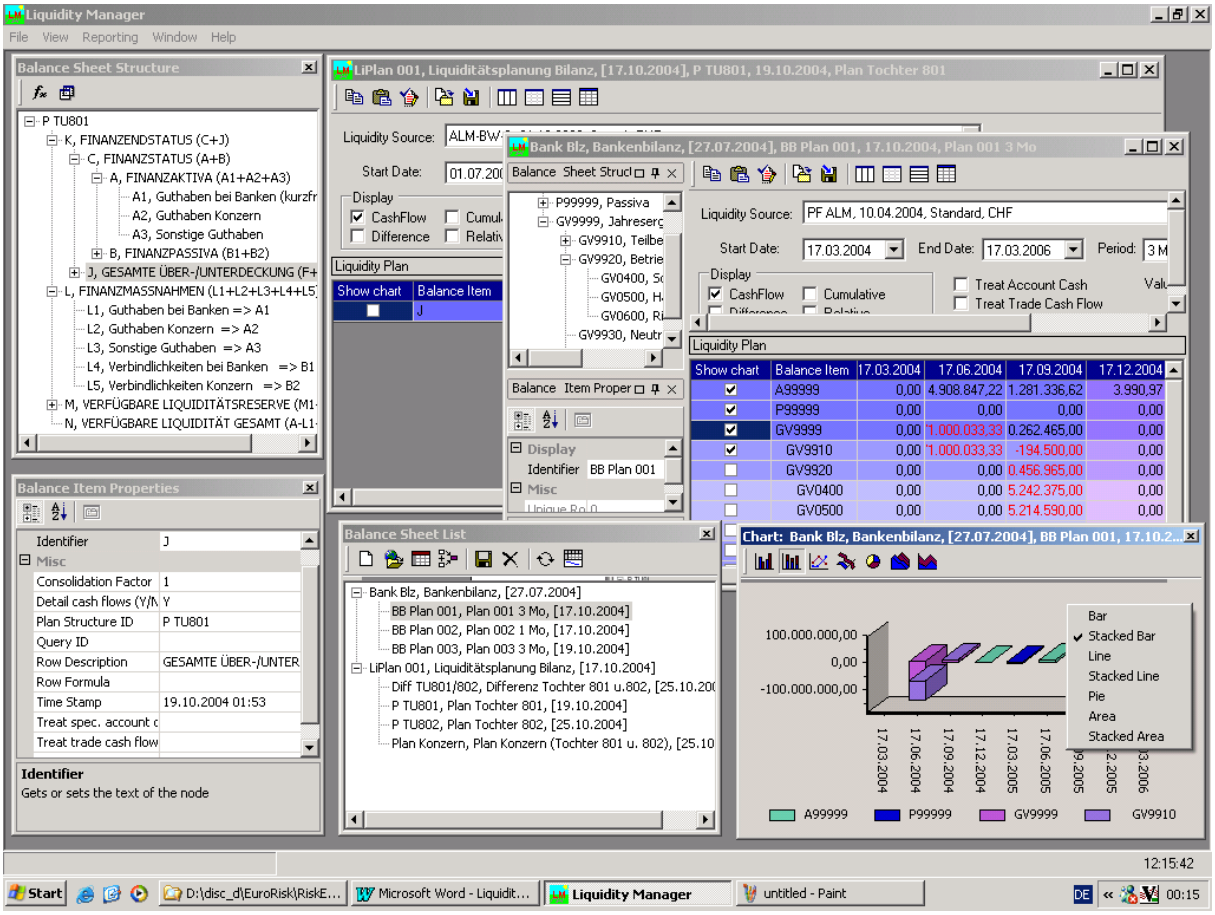
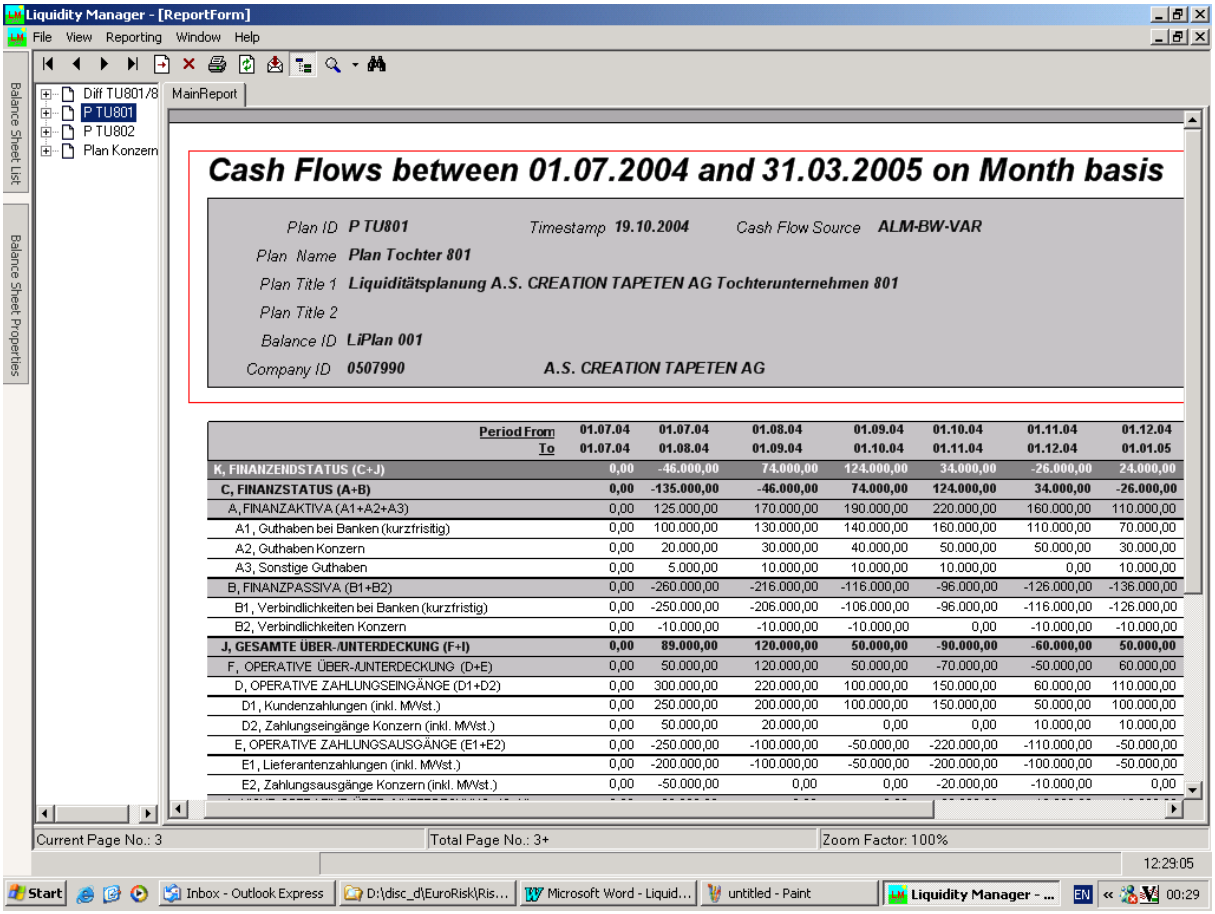


Figure 25: Multi-window representation of the Liquidity Management application

The Liquidity Management application can be started individually multiple times using the .Net-IOS COM wrapper that, from the perspective of.Net applications, exhibits multi-thread behavior. This COM interface is based on the IOS standard, without any modifications. Parallel to this, the IOS can be used by other applications (RTB, RiskEval, etc.) as well.

4.1.10. Liquidity Plan Reports

Reporting (see Figure 26) is performed by running the Crystal Reporter from the tree-shaped structure of balance sheets and liquidity plans. The reporting is context-dependent (reports of one plan, reports of all plans from one balance sheet structure, or reports of all plans from all balance sheet structures). The content of the report depends on which balance sheet structure or liquidity plan has been selected. After running the Crystal Reporter, a window is activated for the selection of a report file. A standard report can be found in the report file LM_Plan.rpt.



Period From / To	01.07.04 / 01.07.04	01.07.04 / 01.08.04	01.08.04 / 01.09.04	01.09.04 / 01.10.04	01.10.04 / 01.11.04	01.11.04 / 01.12.04	01.12.04 / 01.01.05
K, FINANZENDSTATUS (C+J)	**0,00**	**-46.000,00**	**74.000,00**	**124.000,00**	**34.000,00**	**-26.000,00**	**24.000,00**
C, FINANZSTATUS (A+B)	**0,00**	**-135.000,00**	**-46.000,00**	**74.000,00**	**124.000,00**	**34.000,00**	**-26.000,00**
A, FINANZAKTIVA (A1+A2+A3)	0,00	125.000,00	170.000,00	190.000,00	220.000,00	160.000,00	110.000,00
A1, Guthaben bei Banken (kurzfrisitig)	0,00	100.000,00	130.000,00	140.000,00	160.000,00	110.000,00	70.000,00
A2, Guthaben Konzern	0,00	20.000,00	30.000,00	40.000,00	50.000,00	50.000,00	30.000,00
A3, Sonstige Guthaben	0,00	5.000,00	10.000,00	10.000,00	10.000,00	0,00	10.000,00
B, FINANZPASSIVA (B1+B2)	0,00	-260.000,00	-216.000,00	-116.000,00	-96.000,00	-126.000,00	-136.000,00
B1, Verbindlichkeiten bei Banken (kurzfristig)	0,00	-250.000,00	-206.000,00	-106.000,00	-96.000,00	-116.000,00	-126.000,00
B2, Verbindlichkeiten Konzern	0,00	-10.000,00	-10.000,00	-10.000,00	0,00	-10.000,00	-10.000,00
J, GESAMTE ÜBER-/UNTERDECKUNG (F+I)	**0,00**	**89.000,00**	**120.000,00**	**50.000,00**	**-90.000,00**	**-60.000,00**	**50.000,00**
F, OPERATIVE ÜBER-/UNTERDECKUNG (D+E)	0,00	50.000,00	120.000,00	50.000,00	-70.000,00	-50.000,00	60.000,00
D, OPERATIVE ZAHLUNGSEINGÄNGE (D1+D2)	0,00	300.000,00	220.000,00	100.000,00	150.000,00	60.000,00	110.000,00
D1, Kundenzahlungen (inkl. MWst.)	0,00	250.000,00	200.000,00	100.000,00	150.000,00	50.000,00	100.000,00
D2, Zahlungseingänge Konzern (inkl. MWst.)	0,00	50.000,00	20.000,00	0,00	0,00	10.000,00	10.000,00
E, OPERATIVE ZAHLUNGSAUSGÄNGE (E1+E2)	0,00	-250.000,00	-100.000,00	-50.000,00	-220.000,00	-110.000,00	-50.000,00
E1, Lieferantenzahlungen (inkl. MWst.)	0,00	-200.000,00	-100.000,00	-50.000,00	-200.000,00	-100.000,00	-50.000,00
E2, Zahlungsausgänge Konzern (inkl. MWst.)	0,00	-50.000,00	0,00	0,00	-20.000,00	-10.000,00	0,00

Figure 26: Liquidity plan reports using Crystal Reporter

5. Cash flow/Earning at Risk

This section introduces the valuation principles and operations of the Cash flow/Earning at Risk module. The module is designed as an analysis for liquidity planning and is integrated in the Liquidity Manager application with its own license control and user rights.

The Cash flow/Earning at Risk analysis calculates risk distributions for each plan item in the balance sheet structure for a forecasted period via a multi-dimensional (risk factors x forecasted time periods) Monte Carlo simulation of risk facotrs. Risk results for cash flows or performances over time – such as Expected Values, Cash Flow/Earnings at Risk (CfaR/EaR), Confidence Values, Expected Loss, etc. – are taken from the distributions and displayed in tabular form, on reports and in 2D and 3D charts. The calculated results provide information about the stability of balance sheet plans against changes in risk factors for future time periods. Despite a positive balance of a liquidity plan, it is possible for Confidence Values (e.g. at 95%), and even Expected Values, to become negative in case of unfavorable developments in risk factors. In such situations, measures such as re-planning or hedging, should be initiated.

5.1. Definition of Cash flow at Risk (CfaR) and Earning at Risk (EaR)

The meaning of Cash flow at Risk (CfaR) and Earning at Risk (EaR) is similar to Value at Risk (VaR) for market risks. It regards the measurement of probable losses in volatile projects or businesses at a given confidence level. The main difference lies in the observation period, since CfaR/EaR calculations simulate risk for longer analysis periosds, while in VaR present value losses are only measured at the point of valuation (see section 9.5.2).

Cash flow at Risk (CfaR):

The maximum net cash flow loss of a balance sheet item, that can be lost relative to the net project cash flow (budget value) and a confidence interval within the observed period due to market risk influences.

Earning at Risk (EaR):

The maximum loss of income of a balance sheet item, that can be lost relative to the project income (budget income) and a confidence interval within the observed period period due to market risk influences.

5.1.1. Comparison between Marktrisiko and CfaR/EaR

The main differences between Market Risk (VaR) and Cash flow at risk (CfaR)/Earning at rRsk (EaR) are summarized in the table below. CfaR and EaR are primarly used in the corporate sector to measure the risks of business plans, liquidity plans and budgeting models. However, it is easily possible to use CfaR/EaR in the financial sector as well to simulate cash flows and income from financial instruments for future periods. Business and liquidity plans also include financial instruments to represent the financing of production projects on money or capital market. Business and liquidity plans must be hedged more often using financial derivatives such as Interest Rate Swaps, Currency Swaps, Forwards, Options, etc. The CfaR/EaR analysis can also be used for the numerical simulation of complex exotic instruments with multiple risk factors (e.g. fixing in two interbanking rates, payments in foreign currency and complex multi-callable condition).

Parameter	Market Risk	CfaR and EaR
Area	Financial	Corporate
Framework	RiskMetrics, VaR/CoVaR	CorporateMetrics
Accounting treatment	Fair Value (mark to market)	Earnings, cash flow (accounting approach)
Horizon	Daily, monthly	Monthly, quarterly, annually
Period	For one short period	For several periods
Confidence interval	1%	5%
Benchmark	Risk grid points (market, index, currency rates, yield curves)	Specified targets (business plans, budgeted plans, spot, forward, expected and analyst forecast)
Aggregation	Portfolio structure	Balance sheet structure

Other key features of the CfaR/EaR analysis include periodic risk assessment and long-term risk horizon, which can extend over two or more years. Typical analytical time periods are: monthly, quarterly, annually, two years. It is entirely possible to create daily or weekly simulation periods. Such sort of analysis requires the forecasting of future cash flows or performances of the risk factors, as well as their corresponding future volatility and correlation. Implicit forwards and volatilities, as well as user specifications, can be used during forecasting. Historical performances of the risk factors (Commodities, Exchange Rates, Interest Rates, etc.) are applied when creating a simulation to determine historical volatilities and correlations. They are also used for the generation of simulated daily prices. In the CfaR/EaR module, risk factors are simulated within a simulation market and linked to historical data supplies, in order to be able to deliver historical values.

5.1.2. CfaR/EaR Calculation Method

The calculation methods for Cash flow at Risk (CfaR) and Earning at Risk (EaR) are taken from the literature (see literary sources at the end of the document) and have been adapted for the Liquidity Manager application. In this way the Liquidity Manager application implements the “CorporateMetrics” and “LongRun” valuation models. The evaluation principles are briefly illustrated in the following sections. Details and formulas can be found in the literature.

5.1.2.1. Framework for the Evaluation of CfaR/EaR

The evaluation framework is based on the structure of the liquidity plans within the Liquidity Manager:

1. Presentation of volatile and operational cash flows and performances for corporates and banks for medium to long-term risk horizons (3, 12, 24 months).
2. Description of the dependence of individual cash flows on market factors (Commodities, Exchange Rates, Interest Rates, Indices).
3. Definition of corporate-specific equations for cash flows or performances.
4. Periodical illustrations (daily, weekly, monthly, quarterly) of cash flows projects or performances within business plans, budgeting models and liquidity plans, through periodic dependencies or "pro forma statements" (manual specifications).
5. Structuring of plan items within hierarchical balance sheet structures.

5.1.2.2. Simulation of Risk Factors

The entire plan structure is evaluated using a Monte Carlo simulation. Future performances of various risk factors, at various, points in time are being simulated. The simulation includes the following aspects:

1. Long-term forecast of risk factor performances and volatilities at future basis points according to a predifined analytical time period; simulation of basis points; definition of daily values between the basis points via interpolation; simulation via Volatility Bridge.
2. Multi-dimensional Monte Carlo simulation (risk factors x basis points) of risk factors; simulation of dependent plan items via corporate-specific equations.
3. Cash flow and value aggregation for each future period along the balance sheet structure.
4. Definition of the distributions for cash flow and performances per plan item in the balance sheet, and according to a predefined future period.
5. Taking multi-dimensional CfaR and EaR results from the generated distributions, that are expressed according to a perdefined period, according to a balance sheet item or according to the total balance sheet, for a given confidence interval.

5.1.2.3. Market Rates as Risk Drivers

Various market sizes – for which historical volatilities and correlations can be calculated by using time series – are applied as risk drivers for the Monte Carlo simulation. Some examples are:

1. Commodity prices

   Aluminum, copper, iron, ..., wood, ..., plastic, ..., wool, cotton, silk, ..., luxury foods, ..
2. Energy

   Brent oil, WTI oil, gas, electricity, ...
3. Finances

   Interest, exchange rates, prices, returns, tax rates, ...
4. Industry metrics

   Structured share indices, industry indices, fund indices, ...
5. National and international indices, as well as statistics of countries or of the entire economy

   Inflation rate, gross domestic product, key figures on the economic cycle, ...

5.1.2.4. Exposure Maps: Corporate-specific Equations

The following example illustrates a production plan with which cash flows, performances and results of simulations are more colsely examined and explained.

Beispiel: German company produces aluminum products and sells them to the US.

Risk horizon:	1 year
Analytical observation:	Quarterly
Purchase of commodities:	Aluminium in EUR
Export of the produktion:	USA
Financing:	3-Month Libor + 100 BP

The table bellow shows cash flows and performances of plan items in the form of plan prognosis. Simulated risk factors include: Aluminum price in EUR, Exchange Rate in USD and the 3-month Interest Rate.

Period		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Plan (Budget) Prognosis	01.02.2005	01.05.2005	01.08.2005	01.11.2005	01.02.2006	
CF Balance EUR	0	17.006	8.689	17.537	3.739	46.972
Purchase Alu: EUR	-168.000	-174.460	-172.280	-185.220	0	-699.960
Purchase Alu: Tons	120	122	118	126	0	486
Price Alu: EUR	1400	1430	1460	1470	1490	
Sale: EUR	0	186.300	184.500	191.160	190.400	752.360
Sale: USD	0	230.000	225.000	236.000	238.000	929.000
Course: USD/EUR	0,80	0,81	0,82	0,81	0,80	
Interest Rate in EUR	0	-1.294	-1.351	-1.343	-1.441	-5.428
3 Mo Interest Rate	2,08%	2,10%	2,12%	2,11%	2,09%	

The dependent items are defined using corporate-specific equations:

Purchasing Aluminium in EUR = - Buy Alu: Tons*Price Alu: EUR

Selling to USA in EUR = Sell: USD*ExRate: USD/EUR

Financing on the money market = - Buy Alu: EUR[prev period]*(3 Mo IR[prev. period]+1.0)/4

Cash flow balance in EUR = Sell: EUR+Buy Alu: EUR[prev, period]+IR in EUR

Period		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Expected Value	01.02.2005	01.05.2005	01.08.2005	01.11.2005	01.02.2006	
CF Balance EUR	0	-13.797	-16.644	9.871	-3.965	-24.535
Purchase Alu: EUR	-198.487	-198.281	-183.014	-196.195	0	-775.978
Purchase Alu: Tons	120	122	118	126	0	486
Price Alu: EUR	1.654	1.625	1.551	1.557	1.537	
Sale: EUR	0	186.218	183.173	194.311	193.756	757.457
Sale: USD	0	230.000	225.000	236.000	238.000	929.000
Course: USD/EUR	0,8015	0,8096	0,8141	0,8234	0,8141	
Interest Rate in EUR	0	-1.528	-1.535	-1.426	-1.525	-6.014
3 Mo Interest Rate	2,0800%	2,0975%	2,1173%	2,1112%	2,0888%	

After creating a balance sheet structure and defining corporate-specific equations, risk factors can be simulated, assuming correlated normal distributions. Future performances and volatilities are estimated. Monte Carlo simulation determines risk distributions for each time period and for all risk factors, and creates dependent plan items along the balance sheet structure. The table below shows the expected values of distributions. The expected value can differ from the forecasted value due to valuations of risk factors and non-linear correlations in equations.

Cash Flow/Earnings at Risk can be determined for the risk distributions of each plan item and each time period, and is calculated as the difference between forecast and confidence value (at 95%). Cash Flow/Earnings at Risk identify risk factors and their corresponding plan items. Specific forecast items – such as the planned purchase of aluminum in tones and the planned sale of production – are considered as independent of market fluctuations and present no risk.

Period		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Cash flow at Risk	01.02.2005	01.05.2005	01.08.2005	01.11.2005	01.02.2006	
CF Balance EUR	0	17.956	28.052	36.936	45.352	128.296
Purchase Alu: EUR	0	16.381	22.594	29.630	0	68.605
Purchase Alu: Tons	0	0	0	0	0	0
Price Alu: EUR	0	134	191	235	272	
Sale: EUR	0	17.956	25.051	32.269	37.629	112.905
Sale: USD	0	0	0	0	0	0
Course: USD/EUR	0,0000	0,0781	0,1113	0,1367	0,1581	
Interest rate in EUR	0	0	125	172	221	518
3 Mo Interest Rate	0,0000%	0,0844%	0,1204%	0,1479%	0,1710%	

Confidence values per plan item and per point in time are determined from the distribution with a 95% confidence level. They represent plan item performances in the event of unfavorable market developments of risk factors.

For example, the table below shows that the performance of the CF balance sheet in EUR is negative, in contrast to the planned (budget) forecast, which is consistently positive, i.e. with a probability of 5% one would have to assume considerable losses in the production. Losses arise from Expected Values. As a result, the balance sheet has to be planned anew or risk factors have to be hedged. In this specific case, one could, for example, hedge the Exchange Rate to USD using a Currency Swap and neutralize the fluctuation in the aluminum price by using Futures.

Period		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Confidence Value	01.02.2005	01.05.2005	01.08.2005	01.11.2005	01.02.2006	
CF Balance EUR	0	-31.754	-44.696	-27.065	-49.316	-152.831
Purchase Alu: EUR	-198.487	-214.662	-205.608	-225.825	0	-844.582
Purchase Alu: Tons	120	122	118	126	0	486
Price Alu: EUR	1.654	1.491	1.359	1.322	1.265	
Sale: EUR	0	168.262	158.122	162.041	156.127	644.552
Sale: USD	0	230.000	225.000	236.000	238.000	929.000
Course: USD/EUR	0,8015	0,7316	0,7028	0,6866	0,6560	
Interest rate in EUR	0	-1.528	-1.660	-1.598	-1.746	-6.532
3 Mo Interest Rate	2,0800%	2,0130%	1,9969%	1,9633%	1,9179%	

5.1.2.5. Demonstration of Exposure Maps via Exposure Formulas

Periodical performances of dependent plan items are determined by formulas. Formulas aggregate the value of plan items along the balance sheet structure, applying a predefined formula for all periods of the plan item.

1. Linear formula: Linear correlations between risk factors and plan items are defined. Given an assumed normal distribution of risk factors, plan items will have a normal distribution as well.

   Example: One period (buying commodities, selling abroad)

   Simulation rates are: Price_Commodity, Exchange Rate

   Cash flow = - Volume_Commodity * Price_Commodity

   + Volume_Product * Exchange Rate

2. Non-linear formulas: Non-linear correlation between risk factors and plan items is defined, making it possible for data from previous periods to be accessed. At an assumed normal distribution of risk factors, the distributions for plan items are skewed. Risk assessment is managed via the

Monte Carlo simulation.

Example: Multiple periods with price elasticity (sales abroad)

Simulation rate is the Exchange Rate: FX_{i-2}, FX_{i-1}, FX_i

The price for each subsequent period is adjusted by 70% to the changes in Exchange Rates from the previous period:

$Price_i$ = $Price_{i-1}$ * [1+ 0,7 * (FX_{i-1} / FX_{i-2} -1)] // stohastic division

$Cash\ flow_i$ = $Price_i$ * Volume * FX_i

3. Demonstration of Options: Further non-linear correlation between risk factors and plan items can be defined using conditions, whereby option behavior of plan items and, ultimately, financial options can be shown. Given an assumed normal distribution of risk factors, there can be skewed and cut distributions for plan items. The risk assessment is managed via the Monte Carlo simulation.

Example: Exposure Limit: the US sales depend on the USD Exchange Rate

Simulation rate is the Exchange Rate: USD/EUR

USA-Sale = if (ExRate: USD/EUR > 0.75; ExRate: USD/EUR; 0.75) * Sale: USD

Example: Call Option for the Exposure: execution when USD > 0.75.

Simulation rate is the Exchange Rate: USD/EUR

Call Option = if (ExRate: USD/EUR > 0.75; ExRate: USD/EUR - 0.75; 0) * Sale: USD

5.1.2.6. Valuation of Volatilities and Expected Cash Flows

Volatilities and expected cash flows or performances must be estimated for each risk factor and for each forecasted time period along the time axis. Procedures for the estimation are introduced in the document „LongRun Technical Document“ (see literary sources). The general procedures are listed as follows:

- Forecasts from historical data: Volatilities and performances are calculated from time series of Market Prices, Indices, Exchange Rates and Interest Rates and are applied to future scenarios.
- Forecasts from Futures and Forwards: future prices can be estimated from market prices of Futures and Forwards.
- Forecasts from market curves: after converting market curves to zero curves, forward interest rates can be calculated for future periods.
- Forecasts from Options and Swaptions: Implied volatilities (term structure of implied volatility) and “Volatility Smile” can be determined from Option and Swaption prices.
- Forecast via parametric or non-parametric Econometric Models: Difference VARM (DVAR), Vector ECM (VECM) and Adaptive ECM (AECM).
- User-defined scenarios: specification of scenarios for volatilities and expected cash flows, taking the economic cycle into consideration.

The CfaR/EaR analysis works with user-defined scenarios for volatilities and expected cash flows or performances, which can be taken from external sources via clipboard or import.

5.1.2.7. Simulation Framework: Calculation of Simulation Data

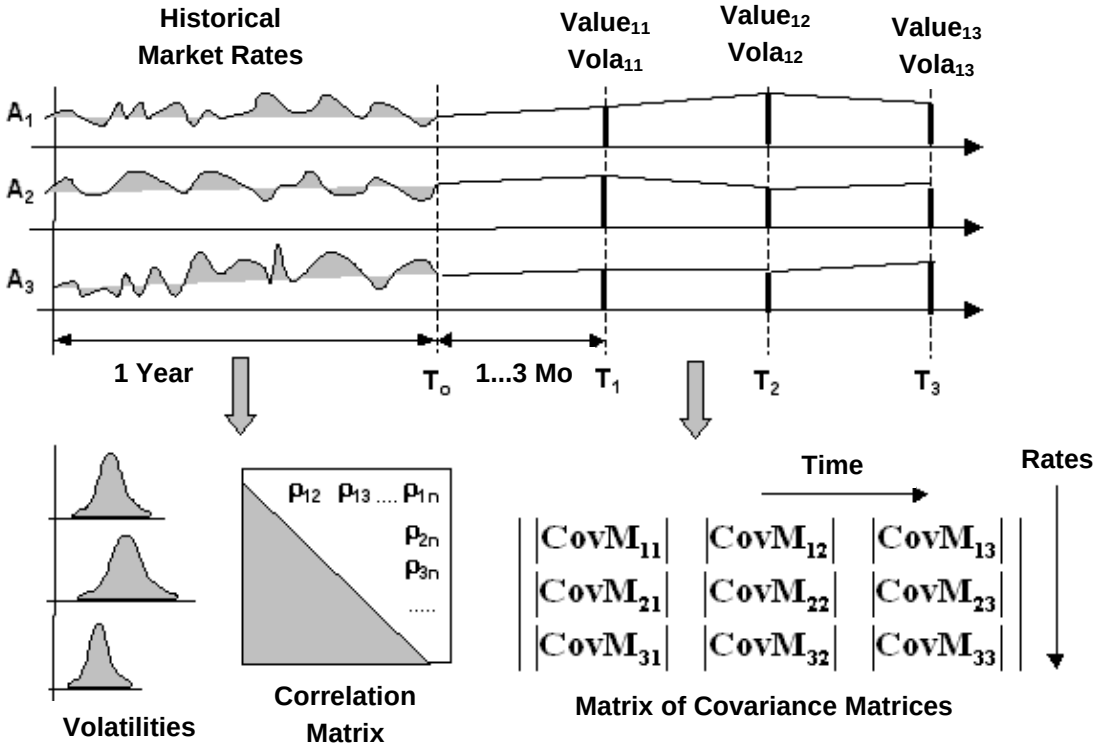


Figure 27: Calculation of historical volatilities and correlations

Figure 27 demonstrates the calculation of historical volatilities and correlations of risk variables (risk factors) within a simulation market. Risk variables are connected to the data delivery, so that historical daily data of Market Rates, Interest Rates, Exchange Rates, Interbanking Rates and Indices can be loaded from the database. In the simulation, daily volatilities and correlations are used for the definition of daily values between future base points. This is achieved via „Volatility Bridges“.

Based on the estimations of forecasted performances and volatilities of risk variables on several base points, as well as on historical performances, one can calculate the matrix of covariance matrices. The matrix contains matrices for the auto-covariance of each risk variable (time x time) along the time axis, as well as matrices for the cross-covariance (rate x time) between basis points of different risk variables along the time axis.

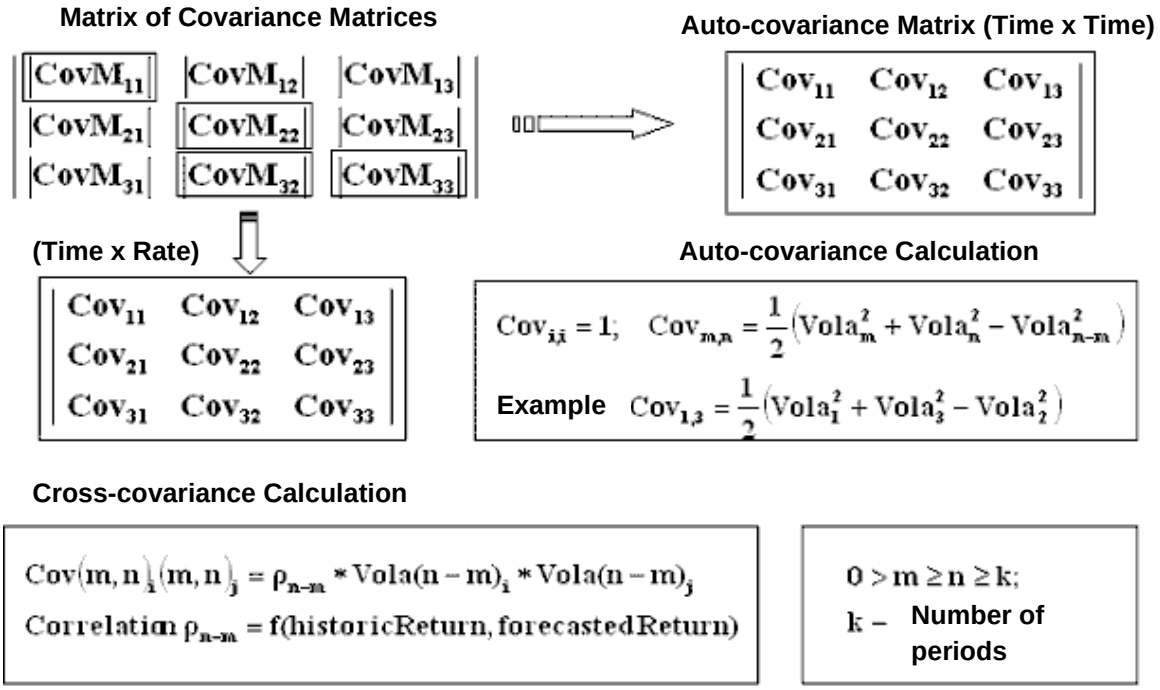


Figure 28: Calculation of the matrix of the covariance matrices

The calculation formulas for auto- and for cross-covariance are given in Figure 28. Further details can be found in literary sources. When calculating auto-covariance, the assumption is that the volatility between two interpolation points is equal to the volatility from the same time interval, with respect to the valuation point, i.e. Vola (m, n) = Vola (0, n-m) for n>m. In this way, the covariance between base points is 3 and 5:

Covariance(3, 5) = 0.5 * (Vola(0, 3)^2 + Vola(0, 5)^2 + Vola(0, 2)^2)

Cross-covariance for the time points m and n (n> m), as well as risk variables i and j, results from the general formula:

Covariance(m,n,i)(m,n,j) = Correlation(n-m) * Vola(n-m,i) * Vola(n-m,j)

The correlation (n-m) is determined from historical and forecasted returns in the base period (s. LongRun Technical document from the literary sources).

5.1.2.8. CfaR and EaR Framework, Level I Simulation (Base Points)

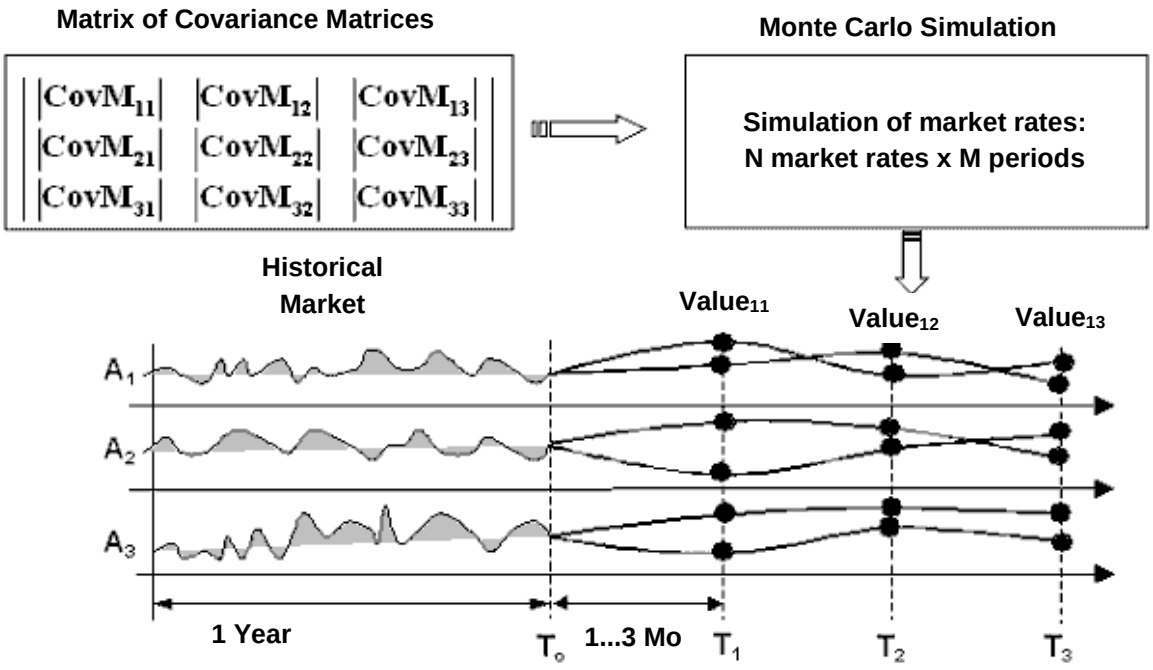


Figure 29: Sumulation of base points – Level I Simulation

The matrix of covariance matrices is used for the Monte Carlo simulation of base points (Level I Simulation). Correlated changes in performances are simulated for all risk variables at all base points. Level I Simulation is comprised of the following steps:

- The entire correlation matrix (rate x time) x (rate x time) is obtained from covariance matrices. Such a transformation is possible since the volatility for each base point is known.
- The correlation matrix is used for the calculation of the Sholesky matrix.
- With the help of the random generator, a preselected number of scenarios (e.g. 10,000) is generated for all base points (rate x time). The scenarios are normally distributed and should have a standard deviation of 1, an expected value of 0 and a mutual correlation of base points of 0.
- What follows are corrections of random numbers, expected values and mutual correlation for standard deviation, as well as normal distribution.
- The random numbers are then multiplied with the Sholesky matrix and volatilities, after which they can be used for the simulation as correlated and volatility-appropriate scenarios.
- Changes in performances of base points are calculated for each simulation run using scenarios.

The calculated values of base points are used as the basis for generating daily changes as part of the Level II Simulation.

5.1.2.9. CfaR and EaR Framework, Level II Simulation (Volatility-Bridge)

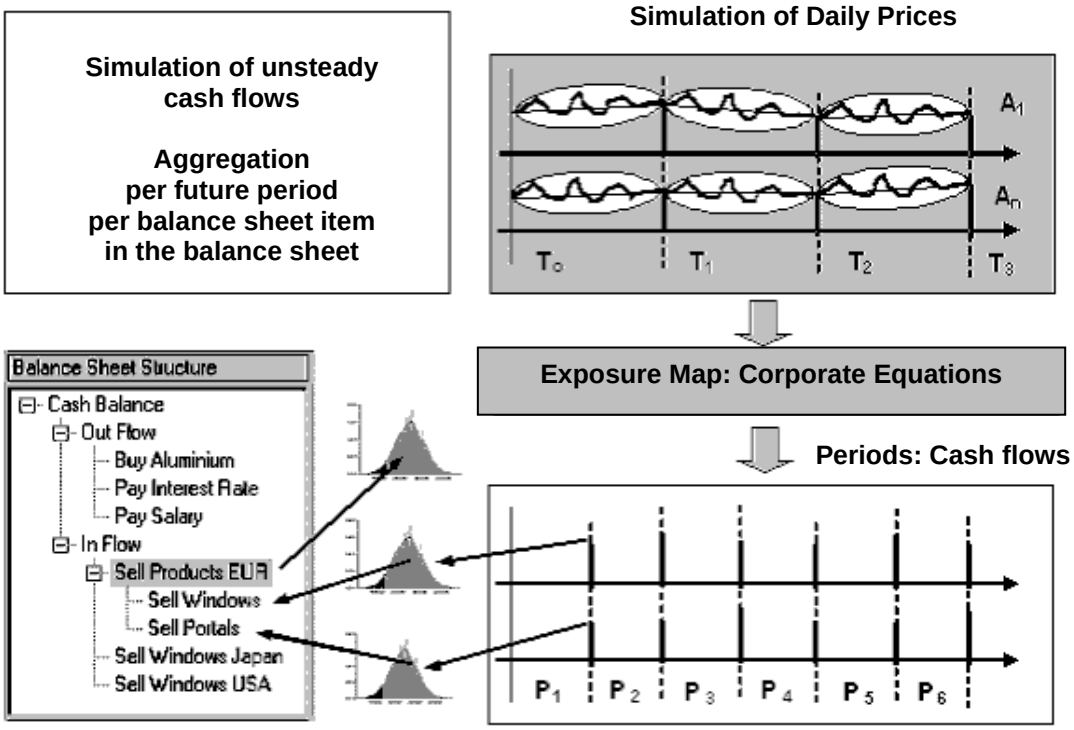


Figure 30: Sumulation of daily prices – Level II simulation

For each simulation run in the Level I Simulation, values for the base points are determined anew. With the help of the "Volatility Bridge", Level II Simulation undertakes a stochastic interpolation between base points. The following principles must be adhered to:

- Expected values between base points are interpolated linearly.
- Daily fluctuations are generated with the help of an embedded second Monte Carlo simulation (Level II Simulation) of daily changes, which are obtained from historical volatilities and correlations (see Figure 31).
- Daily fluctuations move through all base points.

In this way, daily fluctuations are generated for all risk variables, for all days of the observation period. The simulation of risk variables in a simulation market is calculated independent of the time grid and time periods of the plan items to be simulated. Simulation values are taken from the simulation market for all primary cash flows or plan values, as well as for all simulation runs. All corresponding plan items are calculated using the valuation formulas. Ultimately, at the end of the simulation, value distributions are generated per plan item and per time period, from which simulation results (such as CfaR, Expected Value, Expected Loss, Confidence Value, etc.) can be read.

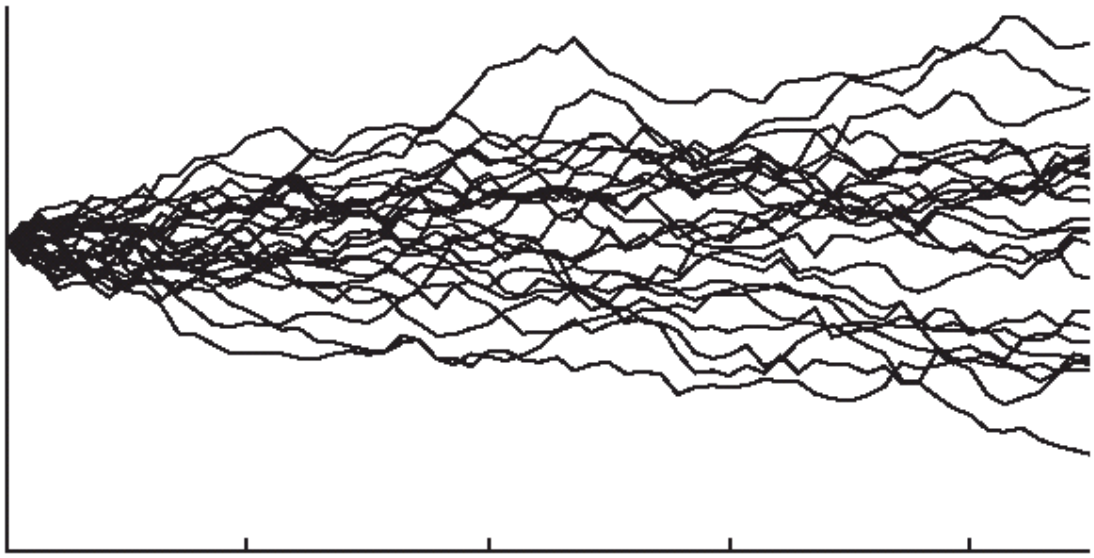


Figure 31: Sumulation of daily prices – Simulation path

Expected and confidence values (with a preselected confidence level, e.g. 95%) are primarily determined from distributions. The following results can be calculated in a subsequent calculation:

Expected Loss = Plan (Budget) Value – Expected Value

CfaR = Expected Value – Confidence Value

Total VaR = Plan (Budget) Value – Confidence Value

5.1.3. CfaR/EaR Analysis

5.1.3.1. Definition of Risk Variables (Risk Factors) and Simulation Markets

The CfaR/EaR analysis requires the definition of risk variables (risk factors, market rates) that can be applied to various simulation markets. To open the window for the definition of risk variables and simulations markets, on must open the main menu CfaR/EaR Markets/Define Market for Liquidity and CfaR/EaR Manager.

Definition of Risk Variables

In the first step, risk variables are defined, modified or removed independent from simulation markets. This is achieved via the pop-up menu in the window Risk Variables, by pressing the right mouse button or using the buttons in the graphical interface. The variables are then combined to form simulation markets and thus provide the simulation space for the evaluation of liquidity plans.

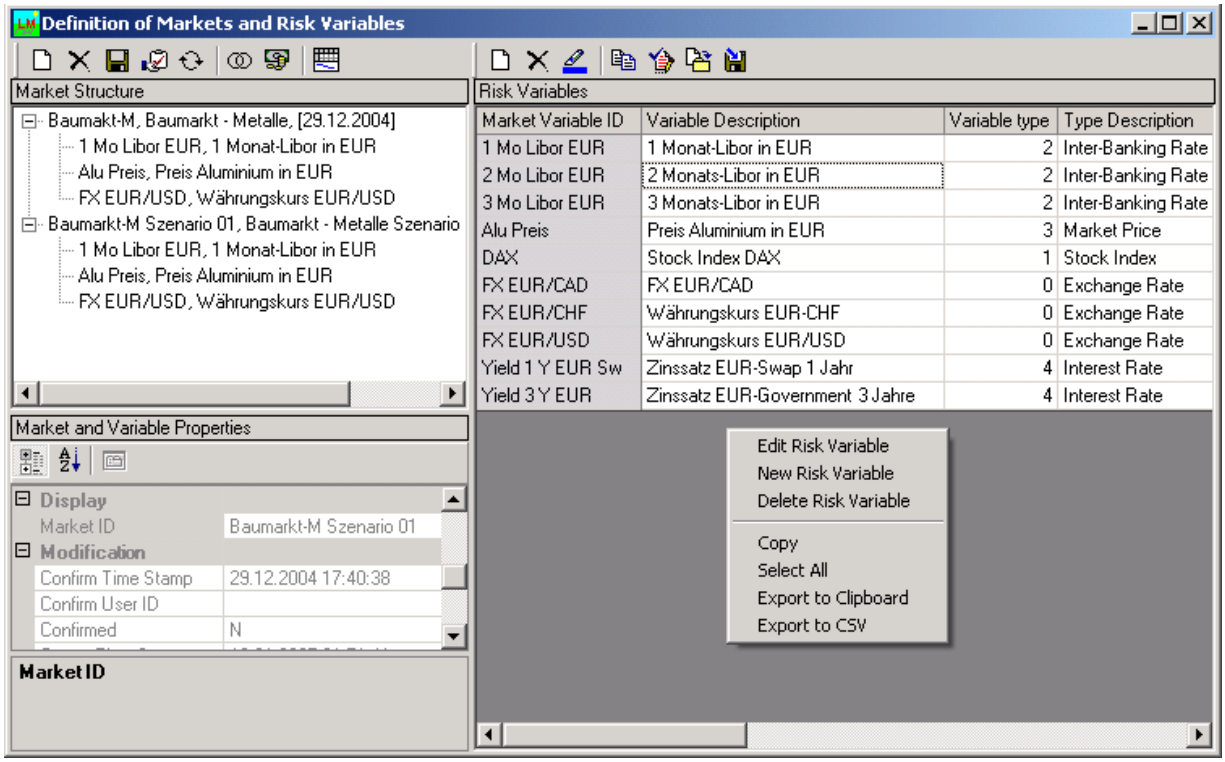


Figure 32: Definition of simulation markets and risk variables (risk factors)

The following table contains the description of the context-dependent buttons and their corresponding context-dependent pop-up menu items within the Risk Variables browser (see Figure 32):

Button, Menu Item	Description
Edit Risk Variable	Opens the browser for the modification of an existing risk variable that has previously been selected (s. Figure 33). “Update” rights are required for this operation.
New Risk Variable	Opens the browser for the definition of a new risk variable (s. Figure 33). „Add“ rights are required for this operation.

Button, Menu Item	Description
Delete Risk Variable	Deletes an existing risk variable that has previously been selected in the browser. Depending on the user right, the deleting is either logical (market as „deleted“) or physical (deleted from the database). „Remove“ rights are required for the logical, and „exclusive“ rights for the physical removal.
Copy	An area that has previously been selected is copied into the clipboard.
Select All	All rows in the browser are selected. This is usually performed prior to copying to clipboard.
Export to Clipboard	The entire area of the browser is exported (copied) to the clipboard.
Export to CSV	The entire area of the browser is exported (copied) to a CSV file. The file name is selected or entered in a Windows window before the export.

The table below contains the descriptions of the browser columns shown in Figure 32:

Browser Column	Description
Market Variable ID	Freely definable ID of market variables (risk variable, risk factor)
Variable Description	User description of market variables
Variable Type	Market variable type (0 - Exchange Rate, 1 - Stock Index, 2 - Inter-Banking Rate, 3 - Market Price, 4 - Interest Rate).
Type Description	Description of the variable type
Data source	
Variable ID	Unique ID for the time series for Exchange Rate, Stock Index, Inter-Banking Rate, Market Price or Interest Rate
Provider	Data provider for time series
Market ID	Market for the time series
BidMidAsk	Indicator for bid-, mid- or ask-time series
Currency	Currency of the time series (first currency for the Exchange Rate)
FX Currency	Second currency of the time series for the Exchange Rate
Offset (years)	Maturity at Interest Rate, in years
Offset (months)	Maturity at Interest Rate, in months
Offset (days)	Maturity at Interest Rate, in days

Browser columns in the group “Data Source” show the definition of historical data sources for risk variables. Historical data sources for risk variables are assigned in the window Definition of Risk Variables. Historical time series are defined by calculating the daily volatility and correlation of risk variables within a simulation market, as well as by determining the autocorrelation of each risk variable along the time grid.

The definition of risk variables and their historical data sources is performed in the window Definition of Risk Variables (see Figure 33).

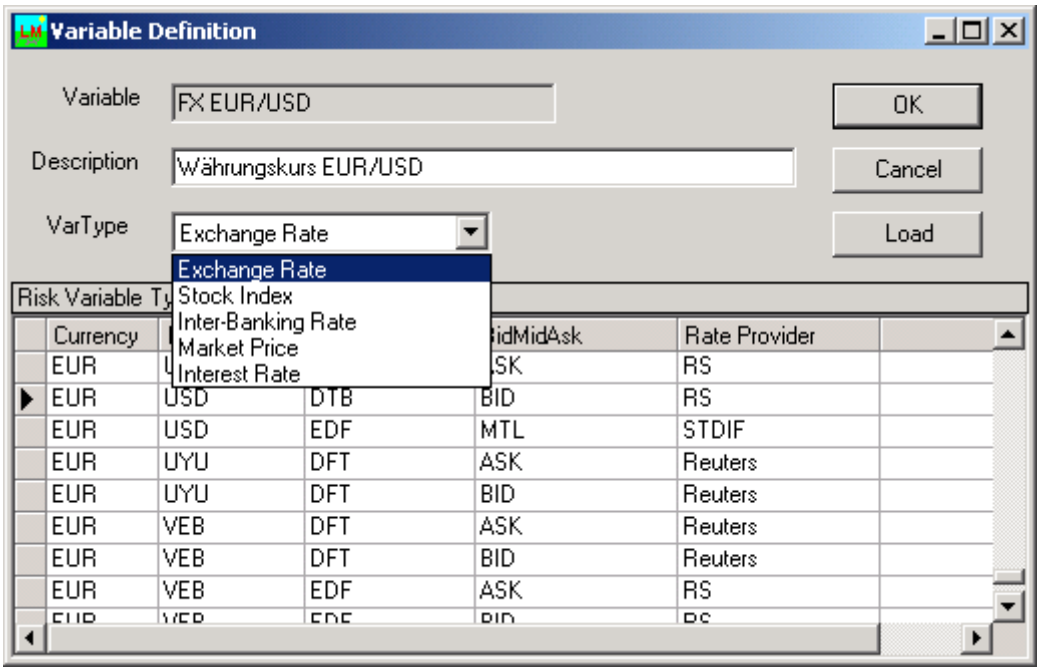


Figure 33: Browser for the definition of a new risk variable

The table below contains the description of fields and buttons in the window Definition of Risk Variables (see Figure 33). Browser columns are contextual and depend on the market variable type. Columns describe the selection criteria for time series, which are important for accessing historical data in the data tables. The following table contains the description of browser columns for the variable type Interest Rate.

Field, Button	Description
Variable	Freely definable ID of market variables (risk variable, risk factor)
Description	User description of market variables
Var Type	Combo box for the selection of the market variable type (Exchange Rate, Stock Index, Inter-Banking Rate, Market Price, Interest Rate).
OK	Closes the window and confirms the specifications
Cancel	Closes the window ignoring the specifications
Load	Loads all descriptions and selected parameters from the time series of a selected variable type. For a time series to be assigned as data source of a risk variable, a corresponding row in the browser must be selected
Browser Columns	**Description**
	Only for the variable type Interest Rate
Market Definition ID	Unique ID of a time series for Exchange Rate, Stock Index, Inter-Banking Rate, Market Price or Interest Rate
Market Description	Description of the market variable
Interest Rate Basis	Daily counting convention
Money Market Def.	Money market curve
IsMoneyMarket	Indicator for money market curve
Corresponding Currency	Currency of the time series
Source Market	Market of the time series
Curve Provider	Data provider for the time series

Field, Button	Description
BidMidAsk	Indicator for bid-, mid- or ask-time series
Offset in years	Maturity at Interest Rate, in years
Offset in months	Maturity at Interest Rate, in months
Offset in days	Maturity at Interest Rate, in days
id	Internal ID (counter) of the time series

Definition of Simulation Markets

The second step in defining a simulation environment is the definition of a simulation market. To define a simulation market and assign risk variables to it, one uses the tree structure that is located on the left-hand side of the window Definition of Simulation Markets and Risk Variables (see Figure 32). One can use a pop-up menu (see Figure 34) or buttons in the tree structure.

To navigate the tree-shaped illustration of simulation markets, one presses the left mouse button on the tree branch marked with “+” or “-” to open and close the branch (see Figure 32).

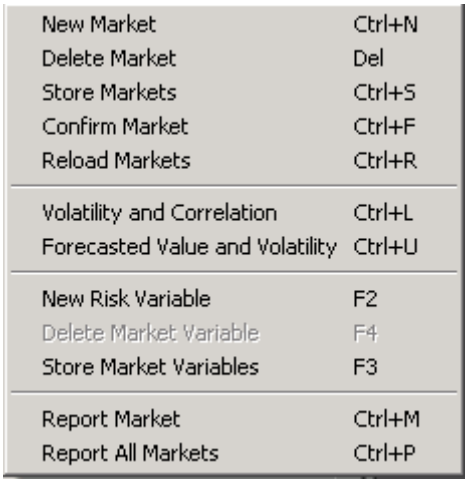


Figure 34: Pop-up menu for the definition of simulation markets and risk variables

The following table contains the descriptions of menu items from the pop-up menu:

Button, Menu Item	Description
New Market	Opens a window for the definition of a new simulation market (s. Figure 35). “Add” rights are required for this operation.
Delete Market	Deletes an existing simulation market that has been previously selected in the tree. The deleting is either logical (marked as deleted) or physical (removed from the database), depending on the user rights. “Remove” rights are required for the logical removal, while “exclusive” rights are required for the physical removal.
Store Market	Stores an existing simulation market, that has been previously selected in the tree, in the data base. „Update“ rights are required for this operation.
Confirm Market	Confirms an existing simulation market, that has previously been selected in the tree. The tree cannot be modified after the confirmation. „Confirm“ rights are required for this operation.

Button, Menu Item	Description
Reload Markets	Loads simulations markets and their associated risk variables from the database, while ignoring all changes that have not been saved. „View“ rights are required for this operation.
Volatility and Correlation	Opens a window for the calculation of historical daily volatilities and correlations (s. Figure 38). Calculates daily volatilities and correlations from historical time series for risk variables of a simulation market, for the period of one year. Daily volatilities and correlations are required in the Monte Carlo simulation for the definition of the “Volatility Bridge”.
Forecasted Value and Volatility	Opens the window for the forecasting of performances and volatilities of risk variables (s. Figure 40), where one can define performances and volatiles of risk variables within a simulation market for a future time period. The calculation of auto- and cross-correlation of risk variables is performed prior to the Monte Carlo simulation, using historical data and future performance and volatility.
New Risk Variable	Opens a browser for the definition of new risk variables (s. Figure 33). „Add“ rights are required for this operation.
Delete Market Variable	Deletes an existing risk variable, that has previously been selected in the tree.
Store Market Variables	Stores all risk variables in the data base. „Update“ rights are required for this operation.
Report Market	Runs the Crystal Reporter for the generation of a report of an existing simulation market, that has previously been selected in the tree.
Report All Markets	Runs the Crystal Reporter for the generation of reports of all simulation markets.

To add risk variables to a simulation market, one uses the Drag&Drop feature. A risk variable from the window Risk Variables is moved with the mouse to the tree node of a simulation market in the Market Structure tree.

Risk variables from a simulation market create an evaluation space for the Monte Carlo simulation of a liquidity plan. Only risk variables from the simulation market are simulated. For these risk variables historical volatility and correlation, as well as auto-correlation and cross-correlation, are calculated.

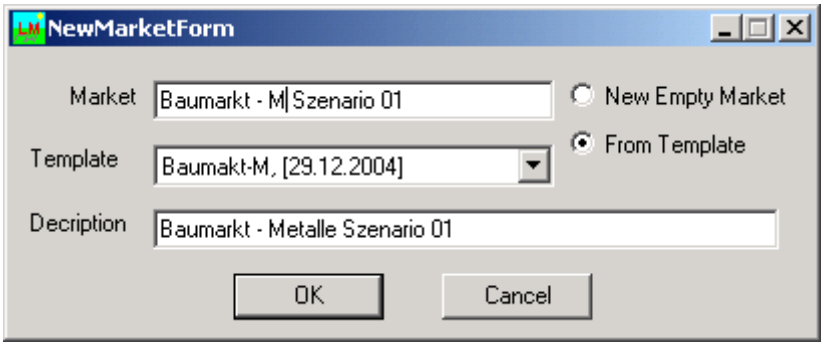


Figure 35: Definition of a new simulation market

A new market can be defined in the window Definition of a new simulation market. The following table is comprised of descriptions of fields and buttons within this window (s. Figure 35):

Field, Button	Description
Market	Unique ID of the market (up to 30 characters)
Template	Selects an existing market as a template model
Description	Description of the market (up to 50 characters)
New Empty Market	Defines a new market
From Template	Creates a market from a set of templates; creates a copy of an existing market
OK	Closes the window and confirms the settings
Cancel	Closes the window ignoring the settings

5.1.4. Properties of Simulation Markets and Risk Variables

Each simulation market is characterized by having its own properties. Important properties include automatically supported data (see Figure 36) for the historization (date and user ID for creating, modifying, confirming and deleting simulation markets), that conform to the corresponding user rights.

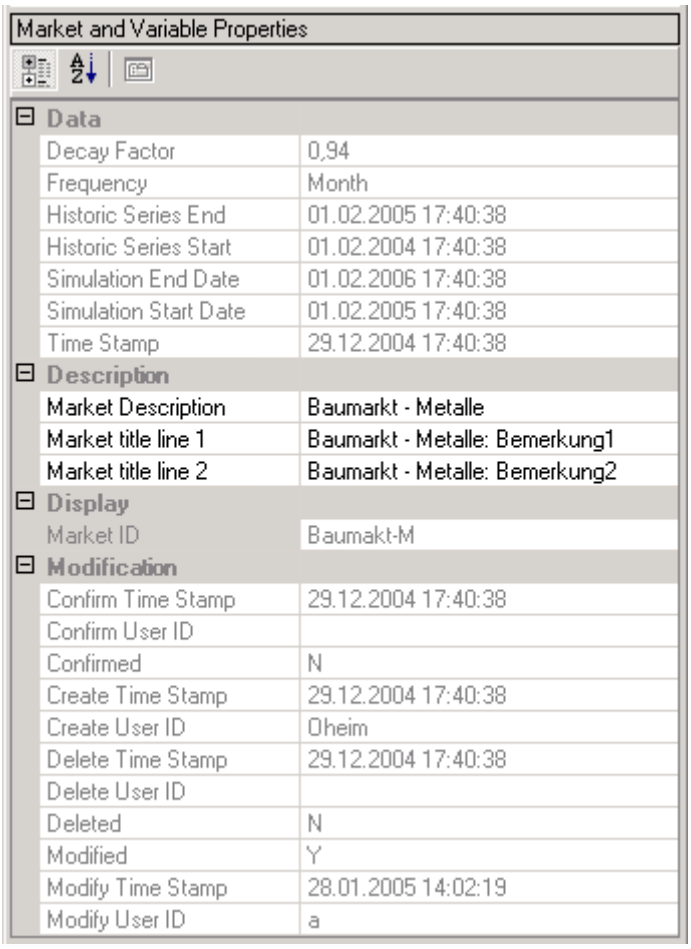


Figure 36: Simulation market properties

The following table contains the description of the fields in the window Simulation market properties (see Figure 36):

Field	Description
Group Data	
Decay Factor	Decay factor in the calculation of historical volatility and correlation of time series
Frequency	Time grid of the simulation period (daily, weekly, monthly,...)
Historic Series End	End of the observed period of historical dates
Historic Series Start	Start of the observed period of historical dates
Simulation End Date	End date of the simulation time period
Simulation Start Date	Start date of the simulation time period
Time Stamp	Time stamp of the simulation market
Group Description	
Market Description	Description of the simulation market (up to 50 characters), editable
Market tittle line 1	Extended description 1 of the simulation market (100 characters), can be displayed when reporting, editable
Market tittle line 2	Extended description 2 of the simulation market (100 characters), can be displayed when reporting, editable
Group Display	
Market ID	Unique ID of the simulation market (up to 30 characters)
Group Modification	
Created, Create User, Create Time Stamp	Definition of the simulation market: Status (Y/N), user ID, date of creation
Modified, Modify User, Modify Time Stamp	Modification of the simulation market: Status (Y/N), user ID, date of modification
Confirmed, Confirm User, Confirm Time Satamp	Confirmation of the simulation market: Status (Y/N), user ID, date of confirmation
Deleted, Delete User, Delete Time Stamp	Removal of the simulation market: Status (Y/N), user ID, date of the deletion

Each risk variable has its own properties too (see Figure 37), which are specified when variables are being defining and assigned to historical data sources.

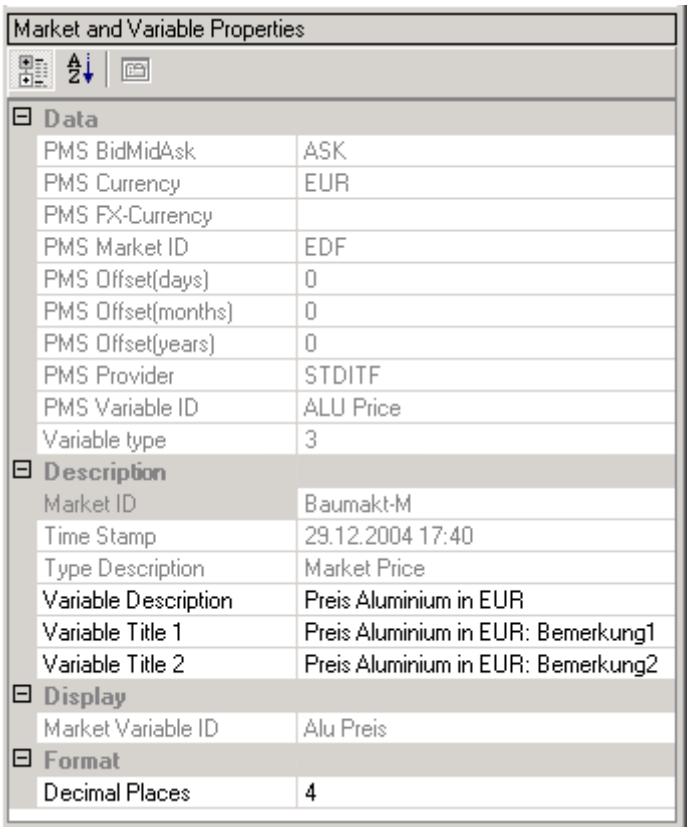


Figure 37: Risk variable properties

The following table contains the descriptions of fields in the browser Risk variable properties (see Figure 37):

Field	Description
Group Data	
BidMidAsk	Indicator for bid-, mid- or ask-time series
Currency	Currency of the time series (first currency for the Exchange Rate)
FX-Currency	Second currency of the time series for Exchange Rate
Market ID	Market of the time series
Offset (years)	Maturity at Interest Rate, in years
Offset (months)	Maturity at Interest Rate, in months
Offset (days)	Maturity at Interest Rate, in days
Provider	Data provider for the time series
Variable ID	Unique ID of the time series for Exchange Rate, Stock Index, Inter-Banking Rate, Market Price or Interest Rate
Variable Type	Market variable type (0 - Exchange Rate, 1 - Stock Index, 2 - Inter-Banking Rate, 3 - Market Price, 4 - Interest Rate)
Group Description	
Market Variable Id	Unique ID of the simulation market to which the risk variable is assigned
Time Stamp	Time stamp for the risk variable
Type Description	Description of the variable type
Variable Description	User description of risk variables

Field	Description
Plan title line 1	Extended description 1 (100 characters) of risk variables, can be displayed when reporting, editable
Plan title line 2	Extended description 2 (100 characters) of risk variables, can be displayed when reporting, editable
Group Display	
Market Variable ID	Unique ID of the market variable (risk variable, risk factor)
Group Format	
Decimal Places	Number of decimal positions after the comma when expressing results in the results browser

5.1.5. Calculation of Historical Daily Volatilities and Correlations of Risk Variables

As the name suggests, in the window Daily Historic Volatility and Correlation Matrix (see Figure 38) one can perform calculations for historical volatilities and correlations of simulation markets. Via a combo box the user can select an already defined simulation market and can choose a start date and end date for the calculation. If all or some risk variables in the simulation market are not connected to the historical data supply, the user can enter the volatilities and correlations manually. It is also possible to edit the calculated values. Historical volatilities and correlations of the simulation market are used to generate daily values with the help of a “Volatility Bridge”,.

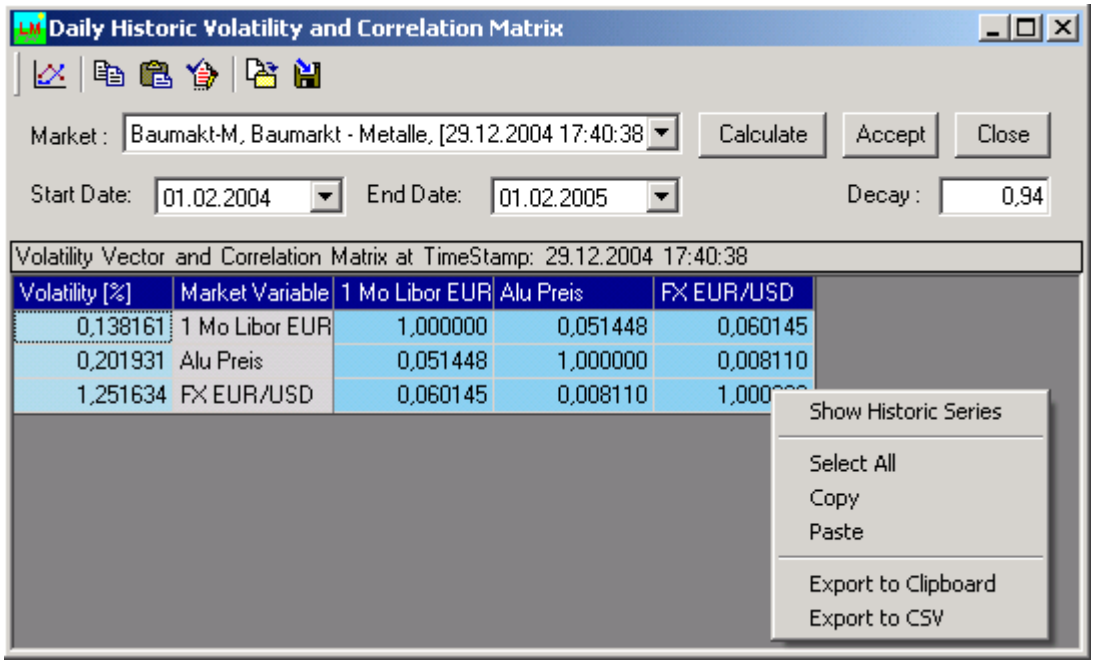


Figure 38: Calculation of daily historical volatility and correlation

The following table contains the descriptions of buttons and columns in the browser, as well as options in the pop-up menu, that are shown in Figure 38:

Element	Description
Fields and Buttons	
Market	Selects the simulation market
Start Date	Start date of the historical period
End Date	End date of the historical period
Decay	Decay factor in the calculation of historical volatility
Calculate	Calculates historical volatility and correlation
Accept	Saves the calculated or entered historical volatility and correlation in the database
Close	Closes the window
Browser Columns	
Volatility	Historical daily volatility of risk variables (expressed in %)
Market Variable	Description of market variables
Description of Risk Variables	Description of risk variables in the columns of the correlation matrix
Pop-Up Menu	**(Buttons in the upper part of the window)**

Element	Description
Show Historic Series	Tabular and graphical illustration of a historical time series selected in the dialogue Historic Series.
Select All	Selects all elements in the browser, normally used for Copy and Paste.
Copy	Copying of a previously marked area in the browser to the clipboard.
Paste	Inserts data from the clipboard, with respect to the data that has been selected in the browser. This means that externally calculated data can be transferred.
Export to Clipboard	Export of the entire browser content, including fields in the dialogue, to the clipboard.
Export to CSV	Export of the entire browser content, including fields in the dialogue, to a CSV file. A user dialog for the selection of a CSV file opens.

For each risk variable, a new Historic Series window can be opened, by using a pop-up menu and selecting the option Show Historic Series. It shows historical data for each date in a given historical period, in tabular and graphical form (see Figure 39).

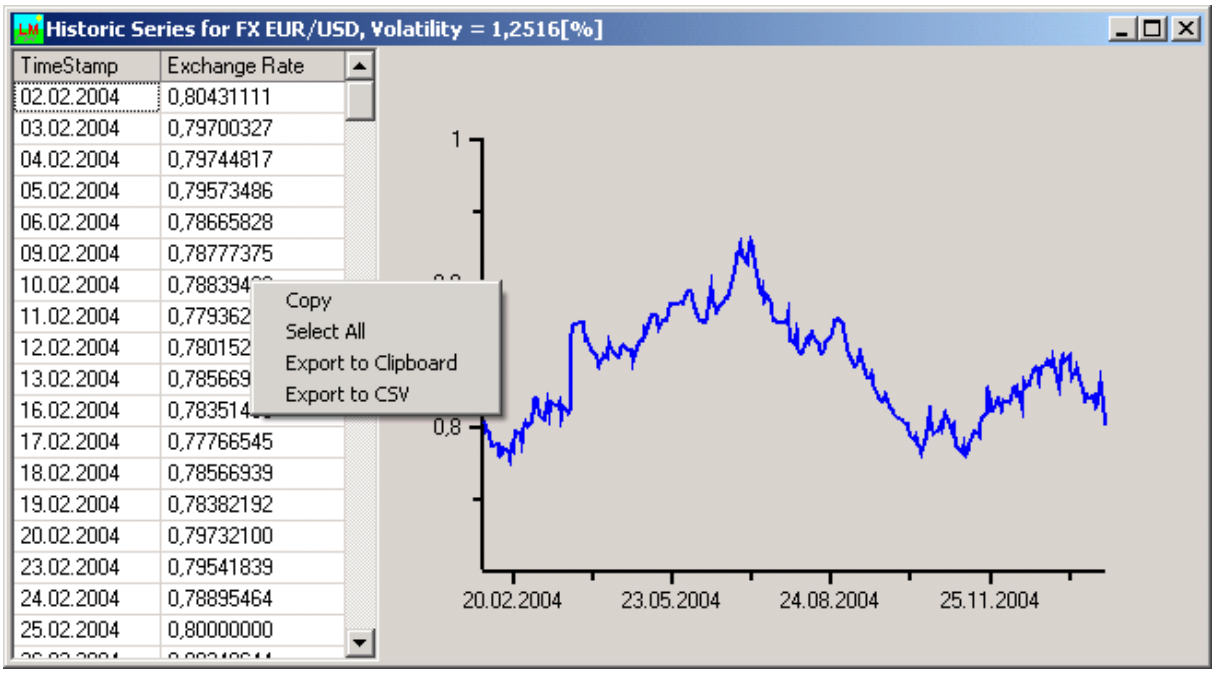


Figure 39: Graphical illustration of historical time series for one risk variable

The description of options within the pop-up menu (see Figure 39) is displayed in the following table:

Option	Description
Copy	Copies a previously selected area in the browser to the clipboard.
Select All	Selects all elements in the browser, normally used for Copy and Paste.
Export to Clipboard	Export of the entire browser content to the clipboard.
Export to CSV	Export of the entire browser content to a CSV file. A user dialog for the selection of a CSV file opens.

5.1.5.1. Forecasting of Future Performances and Volatilities of Risk Variables

In the browser Forecasted Value and Volatility one can perform forecasts of future performances and

volatilities of risk variables within a simulated market (see Figure 40). The user selects a previously defined simulation market from the combo box Market and chooses the start and end date of the forecast, as well as the time grid. Future time points of the forecast are calculated according to the specified period and displayed in the browser. The same number of historical time points is calculated as well, going backwards from the start date. The forecasted and historical periods are used for the calculation of cross-correlation and cross-covariance of risk variables along the time axis (see Figure 28). For each risk variable, two rows are created in the browser – one for the performance and one for volatility, expressed annually, in %.

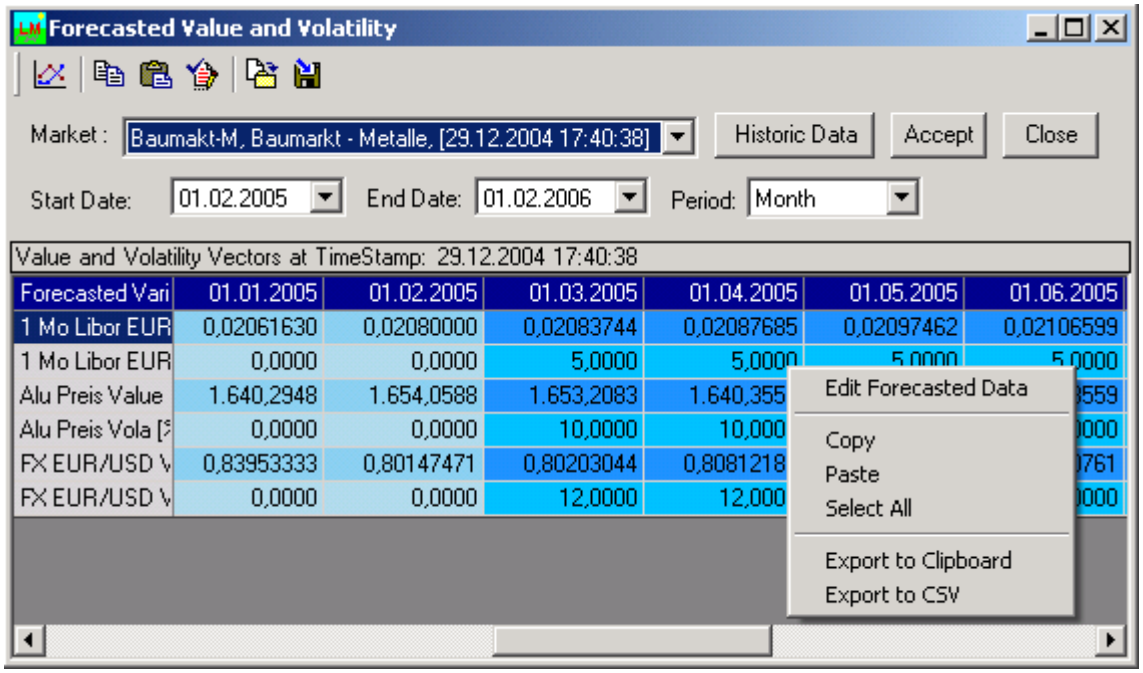


Figure 40: Forecasted performances and volatilities for risk variables

The forecasted performances and volatilities can be directly edited and created graphically in the browser by selecting the option Edit Forecasted Data in the pop-up menu. Historical performances can also be edited or they can be taken from historical data supplies by pressing the button Historic Data. The volatility in the historical period is always equal to 0. If all, or just one part, of risk variables within the simulation market is not connected to the historical data supply, a user can manually enter the necessary values in the browser. It is also possible to subsequently edit the calculated values.

The table below contains the descriptions of options from the pop-up menu shown in Figure 40:

Option	Description
Edit Forecasted Data	Opens a dialogue within a browser with a interactive graphical interface, specifying the performance and volatility of a selected risk variable.
Copy	Copies a previously marked area in the browser to the clipboard.
Paste	Inserts data from the clipboard, with respect to the data selected in the browser. In this way externally calculated data and forecasts can be transferred.
Select All	Selects all elements in the browser, normally used for Copy and Paste.
Export to Clipboard	Export of the entire browser content to the clipboard.
Export to CSV	Export of the entire browser content to a CSV file. A user dialog for the selection of a CSV file opens.

For each risk variable, the window Edit Forecasted Data can be opened, by selecting the option Edit Forecasted Data from the pop-up menu. It shows the historical and future performances and volatilities for specified historical and future dates within a simulated market. A 2D chart is displayed as well (see Figures 41 and 42). It is possible to define and edit future performances and volatilities of risk variables in the browser's interactive graphic.

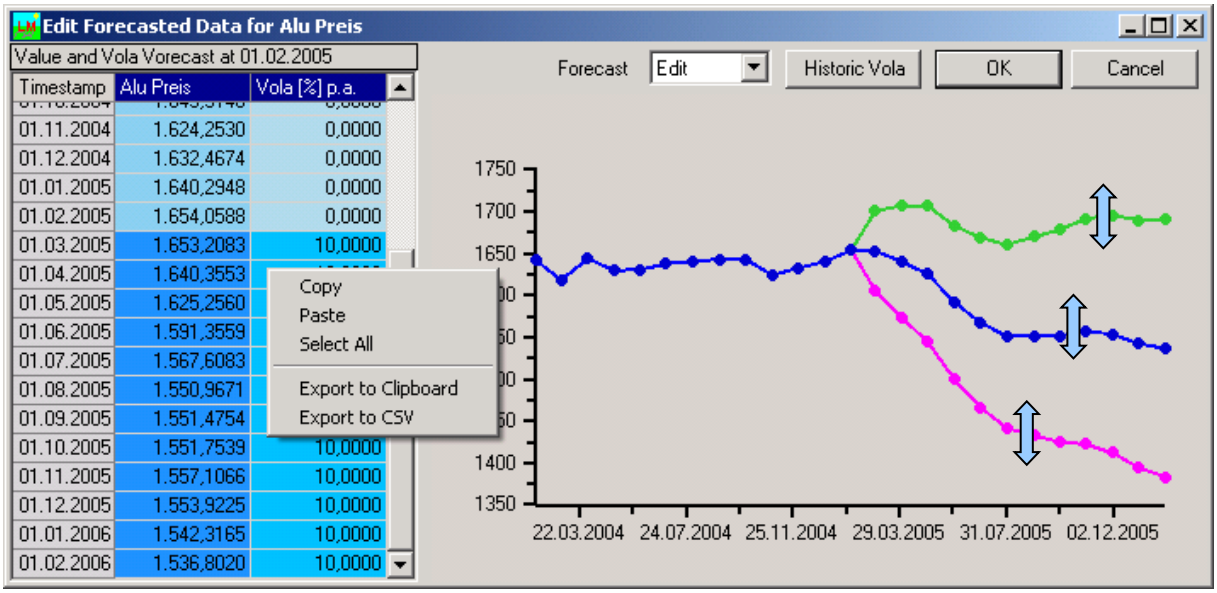


Figure 41: Graphical illustration of forecasted performances and volatilities of risk variables

The following table contains the descriptions of fields, buttons and columns in the window, as well as options in the pop-up menu (see Figure 41):

Element	Description
Fields and Buttons	
Forecast	Navigates through an interactive graphical editor for the forecast of performances and volatilities of risk variables.
Historic Vola	Transfer of calculated historical volatility as future volatility for all basis points (s. Figure 38). The historical daily volatility is calculated using the square root-time formula and is extrapolated p.a.
OK	Closes the dialogue and transfers the edited values into the browser Forecasted Value and Volatility (s. Figure 40.)
Cancel	Closes the window without taking into account the edited values.
Browser Columns	
Timestamp	Historical or future time period within the historical or future time span.
Description of risk variables	Description of the edited risk variables
Vola % p.a.	Forecasted volatility of risk variables (in %), on an annual basis
Pop-Up Menu	
Copy	Copies a previously marked area in the browser to the clipboard.
Paste	Inserts data from the clipboard, with respect to the data selected in the browser. This means that externally calculated and forecasted data can be transferred.
Select All	Selects all elements in the browser, normally used for Copy and Paste.
Export to Clipboard	Exports the entire browser content to the clipboard.

Element	Description
Export to CSV	Exports the entire browser content, including fields in the dialogue, to a CSV file. A user dialog for the selection of a CSV file opens.

To graphically edit performances and volatilities of risk variables, go to the window Edit Forecasted Data and to the chart area on the right (see Figure 42). Historical and future performances are displayed with a blue line chart. The volatility of future time periods is displayed with a green chart line for positive fluctuations and a red one for negative fluctuations. For each point within these chart lines, a positive or negative shift is calculated, compared to the values from the blue chart line. This is achieved by using the root-time formula of volatility. Every future point within the three chart lines can be moved via the Drag&Drop feature, by pressing the left mouse button, whereby the corresponding values in the browser change accordingly. The volatility is converted back to an annual basis by reversing the square root-time formula. The shifting of points (individually or in groups) depends on the settings defined in the Forecast combo box (see Figure 42). Possible settings are:

- Edit: Editing of a single point with the mouse
- Shift: Parallel displacement of all points with the mouse
- Twist: Shifting of one point and interpolated shifting of all other neighboring points (bending of the curves)

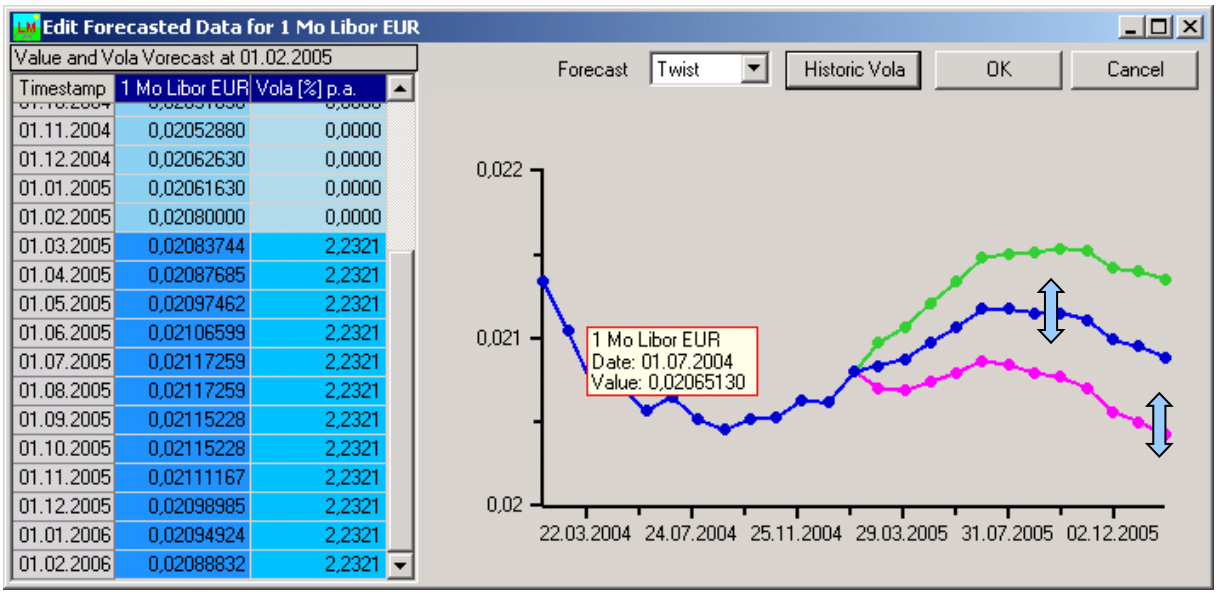


Figure 42: Graphical editing of forcasted performances and volatilities for risk variables

9.5.4.5 Linking Market Variables to Balance Sheet Items

To link balance sheet or plan items to risk variables in a simulation market for a subsequent CfaR/EaR simulation, the following steps must be followed: open a pop-up menu in the list Balance Sheet Structures and select the option Open Balance Sheet (see Figure 4).

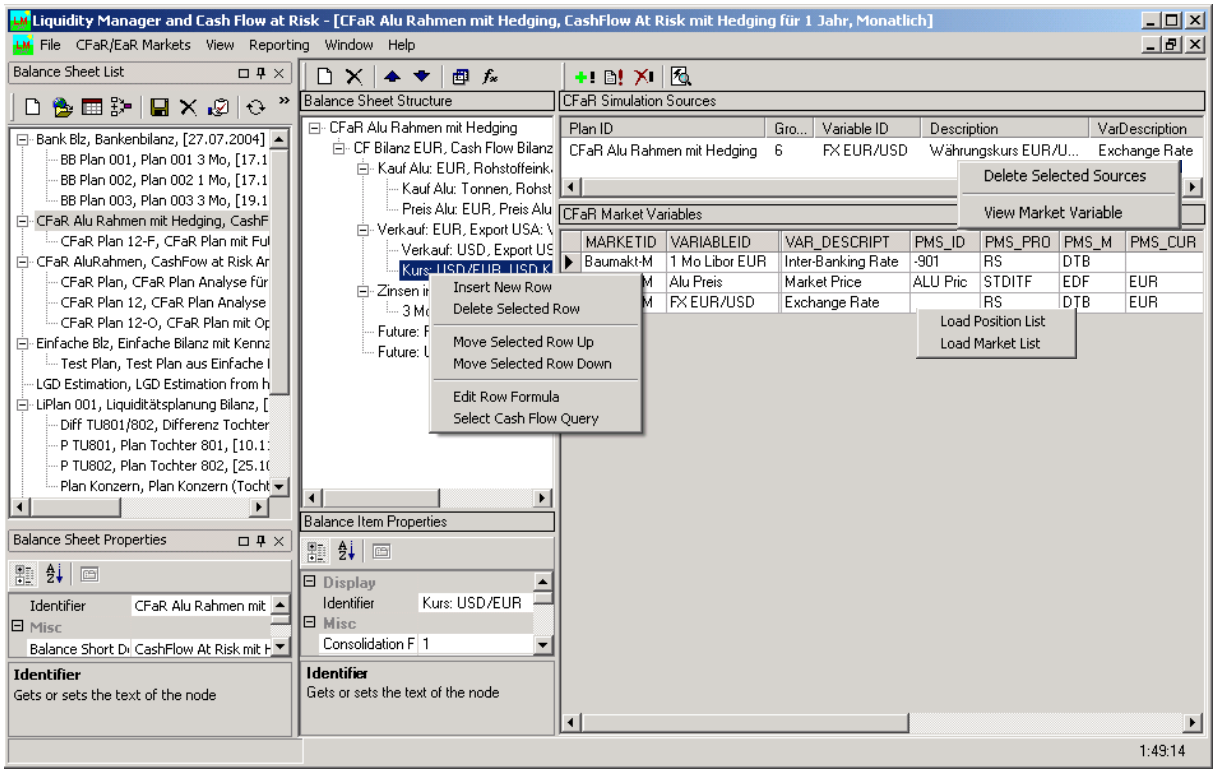


Figure 43: Connecting market variables to balance items

Simulation Sources

Simulation sources for the lowest balance nodes (base items) in the tree structure can be risk variables of a simulation market. The simulation market is selected in the browser (see Figure 44) and risk variables are assigned to the lowest balance node from the simulation market: on the right in the CfaR Market Variables area, select the variables in the leftmost column and then use the Drag&Drop feature to move them onto a base item in the Balance Sheet Structure area (see Figure 43). Browsers CfaR Simulation Sources and CfaR Market Variables (Figure 43) can be filled with data via pop-up menus. To see the assigned risk variable for the selected basis item, open the menu by pressing the right mouse button in the CfaR Simulation Sources area and choose the option View Market Variable. To open the browser for the Selection of Simulation Markets (Figure 44), press the right mouse button in the CfaR Market Variables area and select Load Market List from the menu.

Static simulation sources can be selected in the CfaR Simulation Sources area and are deleted using the pop-up menu (press the right mouse button in the CfaR Simulation Sources area and select the Delete Selected Sources option) as shown in Figure 43.

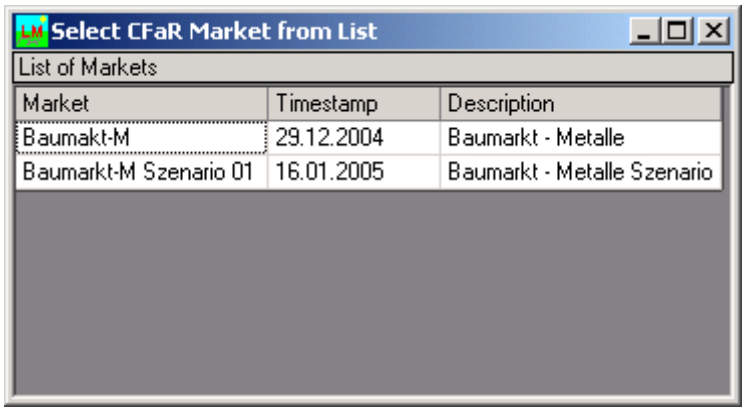


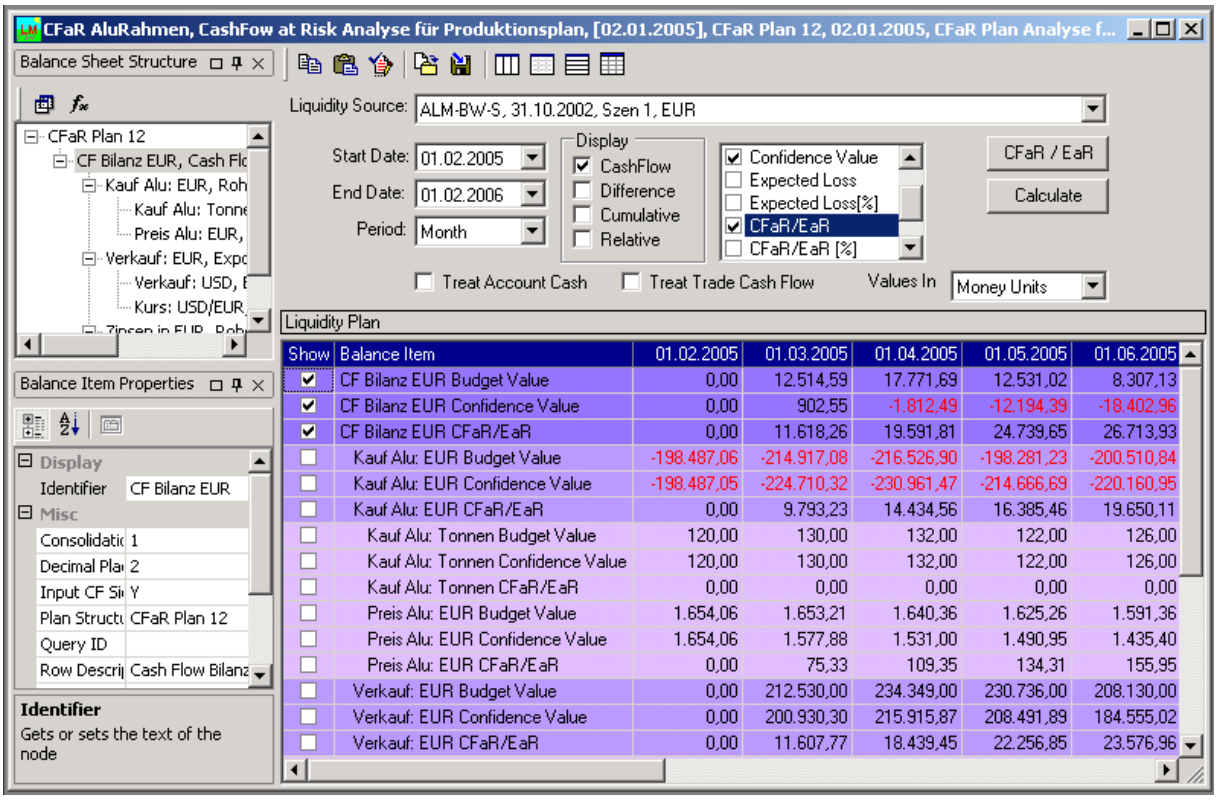
Figure 44: Selection of a simulation market that represent simulation sources for balance items

The table below contains the description of columns in the windows Selection of a simulation market (see Figure 44). The selection is performed by double-clicking a browser column.

Feld, Button	Description
Market	Name of the simulation market
Timesatamp	Timestamp of the simulation market. Simulation markets with the same name and different time stamps can be defined.
Description	Description of the simulation market

5.1.5.2. Simulation Results Browser

The dialogue that displays simulation results (see Figure 45) is a natural extension of the browser for tabular and graphical representations of cash flows in liquidity management (see Figures 18 and 19). The meaning of fields and their corresponding pop-up menu items (see Figure 46) is identical to the cash flow browser (see Figure 18 and 19).



Show	Balance Item	01.02.2005	01.03.2005	01.04.2005	01.05.2005	01.06.2005
☑	CF Bilanz EUR Budget Value	0,00	12.514,59	17.771,69	12.531,02	8.307,13
☑	CF Bilanz EUR Confidence Value	0,00	902,55	-1.812,49	-12.194,39	-18.402,96
☑	CF Bilanz EUR CFaR/EaR	0,00	11.618,26	19.591,81	24.739,65	26.713,93
☐	Kauf Alu: EUR Budget Value	-198.487,06	-214.917,08	-216.526,90	-198.281,23	-200.510,84
☐	Kauf Alu: EUR Confidence Value	-198.487,05	-224.710,32	-230.961,47	-214.666,69	-220.160,95
☐	Kauf Alu: EUR CFaR/EaR	0,00	9.793,23	14.434,56	16.385,46	19.650,11
☐	Kauf Alu: Tonnen Budget Value	120,00	130,00	132,00	122,00	126,00
☐	Kauf Alu: Tonnen Confidence Value	120,00	130,00	132,00	122,00	126,00
☐	Kauf Alu: Tonnen CFaR/EaR	0,00	0,00	0,00	0,00	0,00
☐	Preis Alu: EUR Budget Value	1.654,06	1.653,21	1.640,36	1.625,26	1.591,36
☐	Preis Alu: EUR Confidence Value	1.654,06	1.577,88	1.531,00	1.490,95	1.435,40
☐	Preis Alu: EUR CFaR/EaR	0,00	75,33	109,35	134,31	155,95
☐	Verkauf: EUR Budget Value	0,00	212.530,00	234.349,00	230.736,00	208.130,00
☐	Verkauf: EUR Confidence Value	0,00	200.930,30	215.915,87	208.491,89	184.555,02
☐	Verkauf: EUR CFaR/EaR	0,00	11.607,77	18.439,45	22.256,85	23.576,96

Figure 45: Simulation results window

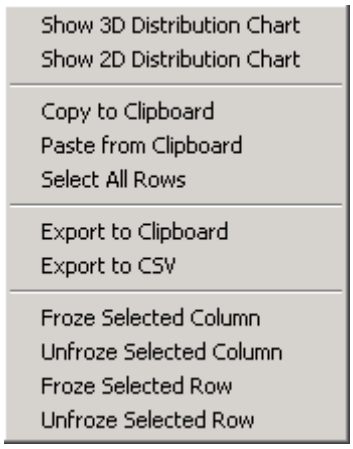


Figure 46: Pop-up menu of the Simulation Results window

The elements from the dialogue shown in Figure 45 are explained in the following table:

Element	Description
Field	
CfaR/EaR	Opens a window for the Monte Carlo simulation.
Listbox	
Simulation results	Simulation results are displayed in the browser. The following simulation results are available: **Plan Value** = Plan (Budget) - Liquidity management values **Expected Value** = Expected value of the distribution from the simulation **Confidence Value** = Value at the selected confidence level (e.g. 95%) **Expected Loss** = Plan Value - Expected Value **Expected Loss** [**%**] = Expected Loss / Plan Value * 100 **CfaR/EaR** = Expected Value - Confidence Value **CfaR/EaR** [%] = CfaR/EaR / Plan Value * 100 **Total VaR** = Expected Loss + CfaR/EaR **Total VaR** [%] = Total VaR / Plan Value * 100 **Skewness** = Sharpness of the distribution compared to a normal distribution **Kurtosis** = Skewness of the distribution compared to the normal distribution **Min Value** = Minimum simulation value **Max Value** = Maximum simulation value **Total Range** = Max Value - Min Value
Pop-Up Menu	
Show 3D Distribution Chart	A 3D distribution chart of all forecasted time periods of a CfaR plan (s. Figure 52 and 53).
Show 2D Distribution Chart	A 2D distribution chart of a selected time period of a CfaR plan (s. Figure 50 and 51).

The following results can be displayed in the browser for each plan item:

- 1 result from a Liquidity Plan
- 13 results from a Monte Carlo simulation (s. above)
- 4 rows (Cash flow, Difference, Cumulative, Relative) for each result

There are a total of (1+13)*4=56 result rows for each plan item. Each of these rows can be shown graphically. However, the graph (see Figure 47) can only show a maximum of eight performances at the same time. The chart in Figure 47 shows the positive plan development of a balance sheet value (the purple graphic). The confidence value, that has been calculated during the simulation (the red graph) is negative for the majority of forecasted time periods. This means that, with a probability of 5% (with a 95% confidence interval), the balance sheet value will be negative and the planning will not work. In this case, the plan should be restructured or redrawn. Another possibility would be to hedge the risk factors in order to keep the confidence value positive.

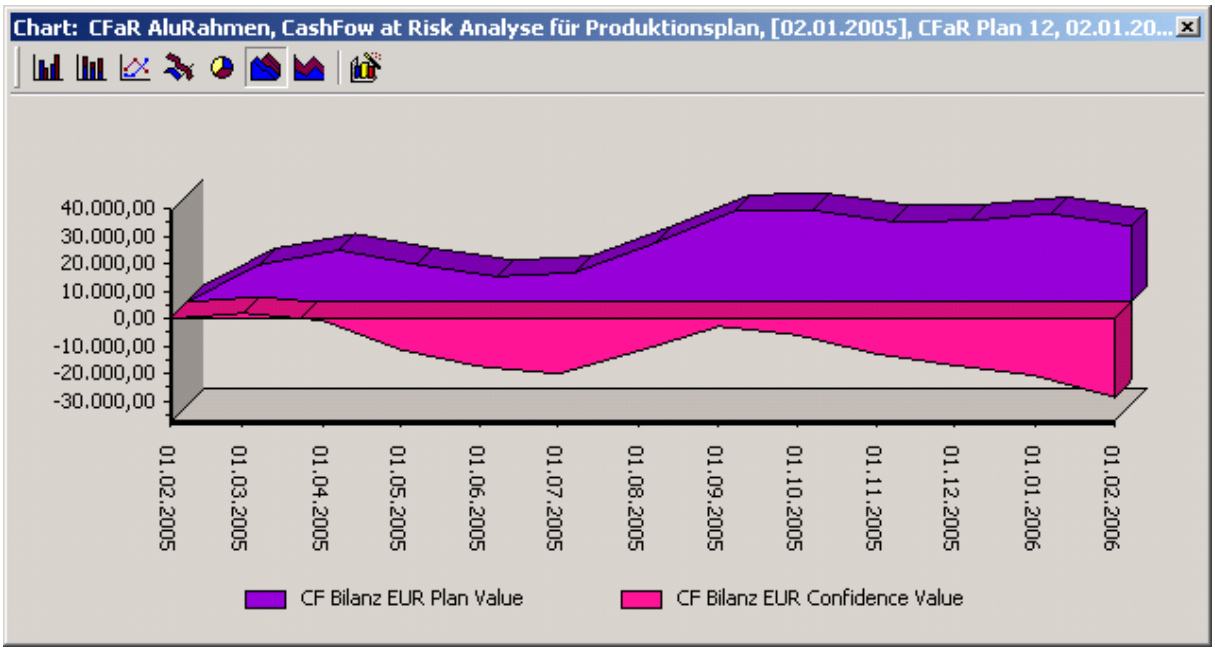


Figure 47: Graphical illustration of the performance of planned and confidence values

5.1.5.3. Navigation of the Monte Carlo Simulation

The window for the navigation of the Monte Carlo simulation is invoked from the browser that displays simulation results, via the CfaR/EaR button.

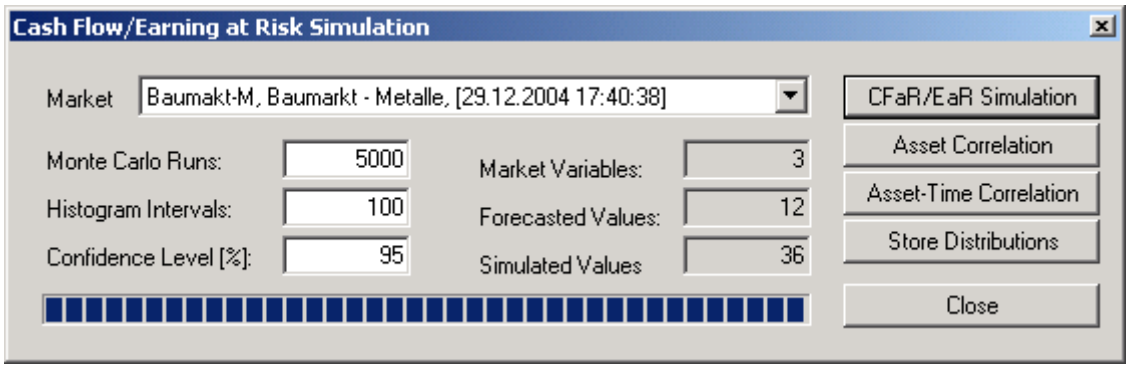


Figure 47: Navigation of the Monte Carlo simulation

The meanings of the fields and buttons in the window shown in Figure 47 can be found inside the following table:

Field/Button	Description
Fields	
Market	Combo box for the selection of simulation markets; several mutually derived and modified simulation markets can be selected one after the other as scenarios for the simulation
Monte Carlo Runs	Number of Monte Carlo simulation steps
Histogram Intervals	Number of periods for the display of histograms of 2D and 3D distributions
Confidence Level [%]	Confidence interval for CfaR/EaR (in %)
Market Variables	Number of simulated risk variables

Field/Button	Description
Forecasted Variables	Number of forecasted simulation time periods
Simulated Values	Total number of simulated variables = risk variables * simulation times
Buttons	
CfaR/EaR Simulation	Start of the Monte Carlo simulation
Asset Correlation	Displays the correlation matrix of risk variables (s. Figure 48)
Asset-Time Correlation	Displays auto- and cross-correlation matrices of risk variables and time periods (s. Figure 49.
Store Distributions	Saves the simulation distribution for all time periods of all plan items to the data base
Close	Closes the window

Figures 48 and 49 show the correlation matrix of risk variables, as well as auto- and cross-correlation matrices of risk variables and times periods. The meaning of the options in the pop-up menus in both browsers is as follows:

Menu options	Description
Copy	Copies an area that has previously been selected in the browser to the clipboard.
Select All	Highlights all elements in the browser, mostly used for Copy.
Export to Clipboard	Exports all browser content to the clipboard.
Export to CSV	Exports the entire browser content to a CSV file. A user dialog for the selection of the CSV file opens.

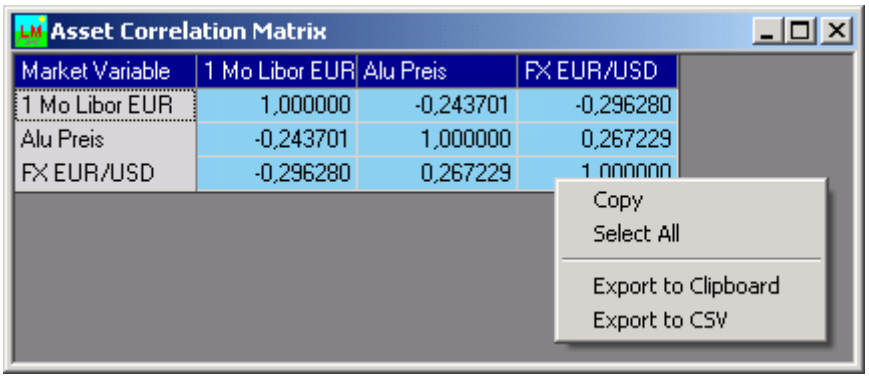


Figure 48: Correlation matrix of market variables

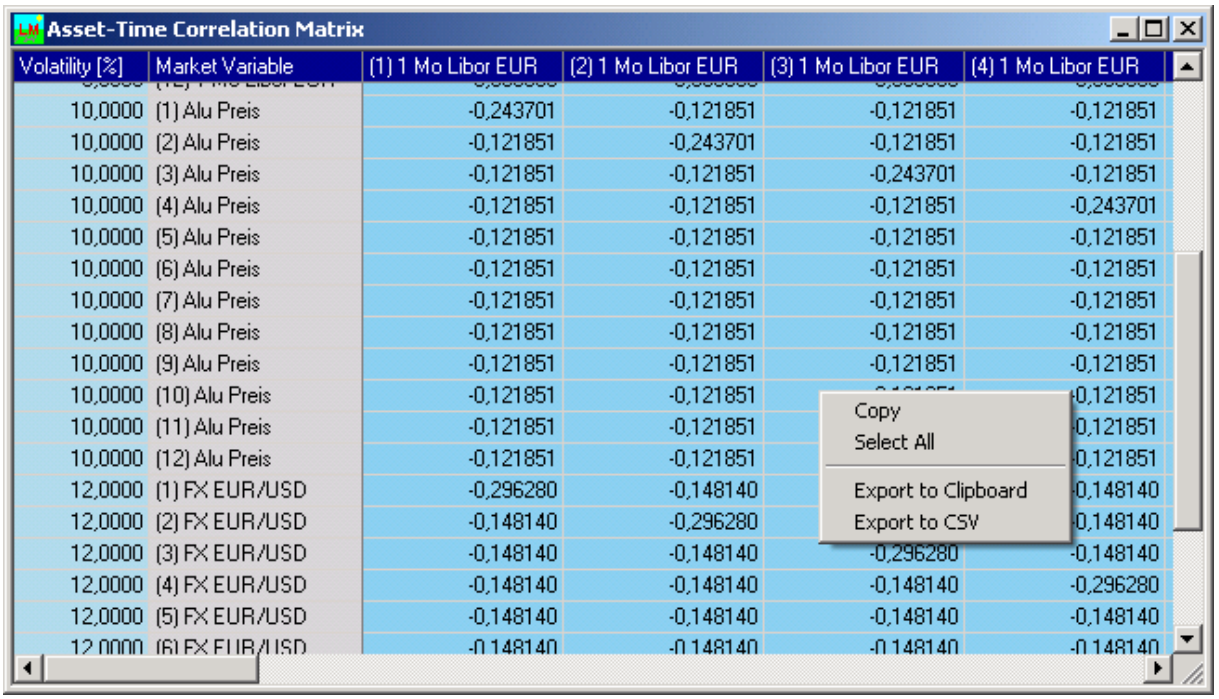


Figure 49: Auto- and cross-correlation matrix of market variables and time periods

5.1.5.4. Graphical Illustration of the Simulated Results

The distribution of simulated time periods can be illustrated using 2D graphics (see Figure 50 and 51). The red area that can be seen in the graph, marks all simulation values to the left of the confidence value. The graph in Figure 51 illustrates a distribution with limitations (option).

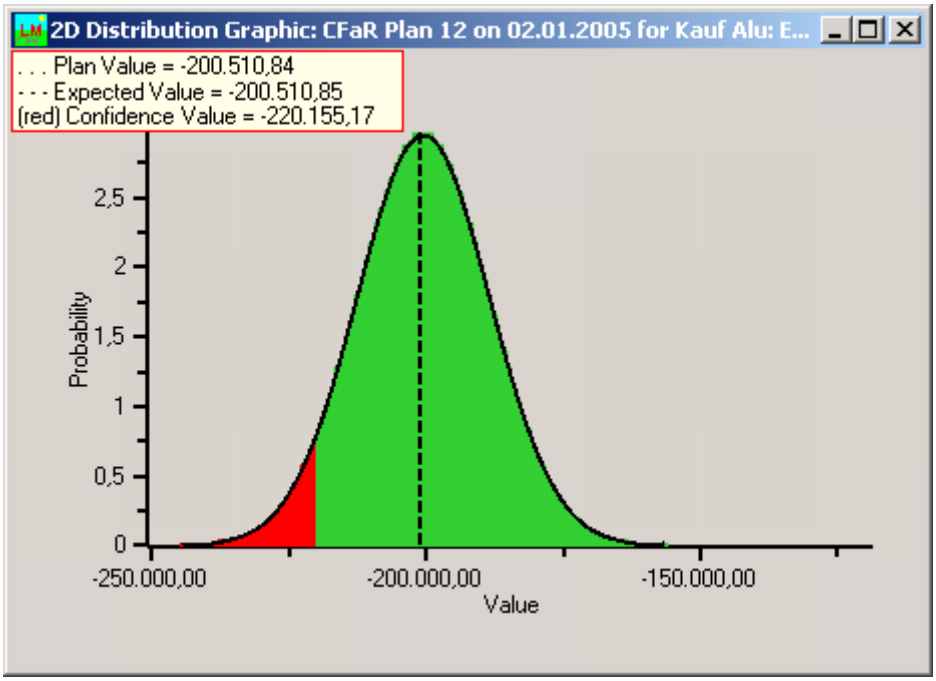


Figure 50: 2D distribution graphic of the time period of the plan item

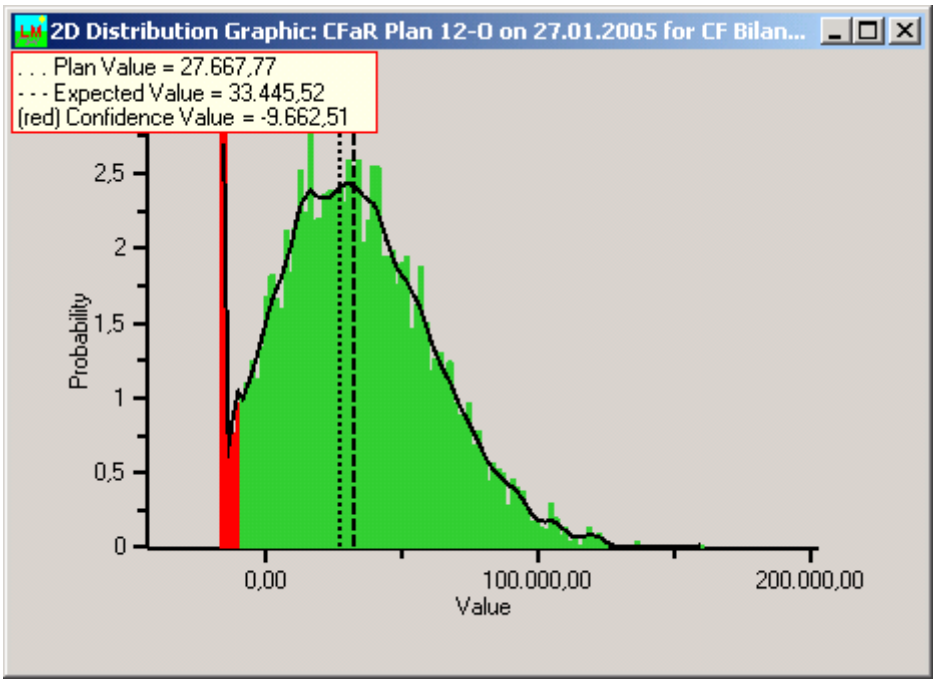


Figure 51: 2D distribution graphic the time period of the plan item with limitations

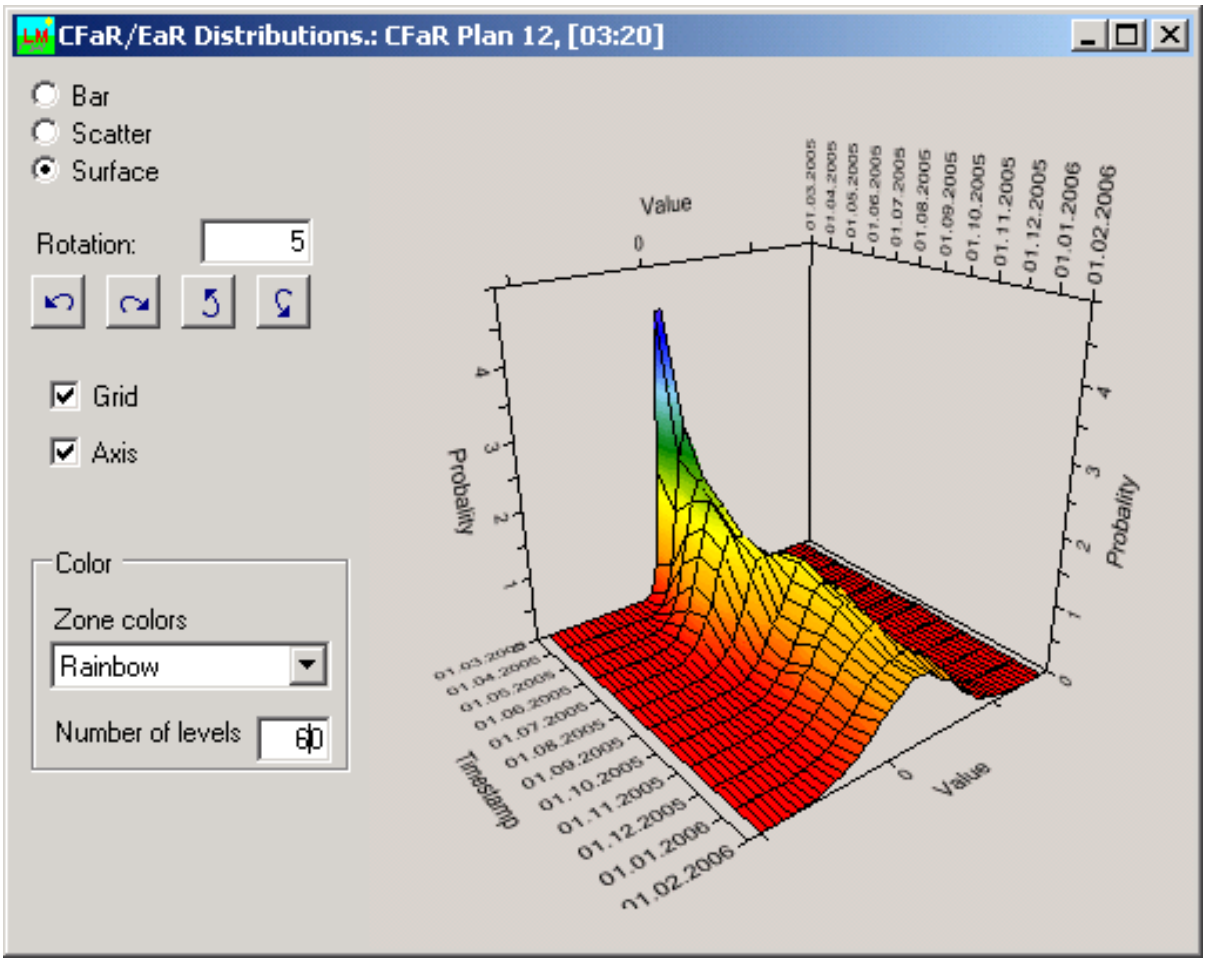


Figure 52: 3D distribution graphic of a CfaR plan

The distribution of all simulated time periods of a CfaR plan can be illustrated in a 3D graphic (see Figures 52 and 53). The chart in Figure 51 shows a 3D distribution with limits (options).

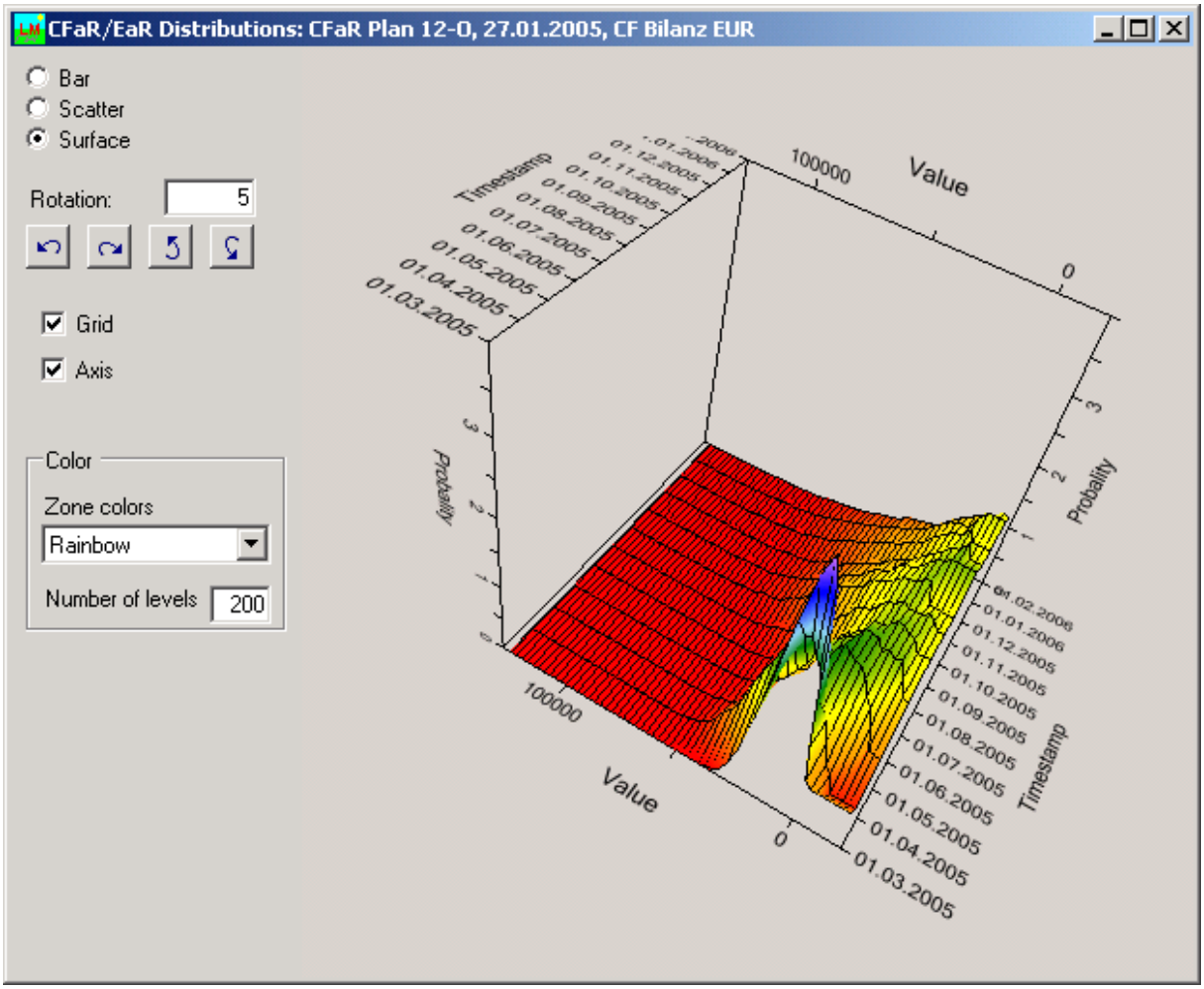


Figure 53: 3D distribution of a CFaR plan with limits

The descriptions of the controls shown in the graphical dialogue (see Figure 52 and 53) are presented in the following table:

Control	Description
Radiobuttons	Chart type: Bar, Scatter, Surface
Rotation	Keys and angles that enable the rotation of the graphic
Grid	Switching the grid on and off when the graphic is displayed
Axis	Switching the designation of the axes on and off
Color	Combo box for the selection of the color palette
Number of Levels	Number of colors in the 3D representation of the probability

The 3D chart can be moved, scaled and rotated. In order to do that, one must move the mouse while pressing the left mouse button and choosing the Drag&Drop feature in the graphic menu:

- Without using the keyboard: Rotating
- Shift key: Moving
- Ctrl key: Scaling

5.1.5.5. Reports for Simulation Markets and CfaR/EaR Results

The reporting of simulation markets and market variables (see Figure 54) is achieved by running the Crystal Reporter from the tree-shaped structure of simulation markets. The report is context-dependent (reports of one simulation market or of all simulation markets) and activates the Crystal Reporter depending on whether one or all simulation markets have been selected. After the activation, a Windows dialogue pops up for the selection of the report file. A standardized report can be found in the report file CfaR_Markets.rpt.

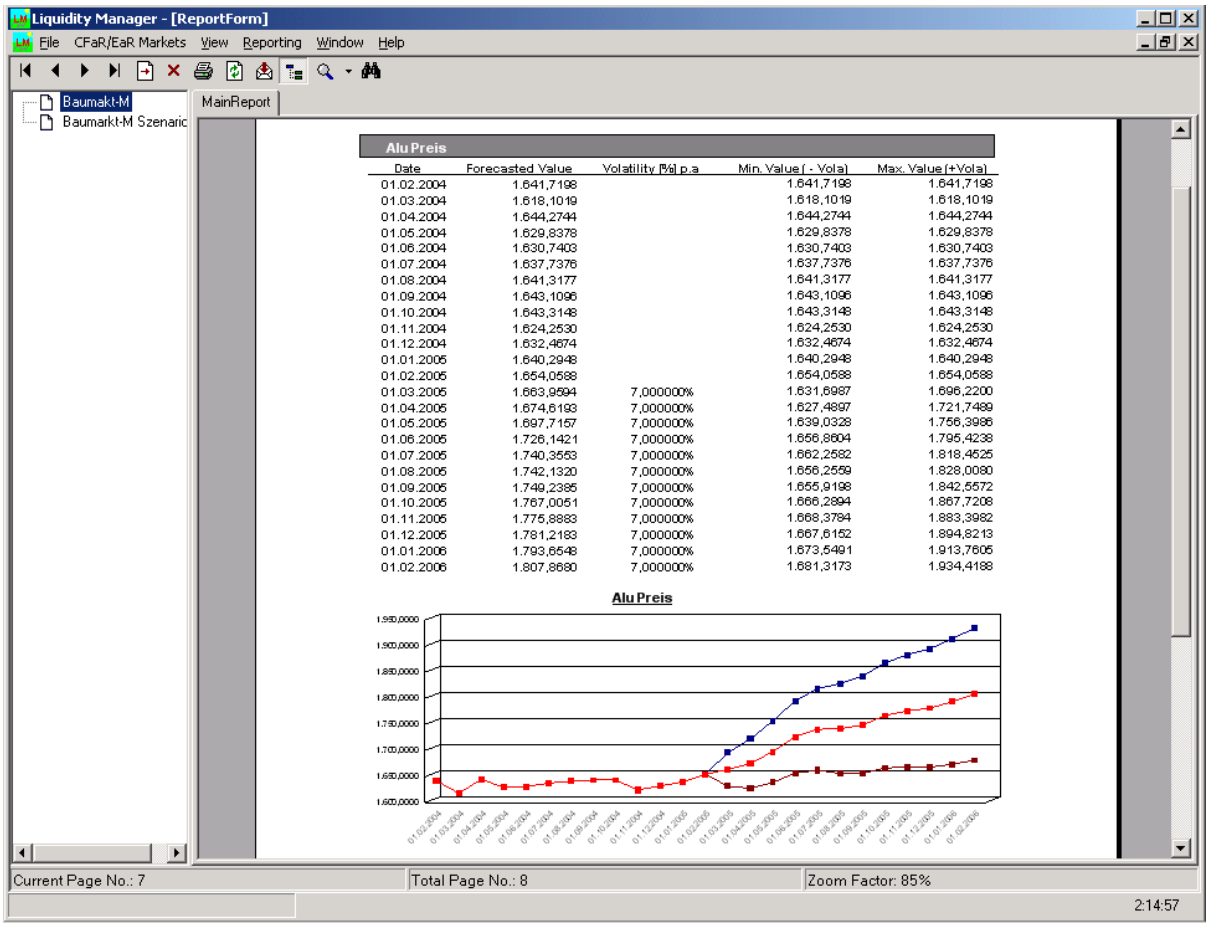


Figure 54: Reports of market simulations and market variables using Crystal Reporter

The reporting of CfaR/EaR results (see Figure 54) is achieved by running the Crystal Reporter from the tree-shaped structure of balance sheet structures and liquidity plans. The report is context-dependent (reports of one plan, reports of all plans from one balance sheet structure, or reports of all plans from all balance sheet structures) and activates the Crystal Reporter depending on whether a liquidity plan or a balance sheet structure have been selected. After the activation, a Windows dialogue pops up for the selection of the report file. A standardized report can be found in the report file CfaR_Plan.rpt.

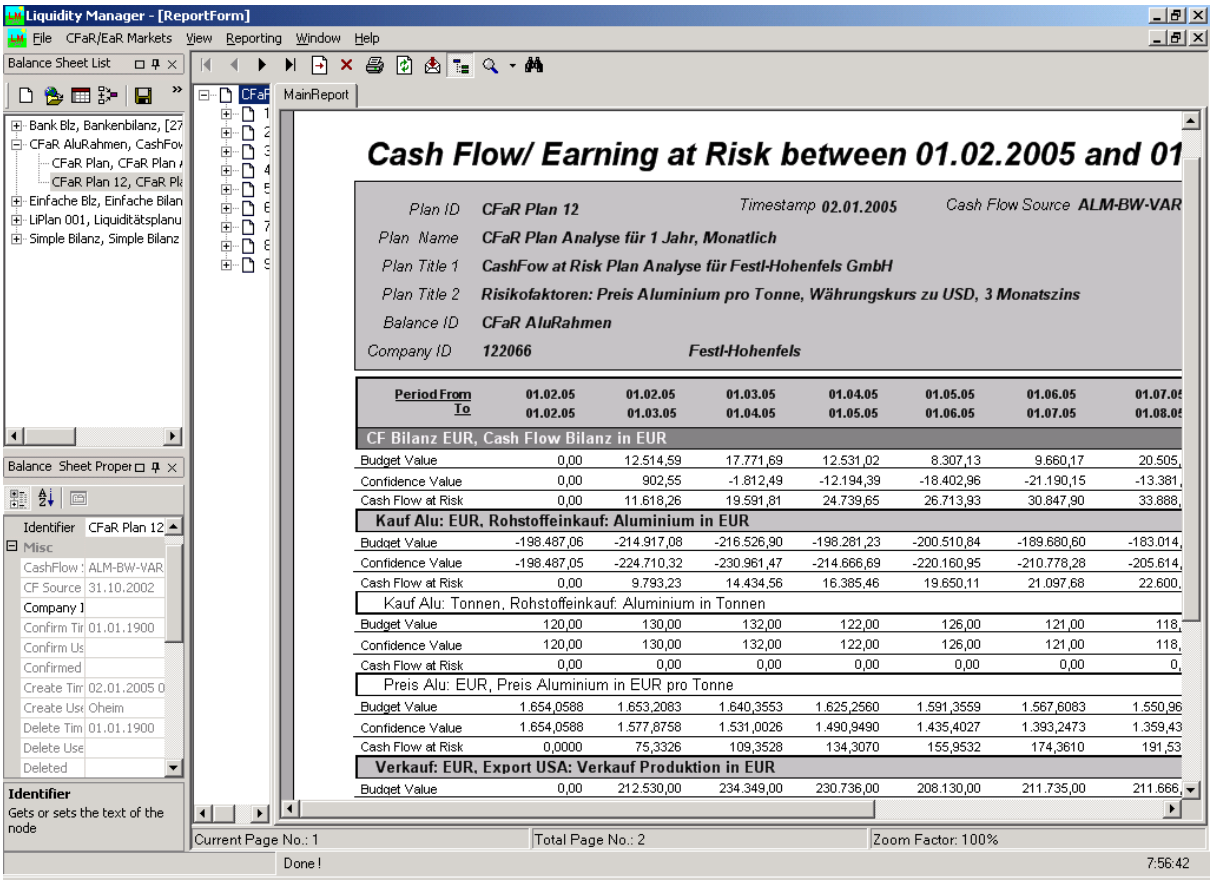


Figure 55: Reports of CfaR/EaR results using Crystal Reporter

Literary sources from www.riskmetrics.com:

1. CorporateMetricsTechDoc.pdf – Description of the framework
2. LongRunTechDoc.pdf – Description of the long-term forecasts and the Volatility Bridge.
3. rmj4q04.pdf - Risk management for non-financial corporations