

Institute for Operations Research and Computational Finance

University of St.Gallen

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DEVA +
(Dynamic Expectation Variance Analysis)

Product Description
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Summary: The existence of changing correlation structures needs to be taken into account when modelling an asset allocation situation. DEVA + (Dynamic Expectation Variance Analysis) is a multiperiod stochastic optimization approach to identify the optimal tactic and strategic asset allocation. The identified allocation strategies are efficient in a multiperiod context, i.e. under consideration of rebalancing activities, transaction costs, stochastic correlations and volatile financial markets. The dynamic asset allocation approach is designed for financial institutes, which have to fulfil a pension and insurance mandate (DEVA + L, where L stands for liability), and for investors, who want to assess their own asset allocation results against the background of the general market development (DEVA + B, where B stands for benchmark).

Asset allocation management is becoming more and more complex

The international financial markets are going through fundamental changes. On the one hand the increasing integration of national financial markets leads to raised systemic risk and to quantitatively changed risk structures. On the other hand enormous technical progress, as well as reams of product innovations are to be observed. The consequence of this structural change is a drastic increase in the complexity associated with asset allocation management. Institutional and private investors today stand in front of challenges as high as never before.

Amongst other characteristics the distribution of returns exhibit fat tails

The existence of changing correlation structures across time, as well as the derived phenomena like *fat tails*, *volatility clustering*, *contagion*, *co-movement* and *decoupling*, have been proven by Empirical Finance. These factors need to be considered when modelling an asset allocation situation.

Multistage stochastic models are demanded

The complexity inherited in the situation is asking for approaches which take the dynamics of the decision process, the uncertainty of the financial markets and the existing frictions into account. Only this way the challenges of managing asset allocations can be coped with. DEVA + (Dynamic Expectation Variance Analysis) is a multiperiod stochastic optimization approach to identify the optimal tactic and strategic asset allocation. The identified allocation strategies are efficient in a multiperiod context, i.e., under consideration of rebalancing activities, transaction costs, stochastic correlations and volatile financial markets.

Pension funds are managing their asset allocation in alignment with their liabilities

DEVA + L (L for liabilities) is designed for financial institutes, which have to fulfil a pension and insurance mandate. While guarantees are often granted on the passive side of the financial statement (guaranteed insurance benefits, minimum return rate, etc.), there exist no respective guarantee on the active side provided by the financial and capital markets. The necessary matching of the liabilities therefore is in danger when taking into account the interest rate risk. DEVA + L allows the explicit consideration of liabilities by means of a synthetic index, by which also the correlations of the assets with the liabilities are considered adequately in the optimization. With DEVA + L the investor is given an integrative asset & liability system, which supports him with the analysis and the controlling of shortfall-risks and in addition allows him to assess strategic specifications.

Objective performance assessment of asset allocations with the help of benchmarks

DEVA + B (B for benchmark) enables the investor to assess his own asset allocation result against the background of the general market development, i.e., to align the asset allocation with a benchmark (e.g., a specific market index). With DEVA + B the portfolio result can be assessed objectively.

DEVA + is our solution for the increasing challenges at the financial markets.

Product characteristics

DEVA + supports institutional and private investors in the identification of the optimal tactic and strategic asset allocation, as well as in the analysis and reporting of shortfall-risks. In particular the following product characteristics are essential for the investor.

- ***Multi-period asset allocation horizon:*** DEVA + is based on a multi-period portfolio selection approach. The planning horizon thereby is divided into sub-periods, each of them allowing additional money in- and outflows to be taken into account. With this multi-period approach, rebalancing activities and the dynamics of the asset returns can be considered adequately.

- ***Stochastic modelling of volatilities and correlations:*** Empirical phenomena like *fat tails, volatility clustering, contagion, co-movement* and *decoupling* are included in the optimization process of DEVA + by means of stochastically modelled asset returns, volatilities and correlations. Different return dynamics, which correspond to different regimes at the financial markets are estimated in a coherent way in DEVA + . With help of the regime-switch the development of risk structures over time is taken account of and the identification of efficient portfolios on the basis of latest market information is assured today and in the future.

- ***Integration of frictions:*** The integration of frictions, like, e.g., transactions costs, future cash drains or cash flows, not traded assets, market illiquidity or asset allocation restrictions is most important in a dynamical asset allocation decision process. DEVA + allows to model these frictions in an adequate form.

- ***Benchmark orientation:*** With DEVA + B investors are given the possibility to chose a benchmark (e.g., a specific market indices) as a target return. Using this option the portfolio performance is set into the context of actual market developments and a more objective assessment is possible.

- ***Explicit consideration of liabilities:*** Pension fund investors are dependent on an integrative consideration of assets and liabilities. With DEVA + L future obligations and their interdependence with other assets can be modelled and subsequently optimized in an integrative way. DEVA + L therefore provides an integrative asset & liability system.

- ***Execution of important analyses:*** DEVA + allows its users to conduct various analyses, e.g., the assessment of strategic guidelines, the calculation of shortfall probabilities and sensitivity analyses with regard to the diversification potential. In addition the user-friendly graphical interface of DEVA + supports a flexible and interactive usage, which, e.g., enables also the direct export of data into excel.

Internal and external information

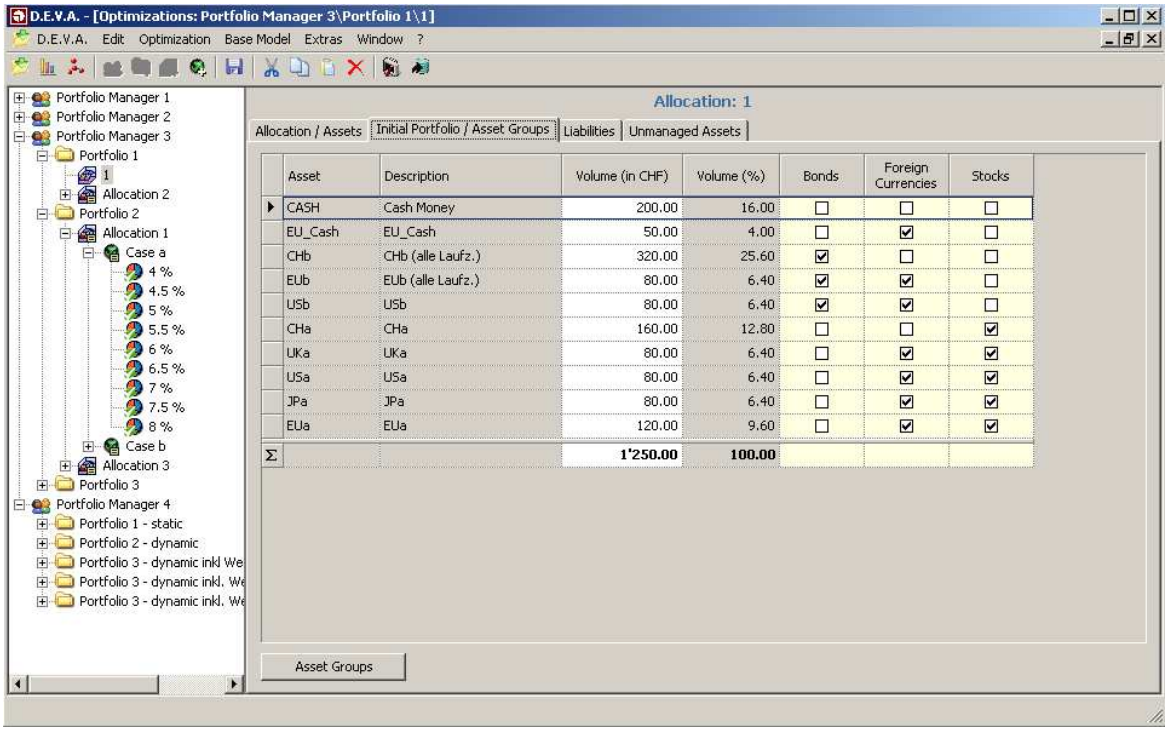
DEVA + provides institutional and private investors with a decision support system for the portfolio optimization process, aligned to the specific requirements and individual needs of the individual investor. The following customized information is needed to run the optimization:

Asset universe

The **asset universe** can be defined by the user himself. Shares, bonds, etc., as well as client specific products can be included. Subsequently the user chooses those assets from the defined asset universe which should in his view be part of the portfolio optimization process.

Initial portfolio

Market frictions lead to direct costs when changes in the asset allocation are made. In order to assess the efficiency of certain rebalancing activities and in order to determine the risk-return profiles of portfolios, the **initial portfolio** is of high importance. Specifying the initial portfolio the user has the possibility to define asset groups. This way individual asset categories can be considered in a cumulative way and respective restrictions can be defined. (Regarding restrictions also refer to the section on asset restrictions.)



Liabilities

Applying DEVA + L the user additionally needs to define the **liabilities**, which should be considered in the optimization process. This synthetical index is based upon client specific information about future obligations and considers the correlation of those liabilities to the remaining assets in the optimization.

Asset restrictions

In general portfolio managers have to make their investment decisions subject to regulative and company internal standards. These standards can correspond to the limitation of individual asset positions, as well as to the limitation of asset groups, such as shares, bonds, foreign currencies and industries. DEVA + allows the user to specify **restrictions** with regard to individual assets and with regard to individually defined asset classes, e.g., shares worldwide, bonds in foreign currency. (Also refer to the section on initial portfolios.) Furthermore, the multistage optimization ensures that those restrictions are complied with over the entire planning horizon. Possible rebalancing activities and their respective costs are integrated in the optimization process.

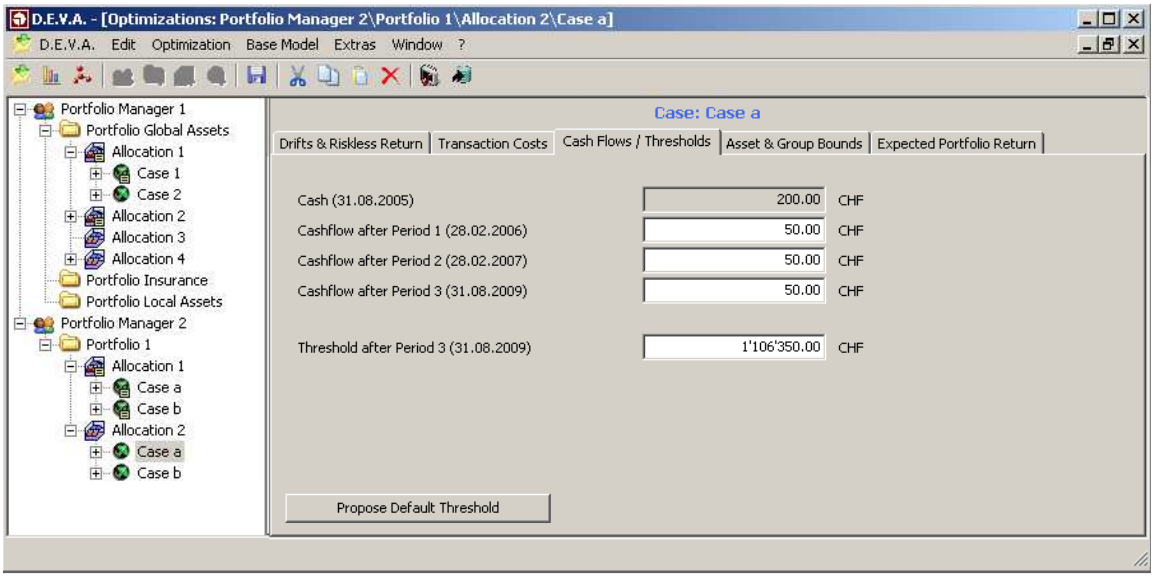
Unmanaged assets

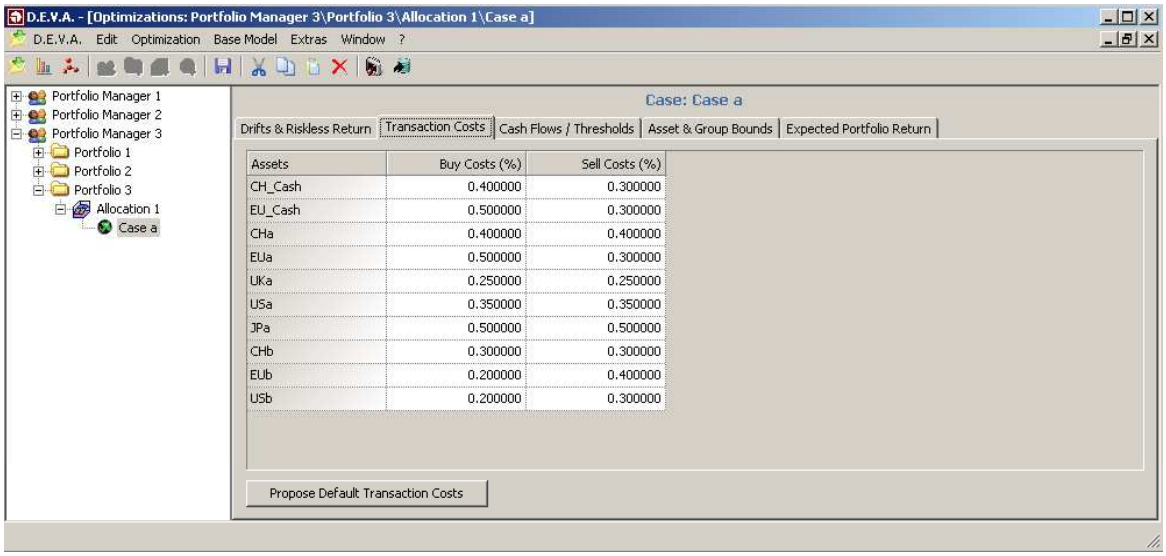
Many investors own **unmanaged assets**, which cannot be traded and should therefore not be considered in the optimization. However the consideration of latter is highly important when shortfall-risks are being analyzed. DEVA + provides the investor with the possibility to gather those unmanaged assets and to consider them in the analyses of shortfall-risks.

Cash-related data

The assessment of a given asset allocation highly depends on future **cash in- and outflows** and on the liability structure of the investor. The multistage approach of DEVA + allows the investor to comprehend these cash-related data. The respective inputs are considered in an integrative way in the asset allocation and in the risk analyses.

An important aspect when optimizing portfolio allocations are the occurring **transaction costs**. The investor always faces the trade-off between the occurring transaction costs and the targeted gain in efficiency. DEVA + provides the possibility to specify transaction costs for each asset, whereas buy and sell can have different values. In that way, individual market frictions for the various assets can be considered in the analyses.



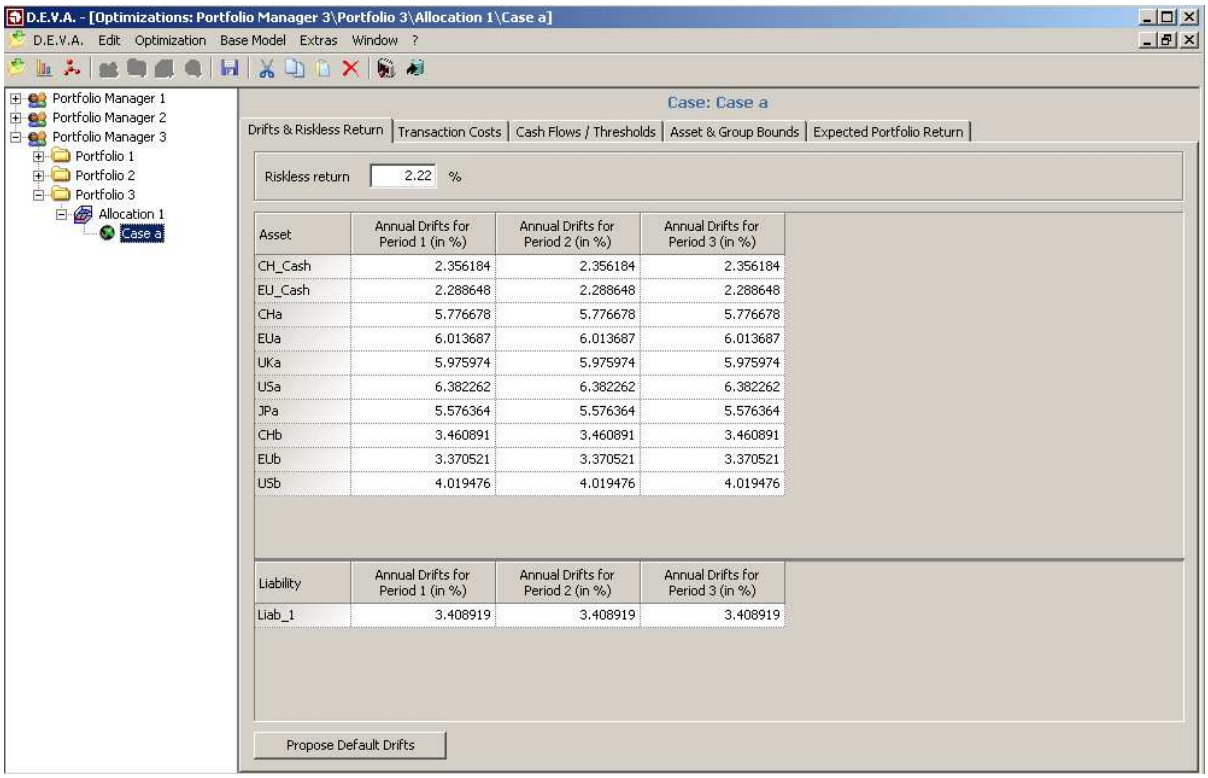


Asset returns

Due to specific economic cycles or market situations an investor might have time-specific **return expectations**. Hence the user of DEVA + is given great flexibility in the parameterization, as he can adjust or change the return expectation provided by DEVA + with individual estimates. In addition the multiperiod approach of DEVA + allows to specify return estimates dependent on individual periods and therefore provides the possibility to consider short- and long-term developments at the capital markets.

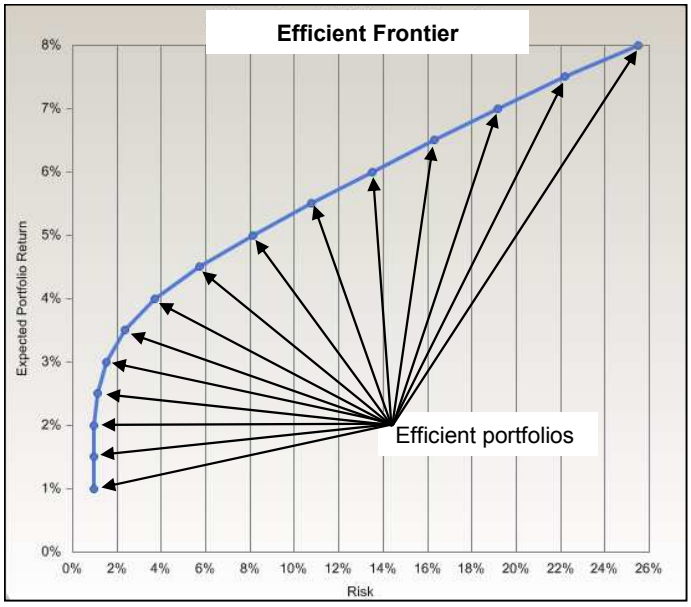
Liability development

Additionally the investor is given the possibility in DEVA + L to adjust the provided **development of the liabilities** to individual assumptions. Also at this stage the multiperiod approach of DEVA + allows to make period specific adjustments and therefore ensures an integrative consideration of the liabilities in the asset allocation process.


D.E.V.A. - [Optimizations: Portfolio Manager 3\Portfolio 3\Allocation 1\Case a]
D.E.V.A. Edit Optimization Base Model Extras Window ?
Portfolio Manager 1
Portfolio Manager 2
Portfolio Manager 3
Portfolio 1
Portfolio 2
Portfolio 3
Allocation 1
Case a
Case: Case a
Drifts & Riskless Return
Transaction Costs
Cash Flows / Thresholds
Asset & Group Bounds
Expected Portfolio Return
Riskless return 2.22 %
Asset | Annual Drifts for Period 1 (in %) | Annual Drifts for Period 2 (in %) | Annual Drifts for Period 3 (in %)
CH_Cash 2.356184 2.356184 2.356184
EU_Cash 2.288648 2.288648 2.288648
CHa 5.776678 5.776678 5.776678
EUa 6.013687 6.013687 6.013687
UKa 5.975974 5.975974 5.975974
USa 6.382262 6.382262 6.382262
JPa 5.576364 5.576364 5.576364
CHb 3.460891 3.460891 3.460891
EUb 3.370521 3.370521 3.370521
USb 4.019476 4.019476 4.019476
Liability | Annual Drifts for Period 1 (in %) | Annual Drifts for Period 2 (in %) | Annual Drifts for Period 3 (in %)
Liab_1 3.408919 3.408919 3.408919
Propose Default Drifts

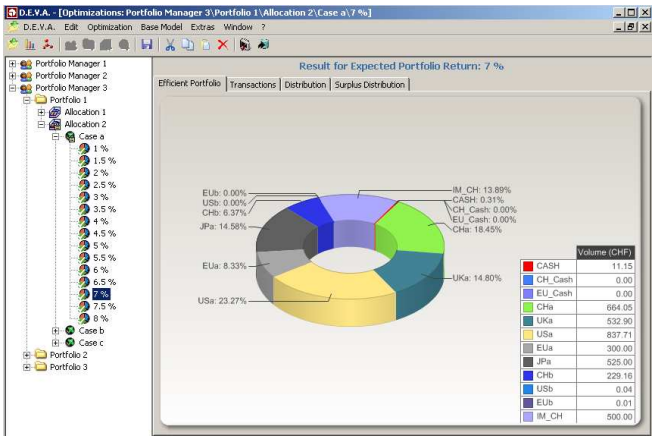
Reports and visuals

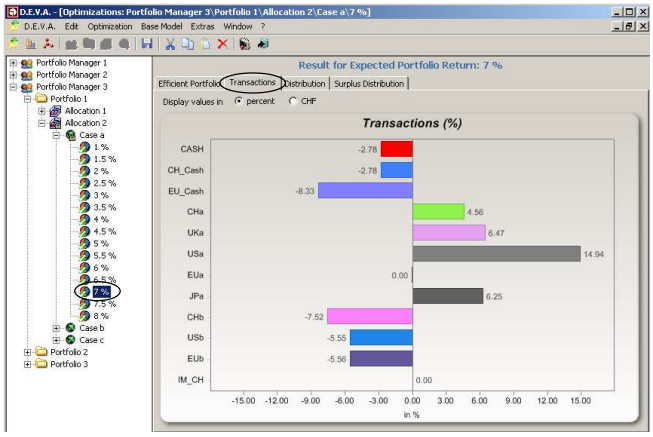
The various optimization results in DEVA + take the dynamics of the financial markets, the future re-balancing activities and its associated costs into account. The identified portfolios are therefore efficient in a dynamic context and can be recalled by the user in different aggregation modes. More precisely the user has the possibility to display / analyze the whole efficient frontier or only a single portfolio (final wealth). In the mode of 'single portfolio' the structure and the risk-return profile of individual efficient portfolios is displayed. The level of detail is high and the comprehensive information provided supports a precise reporting. In order to make comparisons between different efficient portfolios and in order to display whole efficient frontiers, DEVA + provides the aggregated level of 'efficient frontier'.



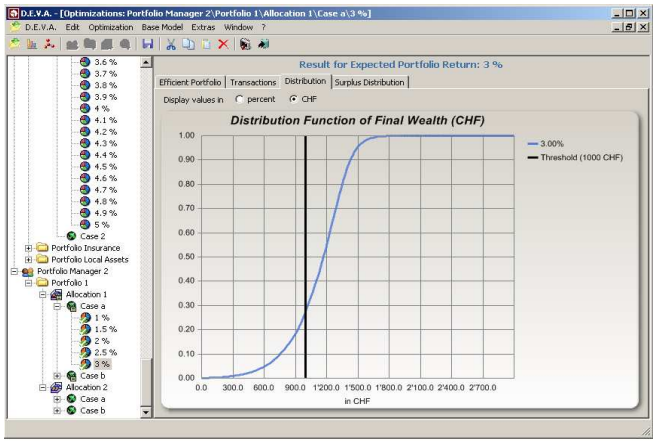
Detailed mode 'single portfolio'

For each efficient allocation the user receives detailed information about the structure of the respective portfolio and the necessary transactions in order to implement this specific asset allocation. With DEVA + comprehensive information about the risk-return structure of the efficient portfolio is provided. Specifically the optimal wealth distribution, which has to be obtained until the end of the first period is provided.



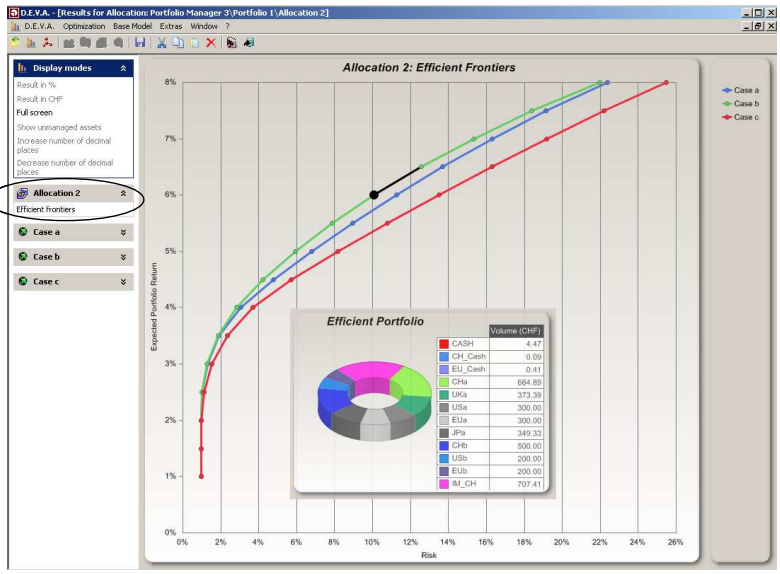


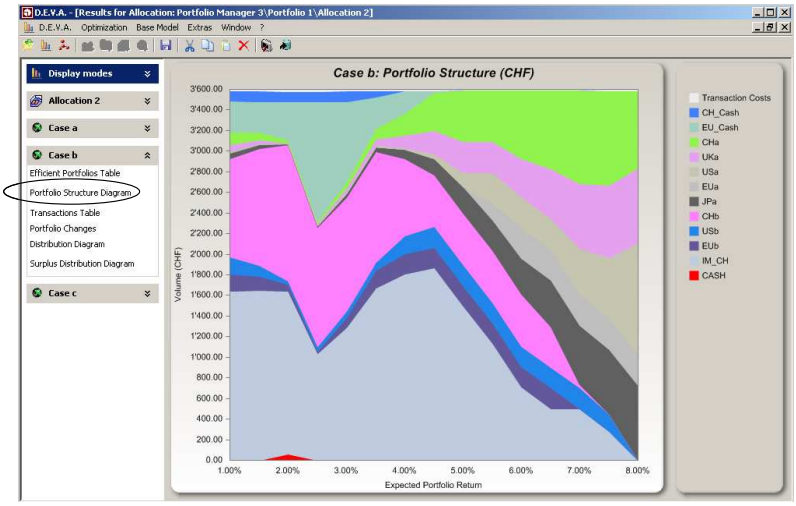
Key data about the risk structure at the and of the planning horizon - based on the provided, optimal rebalancing activities - can be identified by the distribution function of the final wealth (as, e.g., value-at-risk, surplus, liquidity ratio).

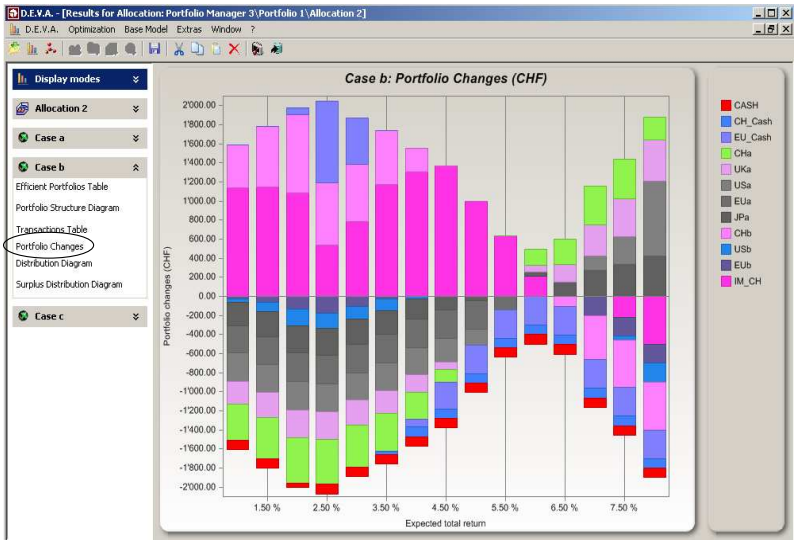


Aggregated visualising mode 'efficient frontier'

The efficient frontiers for various market parameterizations – specified by the user – are displayed in graphical and in table form. The portfolio structure of different efficient frontiers and the implication of different return expectations can therewith be easily compared and analysed. DEVA + allows to gather a fast overview on necessary transactions, required in order to implement the different efficient allocations. If only few transactions are required the current held portfolio is already close to being efficient. Also on this aggregation level the distribution of the final wealth at the end of the planning horizon is displayed, whereby the already mentioned key data on risk can easily be derived.


D.E.V.A. - [Results for Allocation: Portfolio Manager 3\Portfolio 1\Allocation 2]
D.E.V.A. Optimization Base Model Extras Window ?
Display modes
Result in %
Result in CHF
Full screen
Show unmanaged assets
Increase number of decimal places
Decrease number of decimal places
Allocation 2
Efficient frontiers
Case a
Case b
Case c
Allocation 2: Efficient Frontiers
Expected Portfolio Return
Risk
Case a
Case b
Case c
Efficient Portfolio
Volume (CHF)
CASH 4.47
CH_Cash 0.09
EU_Cash 0.41
CHa 664.89
UKa 373.39
USa 300.00
EUa 300.00
JPa 349.33
CHb 500.00
USb 200.00
EUb 200.00
IM_CH 707.41


D.E.V.A. - [Results for Allocation: Portfolio Manager 3\Portfolio 1\Allocation 2]
D.E.V.A. Optimization Base Model Extras Window ?
Display modes
Allocation 2
Case a
Case b
Efficient Portfolios Table
Portfolio Structure Diagram
Transactions Table
Portfolio Changes
Distribution Diagram
Surplus Distribution Diagram
Case c
Case b: Portfolio Structure (CHF)
Volume (CHF)
Expected Portfolio Return
Transaction Costs
CH_Cash
EU_Cash
CHa
UKa
USa
EUa
JPa
CHb
USb
EUb
IM_CH
CASH


D.E.V.A. - [Results for Allocation: Portfolio Manager 3\Portfolio 1\Allocation 2]
D.E.V.A. Optimization Base Model Extras Window ?
Display modes
Allocation 2
Case a
Case b
Efficient Portfolios Table
Portfolio Structure Diagram
Transactions Table
Portfolio Changes
Distribution Diagram
Surplus Distribution Diagram
Case c
Case b: Portfolio Changes (CHF)
Portfolio changes (CHF)
Expected total return
CASH
CH_Cash
EU_Cash
CHa
UKa
USa
EUa
JPa
CHb
USb
EUb
IM_CH

Analytical basics

The software tool DEVA + is based on a multistage stochastic optimization approach, which adequately maps the interaction of time and uncertainty. The estimation of risk structures is conducted with a factor model, which allows to model stochastic regime-switches at the financial markets. Particularly in recent years, the need for an integrative asset and liability viewpoint has become indispensable and is answered with the synthetical liability index of DEVA + L.

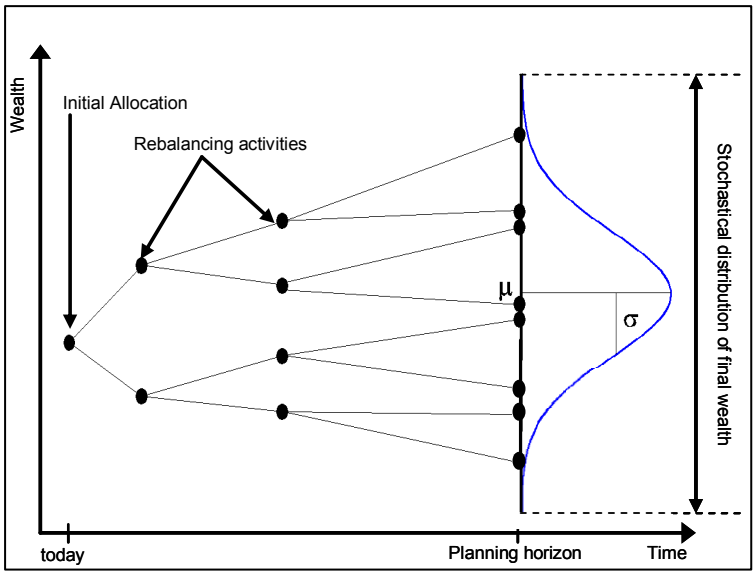
Multistage stochastic optimization

DEVA + implements the latest findings in multistage stochastic optimization. The model is being developed in the past years at the Institute for Operations Research and Computational Finance (ior/cf – HSG) at the University of St.Gallen.

To account for the uncertain developments at the financial markets, the statistic distributions of asset returns are discretized with a scenario tree. The multistage approach allows to parameterize the theoretical distributions for each period separately. In each period, different risk structures can be considered, which correspond to different regimes at the financial markets. By the stochastic modelling of the relevant data empirical facts like *fat tails, volatility clustering, contagion, co-movement* and *decoupling* can be taken into account adequately.

The multistage approach of DEVA + allows to consider the dynamics of the asset allocation decision. At the beginning of each period, the respective actual portfolio is adjusted to the new market situation. The rebalancing activities induce transaction costs and therefore lead to the reduction of liquidity.

The initial portfolio, the transaction activities and the uncertain return developments constitute the stochastic distribution of final wealth. In analogue to the classical mean-variance approach the objective function represents a parametric minimization of the variance.

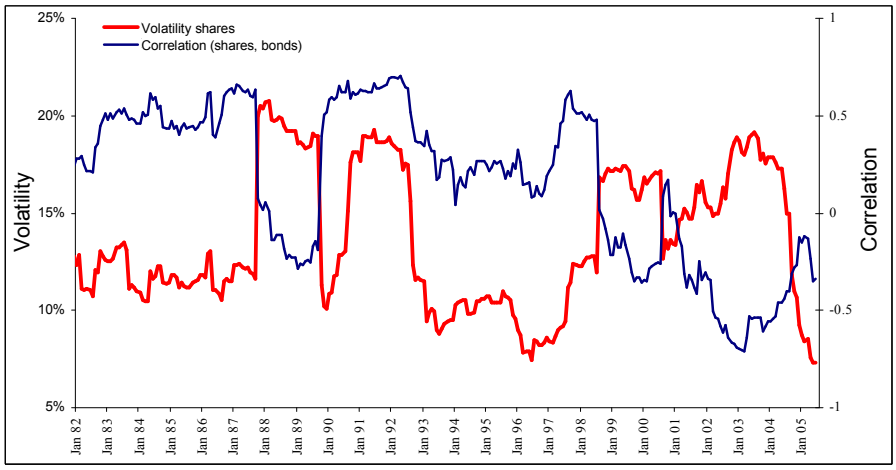


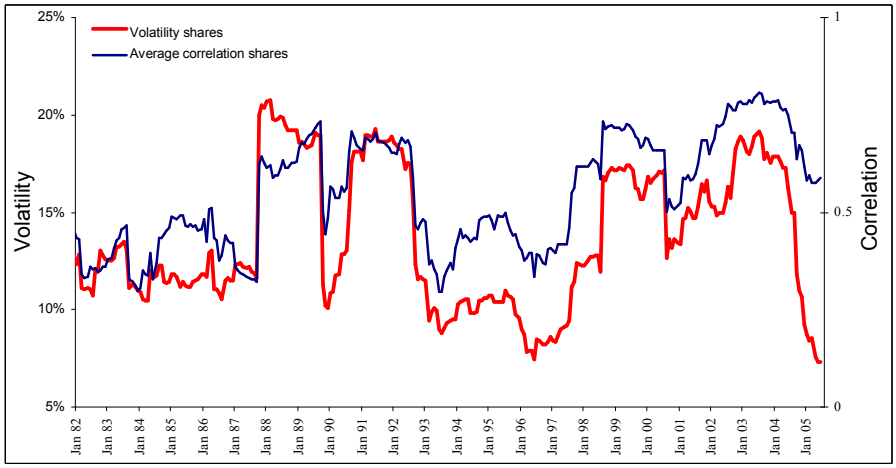
Factor models used to estimate risk structures

A historically low volatility of asset returns during the mid nineties was displaced in 1997 with a time of increased market movements, introduced by the emerging market crisis. Nowadays the volatility is decreasing again. DEVA + models this interaction between correlation and volatility with a factor model, which explicitly takes the different regimes at the financial markets into account and therefore grants a realistic modelling of markets. Empirical analyses show, that at least two regimes are indispensable:

- The first regime corresponds to a volatile market situation, whereas the covariance matrix displays the following characteristics: High volatility of shares, negative correlation of bonds with shares and high correlation in between the shares.
- The second regime corresponds to a situation with low volatility of the shares and a positive correlation between bonds and shares. In addition the low correlation in between the shares allows a rather high diversification effect.

In order to identify the short term volatility, the two main shapes are each added a short term market dynamic. Therefore DEVA + not only considers the strategic but also the tactical aspects of asset allocation.

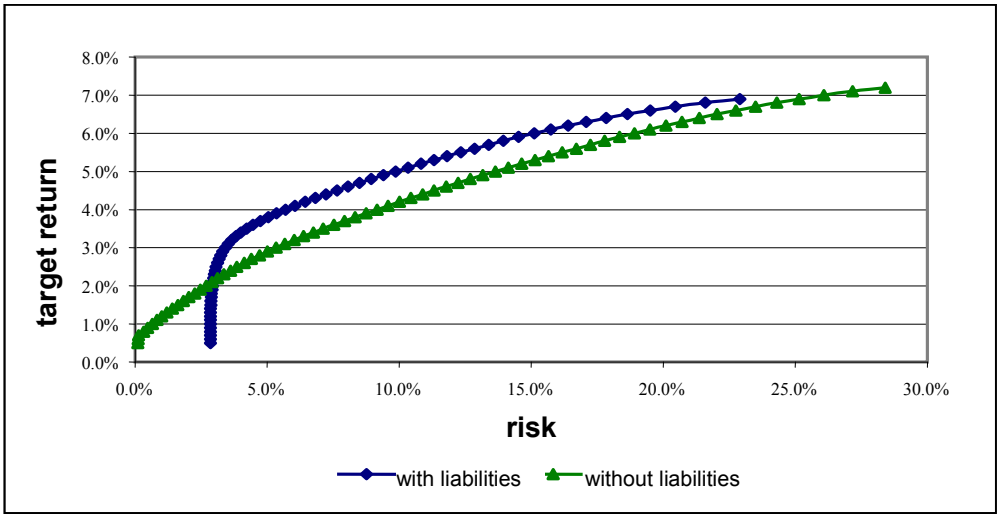




Integrative modelling of liabilities

With the financial market crisis in past years, not only industrial undertakings but also pension funds and life insurances companies encountered difficulties. Those undertakings were often times characterised by contribution guarantees on the liability side (guaranteed level of insurance benefits, minimum return, etc.) opposed with no respective guarantees on the asset side. The required matching of liabilities therefore exhibits an inherent interest rate risk, which can only be answered with an integrative consideration of liabilities in the asset allocation process.

DEVA + L takes future obligation of the investor via a synthetical index into account and therefore allows the integration of the liabilities as an additional argument in the optimization. Furthermore, the correlation of the liabilities with the asset categories is considered, which in return allows to exploit the available diversification potential the most. With DEVA + L the investor is given an integrative asset and liability system.



Closing remarks

Concluding this manual the Institute for Operations Research & Computational Finance wants to thank those institutions, who provided continuous support and feedback starting from the development process of DEVA till today! Only with this cooperation the bridge between fundamental and applied research could be taken and the applicability of DEVA to practical asset allocation challenges could be warranted.

For any further feedback on DEVA, on this user manual or for other helpful suggestions, please contact the team of the Institute for Operations Research & Computational Finance.

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