

Alluve MarketSimulator

White Paper

August 2009

Abstract

Alluve MarketSimulator is a simulation-based risk calculation system. Its outputs are used by risk analysts and utilised for other risk-related analysis, such as daily risk monitoring or benchmarking future portfolio returns.

Alluve MarketSimulator implements Monte-Carlo simulation and custom stress testing (running a set of user-defined market scenarios).

Alluve MarketSimulator's modular design allows clients to replace built-in models with their own, or add pricing modules to extend the coverage of financial instruments. The computations can be distributed to a large number of processors, making the solution scalable to financial portfolios of any size.

Alluve MarketSimulator offers a compact, integrated and cost-efficient solution to monitor and analyse market and credit risks.

Background

For a financial institution, risk management is not just a matter of business efficiency, it is a matter of survival. The tools and models that were considered adequate a year ago, might be unacceptable today, for a number of reasons.

- Increasing complexity of transactions demands advanced models, which are often computationally expensive.
- The complexity of models requires more transparency of the risk systems, that would allow risk managers to understand the risks and attribute them appropriately.
- Sharp market moves require frequent recalculations of risk measures.
- Emerging practices, such as automated hedging, impose new requirements on the risk assessment tools.
- Faster introduction of new trading instruments requires shorter development cycle to incorporate their support into risk systems.
- Finally, the pressure to lower the cost of running risk management departments remains, or even increases.

To meet those challenges, a financial organisation must manage risks in a mathematically sound, flexible and transparent way. The tools employed for these tasks are required to be scalable, robust and versatile.

The current practice of assessing credit and market risk is market simulation. The risk calculation tool generates scenarios of future market development, and finds the value of a financial portfolio under these conditions. By repeating this routine a sufficient number of times (10,000 or more), the tool obtains the distribution of the possible portfolio values in the future. Various risk measures (value at risk, expected shortfall, exposure at default, etc.) are calculated from that distribution.

Introduction

Alluve MarketSimulator computes market and credit risk measures by simulating the future market. It can be used as an interactive tool, as well as a service that automatically recalculates risks when a new trade is booked or market conditions change.

Alluve MarketSimulator computes the values of individual trades as well as the entire portfolios (trades that are pooled together). Thus it takes into account correlations between different underlyings, as well as cases when different trades partially offset each other. For each portfolio, users can specify if there is a netting or collateralisation agreement in place.

Alluve MarketSimulator computes both credit risk (potential exposure, expected exposure and tail exposure) and market risk (value at risk and expected shortfall). It computes the risk measures at multiple points in the future and shows the risk profile. Besides, Alluve MarketSimulator obtains the complete distribution of the future returns of a financial product. This allows a user, for example, to assess the risk and return profile of an investment portfolio.

Users

Alluve MarketSimulator aims to serve hedge funds, trading houses, asset managers and other institutions that trade in financial derivatives.

Coverage

Alluve MarketSimulator supports the following instruments.

Equity:

- stocks, exchange-traded funds and indices
- vanilla options (American and European)
- barrier options[†]

Fixed income:

- bonds
- swaps and cross-currency swaps
- forward rate agreements
- caps and floors
- swaptions[†]
- FX forwards
- FX options
- barrier options on FX[†]

Users can add their own pricing modules, extending Alluve MarketSimulator's coverage to other instruments.

[†] At the time of this writing (August 2009) this feature is still in development.

Results

Alluve MarketSimulator provides not only the risk measures (such as VaR or exposure), but also the means to understand and explain these results.

Risk measures

The risk measures are provided to risk analysts or to risk management tools (such as limit checkers). For each trade pool, Alluve MarketSimulator calculates:

- expected values
- quantiles (e.g. 95%-ile, 5%-ile)
- tail expected values (e.g. the expected value on condition that the value is below 5%-ile)
- value at risk
- expected shortfall (sometimes referred to as conditional value at risk)

Users specify which measures will be calculated. For example, one might want to see the portfolio's expected exposure alongside of 95% exposure, or compare value at risk at 1% probability with expected shortfall at 5%.

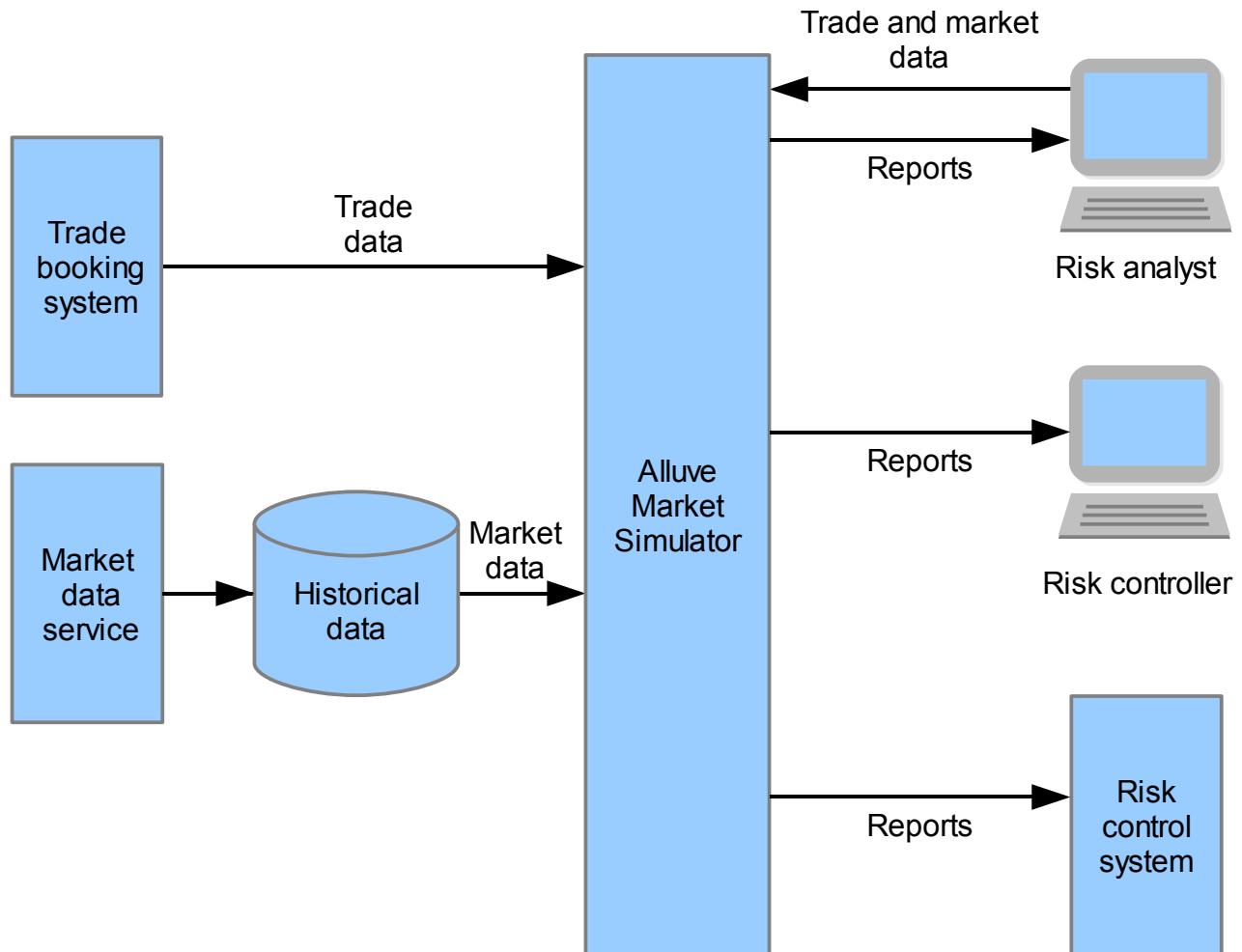
Supplementary results

To a risk controlling officer, Alluve MarketSimulator provides a wealth of statistics to help understand and explain the risk measures. For instance, Alluve MarketSimulator will help to find out which position in the portfolio was the biggest contributor to the expected shortfall.

Other measures

Analysts can compose portfolios using Alluve MarketSimulator's user interface. For example, one can check how a portfolio's risk will change if a certain trade is added to the portfolio (marginal risk), or the notional amount of a specific position is changed (incremental risk). To facilitate risk attribution, Alluve MarketSimulator can show the risks' sensitivity to a single risk factor, such as the parallel shift of the interest rates.

Along with risk measures, Alluve MarketSimulator produces the complete distribution of a portfolio's returns under simulated market conditions. This distribution can be used, for instance, to compare the portfolio's performance to a benchmark.



A typical deployment scheme of Alluve Market Simulator.

Trading positions, along with their netting or collateralisation structures, are imported from the front-office booking system. Users can also compose portfolios via a user interface.

Historical market data (interest and exchange rates, stock prices, and implied volatilities) can be obtained from any database with ODBC interface.

Parallelism[†]

Alluve Market Simulator is a parallel application, which can utilise a large number of individual CPUs. This allows users to scale Alluve Market Simulator according to their requirements for calculation speed and budget. Being able to run on commodity PCs under various operating systems (Windows and Linux), Alluve Market Simulator offers a cost-efficient way of performing large volumes of computation.

[†] At the time of this writing (August 2009) this feature is still in development.

Market Simulation

The price of a financial derivative is determined by a number of risk factors. For instance, a vanilla option price depends on the price of the underlying equity, implied volatility, and risk-free interest rate. To calculate risk measures for a specific portfolio, Alluve MarketSimulator generates a number of market scenarios. Each scenario is a set of values of the risk factors relevant for the given portfolio. Alluve MarketSimulator evaluates the portfolio in each scenario, getting the distribution of the portfolio prices. The distribution is used to calculate quantiles and expectations.

Path consistency

For path-dependent contracts (such as a physically settled swaption after the execution date), the risk factors will be simulated on the date in the future when the portfolio is evaluated, and one or more dates before the valuation date. Alluve MarketSimulator not only produces correct distributions of the risk factors' values on each date, but makes sure that the joint distribution on all dates is consistent with the model. This feature is crucial for accurate risk calculation on path-dependent trades.

Correlation

Historical time series show various levels of correlation between different risk factors. These correlations are reproduced by the simulation.

Monte-Carlo simulation

Monte-Carlo simulation produces scenarios according to a model, which is calibrated to the historical time series. Alluve MarketSimulator uses geometric Brownian motion and mean-reverting geometric Brownian motion to model the evolution of risk factors. Users can choose the models implemented in Alluve MarketSimulator or provide their own models.

Stress testing[†]

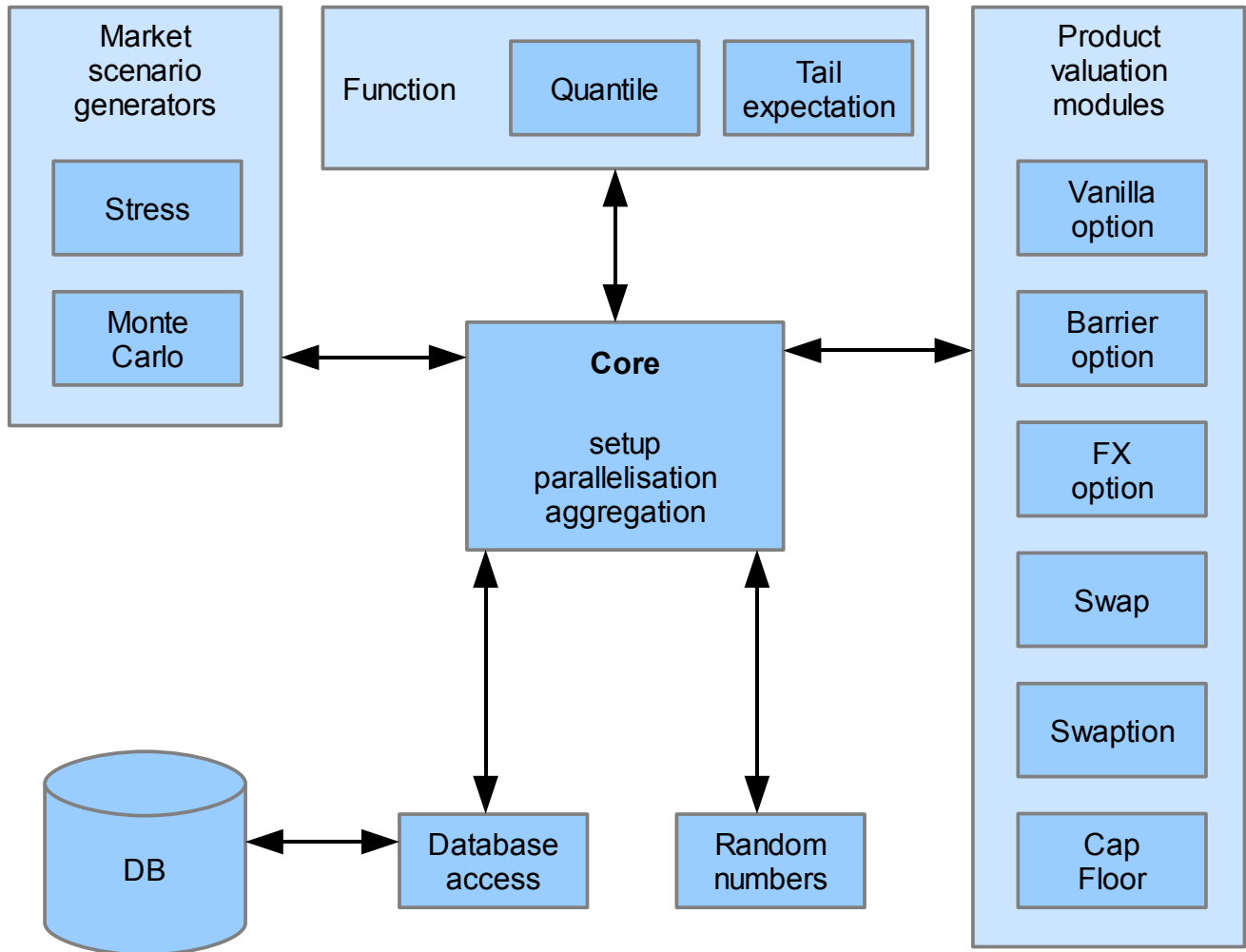
Stress testing calculates the value of the portfolio on scenarios specified by the user. Users often choose to observe the evolution of the portfolio's value under selected “extreme” market moves. This technique may reveal the portfolio's sensitivity to “event risks,” which might not be captured by the Monte-Carlo simulation calibrated to historical data.

Flexibility

Alluve MarketSimulator's functionality is implemented by *plugins*, software modules with unified interfaces. Plugins can be easily added to (plugged in) the system or removed from it. Alluve MarketSimulator's plugins are managed by the Core, which also takes care of parallelisation of calculations and aggregation of results.

The modular design of Alluve MarketSimulator allows the users to choose between models for generating market scenarios, select the modules to price financial derivatives, or add their custom market models and pricing modules.

[†] At the time of this writing (August 2009) this feature is still in development.



Architecture of Alluve Market Simulator.

Plugins interact with each other via the Core.

Each plugin group (Product valuation, Scenario generation, and Functions) defines a uniform interface for plugins. The plugins can be easily added or replaced.

Summary

Alluve Market Simulator incorporates state of the art risk modelling techniques in a modular, high performance software system. Alluve Market Simulator is easy to fit into the enterprise IT structure, and adjusts quickly to specific customer needs. Alluve Market Simulator can be used both for automatic daily risk reporting and interactively for risk analysis and portfolio performance tests.