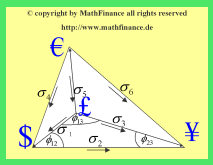
derivatives and risk management in theory and practice

Frankfurt MathFinance Workshop

27th - 28th March 2006

http://workshop.mathfinance.de/



1. Organising committee

- Uwe Wystup, HfB / MathFinance
- Tino Kluge, University of Oxford, OCIAM
- Susanne Griebsch, HfB - Business School of Finance and Management

The event takes place at HfB Audimax (Monday) and in the conference room no 1, 7th floor, Commerzbank Tower (Tuesday). For further details refer to our web site or contact us at info@workshop.mathfinance.de.

2. Contents

The workshop is intended for practitioners of the areas of trading, quantitative or derivative research and risk management as well as for academics studying or researching in the field of financial mathematics or finance in general.
The talks during the two days of the workshop cover a broad range of current topics and are presented by internationally known academics and practitioners. There will be enough time for questions and discussions after each talk and additional breaks provide you the opportunity to build networks within the quantitative finance community.
The workshop will be held in English.

3. List of speakers

- Prof Joachim K Anlauf
- Dr Andreas Binder
- Dr Oliver Brockhaus
- Prof Peter Carr
- Dr Matthias Fengler
- Dr Christian Fries
- Alexander Giese
- Dr Simon Johnson
- Prof Christoph Kühn
- Jan Maruhn
- Prof Gunter Meissner
- Prof Thorsten Schmidt
- Prof Stephen Taylor
- Prof Robert G Tompkins
- Prof Jan Vecer
- Dr Ralf Werner

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Monday, 27 March 2006: HfB Audimax

08:30 Registration

09:00 Prof Stephen Taylor

A Multi-Horizon Comparison of Density Forecasts for the S&P 500 Using Index Returns and Option Prices

We compare density forecasts of the S&P 500 index from 1991 to 2004, obtained from option prices and daily and five-minute index returns, over seven horizons ranging from one day to twelve weeks. Risk-neutral forecasts are derived by estimating the Heston stochastic volatility model from option prices, which provides a closed-form density for all future times. Out-of-sample methods, both parametric and non-parametric, are applied to transform the risk-neutral densities into real-world densities. These option-based densities are compared with historical densities defined by ARCH models.

We find the best forecasts are produced by the parametric risk-transformation of the risk-neutral densities, for horizons of one day, one week and two weeks, when forecast methods are ranked by the out-of-sample likelihood of observed index levels. For longer horizons, option-based densities continue to outperform the historical densities. A mixture of the parametric transformation of the risk-neutral densities and the historical densities obtained from five-minute returns has a higher likelihood than both components of the mixture, for the one-day and one-week horizons.

The Kolmogorov-Smirnov and Berkowitz diagnostic tests show that the risk-transformed, option-based densities nearly always pass these tests, and they do so more often than the other density forecasting methods.

This is joint work with Mark B. Shackleton and Peng Yu.

09:50 Dr Matthias Fengler

Better than its Reputation: An Empirical Hedging Analysis of the Local Volatility Model for Barrier Options

We discuss the pricing and hedging of barrier options within the framework of the local volatility model. While there is an ample literature on pricing issues, we focus on the dynamic hedging under alternative stickiness assumptions on the implied volatilility dynamics and different hedging strategies. Alternative stickiness assumptions on the implied volatilility dynamics lead to different computational procedures for the delta: The delta can be computed assuming that the local volatility surface is fixed (sticky-local-volatility or model-consistent delta), or assuming that the implied volatility surface is fixed (sticky-strike delta), or assuming that the implied volatility surface floats with the underlying spot value (sticky-moneyness delta). Using data of the EUREX for options on the DAX, we compare the three delta concepts in an empirical hedging analysis for barrier options with a maturity of one and two years. We find that delta hedging alone does not lead to satisfactory results with the sticky-strike assumption performing best. However, when we use plain vanilla options as additional hedging instruments, the hedging performance can be improved considerably. We analyze two different dynamic hedging strategies involving plain vanilla options and demonstrate that the resulting hedging errors are distributed around zero with a small variance. Several non-parametric tests on the empirical time series of hedging errors confirm that the sensitivities computed under the sticky-strike assumption yield the best hedging results, while model-consistent hedges have the largest variance.

This is joint work with Bernd Engelmann (Quanteam) and Peter Schwendner (Sal. Oppenheim).

10:40 tea break

11:00 Alexander Giese

On the Pricing of Auto-Callable Equity Structures in the Presence of Stochastic Volatility and Stochastic Interest Rates

Auto-callable equity structures have become very popular in the last few years. The characteristic feature of these structured products is that depending on the path of the equity underlying the product is automatically called and the notional is redeemed early on pre-prescribed dates known as the auto-call dates. Clearly, auto-callable equity structures carry exposure to the implied volatility skew, the volatility of the interest rates and to the correlation between equity and interest rates. In order to take these risk factors into account when pricing auto-callable equity structures, we develop option pricing models that admit stochastic volatility, stochastic interest rates and correlation between equity and interest rates. Using these hybrid models we analyze the impact of the various risk factors on the price of auto-callable structures.

11:50 Prof Robert Tompkins

Catch the Drift? - Finding the Change of Measure from The Real World to Risk Neutral

To address many of the anomalies in option prices, GARCH models have been proposed for the pricing of options. Risk neutral drift adjustments often assume normal processes and employ continuous time limits. Of particular interest is what happens when we consider discrete time and non-normal processes for the underlying returns.

This research considers the problem of finding the drift adjustment that assures that all future prices conform to a local martingale. To determine the appropriate drift adjustment, simulated prices

are determined using a Monte Carlo simulation. The logs of the average prices are estimated and a regression of these versus time is estimated. The slope coefficient of this regression can be interpreted as the change of measure. A simple experiment with the standard Geometric Brownian Motion (GBM) model finds a slope coefficient insignificantly different than the usual theoretical drift adjustment. This approach is compared to the Empirical Martingale Simulation method proposed by Duan and Simonato (1995) and the results are indistinguishable. This new approach is also related to the moment matching method of Barraquand (1994), with the additional feature that a multiplicative adjustment is made which ensures arbitrage is not violated by the estimated option prices.
Once this approach has been shown to work in simulation of a known model, we turn to the Real World. For this we consider the British Pound / US Dollar from 1990 to 2004. The Mixed Unconditional Disturbances (MUD) approach of Tompkins and DEcclesia (2006) is used to determine the empirical distribution of historical returns. This model first estimates a GARCH (1,1) model and devolatises standardised returns. These returns are mixed randomly and reprojected to simulate new price series (re-introducing the GARCH(1,1) volatility). The average log return is regressed against the time horizon of the simulation and it is found that the drift adjustment that yields asset prices as exponential martingales is quadratic. The results are compared to what the theoretical drift adjustment would be for the GARCH pricing model of Heston and Nandi (2000). It is found that the simulated price series conforms to the first order drift adjustment of Heston and Nandi (2000), but because the prices are estimated discretely and the underlying process does not conform to GBM, the higher order drift adjustments appear related to the variance of the variance.
Finally, as a check, a standard Bootstrapping approach was completed to compare the results from the MUD simulation. The results of the Bootstrapping method are roughly in line with the MUD simulation, but the resampling introduces considerable error in the estimation of the drift coefficients in the regression. The MUD simulation reduced the error in estimation by a factor of between 8 and 10 times.

12:40 lunch

14:00 Prof Peter Carr
Vanilla No Touch Duality

14:50 Prof Gunter Meissner
Valuing credit default swaps with counterparty risk A combined copula-LMM approach
The paper derives a model with a closed form solution for valuing credit default swaps including reference asset counterparty default correlation. The default correlation between the reference asset and the counterparty is incorporated in two quadruple trees. One tree represents the default swap payoff of the default swap seller; the other tree represents the default swap premium payments of the default swap buyer. Swap valuation techniques are then applied to derive the fair default swap price.
The model incorporates two correlation approaches used in todays credit practice, the Gaussian copula approach and the discrete correlation approach. The Gaussian copula results in a higher credit default swap premium than the discrete approach, since it produces lower joint default probabilities.
The model is represented with three LMM (Libor Market Model) processes. One LMM process simulates risk-free short-term interest rates. Two more LMM processes generate the reference asset default probabilities and the counterparty default probabilities. A Visual Basic open source code version of the model is provided.
Co-Authors: Michael Hamp, Janne Kettunen

15:40 tea break

16:00 Dr Simon Johnson
Numerical Methods for the Markov Functional Model
Some numerical methods for efficient implementation of the 1- and 2-factor Markov Functional models of interest rate derivatives are proposed. These methods allow a sufficiently rapid implementation of the standard calibration method, that joint calibration to caplets and swaptions becomes possible within reasonable CPU time. Prices for Bermudan swaptions generated within the Markov Functional model are found to be very close to market consensus prices. Bermudans are therefore a good example of a product ideally suited to this model.

16:50 Dr Andreas Binder
Can you feel the heat? Inverse problems in finance and thermal processes
Calibration - or parameter identification - in computational finance is an inverse problem, which is typically ill-posed in the sense of Hadamard, which means that arbitrarily small perturbations or noise in the data may lead to arbitrarily large changes in model paramaters if this type of problems is not handled carefully.
We describe some model problems from engineering applications and from finance and show the common difficulties. We present the basic (and some advanced) concepts of regularization techniques like Tikhonov regularization or Landweber iteration. Some examples show the key features of regularization and its limitations.

Tuesday, 28 March 2005: Commerzbank Tower, Kaiserplatz

08:30 Registration

09:00 Prof Jan Vecer

Trading Maximum Drawdown and Options on Maximum Drawdown

Maximum Drawdown is becoming increasingly important in the risk management and in the portfolio optimization. In this talk, we note that the Maximum Drawdown can be traded as a derivative asset. Several related contracts, such as Call or Put options on the Maximum Drawdown, or barrier option on the Maximum Drawdown (Crash option) are also discussed. These contracts can facilitate risk management for financial institutions concerned with control of the drawdown of their portfolio.

09:50 Jan Maruhn

Eliminating Model Parameter Uncertainty from Static Hedge Portfolios: The Case of Barrier Options

The static hedging approaches for barrier options developed in the literature so far can perform very poorly if applied to a real world setting. One of the main reasons for this bad performance is that the approaches do not take model parameter uncertainty into account. During the talk we present a new approach to derive static super-replication strategies in general financial market models. Furthermore, by using appropriate optimization methods, the strategies can be robustified with respect to changes in the model parameters. We will illustrate the concept and numerical results for the Black Scholes model as well as general stochastic volatility models. As it turns out, the resulting hedging strategies have attractive properties and are only marginally more expensive than the barrier option itself.

10:40 tea break

11:00 Dr Christian Fries

Efficient Calibration for Libor Market Models - Alternative strategies and implementation issues

Proxy simulation schemes using likelihood ratio weighted Monte Carlo for generic robust Monte-Carlo sensitivities and high accuracy drift approximation with applications to the LIBOR Market Model.

We consider a generic framework for generating likelihood ratio weighted Monte Carlo simulation paths, where we use one simulation scheme K (proxy scheme) to generate realizations and then reinterpret them as realizations of another scheme K* (target scheme) by adjusting measure (via likelihood ratio) to match the distribution of K^* such that

$$E[f(K^*)|Ft] = E[f(K)w|F_t]. \quad (1)$$

This is done numerically in every time step, on every path. This makes the approach independent of the product (the function f in (1)) and even of the model, it only depends on the numerical scheme.

The approach is essentially a numerical version of the likelihood ratio method and Malliavins Calculus reconsidered on the level of the discrete numerical simulation scheme. Since the numerical scheme represents a time discrete stochastic process sampled on a discrete probability space the essence of the method may be motivated without a deeper mathematical understanding of the time continuous theory (e.g. Malliavins Calculus).

The framework is completely generic and may be used for high accuracy drift approximations and the robust calculation of partial derivatives of expectations w.r.t. model parameters (i.e. sensitivities, aka. Greeks) by applying finite differences by reevaluating the expectation with a model with shifted parameters. We present numerical results using a Monte-Carlo simulation of the LIBOR Market Model for benchmarking.

This is joint work with Jörg Kampen of Heidelberg University.

11:50 Prof Joachim Anlauf

Pricing of Derivatives by Fast, Hardware Based Monte Carlo Simulation

In this talk we will show how typical problems of financial engineering can be solved completely in hardware (as opposed to software solutions running on traditional computers). As an example we have chosen the pricing of derivatives by Monte Carlo simulations. It turns out that so called FPGAs (field programmable gate arrays) can be configured to run the whole algorithm in parallel, where the calculation is accelerated by two orders of magnitude measured against a state-of-the-art personal computer. These results are achievable using a single FPGA-chip mounted on a PCI-card that is plugged into a standard PC.

The talk is organized as follows:

After introducing the architecture of FPGAs and the way of configuring (programming) them, the example application will be presented. Some remarks about the implementation of the Monte Carlo simulation will show that we are able to exploit the parallelism of many algorithms with the help of FPGAs. Depending on the scenario a huge speedup can be obtained. Advances in programming languages and compilation tools make it reasonable to apply these techniques to many problems of financial engineering, including the traditionally very time consuming risk management calculations.

12:40 lunch

14:00 Dr Oliver Brockhaus

Implied Sampling: Properties and Pitfalls

Sampling according to the equity distribution implied by Vanilla options has become a market standard. The main advantage is that this method allows to efficiently simulate path dependent payoffs. We discuss the approach, its limitations and generalisations. In particular, we study the model prices for various products in comparison with alternative (computationally less efficient) methods.

14:50 Prof Thorsten Schmidt

Pricing Corporate Securities under Noisy Asset Information

We consider the pricing of corporate securities when investors do not have full information. One approach for this is to consider a random default boundary, such that even if the firm value was known, the time of default would not be predictable. On the other side, in reality investors do not have access to the true firm value. This is taken into account using an approach which considers the firm value unobservable and uses noisy asset information to obtain a filter problem. The filter problem is solved approximately and consequences to the pricing of equity and debt are examined.
This is joint work with joint work with Rdiger Frey of Leipzig University.

15:40 tea break

16:00 Dr Ralf Werner

Calibration of the Svensson Model to Simulated Yield Curves

In contrast to existing investigations on the calibration of the Svensson model to real world yield curves, the calibration to simulated curves faces rather different hurdles. As simulated yield curves usually come from a mathematical model (e.g. Black-Karasinski 2-factor model) the availability of reliable data points to derive the fit is not crucial. In contrast to usual applications, for Monte Carlo simulations several thousand different yield curves with a broad shape have to be calibrated. This demands both a very efficient calibration, i.e. acceptable computation time, as well as the guarantee of convergence to the global optimum.
We investigate the behaviour of different formulations for the calibration problem and highlight problems using a simple approach based on standard optimization routines. We show how these results can be improved using a newly developed deterministic adaptive global optimization routine based on sparse grids, while keeping computation times within reasonable limits. We close the talk with a description of potential applications within risk capital models of insurance companies.
This is joint work with Izabella Ferenczi, TU München.

16:50 Prof Christoph Kühn

Optimal Portfolios in Markets with a Large Investor

A large investor is somebody whose trades move market prices significantly. Put differently, he is faced with an illiquid financial market. The first part of this talk is about a microeconomic motivation of illiquid market models with both a permanent and a non-permanent price impact caused by a transaction of a large investor. Then, we discuss the large investor's utility maximization problem.

17:30 End of Conference

5. Personal descriptions

Prof Joachim K Anlauf, University of Bonn

Joachim K. Anlauf is professor at the Institut für Informatik II, Rheinische Friedrich-Wilhems-Universität in Bonn.

Dr Andreas Binder, MathConsult Linz

Andreas Binder obtained his Ph.D. in applied mathematics (with a thesis on continuous casting of steel) in 1991 from the University of Linz, Austria, one of the worlds leading centres of inverse problems research. Since 1996, he has been managing director of MathConsult, a company developing software solutions for engineering applications and for the finance industry.

Dr Oliver Brockhaus, Commerzbank

Dr Oliver Brockhaus is head of equity financial engineering at Commerzbank Corporates & Markets. Before Commerzbank, he was a quant at Deutsche Bank, JPMorgan, Hypovereinsbank and Calyon. His interests include smile and correlation modelling for equities and credit.

Prof Peter Carr, Bloomberg

Dr. Peter Carr is the Head of Quantitative Financial Research at Bloomberg LP, where his group is responsible for all facets of the business operation relating to modeling and analytics. He is also the Director of the Masters in Math Finance program at NYU's Courant Institute. Prior to his current positions, he headed equity derivative research groups for six years at Banc of America Securities and at Morgan Stanley. His prior academic positions include 4 years as an adjunct professor at Columbia University and 8 years as a finance professor at Cornell University. Since receiving his PhD. in Finance from UCLA in 1989, he has published extensively in both academic and industry-oriented journals. He is currently the treasurer of the Bachelier Finance Society and a practitioner director for the Financial Management Association. Peter is also an associate editor for 6 academic journals related to mathematical finance and derivatives. He has given numerous talks at both practitioner and academic conferences. He is also credited with numerous contributions to quantitative finance including: co-inventing the variance gamma model, inventing static and semi-static hedging of exotic options, and popularizing variance swaps and corridor variance swaps. Peter has recently won awards from Wilmott Magazine for Cutting Edge Research and from Risk Magazine for Quant of the Year.

Dr Matthias Fengler, Sal. Oppenheim

Dr. Matthias Fengler is a quantitative analyst at Sal. Oppenheim, Frankfurt. He obtained his PhD in Quantitative Finance from the Humboldt-Universität zu Berlin and is author of the book Semiparametric Modeling of Implied Volatility recently published in the Lecture Notes in Finance, Springer-Verlag.

Dr Christian Fries, DZ Bank

Christian Fries is head of model development, rates & hybrids at DZ Banks risk control and a lecturer at University of Frankfurt. He obtained a Ph.D. in mathematics (PDEs) from RWTH Aachen. His current research interests are hybrid interest rate models and Monte Carlo methods.

Alexander Giese, Hypovereinsbank

Alexander Giese is Co-Head of Quantitative Research for Equity, Indices and Portfolio Strategies in the Global Derivatives Team of HVB Corporates & Markets.

Dr Simon Johnson,Commerzbank

Dr Simon Johnson is co-head of credit and interest rate Financial Engineering at Commerzbank Corporates & Markets. Before Commerzbank, he was a senior quant at NumeriX and a quant at Reech Capital plc. He started his career as a technology consultant at The Technology Partnership plc. His interests include term structure models of interest rates and smile modelling.

Prof Christoph Kühn,
Frankfurt MathFinance Institute

Christoph Kühn is Juniorprofessor at the Frankfurt MathFinance Institute. He holds a diploma in mathematical economics from the University of Marburg and a PhD in mathematics from Munich University of Technology. His main research interests are pricing and hedging of derivatives in incomplete markets and the microstruture of financial markets.

Jan Maruhn, University of Trier

Jan Maruhn works as a research associate at the University of Trier in the numerical analysis group lead by Prof. Dr. Sachs. His research interests include the application of robust optimization as well as nonlinear and stochastic programming techniques to optimization problems arising in finance. Currently, he is particularly interested in the development of numerical algorithms for the computation of static hedge portfolios for barrier options.

Prof Gunter Meissner, Hawaii Pacific University

Gunter Meissner is Founder and President of Derivatives Software. After a lectureship in Mathematics and Statistics at the Economic Academy Kiel he joined Deutsche Bank in 1990, trading interest rate futures, swaps and options. Gunter Meissner became Head of Product Development in 1994, responsible for originating algorithms for new derivative products. In 1995/1996 he was Head of Options at Deutsche Bank Tokyo. Presently, he is also Professor for Finance at the Hawaii Pacific University (www.hpu.edu).

Prof Thorsten Schmidt, University of Leizpig

Thorsten Schmidt is juniorprofessor in financial mathematics at

the University of Leipzig. He has a strong background in statistics and probability theory and is currently working on pricing and hedging credit risk, infinite dimensional models and incomplete information issues.

Prof Stephen Taylor, Lancaster University

Stephen Taylor is Professor of Finance at Lancaster University, England. He is the author of Asset Price Dynamics, Volatility and Prediction, published by Princeton University Press in 2005. His research into stochastic volatility models and option prices has been published in several influential papers, in Mathematical Finance, the Journal of Financial and Quantitative Analysis, the Journal of Econometrics and other premier journals.

Prof Robert G Tompkins,
HfB - Business School of Finance and Management

Dr. Robert G. Tompkins was born in Oklahoma, USA and he received his A.B. (1980), his A.M. (1980) and his MBA (honors) (1986) from the University of Chicago. He moved to England in 1986 and subsequently became a British citizen. He earned a Ph.D. (1998) from the University of Warwick and his Habilitation (2000) from the University of Technology, Vienna, where Dr. Tompkins lived from 1998 to 2003.

Prof Jan Vecer, Columbia University

Prof Jan Vecer received his PhD in Mathematical Finance from Carnegie Mellon University. He held academic jobs at the University of Michigan and Kyoto University before joining the faculty of the Department of Statistics at Columbia University in 2001. He works in the areas of option pricing and stochastic optimal control.

Dr Ralf Werner, Allianz

Dr. Ralf Werner currently holds a position as Senior Risk Analyst within the Risk Methodology team of Allianz, Group Risk Controlling. His research is mainly focused on various applications of optimization in finance, with emphasis on non-linear and robust optimization methods.