AFMathConf 2023

14th Actuarial and Financial Mathematics Conference

Interplay between Finance and Insurance

Brussels, 9-10 February 2023

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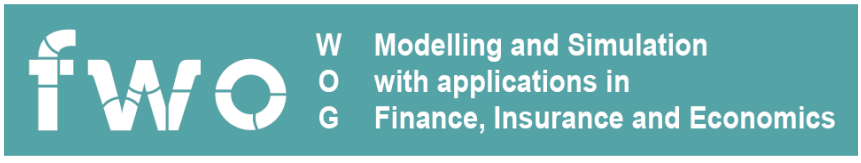

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Practical info

Registration desk

Location: Marble room
Opening hours: Thursday 9:00 – 17:30, Friday 8:30 – 13:00
Representative: Achille Demares

Conference locations

Presentations: Auditorium Albert II
Poster session: Marble room
Lunches & coffee: Marble room
Conference dinner: University foundation (Egmontstraat 11, 1000 Brussel)

Map available at http://www.afmathconf.ugent.be/index.php?page=practicalinfo

Wireless internet

SSID: academie (no password needed)

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On the application of machine learning to enhance algorithms in computational finance

Cornelis Oosterlee, Utrecht University, The Netherlands
Joint work with Shuaiqiang Liu, Kristoffer Andersson, Balint Negyesi and Lech Grzelak

In this presentation, we will first give a brief overview of our experiences with the use of artificial neural networks (ANNs) in finance. We'll give an example of supervised, unsupervised and reinforcement learning. After this we will outline the use of neural networks for the calibration of a financial asset price model in the context of financial option pricing. To provide an efficient calibration framework, a data-driven approach is proposed to learn the solutions of financial models and to reduce the corresponding computation time significantly. Specifically, fitting model parameters is formulated as training hidden neurons within a machine-learning framework. The rapid on-line computation of ANNs combined with a flexible optimization method (i.e. Differential Evolution) provides us fast calibration without getting stuck in local minima.

Scenario generation for market risk models using generative neural networks

Solveig Flaig, Deutsche Rückversicherung AG / Carl von Ossietzky Universität, Germany
Joint work with G. Junike

In this research, we show how to expand existing approaches of generative adversarial networks (GANs) being used as economic scenario generators (ESGs) to a whole internal model - with enough risk factors to model the full band-width of investments for an insurance company and for a one year horizon as required in Solvency 2. For validation of this approach as well as for optimisation of the GAN architecture, we develop new performance measures and provide a consistent, data-driven framework. Finally, we demonstrate that the results of a GAN-based ESG are similar to regulatory approved internal models in Europe. Therefore, GAN-based models can be seen as an assumption-free data-driven alternative way of market risk modelling.

The interest rate risk of equity-indexed annuities with investment guarantees

Peter Hieber, HEC Lausanne, Switzerland
Joint work with Sascha Günther (HEC Lausanne)

Rapidly changing interest rate levels have made it almost infeasible to offer long-term investment guarantees to policyholders. This talk considers equity-indexed annuities containing an annual (cliquet-style) investment guarantee. Conditioning on the annual interest rate levels of a stochastic interest rate model, we develop a closed-form expression for the moments and Laplace transform of the product payoff. This introduces a novel technique that is based on a combination of matrix multiplications and Black-Scholes-type formulas. We avoid any integration or numerical Fourier inversion.

Dual Formulation of the Optimal Consumption Problem with Multiplicative Habit Formation

Thijs Kamma, Technical University of Munich, Germany
Joint work with Antoon Pelsser

This paper derives a dual formulation of the optimal consumption problem with internal multiplicative habit formation. In this problem, the agent derives utility from the ratio of consumption to the internal habit component. Due to this multiplicative specification of the habit model, the optimal consumption problem is not strictly concave and incorporates irremovable path-dependency. As a consequence, standard Lagrangian techniques fail to supply a candidate for the corresponding dual formulation. Using Fenchel's Duality Theorem, we manage to identify a candidate formulation and prove that it satisfies strong duality. On the basis of this strong duality result, we are able to derive duality relations that stipulate how the optimal primal controls depend on the optimal dual controls and vice versa.

On the implied volatility of Asian options under stochastic volatility models

Eulalia Nualart, University Pompeu Fabra Barcelona, Spain
Joint work with Elisa Alòs and Makar Pravosud

In this paper we study the short-time behavior of the at-the-money implied volatility for arithmetic Asian options with fixed strike price. The asset price is assumed to follow the Black-Scholes model with a general stochastic volatility process. Using techniques of the Malliavin calculus such as the anticipating Itô's formula we first compute the level of the implied volatility of the option when the maturity converges to zero. Then, we find and short maturity asymptotic formula for the skew of the implied volatility that depends on the roughness of the volatility model. We apply our general results to the SABR model and the rough Bergomi model, and provide some numerical simulations that confirm the accurateness of the asymptotic formula for the skew.

Implied Value-at-Risk and Model-Free Simulation

Andrea Perchiazzo, Vrije Universiteit Brussel, Belgium
Joint work with Carole Bernard and Steven Vanduffel

We propose a novel model-free approach for extracting the risk-neutral quantile function of an asset using options written on this asset. We develop two applications. First, we show how for a given stochastic asset model our approach makes it possible to simulate the underlying terminal asset value under the risk-neutral probability measure directly from option prices. Specifically, our approach outperforms existing approaches for simulating asset values for stochastic volatility models such as the Heston, the SVI, and the SABR models. Second, we estimate the option implied Value-at-Risk (VaR) and the option implied Tail Value-at-Risk (TVaR) of a financial asset in a direct manner. We also provide an empirical illustration in which we use S&P 500 Index options to construct an implied VaR Index and we compare it with the VIX Index.

Risk-sharing in equity-linked products: Stackelberg equilibrium between an insurer and a reinsurer

Yevhen Havrylenko, Technical University Munich, Germany, and University of Copenhagen, Denmark
Joint work with Maria Hinken and Rudi Zagst

Equity-linked insurance products often have a capital guarantee, i.e., a promise by an insurance company that a client receives at least a specific amount of money at product maturity. In the low-interest-rate environment, it is challenging for insurance companies to ensure capital guarantees for clients and simultaneously generate decent profit for shareholders. As a result, some insurers offering equity-linked products tried to invest riskier but share financial risk via reinsurance. In practice, the decisions that insurers and reinsurers meet within reinsurance contracts are dependent, e.g., a high reinsurance premium may motivate the insurer to buy less reinsurance. Moreover, reinsurance contract parties are not always in the same negotiating position. We study how an insurer and a reinsurer can decide on optimal reinsurance contract parameters as well as optimal investment strategies in the context of an equity-linked insurance product. This situation is modeled as a Stackelberg game. The reinsurer is the leader in the game and maximizes its expected utility by selecting its optimal action, i.e., its investment strategy and a safety loading for a reinsurance contract it offers to the insurer. The reinsurer can assess how the insurer will rationally respond to each action of the reinsurer. The insurance company is the follower and maximizes its expected utility by choosing its investment strategy and the amount of reinsurance the company purchases at a price offered by the reinsurer. For general utility functions, we provide the analytic expression of the Stackelberg equilibrium, i.e., the solution to the Stackelberg game. In numerical studies, we equip the parties with power-utility functions, derive the equilibrium and discuss the economic implications of it.

Models and numerical methods related to renewable energy certificates

Carlos Vázquez Cendón, University of A Coruña, Spain
Joint work with María Baamonde and M. Carmen Calvo-Garrido

In this talk, some new pricing methods for Renewable Energy Certificates (RECs) or green certificates and associated derivatives products are presented. For this purpose, starting from a system of FBSDEs and using Ito lemma, we first propose a mathematical model based on a semilinear PDE arising from the consideration of two stochastic factors: the accumulated green certificates sold by an authorized generator and the natural logarithm of the renewable electricity generation rate. One main novelty of the work comes from the numerical treatment of the nonlinerity that appears in the term containing first order derivative in the PDE. Thus, mainly a couple of numerical strategies are proposed. Moreover, we state the mathematical model that governs the valuation of derivatives whose underlying is a REC, in particular we study European options and futures contracts. Thus, we derive the PDE model to price these derivatives, study the existence of solution and propose how to solve the models by using appropriate numerical techniques. Finally, we show some numerical results that illustrate the performance of the proposed model and the numerical methods.

The Wang transform is a matter of inequality

Pasquale Cirillo, ZHAW, Switzerland & New York University, USA
Joint work with P. Carr (NYU)

Exploiting the connections between the well-known Wang transform and a class of Lorenz curves generated by unimodal distribution functions, we show how several important results in pricing and risk management can be restated using tools from the literature on economic inequality. Quantities like the Gini and the Pietra indices acquire a brand new interpretation, and they help us in clarifying some theoretical and practical aspects of the change of measure operation, of distortion functions, and of moneyness among others. We conclude the talk by sketching some promising extensions of our results.

Is accumulation risk in cyber systematically underestimated?

Gabriela Zeller, Technical University of Munich, Germany
Joint work with Matthias Scherer

Many insurers have started to underwrite cyber in recent years. In parallel, they developed their first actuarial models for this new type of risk. On the portfolio level, two major challenges hereby are the adequate modelling of the dependence structure among cyber losses and the lack of suitable data based on which the model is calibrated. The purpose of this presentation is to highlight the importance of taking a holistic approach to cyber. In particular, we argue that actuarial modelling should be viewed as an integral part of an interconnected value chain with other processes such as cyber-risk assessment and cyber-claims settlement. We mathematically illustrate that otherwise, i.e. if these data-collection processes are not aligned with the actuarial (dependence) model, naïve data collection necessarily leads to a dangerous underestimation of accumulation risk. We analyze the detrimental effects on the assessment of the dependence structure and portfolio risk using a simple mathematical model for dependence through common vulnerabilities. The presentation will conclude by highlighting the practical implications for insurers.

Projecting Life Expectancy Using Cause-of-Death-Specific Mortality Scenarios

Torsten Kleinow, University of Amsterdam, Netherlands
Joint work with Alex Yiu and George Streftaris

During the past decade, improvements in all-cause mortality rates and life expectancies for males and females in England and Wales have slowed down. In this talk, cause-specific mortality data for England and Wales from 2001 to 2018 are used to investigate the cause-specific contributions to the slowdown in improvements. Death counts are modelled using negative binomial generalised linear models and a breakpoint in the linear temporal trend in log mortality rates is investigated. Cause-specific scenarios for future mortality rates are generated on the basis of two assumptions: a reversion of post-breakpoint temporal trends for certain causes to pre-breakpoint improvement rates and cause-specific rates based on expert judgement. The effects of these changes on all-cause age-standardised mortality rates and period life expectancies are examined. We find that reduced improvement rates at older ages for the mortality from diseases of the circulatory system, as well as the worsening of mortality caused by mental and behavioural disorders and diseases of the nervous system provide the greatest contributions to the decline of improvements in age-standardised mortality rates and period life expectancies. In most scenarios for future life expectancies we find that the reversion of the improvement rates for a single cause of death will not be sufficient to restore improvement rates in life expectancies seen at the beginning of this century.

Blockchain mining in pools: Analyzing the trade-off between profitability and ruin

Dina Finger, University of Lausanne, Switzerland
Joint work with Hansjoerg Albrecher and Pierre-Olivier Goffard

The resource-consuming mining of blocks on a blockchain equipped with a proof of work consensus protocol bears the risk of ruin, namely when the operational costs for the mining exceed the received rewards. In this paper we investigate to what extent it is of interest to join a mining pool that reduces the variance of the return of a miner for a specified cost for participation. Using methodology from ruin theory and risk sharing in insurance, we quantitatively study the effects of pooling in this context and derive several explicit formulas for quantities of interest. The results are illustrated in numerical examples for parameters of practical relevance.

A multi-task network approach for calculating discrimination-free insurance prices

Andreas Tsanakas, Bayes Business School, City, University of London, UK
Joint work with Mathias Lindholm, Ronald Richman and Mario Wüthrich

In applications of predictive modelling, such as insurance pricing, indirect or proxy discrimination is an issue of major concern. Namely, there exists the possibility that protected policyholder characteristics are implicitly inferred from non-protected ones by predictive models, and are thus having an undesirable (and possibly illegal) impact on prices. A technical solution to this problem relies on building a best-estimate model using all policyholder characteristics (including protected ones) and then averaging out the protected characteristics for calculating individual prices. However, such approaches require full knowledge of policyholders' protected characteristics, which may in itself be problematic. Here, we address this issue by using a multi-task neural network architecture for claim predictions, which can be trained using only partial information on protected characteristics, and it produces prices that are free from proxy discrimination. We demonstrate the proposed method on both synthetic data and a real-world motor claims dataset, in which proxy discrimination can be observed. In both cases we find that the predictive accuracy of the multi-task network is comparable to a conventional feed-forward neural network, when full information is available. Moreover, the multi-task network has clearly superior performance in the case of partially missing policyholder information.

Mandatory pension saving and homeownership

Marlene Koch, University of Konstanz, Germany
Joint work with Bjarne Astrup Jensen and Marcel Fischer

We explore the implications of mandatory minimum contributions to retirement accounts over the life cycle. These contributions alter housing market entry and have substantial welfare effects. We propose a flexible retirement saving scheme that only requires individuals to contribute to retirement accounts if they have not built up sufficient savings. This flexible retirement saving scheme partly alleviates the unintended side effects of mandatory minimum contributions and simultaneously ensures that individuals build up sufficient retirement savings.

Model-free and data-driven methods in mathematical finance

Antonis Papapantoleon, TU Delft, The Netherlands

Academics, practitioners and regulators have understood that the classical paradigm in mathematical finance, where all computations are based on a single "correct" model, is flawed. Model-free methods, where computations are based on a variety of models, offer an alternative. More recently, these methods are data-driven, i.e. they incorporate (implied) information available in financial markets. In this talk, we will discuss model-free and data-driven methods and bounds, and present how ideas from probability, statistics, optimal transport and optimization can be applied in this field.

Multi-factor, Age-Cohort, Affine Mortality Models: A Multi-Country Comparison

Francesco Ungolo, University of New South Wales, Australia
Joint work with M. Sherris and Y. Zhou

Affine mortality models, developed in continuous time, are well suited to longevity applications including pricing and risk management. Advantages of this modelling approach include closed-form derivations of cohort survival curves, with these survival curves consistent with the dynamics of mortality rates. We compare a number of multi-factor continuous time affine models applied to age-cohort mortality data in a multi-country comparison of five countries with differing lengths of time series mortality data. We develop improved estimation methods for these models and provide R code. Parameters are estimated using maximum likelihood with the univariate Kalman Filter, which accounts for the Poisson variation in the measurement equation. We show how this estimation method is faster and more robust compared to the traditional formulation which heavily uses large matrix multiplication and inversion. We also discuss and address numerical issues with the estimation process. We provide graphical and numerical goodness-of-fit checks, and assess model robustness. We then project cohort survival curves and assess the out-of-sample performance of the analysed models. Although the CIR mortality model fits historical data well, particularly at older ages. Other affine mortality models provide better out-of-sample performance, although less so old ages. We show that the affine mortality models analysed are robust with respect to the set of age-cohort data used for parameter estimation.

On the causality-preservation capabilities of generative modelling

Yves-Cédric Bauwelinckx, KU Leuven, Belgium
Joint work with Jan Dhaene, Milan van den Heuvel and Tim Verdonck

Modeling lies at the core of both the financial and the insurance industry, not only for pricing and provisioning, but also for determining capital requirements and liability management, as well as for fraud detection and more generally also in a context of market predictions. These modeling activities impact many parts of the global economy and contribute to the health of our financial systems. The rise and development of machine learning and deep learning models have created many opportunities to improve our modeling toolbox and increase our capacity to grasp complex phenomena. Breakthroughs in these fields have, however, often come with the requirement of large amounts of data. Such large datasets are often not publicly available in finance and insurance, mainly due to privacy and ethics concerns, restraining institutions from sharing data with researchers, other companies, or even between their own departments. This lack of data is currently one of the main hurdles in developing better models that can contribute to society and the economy as a whole. One possible option to alleviating this issue is generative modeling. Generative models are capable of simulating fake but realistic-looking data, also referred to as synthetic data, that can be shared more freely. While generative modeling is nothing new, a major breakthrough was achieved in 2014 with the introduction of Generative Adversarial Networks (GANs). This method increased our capacity to fit very high-dimensional distributions of data. While research on GANs is an active topic in fields like computer vision, they have found limited adoption within the human sciences, like economics and insurance. A reason for this is that in these sciences, most questions are inherently about identification of causal effects, while to this day neural networks, which are at the center of the GAN framework, focus mostly on high-dimensional correlations. In this paper we study the causal preservation capabilities of GANs and whether the produced synthetic data can reliably be used to answer causal questions. This is done by performing causal analyses on the synthetic data, produced by a GAN, with increasingly more lenient assumptions. We consider the cross-sectional case, the time series case and the case with a complete structural model. We find that in the cross-sectional scenario the GAN preserves causality, but for more advanced analyses challenges arise.

Multi-step valuation methods for hybrid life insurance products in a stochastic interest rate framework

Oussama Belhouari, UCLouvain, Belgium
Joint work with Pierre Devolder and Griselda Deelstra

In a complete financial market, financial products are valued with the risk-neutral measure and these products are completely hedgeable. In life insurance, the approach is different as the valuation is based on an insurance premium principle which includes a safety loading. The insurer reduces the risk by pooling a vast number of independent contracts. In our framework, we suggest valuations of a class of products that are dependent on both mortality and finance risk, namely hybrid life products. The aim of this paper is to generalize different valuation operators suggested in the literature into a stochastic interest rate framework. We illustrate our methods with a classical application, namely a Pure Endowment with profit. Several numerical results are presented, and an extensive sensitivity analysis is included.

Modelling Mortality Dependence with Time Series Vine-Copulae - A unified Approach for Serial and Cross-correlation

Atibhav Chaudhry, University of Melbourne, Australia, and KU Leuven, Belgium
Joint work with Rui Zhou, Katrien Antonio and Benjamin Avanzi

Time series vine copulas, which can handle non-linearity and asymmetry in the serial and cross-dependence of multivariate time series, have been found to have superior forecasting performance for financial data compared to the widely used Vector Autoregressive (VAR), ARIMA-vine-copula, and Sparse VAR approaches. This paper explores the application of time series vine copulas in mortality dependence modelling. We consider four types of time series vine copulas: multivariate S-vine, M-vine, D-vine, and Stationary-COPAR. We assess the suitability of these models for mortality data and demonstrate the estimation and forecasting process. We also simplify the estimation process for the Stationary-COPAR model. Our results indicate that time series vine copulas often provide more accurate mortality forecasts than VAR, Sparse VAR, and ARIMA-vine-copula. Furthermore, we show that the complex dependence structure captured by the time series vine copulas can significantly impact the pricing of a longevity bond similar to KORTIS.

Pricing Multi-Asset Options Using The Monte Carlo-Tree (MC-Tree) Method

Bernard Hanzon, University College Cork, National University of Ireland, Ireland
Joint work with Yen Thuan Trinh

This presentation introduces the Monte Carlo-Tree (MC-Tree) method to price the multi-asset options. For pricing single asset options, MC-Tree combines the MC method with the recombining binomial tree based on Pascal's triangle. Similarly, MC-Tree combines the MC method with the recombining multinomial trees based on Pascal's simplex for pricing multi-asset options, see Sierag and Hanzon (2018).

In the higher dimensional case, we develop and apply an optimization algorithm for the convex combination of a collection of (mixing) densities to find the maximized entropy of compound densities. As well known from the literature, the standard bivariate normal density has the maximal entropy at $\log(2\pi)+1\approx 2.837877$. We found the entropy at 2.829718 after applying our optimization algorithm at the tree depth N=10. We also work with a much simpler mixing density for which the entropy is 2.829633. The difference between those two values is possibly insignificant of 10^{-3}.

The core of the MC-Tree method is to very accurately approximate standard Gaussian expectations. In one asset case, we use that mixing zero mean distributions gives a zero-mean distribution, and mixing distributions with the second moment at one produces a distribution with the second moment at one. In the d assets case, we can conclude that maximizing the entropy over the rotation-and reflection-invariant densities, conditional on Mean at $(0,0,...,0)^T$ and the covariance matrix at I_d is equivalent to maximizing the entropy over all densities for a radius of vector-nodes after N steps in the tree, R, on $[0,\infty)$, where $R=\|X\|_2$, conditional on $E(R^2)=d$. In two-assets case, we apply an alternative approach and conclude that maximizing the entropy over the rotation-and reflection-invariant densities, conditional on the $\text{Mean}=(0,0)^T$ and the covariance matrix = I_2 is equivalent to maximizing the entropy over all densities for $\rho=R^2/2$ on $[0,\infty)$, where R^2 is the squared radius, conditional on mean at one and variance at one. As well-known from the literature, the exponential distribution with mean at one and variance at one is the distribution with the maximal entropy at one among all distributions on $(0,\infty)$.

Based on numerical results from pricing multi-asset options, the MC-Tree method is more accurate than the recombining multinomial tree based on Pascal Simplex and the MC Method, using the same tree depth or numbers of simulations.

Optimal Risk Pooling for Peer-to-Peer Insurance

Wentao Hu, KU Leuven, Belgium
Joint work with Ze Chen, Runhuan Feng, Chongda Liu and Yu Mao

Some emerging InsurTech models jointly incorporate the forms of centralized insurer's underwriting and decentralized peers' risk-sharing. Under these forms, the risk is separated into two layers under the mechanisms in which the first below-deductible part is shared within a community and second above-deductible loss, exceeding the community's risk-bearing capacity, are covered by an insurer. In this paper, we mathematically formalize two existing business models: the individual- and group-covered peer-to-peer insurance models. From the perspective of risk averse participants, we studies the optimal deductible in both models.

A review on autocalibration

Julie Huyghe, Université Libre de Bruxelles (ULB), Belgium
Joint work with Michel Denuit, Julien Trufin and Thomas Verdebout

Autocalibration property is interesting in any context where a global balance as well as a local balance is desired. Typically in insurance, it is interesting to have a pure premium that satisfies the autocalibration property. This property is closely related to the performance curves (Lorenz and concentration curves) of a predictor. This allows us to construct a statistical test for autocalibration. This property is interesting by itself in the context of insurance, but it is also interesting in a model comparison context. In particular, the Gini index, the Pearson linear correlation coefficient and the ICC become strictly consistent scoring functions within the class of autocalibrated predictors. This is interesting since it allows to approximate the true pure premium by score maximisation.

Model uncertainty assessment for unimodal log-symmetric distributions

Rodrigue Ghassan Kazzi, Vrije Universiteit Brussel, Belgium
Joint work with Carole Bernard and Steven Vanduffel

It is common in actuarial and financial modeling to deal with risks whose distributions become symmetric unimodal after a log transformation. However, jumping to a conclusion about the model (e.g., adopting a Log-normal distribution) entails some model uncertainty. One natural way to address model uncertainty is to compare the adopted model with the worst-case and best-case models that are consistent with a set of trusted assumptions (e.g., unimodality and symmetry of the log-transformed distribution). This poster presents two approaches to deriving the extreme models that are necessary for the model uncertainty assessment. The first one focuses on the transformed variable, where the trusted assumptions are the unimodality, symmetry, mean, and maximum variance of the transformed distribution. The second one focuses on the original variable, in the sense that the trusted assumptions are the unimodality, log-unimodality, log-symmetry, median, and the first two moments of the original distribution. We also apply our results to a general liability claims dataset and compare them to previous findings in the literature.

Efficient numerical valuation of European options under the two-asset Kou jump-diffusion model

Pieter Lamotte, University of Antwerp, Belgium
Joint work with Karel in 't Hout

This poster concerns the numerical solution of the two-dimensional time-dependent partial integro-differential equation (PIDE) that holds for the values of European-style options under the two-asset Kou jump-diffusion model. A main feature of this equation is the presence of a nonlocal double integral term. For its numerical evaluation, we extend a highly efficient algorithm derived by Toivanen (2008) in the case of the one-dimensional Kou integral. The acquired algorithm for the two-dimensional Kou integral has optimal computational cost: the number of basic arithmetic operations is directly proportional to the number of spatial grid points in the semidiscretization. For the effective discretization in time, we study seven contemporary operator splitting schemes of the implicit-explicit (IMEX) and the alternating direction implicit (ADI) kind. All these schemes allow for a convenient, explicit treatment of the integral term. By ample numerical experiments for put-on-the-average option values, the stability and convergence behaviour as well as the mutual performance of the seven operator splitting schemes are investigated. Moreover, the Greeks Delta and Gamma are considered.

Portfolio Selection Criteria Based on Generalized Herd Behavior Index for Bespoke Basket

Churui Li, KU Leuven, Belgium
Joint work with Wing Fung Chong, Daniël Linders and Gertjan Verdickt

Pioneered by Markowitz (1952), the optimal mean-variance portfolio is the one with minimum variance of portfolio return for a given expected return. However, the variance only captures the linear dependence between asset returns, while it largely ignores non-linear dependence. Through the use of the Herd Behavior Index (HIX), which measures the degree of positive dependence through option prices (Dhaene et al., 2012), we propose a novel portfolio selection optimization. Indeed, as HIX is measured as the ratio of the realized market situation (i.e. a market index) with a comonotonic (i.e. synthetic) market, this measure improves over the existing optimization parameters since it includes a non-linear factor. More specifically, we propose a portfolio selection optimization, labelled ‘optimal mean-HIX portfolio’, which is one with minimum HIX parameter for a given expected portfolio return. As opposed to Dhaene et al. (2012), we do not require a traded market index, but instead we calculate the HIX by assuming a multivariate Variance Gamma model for the underlying stock price process and estimating the model parameters provided with option prices. Given the joint and marginal distributions of asset returns, we determine the optimal mean-HIX portfolio and test whether it outperforms other benchmark portfolios, such as mean-variance, equal-weighted, or price-weighted portfolios.

A note on dependence and volatility in P and Q

Biwen Ling, KU Leuven, Belgium
Joint work with Daniel Linders, Qian Wang and Jan Dhaene

In this paper, we illustrate how risk-neutral dependence can differ substantially from real-world dependence. This implies that forward looking measures such as the VIX, see Chicago Board Options Exchange (2003), and the HIX, see Dhaene, Linders, Schoutens and Vyncke (2012), which are based on observed option prices, may give wrong risk management information. As an example, we characterize the set of risk-neutral martingale measures in a simple two-dimensional market model and show that depending on the choice of the market regarding the pricing measure, risk-neutral correlations can be high or low. We provide an example illustrating the difference between risk-neutral and real-world correlation, which is called the “correlation gap”. We show how dispersion trading can be used to exploit this correlation gap.

Why segmentation matters: a Machine Learning approach for predicting loan defaults in the Peer-to-Peer (P2P) Financial Ecosystem

Adamaria Perrotta, University College Dublin, Ireland
Joint work with Georgios Bliatsios

Peer-to-Peer (P2P) lending is an online lending process allowing individuals to obtain or concede loans without the interference of traditional financial intermediaries. It has grown quickly the last years, with some platforms reaching billions of dollars of loans in principal in a short amount of time. Since each loan is associated with the probability of loss due to a borrower's failure, this paper addresses the borrower's default prediction problem in the P2P financial ecosystem. The main assumption, which makes this study different from the available literature, is that borrowers sharing the same homeownership status display similar risk profile, thus a model per segment should be developed. We estimate the Probability of Default (PD) of a borrower by using Logistic Regression (LR) coupled with Weight of Evidence encoding. The features set is identified via the Sequential Feature Selection (SFS). We compare the forward against the backward SFS, in terms of the Area Under the Curve (AUC), and we choose the one that maximizes this statistic. Finally, we compare the results of the chosen LR approach against two other popular Machine Learning (ML) techniques: the k Nearest Neighbors (k-NN) and the Random Forest (RF).

Limiting sequential decompositions and applications in finance

Hauke Stier, Carl von Ossietzky Universität Oldenburg
Joint work with Gero Junike and Marcus Christiansen

The sequential updating (SU) decomposition is a well-known technique to obtain a profit and loss (P&L) attribution, e.g. of a bond portfolio, by dividing the time horizon into n subintervals and only vary one risk factor, e.g. FX, IR, CS or calendar time, in each subinterval. We show that the SU decomposition converges for large n if the P&L attribution can be expressed by a smooth function of the risk factors. We consider the average SU decomposition, which does not depend on the order or labeling of the risk factors. Sufficient conditions are given to reduce the computational complexity significantly when calculating the average SU decomposition.

On the optimal combination of naive and mean-variance portfolio strategies

Rodolphe Vanderveken, UCLouvain, Belgium
Joint work with Frédéric Vrins and Nathan Lassance

Tu and Zhou (2011) reaffirm the value of mean-variance portfolio theory by proposing a methodology to combine the sample mean-variance portfolio with the naive equally weighted portfolio. We show that the seemingly natural convexity constraint they impose that the two combination coefficients must sum to one is actually unnecessary has several undesirable consequences relative to the unconstrained portfolio combination. In particular, it leads to an overinvestment in the sample mean-variance portfolio, and a worse performance than the risk-free asset for sufficiently risk-averse investors. However, we demonstrate that relaxing the convexity constraint inflates estimation errors in combination coefficients, which we alleviate using a shrinkage estimator of the unconstrained combination. Empirically, the constrained combination outperforms the unconstrained one for investors with small risk aversion, but severely deteriorates as risk aversion increases. In contrast, the shrinkage unconstrained combination enjoys the best of both strategies and performs consistently well for all levels of risk aversion.

Participants

Hansjoerg Albrecher, University of Lausanne
Nicholas Batens, Milliman
Yves-Cédric Bauwelinckx, KU Leuven
Oussama Belhouari, ISBA, UCLouvain
Carole Bernard, Grenoble EM and VUB
Sandrine Biatour, Allianz Benelux
Christopher Blier-Wong, Université Laval
Tim Boonen, University of Amsterdam
Jean-Philippe Boucher, UQAM
Atibhav Chaudhry, KU Leuven
Pasquale Cirillo, ZHAW School of Management and Law
Ibrahim Coulibaly, Sopra Banking Software
Ann De Schepper, University of Antwerp
Griselda Deelstra, Université libre de Bruxelles
Achille Demares, Ghent University
Michel Denuit, UCLouvain
Lionel Derome, Pensio b
Jan Dhaene, KU Leuven
Dina Finger, University of Lausanne
Solveig Flaig, U Oldenburg/Deutsche Rueckversicherung
Marieke Geeraert, KBC Verzekeringen
Michal Gelbaor, Milliman Israel
Vincent Guillaume, AXA
Donatien Hainaut, UCLouvain
Vanessa Hanna, ISBA, UCLouvain
Bernard Hanzon, University College Cork
Yevhen Havrylenko, TU Munich & U Copenhagen
Peter Hieber, HEC Lausanne
Wentao Hu, KU Leuven
Julie Huyghe, Université Libre de Bruxelles
Karel in 't Hout, University of Antwerp
Charlotte Jamotton, Université catholique de Louvain
Monique Jeanblanc, Paris Saclay University
Gero Junike, University of Oldenburg
Thijs Kamma, Technical University of Munich
Rodrigue Kazzi, Vrije Universiteit Brussel
Torsten Kleinow, University of Amsterdam
Marlene Koch, University of Konstanz
Paul Koerber, Belfius Bank
Richard Kruel, Springer-Verlag
Pieter Lamotte, University of Antwerp
Oskar Laverny, UCLouvain
Churui Li, KU Leuven
Daniel Linders, University of Amsterdam
Biwen Ling, KU Leuven
Lorenzo Marchi, KU Leuven
Ute McCrory, Springer-Verlag Heidelberg
Fernando Mierzejewski, Ageas
Edouard Motte, UCLouvain
Mehdi Naouar, AT Global
Eulalia Nualart, Universitat Pompeu Fabra
Cornelis Oosterlee, Utrecht University
Antonis Papapantoleon, TU Delft
Andrea Perchiazzo, Vrije Universiteit Brussel
Mathieu Pigeon, Université de Québec à Montréal
Jolien Ponnet, National Bank of Belgium
Gregory Rayee, Belfius Bank
Hauke Stier, University of Oldenburg
Julien Trufin, Université Libre de Bruxelles
Andreas Tsanakas, Bayes Business School, U London
Francesco Ungolo, University of New South Wales
Rodolphe Vanderveken, UCLouvain, LIDAM/LFIN
Steven Vanduffel, VUB
Michèle Vanmaele, Ghent University
Carlos Vazquez, University of A Coruna
Eva Verschueren, KU Leuven
Frédéric Vrins, LFIN, UCLouvain
David Vyncke, Ghent University
Erik Vynckier, Foresters Friendly Society
Lewis Walsh, BHRG
Morten Wilke, VUB
Gabriela Zeller, Technical University of Munich
Jingyan Zhang, KU Leuven

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