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Abstracts

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Contents

Keynote: Professor Sam Cohen, Beyond Paper Trading: Generalization, Control and the Use of Data in Financial Mathematics

In traditional mathematical finance, data often takes a back seat to modelling — we begin by writing down a mathematical model, learn how to make decisions in that model, and only at the last stage return to calibrate and compare to data. In this talk, we will consider the alternative approach where data takes a primary position in the modelling cycle, and the major concern is overfitting and information leakage. We will show that, in the context of neural network-based models, there are tools from learning theory which allow us to control these issues, based on the mean-field formalism for neural networks.

Information-Theoretic and Fractional Approaches to Quanto Option Pricing

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In this paper, we derive risk-neutral density functions for a multi-asset approach to model the price of European options by incorporating a constrained minimization of the Kullback measure of relative information. This information-theoretic approach provides a systematic method for obtaining probability distributions consistent with observed market dynamics while avoiding restrictive assumptions on asset return distributions.

Based on the theoretical analysis, when the underlying financial asset prices follow geometric Brownian motion, a two-dimensional Black–Scholes equation for quanto options is obtained. The resulting partial differential equation naturally captures the interaction between multiple underlying assets and the associated exchange rate dynamics, which are essential features of cross-currency derivative products. Correlation effects between asset prices are explicitly embedded within the model, making it suitable for practical quanto option valuation.

To evaluate the explicit solution of this multi-asset option pricing model, a time-fractional extension of the classical framework is introduced using the Liouville–Caputo fractional derivative. The fractional formulation allows the model to account for memory effects and nonlocal temporal behavior that are often observed in real financial markets but are not adequately captured by integer-order models.

An approximate analytical solution of the resulting time-fractional two-dimensional Black–Scholes equation is obtained using the Laplace homotopy perturbation method. The solution is expressed in the form of a convergent series under suitable regularity conditions, providing an efficient and analytically tractable scheme for option valuation. Numerical illustrations demonstrate the effectiveness of the proposed method and highlight the influence of key financial parameters, including volatility, correlation, and the fractional order of the derivative.

The proposed framework integrates information theory, fractional calculus, and multi-asset option pricing into a unified mathematical model, offering a flexible and robust approach for analyzing complex derivative instruments in modern financial markets.

Keywords: Quanto option pricing, Multi-asset derivatives, Black-Scholes equation, Information theory, Fractional calculus, Risk-neutral density.

Risk Distortion and Option Pricing

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In this contribution, we develop a semi-parametric framework to infer option-implied probability distortions and investor risk preferences directly from market prices of European options. The approach is based on distortion risk measures and Choquet integration. Probability distortions are modeled flexibly using piecewise linear distortion functions, which makes the framework both economically interpretable and numerically tractable.

Within this setting, we establish the link between distorted probabilities, the pricing kernel, and the implied risk-neutral density, and derive the price for plain vanilla option using several underlying models. The proposed methodology enables the direct extraction of a market-implied risk-neutral density from observed option prices while simultaneously identifying the shape of the underlying distortion function. This allows us to capture key empirical features of option markets, including the volatility smile.

We implement the framework using European call options across multiple maturities and strikes. Calibration results demonstrate that the distortion-based model provides an excellent fit to observed market prices and systematically outperforms several widely used benchmark models. Overall, the proposed approach offers a flexible and economically grounded tool for recovering market-implied beliefs and risk attitudes from option prices, with potential applications in asset pricing, risk management, and behavioural finance.

Optimal Investment in a Multi-Asset Market with Quadratic-Affine Interest Rates and Heston Stochastic Volatility

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We consider an optimal investment problem in an incomplete multi-asset market with borrowing, stochastic volatility, and random interest rates. The investor aims to maximise the expected power utility of terminal wealth. The market dynamics are driven by a Heston-type stochastic volatility model and a quadratic-affine interest rate model, leading to a nonlinear and multi-input stochastic control problem with unbounded random coefficients. The nonlinearity of the system arises from three distinct sources: the borrowing term, the square-root of the Heston volatility model, and the quadratic dependence of the interest rate on an underlying factor process. These features make the problem more challenging than classical single-asset.

Using a multi-dimensional piecewise completion-of-squares method, we succeed in establishing the existence and uniqueness of an admissible optimal investment strategy. The resulting optimal control is obtained in explicit closed form and admits a linear state-feedback representation. Unlike existing results for single-asset markets (see, for example, [1], [2], [3], [5]), the optimal strategy in the multi-asset setting exhibits up to five distinct regimes, reflecting the complex interaction between borrowing, stochastic volatility, and quadratic-affine interest rates.

The proposed approach significantly extends existing completion of squares method in the literature and provides a tractable framework for solving a class of nonlinear stochastic optimal control problems arising in realistic financial markets with multiple risky assets.

* Lead presenter

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Waiting to Charge: User Costs in EV Fast-Charging Networks

Paul Johnson

The expansion of electric vehicles (EVs) exerts increasing pressure on public fast-charging infrastructure, particularly for users who rely on it without access to home charging. This paper develops a stylised dynamic model of EV charging behaviour to quantify how limitations in public fast-charging accessibility translate into user costs over time. Charging decisions are modelled as a stochastic impulse-control problem in which drivers trade off state of charge, accessibility conditions, and time-related frictions such as detours and waiting.

Accessibility is represented by a reduced-form state variable calibrated using road-network data and public fast-charging locations rated at least 50kW for Great Britain. The results show that time-related frictions generate the largest infrastructure-induced costs: the baseline GB average is £143 per year, while a long-queue scenario more than doubles this value.

Within this stylised benchmark, the findings suggest that policies that reduce queuing, per-session charging time, and the persistence of poor-accessibility states can lower user costs substantially, while call-out penalties and moderate changes in range-anxiety parameters have much smaller effects under the optimal charging policy. Regional disparities remain large, with baseline costs ranging from about £54 per year in London to £233 per year in Scotland.

Keynote: Professor Goran Peskir, The Optimal Mean-Variance Selling Problem with Finite Horizon

Imagine an investor who owns a stock which he wishes to sell so as to maximise his return and minimise his risk upon selling. In line with the classic mean-variance analysis we identify the return with the expectation of the stock price and the risk with the variance of the stock price. The quadratic nonlinearity of the variance then moves the resulting optimal stopping problem outside the scope of the standard/linear optimal stopping theory. Consequently the results and methods of the standard/linear optimal stopping theory are no longer applicable in this new/nonlinear setting. The solution to the nonlinear problem when the horizon is infinite has been known for some time, however, the method of proof used to solve the nonlinear problem in that case is not applicable in the case when the horizon is finite. The purpose of the talk is present a new method of proof which solves the nonlinear problem when the horizon is finite. [This is joint work with P. Johnson and J. L. Pedersen.]

Credit Risk Models: A Functional Perspective

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Probability of Default (PD) models are central to credit risk management, as they estimate if a borrower fails to meet financial obligations within a specified time horizon; an event that can lead to economic losses for the bank and financial distress for the customer.

In traditional PD modeling, customer or loan level features are typically derived from aggregated transactional data, summarized at monthly, quarterly, or annual intervals. Aggregation is considered necessary because raw transactional data are irregular, noisy, and lack consistent structure. However, the aggregation process potentially discards information that could improve predictive performance.

The industry standard for PD modelling is to use logistic regression, which offers reliability and model interpretability. To improve model performance, more advanced non-linear models have been proposed. Yet they still depend on aggregated transactional variables and are therefore also influenced by the information loss caused by aggregation. To address this underlying limitation, we propose applying Functional Data Analysis (FDA) to PD modeling, thereby sidestepping the aggregation process. In this setting, transactional data are treated as a single realization of a stochastic process.

We develop a framework that aligns functional representations according to banking days, ensuring that recurring events, such as salary payments and instalments, occur at consistent relative times for each functional representation. Because interpretability remains essential, we employ a functional logistic regression model to estimate PDs for 25.285 Danish banking customers based on (real) transactional data.

The resulting functional PD model is evaluated against a standard logistic regression and an XGBoost baseline. We show that, when equipped with an effective functional representation of transactional trajectories, the proposed model attains predictive performance on par with XGBoost while consistently outperforming logistic regression. Importantly, the model preserves the interpretability of linear PD models while increasing trustworthiness by grounding decisions in observed, non-aggregated transactional data.

Through-the-Cycle PD Estimation Under Incomplete Data A Basel-Consistent Approach for IRB Portfolios

Barbara Dömötör and Ferenc Illés

Under the Internal Ratings–Based (IRB) approach of the Basel framework, banks must estimate long-run, through-the-cycle (TTC) probabilities of default (PDs) for use in regulatory capital calculations. Although supervisors require TTC PDs to reflect long-run average default conditions, banks often rely on internal datasets that are short, incomplete, or heavily influenced by recent economic states, leading to inconsistencies across sub-portfolios and institutions. We propose a rigorous, mathematically grounded method for the joint calibration of long-term PDs across multiple IRB sub-portfolios within the Vasicek single-risk-factor model. The approach formulates the TTC calibration problem as a unified optimization equation that aggregates information across portfolios and enforces consistency with the prescribed long-run average PD. Solving this equation yields a unique, internally consistent set of cycle-neutral through-the-cycle default probabilities, ensuring full coherence across the entire banking portfolio and providing a principled, model-based foundation for regulatory capital estimation. The approach is particularly relevant for smaller or budget-constrained banks, as it requires only internal loss data and functions effectively even when historical series are incomplete. By lowering data requirements while preserving regulatory consistency, the method offers a pragmatic solution that could enhance both supervisory compliance and the robustness of risk-sensitive capital requirements.

Keywords: Basel regulation; internal ratings-based approach; through-the-cycle probability of default; credit risk capital; missing data estimation; numerical optimization

Mathematics Subject Classification (MSC2020): 91G40 (Primary), 91G70, 62P05, 62M10

Does Inclusive Insurance Have Positive Social and Economic Outcomes? A Whole Systems Modelling Approach

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Inclusive insurance is widely promoted as a tool for improving the social and economic well-being of populations living in poverty. Evidence from the literature points to multiple positive impacts, including increased agricultural investment and productivity, improved access to health care and reduced out-of-pocket expenditure, enhanced asset protection, strengthened household resilience, and contributions to several Sustainable Development Goals. Yet these findings stem from separate sector-specific studies, the interactions between them are poorly understood, and the mechanisms through which they counteract or reinforce one another are not clear.

This paper introduces system dynamics as a methodological approach for developing whole-systems models capable of revealing these interconnections. Using evidence from the literature, we construct causal loop diagrams (CLDs) to map key feedback relationships, such as how insurance uptake influences investment and productivity, or how reduced health expenditure improves resilience and human capital. We present a preliminary qualitative system dynamics model outlining core factors, feedbacks, and behavioural delays interacting in the system.

As next steps, we propose developing a quantitative system dynamics model, which has the potential to support scenario-based analysis and provide policymakers with a decision-support tool to assess which insurance products are most effective for which populations under varying conditions. By integrating fragmented evidence into a unified systems framework, this work lays the foundation for understanding the complex, interconnected impacts of inclusive insurance on poverty reduction and resilience.

Keynote: Professor Andreas Tsanakas, The Proxy Problem: Measuring Discrimination in Insurance Pricing

Fairness and discrimination concerns have become central in evaluating the disparate impacts of algorithmic decisions on sub-populations, in fields such as insurance pricing and credit scoring. Much attention has been paid to the potential demographic impacts of decision algorithms, understood through the joint probability distribution of customers' sensitive attributes (e.g. sex or ethnicity), decision outcomes (e.g. insurance prices or lending decisions), and target variables (e.g. claims costs or default events). Less studied – but at least as important – is the mechanism by which sensitive attributes influence decisions. In the context of insurance pricing, direct discrimination arises when sensitive attributes are used explicitly as inputs to the pricing algorithm. Even if such variables are excluded, proxy discrimination may occur if prediction models implicitly infer policyholders' sensitive attributes from correlated covariates. Addressing proxy discrimination requires assessing its materiality in an insurance portfolio. We propose a broad conceptualisation of proxy discrimination as the sensitivity of insurance prices to changes in the conditional distribution of sensitive characteristics given other covariates. From that perspective, we suggest several local and global measures of proxy discrimination. A key practical challenge is that business decisions may diverge from pure loss predictions. We can then distinguish between different measures by both the specific notion of proxy discrimination they target and by the type of price information they work with: model predictions, observed prices, or data-to-price pipelines. Using insurance loss data, we illustrate the application of our measures and discuss their practical implications and limitations, and relevance for regulatory oversight. (Based on joint work with Mathias Lindolm, Ronald Richman, Mario Wüthrich, and Rui Zhu.)

From Refracting to Ratcheting Dividend Strategies: An Optimal Stopping Approach

M. A. LKABOUS AND Q. NGUYEN

Abstract. This paper addresses the optimal prediction of the last passage time, g, for a refracted Lévy process. Formulated in the $L1$ sense, the problem seeks a stopping time that minimizes the expected distance to g. We first establish the theoretical framework for this prediction problem and characterize the optimal stopping solution. As a primary application, we analyze the optimal moment to switch from a "refracting" dividend strategy where dividends are paid at rate δ above a threshold b (Kyprianou and Loeffen [2]) to a "ratcheting" strategy, where dividends are paid perpetually once a level is attained (Albrecher et al. [1]). Furthermore, we generalize these results to a multi-refracted framework, where dividend payouts follow a level-dependent structure. We provide an explicit characterization of the optimal stopping boundaries for this generalized case. To illustrate the practical utility of our findings, we examine special cases within the Cramér-Lundberg risk model and Brownian motion models with single and dual refraction levels. This work is a joint work with M.A. Lkabous.

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Nonparametric Estimation for Compound Renewal Processes in Weighted Cadlag Spaces

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Based on classical renewal–reward models and prior nonparametric work on compound distributions and decompounding (e.g., (1; 2; 3; 4)), we study the compound renewal process

$$Z(t)=\sum_{i=1}^{N(t)} X_i$$

where N(t) is the renewal counting process driven by i.i.d. interarrival times Yi > 0 (a.s.) and i.i.d. jumps Xi. The process {Z(t), t ≥ 0} is typically used to represent the aggregate claim paid by an insurance company through time. For each fixed t ≥ 0, we define the distribution function Gt of Z(t) through the functional representation

$$\Phi(t,H)(x)=\sum_{k=0}^{\infty} p_k(t,H)F^{*k}(x)$$

$$p_k(t,H) = \Pr\{N(t) = k\} = H^{*k}(t) - H^{*(k+1)}(t),$$

where F and H denote the marginal distribution functions of the jumps and interarrival times, respectively. We propose a nonparametric plug-in estimator $G\hat{}_n(t)=\Phi_t(F\hat{}_n, H\hat{}_n)$, constructed from the empirical distribution functions of the observed jumps and interarrivals. To control the infinite series and obtain uniform bounds, we work in weighted cadlag spaces $D_{\beta\beta}$ and derive moment conditions ensuring $\Phi t(F, H) \in D_{\beta\beta}$, using Cramer–Chernoff bounds for the renewal counts, uniform domination bounds for the infinite series defining Φt, and dominated-convergence arguments for series in Banach spaces. By employing a refined Glivenko–Cantelli result and the Functional Delta Method, we establish strong consistency and asymptotic normality of $G\hat{}_n(t)$and show that bootstrap techniques provide valid confidence bounds.

Keywords: compound renewal process, renewal–reward process, nonparametric plug-in estimation, weighted Skorokhod spaces, con-volution functionals, functional delta method, bootstrap.

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Online Monitoring of Financial Functional Time Series

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Functional time series arise naturally in modern financial econometrics, where high-frequency information is often represented as curves (e.g., intraday risk and volatility profiles, term structures) and where models—frequently ML-driven—must operate reliably under distributional shifts. This paper proposes a tuning-free online change-point detection procedure for functional time series based on an adjusted-range self-normalization (SN) principle. The method avoids long-run variance (LRV) estimation and other bandwidth- or sensitivity-type tuning choices (including the commonly used monitoring parameter γ), while retaining robustness to temporal dependence and conditional heteroskedasticity. We establish asymptotic validity under the null hypothesis of no sequential change-points and consistency under fixed alternatives. Monte Carlo experiments show that the proposed procedure achieves improved size control and competitive detection power relative to existing CUSUM-style and self-normalized benchmarks. Empirical applications to financial and hydrological functional data further illustrate its effectiveness as a real-time monitoring layer for regime change detection.

A Risky Asset Student Model with Long-Range Dependence Through Fractal Activity Time

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Modelling the financial asset returns (log price increments) should accommodate several properties that are not captured by Brownian motion, but which are seen in the data, such as dependence in absolute and squared returns (but not returns themselves) and a marginal distribution that is heavier tailed and higher peaked than Gaussian.

In this work, we present a construction of the Student model for a risky asset that allows for squared returns with long-range dependence (LRD) and returns with Student marginal distribution (a process is said to have LRD or long memory if the sum or integral of its ultimately non-negative correlation function diverges). We consider the fractal activity time geometric Brownian motion (FATGBM) model, where the fractal activity time is constructed via a continuous superposition of Ornstein-Uhlenbeck (supOU) processes. This approach applies new limit theorems for supOU processes to generalize previous non-Gaussian models.

We explicitly derive pricing formulae for various options, including digital, power, and barrier options, and conduct numerical simulations to confirm the validity of these formulae. Furthermore, we apply the model to empirical market data using SPDR S&P 500 ETF (SPY) and Microsoft stock (MSFT) call options. Our results demonstrate that the FATGBM model provides a superior fit to actual market prices compared to the classical Black-Scholes model.

Note: This is joint work with Prof. Nikolai N. Leonenko and Dr. Andrey Pepelyshev.

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A Model-Based Selling Propensity: Prospect Theory, Multiple Agents and the Disposition Effect

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February 15, 2026

We develop a state-dependent measure of asset sale propensity, denoted by $D(\cdot)$, to analyse the disposition effect: the empirical observation that investors tend to sell "winners" too soon while holding "losers" too long. While much of the literature provides single-number estimates of the DE, we instead derive a price-level dependent measure arising from a continuous-time liquida- tion problem.

The price process is modelled as a time-homogeneous regular Ito diffusion P, transformed into a local martingale $X = s(P)$ via the scale function. Let ν denote the distribution of X at the liquidation time τ. We define $D(\cdot)$ as the limit of the ratio between the probability of liquidation in a neighbourhood of a price level x and the expected time spent in that neighbourhood. This construction yields a local measure of selling intensity that depends only on the target distribution ν. We then extend the framework from a single-agent setting to a heterogeneous-agent economy. Agents are characterized by preference parameters $\vartheta \in \Theta \subseteq \mathbb{R}^d$, generating individual target laws ν_ϑ. Imposing a distribution $\varphi(\vartheta)d\vartheta$ over Θ, we obtain an aggregate target distribution by averaging the kernel ν_ϑ against φ. We also show that, under suitable regularity conditions on ν, the Bertoin–Le Jan construction yields a stopping time solving the Skorokhod embedding problem, represented as the first jump time of a Cox process with intensity $D(\cdot)$.

We apply the framework to Prospect Theory, incorporating S-shaped utility and probability weighting. For a single agent, $D(\cdot)$ exhibits a spike at the loss threshold, reflecting a point mass in the optimal distribution. Aggregating across heterogeneous loss-aversion parameters smooths these spikes, producing a continuous aggregate distribution. We show that the resulting model-generated propensity is approximately flat in the loss region and asymmetric between losses and gains, consistent with empirical evidence on the disposition effect.

Linear Short Rate Model with Several Delays

Álvaro Guinea

This paper introduces a short rate model in continuous time that adds one or more memory (delay) components to the Merton model or the Vasicek model for the short rate. The distribution of the short rate in this model is normal, with the mean depending on past values of the short rate, and a limiting distribution exists for certain values of the parameters. The zero coupon bond price is an affine function of the short rate, whose coefficients satisfy a system of delay differential equations. This system can be solved analytically, obtaining a closed formula. An analytical expression for the instantaneous forward rate is given: it satisfies the risk neutral dynamics of the Heath-Jarrow-Morton model. Formulae for both forward looking and backward looking caplets on overnight risk free rates are presented. Finally, the proposed model is calibrated against forward looking caplets on SONIA rates and the United States yield curve.

Implementing Generalized Pareto Distribution to Analyse Extreme Rainfall in Balikpapan-Indonesia

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Supervised by

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The evaluation of rare and extreme events is one of the most challenging aspects of quantifying insurance risk. Particularly in catastrophic insurance, measuring climate-related risks is an important step. In this study, we assess the risk of extreme rainfall that can increase the likelihood of flooding. The study focuses on the rainfall event in Balikpapan, Indonesia, which is a buffer city for the New Capital of Indonesia (IKN-Indonesia).

The Generalized Pareto Distribution (GPD) is employed to model extreme rainfall. This study compares three different threshold selections, which are graphical approach, automated threshold, and meteorological agency's judgement. The parameter of GPD is estimated through the maximum likelihood estimation. Each model is evaluated from the diagnostic plot and the goodness of fit using the Anderson Darling test, AIC, and BIC. The lowest threshold comes from meteorological judgment, while the highest is from the graphical method. The result shows that the estimate of scale parameter decreases as the threshold increases, and vise versa for the shape parameter. Both the diagnostic plot and the Anderson Darling test confirm the reasonable assumed distribution, where the threshold from the graphical approach revealed the highest p-value and lower AIC and BIC. Moreover, the estimate of the return level is calculated from the shortest period of 2 years to the longest period of 100 years. The estimation informs that heavy rainfall over 120 mm is expected to occur in 2 years, while extreme rainfall over 200 mm is expected to occur for less than 20 years. This study emphasizes the high tendency of the extreme rain in the city that needs to be mitigated in the future.

Keyword: Rainfall, Generalized Pareto Distribution, Return Level.

Posters

Ohood Aldalbahi: The Randomly Distorted Choquet Integrals and Risk Measures

Helena Lape: Causal Impact of Fan Polls on Fan Token Price Dynamics: A Data Science and Econometric Perspective

Junior Parfait Ngalamo: Deep Hedging of Autocallable Products

Jiang Zhao: Big Data-Driven Subnational Purchasing Power Parity Forecasting: An Empirical Application of Text Mining Technology