

UNSW-Macquarie-University Workshop (Abstracts)

Speaker: Michael Sherris

Affiliation: School of Risk and Actuarial Studies, UNSW Sydney Business School, UNSW Sydney, Australia

Talk Title: Market Price of Longevity Risk for A Multi-Cohort Mortality Model with Application to Longevity Bond Option Pricing

Abstract

The pricing of longevity-linked securities depends not only on the stochastic uncertainty of the underlying risk factors, but also the attitude of investors towards those factors. In this paper, we investigate how to estimate the market risk premium of longevity risk using investable retirement indexes. A multi-cohort aggregate, or systematic, mortality model is used where each risk factor is assigned a market price of mortality risk. To calibrate the market price of longevity risk, a common practice is to make use of market prices, such as longevity-linked securities and longevity indices. We use the BlackRock CoRI Retirement Indexes, which provides a daily level of estimated cost of lifetime retirement income for 20 cohorts in the U.S. For these 20 cohorts, we assume risk premiums for the common factors are the same across cohorts, but the risk premium of the factors for a specific cohort is allowed to take different values for different cohorts. The market prices of longevity risk are then calibrated by matching the risk-neutral model prices with BlackRock CoRI index values. Closed-form expressions and prices for European options on longevity zero-coupon bonds are determined using the model and the calibrated market prices of longevity risk. Implications for hedging longevity risk with bond options are discussed.

This is a joint work with with Yajing Xu and Jonathan Ziveyi.

Speaker: Eckhard Platen

Affiliation: School of Mathematical and Physical Sciences, University of Technology Sydney, Australia

Talk Title: Market Efficiency and the Growth Optimal Portfolio

Abstract

The paper predicts an Efficient Market Property for the equity market, where stocks, when denominated in units of the growth optimal portfolio (GP), have zero instantaneous expected returns. Well-diversified equity portfolios are shown to approximate the GP, which explains the well-documented good performance of equally weighted portfolios. Our proposed hierarchically weighted index (HWI) is shown to be an even better proxy of the GP. It sets weights equal within industrial and geographical groupings of stocks. When using the HWI as a proxy for the GP the Efficient Market Property cannot be easily rejected and appears to be robust.

Speaker: Yuri Kabanov

Affiliations: University of Franche-Comté, France

Talk Title: Hedging on Markets with Small Transaction Costs

Abstract

We discuss the concepts of approximate replication and super-replication in the context of markets with friction. We consider a class of models where the transaction costs coefficients depend on the number n of transactions, decreasing to zero as $n^{-\frac{1}{2}}$, and show that the impact of transaction costs on the super-replication price has a similar effect as a proportional increase of volatility.

Speaker: Marek Rutkowski

Affiliation: School of Mathematics and Statistics, University of Sydney, Australia

Talk Title: American and game options in nonlinear financial models

Abstract

We reexamine and extend the findings from the recent paper by Dumitrescu et al. (2017) who have studied American and game options using the nonlinear arbitrage-free pricing approach developed in El Karoui and Quenez (1997). We provide a detailed study of pricing, hedging and exercising problems for the two parties in contracts of an American style and game options in a general nonlinear model. We show that solutions to unilateral valuation problems for the issuer and the holder of an American option can be obtained by solving the associated nonlinear optimal replication problems. For a game option, we furnish results on fair unilateral prices, rational exercise, cancellation and break-even times for the counterparties. We also discuss a BSDE approach, which yields more explicit result for prices and optimal exercise or cancellation policies.

This is a joint work with Edward Kim and Tianyang Nie.

Speaker: Ermanno Pitacco

Affiliation: MIB Trieste School of Management, University of Trieste, Italy

Talk Title: Heterogeneity in mortality and relevant impacts in life insurance: a review

Abstract

We provide a review of scientific contributions on mortality heterogeneity, focusing in particular on “unobservable” heterogeneity and the related impact on the results (cash flows, profits, etc.) of life insurance and life annuity business. Heterogeneity of a population in respect of mortality is due to differences among the individuals, which are caused by various “risk factors”. Some risk factors are observable while others are unobservable. The set of observable risk factors clearly depends on the type of population addressed. For example, age, gender and geographical area of residence are observable risk factors commonly accounted for when analyzing mortality in national populations. Possibly, marital status and working vs retired position can constitute further risk factors for national population analysis. More observable risk factors can be allowed for when referring to life insurance and life annuity portfolios, e.g. profession, past and current health conditions, etc., while others are unobservable, e.g. individual attitude towards health, some congenital personal characteristics, etc. It is worth noting that, whatever the type of population concerned, a residual heterogeneity remains because of unobservable factors. The impact of observable risk factors on individual mortality, in particular when they also constitute “rating factors” in the calculation of actuarial values, is usually expressed approximately, according to some pragmatic approach. For example, additive or multiplicative adjustments to the average age-specific mortality are frequently adopted. Conversely, heterogeneity due to unobservable risk factors can be quantified by adopting the concept of individual “frailty”. However, individual frailty can be interpreted and consequently modeled in several ways, according to the causes which are considered as originating the frailty itself: congenital characteristics, environmental features, lifestyle aspects, etc. It follows that the individual frailty can, in particular, be assumed either constant or variable throughout the lifetime. The review starts with an overview of methodological contributions to heterogeneity and frailty modeling, coming from both the demographical and the actuarial context, then shifting to contributions analyzing the impact of frailty, in its various interpretations, on insurance and annuity portfolios and related risk profiles.

Speaker: Pavel Shevchenko

Affiliations: Department of Applied Finance and Actuarial Studies. Macquarie University, Sydney

Talk Title: Valuation of Variable Annuity Guarantees

Abstract

In this talk we discuss methodologies for fair pricing of variable annuity guarantees such as Guaranteed Minimum Withdrawal Benefit (GMWB). These products offer protection from market downturns and gain from market upside, and may include additional death benefit guarantees. Valuation of these products should simultaneously deal with financial risk, mortality risk and human behavior. We consider valuation under the “optimal” and pre-defined policyholder behaviors, extensions to stochastic mortality and stochastic interest rate models, and valuation in a presence of management fees charged for the management of underlying investment account.

The talk is based on several recent papers:

References

- [1] J. Sun, P. V. Shevchenko, M. C. Fung A Note on the Impact of Management Fees on the Pricing of Variable Annuity Guarantees. *Preprint 2017*, <http://ssrn.com/abstract=2967045>
- [2] P. V. Shevchenko and X. Luo Valuation of Variable Annuities with Guaranteed Minimum Withdrawal Benefit under Stochastic Interest Rate. *To appear in Insurance: Mathematics and Economics, 2017*, <http://arxiv.org/abs/1602.03238>
- [3] P. V. Shevchenko and X. Luo A unified pricing of variable annuity guarantees under the optimal stochastic control framework *Risk*, 2(3), 1550024 (26 pages), 2016.
- [4] X. Luo and P.V. Shevchenko Fast Numerical Method for Pricing of Variable Annuities with Guaranteed Minimum Withdrawal Benefit under Optimal Withdrawal Strategy. *International Journal of Financial Engineering*, 2015.
- [5] X. Luo and P.V. Shevchenko Valuation of Variable Annuities with Guaranteed Minimum Withdrawal and Death Benefits via Stochastic Control Optimization. *Insurance: Mathematics and Economics*, 62, pp5-15, 2015.

- [6] X. Luo and P.V. Shevchenko Variable Annuity with GMWB: surrender or not, that is the question. *In T. Weber, M. J. McPhee, and R. S. Anderssen (Eds.), MODSIM2015*, pp959-965, 2015, <http://www.mssanz.org.au/modsim2015/E1/luo.pdf>

Speaker: Stefan Tappe

Affiliation: University of Freiburg, Germany

Talk Title: Affine term structures for interest rate models

Abstract

In interest rate modeling, one is often interested in models which admit an affine term structure, due to their analytical tractability. In this talk, we will present two approaches to affine term structure modeling; one approach which is based on the theory of affine processes, and another geometric approach which is based on affine manifolds. Note that the term "affine" is ambiguous here. Nevertheless, we will demonstrate the connection between these two approaches, and present some recent results regarding the existence of affine term structures; this includes models with jump processes.

Speaker: Benjamin Avanzi

Affiliations:

1. School of Risk and Actuarial Studies, UNSW Sydney Business School, UNSW Sydney, Australia
2. Département de Mathématiques et de Statistique, Université de Montréal, Canada

Talk Title: Modelling insurance claim counts and reporting delays with Cox processes

Abstract

The accurate estimation of the outstanding liabilities of an insurance company is an essential task. This is to meet regulatory requirements, but also to achieve efficient internal capital management. Over the recent years, there has been increasing interest in the utilisation of insurance data at a more granular level, and to model claims using stochastic processes. So far, this so-called ‘micro-level’ approach has largely focused on the Poisson process.

Our presentation is based on [3, 4], which introduce a multivariate Cox process approach to model the arrival process and reporting pattern of insurance claims. This allows for over-dispersion and serial dependency in claim counts, which are typical features in real insurance data. We explicitly consider risk exposure and reporting delays, and show how to use our model to predict the numbers of Incurred-But-Not-Reported (IBNR) claims. We will focus on shot noise processes, and introduce dependencies using either common shocks, or Lévy copulas (see e.g., [1, 2]).

We develop a Reversible Jump Markov Chain Monte Carlo (RJMCMC) filtering algorithm to estimate the unobservable intensity of the Cox process, and use an EM algorithm for parameter estimation and prediction. The model is calibrated and illustrated using real data from the AUSI data set. The AUSI dataset was developed as part of a Linkage Project grant awarded by the Australian Research Council (ARC) for a project titled *Modelling claim dependencies for the general insurance industry with economic capital in view: an innovative approach with stochastic processes*. Its name is an acronym combining of the names of the project partners (Allianz Australia Insurance Ltd, UNSW Australia, Suncorp Metway Ltd, and Insurance Australia Group Ltd).

References

- [1] B. Avanzi and L. C. Cassar and B. Wong Modelling Dependence in Insurance Claims Processes with Lévy Copulas. *ASTIN Bulletin*, 41(2):pp575–609, 2011.
- [2] B. Avanzi and J. Tao and B. Wong and X. Yang Capturing Non-Exchangeable Dependence in Multivariate Loss Processes with Nested Lévy Copulas. *Annals of Actuarial Science*, 10(1):pp87–117, 2016.
- [3] B. Avanzi and B. Wong and X. Yang A micro-level claim count model with overdispersion and reporting delays. *Insurance: Mathematics and Economics*, 71:pp1–14, 2016.
- [4] B. Avanzi and G. C. Taylor and B. Wong and X. Yang A multivariate Cox claim counts model with reporting delays. 2017.

Speaker: Robert J. Elliott

Affiliations:

1. School of Commerce, University of South Australia, Australia
2. Haskayne School of Business, University of Calgary, Canada

Talk Title: Dynamic risk measures and nonlinear expectations with Markov chain noise

Abstract

It is increasingly clear that a good understanding of risk and related dynamic models are required. One aspect of this is the development of simple ways of numerically representing risk. Some of these ways are well known, for example, value at risk, expected shortfall, etc.. Unfortunately, these methods are static and fail to give consistent answers when considered at multiple time points. Progress has been made in developing dynamic risk measures, which give time consistent answers. Some of these ideas are related to the g-expectations considered by Peng and others. Central to the mathematical study of our consistent risk measures is the theory of Backward Stochastic Differential Equations (BSDEs). Most previous work in this area uses only noise from a Brownian motion. In our models the randomness is introduced through a martingale associated with a Markov chain. In particular we show that under certain conditions the solution to a BSDE is a time consistent risk measure.

This is a joint work with Samuel N. Cohen.

Speaker: Pierre Del Moral

Affiliations:

1. INRIA, Bordeaux, France
2. School of Mathematics and Statistics, UNSW Sydney, Australia

Talk Title: On the stability and the uniform propagation of chaos properties of Ensemble Kalman-Bucy filters.

Abstract

The Ensemble Kalman filter is a sophisticated and powerful data assimilation method for filtering high dimensional problems arising in fluid mechanics and geophysical sciences. This Monte Carlo method can be interpreted as a mean-field McKean-Vlasov type particle interpretation of the Kalman-Bucy diffusions. In contrast to more conventional particle filters and nonlinear Markov processes these models are designed in terms of a diffusion process with a diffusion matrix that depends on particle covariance matrices. Besides some recent advances on the stability of nonlinear Langevin type diffusions with drift interactions, the long-time behaviour of models with interacting diffusion matrices and conditional distribution interaction functions has never been discussed in the literature. In this talk we initiate the study of this new class of models. We present a series of new functional inequalities to quantify the stability of these nonlinear diffusion processes. In the same vein, despite some recent contributions on the convergence of the Ensemble Kalman filter when the number of sample tends to infinity very little is known on stability and the long-time behaviour of these mean-field interacting type particle filters. In the second part of this talk we provide uniform propagation of chaos properties as well as L_p -mean error estimates w.r.t. to the time horizon.

Speaker: Marcel Prokopczuk

Affiliation: Institute for Financial Markets, Leibniz University of Hannover, Germany

Talk Title: The Value of High-Frequency Data for Beta Estimation

Abstract

While the literature typically uses low-frequency data to estimate beta, we illustrate that this can yield substantial measurement error. We document that intra-day data can help substantially reduce the measurement error in beta. High-frequency data significantly improves the performance of the historical and hybrid option-implied estimators both in the time-series and cross-section. Overall, the historical high-frequency estimator performs even better than the option-implied estimator. We develop beta signature plots and show that high-frequency data helps resolve the trade-off between conditionality and sample size. High-frequency data are also economically beneficial and our results directly extend to the estimation of downside beta.

This is a joint work with Fabian Hollstein and Chardin Wese Simen.

Speaker: Michael Hanke

Affiliation: Institute for Financial Services, University Liechtenstein, Liechtenstein

Talk Title: Random orthogonal matrix simulation with exact means, covariances, and multivariate skewness

Abstract

We develop a simulation algorithm that generates multivariate samples with exact means, covariances, and multivariate skewness. If required for financial applications, absence of arbitrage can be ensured. Potential applications include the simulation of risk factors for the risk management of financial institutions. We use the Kollo measure of multivariate skewness, which is more informative for these applications than the Mardia skewness previously used in this context.

This is a joint work with S. Penev, W. Schief, and A. Weissensteiner.

Speaker: Carole Bernard

Affiliation: Grenoble School of Management, France

Talk Title: Risk aggregation under model uncertainty

Abstract

A central problem for regulators and risk managers concerns the risk assessment of an aggregate portfolio defined as the sum of d individual dependent risks X_i . This problem is mainly a numerical issue once the joint distribution of (X_1, X_2, \dots, X_d) is fully specified. Unfortunately, while the marginal distributions of the risks X_i are often known, their interaction (dependence) is usually either unknown or only partially known, implying that any computed risk measure of the portfolio is subject to model uncertainty. Previous academic research has focused on the maximum and minimum possible values of a given risk measure of the portfolio when only the marginal distributions are known. This approach leads to wide bounds, as all information on the dependence is ignored. In this paper, we integrate, in a natural way, available information on the multivariate dependence and provide easy-to-compute bounds for the risk measure at hand. We observe that incorporating the information of a well-fitted multivariate model may, or may not, lead to much tighter bounds, a feature that also depends on the risk measure used. We illustrate this point by showing that the Value-at-Risk at a very high confidence level (as used in Basel II) is typically prone to very high model risk, even if one knows the multivariate distribution almost completely. Our results make it possible to determine which risk measures can benefit from adding dependence information (i.e., leading to narrower bounds when used to assess portfolio risk) and, hence, to identify those situations for which it would be meaningful to develop accurate multivariate models.

This is joint work with M. Denuit, X. Jiang, L. Ruschendorf, S. Vanduffel, R. Wang, J. Yao.

Speaker: Spiridon Penev

Affiliation: School of Mathematics and Statistics, UNSW Sydney, Australia

Talk Title: The impact of model risk on dynamic portfolio selection under multi-period mean-standard-deviation criterion

Abstract

We quantify model risk of a financial portfolio whereby a multi-period mean-standard-deviation criterion is used as a selection criterion. In this work, model risk is defined to be the loss due to uncertainty of the underlying distribution of the return of the assets in the portfolio. The uncertainty is measured by the Kullback-Leibler divergence, i.e., relative entropy, or more generally by an α -divergence. In the worst case scenario, the optimal robust strategy can be obtained in a semi-analytical form as a solution of a system of nonlinear equations. Several numerical results are presented which allow us to compare the performance of this robust strategy with the optimal non-robust strategy. As a consequence, we can quantify the model risk associated with an empirical dataset.

This is a joint work with Pavel Shevchenko and Wei Wu.

Speaker: Leonie Tickle

Affiliation: Department of Applied Finance and Actuarial Studies, Macquarie University, Australia

Talk Title: A more meaningful parameterisation of the Lee-Carter model

Abstract

The Lee-Carter model is the most widely used model for mortality forecasting, but is formulated in a way that obscures interpretation and hampers comparison between populations. A new parameterisation of the Lee-Carter model is introduced that offers two advantages. First, Lee-Carter parameters are normalised such that they have a direct and intuitive interpretation, and are directly comparable across populations. Second, the model is reframed in terms of the "needed-exposure" (NE). The NE is the number required in order to get one expected death and is closely related to the "needed-to-treat" measure used to communicate risks and benefits of medical treatments. In the new parameterisation, time parameters are readily and directly interpretable as an overall across-age NE. Age parameters are interpretable as age-specific elasticities: percentage changes in the NE at a particular age in response to a percent change in the overall NE. The same approach can be used to confer interpretability on parameters of other mortality models.

This is a joint work with Piet de Jong.

Speaker: Marek Musiela

Talk Title: How quantitative methods influence and shape finance industry

Abstract

This is a non-quantitative talk about the role quantitative methods play in finance industry. The main focus is on investment banking, hedge funds and asset managers. Development of each area was strongly influenced by different mathematical and statistical ideas which underpinned their different business models, respectively. In each case they deal with risk but in fundamentally different ways. In a very simplistic way one could argue the following.

Investment banks, the sell side of finance industry, sell financial products and hedge the risk. Their business model is to understand and calculate value and sensitivity to the market inputs of the products they sell and charge the client the fair amount plus a margin for service. Advanced mathematical methods are used to support this business.

Systematic trading hedge funds, contrary to their name, do not hedge but take risk in a controlled way. They develop trading strategies and deploy them at as many markets as possible. They rely a lot on sophisticated statistical methods.

The traditional asset managers focus on risk diversification. They also develop quantitative investment processes to support their business models. They use various mathematical and statistical techniques.

At the end of the talk I will attempt to describe current challenges the finance industry faces and speculate which quantitative methodologies are likely to influence and shape its future.