AFMathConf 2016

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Stochastic Modelling with applications in Financial Markets

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Map with important locations : available on

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

Wireless internet

There is wireless internet available in the main building and throne building.

- SSID = academie.
- This is an open network, no password is needed.

Books and software

In the Marble room you can find:

- a demo stand from 'NAG' with numerical software.

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  On claims reserves estimation using individual level claims data

Bermudan options by simulation

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The aim of this study is to devise numerical methods for dealing with very high-dimensional Bermudan-style derivatives. For such problems, we quickly see that we can at best hope for price bounds, and we can only use a simulation approach. We use the approach of Barraquand & Martineau which proposes that the reward process should be treated as if it were Markovian, and then uses this to generate a stopping rule and hence a lower bound on the price. Using the dual approach introduced by Rogers and Haugh & Kogan, this approximate Markov process leads us to hedging strategies, and upper bounds on the price. The methodology is generic, and is illustrated on eight examples of varying levels of difficulty. Run times are largely insensitive to dimension.

Decision-Theoretic Calibration of Option Pricing Models

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Joint work with: David Vyncke

We present a calibration procedure for option pricing models that is based on decision theory and behavioral finance. The inspiration for our approach comes from the Weighted Monte Carlo (WMC) method by Avellaneda and others.

The original WMC method consists of simulating a set of price paths using the arbitrage model that is to be calibrated, and calculating a new (risk neutral) probability measure for this set of paths that reproduces the observed market prices of benchmark options exactly, or almost exactly as in the case of a least squares approach. As we tend to have more paths than benchmark options in a simulation, such a measure is not uniquely defined in general. This problem is solved in the original WMC method by selecting the measure closest to the uniform measure in terms of statistical distance.

It is a well known fact that the divergence minimization problem central to the WMC method is equivalent to a portfolio choice problem where preferences are represented as expected utility. In particular, when the measure of statistical distance is defined by the Kullback-Leibler divergence, which is the prevalent specification in the literature, the divergence minimization problem corresponds to a portfolio choice problem with expected exponential utility. While this point has been mentioned mostly in passing in the literature so far, we explain how a utility formulation of the calibration problem can be thought of as an option pricing model that captures the feedback loop between market participant decision making and the arbitrage models that are supposed to describe the evolution of market prices that form as a result of that (aggregate) decision making.

With this realization in mind, we first present an expected utility formulation of the calibration problem, which differs in a couple of ways from the utility formulation that corresponds to the 'standard' WMC method, with these differences being motivated by both decision theoretic considerations, as well as computational ones. This formulation yields greater computational efficiency for certain benchmark structures compared to the original WMC method, notably when we are calibrating against vanilla options that are spread out over more than one maturity.

This leads us to the main contribution of our talk, which is merging the modified WMC method with Cumulative Prospect Theory (CPT). This greatly increases the out-of-sample fit, as we demonstrate numerically using SPX option data. This is a significant outcome as CPT has so far generally been thought of as incompatible with arbitrage pricing, and as far as we can tell this is the first instance of CPT being used to actually improve arbitrage option pricing model performance.

Finally, we briefly discuss a preliminary GPU implementation of the algorithm and the accompanying speedup.

Arbitrage-free volatility parameterizations with stochastic collocation

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When handling a large number of market volatility quotes it is natural to express them in terms of some parametric form so that the whole range of strikes can be explained by only a few parameters. Once the parametric equation is given one can instantly obtain volatilities by evaluating the parametric function. For several years a market standard for volatility parameterization is the well-known Hagan formula which originates from a short-maturity heat kernel expansion. Although very easy to implement, the density implied by the approximation is not always arbitrage-free, especially not for very low strikes (it becomes negative or the density does not integrate to one). Pricing of specific financial derivatives, like Constant Maturity Swaps (CMS), relies on integration of the payoff over the density which is implied from a volatility parameterization. For these CMS products industrial practice is based on marginals which should be properly defined and arbitrage-free. In other words, these marginals cannot be based on Hagan's formula. In this talk we propose an alternative. During this presentation we will derive a method for determining an arbitrage-free density implied by Hagan's formula. Our technique is based on the stochastic collocation method. The principle is to determine a few collocation points on the implied survival distribution function and project them on a polynomial of an arbitrage-free variable for which we choose the Gaussian variable. In this way we have equality in probability at the collocation points while the generated density is arbitrage-free. Analytic European option prices are available and the implied volatilities stay very close to those initially obtained by Hagan's formula. The proposed method is very fast and straightforward to implement as it only involves 1D Lagrange interpolation and inversion of a linear system of equations. The technique is generic and may be applied to other variants or other models that generate arbitrage like for example the SVI parameterization.

CoCo Bonds and Implied CET1 Volatility

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Joint work with: J. De Spiegeleer, W. Schoutens

In this talk we introduce the notion of implied Common Equity Tier 1 volatility and the concept of a risk-adjusted distance to trigger. Using a derivatives-based valuation approach, we are able to derive the implied CET1 volatility from the market price of a CoCo bond in a Black-Scholes setting. The numerical results show how different contingent convertibles issued by the same bank and sharing a similar contractual CET1 trigger, have almost identical implied CET1 volatility levels. The same results confirm the difference in market risk between Tier 2 and Additional Tier 1 CoCo bonds. The ability to obtain an implied level for the CET1 volatility offers other interesting results. We are able to determine the implied CET1 level corresponding to a coupon cancellation. It further allowed us for example to look at the severity of one of the stress tests imposed by the ECB on European banks in November 2014. In that perspective we were also able to derive implied PONV CET1 levels.

Control of interbank contagion under partial information

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Joint work with: Hamed Amini and Andreaa Minca

By contrast with the traditional approach in risk management, the focus of systemic risk studies is no longer on modeling the risks faced by a single institution, but on modeling the complex interrelations between institutions and the mechanisms of distress propagation among these. We consider here a financial network described as a weighted directed graph, in which nodes represent financial institutions and edges the exposures between them. The distress propagation is modeled as an epidemics on this graph. We study the optimal intervention of a lender of last resort who seeks to make equity infusions in a banking system prone to insolvency and to bank runs, under incomplete information of the failure cluster, in order to minimize the contagion effects. Our study (to appear in SIAM J. Fin.Math.) provides some insight on the relation between the value of a financial system, connectivity and optimal intervention.
More precisely, we consider a stylized core-periphery financial network in which links lead to the creation of projects in the outside economy but make banks prone to contagion risk. The controller seeks to maximize, under budget constraints, the value of the financial system defined as the total amount of projects. Under partial information on interbank links, revealed in conjunction with the spread of contagion, the optimal control problem is shown to become a Markov decision problem. We determine the optimal intervention policy by using dynamic programming. Our numerical results show that the value of the system depends on the connectivity in a non-monotonous way: it first increases with connectivity and then decreases with connectivity. The maximum value attained depends critically on the budget of the controller. Moreover, we show that for highly connected systems, it is optimal to increase the rate of intervention in the peripheral banks rather than in core banks. This insight shows that it is far from obvious that connectivity of a core bank should always be brought forward as an argument for priority intervention and it may be sometimes preferable to invest in non-core banks that lend directly to the economy.
The natural question remains how to create incentives for the banks to attain an optimal level of connectivity and how to design a guarantee fund that would represent an intervention fund that can be used to maximize the benefits of connectivity.

Consistent recalibration of the discrete time multifactor Vasicek model

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Joint work with: P. Harms, J. Teichmann, M.V. Wüthrich

The discrete time multifactor Vasiček model is a tractable Gaussian spot rate model used for yield curve modeling. Typically, two- or three-factor versions of this model allow to capture the dependence structure between yields with different times to maturity appropriately. These two- or three-factor models are then based on a fixed set of model parameters which is calibrated to the prevailing financial market data. Changing financial market conditions may change these parameters considerably over time. Therefore, the model parameters should be understood as being time-dependent, or even stochastic. We introduce in the multifactor Vasiček model the flexibility of updating parameters over time in such a way that the model meets the premise of being free of arbitrage and remains tractable. We refer to this model as consistently recalibrated Vasiček model. This idea leads to a whole family of new term structure models that essentially concatenate yield curve increments of Hull-White extended multifactor Vasiček models with different parameters. These models can also be understood as a parametric version of Heath-Jarrow-Morton models. We introduce these models and demonstrate the effectiveness of the consistently recalibrated model on Swiss interest rate data.

The Benefit of Life Insurance Contracts with Capped Index Participation when Stock Prices are Subject to Jump Risk

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Joint work with: Antje Mahayni

In this research we analyze the benefit of life insurance contracts with capped index participation when the underlying stock price can jump. The main focus is on the perspective of the insured. On a sequence of reference days an insured has the choice between a guaranteed return and capped index participation. The cap limits the upside potential of index participation. Products are structured such that both alternatives have the same price and the option to select is costless (product structuring condition). Generally speaking, equity risk premiums have a positive impact on the utility of index participation. However, it is important to distinguish between jump and diffusion risk. The amount of jump risk might reduce cap rates and its impact on utility is ambiguous. Moreover, investors are exposed to expected future guaranteed returns and thus the overall surplus of the life insurance company. The value of index participation is bounded from above. When guaranteed returns are high then the product structuring condition cannot be met. Nevertheless, CRRA investors might opt for index participation allowing insurance companies to make side profits.

Affine LIBOR models with multiple curves: theory, examples and calibration

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Joint work with: Antonis Papapantoleon, John Schoenmakers, David Skovmand

We introduce a multiple curve framework that combines tractable dynamics and semi-analytic pricing formulas with positive interest rates and basis spreads. The case of negatives rates and positive spreads currently observed in the market can also be accommodated in this framework. The dynamics of OIS and LIBOR rates are specified following the methodology of the affine LIBOR models and are driven by the wide and flexible class of affine processes. The affine property is preserved under forward measures, which allows us to derive Fourier pricing formulas for caps, swaptions and basis swaptions. A model specification with dependent LIBOR rates is developed, that allows for an efficient and accurate calibration to a system of caplet prices.

Model Uncertainty, Frechet Bounds and Applications in Option Pricing

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Joint work with: Antonis Papapantoleon

We consider the problem of finding arbitrage bounds for option prices of multi-asset options (i.e. options on multiple underlyings) in the case when partial information of the assets' probability distribution is available. We focus on the case in which the one-dimensional marginal distribution of each individual asset is known while also partial information on the dependence structure between the assets is available. This is in the literature often referred to as dependence uncertainty. The problem has been extensively studied in the two-asset case for which solutions were given by Tankov (2011) and Bernard et al. (2012). We generalize these results for options that depend on more than two assets. The solution is based on an improvement of the classical Fréchet-Hoeffding bounds that allows for a representation of partial information of the dependence structure. By an extension of the results of Müller and Stoyan (2003) on multivariate stochastic dominance we are able to show that the improved bounds can be interpreted as minimal or maximal distributions with respect to the lower orthant order. The link between the lower orthant order on the set of distribution functions and the prices of multi-asset options is established via a multivariate partial integration formula.

Aspects of Controlling Life Event Risk

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Life insurance and pension savings serve to compensate individuals for economic consequences of life events like dying early or living long. Financial decisions are made with the uncertain lifetime as time horizon, possibly involving preferences of heirs or, perhaps, even future generations. We discuss different aspects of references that formalize the quality of decisions. They include risk aversion but also the elasticity of substituting consumption between different points in time and different life events. Interesting questions concern the individual's decision power and preferences with respect to time and money spent on education, work, health improvement etc. We present some modern formalizations of these questions and discuss their impact on the design of insurance and saving products.

Linking pensions to life expectancy: A solution to guarantee long-term sustainability?

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Joint work with: Humberto Godínez-Olivares (University of Liverpool) and Steven Haberman (Cass Business School)

The decline in fertility rates, the increase in longevity and the current forecasts for the ageing of the baby-boom generation all point to a substantial increase in the dependency ratio, and this will raise serious concerns for the sustainability of Pay-As-You-Go (PAYG) pension systems. Consequently, many European countries have already carried out some parametric reform, or even structural reforms, of their pension systems.

In the meantime, some countries have decided to set up Automatic Balancing Mechanisms (ABMs). ABMs are defined, Vidal-Meliá et al. (2009), as a set of predetermined measures established by law to be applied immediately as required according to an indicator that reflects the financial health of the system. Its purpose is to re-establish the financial equilibrium of PAYG pension systems without the repeated intervention of the legislator.

In this line, Godínez-Olivares et al. (2015) design a new ABM to restore the liquidity into the system under a nonlinear dynamic programming framework. This ABM is the result of minimizing a chosen logarithmic function and calculates the optimal path for the contribution rate, retirement age and indexation of pensions for a PAYG system.

According to DâAddio and Whitehouse (2012) three main automatic mechanisms can be considered for changing pension values. First, adjustments can be made in benefit levels to reflect changes in life expectancy; second, adjustments can be made through revalorization of earlier years' contribution bases and third, adjustments may occur through the indexation of pension payments. In fact, two-thirds of pension reforms in OECD countries contain measures that automatically link future pensions to changes in life expectancy.

With this in mind, the aim of this paper is to twofold. First, using nonlinear optimization, it seeks to assess whether a sustainability factor linked to life expectancy is sufficient to guarantee the financial stability in the pension system. Secondly, considering this sustainability factor, it designs different optimal strategies, that involve variables such as the contribution rate, age of retirement and indexation on pensions, to restore the long-term financial equilibrium of the system. These optimal strategies, which we call ABMs, calculate the optimal path of these variables over time and absorb fluctuations in longevity, fertility rates, salary growth or any other kind of uncertainty faced by the pension system.

JEL Classification: E62, H55, J11, J26.
Keywords: Demographic change, Pay-as-you-go, Public pensions, Optimization,

Risk.

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Modeling dependence in run-off triangles

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Joint work with: M.-P. Côté and A. Abdallah

In order to determine appropriate reserves and risk capital for incurred but unpaid losses, property and casualty insurance companies must account for the fact that their lines of business may be dependent. For each line of business, payments relating to past claims are usually structured in a run-off triangle arranged to rows according to the accident years, and to columns according to the development periods. Generalized linear models (GLMs) provide a convenient way to capture the influence of these two factors on the distribution of the loss ratios in each triangle. Following Shi & Frees (2011, *Astin Bull.*), copulas can then be used to combine these GLMs across lines of business.

To guard against the undesirable effects of an inadequate choice of dependence model on reserve estimation, a two-stage, rank-based inference procedure will be proposed to assist with copula selection and validation in this context. A hierarchical approach will also be advocated for the construction of flexible copulas. As emphasized by Arbenz et al. (2012, *Insur. Math. Econom.*), this modeling strategy relies on a conditional independence assumption whose implications will be highlighted. Under this assumption, the hierarchical structure can be constructed iteratively using rank-based clustering techniques, as detailed in Côté & Genest (2015, *Canad. J. Statist.*). The entire approach will be illustrated with data for six lines of business from a large Canadian insurance company.

The Difference between LSMC and Replicating Portfolio in Insurance Liability Modelling

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Solvency II requires insurers to calculate the one-year Value at Risk (VaR) of their balance sheet. This involves the valuation of the balance sheet in one years time. As for insurance liabilities closed-form solutions to their value are generally not available, insurers turn to estimation procedures. While pure Monte Carlo simulation set-ups are theoretically sound, they are often infeasible in practice. Therefore, approximation methods are exploited. Among these Least Squares Monte Carlo (LSMC) and portfolio replication are prominent and widely applied in practice. In this paper we show that while both are variants of regression-based Monte Carlo methods, they differ in one significant aspect. While the replicating portfolio approach only contains an approximation error, which converges to zero in the limit, in LSMC additionally a projection error is present, which cannot be eliminated. It is revealed that the replicating portfolio technique enjoys numerous advantages and is therefore an attractive model choice.

The Price of Being a SIFI

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After reviewing the notion of Systematically Important Financial Institution (SIFI), we propose a first principles way to compute the price of the implicit put option that the State gives to such an institution. Our method is based on important results from Extreme Value Theory (EVT), one for the aggregation of heavy tailed distributions and the other one for the tail behavior of the Value-at-Risk (VaR) versus the Tail-Value-at-Risk (TVaR).

We show how to value in practice such an option by reconstructing the risk neutral probability from the implicit volatility of options traded in the market for the particular institution and give some values for typical banks. We will conclude by a proposal to make the institution pay the price of this option to a fund, whose task will be to guarantee the orderly bankruptcy of such an institution. This fund would function like an insurance selling a cover to clients.

Risk classification, solvency requirements and pricing revisited: What do we know?

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Joint work with: J. Wagner, M. Steffensen

In this paper we study the consequences of risk classification and solvency requirements within insurance pricing. In a simple setting with a high-risk group and a low-risk group of customers we study three distinct company models: Model 1 with separate solvency requirements and separate premiums for each of the customer groups, as such corresponding to two separate companies; Model 2 with a shared solvency requirement between the two customer groups but separate risk weighted premiums in each of the groups and; Model 3 with a shared solvency requirement and equal premiums across the two customer groups, corresponding to a ban on risk classification. We discuss how solvency regulation affects competition in the market. Further, we show that the effects of adverse selection, when imposing a ban on risk classification between groups, may not be as substantial as often highlighted in the literature. Finally, for the low-risk customers the benefit of entering a shared solvency requirement is in some cases higher than the loss incurred by a ban on risk classification.

Between First and Second-Order Stochastic Dominance

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Joint work with: Marco Scarsini, Ilia Tsetlin, Robert Winkler

We develop a continuum of stochastic dominance rules, covering preferences from first to second-order stochastic dominance.
The motivation for such a continuum is that while decision makers have preference for "more is better," they are mostly risk averse but cannot assert that they would dislike any risk.
For example, situations with targets, aspiration levels, and local convexities in induced utility functions in sequential decision problems may lead to preferences for some risks. We relate our continuum of stochastic dominance rules to utility classes, the corresponding integral conditions, and probability transfers, and discuss the usefulness of these interpretations. Several examples involving, e.g., finite-crossing cumulative distribution functions, location-scale families, and induced utility illustrate the implementation of the framework developed here. Finally, we extend our results to convex (risk-taking) stochastic dominance.

Choquet integrals and risk measures

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We place ourselves in the framework of ambiguity modelled by an initial capacity (i.e. a monotone normalized set function, generalizing the notion of probability measure). In this context, the usual mathematical expectation is replaced by the more general notion of Choquet integral. We present extensions of the notions of increasing, and increasing convex stochastic dominance relations, well-known in the case of a probability measure, to our more general setting. We characterize these "generalized" relations in terms of distribution functions and quantile functions with respect to the initial capacity. We then consider the classes of monetary risk measures (defined on the space of bounded measurable functions) having the properties of comonotonic additivity and monotonicity with respect to a given "generalized" stochastic dominance relation. These classes of risk measures are characterized in terms of Choquet integrals with respect to a "distortion" of the initial capacity. A "Kusuoka-type" characterization of the class of monetary risk measures having the properties of comonotonic additivity and monotonicity with respect to the "generalized" increasing convex stochastic dominance is also established.

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Copula-based bivariate finite mixture models for claim count data

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Modelling multivariate insurance claim count data has received interest in the recent years. The aim is to modelling the number of claim for different types of claim taking into account covariate information for risk classification. Bermúdez and Karlis (2011) proposed a multivariate Poisson regression model, using the shock model approach, and its zero-inflated extensions. Bermúdez and Karlis (2012) used a finite mixture of bivariate Poisson regression model, derived again through a shock model, to allow for unobserved heterogeneity and clustering effects. Recently, Shi and Valdez (2014) proposed a multivariate negative binomial model, to overcome the restrictions implied by Poisson marginal distributions, and using copulas to allow for greater flexibility of the dependence structure. The present paper, combining the experience gained from the papers above, proposes a copula-based bivariate finite mixture model. The new model offers some advantages since it keeps all the pros of a finite mixture while the copula-based derivation can produce a more flexible structure, including negative correlations. Finite mixtures with copulas have been introduced in a recent paper (see Kosmidis and Karlis, 2015). In this paper, the new model is defined, estimation through an EM algorithm is given, and then the model is applied to a Spanish insurance database to analyse the actuarial implications.

Stochastic approximations in CBD mortality projection models

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Comonotonicity has been successfully applied to derive various approximations in the single-factor mortality projection model proposed by Lee and Carter (1992), after Denuit and Dhaene (2007). However, this approach appears to lead to inaccurate approximations in the multi-factor mortality projection models developed by Cairns, Blake and Dowd (2006). Therefore, we propose in this paper an alternative approach which consists in keeping the correlation structure within the time factors unchanged for every calendar year. Proceeding in this way, we provide accurate approximations useful for insurance practitioners avoiding them the simulations within simulations problem whatever the size of their portfolios.

Risk Measure Preserving Approximation of Monte Carlo Simulation Results with Insurance Applications

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Stochastic models in pricing, reserving, or capital modelling are usually very complex, which is why result distributions are typically determined viaMonte Carlo simulations. Regulatory regimes such as Solvency II and SST require assessing risks not only in terms of a few key statistics but in terms of the whole distribution. This, together with the increased necessity to reuse the results of the simulations, motivates us to introduce a compression algorithm which approximates an empirical distribution function through a piecewise linear one. This approximation facilitates the exchange of data between stochastic models by drastically reducing memory requirements compared to storing the full sample distribution. It is designed to preserve the mean and uniformly bound the relative error over a set of spectral risk measures. An efficient, open source implementation is provided.

MORE NEGATIVE EXPECTATION DEPENDENCE: KEY PROPERTIES AND HYPOTHESIS TESTING

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In this poster, we study the more negative expectation dependence concept for pairs of random variables, defined after Wright(Theory Decis 22:111-124, 1987). After having established several of its key properties, hypothesis testing of Kolmogorov-Smirnov type and Cramer-von Mises type is investigated, extending the recent work by Zhu(Ann Inst Stat Math, 1-19, 2014), and asymptotic consistency is shown. We propose and justify a variety of inference based on simulations motivated by the work of Scaillet(Can Journal Stat 33: 415-427, 2005). An empirical illustration is given using insurance loss data.

Key words and phrases: Expectation Dependence, Dependence Dominance, Kolmogorov-Smirnov Test, Cramer-von Mises Test, Boostrap, Multiplier Method.

JEL codes: C12, D81.

Application of evolutions of copulas to the dependence relation between exchange rates

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Copula function is known to provide a theoretical method for analyzing the dependence structure among not necessarily independent random events. Because of its flexibility, copulas have been well employed and much studied these days. However, it is also well recognized that copulas does not fit into time-dependent issues. Observe the discussion in Mikosch [2].

On the other hand, in our previous study [1], we have introduced the concept of evolution of copulas. The idea is that the copula itself evolves according to the time-variable. But the application to real data of this evolution of copulas remains to be open.

Here, following the study in [3], we apply the evolution of copulas to empirical data. As an example, we analyze the dependence relation between euro (EUR) - Japanese yen (JPY) exchange rates and Swiss franc (CHF) - JPY exchange rates. We focus ourselves on rapidly changing events such that their directions of change are almost stable. We consider foreign exchange rates on January 15, 2015, when CHF endured a shock breakout after the announcement that the Swiss central bank had stopped monetary policy efforts to maintain CHF against EUR at more than 1.20.

We calculate the Kendall's tau and apply a smoothing technique to its the transitions. We then evolve an empirical copula to construct discrete evolution, and compare Kendall's tau of this discrete evolution to the moving averages of the empirical copulas. The results are that the discrete evolution copulas approximate fairy well the smoothed transition of empirical copulas from the viewpoint of Kendall's tau.

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Parameter Estimation of Levy-stable Distribution with Application in Non-Life Insurance

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Levy-stable distributions form a rich class of probability distributions that have many mathematically intriguing properties. Well-known special cases are Normal distribution and Cauchy distribution. The general four-parameter Levy-stable distributions are very flexible and have been proposed as models for different physical and economic problems. In practical applications the estimating of parameters is complicated by deficiency of closed form density and distribution functions.

We estimate parameters using characteristic function $\psi(u)$. For any continuous random variable X the characteristic function $\psi_X(u)$ is defined as

$$\psi_X(u) = \mathbb{E}[\exp(iuX)] = \int_{-\infty}^{\infty} \exp(iux)\mathrm{d}F_X(x),$$

where $F_X(x)$ is the distribution function of X. To estimate parameters we assume that empirical and theoretical characteristic functions are equal at the same argument values. The method is called generalized method of moments.

In research we derive parameter expressions for generalized method of moments, carry out simulation experiments and apply the results to non-life insurance data.

Keywords: bootstrap, characteristic function, generalized method of moments, Levy-stable distribution, modelling, parameter estimation, simulation.

Capital allocation principles and compositional data

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In this paper we suggest that capital allocation principles can be interpreted as compositional data. Compositional data are quantitative descriptions of the components of a whole, where relative information is more relevant than absolute values. The reinterpretation of capital allocation principles as compositional data allows to use compositional methods which are coherent with the relative scale of compositions. An immediate practical application of compositional methods is that capital allocation principles can be ranked based on the distances between them and the associated solutions can be appropriately averaged. The practical application of the compositional methods in the context of capital allocation problems is illustrated with an example extracted from the literature.

On claims reserves estimation using individual level claims data

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Accurate loss reserves are essential for insurance companies to meet and administer their contractual obligations to policyholders. Many claims reserving methods have now been established and in the actuarial literature the focus has mainly been on aggregate reserving techniques. In recent years, there have been many proposals of reserving models that are based on individual level claims data. Martinez-Miranda et al. (2013) extend the traditional chain ladder framework towards the continuous use of individual claims data, where data is aggregated by month in run-off triangle and reserves are estimated with non-parametric estimation of the underlying density. The question arises whether estimations based on monthly data substantially outperform results obtained by, say, quarterly data. We consider simulated data under different environmental changes and evaluate the impact of chosen data level (monthly, quarterly and annual) on the predictive distribution of the outstanding reserve. We compare and evaluate the performance of classical chain ladder method and continuous chain ladder method on each considered data level.

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