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Interplay between Finance and Insurance

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Poster session :	Marble room
Lunches and coffee breaks :	Marble room
Conference dinner :	University foundation (Egmontstraat 11, 1000 Brussel)

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.

PROGRAMME - 7 February

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10h45 - 11h30	INVITED SPEAKER - Jean-Philippe Boucher, Université de Québec à Montréal (UQAM), CA **A Claim Score for Dynamic Claim Counts Modeling**
11h30 - 12h00	CONTRIBUTED TALK - Christian Furrer, University of Copenhagen, PFA Pension, DK **Forward transition rates**
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14h45 - 15h15	CONTRIBUTED TALK - Thomas Bernhardt, Heriot-Watt University, UK **How much to put in a tontine**
15h15 - 15h45	CONTRIBUTED TALK - Wing Fung (Alfred) Chong, University of Illinois at Urbana-Champaign, USA **Pricing and Hedging Equity-Linked Life Insurance Contracts Beyond the Classical Paradigm: The Principle of Equivalent Forward Preferences**
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16h15 - 17h00	CONTRIBUTED TALK - Peter Hieber, TU Munich, DE **Valuation of hybrid financial and actuarial products: a universal 3-step method**
17h00 – 17h30	INVITED SPEAKER - Erik Vynckier, Foresters Friendly Society, IFoA and Eli Global LLC PRACTITIONERS LECTURE **Capital and Liquidity Management for Insurers**
18h30 - 22h00	Conference Dinner at University Foundation

08h30 - 09h00	Registration and welcome coffee
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09h45 - 10h15	CONTRIBUTED TALK - Mick Schaefer, Universität Hamburg,DE **Surrender Contagion in Life Insurance: Modeling and Valuation**
10h15 - 10h45	Coffee break
	Chair: Monique Jeanblanc
10h45 - 11h30	INVITED SPEAKER - Geneviève Gauthier, HEC Montréal, CA **Idiosyncratic Jump Risk Matters: Evidence from Equity Returns and Options**
11h30 - 12h00	CONTRIBUTED TALK - Nathan Lassance, Université catholique de Louvain, BE **Optimal Portfolio Diversification via Independent Component Analysis**
12h00 – 13h30	Sandwich lunch combined with **Poster session**
	Chair: Carole Bernard
13h30 - 14h15	INVITED SPEAKER - Gianluca Fusai, Cass Business School, City, University of London & DISEI, U. del Piemonte Orientale, UK and IT **A New Measure of Diversification: the QDX index**
14h15 - 14h45	CONTRIBUTED TALK - Sofie Reyners, KU Leuven, BE **Machine Learning for Quantitative Finance: Fast Derivative Pricing, Hedging and Fitting**
14h45 - 15h15	Coffee break
	Chair: Steven Vanduffel
15h15 - 16h00	INVITED SPEAKER - Elisa Alòs Alcalde, Barcelona Graduate School of Economics, ES **On smile properties of volatility derivatives and exotic products: understanding the VIX skew**
16h00 - 16h15	Closing

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- Miaad Hamad Alqurashi
  Application of State Space Models to Financial and Economic Data
- Shokoufeh Banihashemi
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- Yuqing Zhang
  Dynamic Pricing in Insurance

ABSTRACTS – Presentations – 7 February

Yes, we CANN!

Mario V. Wüthrich

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This presentation has two parts. In the first part, we illustrate how classical actuarial regression models can be integrated into neural network architectures. This approach is universal in the sense that it can be applied to almost any parametric regression model. We call the resulting blended model a combined actuarial neural network (CANN) model. If this CANN model is calibrated appropriately, it will lead to an enhancement of the classical actuarial regression model with neural network features. In the second part, we illustrate telematics car driving data, and we classify individual car driving trips using convolutional neural networks.

Incorporating taxation in the valuation of variable annuity contracts: the case of the guaranteed minimum accumulation benefit rider

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Joint work with: M. Sherris, S. Thirurajah, A. Villegas, J. Ziveyi

We study variable annuity contracts embedded with guaranteed minimum accumulation benefit riders (GMABs) promising the return of the premium paid by the policyholder, or a a higher stepped up value at the end of the investment period of the contract. We present the valuation framework in partial differential equation form which is solved for fair fees with the aid of the computationally efficient method of lines algorithm and root finding methods. We consider two tax setups: one where capital gains can offset losses and a second where gains cannot offset losses, reflecting the institutional arrangements in Australia and the U.S., respectively.

We find that, when capital losses cannot be offset by capital gains, the separation between the valuation curves increases as tax increases, reflective of the increasing value of the contract to the governments. If capital losses can be offset by capital gains, policyholder's optimal surrender behavior changes to the benefit of the insurer, reducing the insurer liabilities for any fee rate they choose to charge.

A Claim Score for Dynamic Claim Counts Modeling

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Joint work with: Mathieu Pigeon

We develop a claim score based on the Bonus-Malus approach proposed by Boucher and Inoussa (2014). We compare the fit and predictive ability of this new model with various models for of panel count data. In particular, we study in more details a new dynamic model based on the Harvey-Fernandès (HF) approach, which gives different weight to the claims according to their date of occurrence. We show that the HF model has serious shortcomings that limit its use in practice. In contrast, the Bonus-Malus model does not have these defects. Instead, it has several interesting properties: interpretability, computational advantages and ease of use in practice. We believe that the flexibility of this new model means that it could be used in many other actuarial contexts. Based on a real database, we show that the proposed model generates the best fit and one of the best predictive capabilities among the other models tested.

Forward transition rates

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Joint work with: M. Steffensen, K. Buchardt

The idea of forward rates stems from interest rate theory. It has natural connotations to transition rates in multi-state models. The generalization from the forward mortality rate in a survival model to multi-state models is non-trivial and several definitions have been proposed. We establish a theoretical framework for the discussion of forward rates. Furthermore, we provide a novel definition with its own logic and merits and compare it with the proposals in the literature. The definition turns the Kolmogorov forward equations inside out by interchanging the transition probabilities with the transition intensities as the object to be calculated.

Mathematical and Actuarial Modelling of Longevity Trends

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The fact that we are living longer in many developed (and developing) countries has a significant financial effect on individuals, governments, social security systems, pension plans and insurance and reinsurance companies. In this context, we will define longevity risk and we will examine the background in terms of historical trends and consider the financial implications. In order to plan in advance for these changes, we require reliable mathematical models that enable the accurate forecasting of future longevity trends and the measurement of uncertainty. This is one of the major challenges facing actuarial science. We will examine different approaches to the modelling of the trends in the underlying mortality rates as well as the mortality improvement rates. We will present some results from comparative studies of mortality modelling and forecasting and reflect on the ways that the science is moving forward to address some of the deficiencies in current modelling approaches.

How much to put in a tontine

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Joint work with: Catherine Donnelly

Combining the best of drawdown and annuity, the investment returns and the longevity credits, tontines offer a great alternative to current pension products. Promoting tontines, we analyze the effect of a bequest motive on the decision to invest in a tontine.
We formulate an investment problem where a pensioner chooses the percentage of wealth in the tontine, an investment strategy and their consumption rate. The investment problem is formulated such that the optimal strategy maximizes the utility of lifetime consumption and the left behind bequest.
We show that, for a risk-averse investor, the percentage in the tontine is around 80% for a wide range of risk aversion and different bequest motives.

Pricing and Hedging Equity-Linked Life Insurance Contracts Beyond the Classical Paradigm: The Principle of Equivalent Forward Preferences

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This talk revisits the pricing and hedging problems for equity-linked life insurance contracts via an indifference perspective. Instead of modeling the value functions by maximal expected utilities as in the classical paradigm, this talk infuses forward investment performance processes into the indifference equation, and thus introduces the principle of equivalent forward preferences. The rationale for adopting this novel forward approach in pricing and hedging equity-linked life insurance contracts is provided. Due to the non-uniqueness of these preferences, forward preferences with zero volatility and non-zero volatility are considered. The prices and hedging strategies of equity-linked life insurance contracts are represented by solutions of random horizon backward stochastic differential equations.

Valuation of hybrid financial and actuarial products: a universal 3-step method

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Joint work with: P. Devolder; G. Deelstra; K. Gnameho

Financial products are priced using risk-neutral expectations justified by hedging portfolios that (as accurate as possible) match the product's payoff. In insurance, premium calculations are based on a real-world best-estimate value plus a risk premium. The insurance risk premium is typically reduced by pooling of (in the best case) independent contracts. As hybrid life insurance contracts depend on both financial and insurance risks, their valuation requires a hybrid valuation principle that combines the two concepts of financial and actuarial valuation. The aim of this paper is to present a novel 3-step projection algorithm to valuate a class of hybrid contracts by decomposing their payoff in three parts: A financial, hedgeable part, a diversifiable actuarial part and a residual part that is neither hedgeable nor diversifiable. The method allows for a separate treatment of unsystematic, diversifiable mortality risk and systematic mortality risk related to, for example, epidemics or population-wide improvements in life expectancy. We illustrate our method in the case of a pure endowment insurance contract with profit and compare the 3-step method to alternative premium principles suggested in the literature. We demonstrate that the 3-step method satisfies most of the desirable features of a premium principle and is straightforward to compute and implement.

Capital and Liquidity Management for Insurers

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A practitioner's guide to capital and liquidity management for insurers is going to be presented.
Capital has always been understood to be the lifeblood for regulated financial institutions such as banks and insurers. Yet Solvency II made capital not only a scarce, but also a very volatile metric for European insurers. Capital management has become a strategic capability not just for the CFO but for the CEO and the Board of an insurance company. A number of pitfalls to watch out for and opportunities to compete more effectively in this brave new world are identified.
Liquidity seems to be the forgotten dimension in Solvency II, yet it cannot be ignored. Unpredictable property and casualty claims, clients lapsing or surrendering policies, and, for life companies completing their risk management with financial derivatives, clearing require a systematic liquidity framework. Finally, liquidity is valuable and the possibility to invest in higher yielding assets not regularly traded may even present a strategic advantage to insurers as long-term investors when compared to other forms of saving and investing.

ABSTRACTS – Presentations – 8 February

Sharp Asymptotics for Large Portfolio Losses under Extreme Risks

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Joint work with: Zhaofeng Tang, Yang Yang

We study the asymptotic behavior of the loss from defaults of a large portfolio. Inspired by the work of Bassamboo, Juneja, and Zeevi (2008, Operations Research), we consider a static structural model in which latent variables governing individual defaults follow a mixture structure incorporating idiosyncratic risk, systematic risk, and common shock. In our setting, the portfolio effect, namely the decrease in overall risk due to the portfolio size increase, is taken into account by assuming that the individual default thresholds are proportional to a positive deterministic function diverging to infinity. Furthermore, the obligor-specific variables form a sequence of independent and identically distributed vectors, which still allows heterogeneity of the portfolio though. We derive sharp asymptotics for the tail probability of the portfolio loss as the portfolio size becomes large under the assumption, among others, that either the common shock variable or the systematic risk factor has a regularly varying tail. Our main finding is that the occurrence of large losses can be attributed to either the common shock variable or the systematic risk factor, whichever has a heavier tail.

This talk is based on a recent joint work with Zhaofeng Tang (University of Iowa) and Yang Yang (Nanjing Audit University).

Surrender Contagion in Life Insurance: Modeling and Valuation

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Joint work with: Chunli Cheng; Christian Hilpert; Aidin Miri Lavasani

This paper incorporates contagious surrender behaviour into the pricing and regulation of participating life insurance contracts, allowing for structural default. The insurance market consists of one representative professional and several retail policyholders, the former being able to optimally exercise the embedded surrender option. In a model of surrender contagion which extends a stochastic surrender intensity by an endogenous self-exciting effect, the contract values and surrender behaviours of both policyholder types depend on each other. While professional's surrender goes at the expense of retail policyholders, the latter will typically benefit from the resulting contagion. Apart from this, a reasonable regulatory intervention is a more effective remedy to retail policyholders than increased capital requirements.

Idiosyncratic Jump Risk Matters: Evidence from Equity Returns and Options

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Joint work with: Jean-François Bégin and Christian Dorion

The recent literature provides conflicting empirical evidence on the pricing of idiosyncratic risk. This paper sheds new light on the matter by exploiting the richness of option data. First, we find that idiosyncratic risk explains 28 percent of the variation in the risk premium on a stock. Second, we show that the contribution of idiosyncratic risk to the equity premium arises exclusively from jump risk. Finally, we document that the commonality in idiosyncratic tail risk is much stronger than that in total idiosyncratic risk documented in the literature. Tail risk thus plays a central role in the pricing of idiosyncratic risk.

Optimal Portfolio Diversification via Independent Component Analysis

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Joint work with: V. DeMiguel, F. Vrins

A popular approach to enhance diversification in portfolio selection is to rely on the *factor-risk-parity portfolio*, which is often defined as the portfolio whose return variance is equally spread among the principal components (PCs) of asset returns. Although PCs are useful for dimensionality reduction, they are arbitrary because any rotation of the PC basis yields an equally-uncorrelated basis. This is problematic because we theoretically demonstrate that any portfolio is the factor-risk-parity portfolio corresponding to a specific uncorrelated basis. To overcome this problem, we consider the factor-risk-parity portfolio based on the independent components (ICs), which are the rotation of the PCs that are maximally independent, and thus, account for higher-order dependencies. This factor basis is found using independent component analysis, an extension of principal component analysis. Specifically, we propose a shrinkage portfolio that combines the minimum-variance portfolio and the IC-risk-parity portfolio. We also show how the IC basis can be used to efficiently estimate the portfolio that achieves factor-risk parity with respect to Value-at-Risk. Finally, we empirically demonstrate that the shrinkage portfolios based on the IC basis outperform those based on the PC basis as well as the minimum-risk portfolios obtained without shrinkage.

A New Measure of Diversification: the QDX index

Gianluca Fusai

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Joint work with: Domenico Mignacca, Director Risk Management Department, Qatar Investment Authority

In this talk, we propose a new index to measure the diversification of a portfolio. Specifically, we outline a new risk decomposition of the portfolio volatility that it is the basis to calculate our new quantitative diversification index (QDX). The index takes values in the range $[0, 1)$, with the extremes signalling lack of or perfect diversification. The appealing feature of our measure is its simplicity in the computation, given that it only requires the covariance matrix and the portfolio allocation and does not involve any optimization. We also provide a mathematical rationale for our QDX index, so that it can be easily extended to homogeneous risk measures not related to the portfolio volatility.

Machine Learning for Quantitative Finance: Fast Derivative Pricing, Hedging and Fitting

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Joint work with: J. De Spiegeleer, D. B. Madan, W. Schoutens

In the derivatives world, daily zillion computations need to be done. We show how machine learning techniques can be deployed in this context. For many classical problems, we can arrive to speed-ups of several orders of magnitude by deploying machine learning techniques based on Gaussian process regression. The price we have to pay for this extra speed is some loss of accuracy. However, we show that this reduced accuracy is often well within reasonable limits and hence very acceptable from a practical point of view. The concrete examples concern fitting and estimation. In the fitting context, we fit sophisticated Greek profiles and summarize implied volatility surfaces. In the estimation context, we reduce computation times for the calculation of vanilla option values under advanced models, for the pricing of American options and for the pricing of exotic options under models beyond the Black-Scholes setting.

Keywords: machine learning, Gaussian processes, derivative pricing, hedging, volatility surface.

References

[1] Jan De Spiegeleer, Dilip B. Madan, Sofie Reyners & Wim Schoutens (2018), Machine learning for quantitative finance: fast derivative pricing, hedging and fitting, *Quantitative Finance*, forthcoming.

On smile properties of volatility derivatives and exotic products: understanding the VIX skew

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Joint work with: David García-Lorite and Aitor Muguruza

We develop a method to study the implied volatility for exotic options and volatility derivatives with European payoffs such as VIX options. Our approach, based on Malliavin calculus techniques, allows us to describe the properties of the at-the-money implied volatility (ATMI) in terms of the Malliavin derivatives of the underlying process. More precisely, we study the short-time behaviour of the ATMI level and skew. As an application, we describe the short-term behavior of the ATMI of VIX and realized variance options in terms of the Hurst parameter of the model, and most importantly we describe the class of volatility processes that generate a positive skew for the VIX implied volatility. In addition, we find that our ATMI asymptotic formulae perform very well even for large maturities. Several numerical examples are provided to support our theoretical results.

ABSTRACTS – Posters

Mortality modeling for a single and multiple population

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Joint work with: Spyridon Vrontos Haslifah Hashim

This paper introduces various approaches to model the mortality rates in single and multiple populations to get better and consistent mortality forecasts. We extend the Lee Carter (LC) and Common Age Effect (CAE), which uses singular value decomposition (SVD) and principal component analysis (PCA) method respectively. We review the LC model, by estimating the parameters using PCA rather than maximum likelihood methods. We concentrate on the use of PCA in the study as we extend this method to several other methods, such as Multi PCA, Flury's PCA and Dual Generalized PCA to obtain the estimates of the common age effects. We also look at different methods such as Robust SVD, Sparse SVD and Robust Regularized SVD in modelling the mortality for a single population instead of the normal SVD in the classical LC model. We also study the differences in the goodness of fit between individual's models and multiple population models. We want to see how are the goodness of fit for the individuals models compared to the multiple population models. This study adds to existing research by applying different types of SVD and PCA analysis to single and multiple population groups and combines it with existing mortality models in order to get a model for forecasting life expectancy across populations. We also extend the study to examine the area modeling of the sub-population in the UK (Scotland, Northern Ireland and England and Wales) and compare the performance of the multiple population as compared with individual population of the UK.

Application of State Space Models to Financial and Economic Data

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In dynamic modelling of financial and economic data the concept of cointegration plays an important role. It refers to the existence of long-term equilibrium relations between financial/economic variables in a dynamic environment. In the literature so-called VAR models with cointegration are popular. In its Edgeworth Centre, University College Cork are developing parameterization/estimation methods for alternative models, namely State Space models with cointegration. The research topic in this project is to study cointegration of financial data and how a state space representation of these processes can be constructed. We will first start off by giving a brief introduction on cointegrated I(1) processes before explaining further the VAR model. After laying out the groundwork of the Engle and Granger approach and of Johanson's work using the VAR model,see[1][2], we will consider how a state space representation of the cointegration model using a maximum likelihood criterion can be beneficial as opposed to Johanson's VAR model. We introduce the state-space error correction model (SSECM) and discuss in detail how to estimate SSECMs by maximum likelihood methods, including reduced rank regression techniques which allow for a successive reduction of the number of parameters in the original constrained likelihood optimization problem,see(Thomas Ribarits and Bernard Hanzon, SSRN, 2014)[3]. In doing so, we follow very closely the Johansen approach for the VAR case, see Johansen (1995). Finally, the remaining free parameters will be represented using a new local parametrization technique which has several advantages,and we show how efficient gradient-type algorithms can be employed for the numerical optimization in the resulting lower dimensional unconstrained problem. Simulation studies and applications will be presented.

References

[1] R.F. Engle and C.W. Granger, Co-integration and Error Correction: Representation, Estimation and Testing, Econometrica (1987)

[2] S. Johansen, Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, Econometrica(1991).

[3] T. Ribarits and B. Hanzon, The State-Space Error Correction Model: Deffinition, Estimation and Model Selection,(SSNR),2014.

Portfolio Modeling and Measuring Risk in Normal Mixture Distributions

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Financial returns exhibit stylized facts such as leptokurtosis, skewness and heavy-tailness. Regarding this behavior, we apply Normal mixture distributions to portfolio modeling, using Conditional Value at Risk (CVaR) as a risk measure and allocating best weights for portfolio selection. These kind of distributions have a natural multivariate with good properties in mean-risk portfolio optimization problem. So instead of traditional heavy-tailed distributions, we consider the Normal inverse Gaussian (NIG), variance Gamma (VG), Normal tempered stable (NTS) distributions and generalized hyperbolic distribution (GH) as class of Normal mixture distributions. In addition, to evaluate the level of risk we have used CVaR as a risk measure and simulated by Monte Carlo method. For finding the CVaR, the characteristic function as a Fourier transformation is used. Finally, a real data set of Iran stock market is given to illustrate the effectiveness of the introduced model.

Representation of Distortion Risk Measures and Applications

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A family of concave distortion functions is a set of concave and increasing functions, mapping the unity interval onto itself. Distortion functions play an important role defining coherent risk measures. We prove that any family of distortion functions which fulfils a certain translation equation, can be represented by a distribution function. An application can be found in actuarial science: for a risk X, we construct a coherent risk measure, based on a concave distortion function and depending on X such that the premium principle of that risk measure reduces to the Expected Value, the Standard Deviation or the Variance Premium Principle when applied to risk X. The price of another insurance risk Z may then be compared to the premium of X, even if the variance of Z does not exist.

Consolidation in the Light of Solvency II – The Impact of Mergers and Acquisitions on Insurers' Default Risk

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Following Solvency II coming into effect in 2016, academics and practitioners anticipate further consolidation in the insurance industry as the new regulatory framework rewards well diversified insurers with lower capital requirements and challenges smaller insurers to meet (operational) regulatory requirements. Since the academic literature has failed so far to shed light on the default risk implications of mergers within the insurance industry, this study examines a sample of 478 mergers and acquisitions between 1984 and 2015 by employing Merton's distance to default. The analysis reveals four major findings:
First, mergers are on average risk enhancing although this does not hold for deals of insurers inside the European Union and for reinsurers. Focusing on relatively safe insurers and reinsurers, however, the study reveals that mergers are significantly risk increasing for firms from all analyzed regions and business lines. Second, deals announced during crisis periods perform differently and lead to notable reductions in bidders' default risk. Third, diversifying mergers indeed provide diversification benefits and therefore confirm the "strategic diversification hypothesis". However, this does not apply for all diversifying strategies. While geographically diversifying mergers do not provide any risk decreasing benefits, diversification benefits are particularly pronounced for activity diversifying and highly diversifying (i.e. geographically and activity diversifying) deals. By contrast, focusing strategies appear to be risk neutral. Fourth, merger-related default risk changes are mostly driven by acquirer characteristics (e.g. size, leverage, growth, non-insurance activities, pre-merger risk profile etc.) and only to a limited extent by additional deal characteristics and macroeconomic control variables.
In light of these empirical findings, some important implications can be derived for policymakers and managers. Since Solvency II generally aims to enhance the financial soundness of the insurance sector and its firms, regulators should be aware of the merger-related contrary risk effect as it might thwart the initial benefits of stricter regulation. Next, policymakers should more rely on the power of self-regulating markets in crisis periods since these mergers, on average, are risk-reducing and thus could work as a catalyst to stabilize the system. Turning to management implications, managers need to be aware that certain deal strategies are more likely to improve the risk profile than others. Moreover, since risk drivers of transactions within the insurance industry are mainly firm-specific, mergers and acquisitions might not be an appropriate strategy for all insurers to optimize their risk profile.

Structural Option Pricing: A Test of Relative Pricing Between the Option and the CDS markets

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In this work we propose a new structural model of default inspired by the n-fold compound option model in Geske (1977). Here the stockholders are given the choice to default on bond reimbursements: at each payment date, the continuation value of the equity is compared with the face value of the bond due on that date. If the continuation value is larger than the payment due, the firm is kept alive and continues until the next payment date in which the same mechanism operates. Despite structural models have been mainly used in the literature for pricing risky bond and computing credit spreads, the structural model proposed herein is used instead for pricing the firm's equity. This allows to carry default risk in a new (structural) option pricing model in which the process driving the stock price is not a geometric Brownian motion but an 'extension' of the CEV model. This richer structure allows to capture some of the stylised facts observed in the option markets such as the leverage effect. After calibrating the model parameters on the firm's stock price and the series of risk-neutral probabilities of surviving extracted from the CDS spreads, a test of relative pricing is performed to assess whether the US derivative markets of equity (option market) and debt (CDS market) price default risk consistently.

Intensity based Model for CDS Spread with Time-Changed Levy Process

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In credit default swap (CDS) pricing, it is important to find both flexible and tractable models. In this paper, by setting upl a time-changed Levy process subordinated by Ornstein-Uhlenbeck we present an intensity based mode for the CDS spread. We apply a stochastic volatility model driven by infinite activity Levy processes that is consistent with phenomenon observed in underlying asset. Some typical Levy process, aiming to capture the leptokurtic feature in asset returns and volatility clustering effect in returns variance are investigated. The asset value processes of these models are able to fit any valid CDS curve that would possibly be of both finite variations.

Furthermore, we obtain a closed form formula for its survival function in terms of characteristic function of the time-changed Levy and the default is triggered by a predetermined barrier. This pricing formula is well calibrated on the CDS market.

Central Banks' Portfolio Optimization Considering Cryptocurrencies

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Cryptocurrencies are a new phenomenon that make many challenges for central banks and their monetary policies. One of these challenges is whether Cryptocurrencies considered as a currency, commodity, or securities and if they are currency, so which of them and how much should be available in Central Banks' official foreign exchange reserves in order to have optimal portfolio.
In this paper, At first by calculating correlation between cryptocurrencies and popular fiat currencies concludes that just some of them that based on private blockchain can play money functions include store of value, medium of exchange and unit of account. Then, we use mean- Conditional Value at Risk (CVaR) framework to obtain optimal foreign exchange reserves, include fiat and cryptocurrencies, for Central Banks. Due to the excess kurtosis and positive skewness in cryptocurrencies, standard normal distribution is a poor approximation. We can conclude that portfolios containing cryptocurrencies are better than other portfolios. Finally, real data in Iran Central Bank are given to illustrate the effectiveness of our model.

Risk management of interest rate derivatives in presence of interbank risk.

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The credit crunch of 2007 caused major changes in the interbank market rates making existing interest rate theory inconsistent. Based on the work of F. Mercurio (2009), We remind one way to reconcile practice and theory by modifying the arbitrage-free condition. In this framework, the simple forward Libor rate is not considered anymore as a risk-free rate and its dynamic is driven by the presence of the credit and liquidity risk within the interbank market. We model the simple forward Libor rate taking into account the new market features through the multiple-curve approach studied by D. Filipovic, Anders B. Trolle, and M. Henrard (2012, 2014). In this approach, we model the joint evolution of the default-free rates, assimilated to overnight interest swap rates, and the default times of the interbank market. To deal with the credit risk of this generic counterparty we use the reduced form approach and model the arrival rate of defaults by a self-exciting process. The diffusion part is structured as a CIR model to insure both the non-negativity and mean-reverting property. Whereas the jump part follows an inhomogeneous Poisson process that allows positive jump when a credit event occurs. We next deduce the dynamic of the simple spot forward Libor rates, and explicitly present the impact of jumps on the Libor dynamic. We finally provide pricing formulae for options on simple forward Libor rates and swap rates.

Sensitivity analysis of annuity models

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Annuities constitute a fundamental branch in the life insurance business. To obtain the cost of annuities, financial and demographic factors are the key inputs for the related mathematical quantitative models. However, we have not found in the literature a systematic sensitivity analysis of these models.

In this work, we use and compare different approaches to gain insights on the behavior of annuities, their structure and on the importance of their input factors.

Dynamic Pricing in Insurance

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We develop a pricing policy that enables an insurance company to find the optimal price and maximize the expected profit. The insurance company sells a single product and adopts prices to learn its customers' responses. The pricing policy is determined by the selling price and other model parameters. The parameters of the underlying model are initially unknown to the insurance company, so each price decision involves a trade-off between learning and earning. Maximum quasi-likelihood estimation (MQLE) is used to estimate the unknown parameters in the model. We build an algorithm that guarantees that MQLE parameter estimates eventually exist and converge to the correct values, which implies that the sequence of chosen prices also converge to the optimal price. The performance of the pricing policy is measured in terms of the *regret*: the expected revenue loss caused by not using the optimal price. Upper bounds on the regret can be achieved by our pricing algorithm.The advantages of this new pricing policy are clear. Firstly, it formulates a learning-and-earning problem, where price is used as a learning tool to explore the demand and claims response to different prices. Secondly, only very limited assumptions are made on the model. Finally, although similar results exist in other domains, this is among the first to consider dynamic pricing problems with model uncertainty in the field of insurance.

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