

## ATRC 2019 ABSTRACTS

Thursday 27th June

### 09:45 – 11:00 – Session on Investment I

**Martin White (RMSL): Aspects of stewardship: wealth creation, working lives, wealth extraction – the needs, the education and empowerment of individuals, and the relevance and contribution of the actuarial profession**

*(speaking as an individual and not as a representative of either employer or the Actuarial Profession)*

Stewardship was arguably the driver for the creation of the actuarial profession, when groups of people came together to give mutual support – the early friendly societies and mutual life insurers in the UK. The mutual model preceded the shareholder model.

The speaker will suggest that some aspects of stewardship do not get the attention they deserve, and that today's investment mechanisms do not operate in the interests of the individual to the extent that they perhaps could or should. The actuarial profession and actuarial research arguably has a contribution to make here, and some ideas will be put forward for ways in which the balance of power and capability could be tilted towards the individual. How well do the actuarial education and exams prepare us to think as intelligent investors, and how well prepared are we to take the lead in sharing the important principles in such a way that we could influence policy?

The individual as saver, investor, and customer for mechanisms to mitigate risks such as mortality, longevity and inflation – that's how we tend to think within the actuarial profession, with investing in the real economy as an important component of solutions. But we should also remember that the investment strategies and investment objectives on which we have some influences have human consequences within society. The topic of "ESG", environmental and social governance, gets a lot of attention. Less attention is placed on the impact of corporate cultures, themselves influenced by corporate owners, on the impact on the wider economy and on the impact of the life experiences of the employees.

**Colm Fitzgerald (University College Dublin): Very long-term historical investment return data - what can we learn from looking back 200-750 years into history?**

The research used actuarial techniques and historical commodity price data to synthetically create new historical investment return data going back 200-750 years - mostly based on data from the US, England and the EU. The research produced a surprising result - that equities may not be the investment class with the highest historical investment returns. The research also enabled comparison of investment risk over very long periods of time - both in relation to variance and skew - again showing surprising results. The research will be of interest to actuaries involved in asset-liability modelling and it presents a potential challenge to accepted wisdom in the investment industry. The implications of the results are discussed from a variety of perspectives, including that of a pension's actuary, but also from a more general investment perspective. Furthermore, the results are presented in light of the prolonged Quantitative Easing monetary policies enacted by the

major central banks around the world. A possible hedge to potential downsides risks arising from this form of monetary policy is also discussed.

**Keywords:** historical returns, economic history, investment history, alternative investment returns

## 11:30 – 13:00 – Session on Longevity

### **Liang Chen (University College Cork): Bayesian Method for Small Population Longevity Risk Modelling**

*Joint work with Andrew J.G. Cairns and Torsten Kleinow (Heriot-Watt University, Actuarial Research Centre (ARC) of the Institute and Faculty of Actuaries (IFoA))*

This talk considers the impact of sampling variation on the calibration of stochastic mortality models. Random variation in deaths counts results in parameter uncertainty in estimates of age, period and cohort effect in the model. In turn, this has an impact on time series parameter estimates. With small populations, sampling variation causes an upwards bias in the estimated volatility of period effects using standard maximum likelihood methods. We seek to counteract this problem of bias using Bayesian inference and study the financial implication of the Bayesian methods by calculating annuities and longevity risk. We find that the Bayesian methods generate improved estimation for the volatility of small population. The influence of the informative prior distribution (e.g. ARIMA likelihood) becomes stronger for smaller population and restricts the latent parameter estimation to be more like the proposed time series model. There are shifting effects observed for the influence of the sampling variation on the posterior distribution of the model parameters as well as the posterior predictive distribution of the projected mortality rate.

**Keywords:** stochastic mortality models, Bayesian inference, sampling variation, informative prior distribution, time series model, longevity risk

### **Cristian Redondo Loures (Herriot-Watt University): Cause of death specific cohort effects in US mortality**

*Joint work with Andrew J.G. Cairns (Herriot-Watt University)*

We use stochastic mortality modelling on publicly available cause of death data for the United States, with the aim of finding how cohort effects have evolved for people born in the early to mid-20th century. We include several different groups of causes of death, for two different education groups and both genders. The talk will explore the different patterns that emerge for cohort effects for different causes of death and how these might be related to underlying risk factors. For example, we identify a smoking related cohort effect for lung cancer and chronic obstructive pulmonary diseases that is distinctively different from the all-cause cohort effect. The aim is to understand the underlying drivers of the observed cohort effects for each of the groups analysed

**Keywords:** stochastic modelling, cohort effects, drivers of mortality

**David Smith (Cass Business School, City University of London): Does living in a retirement village extend life expectancy? The case of Whiteley Village, England**

*Joint work with Ben Rickayzen and Les Mayhew (Cass Business School, City University of London)*

The benefits or otherwise of communal living in later life are of considerable interest in the context of a growing and increasingly elderly population because of the continuously rising cost pressures on health and social care and the need to provide more suitable accommodation. Such establishments have the capacity to provide in one location all the needs of residents whilst providing a stimulating and high quality living environment, which insulates residents from the day-to-day problems of growing old. Whiteley Village in England, which recently celebrated its 100th anniversary, is one of the main forerunners of this kind of retirement living anywhere in the world. The aim of this study is to investigate the possible benefits of retirement village life with respect to life expectancy i.e. whether Villagers live longer on average than the general population. Our results show that there is strong statistical evidence that female residents, in particular, receive a substantial boost to their longevity when compared to the wider population – at one point in time reaching close to five years. Whiteley’s longevity advantage is even greater once we take account of the fact that the resident population is drawn from the poorest pensioners, who would be expected to experience higher mortality rates. Although we were unable to find sufficient statistical evidence that the male residents of Whiteley outlive their counterparts in the wider population, there was certainly evidence that the majority lived at least as long on average (i.e. the effects of living at Whiteley appears to combat the inequalities caused by social deprivation).

**Key words:** Population aging – longevity – life expectancy – social deprivation – social care

## **14:00 – 15:30 – Session on Social Welfare and Pensions**

**Pradip Tapadar (University of Kent): How can adverse selection increase social welfare?**

This talk will focus on the effects of bans on insurance risk classification on utilitarian social welfare. We consider two regimes: full risk classification, where insurers charge the actuarially fair premium for each risk; and pooling, where risk classification is banned and for institutional or regulatory reasons, insurers do not attempt to separate risk classes, but charge a common premium for all risks. For the case of iso-elastic insurance demand, we derive sufficient conditions on higher and lower risks' demand elasticities, which ensure that utilitarian social welfare is higher under pooling than under full risk classification. Empirical evidence suggests that these conditions may be realistic for some insurance markets.

**Keywords:** Social welfare; elasticity of demand; adverse selection; insurance risk classification.

**Zhaoxun Mei (Heriot-Watt University): The comparison of smoothing methods in pension contracts**

Return smoothing method is an important feature of traditional pension contract and is believed to be a virtue of it. In this paper, we compare three smoothing methods used in current with-profits contracts in terms of fairness and smoothing effects. We not only compare the absolute terminal value of each smoothing methods, but also study the smoothing effects by calculating the interim utility using MCPT (Multi Cumulative Prospect Theory). Our result show that the GA (geometric average) smoothing method underpays the customer while the BW (bandwidth) method overpays

the customer. The WS (weighted sum) smoothing mechanism generates a fair payout. In terms of interm utility, GA method generates the highest while BW provides the lowest. This result holds when the underlying investment follows either a geometric Brownian motion or a bi-variate trending OU process

**Inmaculada Dominguez-Fabian (University of Extremadura): Actuarial analysis of a two-steps decumulation pension scheme**

*Joint work with Pierre Devolder (Institute of Statistics, Biostatistics and Actuarial Sciences Catholic University of Louvain)*

The problems of the different pension systems motivated by longevity and exacerbated by the economic crisis mean that all countries are undertaking certain reforms in order to try to solve them. These reforms are made on two forms, either parametric or structural. The parametric ones suppose that the system parameters are modified, such as the age of retirement or the formula to calculate the pensions, for example. The structural reforms involve changes in the chosen system, moving from the pay-as-you-go system to the capitalization system, as an example. In this paper we propose a different system, which does not imply the modification of any parameter nor does it imply structurally changing the system. We explore the idea of modifying the way in which benefits are perceived. In all the pension systems currently applied, the pension collected during retirement is composed of two amounts: the one generated by social security with the pay-as-you-go system, and at the same time, the one obtained with the private system. The basic idea of the model we propose, called two-steps mixed system, instead of an horizontal superposition of the two pillars after retirement age, proposes to decumulate in two phases. In our two-steps mixed system, when workers reach their ordinary retirement age they receive a 'term annuity' generated by their previous capitalized savings to be replaced by a Social Security defined contribution 'pure life annuity' when the so-called 'grand age' is reached.

We have worked with this idea in other papers (Herce et al. (2013), Domínguez et al. (2018), Devolder et al. (2018a, 2018B)), and now in this one we generalize the simple two period model presented in our previous paper and consider a very general multi age actuarial model. For further progress in the design and development of Two step system board we give also new results on the way to define the grand age based on two possible ways to define continuity of the model. Finally we will make a simply example by applying the Two step model to the UK pension system.

**Keywords:** individual analysis, grand age, two-steps mixed system, term annuity, JEL codes: G00; G22; G29

## 16:20 – 16:50

**Oliver Bettis (Great Lakes Insurance SE): IFoA's research effort in economics**

The aim of this paper is threefold. First, is to understand the interplay between economic thought and actuarial practice. Second, is to understand the consequences of current approaches to economics. Last, is to set out an agenda for the Profession such that it gains the most benefit from its use of economics as a discipline, and not some potentially limiting subset of it. New ways of economic thinking are already manifest, and the prominence of such approaches is growing. However, for the Profession to ask the right questions of economics, broadly defined, this requires going back to first principles about the role of the actuary and actuarial work.

## 16:50 – 17:15

### **Martin White (RMSL, member of IFoA Research and Thought Leadership Board): Actuarial Research Centre (ARC): update on research programmes**

In 2015, the IFoA issued a call for research proposals, together with a very broad discussion document on the areas in which developments in actuarial science could benefit society, against a backdrop of ageing populations and economic uncertainty. The questions set out included:-

- Optimal ways to bear risk
- Actuarial consequences of changes in how people age: estimating mortality and morbidity; care costs; pensions and retirement; health and life insurance
- Managing investment strategies in a changing environment: examining causes of change, and the consequential issues including the “human” factors such as psychological aspects of decision making

A number of projects were commissioned through the Actuarial Research Centre, and we will discuss how these are progressing. Useful outputs have been appearing, they are all placed in the public domain, and a number of webinars can easily accessed.

As part of the session, we will have an open discussion on research ideas – so come prepared to contribute!

Friday 28th June

## 09:45 – 11:00 – Session on Investment II

### **Andrew Smith (University College Dublin): Equity Release Mortgages: the Irish Experience**

Equity release mortgages (ERMs), also called lifetime mortgages, have played an increasing role in generating income for retired homeowners. As new liquidity rules have reduced the supply of bank lending, so insurers have stepped in, encouraged by generous regulatory treatment for annuity writers. Some methods for valuing ERMs have proved controversial, particularly in relation to assumptions for future growth in house prices, which determine whether the lender is able to recover the mortgage balance on the borrower's death. As the volume of these assets grows on insurance balance sheets, there are concerns that insurers' reliance on continued house price growth could make the industry less resilient to the next house market downturn.

This paper describes the basic products and illustrates alternative valuation methods with reference to Ireland and the UK. We summarise recent research and provide example calculations to illustrate the competing methods, highlighting areas of actuarial debate. We conclude with a discussion of the value of these products – both positive and negative – to society as a whole.

**Keywords:** equity release mortgage, option pricing, house prices, illiquidity premiums

### **Axel Helmert (msg life): Integrated Unit Linked Collective Assets – ICA: Products using a collective approach**

The situation of life insurance companies and pension providers is challenging. One of the most difficult aspects is the low interest rate challenge. Together with the increasing requirements on solvency and other regulations, this is developing pressure in search of new solutions. We have seen many attempts adopting long-term guarantees in various new products, the results are not satisfying. In recent years, the opinion has prevailed that we need a more general approach. This leads us to the following questions: Is it possible to provide a high level of security combined with acceptable yields without traditional long-term guarantees? Could we bring together the advantages of individual unit linked life insurance products with the traditional collective approach in a cost efficient automated environment?

### **Julia Eisenberg (UWien/University of Liverpool) and María del Carmen Boado-Penas (University of Liverpool): New pension product design under protracted ultra-low interest rates**

*Joint work with Axel Helmert (msg life) and Paul Krühner (University of Liverpool)*

The increase in longevity and the ultra-low interest rates have put significant strain in the pension industry. Additionally, the guarantees associated to pension benefits let the ghost of bankruptcy loom over the whole branch. Consequently, insurers need to offer satisfactory benefits to participants while keeping companies solvent. Our proposed pension design goes beyond the annuity pools and unit-linked insurance products. The purpose is to replace traditional guarantees with low volatility, mainly achieved by collective smoothing algorithms and an adequate asset management. With the aim of offering security to the insured, we discuss the optimisation of some

key variables of the proposed pension product to target both a high value of the initial pension and stable pension payments over time.

**Keywords:** Pensions, Guarantees, Unit-linked contracts, Ultra-low interest rates, Collective mechanism, Volatility smoothing

**Andreas Tsanakas (Cass Business School, City, University of London): Scenario Weights for Importance Measurement - An R package for sensitivity analysis**

When modelling portfolios of risks, it is of central importance to analyse the propagation of changes in model assumptions. As is typical in applications, we view a model as a random vector of input factors that is mapped, via an aggregation function, to a random output. Performing sensitivity testing includes stressing the inputs and observing the impact on the output, as well as stressing the output and monitoring the impact on different inputs (reverse sensitivity testing). We propose an approach to sensitivity analysis, based on [1], that circumvents the need for additional simulation runs and thus does not require time-consuming re-evaluations of the aggregation function. The approach is implemented via the R-package SWIM. Specifically, we define a stress on a random variable as a probabilistic modification, resulting from an increase or decrease in e.g. moments or risk measures such as VaR and ES. The distribution of the stressed random variable is chosen such that, subject to the constraints, the Kullback-Leibler divergence is minimised. In a Monte Carlo setting, the R-package calculates the importance weights of the resulting change of probability measure. Thus, using the weighting of simulated scenarios, the entire probabilistic characterisation of the stressed model is provided. Calculation of the stressed model including usual common sensitivity metrics and plotting facilities are implemented in the R-package. This is joint work with Alberto Bettini, Pietro Millosovich and Silvana Pesenti.

**Keywords:** sensitivity analysis, risk measures, R package, internal models, validation.

**References:**

[1] Pesenti, S.M., Millosovich, M., Tsanakas, A. (2018). Reverse sensitivity testing: What does it take to break the model? *European Journal of Operational Research* 274/2, 654–670.

## 11:50 – 13:20 – Session on Life

**Oytun Haçarız (Heriot-Watt University): Genetics, Insurance, and Cardiomyopathies: “A Case Study of Hypertrophic Cardiomyopathy (HCM)”**

*Joint work with Torsten Kleinow and Angus S. Macdonald (Heriot-Watt University)*

The economic impact of genetic information on life insurance has been discussed since DNA-based genetic testing became available in the 1990s. Macdonald & Yu (2011) estimated the highest increases in life insurance premium rates were about 0.6% if genetic test results were undisclosed to the insurers. Howard (2014) concluded that premium increases could be as high as 12% if the insurers are banned to access genetic test results. Although both studies used different methodologies, the differences in their conclusions was due to the inclusion of the cardiomyopathies (inherited heart muscle disorders), which were absent in Macdonald & Yu (2011). Hypertrophic Cardiomyopathy (HCM) is the most prevalent of these disorders with the prevalence

rate of 0.2% in the general population. We aim to model the impact of genetic testing in HCM in a life insurance market.

**References:**

Howard, R. C. W. (2014), 'Report to CIA research committee: Genetic testing model: If the underwriters had no access to known results', Canadian Institute of Actuaries (CIA).

Macdonald, A. & Yu, F. (2011), 'The impact of genetic information on the insurance industry: Conclusions from the bottom-up modelling programme', *Astin Bulletin* 41(02), 343–376.

**Aniketh Pittea (University of Kent): Examining Pension Plan Risks from an Economic Capital Perspective**

The generation born in the 20 years following the end of World War II has had a profound impact on long-term economic growth in developed countries over the last half of the 20th century. The retirement of this “boomer” generation has the potential to continue to be a dominant economic factor.

We use the economic model alongside demographic models to examine the risks of UK, US and Canadian pension plans. Although the modelling methodology remains the same, we fit the economic and demographic models to data from all three countries. We then use a framework similar to the Solvency 2 framework to calculate the economic capital for existing and “stylised” pension plans. We further carry out sensitivity analysis by varying the demographic assumptions and the asset allocations of the pension plans. The aim of the overall exercise is to determine and compare the long-run sustainability of pension plans in different countries.

**Pietro Millosovich (Cass Business School, City, University of London and DEAMS, University of Trieste): Monte Carlo valuation of the initiation option in a GLWB variable annuity**

*Joint work with Anna Rita Bacinello (DEAMS, University of Trieste)*

We focus on the initiation option featured in many Guaranteed Lifelong Withdrawal Benefit variable annuity contracts, granting their owner the right to decide the age at which lifetime withdrawals should begin. Such contracts have been successfully analysed using a PDE approach, see Huang et al. (*IME*, 56(2014), 102-111). While the latter method is elegant, it becomes less viable when the valuation model is more involved and other guarantees are considered. We exploit the Least Square Monte Carlo method and explore the interaction of the initiation option with lapses and other riders, and the effect of stochastic volatility, interest rates and mortality.

**Keywords:** Variable annuity; GLWB; Least Square Monte Carlo; withdrawals; initiation option



## 14:20 – 16:00 – Session on Data Science

### **Paul King (University of Leicester): Data Science for Actuaries**

Before you can dive into deep learning, get lost in a random forest, or dredge for publishable p-values you need some raw material. To get it you might have to post a request to a RESTful API, send an SQL query, or scrape a website. Then you will have to munge, wrangle and mutate before doing some EDA. You will want to work reproducibly, regularly committing your literate code to a Git repository, and openly – pushing to a remote GitHub repo and dealing with pull requests.

I will discuss how a solid foundation in handling data programmatically can set students up to be active and productive learners of analytics and machine learning; demonstrate some of the tools that make this easy and fun; and, I hope, provoke discussion about what actuaries (who, after all, were doing data science before Charles Babbage's cogs were a gleam in Ada's eye) need to know to avoid falling off the bandwagon.

### **Hirbod Assa (University of Liverpool): On some applications of machine learning in banking and insurance**

In this talk, I take a brief look at some applications of machine learning methods in banking and insurance. After reviewing the fundamentals, I discuss applications in factor analysis, credit risk valuation adjustment and applications in insurance conversion rate. In the end, I will discuss to which extent machine learning can be used to interpret the forecasting results in insurance applications.

### **Colin Thores and Patrina Effer (IFoA): Data Science: supporting IFoA members?**

## 16:00 – 16:35

### **Colm Fitzgerald: Actuaries of the future**