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INDIAN ACTUARIAL PROFESSION
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2. Economic capital modelling and statutory/shareholder requirement

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2. Ability to be part of an analytics driven, multi-cultural team
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About the team

Financial Risk & Regulations - We are a team that includes subject matter experts with deep industry experience and from varied backgrounds including banking, insurance, risk management, treasury, rating analyst, information technology and consulting. This enables us to address a variety of client issues.

The team's skillsets and competencies span across multiple fields that demand an in-depth knowledge of quantitative methods across risk analytics, predictive and decision modelling, advanced analytics like ML/AI, actuarial science, capital estimations, pricing of financial instruments including derivatives and regulatory remediation.



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"A noble man's thoughts will never go in vain. -Mahatma Gandhi."

"I hold every person a debtor to his profession, from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavour themselves by way of amends to help and ornament thereunto - Francis Bacon"

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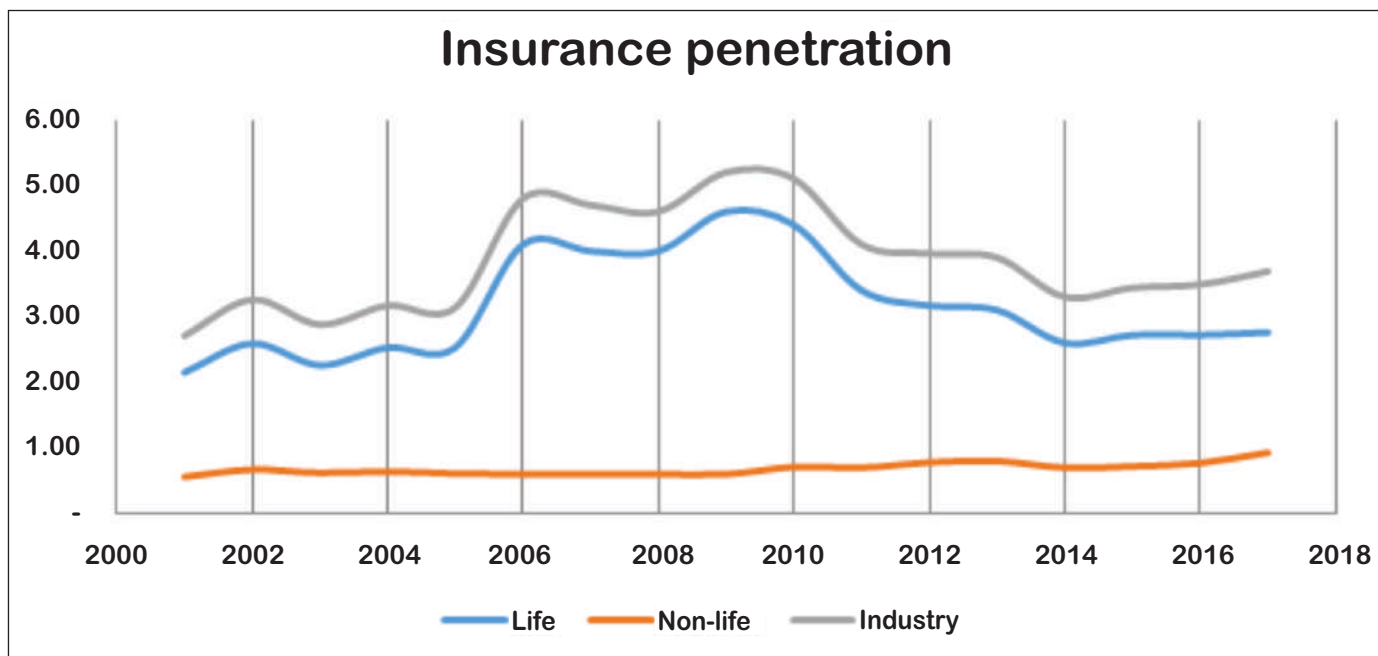


The outcome of General elections 2019 was very decisive and clear for continuation of the NDA government at the centre. The market started cheering up and there was a full spread of positive vibes in all sectors of the society and economy. My heartiest congratulations to all winners in the election and the NDA as a whole for overwhelming win across the country.

Political stability is the first and foremost requirement for systematic development of society and economy. We are likely to witness a number of reforms for sustainable development and progress of the nation. What is the expectation of the insurance sector and actuarial profession during the coming years?

The insurance penetration in India is at much lower level at 3.69% compared with global average. There is a huge potential and it will require a lot of efforts to take it to the global average level.

The chart below gives the trend in the insurance penetration



Currently we have 68 insurers/reinsurers operating in India; of which 24 are life, 27 are non-life, 6 are standalone health and 11 re-insurers. Given the mere size of country and population there is a space and opportunities for more insurance players in India. We need to look at how we could make India as preferred destination for Insurance companies and reinsurance companies.

Beside expansion of insurance market, the situation is also opportunistic for Actuarial Profession to engage in wider areas like Banking, Data Science and Risk Management.

Following table broadly reflects the areas where actuaries can find opportunities and play significant role:

Industries/ Segments	Key areas of work	Current status
Life/General and Health Insurance	Product Pricing, Reserving, Valuation, Risk Management, Data Science and Analytics, Product Marketing , Business Planning, ALM	Partially Explored
Employee benefits and pensions	Pension, Gratuity and Leave encashment Benefit schemes Funding and Valuation	Explored
Off-shore Actuarial Centre of Excellence	ESOP and Stock Appreciation Rights Valuation and pricing Knowledge process outsourcing for Multinational insurance firms and/or companies across world	Un-explored Partially Explored
Actuarial consultancy services	IFRS 17 and IFRS9 Centre of Excellence	Un-explored
Regulators- SEBI, IRDA, PFRDA	All actuarial related jobs related to Insurance Audit and Inspection, Product Approvals and New regulations	Explored Partially Explored
Planning , Social Security, Health department of Govt. of India	Effectiveness of scheme, Experience analysis, pricing, sustainability of the schemes run by government of India	Not Explored
Banking, NBFC and Micro Finance Institutions	Risk Management, ALM, Portfolio management, Cash flow analysis, Sensitivity testing and Matching	Unexplored
Credit rating agencies	Risk management, risk rating	Un-Explored
Universities and colleges	Preparation of Actuarial Curriculum, Setting standards, teaching and Research	Un-explored

One of the key emerging role is in Enterprise Risk Management; though we have more than 400 fellow members, not many have put their foot in this area. Those who have already qualified CERA are yet make move to ERM roles. I urge all our fellow members to make an attempt to qualify CERA and penetrate into the role of Chief Risk Officer and lead to build up this area in all companies they work though dual roles are played by actuaries in many companies.

There are some opportunities for actuaries in the non-banking finance sector when recently, the RBI has issued circular to appoint a CRO in all such Institutions with more than ₹ 5000 Cr asset size in order to improve their standards of risk management. We need to work for taking such roles in the Banking sector as well in pursuance with RBI and the Government.

Working on the direction of wider areas, the 2nd Seminar on Banking, Finance and Investment was held on 22nd May 2019 attended by experts from different sectors than Insurance. One of the main attraction of the program was a round table moderated by me with panel speakers as **Mr. MP Baliga**, Senior Programme Director, CAFRAL, RBI, **Mr. Kuntal Sur**, Partner - Financial Risk and Regulation Leader, PWC, **Mr. G Srinivas**, CRO, ICICI Bank and **Mr. Raminder Singh Pal Bagri**, Deputy General Manager, Canara Bank.

Mr. MP Baliga mentioned that actuaries can play a crucial role in the risk management in banking given their knowledge and subjects. **Mr. Kuntal Sur**, said that they

already have a large team of Sr Actuarial analysts who have been working for the Indian Banking Industry. He was extremely happy with relevance of actuarial analyst with the banking work. Same was endorsed by **Mr. Srinivas**. He in fact asked IAI to help provide them assistance in hiring Actuarial resources.

I firmly believe that an Actuary is not an Actuary if he/she is only an Actuary. While we have many role models in insurance and Pension Industry we need more role models in banking and Risk management. We will continue to work in wider areas and creating more and more opportunities for actuarial resources. I must thank **Mr. SC Khuntia**, Chairman IRDAI, all council members, advisory group members and all volunteers for their support and motivation to take this journey forward.

The countdown for June 2019 examinations have already started. The new curriculum and practical examinations throws bigger challenge in view of changes in the syllabus content and modelling requirements in R and Excel. I conclude with sharing the famous quote by George S Patton who was the General of the US army who commanded Mediterranean theatre of World War II as "Accept the challenges so that you can feel the exhilaration of victory".

I look forward to support of all volunteers to grow the profession and take this profession to world of more and more opportunities.

With this I would like to sign off for now.

It was an eventful month with year end activities closing out, a conclusive election result followed by new government formation, and start of the Cricket World Cup among many others! The mention of cricket reminds me of the fact that the famous Duckworth Lewis method was developed by statistician Frank Duckworth and mathematician Tony Lewis. Statistics and mathematics are key skills of an actuary and this strengthens one's instinct that if actuaries are able to develop robust tools to address a real world dilemma using their specialized skills, there are numerous newer areas where actuaries will find a place, maybe even in the pages of history!

As a reporting actuary, it is easy to observe the increasing interest of financial institutions in lead reporting parameters over lag reporting, and rightly so. This is where data analytics and predictive modelling become increasingly important for actuaries of the future, and good skills for actuaries to encourage and develop to find relevance in varied businesses.

Meanwhile, it's heartening to see more than a few actuaries venturing into wider non-traditional areas in India - we will aim to bring their experiences and journey to you over the next few issues. This issue includes varied features on use of machine learning and digital medium, financial reinsurance, interest rate models and seminar reportages.

I would like to thank all members who are actively contributing to the magazine. Thank you for sharing



your perspectives and knowledge with the fraternity and other professionals.

We are looking to build an energetic editorial team for the Actuary India magazine that will be actively involved with exploring themes for the magazine, developing content, liaising with authors, putting together interviews of successful professionals among others. So whether you are a young student or an actuary with several years of experience who would enjoy being in the midst of such action, please email us with an expression of interest and brief profile. Please also continue to send in your articles and suggestions at library@actuariesindia.org.

Best wishes for all students appearing for examinations in June! See you next month.



Organised by: Advisory Group on IFRS 17 (IND AS 117)
Venue: The PIlazio Hotel, Gurugram **Date:** 10th May, 2019

Session : Methodology deep-dive: measurement approach for participating products

Speaker: Mr. Philip Jackson



Philip Jackson is a consultant in Milliman's life insurance consulting practice, based in Mumbai. He supports Milliman's projects in India and the Asia-Pacific region. Philip is one of the key members of the Milliman Asia IFRS 17 working group, focusing on with-profits products and the Variable Fee Approach (VFA) of measurement. He is also a member of the IFRS 17 group constituted by Institute of Actuaries of India (IAI).

Session Highlights

Philip discussed two key areas for participating products. The first area of discussion was around approaches available to treat participating products under IFRS 17 using either the General Measurement Model (GMM) approach or the Variable Fee Approach (VFA). The second area of discussion focused on the suitability of financial statements under IFRS 17 for par business, given current laws and regulations. Within the Indian insurance industry, as of now there is no consensus on the measurement approach to par products. The emergence of profits may not be smoothed under IFRS17 as compared to IFRS 4. Under VFA, the contractual service margin (CSM) is more volatile as compared to GMM due to unlocking, thus

leading to a lower level of volatility in the total comprehensive income. Due to this reason, the VFA approach is preferred in countries such as the UK. Although it is intuitively less clear what the 'variable fee' is in relation to par business, shareholder transfers could be considered to be variable fee earned. GMM or VFA approach could also be adopted basis the level of guarantees available in a product.

Definition of direct participation requires amongst other things, an identified pool of underlying assets and substantial fair value returns to be shared with par policyholders. IFRS 17 is not prescriptive about this while regulation may be specific about underlying assets and the return thereon, leading to ambiguity in financial statements. Moreover, the definition of fair value is also open to interpretation.

Mutualisation or risk sharing which aids in loss absorbency was also discussed.

Session : IFRS 17 cash flow illustration for a Non Participating Savings product - General Model approach

Speaker: Mr. Abhishek Chadha & Mr. Gaurav Taneja



Abhishek Chadha is Senior Consultant with the Insurance Consulting & Technology division of Willis Towers Watson India with close to 12 years of

experience of working in the life insurance sector. Abhishek has worked in a number of locations globally and has extensive experience of working on regulatory matters including supporting Appointed Actuary services and insurance regulators in various countries. He has also worked on Solvency II internal model development in the UK and peer review of statutory liabilities in India. In addition to this, he has significant experience of working on embedded value related projects including IPO, M&As and embedded value reviews in UK and India. He is currently involved in several IFRS 17 implementation projects, assisting companies through their transition journey.

Gaurav Taneja is senior manager at HDFC Life insurance. He is a Fellow member of the Institute and Faculty of Actuaries, UK. Gaurav has around 8 years of experience in diverse areas of Indian life insurance industry, including Economic capital, Asset Liability Management, statutory & shareholder reporting and modeling. He is currently part of the team working on implementation of IFRS 17 reporting and transition for HDFC Life Insurance.

Session Highlights

Abhishek provided some background on key concepts such as grouping of contracts under IFRS 17, onerous and non-onerous contracts and treatment of the same. He took the audience through a detailed example of calculations underlying a non-par savings product under IFRS17. Aspects of projection of cashflows, calculation of Contractual Service Margin (CSM) at inception and roll forward of CSM, as well as components of the P&L statement were discussed at length.

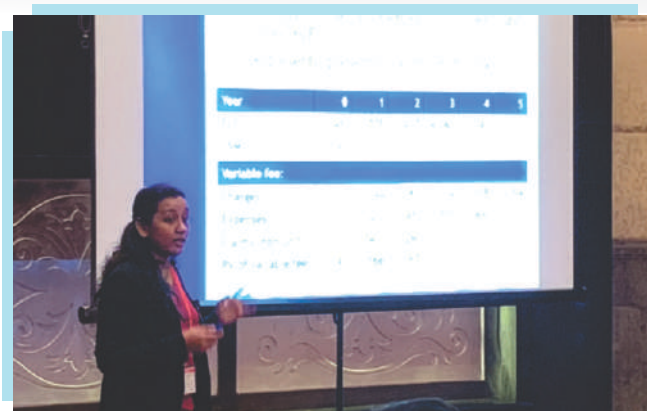
Gaurav continued discussion of the same product and delved into sensitivity of the P&L to various parameters and effect of actual and expected experience on the P&L statement.

Overall, the talk highlighted the aim of IFRS 17 to improve transparency in financial reporting by companies by recognizing profits as insurance service is delivered, to assess expected future profits from insurance contracts and to improve comparability amongst groups of insurance contracts and companies.

Session : IFRS 17 cash flow illustration for a Unit Linked product - Variable Fee approach

Speakers: Ms. Kruti Malde

Kruti Malde is nearly qualified actuary and student member of Institute of Actuaries of India (IAI) as well as



Institute and Faculty of Actuaries (IFoA), UK. She has been associated with ICICI Prudential Life Insurance Company for the last 5 years with experience in Prophet modelling, U.S. GAAP and IFRS reporting. Currently she is part of the IFRS 17 implementation project and also responsible for Ind AS pro forma quarterly submissions made to IRDAI. She is also a member of IFRS 17: CSM working party formed by the UK Institute.

Session Highlights

Kruti introduced the VFA and key differences between the GMM and VFA, as well as what constitutes a variable fee. She also discussed the key requirements of direct participation features (DPF) and how VFA applies to it. Kruti took the audience through the requirements for modelling a unit-linked product under the VFA. She described in detail the backing calculations for a non-onerous and onerous unit-linked product and explained the profit and loss (both insurance service result and net financial result) and balance sheet impacts for both categories of products. She explained the impact of financial risks and fair value changes on the CSM.

Session : Methodology deep-dive: Transition approach - Fair Value assessment

Speaker: Mr. Kshitij Sharma

Kshitij Sharma is a Partner with EY Actuarial Services LLP. He is a Fellow member of the Institute of Actuaries of India and the IFoA, UK. Kshitij has been an actuarial consultant for around 15 years and worked for a number insurance markets globally including India, UK, Continental Europe, Sri Lanka, Hong Kong, Singapore, Japan and the Middle-East. Kshitij has extensive experience in diverse areas of life insurance, including statutory and shareholder reporting, business planning, product development and pricing, actuarial modelling, risk management,



reinsurance and policy administration systems. He is actively involved in the Ind AS 117 implementation for multiple life insurers and has conducted numerous trainings and workshops on the same.

Session Highlights

Kshitij discussed permissible modifications to the fair value approach in the transition period. If sufficient information is not available at the inception date of a contract, then modifications around grouping of contracts (including grouping for periods exceeding annual periods), choice of discount rate and measurement model are permissible. The possible approaches to a fair value approach at the transition date range from a retrospective approach (complete data available) to a fair value approach (having no/less data availability), with a modified retrospective approach (partial data available) in between. These approaches differ in ease of implementation, level of judgement needed and level of CSM, amongst other things.

Kshitij suggested that IFRS 17 and IFRS 13 (fair value calculations) should be considered together. This is because IFRS 13 has a more detailed definition of fair value and provides a framework for measurement of the same. He also discussed practical issues involved in applying IFRS 13 to measure the fair value of insurance liabilities and the requirement for additional disclosures.

Session : Premium Allocation Approach Eligibility

Speaker: Mr. Sourav Roy

Sourav has over 12 years of experience in actuarial and finance areas. At present he is appointed actuary of Shriram General Insurance Company Limited. In his prior role, he was Director, Insurance Consulting and Technology Willis Towers Watson, India and worked on IFRS 17, reserving and financial modeling for general insurance companies.

Session Highlights

In his presentation, Sourav mentioned that IFRS 17 is not likely to have a major impact on the P&C industry. This is because many P&C contracts are short-term and reserved on unearned premium (UPR) basis. Furthermore, regulated business, such as Motor TP business in India, is not covered under IFRS 17.

UPR is broadly similar to a combination of CSM and fulfilment cashflows and is used to represent these under the Premium Allocation Approach (PAA). The PAA eligibility test needs to be satisfied before this method is used. However, GMM models would need to be maintained to check that the liability for remaining coverage (LFRC) is adequate and does not differ materially from the GMM in reasonable scenarios, as this is a requirement under the PAA test. Another reason for GMM models to be developed is that P&C long-term business would require GMM models.

There is also a larger requirement for disclosure of material elements under the PAA approach.

In summary, this session on IFRS 17 was very useful and participants appreciated the opportunity to interact and ask questions during the sessions.

Thank you!

Written by



Ms. Arundhati Ghoshal

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“Ms. Arundhati Ghoshal is Director (Actuarial Services) at MetLife Global Shared Services. She is a life actuary and has worked across life insurance and risk management in a number of companies in India and the UK.”

Organised by: Institute of Actuaries of India (IAI)

Venue: Ramada Gurgaon Central, Gurugram

Date: 17th May, 2019**Session : Education Curriculum 2019 & Exam techniques****Speakers:** Mr. Varun Gupta, Senior Vice President and Chief Products and Strategy Officer, DHFL Pramerica Life Insurance Company Limited and

Mr. Suresh Sindhi, Director-Actuarial Services, MetLife GOSC

**Session Highlights**

The session started with a discussion about the establishment of Institute of Actuaries of India, which is a statutory body which regulates the actuarial profession in India. Mr. Varun discussed that, to be fit for the actuarial profession, apart from liking maths one should also have the ability to solve problems, have business awareness and judgemental skills. Mr. Varun and Mr. Suresh then explained in detail the education curriculum 2019. In the old curriculum 15 papers had to be passed to become a Fellow of the Institute of Actuaries of India but the new curriculum necessitates clearing 13 papers, since a few of them have been clubbed, however the standard has not been diluted. The curriculum has also been revised to include the latest developments in the field of actuaries like Big Data, more focus on Risk, use of software R & Excel, etc.

Since specialisation is not necessary at the initial stages, subjects such as CT 4 and CT 6 which focus on different aspects have been combined to provide a more general

understanding of the field. Secondly, practical examinations have been added to give students a glimpse of real life application of their theoretical knowledge. This was continued with the discussion on how 'Excel' and 'R' are important in the actuarial world.

The session was followed with interactive questions and answers and discussion on exam techniques that students should and should not adopt and how to overcome the common mistakes.

Session : Opportunities in Insurance areas (Life, General, Health, Pension, Risk)**Speakers:** Mr. Puneet Sudan, Consultant, Paramount Consultants and

Ms. Saigeeta Bhargava, Associate Director and Lead - Actuarial Services, PwC India

**Session Highlights**

Mr. Puneet started the session by providing clarity about the actuarial profession and the areas in which actuaries work. He provided detailed information about General Insurance areas in which actuaries work, some of which are Pricing, Modelling, Reserving, Reinsurance optimization etc. He discussed why different companies charge different rates of premiums for the same coverage. He also briefed about the emerging opportunities which included new technology development products, age travel products

and insurance analytics: Consumer behaviour and Fraud detection.

Ms. Saigeeta continued the discussion around Life Insurance & Pensions. She initiated the discussion by providing insights on why there is a need of insurance and how the process takes place in the insurance industry. This is done by designing, pricing, regulatory filing, system setup, modelling and finally monitoring. She also discussed the risks in Life Insurance and emphasized that business reporting is a crucial element in this industry. The speaker further explained about consultancy as an area of work and how actuaries play an important role in this area. She concluded by highlighting that wherever there is an involvement of risk, actuaries are required and hence also the main function of actuaries is to manage the risks.

Session : Opportunity in Wider Areas (Data Science & Analytics, Banking, Finance & Investment)

Speaker: Mr. Khushwant Pahwa, Founder & Principal Consultant, KPAC



Session Highlights

The session kick started with a brief background of data science and the role of actuaries in the same. The discussion revolved around the importance of data science. He mentioned how things have evolved over time, computers have become powerful and data is readily available which has led to the emergence of data science. **Mr. Khushwant** gave brief insights into the role of actuaries in banking, finance and investments also. He emphasized on the fact that students should be confident and put more and more efforts in upgrading their soft skills and technical skills in programming software used in the industry like R, SAS, VBA, Python, MS Excel. He also mentioned that basic knowledge about insurance industry and to know about the challenges of this industry is an added advantage.

Session : Moving between Markets

Speaker: Akshay Dhand, Director - Actuarial & Products and Appointed Actuary, Canara HSBC Oriental Bank of Commerce Life Insurance Co. Ltd.



Session Highlights

The highlights of the session included the opportunity to move around with this profession, getting an actuarial job in another country, to consider before relocating abroad, the challenges that people face and how it is like to settle back in India. **Mr. Akshay** discussed how actuarial is truly a global profession and how the move can happen at all levels. He shared some videos of his friends to give the students an understanding on the experiences of different people after relocating abroad and the challenges those people face which include cultural differences, HR policies, regulatory regime etc. He also shared his personal experience and stated that the nature of actuarial profession allows its members to move between markets around the world which has its advantages and challenges and one should prepare for the same. Lastly, he stressed on the importance of conducting extensive research before taking the decision of shifting to a new environment.

Session : Cracking the recruitment and selection process

Speaker: Mr. Gautam Rao, Head- HR, Max Life Insurance Co. Ltd.

Session Highlights

Mr. Gautam conducted a highly motivational session and addressed the question of what organisations are looking for. In his discussions he referred to the quote "Education is just half the equation". He also discussed about Max Life Insurance company Ltd. He explained how students should not miss the opportunities of doing internships and gain experience and emphasized on the



quote “Content is King, Context is King Kong”. He added that the landscape of talent is changing and so the new

requirements of the market includes smart & simplified, more efficient & productive and result oriented resources. He guided the students and concluded that articulation is the key to catch the eye of recruiters and companies hire for attitude and train for skills, for which self-awareness is a must.

Written by



Ms. Ekjot Kaur



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“ Ms. Ekjot Kaur is a student actuary and currently working with Mazars LLP as an Actuarial Technician. ”

The Actuary India wishes many more years of healthy life to the fellow members (above 60) whose Birthday fall in June 2019

*Andrew Willis Cartwright
Dionys Emil Boeke
K Subrahmanyam
Liyaquat Khan
P A Balasubramanian
Richard Walter Leiser-banks
R Kannan*



ANNOUNCEMENT

6th Seminar on Enterprise Risk Management (ERM)

Organised by: Advisory Group on Risk Management

Venue: Hotel Sea Princess, Mumbai Date: 28th June, 2019 Time: 9:30am to 5pm

Introduction

The Institute of Actuaries of India (IAI) is pleased to announce scheduling of the 6th ERM Seminar. In the current business environment, which is marked by unprecedented pace of disruption and volatile capital markets, the importance of sound risk management cannot be over-emphasized.

The objective of this seminar is to progress the development of professionalism in risk management and provide thought leadership and insights to professionals and actuaries working in the area of Enterprise Risk Management.

We hope this seminar will help in bringing out the latest developments and best practices in the field of risk management to the forefront and will provide participants with practical perspective on implementation of sound risk management practices. This is not a typical theoretical download and expect to hear from the industry experts across a variety of critical areas!!

The Seminar would focus on the following topics:

With an intention to focus on practical aspects, while building on the theoretical frameworks, this Seminar will include the following sessions:

- ▲ **Deferred annuity** - Business opportunity and its risk management
 - Mr. Dinesh Pant, Appointed Actuary LIC
 - Another speaker from the industry (TBC)
- ▲ **Crop Insurance** - Business growth in the last 3 years and appropriate pricing in an uncertain market
 - Mr. Harini Kannan, Director P&C, Swiss Re
- ▲ **Credit risk** - What is a true AAA rated paper, learnings from experience?
 - Mr. Rajosik Banerjee, Partner and Head FRM, KPMG
 - Partner Risk, EY (TBC)
 - Industry expert / Independent Director (TBC)
- ▲ **Operational and Liquidity Risk** - Learnings from the banking world
 - Mr. Prateek Rastogi, Executive Vice President, Yes Bank
- ▲ **Risk Based Capital** - Regimes in Asia and lessons for India, including an update on RBC in India
 - Mr. Heerak Basu, Consulting Actuary and Shamit Gupta, Principal and Consulting Actuary, Milliman
- ▲ **Cyber security and cyber risk**
 - Mr. Mubin Shaikh, Cyber security specialist, Partner KPMG (Tentative)
- ▲ **Catastrophic Risk (General Insurance)** - Pricing and using Reinsurance for risk management
 - Ms. Jyoti Majumdar and Mr. Manish Singh, Willis Towers Watson
- ▲ **Role of Risk functions in strategic decision making** - Panel Discussion (TBD&C)

Who Should Attend?

1. Chief Risk Officers, Heads of ERM / FRM teams and Appointed Actuaries.
2. Professionals working in the financial services industry in particular in risk management, audit, compliance, strategy, finance, actuarial and underwriting departments.
3. Individuals interested in the field of Enterprise Risk Management in general.

Registration Fees (Excluding 18% GST)

Categories	Amount in INR
Students & Associate Members	3,500
Affiliate & Fellow Members	7,000
Non Members	7,500

Kindly select area of practice while registering for the seminar.

General Points:

- ☞ Registration Ends : 21st June, 2019
- ☞ Register at: <http://www.actuariesindia.org/SeminarRegistration.aspx>
- ☞ CPD Credit for IAI Members: 6 hrs Technical (Any one practice Area as per APS 9 - Rev. Ver 3).
- ☞ Point of Contact for any query: Ambreen Surve (Ambreen@actuariesindia.org)

Background

In the current era of high power computing, analytics is no longer restricted to structured data available in relational databases like tables. There is a need to analyse the unstructured data comprising of text, images, videos, audios which are getting generated through various sources thanks to the social media, cloud computing, Internet of Things and other modern technologies in order to take better informed decisions. Today many solutions of machine learning, image processing, text mining and other areas are based on this unstructured data which is generally High dimensional (More variables/features) in nature. The huge size of such a data poses different challenges for good analytics. For example, an image is a collection of pixels. Every pixel is a feature of the image. So if an analysis needs to be done on a 30x30 pixel image, 900 features one for each pixel need to be stored and analysed. Even a structured data analysis which uses hundreds of explanatory variables to predict an outcome comes under the high dimensional data.

Need for Feature selection

Number of attributes and number of samples based on which analytics is performed have significantly increased during the last couple of decades. Different learning methods tend to perform poorly and slowly because of this high dimensionality. Some common problems observed are

- **Over fitting** is observed in models where the features are very high relative to the number of samples used. It is found that the **curse of dimensionality** reduces the performance of many learning models. Along with that, computational time and resources also increase manifold.
- Many features may be **irrelevant, redundant and noisy** and including them will result in wastage of computing resources.
- Storage of such high dimensional data requires huge investment in infrastructure as well.

Reducing the dimensionality of the data and improving the learning accuracy in a reduced time with limited memory resources can be done using two major techniques

- **Feature Extraction** combines the original features and maps them into a feature space with lower dimensionality. Interpretation of new dimensions is

very difficult (E.g. Principal Component Analysis)

- **Feature Selection** retains a subset of variables from the original feature set without changing their dimensions. Understandability and Interpretability are in-tact.

Definition and Basic Concepts

Feature selection is a process of shortlisting a small subset of important and relevant features (Explanatory variables) from a high dimensional feature set using different techniques. The main objective of this mechanism is to ensure that the learning process becomes more accurate while at the same time the overheads with respect to time of execution and system memory are considerably reduced. It is also associated with the removal of irrelevant, redundant and noisy features during the pre-learning phase itself. Relevance of a feature needs to be evaluated from the perspective of its contribution to the classification process (Supervised learning) or clustering process (Unsupervised learning).

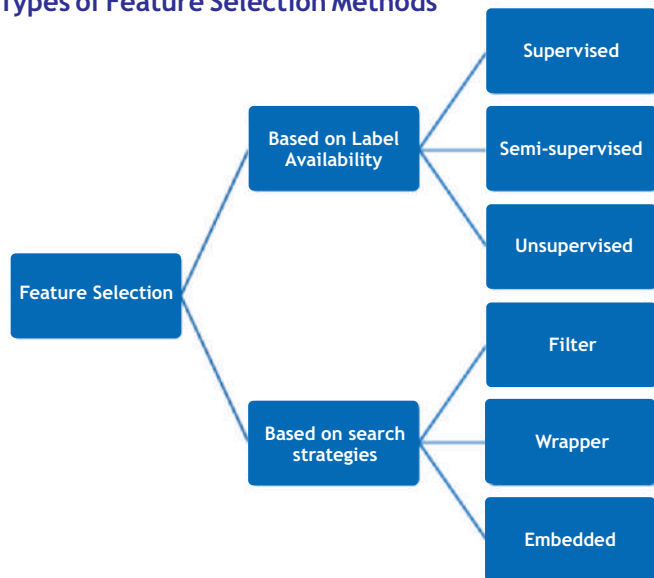
If an **irrelevant** feature is removed, there will not be any negative impact on the learning process, while in some cases there might be a positive impact because of reduced confusion. For e.g. if “Debt to Income ratio” and “Age of the borrower” are two features which are used in classifying a person as a defaulter or not, and suppose it is found that many defaulters have Debt to Income ratio of more than 10 and there is no specific age group that is more prevalent among the defaulters. In that case, “Debt to Income ratio” is a relevant feature whereas “Age of the borrower” is irrelevant and removing it will not impact the learning process.

Sometimes a feature may be relevant but may be **redundant** (Another existing feature is explaining the same phenomenon). Removing these features also will not impact the learning process. Especially when two features are strongly correlated, we can identify that one of them is redundant. It is better to remove them because they may not add any extra value to the classification/clustering process, rather they increase the computational time. Some features may be **noisy** because of the limitations in data capturing process which may confuse the learning model. Sometimes a few noisy features complement each other and improve the learning process, in which case they need not be removed.

Some of the use cases in insurance where feature selection can be deployed are given below

- Fraud detection using different demographic, behavioural and product specific attributes.
- Insolvency prediction using financial ratios
- Determining factors that contribute to the disparities in health care
- Identification of important rating factors in risk assessment
- Insurance scoring

Types of Feature Selection Methods



Based on availability of labels

Supervised Learning

- Generally used for classification models
- Algorithms select features based on their ability to distinguish samples across different classes.
- Evaluation methods like Information Gain, Gini Index are used to select the relevant features
- The shortlisted features along with the labels are used to train the classification model.

Unsupervised Learning

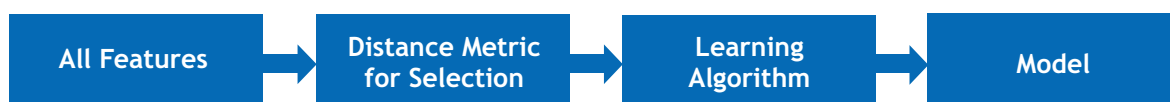
- Generally used for solutions which involve clustering (No Label)
- To identify the relevant features, the feature selection process first identifies different clusters in the data based on various clustering algorithms (K-Means, Hierarchical, Model based etc.). These clusters are labelled resulting in the conversion of

unsupervised learning model to a supervised one. Feature selection is done in the same way as it is for a labelled data.

- The above step is repeated until the desired result is reached.

Semi-Supervised Learning

- Generally used when only a small portion of data is labelled
- Cannot use supervised feature selection (Insufficient labels) or unsupervised selection (Cannot use labels)
- These methods take the advantage of both labelled and unlabelled data.
- Algorithms construct similarity matrix based on labelled as well as unlabelled data and select features that best fit the similarity matrix



- Selection of features is done based on characteristics of the data and not through learning algorithms
- Features are ranked based on different criteria like the capability to separate samples across different classes by evaluating the variance between and within the classes, the relationship between the features and the labels, relationship among the features etc.
- Top few highest ranked features will be selected for the learning process.
- Algorithm agnostic - This method ignores how the entire selected subset of features impact the overall learning algorithm (Some important features may be omitted because of this reason)

Wrapper



- Feature selection is done by considering the biases and heuristics of a specific learning algorithm
- Feature search creates an initial feature subset based on different search strategies (Hill climbing, Best first, branch and bound, Genetic algorithms etc.) which is evaluated by a pre-defined learning algorithm.

- The output of this algorithm is sent as an input to the feature search process for the next iteration of subset selection. This process repeats and the best performing subset is finalized and used for learning process
- Better predictive accuracy but are computational more expensive
- Different learning algorithms like Naïve Bayes, K-Nearest Neighbours, CART based decision trees, Support vector machines, Back-propagation based neural networks can be used.

Embedded

- Best of both worlds: Feature selection is embedded into the learning models (Less time than wrappers to execute)
- Features are selected during the model construction process and not as a separate evaluation exercise.

Different Types of Features

Static Features

- We know the features in advance
- They may be independent or exhibit some structures like trees, graphs etc.
- Understanding these structures can improve the learning process and thus the feature selection process significantly

Streaming Features

- New features are created dynamically based on the new data that is passed to the algorithms.
- Designing feature selection algorithms to select these features is a big difficulty.

Different Evaluation criteria considered

1. Bayesian Error Rate $E(S) = \sum_{c \in P} (S) (1 - \max_i (p(c_i|S)))$
where c_i consists of all possible classes and S is the feature of interest
2. Euclidean Distance between two features a and b :
 $d(a;b) = \sqrt{\sum (a_i - b_i)^2}$
3. Correlation coefficient between two features a and b .
 $r(a,b) = \frac{\text{Covariance}(a,b)}{SD(a) * SD(b)}$
where SD stands for standard deviation
4. Mutual Information between two features a and b :
 $I(a;b) = \sum_a \sum_b p(ab) * \log \left(\frac{p(ab)}{p(a)*p(b)} \right)$
where $p(.)$ constitutes the probability density function
5. Information Distance between a and b :
 $d(a,b) = \frac{H(a|b) + H(b|a)}{2}$
where $H(a|b)$ is the conditional entropy of a given b .

6. Other advanced Methods like Laplacian score, Fisher score etc.

Some state of the art feature selection methods

These techniques are either filter based or wrapper based and they are available as a part of software packages like R.

- Relief F
- Information Gain
- mRMR
- JMI
- SVM-RFE

Current challenges in Feature selection

- Scalability Issue: Large data cannot be loaded completely into memory but the current feature selection algorithms need the entire high dimensional data to be loaded. Feature selection score cannot be used without evaluating the density around each sample.
- Algorithms which provide high accuracy and stability in feature selection process need to be developed.
- Current Feature selection algorithms cannot determine the optimal number of features required for the dataset. They rather depend on the user's input of number of features to be selected. Too small and too large both have their disadvantages. If grid search is performed to try different combinations to extract the optimal number, it becomes computationally intensive and expensive.
- Even identifying the number of clusters in unsupervised feature selection scenarios is also a cause of concern that needs to be addressed.

Conclusion

Feature selection is one of the essential processes in effective machine learning. Identifying the right techniques through proper understanding of the data and features can lead to improved accuracy of the deployed machine learning models at a reduced computational overhead.

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Introduction

Digital world has greatly empowered the customer who has become more discerning than before. Intensifying competition in the market place has resulted in marketers using various strategies to win over the customer's trust. Yet the truth is that customers have more trust in fellow customers than the business organization from whom they procure goods and services. We are living in a world where "feedback" about products and services on digital media has significantly influenced buyer behavior.

Businesses vie with one another to track customers so that they can land a greater share of the customer's wallet. Digital marketing tactics (attract, engage, convert, close and delight customers) have now become ingrained as part of the business ecosystem. Businesses have to present themselves to customers where they are. "Pull" marketing is the in-thing today.

Digital tracking has also raised concerns about privacy of customers. In US, consumers revolted against attempts by businesses to use data mining techniques to invade their private lives for their own interests. The good thing is that there is greater awareness about these techniques and customers strive to become vigilant to protect their interests.

What is digital tracking?

Today it has become imperative for organisations to reach out to customers across multiple channels. Customers expect a seamless experience as they move from one channel to another. A customer may wish to buy a laptop online. But if not satisfied with the array of offers online, nothing can stop the customer from visiting a "brick and mortar" outlet to get a feel about the product.

Digital tracking is close scrutiny of behavioral aspects of customers so that businesses can target specific offers to customers based on their preferences. This enables them to influence buyer behavior to buy their products. Three objectives characterize digital tracking

- Deliver an enriching experience for customers
- Use this experience to grow the customer base
- Scale the business

We are going to discuss the use of cookies in this article.

Cookies

A cookie is a small text file that is dropped by a website server on a user's computer at the internet browser level (Google Chrome, Mozilla Firefox, Internet Explorer, Safari etc.). Cookies are stored as text files on the hard drive of your computer. Whenever you return to a website that you accessed before, the cookies are automatically sent by the browser so that the website recognizes your computer and tailors your online experience accordingly. As we visit different websites, we end up collecting as many cookies.

Akin to a restaurant waiter who recognizes you as a loyal customer and knows your preferences well, cookies store information about you. Cookies are intended to save the customer's time and make the browsing experience as smooth as possible. Search engines and websites (e-commerce sites in particular) use cookies to remember your preferences. Shopping cart in Amazon and Flipkart gets filled with the items that you select thanks to the use of cookies.

The information in the cookie file travels back and forth between the browser it is stored on and the websites you visit.

Types of cookies

There are three types of cookies. First party cookies are created by the websites a user visits. Third party cookies are the same small text files but these travel between the browser and the website of the company that is displaying ads on the page that you are visiting. If you are visiting the website of timesofindia.com, the cookies created are first party cookies. If you are visiting the website of timesofindia.com and there is a display ad of "Myntra" and you end up clicking the ad, the cookie is a third party cookie that travels between your browser and the website of Myntra.

Research has revealed that most people spend 10% of time on search engines and 90% of time on browsing. Therefore, advertising companies use third party cookies to keep track of the number of customers who clicked that ad. Thus, the advertisers are delivered to match the customer's browsing habits. These cookies can enable an advertiser to track the effectiveness of the ad campaign.

Advertisers are now dismayed about ad-blockers that

can be used by customers to prohibit cookies from accessing their personal information. Customers can also go to their computer settings and clean out the cookie files. The one complaint about cookies is that they reduce the computing speed.

The third type of cookies is flash cookies. A flash cookie is a text file sent by a web server to a client when the browser requests content supported by Adobe flash, a browser plug-in. Flash cookies are used by Google Chrome, You Tube and advertisers who use videos to promote their products and services. Flash cookies personalize the customer's experience. They can hold 100 kb data while the other two cookies can store 4 kb. Flash cookies must be cleared via Adobe flash player settings.

What cookies cannot do

While no shopping carts are possible without cookies, a cookie cannot track across devices. With more and more consumers shopping using their smart phones, the power of cookies has somewhat diminished. Customers can opt-out of being tracked by cookies. On the mobile web,

cookies reset every time users close their browser. Cookies cannot be shared across different apps. So, brands and advertisers see the same customer as three different customers and here lies the problem.

How to solve this dilemma

The problem faced by advertisers with regard to the reduced power of cookies on smart phones has led to a concept called cross-device identity tracking. Cross device tracking is also called as people-based analytics. There are privacy issues associated with cross device tracking too; but this method enables marketers to target tailored offers to customers who are becoming more fastidious than ever.

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Asian Age, 28 May 2019; Mumbai, Delhi, Kolkata, London edition
<http://onlinepaper.asianage.com/article/detailpage.aspx?id=13084104>

No. of actuaries to touch 480 in FY19

MADHUSUDAN SAHOO
NEW DELHI, MAY 27

The tiny population of actuaries, who help in the measurement and management of risks in the insurance and pension sectors, is creeping up in the country's financial sector. The Institute of Actuaries of India (IAI) estimates that the number of qualified actuaries will reach 480 by this fiscal-end, from 439 now. This is a significant jump, considering that India had only 120 actuaries in the year 2000.

"We have got students pursuing actuarial courses from across the country at the moment and we hope

that there will be 480 qualified actuaries by the end of the current fiscal," said Sunil Sharma, President, IAI.

The IAI was formed in 2006, and thereafter it became a statutory body under an Act of Parliament, on the lines of ICAI, ICSI and ICWAI. The IAI conducts exams for actuaries. It also trains actuaries.

In India, though actuaries are mostly engaged in the insurance and pension sectors, their services are sought in banking, risk management and investment banking. Sharma said the IAI has mutual recognition agreements (MRA) with its coun-



terparts in three countries: the Institute & Faculty of Actuaries (IFO) in the UK, the Institute of Actuaries in Australia, and the Casualty & Actuarial Society of America. By this, actuaries qualified in India can practise in those three countries and vice versa.

Sharma said now that banks have to comply with

Basel-III and Solvency-II norms, the new breed of actuaries can be of much help to them.

"However, the problem was that there was not an effective single financial regulator in the country like the Monetary Authority of Singapore or the Bank of Negara (Malaysia). Once this happens, it will pave the way for absorption of actuaries in various other financial sectors like banking, risk management, investment banking and risk-based capital," Sharma said.

India's financial sector is under various regulators like the RBI, SEBI and the IRDAI.

It has been an extremely busy few months for members involved in actuarial valuations for employee benefits. During that time members may have missed a Gazette notification published by the Central Government, in consultation with the National Financial Reporting Authority, that made some amendments to the Companies (Indian Accounting Standards) Rules, 2015. These are the rules for the INDAS reporting.

Specifically, Section VI of the Notification refers to amendments to Ind AS19 which the accounting standard for Accounting for Employee Benefits. **The amendments are effective for accounting periods that begin on or after 1 April 2019.** The updates cover clarifications related to when a plan amendment, curtailment or settlement occurs.

Below is a brief summary.

- A. Paragraph 99 dealing with “Past service cost and gains and losses on settlement” has been updated to clarify that one should be measuring the impacts of such events using Fair value of assets, market interest rates and actuarial assumptions as at the time of the event.
- B. Paragraph 101A has been added explicitly confirming that the asset ceiling should not be considered when measuring the cost impact of any plan amendment, curtailment or settlement event. Any asset ceiling should be considered after the recognition of cost related to the event.
- C. Paragraph 122A has been added to clarify that current service cost is measured using start of the year actuarial assumptions. However, in circumstances where there is a past service cost or gains and loss on

curtailment/settlement, the remaining period's service cost should be calculated using the actuarial assumptions used to remeasure the net liability/asset for the said event.

- D. Paragraph 123 for the calculation of net interest cost on the net liability/asset has been expanded to make it consistent to the added paragraph 122A; in that the interest cost for the remaining period should be updated and recalculated to reflect the change in the net liability/asset, post any plan amendment, curtailment or settlement. Specifically to use the discount rate at the time the net liability/asset is remeasured.
- E. In line with the above updates a couple of further paragraphs have been updated to incorporate the same principle in the situation of a plan amendment, curtailment or settlement event. #125 in terms of clarity on interest on plan assets and #126 for the applicability of the asset ceiling.

Commentary: Actuaries should make it clear to clients that they will need to recalculate net liability/assets and projected P&Ls due to change in service costs and interest costs for remaining periods. Ideally this should be done at the time of the amendment/event and so there may be out of cycle valuations from actuaries required in such circumstances. Even though they may or may not be a similar amendment for AS15 (Revised) we suggest the principle be also adopted for any AS15 (Revised) valuations as well.

The full text of the Notification can be found at http://www.mca.gov.in/Ministry/pdf/RuleIndAsSecondEng_30032019.pdf

NOTICE

ANNUAL MEMBERSHIP FEE 2019-20

Annual Membership Fee for the year 2019-20 is due on 1st April 2019 and the last date for payment is 30th June 2019. In case, you have not paid your Annual Membership fees, request you to pay the same on or before 30th June 2019, failing which your membership will lapse.

The current membership fees are as under:

Class of Membership	Fees in Indian Rupees (INRs.)
Fellows and Affiliates	9,000+(18% GST) = 10,620
Associates	3,000+(18% GST) = 3,540
Students	2,000

For payment and other details, visit our website at www.actuariesindia.org or contact Ms. Prajakta Bhosle at actsoc@actuariesindia.org or at 022-62433333.

1. Introduction and Background

Reinsurance is an arrangement between an insurer and a reinsurer, by which the insurer transfers a proportion of the risk to a reinsurance company in exchange of a payment called the reinsurance premium. The exact terms and conditions including the extent of risk transfer are defined in the reinsurance treaty. The objective of reinsurance is to hedge the risk with an aim to protect the insurer from large losses, increase the capacity of the insurer to write large amount of insurance, stabilization of financial results, receive technical expertise etc. A reinsurance arrangement can also be designed to receive financial assistance from the reinsurer by the insurer under an arrangement commonly known as “Financial Reinsurance”.

1.1 Financial Re-insurance: Financial Reinsurance can be described as risk transfer to reinsurer with an objective to generate favorable financial impact on the balance sheet/financials of the company in addition to the usual benefits of reinsurance. The design of the Financial Reinsurance is shaped to enable the insurance company to manage its capital & financial earning by transferring a portion of future profits and risk to the reinsurers in exchange of a lump sum payment whose repayment is conditioned on future profit emergence under that portfolio of policies.

1.2 Objective of Fin-Reinsurance: In addition to risk transfer one of the overarching aim of financial reinsurance is to capitalize the future profits to the insurers, strengthening its current financials and the solvency enabling it to;

- write greater volume of business
- to reduce the capital injection required by the shareholders.
- increase the capacity to pay dividends.
- enhance the creditworthiness of the company to raise further capital

In addition to the above factors Financial Re-insurance allows the company to raise capital in a cost effective way with the repayment being conditioned on the

emergence of future profits from the portfolio. A tailored Fin-Reinsurance contract between the insurer and the reinsurer renders great deal of flexibility and possible savings in term of operational cost associated with raising the capital from alternative sources.

1.3 Common Types of Financial Reinsurance: There are a range of possible financial reinsurance structures such as “Deficit Account”, “Virtual capital” etc. In this paper, the aim is to bring out the benefits/ impact of a simple fin-re arrangement on the balance sheet/financials of the insurers.

2. Regulatory Developments in India

In Dec-2018, the Insurance Regulatory and Development authority of India (IRDAI) came up with Reinsurance regulations, allowing Financial Re-insurance/ Alternative Risk Transfer amongst other key changes. This regulatory development is likely to have far reaching consequences in the solvency and capital management landscape of the Indian Insurance industry.

As per the Regulations, the insurer intending to avail Financial Re insurance/Alternative Risk Transfer needs to submit the proposal to the authority, which may allow the programme after necessary examination. The insurers may therefore; develop their fin-reinsurance programme with an aim to optimize the impact on the financials, subject to the regulatory approval.

This paper aims to explore the impact of the financial reinsurance on the statutory and the risk based balance sheet, and to throw light on a few related areas to assess the impact of financial reinsurance in a comprehensive way.

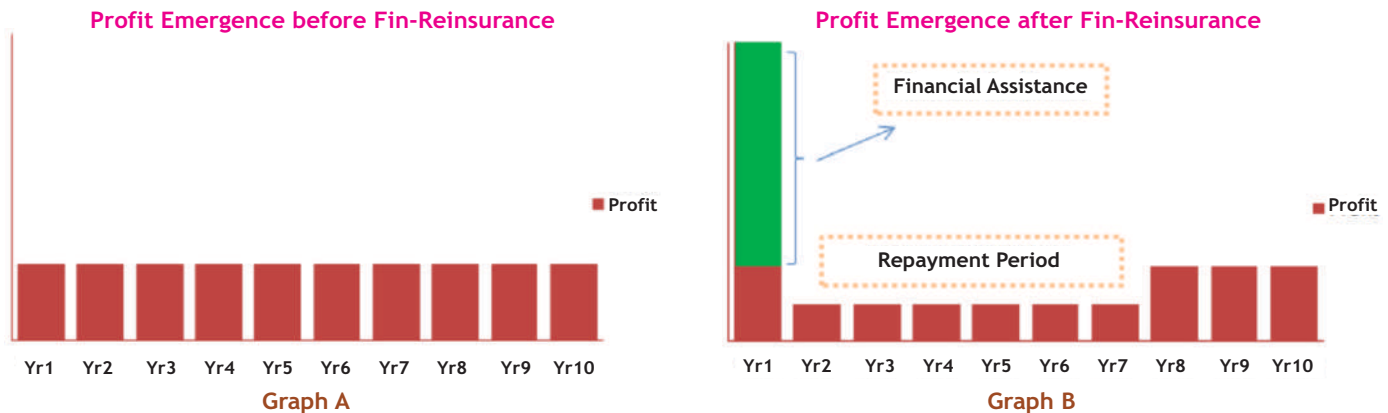
3. Financial Reinsurance Schedule

As mentioned earlier, reinsurance regulations allow the insurance companies to design their own financial reinsurance programme, in this context one of the possible financial reinsurance structure could be as follows;

Category	Details
Financial Reinsurance Scope	A Part of the In-force Business, for e.g. Non-Linked Non-Participating or any other full or part of the business portfolio.
Initial Commission (Extent of Financial Assistance via Fin Re)	Normally 50% to 70% of the Value of in Force business (VIF) of relevant business. VIF would be calculated as Present Value of future non-participating profits post allowance for risk and tax (if applicable).

Category	Details
	The assumptions used for future profit projections for the determination of the VIF will be agreed between the insurer and reinsurer.
Quota Share	For the Financial Reinsurance arrangement it represents the percentage of the profits being used to return the Financial assistance/Initial Commission. For e.g. 50% Quota share would imply 50% of the profit emerging shall be used for the payment.
Term of Repayment	Might be based on DMT of the Liabilities or any such measure, For e.g. DMT Less 5 Years or up-to full repayment run-off.
Cost of Financial Reinsurance	10 year Swap Rate + Risk Premium Exact format need to be agreed between both the parties
Risk Review	Reinsurer shall reserve the right to review the Market (Asset quality) and Life Risk to ensure that the future profit emergence is in line with projections made at the time of Quota share development.

4. Profit Emergence- before and after Reinsurance



As displayed in the graphs above, Financial Reinsurance results in acceleration of profit to the insurer, i.e. a percentage of future profits are exchanged in return for an immediate financial assistance. The reinsurer would also charge for the financial assistance/initial payment and hence the reduction in future profits would also include a loading for the cost of financial reinsurance. For the sake of simplicity the above example assumes that the profit emergence (before reinsurance) is level. In reality, however, for an existing business portfolio with no new business addition, the profit emergence is likely to be a decreasing curve broadly due to reduction of in-force book by way of decrements such as Lapse, Maturity etc.

5. Fin-Re-insurance-Impact on the Statutory Balance Sheet

The charts below show the impact of Financial Reinsurance on the statutory balance sheet as illustrated under value transfer mechanism.



A brief description of impact of Financial Reinsurance on the statutory balance sheet and Embedded Value (and its components) is contained in the table below;

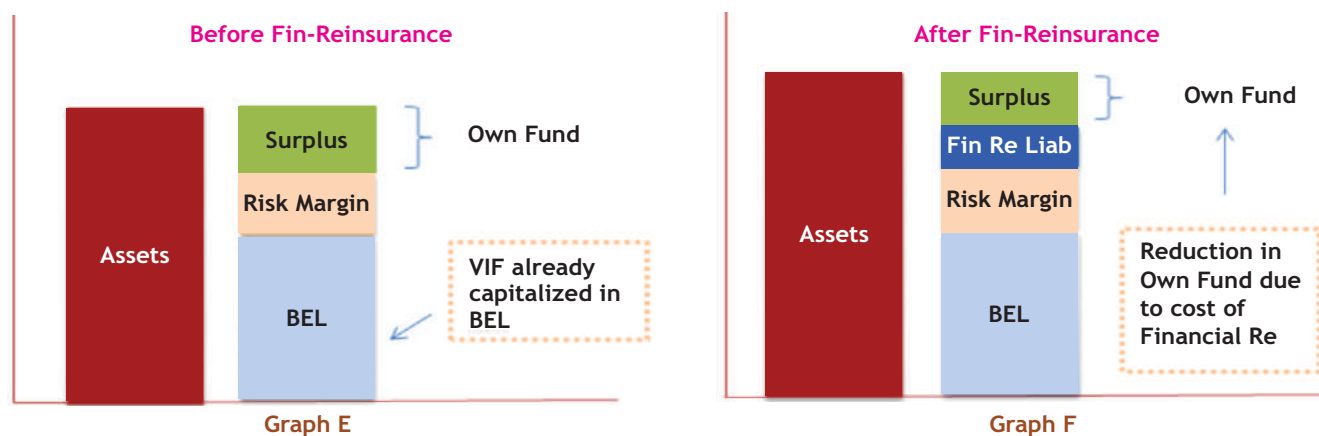
Category	Details
Statutory Liabilities	No Change; since Financial Reinsurance is unlikely to impact the cashflows underlying the statutory liabilities. There might be a change in the valuation interest rate depending on where Financial assistance received is invested; however in the above example no such change is assumed.
Asset	No change in the asset backing statutory liabilities
Net Worth	There shall be an increase in the Net Worth due to capitalization of VIF, i.e. the future profits. Effectively there is a movement of capital from VIF to Net Worth resulting in an increase in Net Worth.
VIF	Decrease in VIF due to following factors; • Capitalization of future profits to increase Net Worth. • Reduction in VIF due to transfer of Profits to Reinsurer as cost of financial assistance.
Embedded Value	Everything else remaining the same the Embedded Value of the company is likely to reduce on account of transfer of Profits to Reinsurer as cost of financial assistance. However the actual impact on the EV of the company would also depend on the Fin Re deal terms vis a vis EV assumptions. A good deal with a favorable impact on the risk and capital management may increase the EV of the company. Such an increase is likely to flow through the Net Worth.

6. Fin-Re-insurance: Impact on the Economic Balance Sheet

The economic balance sheet captures the market consistent value of assets and liabilities, with an aim to represent a risk based view of the assets and liabilities. While the assets are recorded at the quoted market price (fair value if market value is not available) the liabilities or technical provisions are calculated in a manner that represents the amount that life insurer will have to pay to transfer its obligations to another insurer in an immediate manner. Since a deep, liquid and efficient market is not available for liabilities, technical provisions are calculated as a sum of Best Estimate Liability (BEL) and Risk Margin where BEL is probability weighted present value of best estimate cashflows discounted using a risk free curve and risk margin is an additional amount to be paid to the buyer as a compensation for possible adverse deviation from the best estimate assumptions.

Solvency capital required (SCR) represents the economic or risk based capital required to support the applicable risk that may impact the solvency and profitability of the company. It is calculated as the change in the surplus (asset less liability) following value at risk based shock.

The graphs below represent a simplistic view of the impact of financial reinsurance on the economic balance sheet.



In case of economic balance sheet, while there are sources of future profit generation (release of risk margin, release of TVOG etc.) yet since most of the VIF is already capitalized in the BEL ,there might be a requirement to recognize repayment liability on the liability side of the balance sheet (as shown in Graph F). With this background the impact on some of components of the Sol II Balance sheet shall be as follows;

The table below aims to capture the immediate impact of financial re-insurance on technical provision & economic capital (SCR) requirement.

Category	Details								
Best Estimate Liability	No Change; since Financial Reinsurance is unlikely to impact the cashflows underlying the best estimate liabilities and the risk free discount rate. There might be a change in the RFR if there is volatility or mismatch adjustment in the RFR, because the value of these adjustment might change depending on where financial assistance received is invested; however in the above example it is assumed that these adjustments are not applicable.								
SCR: Life Underwriting Risk	No Change; since the underwriting risk profile in not likely to change due to Fin Re and no allowance is made for change in volatility or mismatch adjustment.								
SCR: Market Risk	Is likely to change depending upon the investment profile of Financial assistance received for e.g. <table border="1"> <tr> <td>Interest Rate</td><td>May increase/decrease subject to contribution of new investment to ALM position of company.</td></tr> <tr> <td>Spread Risk</td><td>May increase if the new investment is in securities that carry credit risk (for e.g. Corporate Bonds)</td></tr> <tr> <td>Concentration</td><td>May increase/decrease if the new investment is in existing/new counterparties</td></tr> <tr> <td>Equity Risk</td><td>May increase if the new investment is in equities</td></tr> </table> An increase in the Market SCR will result in an increase in overall SCR.	Interest Rate	May increase/decrease subject to contribution of new investment to ALM position of company.	Spread Risk	May increase if the new investment is in securities that carry credit risk (for e.g. Corporate Bonds)	Concentration	May increase/decrease if the new investment is in existing/new counterparties	Equity Risk	May increase if the new investment is in equities
Interest Rate	May increase/decrease subject to contribution of new investment to ALM position of company.								
Spread Risk	May increase if the new investment is in securities that carry credit risk (for e.g. Corporate Bonds)								
Concentration	May increase/decrease if the new investment is in existing/new counterparties								
Equity Risk	May increase if the new investment is in equities								
Risk Margin	No change, as there is no change in Life Underwriting Risk, BEL and RFRs (assuming no non-hedgeable market risk is present)								
Surplus	As mentioned earlier there might be a need to provision for the Fin Re liability and such a provision is likely to be higher than the assistance received on account of the cost attached with it therefore the surplus may reduce post fin reinsurance.								

7. Fin-Reinsurance Challenges in India;

Some of the key challenge areas that may impact the financial re-insurance structure for the insurer and reinsurer could be as follows;

Regulatory Clearance: Fin-Re-insurance has only recently been allowed by the Indian regulator(IRDAI). There is no precedence to the regulatory scrutiny and other requirements that could be sought before a regulatory clearance can be obtained. The regulator amongst other areas might want to assess;

- The financial position of the company including statutory reserves before and after the financial reinsurance.
- Proposed use of the capital to be raised by way of Financial Re-insurance.

- The need - why financial reinsurance being preferred over other sources of capital.

Stability of Profit emergence: Financial-Reinsurance is based on capitalizing/accelerating the future profits and therefore it is important that the reinsured portfolio is of reasonable vintage with stable stream of profits. This is not only important for the reinsurer to be able to value the contract and estimate the risk premium but also is crucial for the insurer to be able to pay back the financial assistance in a regular way.

Contract design factors: There are a variety of factors which need to be agreed between the insurer and reinsurer in the context of financial reinsurance. Amongst other things the determination of the volume of financial assistance and the mechanism of payback are likely to be key factors in the contract designs.

Some of the key questions that need to be addressed would be around the treatment of adverse experience variance.

Risk Appetite of the Reinsurer: Risk appetite or the capacity of the reinsurer to provide capital assistance might be limited. Additionally past experience on profit emergence might be limited for the reinsurers to assess the risk adequately. Therefore Reinsurers are likely to do a feasibility assessment in offering the Financial-Reinsurance terms.

Tax treatment: Tax treatment of financial reinsurance is an important issue with a need for greater clarity on all aspects clarity so as to avoid any undesired

outcomes. The key question in this case might be the income tax and GST treatment of the financial assistance received. Therefore detailed opinion of tax matter experts might be required on the tax treatment of Financial Re-insurance.

In summary Financial Reinsurance provides an insurer with a unique opportunity of raising cost efficient capital using the future profit emergence with favorable impact on the company's financials. However a lot of aspects pertaining to contract design, risk transfer, accounting and tax treatment etc. need to be explored in a proper manner for a smooth development of financial reinsurance as an effective tool for risk transfer and capital management.

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We continue our series on Interest Rate Models from our previous discussion (which appeared in the Oct-Nov 2018 of the Actuary India), by moving from the basic foundation to Short rates models. One of the well known Short rates model is the Vasicek model. Vasicek model assumes that the instantaneous spot rates under the real world measure evolve as an Ornstein-Uhlenbeck process with constant coefficient. It is an endogenous term-structure models, meaning that the current term structure of rates is an output rather than an input of the model. The generalized diffusion process for one factor short rate model under risk neutral measure is represented by,

$$dr = (\eta - \gamma r)dt + \sqrt{\alpha r + \beta} dW \quad \text{----- 2.1}$$

The Vasicek model is represented by,

$$dr_t = (\eta - \gamma r_t)dt + \sqrt{\beta} dW_t \quad \text{----- 2.2}$$

Simplifying further,

$$dr_t = \gamma(\theta - r_t)dt + \sigma dW_t \quad \text{----- 2.2.1}$$

$\frac{\eta}{\gamma}$ - Mean reverting interest rate level, theta θ

γ - Mean reversion rate, kappa

β - Variance of the diffusion process

σ - Volatility of the diffusion process

It is also an equilibrium short rate interest model. Equilibrium models usually start with assumptions about economic variables (eg mean reversion, constant volatility) and derive a process for a particular interest rate, such as the short rate. The model can then be used to price products that can be expressed in terms of this interest rate. It is a time homogenous model where the parameter is constant and independent of time. The basic model is one factor with one source of randomness. It assumes that the short rate follows a Markov process. As a consequence filter, F is equivalent to conditioning on the current value of the short rate.

The most important feature of Vasicek model is the mean reversion, which means that if the interest rate is bigger than the long run mean ($r > \theta$), then the coefficient γ (> 0) makes the drift negative so that the rate will be pulled down in the direction of θ . Similarly, if the interest rate is smaller than the long run mean ($r < \theta$), then the coefficient γ (> 0) makes the drift positive so that the rate will be pulled up in the direction of θ . There are also compelling economic arguments in favor of mean reversion. When the rates are high, the economy tends to slow down and borrowers require fewer funds. Furthermore, the rates pull back to its equilibrium value and the rates decline. On the contrary when the rates are

low, there tends to be high demand for funds on the part of the borrowers and rates tend to increase. This feature is particularly attractive because without it, interest rates could drift permanently upward the way stock prices do and this is simply not observed in practice.

Vasicek model is still popular because of their tractability and their closed form solutions for various interest rate derivatives. For a suitable choice of the market price of risk, this is equivalent to assume that r follows an Ornstein-Uhlenbeck process with constant coefficient under the risk-neutral measure as well that is under Q .

Closed form solution:

We now solve the partial differential equation using integrating factor to get the closed form solution. The detailed derivation is shared as annexure @ <https://github.com/mail2rajc/Actuary.git> We show here the result.

Spot rate under Vasicek model is given by,

$$r_T = r_t e^{-\gamma(T-t)} + \frac{\eta}{\gamma} [1 - e^{-\gamma(T-t)}] + \sigma \int_t^T e^{-\gamma(T-u)} dW_u \quad \text{----- 2.3}$$

The above equation represents the closed form solution for spot rate at time "T" given information at time "t". By considering the Brownian motion properties the distribution of the spot rate is normal and the expectation and variance is given below under risk neutral probability measure.

$$E(r_T)|_t = r_t e^{-\gamma(T-t)} + \frac{\eta}{\gamma} [1 - e^{-\gamma(T-t)}] \quad \text{----- 2.4}$$

$$\text{var}(r_T) = \frac{\sigma^2}{2\gamma} [1 - e^{-2\gamma(T-t)}] \quad \text{----- 2.5}$$

Limiting value of interest rate under Vasicek model:

As T tends to infinity, the expected rate and variance converge to,

$$E(r_T)|_t \rightarrow \frac{\eta}{\gamma} \rightarrow \theta \quad \text{----- 2.6}$$

$$\text{var}(r_T)|_t \rightarrow \frac{\sigma^2}{2\gamma} \quad \text{----- 2.7}$$

So when the mean reversion speed is increased the long run mean remains unaffected but the variance decreases and the time to revert to the long run mean decreases. Hence mean reversion speed is important for derivatives which are dependent on the volatility of interest rate such as derivatives having option features.

Affine model:

Diffusion process which can be expressed in the form of equation 2.1,

$$dr = (\eta - \gamma r)dt + \sqrt{\alpha r + \beta} dW$$

Are called affine models, as for such models the zero coupon bond price can be expressed in the form.

$$Z(r, T) = e^{(A(t, T) - rB(t, T))} \quad \text{----- 2.8}$$

For Vasicek model we have:

$$B(t, T) = \frac{1}{\gamma} (1 - e^{-\gamma(T-t)}) \quad \text{----- 2.9}$$

$$A(t, T) = \frac{1}{\gamma^2} (B(t, T) - T + t) \left(\eta\gamma - \frac{\beta}{2} \right) - \frac{\beta * B(t, T)^2}{4\gamma}$$

$$A(t, T) = \frac{1}{\gamma^2} (B(t, T) - T + t) \left(\theta\gamma^2 - \frac{\beta}{2} \right) - \frac{\beta * B(t, T)^2}{4\gamma}$$

$$\text{In term of theta } \beta = \sigma^2 \quad \text{----- 2.10}$$

Calibration of Vasicek model parameters:

$$dr_t = \gamma(\theta - r_t)dt + \sigma dW_t$$

We can calibrate the parameters of the diffusion process using the historical spot rate data observed in the market. We cover here two approaches for calibration of parameters by using the BoE data as covered in our earlier foundation series.

Using MLE:

In MLE we search for the parameter values of the underlying model, such that the observed samples are most likely generated by the fitted model. We use the distribution of r_t with the mean and standard deviation found in equation 2.4 and 2.5.

$$f(r_{t+\delta t} | r_t, \theta, \gamma, \sigma) = \frac{1}{\sqrt{2\pi\tilde{\sigma}^2\delta t}} \exp\left(-\frac{(r_t - \tilde{\mu})^2}{2\tilde{\sigma}^2\delta t}\right) \quad \text{----- 2.11}$$

$$\tilde{\mu} = r_t e^{-\gamma(T-t)} + \frac{\eta}{\gamma} [1 - e^{-\gamma(T-t)}]$$

$$\tilde{\sigma}^2 = \frac{\sigma^2}{2\gamma} [1 - e^{-2\gamma(T-t)}]$$

$$L = \ln\left(\prod_{i=1}^n f(r_i | r_{i-1}, \theta, \gamma, \sigma)\right) \quad \text{----- 2.12}$$

Parameter estimated by maximizing the likelihood function 2.12 and the results are given below:

Kappa	Theta	Sigma
0.262364	0.060447	0.004501

Using OLS:

Vasicek model is equivalent to a first order autoregressive

AR (1) model hence we can also use ordinary least square method by reducing the diffusion process into a linear form and then determining the coefficients. The relation between consecutive day's spot rates can be expressed with an i.i.d normal random term,

$$r_t = ar_{t-1} + b + \epsilon \quad \text{Comparing with equation 2.4}$$

$$r_T = r_t e^{-\gamma(T-t)} + \theta [1 - e^{-\gamma(T-t)}] + \sigma \int_t^T e^{-\gamma(T-u)} dW_u \quad \text{----- 2.13}$$

$$a = e^{-\gamma(T-t)}$$

$$b = \theta [1 - e^{-\gamma(T-t)}]$$

$$\text{std}(\epsilon) = \sqrt{\frac{\sigma^2}{2\gamma} [1 - e^{-2\gamma(T-t)}]}$$

By regressing the spot rate at t and t-1 for the sample set of data, we arrive at the coefficient using OLS method and then using the above relation we derive the parameter of the Vasicek models. The results based on the sample data considered from January, 2005 to October, 2008 are:

Method	Kappa	Theta	Sigma
MLE	0.262364	0.060447	0.004501
OLS	0.262364	0.060447	0.004506

One thing need to be noted, here is that in spite of having the recent data of spot rate from BoE we had used the calibration window from regime before the 2008 crisis. Since the spot rate was very volatile with low level of spot rate after the crisis leads to a negative rate of mean reversion. Hence using post crisis calibration window would lead to explosive process instead of mean reverting which also highlights the problem of using Vasicek model in low interest rate and high volatility regime.

Calibration of the parameter: MLE and OLS method, which is better?

Now we have the question which method is better for calibration of Vasicek model as both almost yielded the same results.

OLS does not make stringent distribution assumption for the model error; it only minimizes the sum of square of the residual error. OLS can be used under different distributional assumptions and the estimator will still make sense as the minimum variance unbiased estimator.

Maximum likelihood (ML) can be used for different distributions which have to be chosen in advance. If the realized data distribution appears to be different from the assumed distribution, then the ML estimator will no longer make sense, as the estimator maximizes the assumed joint probability density of the model.

Finally which method is better to use depends on the underlying objective function. If we want to maximize the joint probability density then go for MLE with check on the model fit with the actual data. And if we want to minimize the sum of squared residuals go for OLS. In our case we know that Vasicek model assumes normal distribution of spot rate hence better to use MLE approach for fitting the parameters. Further OLS and MLE are same under normal distribution assumption for simple linear model hence either would work and we can choose the one which shows lesser residual error between the observed and fitted data.

Instantaneous forward rate:

Forward rate is related to the zero coupon bond price as,

$$f(t, T) = -\frac{\partial}{\partial T} \ln(Z(r, t)) \quad \text{----- 2.14}$$

Using the affine bond price for Vasicek model we get,

$$f(t, T) = -\frac{\partial}{\partial T} \ln(e^{A(t, T) + rB(t, T)}) = -A'(t, T) + rB'(t, T) \quad \text{----- 2.15}$$

Differentiating value of $A(t, T)$ and $B(t, T)$ from equation 2.9 and 2.10 we get,

$$B'(t, T) = e^{-\gamma T}$$

$$A'(t, T) = -(1 - e^{-\gamma T}) \left(\theta - \frac{\sigma^2}{2\gamma^2} \right) - \frac{\sigma^2}{2\gamma^2} * (1 - e^{-\gamma T}) * e^{-\gamma T}$$

This gives the expression for the forward rates as,

$$f(t, T) = r(t) e^{-\gamma T} + (1 - e^{-\gamma T}) \left(\theta - \frac{\sigma^2}{2\gamma^2} \right) + \frac{\sigma^2}{2\gamma^2} * (1 - e^{-\gamma T}) * e^{-\gamma T} \quad \text{--2.16}$$

Condition for realistic model:

In order for the Vasicek model to be a realistic model of interest rates, the long term rates level need to be positive.

Using the equation 2.16 as $\tau = T - t \rightarrow \infty$ we get the long rate under real world as,

$$f(t, T) = \theta - \frac{\sigma^2}{2\gamma^2} \quad \text{----- 2.17}$$

Hence the parameter values must satisfy the inequality for model to be realistic.

$$\theta - \frac{\sigma^2}{2\gamma^2} \geq 0 \quad \text{----- 2.18}$$

Probability of negative interest rate:

If the current level of interest rate is low and the noise term is large it may lead to negative short term interest rate since the rates are normally distributed with

$$\tilde{\mu} = r_t e^{-\gamma(T-t)} + \theta [1 - e^{-\gamma(T-t)}]$$

$$\tilde{\sigma}^2 = \frac{\sigma^2}{2\gamma} [1 - e^{-2\gamma(T-t)}]$$

$$\text{Probability of negative interest rate} \mid r_t = \Phi\left(\frac{\theta - \tilde{\mu}}{\tilde{\sigma}}\right)$$

The probability depends on the parameter values of Vasicek model, if the theta is close to zero and the sigma is low then higher is the probability of negative interest rate. Else the probability of negative rates is small possibly because the time horizon is short. In other cases (especially longer-term actuarial, project management and pension applications) the probability and severity of negative interest rates can be significant under Vasicek model.

Zero Curve construction and shape generated by Vasicek model:

Using the equation 2.8 we can determine the zero coupon bond price for different maturity "T". We then get the implied yield for the term "T" from the zero coupon bond price. The plot below shows the zero curves derived using the calibrated parameter values.

The yield curve $Y(r_t, t)$ is called normal if it is a strictly increasing function of t , inverse if it is a strictly decreasing function of t and humped if it has exactly one local maximum and no minimum on $(0, \infty)$.

From equation 2.16 we have:

$$f(t, T) = r(t) e^{-\gamma T} + (1 - e^{-\gamma T}) \left(\theta - \frac{\sigma^2}{2\gamma^2} \right) + \frac{\sigma^2}{2\gamma^2} * (1 - e^{-\gamma T}) * e^{-\gamma T}$$

$$f(t, T) = r(t) e^{-\gamma T} + (1 - e^{-\gamma T}) * r_\infty + k * (1 - e^{-\gamma T}) * e^{-\gamma T}$$

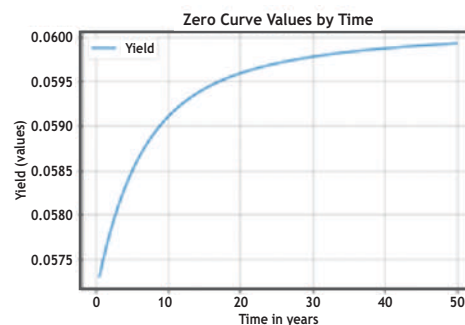
$$K = \frac{\sigma^2}{2\gamma^2}$$

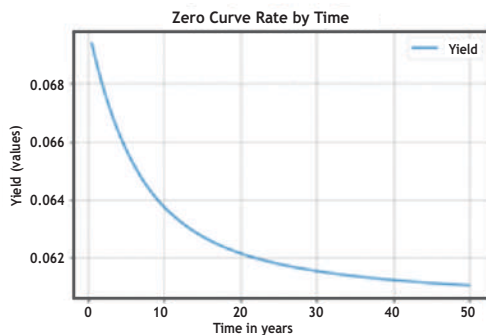
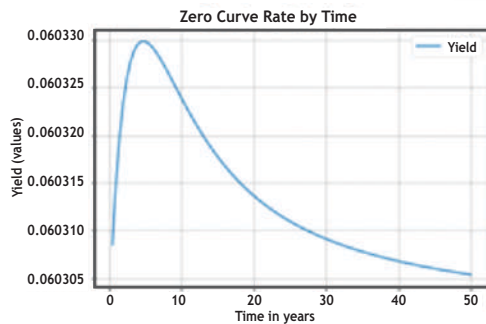
$$r_\infty = \theta - \frac{\sigma^2}{2\gamma^2}$$

The yield curve would be humped if there is a stationary point for some positive value of tau. This can be found by differentiating the forward curve and we get the below condition.

$$0 < \text{shape} = \frac{r(t) - r_\infty + k}{2k} < 1 \quad \text{for hump curve}$$

If shape < 0 then we get normal yield curve and for shape > 1 we get inverse yield curve.





Sensitivity of Model parameters:

$$E(r_t)|_t \rightarrow \frac{\eta}{\gamma} \rightarrow \theta \quad \text{----- 2.6}$$

$$\text{var}(r_t)|_t \rightarrow \frac{\sigma^2}{2\gamma} \quad \text{----- 2.7}$$

Kappa:

$$dr_t = \gamma(\theta - r_t)dt + \sigma dW_t$$

If the mean reversion rate is increased by small amount then the diffusion equation becomes,

$$dr_t = (\gamma + \delta\gamma)(\theta - r_t)dt + \sigma dW_t$$

Hence the next step interest rate would increase or decrease by amount $\delta\gamma(\theta - r_t)dt$ depending on the current level of interest rate and long run mean.

Since the long run expected short rate doesn't depend on mean reversion rate, the change in kappa will not affect the short rate in long term but only affect the time which is necessary for the interest rate to come back to the long-run mean level. On the other hand, when the kappa is increased the variation of the interest rate decreases, so the volatility decreases as evident from equation 2.6 and 2.7. Therefore, kappa is important in the pricing of the financial instruments which are dependent on volatility, but are not dependent on the long term expected value of the simulated interest rate.

Mean reversion speed kappa can also be interpreted as half-life, the time for interest rate to travel half the distance toward the equilibrium level which can be calculated from $HL = \ln(2)/\gamma$. Generally kappa should be positive, since interest rates do not tend to explode.

Theta:

$$dr_t = \gamma(\theta + \delta\theta - r_t)dt + \sigma dW_t$$

Change in the value of theta would lead to change in the short term interest rate by $\gamma(\delta\theta)dt$. The long run means also change by the same amount but the variation remains unaffected.

Sigma:

$$dr_t = \gamma(\theta - r_t)dt + (\sigma + \delta\sigma)dW_t$$

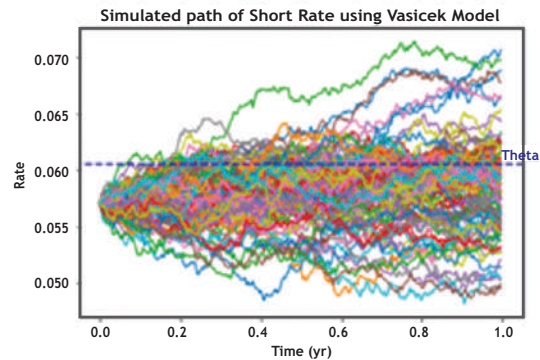
Change in the value of sigma would lead to change in the short term interest rate by $\delta\sigma * dW_t$. This adds to the volatility of short rate but doesn't affect the expected value of short rate in long run.

Simulation of Vasicek model:

Using the vasicek diffusion process and calibrated parameter 100 simulation was done to demonstrate the evolution of short rate over next one year. The simulation based approach can also be used for pricing interest rate derivatives based on Vasicek model. This was done using the discrete form of the diffusion process as given below.

$$r_t = r_{t-1} + \gamma(\theta - r_{t-1})\Delta t + \sigma * \Delta t * \text{norminv}(\text{rand}) \quad \text{----- 2.19}$$

In the plot the simulated path of spot rate over time shows the trend of mean reverting to the long run mean.



Analytical formula for Derivative Product:

The model to use depends on the purpose of pricing. For long and short caps at different maturities, one needs a model that captures the term structure of volatilities. Whereas for position with out of money volatility, then one need a model that captures the volatility vs strike dynamics.

Hence one factor Vasicek model doesn't capture the entire term volatility surface and is based on one source of randomness. Further the yield curve produced by these models doesn't match the yield curve observed in the market and hence not practically used for derivatives pricings rather used for information to see the relative value of implementing strategies. We do

have analytical formula for options on bonds, caps and floors which makes easy to evaluate alternative benchmark price.

Analytical formulas for options on zero coupon bonds under Vasicek model are given below:

$$\text{Call option value} = L * P(0, s) * N(h) - K * P(0, T) * N(h - \sigma_p)$$

$$\text{Put option value} = K * P(0, T) * N(-h + \sigma_p) - L * P(0, s) * N(-h)$$

Where,

s - Maturity of underlying bond

T - Maturity of options

L - Face value of bond and K strike

$$h = \frac{1}{\sigma_p} \ln \left(\frac{L * P(0, s)}{P(0, T) * K} \right) + \frac{\sigma_p}{2}$$

$$\sigma_p = \frac{\sigma}{\gamma} [1 - e^{-\gamma(s-T)}] * \frac{1 - e^{-2\gamma T}}{2\gamma}$$

In similar way cap and floor can also be valued by expressing as a portfolio of options on zero coupon bonds and each can be priced using the above formula.

Market price of Risk:

Market price of risk would be required to switch the process from real to risk neutral world or vice versa.

$$dr_t = \gamma(\theta - r_t)dt + \sigma dW_t \quad \text{Under } Q \text{ measure} \text{-----} 2.2.1$$

$$dr_t = \gamma(\theta - r_t)dt + \lambda dt + \sigma dW_t \quad \text{Under } P \text{ measure} \text{-----} 2.2.1$$

$dr = u(r, t)dt + w(r, t)dW$ generic form used for deriving the bond price equation in our earlier series.

The slope of the yield curve $= \frac{1}{2}[(u - \lambda w)]$ as shown in the annexure. This can be obtained from the market data or from the yield surface constructed using the Vasicek model.

drift term $u = \gamma(\theta - r_t)$

Variance term $w = \sigma$

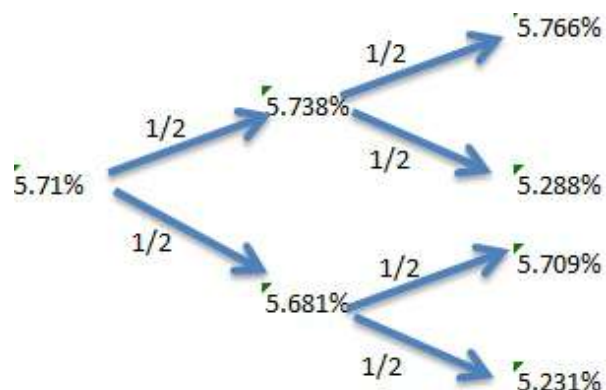
Given the calibrated parameter value for Vasicek model we can compute u and W and from the yield curve the slope can be estimated and finally we can reverse calculate the risk premium. Market risk premium can be computed at each point of time in the yield curve which would be spiky.

Building Tree using Vasicek Model:

One can also use binominal tree approach for pricing derivatives using Vasicek diffusion equation. This tree does not recombine since the drift increases with the difference between the short rate and θ . The short rate at next step is derived using the below relation and each path has a real probability of $\frac{1}{2}$.

$$r_t = \gamma(\theta - r_{t-1}) * \frac{1}{250} \pm \frac{\sigma}{\sqrt{250}}$$

We build the tree using our calibrated model with time step of one day. As seen at end of one day, we have rate (5.738%, 5.681%) now the rate 5.681% is further from θ than 5.738%, hence the drift from 5.681% is greater than the drift from 5.738%. Hence the move up from 5.681% is greater than the move down from 5.738%. This leads to a non-recombining tree and complicates the tree structure for longer horizon. The same approach can be extended for a trinomial tree construction as well.



There are many ways to represent the Vasicek model with a recombining tree. One approach would be by changing the probability measure such that the expected value and standard deviation are matched with those derived using real probability non-recombining tree.

“Success is not a Markov Process”
Keep the momentum going!!!

In this article we have widely covered most of the technical aspects of Vasicek model. I hope this article serves as a one stop for quickly understanding the nitty-gritty of Vasicek model. The models do have a limitation of generating negative interest rate and one factor model. But due to tractability of the model it finds its wide application in financial markets. Hence it is important for actuaries to understand this model for venturing into wider field including Banking and Finance. In the next series we would further continue our momentum of deep diving in understanding another interest rate model in the similar fashion.

Further for your reference the modeling and computation was done in Python, the code, input data and annexure are shared @

<https://github.com/mail2rajc/Actuary.git>

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