Institute of Actuaries of India

# Interest Rate Guarantee and GN29

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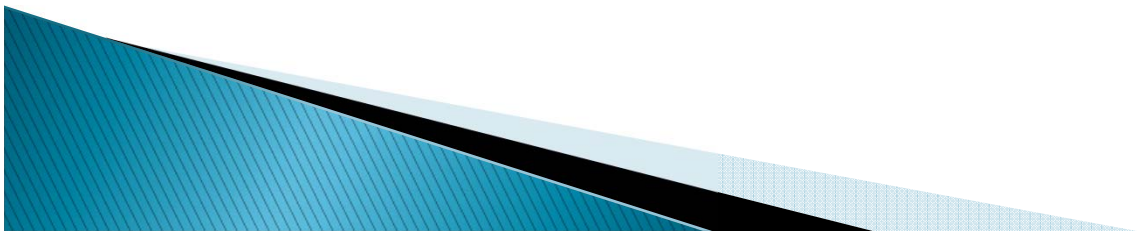
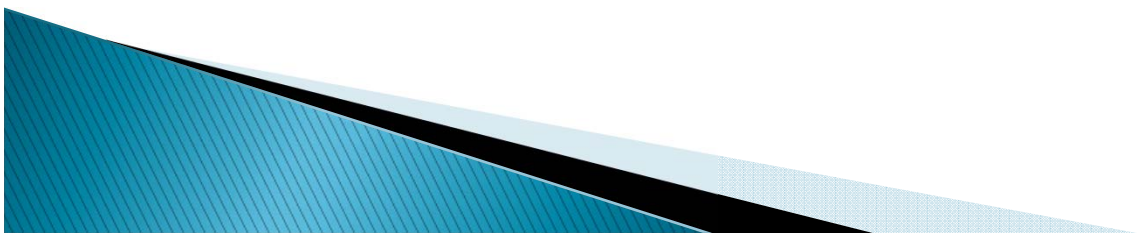
# Agenda

- GN 29 : An Overview
- Valuation Approaches
- Log Normal Model Approach
- Stochastic Models Revisited
- Autoregressive Modelling Approach
- Term Structure Models
- Commonly used Short Rate Models
- Constructing Short Rate Models
- Summary



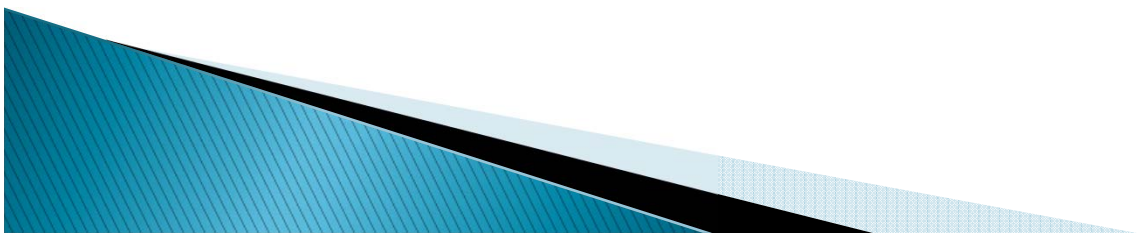
# GN 29: An Overview

- Valuing Interest Rate Shortfall arises when future investment earnings rate falls below the guaranteed rate of interest
- Forecast the future investment earnings rates
- Time horizon for forecasting is the estimated remaining term of obligations which in turn will be influenced by the attrition rate and mortality rate assumptions



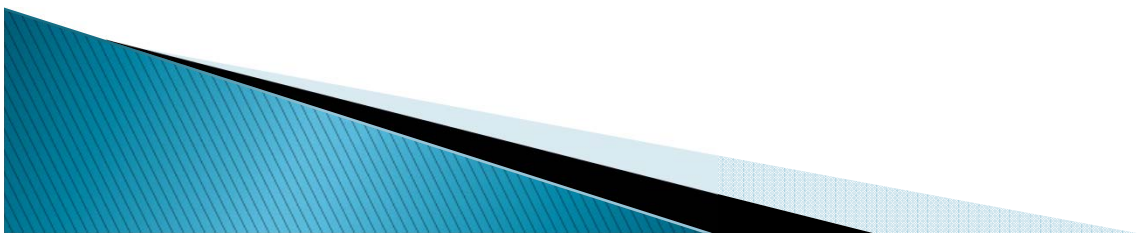
## Forecasting future investment earnings rate

- Model Used for Valuing the Interest Rate Guarantee
  - Log Normal Models
  - Auto Regressive Models



# Log Normal Model

- The Log Normal Model (Black's Model), which provides a closed form solution for the value of a floor, assumes that the interest rate R (k) follows a lognormal distribution with a specified volatility parameter
- The following steps are involved in applying this model for valuing the interest rate guarantee embedded in an exempt provident fund.

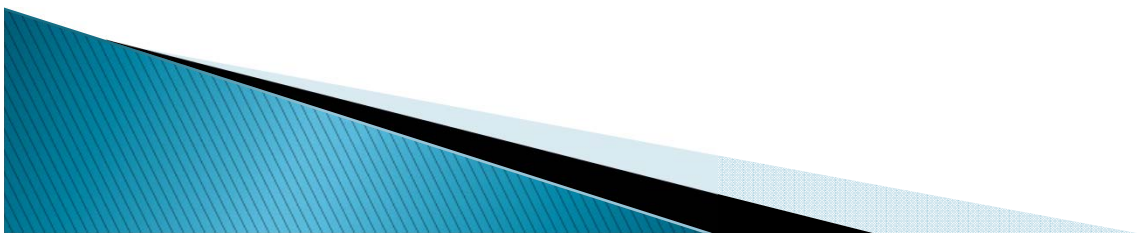


# Log Normal Model (continued)

- Obtain the continuously compounded Zero Coupon gilt yield curve [as on the balance sheet date] over the "decrement adjusted" expected working lifetime of the members of the exempt provident fund.
- Derive the one-year forward rates from the Zero-coupon yield curve obtained in the previous step.
- Adjust the one-year forward rates for the yield spread between the portfolio rate of return and the yield on the gilts of an appropriate term. The portfolio rate of return refers to the rate of return on the asset portfolio backing the PF accumulation.
- Determine an appropriate volatility parameter for the spread adjusted one-year forward rates. This parameter can be estimated as the standard deviation of the historical rates of return on the asset portfolio backing the PF accumulation.

## Log Normal Model (continuied)

- Project the guaranteed rates of return based on the recent rate declared by the EPFO
- Use the Black's Model for estimating the value of the floor let for each year of the decrement adjusted remaining working life time. The value of the floor will be equal to the sum of the values of the floorlets.
- The PVO [Present Value Obligation] of the Interest Guarantee is equal to the value of the floor.



# Log Normal Model (continued)

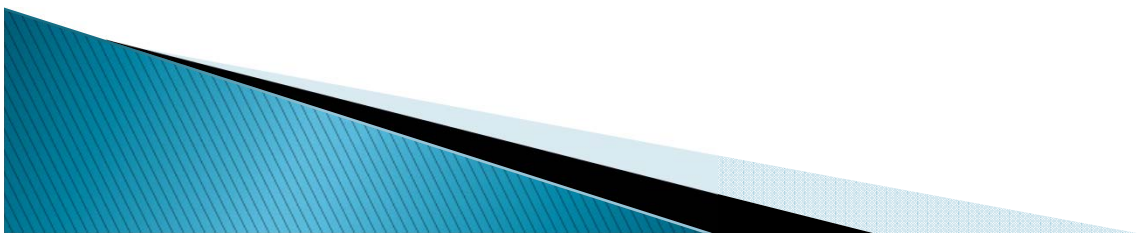
PVO of Interest Guarantee Using Black's Model (Floor Only)

- Accumulated PF Balance: Rs. 500 mln
- Decrement Adjusted Average Working Life Time: 5 years
- Yield Spread : 0%

| Year | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Zero Coupon Gilt Yields | 8.15% | 8.17% | 8.19% | 8.24% | 8.32% |
| Spread Adjusted Forward Rates | 8.15% | 8.19% | 8.25% | 8.39% | 8.60% |
| Volatility Parameter [% pa] | 10% | 10% | 10% | 10% | 10% |
| Guaranteed Rate of Return | 8.5% | 8.5% | 8.5% | 8.5% | 8.5% |
| Present Value of Floor lets (Rs. Mln) | 1.60 | 2.19 | 2.38 | 2.30 | 2.08 |
| Present Value of Floor (Rs. Mln) | 10.55 | | | | |
| PVO of Interest Guarantee | 10.55 | | | | |

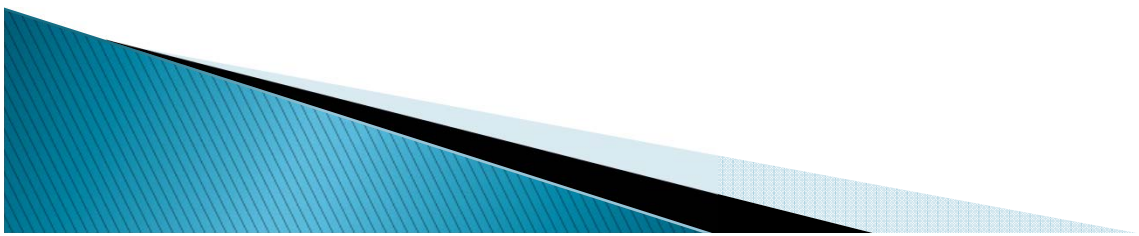
# Stochastic Models Revisited

- Several basic types of models are available, each making different assumptions about the processes that generate investment returns
- Two Basic Types of Models
  - ✓ Continuous Time Log Normal Model
  - ✓ Autoregressive Models



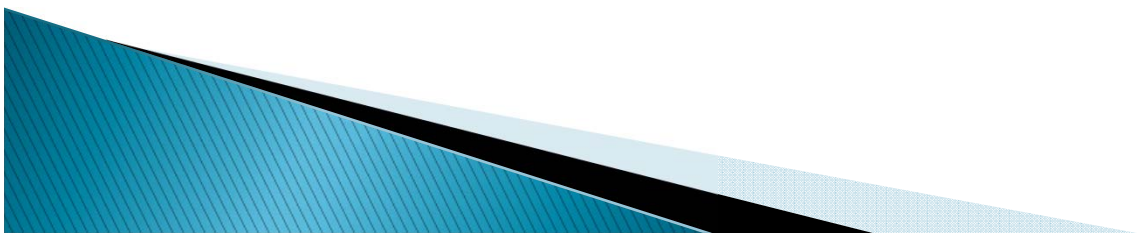
# Auto Regressive Modelling Approach

- The steps involved in applying this approach for valuing the interest rate guarantee are as follows:
- Obtain the (continuously compounded) Zero coupon gilt yield curve on the balance sheet date over the decrement – adjusted expected working life time of the members of the exempt provident fund.
- Using the Zero coupon yield curve in conjunction with any appropriate stochastic interest rate projection model, project the short-rates [one-year forward rates] over the decrement adjusted working lifetime. The short rates need to be adjusted for the yield-spread as defined under the closed-form approach.



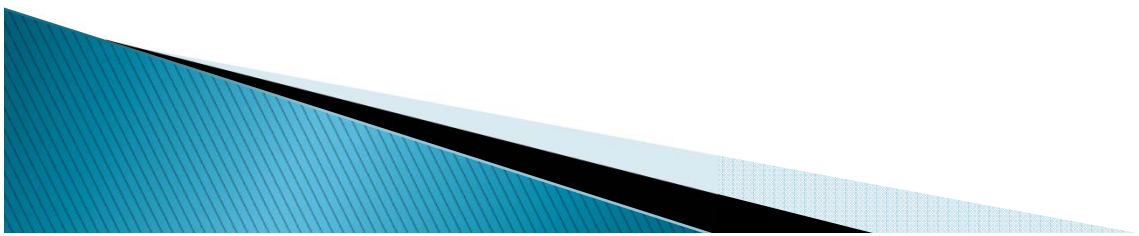
# Auto Regressive Modelling Approach

- Under each of the interest rate paths, determine the present values of the shortfalls and the present value of the surpluses. A shortfall will arise in the year(s) in which the projected interest rate falls below the guaranteed interest rate and "surplus" will arise in the year(s) in which the projected interest rate is above the guaranteed interest rate. The PVO of Interest Guarantee will be equal to the Present Value of the Shortfalls
- Rank order the "PVOs of Interest Guarantee" values obtained for the various interest rate paths starting with the "largest" PVO and ending with the "smallest" PVO. Select an appropriate point in the tail of this rank-ordered distribution and compute the CTE [Conditional Tail Expectation] at that point. The "PVO of Interest Guarantee" will be equal to this CTE.



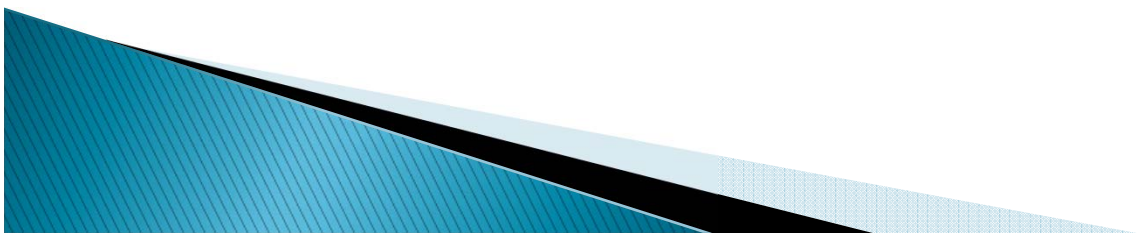
# Auto Regressive Modelling Approach

- The CTE(p) is defined as the arithmetic mean of the largest 100(1-p) % PVOs from the rank-ordered PVO distribution. For example, a 95% CTE will be the arithmetic mean of the largest 5% of the PVOs. The CTE approach is recommended because it is consistent with the approach recommended in “GN22: Reserving for Guarantees in Life Assurance Business” issued by the Institute of Actuaries of India



# Term Structure Models : Desirable Characteristics

- The model should be arbitrage-free
- Interest rate should be positive
- Interest rates should be mean-reverting
- It should fit historical interest rate data adequately
- It should be easy to calibrate to current market data



# Commonly used Short Rate Models

## Vasicek Model

$$dr(t) = \alpha[\mu - r(t)]dt + \sigma dW(t)$$

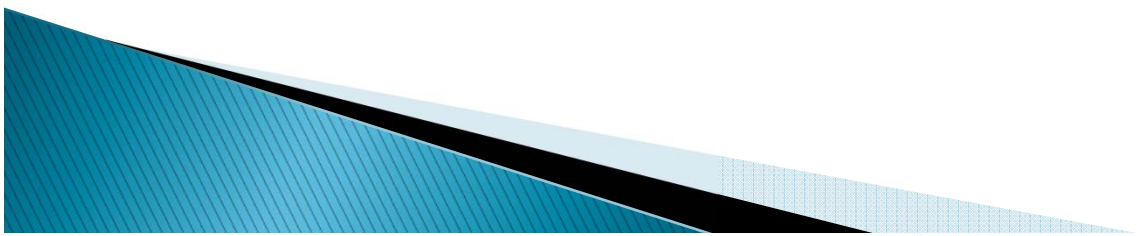
## Cox –Ingresoll–Ross (CIR) Model

$$dr(t) = \alpha[\mu - r(t)]dt + \sigma * r(t)\hat{}\, dW(t)$$

## Hull and White Model

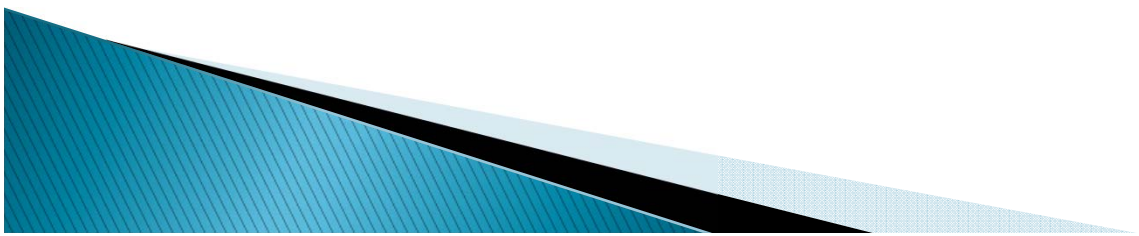
$$dr(t) = \alpha[\mu(t) - r(t)]dt + \sigma dW(t)$$

Where $\mu\,(t) is\ a\ deterministic\ function$

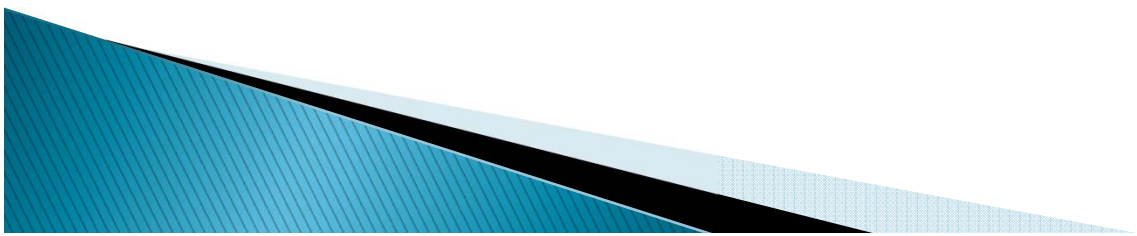


# Constructing Short Rate Models

- Using the C-I-R Model
  - ✓ Estimation of parameters
  - ✓ Simulating future short term interest rates
  - ✓ Modelling longer Term Rates
  - ✓ Modelling packages



# Questions



Thank You