

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

17th September 2021

Subject CP2B – Actuarial Modelling (Paper B)

Time allowed: 3 Hour 30 Minutes (09.30 – 13.00 Hours)

Total Marks: 100

Exam Requirements

Read the background document that describes the scenarios that have been modelled and documented for this project, and the work that remains outstanding.

Read the audit trail that has been written by your colleague, another actuarial student, for the work done till date. This will assist you in following and understanding the calculations performed in the spreadsheet model.

Background

An established, actuarial student's Co-operative bank is planning to launch a monthly recurring deposit scheme named "OnTime" for the working actuarial students who are members of the bank on 1st January 2022. Eligible members can sign-up for the "OnTime" scheme on the first day of any calendar month starting from the date of launch of the scheme. Upon successful sign up to "OnTime" scheme, a recurring deposit account in the name of the member gets operational with the bank. The monthly deposit amount is fixed at INR 5,000 and the deposit will mature at the end of 3 years from the date of opening of the account. The amount deposited into account earns interest on cumulative basis.

Under the "OnTime" scheme, the bank is considering to offer three different types of accounts to cater to the varying risk appetite of account holders. This will help bank attract a large number of members. The only difference between these accounts is in the structure of interest rate. Depositors will choose the account commensurate with own risk appetite.

Below are different account types and corresponding interest rate structure.

Account Type	Interest rate structure
Reliable	Fixed Interest of 7% p.a.
Floating	Variable Interest: Equals to 90 days T-bill yield as at the end of the calendar month less a spread of 0.05%.
Swing	Equity Yield: Equals to annualized return as at the end of the calendar month on a Fifty50 equity index less a spread of 0.15%.

- There is a one-time option available to the depositor to switch between the accounts at the end of 18 months from the date of opening of the account.
- The bank does not expect any mid-term withdrawal.

The bank is considering to place the deposit money received under "OnTime" scheme with an established corporate firm to earn higher interest income and generate surplus from the scheme. Bank is in advance discussion with an established corporate firm with AA+ credit rating to secure an interest rate of 8% p.a. on the amount deposited with the corporate firm.

The bank has approached an actuarial firm, you work for, to assess the surplus amount it will generate from running the scheme. Bank expects that as on the date of launch of the scheme 1,000 accounts will be opened under each type of account. Your boss, a qualified Actuary who is currently overseeing the project has asked you to take the project forward. You have been provided with the model and audit trail of the work done by your colleague. You should assume that the model and

the audit trail have been reviewed and are correct. You are not required to add to or amend the audit trail.

To project 90 days T-bill yield, your boss has asked to follow lognormal distribution with

Mean: 1.998
Standard Deviation: 0.0820

To project return on a Fifty50 equity index, your boss has asked to follow Normal distribution with
Mean: 10%
Standard Deviation: 5%

As part of the data, random numbers are provided for the projection of returns under different distributions/asset class.

Your Actuarial firm has developed a working model to calculate surplus on maturity of the deposit under the three different types of accounts. The surplus is difference between maturity proceeds received from the corporate firm and maturity proceeds paid to account holders.

The CFO of the bank is concerned with mismatch risk in assets and liabilities under Swing account type. She has asked to evaluate impact of investing in equities with higher average return and standard deviation to better match liabilities and make higher surplus. You have been asked to recalculate the surplus under the proposed change in asset allocation under Swing account with the following information.

Investing the monthly deposited amount in a Managed Mid-Cap Equity fund that follows a Normal Distribution with

Mean: 12%
Standard Deviation: 10%
MidCap Equity Spread :0.50%

You are required to perform the following assignments:

- Q. 1)** i) Extend the model to calculate the Surplus / (deficit) if the bank opts to invest all the deposit amount received under Swing account type in Managed Mid-Cap Equity Fund. (5)
- ii) The bank comes to the conclusion that Managed Mid-Cap Equity Fund is a suited asset class for deposits placed under Swing accounts. With this background, you have been asked to recalculate the Surplus/ (deficit) if 50% of Floating account holders switch to Swing account at the end of 18th month. (5)

You may copy the Sheet! CF Projection I to do calculations and add the tables in the results sheet as needed.

[10]

- Q. 2)** Prepare a chart to compare the surplus / (deficit) for each of the three account types and Total for the scenarios given below.
- Scenario – 1: Bank lends the entire deposit amount to the corporate at secure interest rate of 8%
 - Scenario – 2: Bank lends the deposit amount under Reliable and Floating at secure interest rate of 8% and invests the amount under swing in Managed MidCap Fund

- Scenario – 3: Same as Scenario – 2 above with 50% of Floating account holders switch to Swing account at the end of 18th month.

[5]

Q. 3) Prepare a Summary document capturing the main features and the results of the model prepared by your colleague and the modifications done by you. You may assume that the summary is being prepared for the senior management.

Your summary document should include the following:

- Purpose of the project, data, methodology and assumptions used for the project.
- Results, including charts, if any
- Commentary on the results and the next steps

The Summary should explain the full scope of the model, including the options that were modelled in the spreadsheet.

Audit trail prepared by one of the student members is provided below for your reference. You may assume that the audit trail is correct and you are not required to add or amend the audit trail.

Marks available for the Summary:

- Purpose, data and assumptions (10)
- Methodology (20)
- Data checks and reasonableness checks (5)
- Results, including charts (5)
- Commentary on results and conclusions (20)
- Next steps (15)
- Drafting (10)

[85]

Audit Trail

Background

An established actuarial student's Co-operative bank is planning to launch a monthly recurring deposit scheme named "OnTime" with fixed monthly deposit amount of INR 5000, and maturity period of 3 years for its members.

Under this deposit scheme, the bank is considering to offer three types of accounts with different interest rates to cater to varying risk appetite of the account holders. The bank also allows one time switching of method of interest calculation at the end of 18 months.

The bank is considering lending the deposit money to a AA+ rated corporate firm to secure an interest rate of 8% p.a. There is also a proposal to invest the deposit amount under one of the account types in equities.

The enclosed spreadsheet models the said recurring deposit under different methods of interest calculation.

Objective

The objective of this project is to calculate the surplus / (deficit) amount that will accrue to the bank on maturity of the deposits. The surplus / (deficit) is difference between maturity proceeds received from the corporate firm and maturity proceeds paid to account holders.

Data

The random numbers required to generate the monthly variable interest rate and equity yields are provided separately for each of the 36 months.

Assumptions

- Monthly deposit amount is fixed at INR 5,000.
- The number of depositors will be 1000 under each of the three interest options.
- The numbers given in the data are purely random and independent of each other.
- Annual rate of interest under fixed option is set at 7% p.a. for the entire duration of the deposit.
- The secured interest rate is fixed at 8% p.a. for the 36 months.
- Variable interest follows a lognormal distribution with mean 1.998 and standard deviation 0.0820 per annum.
- Fifty50 equity yield follows a normal distribution with mean 10% and standard deviation 5% per annum.
- The Managed Mid-Cap Equity index follows a normal distribution with mean 12% and standard deviation 10% per annum.
- The monthly deposit is assumed to be made on the first day of every month.
- Interest is calculated on the last day of every month.

Worksheet: Assumptions

The assumptions used in the model are listed here. The parameters are named as follows

INTA	Fixed rate of Interest in Cell C2
INTS	Secured rate of Interest in Cell C3
CONTM	Monthly Instalment in Cell C4
INT_Mean	Variable Interest Rate Mean of Lognormal distribution in Cell C7
INT_SD	Variable Interest Rate Standard Deviation of Lognormal distribution in Cell C8
VISpread	The spread of variable interest rate in Cell C9
EQ_Mean	Fifty50 Equity Yield Mean of Normal distribution in Cell C12
EQ_SD	Fifty50 Equity Yield Standard Deviation of Normal distribution in Cell C13
EQSpread	The spread of Fifty50 equity Yield in Cell C14
MMEQ_Mean	Managed Midcap Equity Index Mean of Normal distribution in Cell C17
MMEQ_SD	Managed Midcap Equity Index Standard Deviation of Normal distribution in Cell C18
MMEQSpread	Managed Midcap spread of equity Yield in Cell C19
No_Acc	Number of accounts in each of the three options in Cell C21

Worksheet: Data

The Random numbers required for calculation of Variable interest rate, Fifty50 Equity Yield and Managed Mid-Cap equity yield for each of the months are respectively given in columns B to D.

Worksheet: CF Projection I

- Column – A Shows the serial number of the month of deposit (1 to 36)
- Column – B Month of Deposit Jan-2022 to Dec-2024
- Column – C Monthly Deposit – is set equal to CONTM for all rows from C4 to C39
- Column – D Reliable A/C interest rate is set equal to INTA for all rows from D4 to D39
- Column – E Floating A/C interest rate calculated as follows using Excel Formula and expressed as percentage for each of the rows E4 to E39. The random numbers given in sheet Data cells B2: B37 are used here. The formula for Cell E4 is written as

$\text{LOGNORM.INV}(\text{Data!B2}, \text{INT_Mean}, \text{INT_SD})/100 - \text{VISpread}$

The formula is dragged down from Cells E4 to E39

- Column – F Swing A/C interest rate calculated as follows using Excel Formula and expressed as percentage for each of the rows F4 to F39. The random numbers given in sheet Data cells C2: C37 are used here. The formula for Cell F4 is written as

$\text{NORM.INV}(\text{Data!C2}, \text{EQ_Mean}, \text{EQ_SD}) - \text{EQSpread}$

The formula is dragged down from Cells F4 to F39

- Column – G Interest rate on deposit with corporate - is set equal to INTS for all rows from G4 to G39

- Column – H Cumulative Amount at the end of the month calculated using Reliable A/C.
For the first row Cell H4, amount is calculated as $\text{Monthly Deposit} * (1 + \text{Interest Rate}/12)$ This cell is not copied down and hence highlighted in yellow i.e $\text{C4} * (1 + \text{D4}/12)$

For the next row onwards, the cumulative amount in the cell above plus the monthly deposit is multiplied by $(1 + i/12)$ where i is the interest rate. E.g, for Cell H5 the formula is $(\text{H4} + \text{C5}) * (1 + \text{D5}/12)$

The formula is dragged down from Cells H5 to H39

- Column – I Similar to Column H but calculated using Floating A/C interest rate calculated in column E

- Column – J Similar to Column I but calculated using Swing A/C interest rate calculated in column F

- Column – K Similar to Column J but calculated using interest rate on Deposit with Corporate calculated in column G

Results of a few cashflow checks carried out are shown in column M

Worksheet: Result

The results are tabulated in the given table linked to the respective columns in sheet CF Projection I respectively for account types Reliable, Floating, Swing & Total

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- Row 5 Cells C5, D5 and E5 are the number of accounts No_Acc and F5 is Sum(C5:E5)
- Row 6 Cells C6 linked to 'CF Projection I'!H39, D6 to 'CF Projection I'!I39 and E6 to 'CF Projection I'!J39 and F6 is Sum(C6:E6)
- Row 7 The cells C7:F7 are linked to 'CF Projection I'!K39 and F7 is sum(C7:E7)
- Row 8 The surplus / (deficit) is calculated as the difference of row 7 and row 6 multiplied by number of accounts (C7-C6)*C5 and F8 is Sum(C8:E8)
- Checks the data checks and reasonableness check are shown in cells H2 to I17
