

Institute of Actuaries of India

Subject CP2B – Actuarial Modelling (Paper B)

September 2021 Examination

INDICATIVE SOLUTION

Introduction

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable.

Summary

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 5,000, 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 structure to cater to the varying risk appetite of the account holders. The bank also allows one time switching between different account types at the end of 18 months.

The bank is considering investing the deposit amount received under OnTime scheme with a AA+ rated corporate firm to earn a fixed interest rate of 8% p.a. or in equities or a combination of the two to reduce assets and liability mismatch.

Purpose

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 the difference between maturity proceeds received from the investments and maturity proceeds payable to the account holders.

Data

- Bank has provided relevant data related to "OnTime" scheme as listed below:
- Monthly deposit amount is fixed at INR 5,000.
- Expected number of depositors will be 1,000 under each of the three interest options.
- Annual rate of interest under fixed option is set at 7% p.a. for the entire duration of the deposit.
- The interest rate on deposit with corporate firm is fixed at 8% p.a. for the 36 months.
- The random numbers required to generate the monthly variable interest rate and equity yields are provided separately for each of the 36 months.

Assumptions

- 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.
- There is no pre-mature closure of deposits.
- Inflation is ignored and there are no other charges levied.
- It is assumed that there is no time lag between members depositing with the bank and bank depositing with the corporate
- It is assumed that there are no charges on transfer of funds
- It is assumed that monthly interest rate or monthly return is 1/12th of annual interest rate or investment return
- It is assumed that there are no mid-term withdrawals or auto renewal of the scheme
- It is assumed that there are no taxes to be paid or collected
- It is assumed that present value of money is ignored for surplus estimation
- Random numbers follow uniform distribution in the range of 0 to 1.
- All the future deposits are ignored for the projection of surplus.
- Administration expenses related to management of the scheme are ignored from the projection of surplus.
- Variable interest follows a lognormal distribution with mean 1.998 and standard deviation 0.0820 p.a.
- 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% p.a.

Methodology

The bank is offering three different types of accounts to cater to the varying risk appetite of account holders with different rates of interest. The description of different types of accounts is as below:

1. Reliable: With fixed rate of interest of 7% p.a.
2. Floating: Variable Interest: Equals to 90 days T-bill yield as at the end of the calendar month.
3. Swing: Equity Yield: Equals to annualized return as at the end of the calendar month on a Fifty50 equity index
4. The bank has secured an interest rate of 8% p.a. from an AA+ rated corporate firm on the amounts deposited under Reliable and Floating accounts.
5. The amount deposited under the Swing account will be invested in a Managed Mid-Cap Equity fund.

In order to calculate surplus from the “OnTime” scheme the maturity proceeds of the deposits and investment are projected from the time of opening of deposit to maturity date. Approach used for the projection is described below:

At the time of opening of the accounts both deposits and investments amount are set to be zero. The deposit and investment amount are projected over the term of 3 years on the monthly basis. The amount at the end of the month is calculated as product of $(1 + \text{monthly interest rate} / \text{investment return})$ and sum of amount at the beginning of the month and deposit for the month.

The annual interest rate and investment return for different accounts are set as below:

<u>Account Type</u>	<u>Annual Interest rate or Return</u>
<u>Reliable</u>	Fixed 7.00% p.a.
<u>Floating</u>	The interest rate is projected using log normal distribution and is netted off with a spread of 0.05%. Excel formula named LOGNORM.INV is used for the projection of interest rate. The parameter values of log normal distribution are mean: 1.998 and standard deviation: 0.0820.
<u>Swing</u>	The interest rate is projected using normal distribution and is netted off with a spread of 0.15%. Excel formula named NORM.INV is used for the projection of interest rate. The parameter values of normal distribution are mean: 10% and standard deviation: 5%.
<u>Deposit with corporate firm</u>	Fixed 8.00% p.a.
<u>Managed Mid-Cap Equity</u>	The interest rate is projected using normal distribution and is netted off with a spread of 0.50%. Excel formula named NORM.INV is used for the projection of interest rate. The parameter values of normal distribution are mean: 12% and standard deviation: 10%.

The projected amount per account is multiplied by the number of accounts to calculate total proceeds.

Modelling the mid-term switch from Floating to Swing account

The projection is similar to above except that the accumulated value of Swing account at the beginning of 19th month is equal to accumulated value under Floating account at the end of 18th month.

Scenario – 1 Calculation of surplus / (deficit) when deposited with corporate firm.

The surplus /(Deficit) for the individual account type is calculated as the product of number of accounts and difference between the maturity amount payable under that account type and accumulated amount received

from the AA+ rated corporate entity. The net surplus /(deficit) is the total of the surplus / (deficit) under each of the account types.

Scenario – 2 Calculation of surplus / (deficit) with amount deposited in ‘Swing’ account invested in managed Mid-Cap Fund.

Similar to the above but the amount deposited under the ‘Swing’ account type is invested in the managed Mid-Cap Equity fund. The amount from other two account types is deposited to earn secured interest rate of 8%. The net surplus /(deficit) will again be the total the surplus / (deficit) under each of the account types.

Scenario – 3 Calculation of Surplus /(Deficit) with Managed Mid-Cap Fund and 500 depositors switching from Floating to Swing

For the account types ‘Reliable’ and ‘Floating’, the surplus /(Deficit) for each of the account types is calculated as the product of number of accounts and difference between the maturity amount payable under the account type and accumulated amount received from the AA+ rated corporate entity. For the ‘Swing’ and switched account types, the difference between the maturity amounts payable and the return from Managed Mid-Cap fund is calculated. The net surplus /(deficit) will be the total the surplus / (deficit) under each of the account types.

Data check and reasonableness check

A variety of check are performed that include

1. All random numbers are between 0 and 1
2. The maturity amount is the total of the monthly instalments with 0% interest rate
3. For the distributions, effective interest rate with near 0% SD is the mean
4. Accumulations follow an increasing pattern
5. The average interest rate for the 36 months is close to the mean of the distribution
6. Given the mean of the distributions, Fixed, variable, Fifty50 and Secured interest rates are in ascending order.

Results

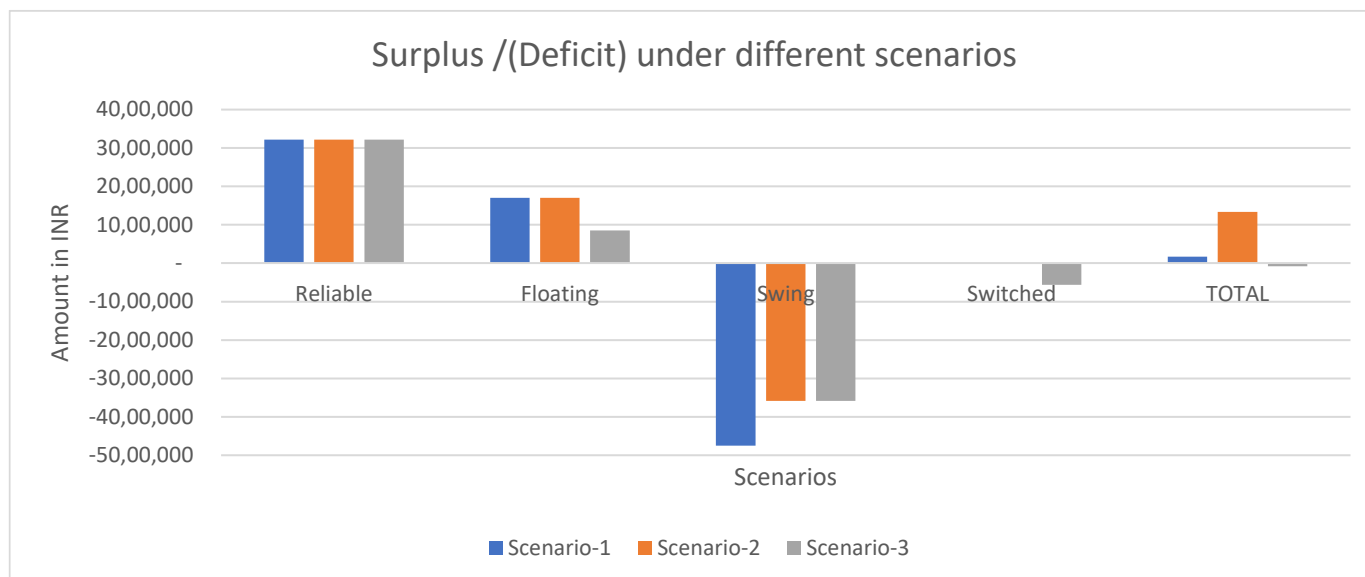
1. The surplus / (deficit) under the required scenarios are given below

Scenario - 1: Surplus /(Deficit) with Secure rate of interest				
	Reliable	Floating	Swing	TOTAL
No. of Accounts	1,000	1,000	1,000	3,000
Maturity Amount - Payable	2,00,815	2,02,326	2,08,773	6,11,914
Maturity Amount - Receivable	2,04,029	2,04,029	2,04,029	6,12,087
Surplus /(Deficit)	32,13,842	17,03,057	(47,43,606)	1,73,294

Scenario - 2: Surplus /(Deficit) with Managed MidCap Fund				
	Reliable	Floating	Swing	TOTAL
No. of Accounts	1,000	1,000	1,000	3,000
Maturity Amount - Payable	2,00,815	2,02,326	2,08,773	6,11,914
Maturity Amount - Receivable	2,04,029	2,04,029	2,05,194	6,13,252
Surplus /(Deficit)	32,13,842	17,03,057	(35,78,165)	13,38,734

Scenario -3: Surplus /(Deficit) with Managed MidCap Fund and 500 depositors switching from Floating to Swing					
	Reliable	Floating	Swing	Switched Method	TOTAL
No. of Accounts	1,000	500	1,000	500	3,000
Maturity Amount	2,00,815	2,02,326	2,08,773	2,06,320	8,18,233
Maturity Amount (Secured)	2,04,029	2,04,029	2,05,194	2,05,194	8,18,447
Surplus /(Deficit)	32,13,842	8,51,529	(35,78,165)	(5,62,635)	(75,429)

2. The chart that compares the surplus / (deficit) for each of the three account types and Total for the scenarios given below.



Comments on results and Conclusions

- Under scenario 1, the surplus under 'Reliable' is maximum amongst three different accounts. However, huge deficit under 'Swing' account drags down overall surplus significantly.
- Under scenario 1, the net surplus of INR 173,294 for a maturity pay out of INR 61.19 Cr works out to only about 0.028%. Under scenario 2 this increases to 0.218%. Both these amounts are unlikely to be sufficient to meet the expenses of the bank and profit margin.
- Given the average interest rate under 'Floating' accounts is 7.37%, the surplus generated with 8% secured interest seems to be insufficient and may not be able to contain the volatility of the T-bill yield. A 0.5% increase in T-Bill Yield is likely to wipe out the surplus.
- The average yield of the Fifty50 equity index is seen to be 9.53%. A fixed 8% return on the deposited funds will result in a deficit and hence there is a case to look for better investment avenues for the amount deposited in 'Swing' accounts
- The investment yield under the Mid-Cap Equity fund is found to be lower than the maturity amount under the swing account. This is resulting in a deficit that is pulling down the overall surplus.
- Under the current simulation, the maturity amount under Managed Mid-cap fund is only marginally higher than the 8% secured yield by INR 1,165. Given the higher standard deviation, this seem to be on lower side.
- Under all three given scenarios, there is a deficit for the 'Swing' account type. This is unviable and a better options to invest the amount needs to be explored or to drop the Swing account type from offering.
- It is seen that 500 depositors switching the method from 'Floating' to 'Swing' is resulting in a deficit. About 527 members need to remain in 'Floating' account for the whole scheme to break even.
- In addition to the volatility of the investments, the overall surplus is likely to be highly sensitive to the switching of account types.
- Given the current economic situation, the fixed interest rate of 7% seems to be unsustainable.

11. The average yield of T-bill is about 7.37% may not be appropriate under the current economic conditions
12. The managed Mid-Cap Equity fund seems to be highly volatile. Though it provides a mean yield of 12%, the standard deviation of 10% will make the entire portfolio highly volatile.
13. Any mid term withdrawal is likely to deteriorate the surplus further.
14. While the deposits are for short / medium term, the investment in equity is expected to give higher returns only on a longer term. There could be asset liability mismatches and resultant liquidity issues.

Next Steps**Product Features:**

1. Review the level of interest rates to be offered to achieve desired level of surplus
2. Review the term of deposit whether a shorter or longer term is suitable to generate higher surplus and reduce mismatch between assets and liabilities
3. Consider offering greater flexibility between switching between account, withdrawal and deposit holiday.
4. Benchmark the interest rates with prevailing G-Secs and other comparable investment options
5. Consider bringing flexibility to monthly deposit amount to attract a greater number of customers

Modelling:

6. Consider using other interest rate models such as Vasicek, Cox-Ingersoll
7. Consider other equity investments with higher mean and lower variance to enhance surplus.
8. Enhance the model to allow for the following:
 - a. Bank administrative expenses
 - b. Required capital and cost of capital as per latest guidelines issued by the regulator
 - c. Credit and market risks
 - d. Analyse tax implications for the bank and returns net of the net of tax for depositors.
 - e. Study the impact of midterm withdrawals on surplus.
 - f. To change model from deterministic to stochastic to enable testing of surplus under numerous scenarios

Others:

9. Ensuring the product design is consistent with the regulatory guidelines applicable to bank deposits and investments.
10. Study target market to estimate reliable number of members opening account under "OnTime"
11. Compare the capital position of the bank viz its risk appetite.
12. Explore other options like loan products to profitably deploy the deposited amount.
13. Explore if the bank has systems and processes to support maturity claim pay-outs and systems to support investments. Else factor in the cost of the same.
14. Necessary steps be taken to ensure that each of the account types are profitable on standalone basis.
