

MAKERERE



UNIVERSITY

COLLEGE OF BUSINESS AND MANAGEMENT SCIENCES

SCHOOL OF STATISTICS AND PLANNING

A MODEL FOR PRICING AND PROFIT TESTING OF A CONVENTIONAL
CREDIT INSURANCE FOR INDIVIDUALS

BY

MWENDEZE DESIRE MARION

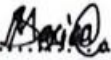
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A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND
PLANNING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN ACTUARIAL
SCIENCE

AUGUST 2026

DECLARATION

I, Mwendeze Desire Marion, 23/U/12522/PS hereby declare to the best of my knowledge that the information in this dissertation has never been presented before by any other student from any other institution of higher learning for award of any academic qualification (Degree, Diploma).

SIGNATURE. 

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APPROVAL

I approve the submission of this research project for examination as the student's university supervisor.

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DEDICATION

I dedicate this project to my loving parent, Mr. Charles Balabye and Mrs. Prossy Balabye, who have greatly supported and nurtured me through my education and life as a whole. Their never ceasing love, care and encouragement have guided me every step of the way. May God bless and reward them for all they do.

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LIST OF ACRONYMS

LCI- Loan Credit Insurance

IRA- Insurance Regulatory Authority

BoU- Bank of Uganda

SACCO- Savings and Credit Cooperative Organization

UBOS- Uganda Bureau of Statistics

PV- Present Value

NPV- Net Present Value

EPV- Expected Present Value

ABSTRACT

This project's objective was to design a conventional credit insurance product for individuals that get loans in Uganda, which pays the individual's outstanding loan amount upon death or permanent disability. Individuals that acquire loans, especially large loan amounts, face challenges of paying the loans especially in the event of permanent disability or death as it leads to financial burden transferred to family members or even loss of assets given in as collateral.

The policy modelled has two decrements; death and disability. Assumptions have been made to aid in pricing and profit testing the model. The profit margins over different ages and policy terms have been computed and the principle of equivalence has been used to calculate the premiums. Python 3.13.9 and Microsoft Excel were utilized to build the pricing and profit testing models.

Results show that the ideal terms for the policy are three to six years, covering both male and female lives between ages of 25 and 60. Premiums tend to increase with age and profit margins tend to decrease with policy terms. This product is priced to ensure premiums are affordable for low-income earners so as to promote inclusivity and consequently promote poverty alleviation.

Additionally, sensitivity analysis was carried out to determine the effect of changes in certain assumptions on the profit margin. The results, show that the interest rate, mortality, expenses and commission affect the profit margin.

A key challenge for this product is distribution to the customers and way of paying premiums in the most economical way. I suggest that insurance companies work with SACCOs and banks to distribute the product to customers and also use mobile money services to pay premiums.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter consists of a background of the study, problem statement, objectives and significance of the study.

1.2 Background Study

Credit is money that people borrow and pay back usually with interest. Loans are a type of installment credit that can be either secured or unsecured (Harmon and Angela, 2022). Secured loans are better collateralized and unsecured loans are less well collateralized (Rampini and Viswanathan, 2025). Credit assessment might predict ability to pay but it is less effective at guaranteeing willingness to pay in adverse circumstances (Lamech Nsamba and Bannet Tumuhaise, 2025). Credit risk is the potential that a contractual party will fail to meet its obligations in accordance with the agreed terms (Brown and Moles, 2014). According to Zhong et al. (2024), financial service providers utilize loan credit insurance to transfer risk to insurer. Additionally, loan credit insurance (LCI) covers unpaid losses resulting from debtor insolvency, bankruptcy or political upheaval. Upon defaulting the loan, insurers will compensate the lender within the policy terms.

Insurance is a risk management tool that provides financial protection against losses, where an individual or entity pays a premium to an insurer to hedge against potential risk. Insurance is a mechanism through which a person transfers risk to a professional risk carrier in this case an insurance company at a consideration called a premium (IRA, 2024). The insurance company in turn promises to compensate the policyholder when a loss occurs. Insurance is globally known to provide risk transfer, financial intermediation and indemnification. As per IRA (2024), insurance uptake is low standing at 0.87%. The insurance industry not only helps in the development of financial sector, but also promotes economic growth (Ul Din, Abu-Bakar, and Regupathi, 2017). This is through transferring savings to more productive investments in the economy.

According to Serwadda (2018), poor credit risk management policies affect banks' performance adversely as they impact on asset quality which eventually results in increased loan losses plus non-performing loans thereby exposing banks to financial distress. There are high costs of getting

business loans by borrowers because of lack of collateral (Twesiime et al., 2024). Additionally, high interest levels lead to loan default among business borrowers because of low profit margin.

1.3 Problem Statement

In Uganda, financial institutions face a significant credit risk when borrowers are unable to meet their loan obligations due to unforeseen adverse events, such as death and permanent disability. These events leave families burdened with outstanding debts while lenders struggle with increased under-performing loans. Individual lending models, provided by banks and SACCOs, rely on personal responsibility to ensure loan repayment, but it is highly vulnerable to shocks when an individual dies or becomes permanently disabled. The burden of repaying the loan falls on the family members (IRA, 2025), straining their finances. Such events increase the default risks and reduce portfolio quality hence threatening sustainability of the financial institutions. Consequently, the individual's dependents are left with debt obligations they cannot meet, increasing emotional, social and financial hardships. Credit life insurance protects borrowers by settling outstanding loan balances upon death or permanent disability, preventing the debt burden from being transferred to families (IRA, 2025)

Despite the increasing growth of insurance products, there is a gap in tailored credit life insurance solutions that cater to various loan types in Uganda such as individual loans. This contributes to the low insurance penetration of 0.87% (IRA, 2024). Without a tailored insurance solution, the individual and their dependents remains exposed to financial instability whenever the member faces life altering events. This creates a pressing need for an individual credit life insurance product to cover outstanding loan balances in the event of death or permanent disability, thereby protecting individuals and ensuring continuity of their financial efforts.

1.4 Study Objectives

The main objective of this project is to develop a credit insurance product for individual borrowers, providing outstanding loan repayment upon death or permanent disability of the individual.

The specific objectives of the study include;

1. To design an affordable individual credit insurance product that protects both borrowers and financial institutions.

2. To create a profit generating credit insurance policy that appeals to commercial insurance companies

1.5 Significance of the Study

This product is significant for borrowers and financial institutions. The project enables the financial institutions regain their capital that was given out as loans by reducing the burden of default risk and improves their portfolio quality. This enables them expand their lending operations with confidence hence enabling capital formation.

The product enables individuals to access credit from financial institutions especially those that struggle to get bank loans due to lack of hard assets like land or buildings. Additionally, the family of the deceased or disabled member are relieved of the debt obligations, reducing the risk of poverty and preserving dignity. This protection enhances the social impact of lending initiatives.

CHAPTER TWO: MODEL ASSUMPTIONS

2.1 Introduction

This chapter consists of the assumptions used in developing the different sections of the model. These are referred to as the basis and the exact values and their sources are provided below.

Table 1: Assumptions

Assumptions	Value
Sum assured	Outstanding loan balance
Initial expenses	25% of premium
Renewal expenses	5% of premium
Initial commission	20% of premium
Mortality	Kenyan mortality tables
Disability rates	Kenyan disability rates
Inflation rate	3.0%(UBOS)
Risk discount rate	20%
Loan interest rate	18%
Interest rate	15%

2.2 Explanation of Assumptions

Mortality and disability rates; the independent death and disability rates were extracted directly from Kenyan Mortality and disability tables respectively.

Interest rate; the interest rate of 15% was derived from a 5-year Bank of Uganda Treasury bond yield to maturity.

Commission; the commission rate of 25% was the bancassurance commission from 2024 (IRA 2024)

Risk discount rate; risk discount rate of 20% was obtained from the Uganda Life Insurance Market Briefing document (Actuarial Pricing Parameters Report 2026)

Inflation rate; the inflation rate was obtained from the Uganda Bureau of Statistics report (UBOS 2026)

Loan interest rate; the loan interest rate of 18% was obtained from the Bank of Uganda data portal as it was the weighted average lending interest rate for commercial banks (BoU 2026).

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter presents the software, various formulae and techniques that were used in the pricing and profit testing models.

3.2 Software

Microsoft Excel was initially used to develop a pricing, reserving and profit testing model for a single life, a 40- year-old male and female with a policy term of 5 years. The same procedure is then replicated using Python 3.13.9, thereby writing a program that performs the pricing, reserving and profit testing as the Excel model for the given ages and policy terms, depending on the input.

3.3 Formulae

The table below shows the formulae used in the model, defining all the terms and symbols mathematically.

Table 2: Multiple decrements formulae

Output	Formula
$(aq)_x^d$	$q_x^d(1 - 0.5q_x^{di})$
$(aq)_x^{di}$	$q_x^{di}(1 - 0.5q_x^d)$
$(ap)_x$	$1 - ((aq)_x^d + (aq)_x^{di})$
$t - 1(ap)_x$	$(ap)_x * t - 1(ap)_x$ And 1 in the first year
$k/(aq)_x^d$	$(aq)_x^d * t - 1(ap)_x$
$k/(aq)_x^{di}$	$(aq)_x^{di} * t - 1(ap)_x$
V	$(1/ (1 + \text{risk discount rate}))$

Table 3: Pricing formulae

Output	Formula
Discount factor	v^{year}
Death benefit	Outstanding loan balance
EPV Death benefit	Death benefit* $k/(aq)_x^d$ * discount factor
Disability benefit	Outstanding loan balance
EPV Disability benefit	Disability benefit* $k/(aq)_x^{di}$ * discount factor
Initial expenses	25% * premium
Renewal expenses	5% * premium * ((1+inflation rate)^(year – 1))
EPV expenses	Initial expense * $t - 1(ap)_x$ * discount factor Renewal expense * $t - 1(ap)_x$ * discount factor
Commission	20% * premium
EPV Commission	Commission * $t - 1(ap)_x$ * discount factor
Premium	Assumed Premium (Before using Goal Seek)
EPV Premium	Premium * $t - 1(ap)_x$ * discount factor
Equation of Value	EPV Premium – EPV death benefits – EPV disability benefits – EPV Total Expenses -EPV Commission

Table 4: Reserving formulae

Output	Formula
Unit annuity EPV	$t - 1(ap)_x$ * Discount factor
Annuity due factor	Sum of Unity annuity EPV / Unit annuity EPV
Unit death assurance EPV	$k/(aq)_x^d$ * Discount factor
Unit disability EPV	$k/(aq)_x^{di}$ * Discount factor
Death assurance factor	Total of Unit death assurance EPV / Unit annuity EPV
Disability assurance factor	Total of Unit Disability assurance EPV / Unit annuity EPV
EPV death Benefits	Death assurance factor * Discount factor
EPV disability benefits	Disability assurance factor * Discount factor
EPV Premium	Premium * annuity due factor
Reserve	EPV death benefits + EPV disability benefits - EPV premium
Reserve at end of the year	$(ap)_x$ * Reserve at start of the year
Cost of increase in provision	Reserve at the end of the year – Reserve at the start of the year

Table 5: Profit testing formulae

Output	Formula
Interest on cashflows	Interest*(Premium – Expenses – Commission)
Interest on reserves	Interest* Reserve at start of the year
Expected death cost	Sum assured $*(aq)_x^d$
Expected disability cost	Sum assured $*(aq)_x^{di}$
Profit	Premium – Expenses + interest on cashflows +interest on reserves – Expected Death cost – Expected Disability cost + Cost of increase in provision
Discounted Profits	Profits * discount factor * $t - 1(ap)_x$
Discounted Premiums	Premium * $v^{(year-1)} * t - 1(ap)_x$
NPV Profits	Sum of discounted Profits
NPV Premiums	Sum of discounted Premiums
Profit margin	NPV Profits / NPV Premiums

3.4 Description of symbols

$(q)_x^d$: independent probability of death

$(q)_x^{di}$: independent probability of disability

$(aq)_x^d$: dependent probability of death

$(aq)_x^{di}$: dependent probability of disability

$(ap)_x$: dependent probability of survival

$t - 1(ap)_x$: probability of the policy being in force from time 0 to time t-1

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter contains the results from the pricing, reserving and profit testing model as presented below. Sensitivity analysis is also included to show how the profit margins can be affected by changes in some of the assumptions such as interest rates, expenses, commission, mortality.

4.2 Results from the Model

The results brought forth in this section are based on a healthy 40-year-old male and a female, with a policy term of 5 years and a decreasing sum assured based on a loan schedule as provided below.

4.2.1 Loan Schedule

The table below shows the loan schedule for an individual loan with a principal amount of UGX. 10,000,0000. The table includes the annual installments paid, the principal part and the interest part of the installment, and the outstanding loan balance at the start and end of each year.

Table 6: Loan Schedule

Year	Outstanding loan at start	Annuity	Principal	Interest	Outstanding loan balance
1	10,000,000.00	3,197,778.42	1,397,778.4	1,800,000.00	8,602,221.58
2	8,602,221.58	3,197,778.42	1,649,378.533	1,548,399.885	6,952,843.05
3	6,952,843.05	3,197,778.42	1,946,266.669	1,251,511.749	5,006,576.38
4	5,006,576.38	3,197,778.42	2,296,594.67	901,183.7484	2,709,981.71
5	2,709,981.71	3,197,778.42	2,709,981.71	487,796.7078	0

4.2.2 Multiple Decrements

Under this section, the multiple decrements tables for both genders are presented. The tables includes both independent and dependent probabilities.

Table 7: Multiple decrements for a male life

Age(x)	q_x^d	q_x^{di}	$(aq)_x^d$	$(aq)_x^{di}$	$(ap)_x$	$t - 1(ap)_x$
40	0.00232	0.00105	0.002319	0.001049	0.996632	1
41	0.002452	0.00112	0.002451	0.001119	0.996431	0.996632
42	0.002583	0.00121	0.002581	0.001208	0.996210	0.993075
43	0.002709	0.00131	0.002707	0.001308	0.995985	0.989312
44	0.002827	0.00143	0.002825	0.001428	0.995747	0.985339

Table 8: Multiple decrements for a female life

Age(x)	q_x^d	q_x^{di}	$(aq)_x^d$	$(aq)_x^{di}$	$(ap)_x$	$t - 1(ap)_x$
40	0.001524	0.00079	0.001523	0.000789	0.997687	1
41	0.00161	0.00084	0.001609	0.000839	0.997551	0.997687
42	0.001701	0.0009	0.001700	0.000899	0.997401	0.995244
43	0.001793	0.00097	0.001792	0.000969	0.997239	0.992657
44	0.001885	0.00106	0.001884	0.001059	0.997057	0.989916

4.2.3 Pricing Model

The fundamental principle used in pricing is the principle of equivalence, i.e EPV income = EPV outgo. Income is the premium paid by the policyholder while the outgo includes the expenses, commissions and claims paid by the insurer.

The following are the pricing results for the two genders.

Table 9: Expected Present Value of death benefits for male life

Age(x)	Amount (loan + f)	Discount	Probability	EPV
40	10,150,000.00	0.869565	0.002318782	20,465.77
41	8,752,221.58	0.756144	0.002442374	16,163.48
42	7,102,843.05	0.657516	0.002563561	11,972.43
43	5,156,576.38	0.571753	0.00267829	7,896.37
44	2,859,981.71	0.497177	0.002783562	3,957.99
Total				60,456.05

Table 10: EPV of disability benefits for male life

Age(x)	Amount (loan + f)	Discount	Probability	EPV
0	10,150,000.00	0.869565217	0.001049	9,256.64
1	8,752,221.58	0.756143667	0.001115	7,378.07
2	7,102,843.05	0.657516232	0.001200	5,604.60
3	5,156,576.38	0.571753246	0.001294	3,815.80
4	2,859,981.71	0.497176735	0.001407	2,000.70
Total				28,055.82

Table 11: EPV expenses of a male life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
40	6,959.145889	1	1	6,959.146
41	1,433.584053	0.996632	0.869565	1,242.397
42	1,476.591575	0.993075	0.756144	1,108.784
43	1,520.889322	0.989312	0.657516	989.3209
44	1,566.516002	0.985339	0.571753	882.5294
Total				11,182.18

Table 12: EPV of commission of a male life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
40	6,959.146	1	1	6,959.146
41	0	0.996632	0.869565	0
42	0	0.993075	0.756144	0
43	0	0.989312	0.657516	0
44	0	0.985339	0.571753	0
Total				6,959.146

Table 13: EPV premium of a male life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
0	27836.58	1	1	27,836.58
1	27836.58	0.996632	0.869565	24,124.21
2	27836.58	0.993075	0.756144	20,902.7
3	27836.58	0.989312	0.657516	18,107.38
4	27836.58	0.985339	0.571753	15,682.32
Total				106,653.19

Table 14: Annual premium for a male life

premium	27,836.58
----------------	------------------

The EPV income and EPV outgo are both UGX 106,653.19 making the equation of value balance out. This implies that the annual premium of UGX 27,836.58 is accurate and this is what the client being considered will pay in order to get the insurance policy.

This premium, was however calculated by initially using an assumed premium to do all the computations of the model. The Goal seek function, which works backward to find the input value needed to achieve a specific desired formula result. After this has been used, all the initial computations done basing on the assumed premium are automatically adjusted to reflect the values based on the actual premium.

Table 15: EPV of death benefits for a female life

Age(x)	Amount (loan + f)	Discount	Probability	EPV
40	10,150,000.00	0.869565	0.001523398	13,445.64
41	8,752,221.58	0.756144	0.001605602	10,625.77
42	7,102,843.05	0.657516	0.001692149	7,902.73
43	5,156,576.38	0.571753	0.001778971	5,244.92
44	2,859,981.71	0.497177	0.001865003	2,651.88
Total				39,870.94

Table 16: EPV of disability benefits for a female life

Age(x)	Amount (loan + f)	Discount	Probability	EPV
0	10,150,000.00	0.869565217	0.000789398	6,967.30
1	8,752,221.58	0.756143667	0.000837383	5,541.75
2	7,102,843.05	0.657516232	0.000894958	4,179.66
3	5,156,576.38	0.571753246	0.000962014	2,836.30
4	2,859,981.71	0.497176735	0.001048322	1,490.63
Total				21,015.63

Table 17: EPV of expenses for a female life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
0	4,776.66422	1	1	4,776.664
1	983.9928293	0.997687	0.869565	853.667
2	1,013.512614	0.995244	0.756144	762.7165
3	1,043.917993	0.992657	0.657516	681.3529
4	1,075.235532	0.989916	0.571753	608.5701
Total				7,682.971

Table 18: EPV of commission for a female life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
40	4776.664	1	1	4776.664
41	0	0.997687	0.869565	0
42	0	0.995244	0.756144	0
43	0	0.992657	0.657516	0
44	0	0.989916	0.571753	0
Total				4,776.664

Table 19: EPV premium for a female life

Age(x)	Amount	$t - 1(ap)_x$	Discount	EPV
40	19106.66	1	1	19106.66
41	19106.66	0.997687	0.869565	16576.06
42	19106.66	0.995244	0.756144	14378.67
43	19106.66	0.992657	0.657516	12470.69
44	19106.66	0.989916	0.571753	10814.13
Total				73,346.21

Table 20: Annual premium for a female life

Premium	19,106.66
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The EPV income and EPV outgo are both UGX 73,346.21 making the equation of value balance out. This implies that the annual premium of UGX 19,106.66 is accurate and is what the client being considered will pay in order to get the insurance policy.

4.2.4 Reserving

Reserving is the process of setting aside money in respect of a policy that is in force, in order to meet future payments on that policy. This being a conventional insurance product, we need to compute the net premium reserves that will help with profit testing. We compute the prospective reserves at the start of the year, reserves at the end of the year and then find the cost of increase in provisions. Below are the reserves for the both genders.

Table 21: Prospective reserves at start of the year for a male life

Year	Amount	EPV death	EPV disability	EPV Premium	Reserve
1	10,150,000.00	85909.03297	40433.33768	106653.1875	19689.18318
2	8,752,221.58	65114.84626	31020.24195	90945.35882	5189.729387
3	7,102,843.05	43519.26827	21080.36778	72835.05836	-8235.422313
4	5,156,576.38	23109.82413	11411.549	51945.11148	-17423.73835
5	2,859,981.71	7025.55426	3551.298218	27836.58356	-17259.73108

Table 22: Reserves at end of year and cost of increase in provisions for a male life

Age(x)	Year	Reserve at start of year	$(ap)_x$	Reserve at end of year	Cost of increase in provision
40	1	19689.18318	0.996632	19622.8786	-66.30458448
41	2	5189.729387	0.996431	5171.205926	-18.52346113
42	3	-8235.422313	0.99621	-8204.211095	31.2112176
43	4	-17423.73835	0.995985	-17353.77418	69.96417125
44	5	-17259.73108	0.995747	0	17259.73108

Table 23: Prospective reserves at start of the year for a female life

Year	Amount	EPV death	EPV disability	EPV Premium	Reserve
1	10,150,000.00	56796.7936	30239.89628	73346.20698	13690.4829
2	8,752,221.58	43087.99891	23131.33075	62520.07881	3699.250853
3	7,102,843.05	28853.02518	15664.77047	50047.9851	-5530.189446
4	5,156,576.38	15361.52364	8463.323008	35675.2642	-11850.41755
5	2,859,981.71	4685.398486	2633.672477	19106.65688	-11787.58592

Table 24: Reserves at end of year and cost of increase in provisions for a female life

Age(x)	Year	Reserve at start of year	$(ap)_x$	Reserve at end of year	Cost of increase in provision
40	1	13690.4829	0.997687	13658.8196	-31.66329463
41	2	3699.250853	0.997551	3690.192691	-9.058161723
42	3	-5530.189446	0.997401	-5515.813889	14.37555658
43	4	-11850.41755	0.997239	-11817.69545	32.72209332
44	5	-11787.58592	0.997057	0	11787.58592

4.2.5 Profit Testing

Profit testing is the process of projecting the income and outgo emerging from a policy, and discounting the results(ActEd, n.d.). In order to determine if the product will be profitable for the insurance company, a profit testing model is developed. It includes the projected cashflows for a policy in force at the start of each year and the discounted cashflows as shown in the tables that follow.

Table 25: Projected cashflows for a male life.

Year	Premium	Expenses	Commission	Interest on other Cashflows	Interest on Reserves	Expected Death Cost	Expected disability cost	Cost of increase in Provisions	Profit
1	27836.58	6959.145889	6959.146	2087.743767	2953.377	23,535.64	10,645.14	-66.3046	(15,287.67)
2	27836.58	1433.584053	0	3960.449925	778.4594	21,448.43	9,790.47	-18.5235	(115.51)
3	27836.58	1476.591575	0	3953.998797	-1235.31	18,335.54	8,583.34	31.21122	2,191.00
4	27836.58	1520.889322	0	3947.354135	-2613.56	13,960.02	6,745.97	69.96417	7,013.47
5	27836.58	1566.516002	0	3940.510133	-2588.96	8,079.39	4,083.99	17259.73	32,717.97

Table 26: Net present value of profits and premium for a male life

Year	$t - 1(ap)_x$	Profit	v^t	Premium	v^{t-1}	PV profits	PV premiums
1	1	(15,287.67)	0.833333	27836.58	1	(12,739.72)	27836.58356
2	0.996632	(115.51)	0.694444	27836.58	0.833333	(79.95)	23119.03507
3	0.993075	2,191.00	0.578704	27836.58	0.694444	1,259.16	19197.0978
4	0.989312	7,013.47	0.482253	27836.58	0.578704	3,346.12	15936.95267
5	0.985339	32,717.97	0.401878	27836.58	0.482253	12,955.85	13227.46552
NPV						4,741.46	99317.13461

Table 27: Profit margin for a male life

Profit margin	4.7741%
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Table 28: Projected cashflows for a female life.

Year	Premium	Expenses	Commission	Interest on other Cashflows	Interest on Reserves	Expected Death Cost	Expected Disability Cost	Cost of increase in Provisions	Profit
1	19106.66	4776.66422	4776.66422	1432.999266	2053.572	15,462.49	8,012.39	-31.6633	(10,466.64)
2	19106.66	983.9928293	0	2718.399607	554.8876	14,085.16	7,345.95	-9.05816	(44.21)
3	19106.66	1013.512614	0	2713.97164	-829.528	12,076.50	6,387.12	14.37556	1,528.34
4	19106.66	1043.917993	0	2709.410833	-1777.56	9,241.26	4,997.39	32.72209	4,788.66
5	19106.66	1075.235532	0	2704.713202	-1768.14	5,388.21	3,028.72	11787.59	22,338.65

Table 29: Net present value of profits and premium for a female life

Year	$t - 1(ap)_x$	Profit	v^t	Premium	v^{t-1}	PV Profits	PV Premiums
1	1	(10,466.64)	0.833333	19106.66	1	(8,722.20)	19106.65688
2	0.997687	(44.21)	0.694444	19106.66	0.833333	(30.63)	15885.38923
3	0.995244	1,528.34	0.578704	19106.66	0.694444	880.25	13205.40959
4	0.992657	4,788.66	0.482253	19106.66	0.578704	2,292.39	10975.90212
5	0.989916	22,338.65	0.401878	19106.66	0.482253	8,886.88	9121.32899
NPV						3,306.68	68294.68681

Table 30: Profit margin for a female life

Profit Margin	4.8418%
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Table 31: Profit margins for male lives.

Age(x)	Policy terms			
	3	4	5	6
25	8.70%	5.54%	3.19%	1.28%
26	8.71%	5.42%	2.99%	1.02%
27	8.70%	5.35%	2.88%	0.91%
28	8.70%	5.33%	2.87%	0.97%
29	8.69%	5.33%	2.94%	1.19%
30	8.68%	5.38%	3.14%	1.57%
31	8.65%	5.49%	3.42%	2.07%
32	8.65%	5.63%	3.77%	2.62%
33	8.62%	5.78%	4.08%	3.10%
34	8.62%	5.92%	4.36%	3.49%
35	8.62%	6.01%	4.55%	3.74%
36	8.61%	6.08%	4.66%	3.90%
37	8.62%	6.11%	4.72%	3.98%
38	8.61%	6.11%	4.74%	4.02%
39	8.61%	6.13%	4.77%	4.05%
40	8.60%	6.14%	4.77%	4.03%
41	8.61%	6.13%	4.75%	3.97%
42	8.60%	6.11%	4.69%	3.87%
43	8.61%	6.09%	4.63%	3.76%
44	8.61%	6.05%	4.55%	3.63%
45	8.61%	6.02%	4.47%	3.49%
46	8.61%	5.98%	4.39%	3.36%
47	8.61%	5.94%	4.30%	3.23%
48	8.61%	5.91%	4.23%	3.14%
49	8.61%	5.88%	4.18%	3.09%
50	8.61%	5.85%	4.17%	3.11%
51	8.60%	5.86%	4.20%	3.33%

52	8.59%	5.88%	4.37%	3.86%
53	8.58%	5.92%	4.78%	4.61%
54	8.45%	6.18%	5.35%	5.41%
55	8.46%	6.49%	5.84%	6.01%
56	8.46%	6.56%	5.96%	6.15%
57	8.45%	6.56%	5.96%	6.16%
58	8.43%	6.54%	5.94%	6.12%
59	8.42%	6.51%	5.90%	6.06%
60	8.40%	6.48%	5.85%	5.98%

Table 32: Profit margins for female lives.

Age(x)	Policy Term			
	3	4	5	6
25	8.72%	5.30%	2.69%	0.45%
26	8.72%	5.23%	2.52%	0.21%
27	8.74%	5.15%	2.38%	0.06%
28	8.72%	5.09%	2.31%	0.05%
29	8.72%	5.09%	2.39%	0.27%
30	8.70%	5.14%	2.57%	0.62%
31	8.68%	5.26%	2.86%	1.14%
32	8.67%	5.39%	3.20%	1.73%
33	8.66%	5.54%	3.57%	2.32%
34	8.63%	5.72%	3.95%	2.87%
35	8.63%	5.87%	4.25%	3.30%
36	8.63%	5.97%	4.44%	3.57%
37	8.63%	6.03%	4.57%	3.78%
38	8.63%	6.08%	4.68%	3.95%
39	8.61%	6.12%	4.76%	4.08%
40	8.61%	6.16%	4.84%	4.36%

41	8.61%	6.18%	5.00%	4.79%
42	8.60%	6.22%	5.34%	5.27%
43	8.48%	6.45%	5.70%	5.68%
44	8.57%	6.64%	5.90%	5.86%
45	8.56%	6.56%	5.76%	5.67%
46	8.55%	6.52%	5.69%	5.56%
47	8.56%	6.49%	5.63%	5.48%
48	8.55%	6.46%	5.57%	5.41%
49	8.55%	6.44%	5.54%	5.38%
50	8.54%	6.42%	5.52%	5.37%
51	8.53%	6.41%	5.54%	5.42%
52	8.52%	6.41%	5.56%	5.47%
53	8.50%	6.42%	5.59%	5.53%
54	8.49%	6.43%	5.62%	5.57%
55	8.48%	6.42%	5.63%	5.60%
56	8.46%	6.42%	5.63%	5.60%
57	8.45%	6.41%	5.62%	5.58%
58	8.44%	8.39%	5.59%	5.53%
59	8.42%	6.36%	5.54%	5.47%
60	8.40%	6.32%	5.49%	5.40%

4.3 Analysis of Results

The graphs below depict the variation in profit margins across the different policy terms and ages for both genders. The longer the policy term, the lower the profit for both males and females, this is because short term policies are more profitable than long term policies as the mortality increases with age, thus increasing chances of claims.

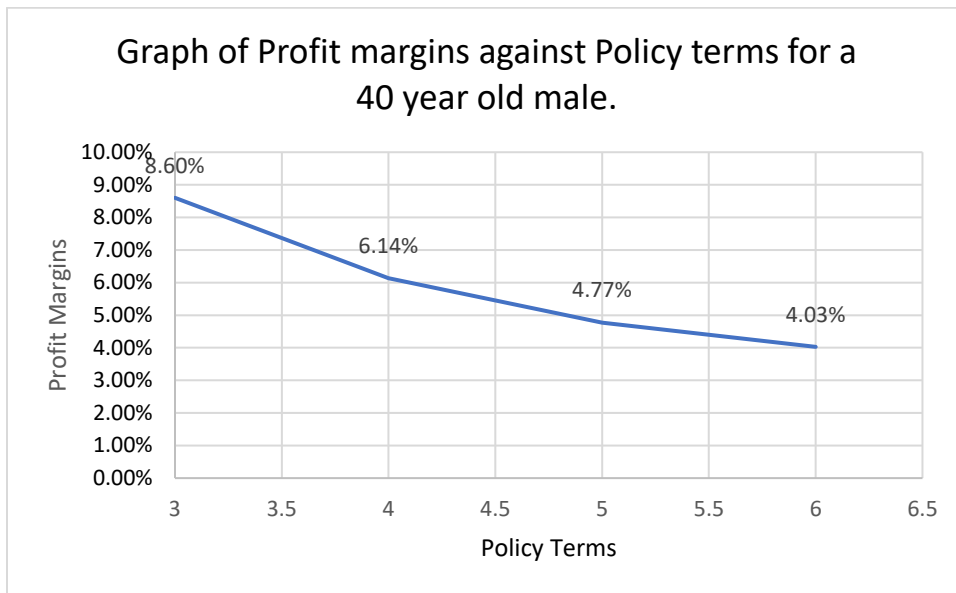


Figure 1: Variations in Profit Margin with policy terms for a 40-year-old male

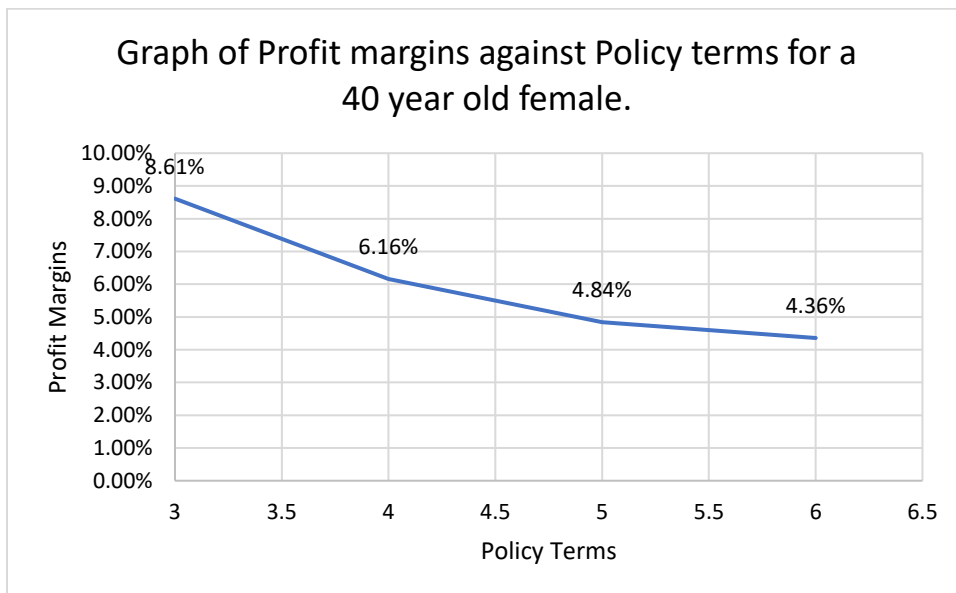


Figure 2: Variations in Profit Margin with policy terms for a 40-year-old male

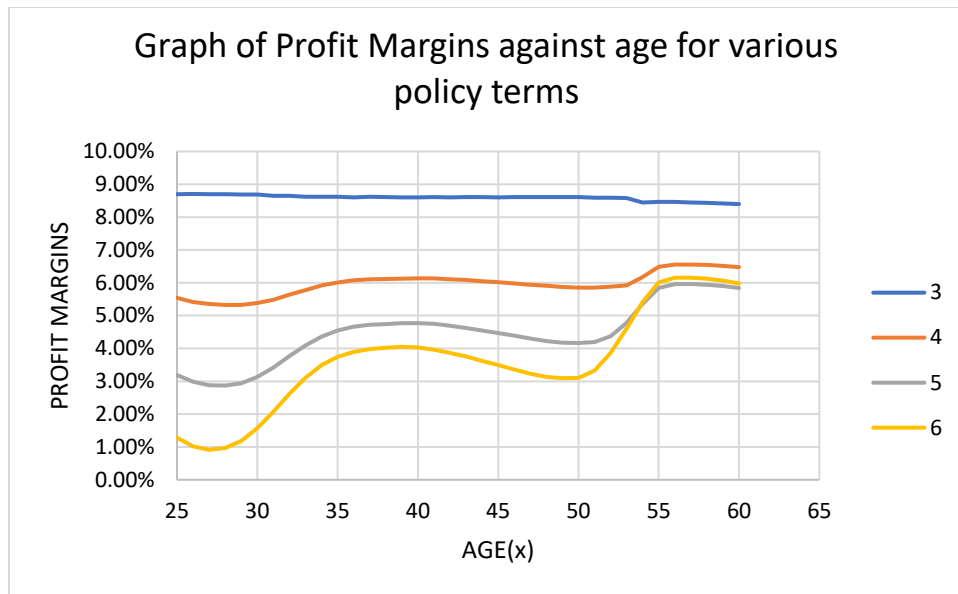


Figure 3: Variation of Profit Margin with age for different policy terms for males.

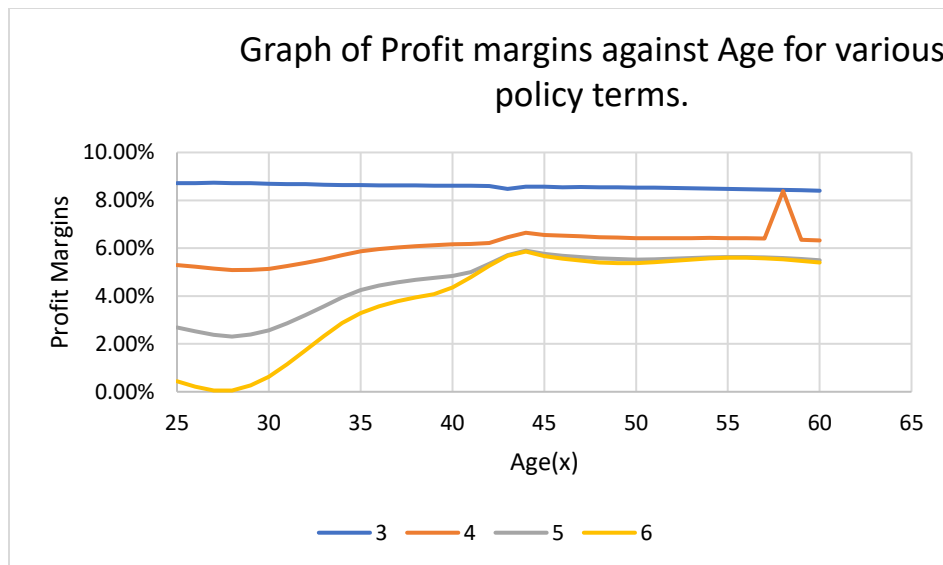


Figure 4: Variation of Profit Margin with age for different policy terms for females.

Generally, the profit margins increase with advancement in age, with an exemption of the short-term policy and the earlier ages between 25-30 years of age because the mortality and disability rates within this age interval are relatively high compared to the consequent ages.

The profit margin decreases as the policy term increases.

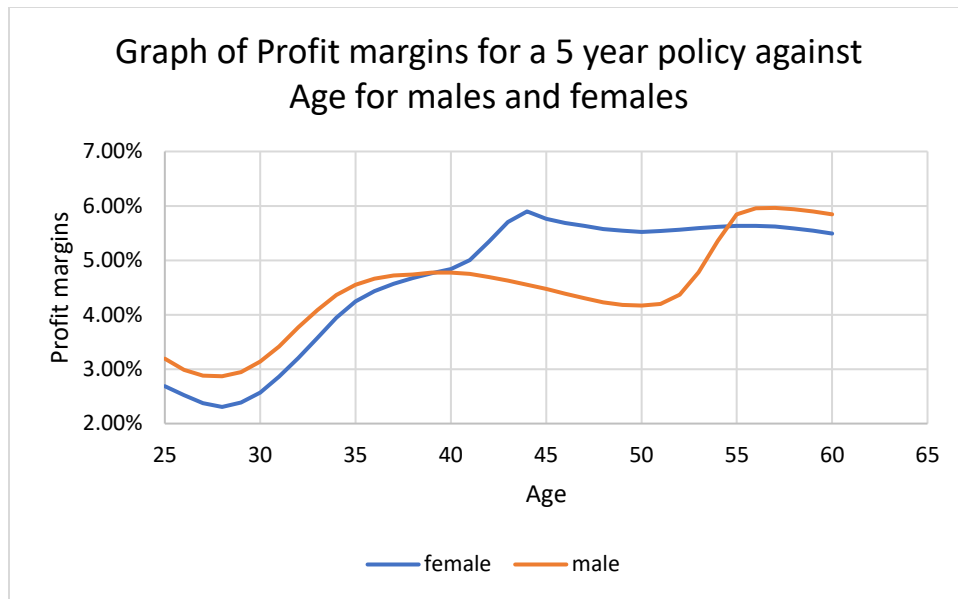


Figure 5: Variations of Profit Margin with Age.

In conclusion, the product is more profitable for females between the ages of 40 and 55 compared to males, and its more profitable for males between 25-40 and 55-60 compared to females. Both males and females have profit margins that are almost the same for the 3-year and 4-year policy terms. Additionally, profit increases with advancement age for both males and females.

4.4 Sensitivity Analysis

This section shows the analysis on how profit margin changes when certain assumptions, for example interest rate, expenses, commission and mortality rate, are varied.

Table 4.23: Sensitivity analysis for a male life

Assumptions	Change	%age change	Profit margin	Comment
Mortality	Increase	10%	4.7654%	Increase in mortality leads to decrease in profit margin and decrease in mortality leads to increase in profit margin.
	Standard	0%	4.7741%	
	Decrease	10%	4.7849%	
Commission	Increase	10%	4.5048%	Increase in commission leads to decrease in profit margin and decrease in commission leads to increase in profit margin.
	Standard	0%	4.7741%	
	Decrease	10%	5.0433%	
Expenses	Increase	10%	4.3800%	Increase in expenses leads to decrease in profit margin and decrease in expenses leads to increase in profit margin.
	Standard	0%	4.7741%	
	Decrease	10%	5.1681%	
Interest	Increase	10%	5.0911%	Increase in interest leads to increase in profit margin and decrease in interest leads to decrease in profit margin.
	Standard	0%	4.7741%	
	Decrease	10%	4.4788%	

Table 4.24: Sensitivity analysis for a female life

Assumptions	Change	%age change	Profit margin	Comment
Mortality	Increase	10%	4.8351%	Increase in mortality leads to decrease in profit margin and decrease in mortality leads to increase in profit margin.
	Standard	0%	4.8418%	
	Decrease	10%	4.8499%	
Commission	Increase	10%	4.5706%	Increase in commission leads to decrease in profit margin and decrease in commission leads to increase in profit margin.
	Standard	0%	4.8418%	
	Decrease	10%	5.1129%	
Expenses	Increase	10%	4.4442%	Increase in expenses leads to decrease in profit margin and decrease in expenses leads to increase in profit margin.
	Standard	0%	4.8418%	
	Decrease	10%	5.2394%	
Interest	Increase	10%	5.1525%	Increase in interest leads to increase in profit margin and decrease in interest leads to decrease in profit margin.
	Standard	0%	4.8418%	
	Decrease	10%	4.5532%	

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter consists of the conclusions drawn from the results, setbacks and recommendations to fill the gaps and other suggestions of the research.

5.2 Conclusion

From the analysis done above, the product is more profitable for females between the ages of 40 and 55 compared to males, and its more profitable for males between 25-40 and 55-60 compared to females. Generally, the product is affordable because of its nature of having a decreasing sum assured which is the outstanding loan balance.

Mortality, interest rate, commission and expenses are the most sensitive assumptions where a slight change in these assumptions causes a change in the profit margin. Mortality, commission and expenses are inversely proportional to profitability of the product, that is an increase in mortality, expenses or commission leads to a decrease in profit margin with profit margin being more sensitive to change in expenses than commission and mortality. The change in interest is directly proportional to profit margin, that is, an increase in interest rate leads to increase in profit margin of the product.

5.3 Recommendations

The insurer should preferably focus on promoting short term policies as they are more profitable compared to the long-term policies. They should also regularly monitor the interest rate, expenses and commission as the product is sensitive to change in these assumptions.

Additionally, in order to ease the premium payment process for its clients, the insurers could partner with digital financial service providers like MTN Mobile Money, Airtel Money to provide convenient payment services to their clients. The insurers could also work with the financial institutions to sale their product to loan applicants, thereby increasing the number of people they reach out to for product marketing and sales.

The model utilizes the gross premium to do the reserving which is consequently used in the cashflow to find the profits. Therefore, the next researcher could find ways of using the net premium to find the net reserves accurately.

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APPENDICES

Appendix 1: Variation in premium across all ages for a 5-year policy

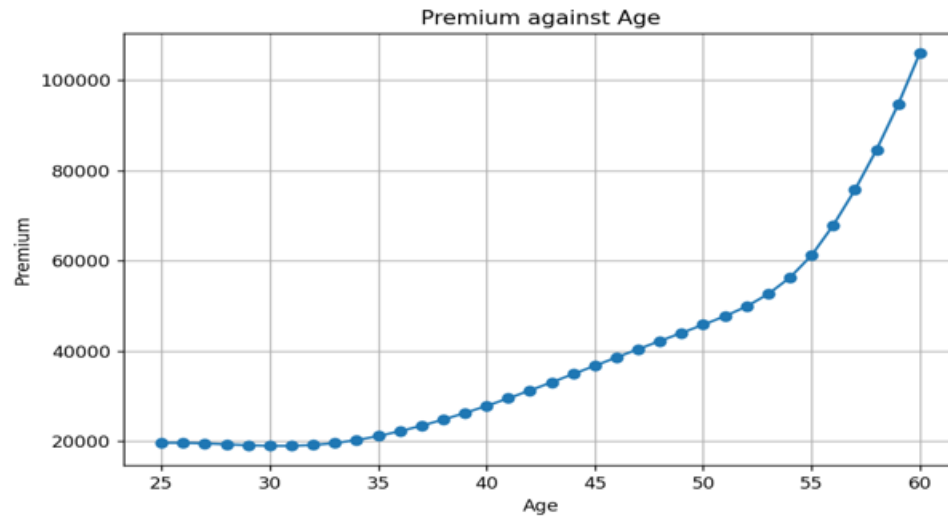


Figure 6: Premium of male lives across all ages for a 5-year policy.

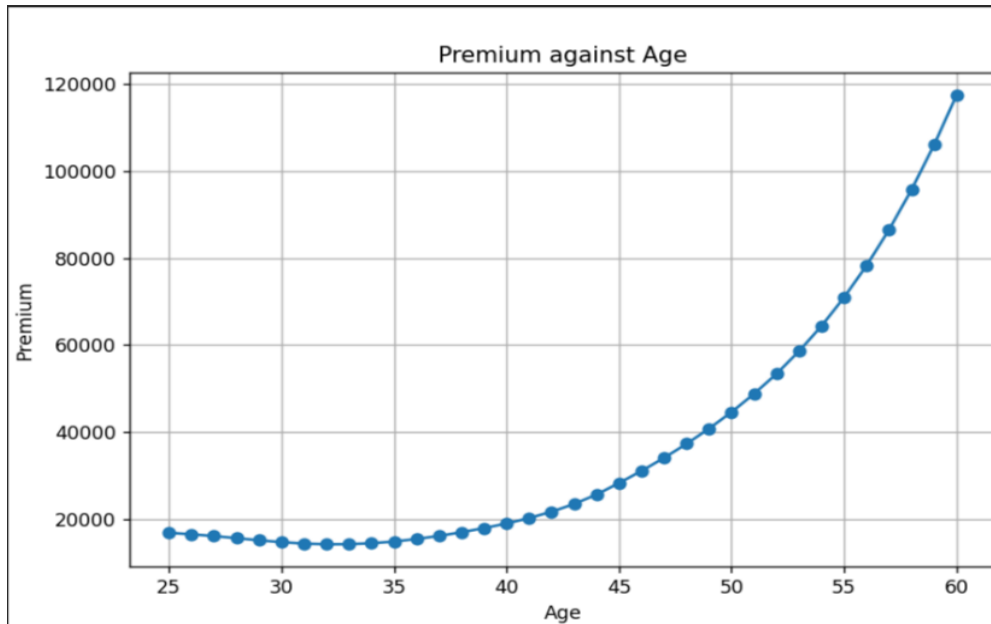


Figure 7: Premium of female lives across all ages for a 5-year policy.

Appendix 2: Python Programme Output

```
Enter your date of birth(YYYY-MM-DD):1986-01-09
AGE: 40
```

```
Please enter an insured value:10000000
```

```
Please enter an assumed premium value:200000
Desired term(range between 3 to 6):5
Enter your gender(Male or Female):male
```

Welcome!

1. Multiple Decrements Table
2. Loan Schedule
3. Pricing Model
4. Reserving Model
5. Profit Testing Model
6. Display only Premium
7. Display only Profit Margin
8. Display table of premium and profit margins across all ages
9. Display table of profit margin across all ages for all policy terms
10. Generate chart of premium against age
11. Generate chart of profit margin against age
12. Generate chart of profit margin against age for all policy terms
13. Terminate the program

```
Please Select an Option to display what you would like to view:1
```

Multiple Decrements

Age	Death rate	Disability rate	Dep.death.rates	Dep.disability.rate	Survival.rate	Based.Survival	Year
40	0.0023200000	0.0010500000	0.0023187820	0.0010487820	0.9966324360	1.0000000000	1
41	0.0024520000	0.0011200000	0.0024506269	0.0011186269	0.9964307462	0.9966324360	2
42	0.0025830000	0.0012100000	0.0025814373	0.0012084373	0.9962101254	0.9930752019	3
43	0.0027090000	0.0013100000	0.0027072256	0.0013082256	0.9959845488	0.9893115715	4
44	0.0028270000	0.0014300000	0.0028249787	0.0014279787	0.9957470426	0.9853390391	5

Year	Age	Opening Balance	Interest	Installment	\
0	1	40	10,000,000.0000000000	1,800,000.0000000000	3,197,778.4179478688
1	2	41	8,602,221.5820521303	1,548,399.8847693834	3,197,778.4179478688
2	3	42	6,952,843.0488736443	1,251,511.7487972560	3,197,778.4179478688
3	4	43	5,006,576.3797230311	901,183.7483501455	3,197,778.4179478688
4	5	44	2,709,981.7101253076	487,796.7078225553	3,197,778.4179478688
		Principal Repayment	Closing Balance	Sum at Risk	
0	1,397,778.4179478688	8,602,221.5820521303	10,150,000.0000000000		
1	1,649,378.5331784855	6,952,843.0488736443	8,752,221.5820521303		
2	1,946,266.6691506128	5,006,576.3797230311	7,102,843.0488736443		
3	2,296,594.6695977235	2,709,981.7101253076	5,156,576.3797230311		
4	2,709,981.7101253136	0.0000000000	2,859,981.7101253076		

Please Select an Option to display what you would like to view:3

Pricing Model

Year	Exp.DeathB	Discount Factor	EPV.DeathB	Exp.DisabilityB	EPV.DisabilityB	EPV.Benefit
1	23,535.6373000000	0.8695652174	20,465.7715652174	10,645.1373000000	9,256.6411304348	29,722.4126956522
2	21,376.2005097578	0.7561436673	16,163.4786463197	9,757.5002860022	7,378.0720499072	23,541.5506962268
3	18,208.5739370301	0.6575162324	11,972.4329330353	8,523.9024709393	5,604.6042383097	17,577.0371713451
4	13,810.8049802982	0.5717532456	7,896.3725717379	6,673.8614866520	3,815.8019656316	11,712.1745373696
5	7,960.9358166791	0.4971767353	3,957.9920792557	4,024.1176893124	2,000.6976952284	5,958.6897744842

Total Benefits: 88511.86487507785

Year	Based.Survival	Discount factorE	Inflated Expense	Expense	EPV.Expense	Commission	EPV.Commission	EPV.ExpenCom
1	1.0000000000	1.0000000000	50,000.0000000000	50,000.0000000000	50,000.0000000000	50,000.0000000000	50,000.0000000000	100,000.0000000000
2	0.9966324360	0.8695652174	10,300.0000000000	10,265.3140908000	8,926.3600789565	0.0000000000	0.0000000000	8,926.3600789565
3	0.9930752019	0.7561436673	10,609.0000000000	10,535.5348172803	7,966.3779336713	0.0000000000	0.0000000000	7,966.3779336713
4	0.9893115715	0.6575162324	10,927.2700000000	10,810.4746556488	7,108.0625663837	0.0000000000	0.0000000000	7,108.0625663837
5	0.9853390391	0.5717532456	11,255.0881000000	11,090.0776937755	6,340.7879152950	0.0000000000	0.0000000000	6,340.7879152950

Total Expenses and Commissions: 130341.58849430662

Year	Discount factorE	Premium	Based.Survival	Exp.Premium	EPV.Premium
1	1.0000000000	200000	1.0000000000	200,000.0000000000	200,000.0000000000
2	0.8695652174	200000	0.9966324360	199,326.4872000000	173,327.3801739131
3	0.7561436673	200000	0.9930752019	198,615.0403860938	150,181.5050178403
4	0.6575162324	200000	0.9893115715	197,862.3142953150	130,097.6834357295
5	0.5717532456	200000	0.9853390391	197,067.8078259645	112,674.1587263994

Total Premiums are:766280.7273538823

Total Expected Outgo is:218853.45336938446

Total Expected Income is:766280.7273538823

Please Select an Option to display what you would like to view:5

Profit Testing Model

Year	premium	expenses	commission	interest on other	interest on reserves	exp_death_cost	exp_disability_cost	cost_of_increase_in_provisions	profit
1	27,836.5835554029	6,959.1458888507	6,959.1458888507	2,087.7437666552	2,953.3774776358	23,535.6373000000	10,645.1373000000	-66.3045844806	-15,287.6661624882
2	27,836.5835554029	1,433.5840531033	0.0000000000	3,960.4499253450	778.4594080145	21,448.4294686931	9,790.4703213996	-18.5234611271	-115.5144155606
3	27,836.5835554029	1,476.5915746963	0.0000000000	3,953.9987971060	-1,235.3133468826	18,335.5438758655	8,583.3403697620	31.2112175955	2,191.0044028981
4	27,836.5835554029	1,520.8893219372	0.0000000000	3,947.3541350199	-2,613.5607528890	13,960.0156093244	6,745.9652540919	69.9641712506	7,013.4709234309
5	27,836.5835554029	1,566.5160015954	0.0000000000	3,940.5101330711	-2,588.9596616571	8,079.3873991937	4,083.9929501486	17,259.7310777140	32,717.9687535934

Year	discount_factor_pro	discount_fcator_prem	PV.Profits	PV.premiums
1	0.8333333333	1.0000000000	-12,739.7218020735	27,836.5835554029
2	0.6944444444	0.8333333333	-79.9482037315	23,119.0350656156
3	0.5787037037	0.6944444444	1,259.1621179621	19,197.0978023168
4	0.4822530864	0.5787037037	3,346.1168695817	15,936.9526746150
5	0.4018775720	0.4822530864	12,955.8464722967	13,227.4655155950

Net Present Value of Profits is:4741.4555

Net Present Value of Premiums is:99317.1346

Profit margin is:4.7741 %

Please Select an Option to display what you would like to view:8

	Age	Premium	Profit Margin
0	25	19,656.4521556888	3.1927756540
1	26	19,666.2111049035	2.9873346142
2	27	19,531.4716779187	2.8813632044
3	28	19,323.4214595417	2.8698089144
4	29	19,122.9473700073	2.9429178850
5	30	18,981.5334689286	3.1374527670
6	31	18,980.1821052243	3.4183223864
7	32	19,165.0563882237	3.7689132801
8	33	19,597.3540482873	4.0841887772
9	34	20,258.4573296340	4.3618588500
10	35	21,149.3730286655	4.5486802935
11	36	22,221.9088586891	4.6602002336
12	37	23,446.8940023611	4.7188287409
13	38	24,808.5125253290	4.7398640614
14	39	26,263.1113151266	4.7723373196
15	40	27,836.5835554029	4.7740558288
16	41	29,509.6549888923	4.7481674201
17	42	31,264.9359014119	4.6899279225
18	43	33,063.7974915695	4.6268521607
19	44	34,901.7138821898	4.5499768897
20	45	36,744.7770698922	4.4731903294
21	46	38,590.6780131219	4.3887270544
22	47	40,425.6831985167	4.3019124174
23	48	42,228.4339212134	4.2294506190
24	49	44,021.9395456632	4.1788965595
25	50	45,835.9040723525	4.1671509049
26	51	47,722.9075019044	4.1966454251
27	52	49,887.9597340380	4.3674682670
28	53	52,642.0118334809	4.7810727661
29	54	56,275.9665377156	5.3541126528
30	55	61,202.1244871295	5.8428331650
31	56	67,873.5413065555	5.9582742980
32	57	75,717.5316250039	5.9633276299
33	58	84,630.2932920162	5.9403994824
34	59	94,709.5805738477	5.9001070272
35	60	106,068.5680140500	5.8475414837

Please Select an Option to display what you would like to view:9

Term	3	4	5	6
Age				
25	8.7030756246	5.5366076986	3.1927756540	1.2769825287
26	8.7065184810	5.4184717368	2.9873346142	1.0168088831
27	8.6979735062	5.3520468472	2.8813632044	0.9130403234
28	8.7017487703	5.3256435452	2.8698089144	0.9725891954
29	8.6869458941	5.3310254633	2.9429178850	1.1854799335
30	8.6843221603	5.3818460669	3.1374527670	1.5697472457
31	8.6516650271	5.4851082577	3.4183223864	2.0668119950
32	8.6480648090	5.6337000925	3.7689132801	2.6171898335
33	8.6241597181	5.7767063816	4.0841887772	3.0996311018
34	8.6203757949	5.9162843156	4.3618588500	3.4938644139
35	8.6168604020	6.0083621306	4.5486802935	3.7439162818
36	8.6054716475	6.0784147414	4.6602002336	3.8960300306
37	8.6188646064	6.1097653757	4.7188287409	3.9831749944
38	8.6074808826	6.1116652786	4.7398640614	4.0166545384
39	8.6061474573	6.1288416662	4.7723373196	4.0462511736
40	8.6003877696	6.1385629070	4.7740558288	4.0278796345
41	8.6070098059	6.1321651859	4.7481674201	3.9653640150
42	8.6020954426	6.1105053515	4.6899279225	3.8655165955
43	8.6079871676	6.0852041392	4.6268521607	3.7558482356
44	8.6067527440	6.0492072594	4.5499768897	3.6252733982
45	8.6058968140	6.0197314287	4.4731903294	3.4948347277
46	8.6107694853	5.9838158462	4.3887270544	3.3602170733
47	8.6107964323	5.9419477583	4.3019124174	3.2293356362
48	8.6112634109	5.9063912589	4.2294506190	3.1355236042
49	8.6100884156	5.8763721567	4.1788965595	3.0910318371
50	8.6101540148	5.8534861085	4.1671509049	3.1066241252
51	8.5954149474	5.8555520717	4.1966454251	3.3291736872
52	8.5939330940	5.8779970260	4.3674682670	3.8636333433
53	8.5815673200	5.9241907660	4.7810727661	4.6087772538
54	8.4499587560	6.1756696880	5.3541126528	5.4096466315
55	8.4641471178	6.4863183846	5.8428331650	6.0127061754
56	8.4632927332	6.5565236414	5.9582742980	6.1523899914
57	8.4485120568	6.5560244962	5.9633276299	6.1560206913
58	8.4337139147	6.5404671949	5.9403994824	6.1237073348
59	8.4184632368	6.5115689555	5.9001070272	6.0642072940
60	8.3972395152	6.4781010025	5.8475414837	5.9838143140

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Welcome!
1. Multiple Decrements Table
2. Loan Schedule
3. Pricing Model
4. Reserving Model
5. Profit Testing Model
6. Display only Premium
7. Display only Profit Margin
8. Display table of premium and profit margins across all ages
9. Display table of profit margin across all ages for all policy terms
10. Generate chart of premium against age
11. Generate chart of profit margin against age
12. Generate chart of profit margin against age for all policy terms
13. Terminate the program

Please Select an Option to display what you would like to view:13

Exiting program
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