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A PRICING AND PROFIT TESTING MODEL FOR A UNIT-LINKED ENDOWMENT MICROINSURANCE PLAN FOR FOOD MARKET VENDORS

BY

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AUGUST 2026

DECLARATION

I, Nangani Edgar, hereby declare that the information contained in this dissertation is my own authentic work and has not been submitted to any college, university or institute for an academic award.

Signature:..... Date:21/08/2026.....

APPROVAL

This research project has been submitted for examination with my approval as the student's university supervisor.

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DEDICATION

I dedicate this project to my loving parents, Mugoya Robert and Kasuubo Esther, who have been my inspiration and a foundation on which I have based to aim higher in life.

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First and foremost, I would like to thank the Almighty Lord. It is only by His Grace that I have been able to do all things that I have done while pursuing my undergraduate degree. All praise and glory belong to Him.

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LIST OF ACRONYMS

BOU	Bank of Uganda
CPI	Consumer Price Index
IRA	Insurance Regulatory Authority
NPV	Net Present Value
EPV	Net Present Value
UBOS	Uganda Bureau of Statistics
GWP	Gross Written Premiums
GDP	Gross Domestic Product
AIO	African Insurance Organisation
KCCA	Kampala Capital City Authority
USD	United States Dollar

ABSTRACT

The objective of this project was to design a unit-linked endowment life microinsurance product for the food market vendors in Uganda, that pays a benefit to the insured in case of permanent disability, death, surrender or on survival to the end of the policy term. Vendors are a vulnerable low-income group since their livelihoods depend on daily sales, and failure to make them can quickly cause financial hardship for them and their families.

The policy designed has three decrements; death, permanent disability and surrender. Various assumptions have been made in the pricing and profit testing models. Premiums have been calculated based on the principle of equivalence and profit margins over various ages and policy terms have also been computed. Microsoft Excel and Python 3.13.9 were used to develop the pricing and profit testing models.

The results show that the ideal terms considered for the policy are five - and ten - year terms, covering clients between 20 and 60 years. Premiums generally ranged between UGX 60,522.96 and UGX 212,351.90 annually while profit margins fell between 4.06% and 15.13% across all ages and policy terms. The results also showed that the premiums tend to increase with age across all policy terms.

Furthermore, sensitivity analysis was also carried out to determine the effect of changes in certain variables on the profit margin. In the results, the risk discount rate, management charge and initial expenses had the highest effect on profit margin while the inflation rate had the lowest effect on profit margin.

Finally, upon achievement of the project objectives, the primary challenge identified was delivering the product to the food market vendors and prompt premium collection. One of the suggestions made to solve this problem was for insurers to partner with mobile money providers such as MTN and Airtel and with market vendor associations to facilitate group enrollment and easy payments.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter entails an overview of the insurance sector; it's development from Uganda to East Africa and across the globe, the project's problem statement, objectives and significance are also described.

1.2 Background to the Study

Insurance is a contractual arrangement in which an individual or business transfers the financial consequences of certain risks to an insurer, who pools these risks and provides compensation when losses occur (Andoh, 2026). Insurance is not just about compensation but also about reducing the shock when losses happen, by ensuring preparedness and financial resilience.

Insurance begins with risk transfer, where individuals or businesses shift the financial burden of uncertain events to an insurer. This is sustained through risk pooling, in which the insurer combines many similar risks from different policyholders, making losses more predictable and manageable. To maintain this system, policyholders pay premiums and these are regular contributions that fund the pool and enable the insurer to cover claims. Finally, insurance provides indemnity, meaning compensation or financial restoration when a covered loss occurs, helping the insured return to their prior financial position (Dionne, 2000). There are two major types of insurance; life insurance which safeguards families and dependents against mortality and longevity risks, and non-life insurance which covers property, health and liability exposures (Liedtke, 2007).

The insurance industry globally has grown at a rate of 10% since 1950 (Browne & Kim, 1993). Insurance globalization has been facilitated by the technical revolution in transport, communication, and data processing (Nayak & Mishra, 2014). The insurance industry in Africa has been growing quickly as more families, businesses, and governments buy life insurance, non-life insurance, and reinsurance. In 2019, insurance premiums across the continent were worth about USD 68.15 billion. Most of this came from just a few countries; South Africa, Kenya, Egypt, Nigeria, Algeria, Angola, and Tunisia, which together made up about 83% of all premiums in Africa that year (Signé & Johnson, 2020).

Insurance penetration is defined as gross written premiums (GWP) expressed as a percentage of Gross Domestic Product (GDP) (Deloitte, 2025). It indicates the relative size of the insurance sector compared to the overall economy. According to the African Insurance Organization's (AIO) annual report for 2025 the insurance penetration in Africa remains low compared to global levels. While the worldwide penetration rate reached 7.4% in 2024, Africa's average was only about 2% of GDP. South Africa continues to dominate the continent's insurance market, contributing 83% of life premiums and 54 % of non-life premiums, while most other countries, such as Uganda, Nigeria, and Tanzania, record penetration rates of less than 1% (AIO, 2025).

Uganda being a developing country is comprised of mostly individuals with low levels of income and this creates the need to develop the micro-insurance sector. Microinsurance is insurance specifically designed for low-income households and it's commonly referred to as "insurance of the poor" (Platteau, De Bock, & Gelade, 2017). The uptake of micro-insurance in Uganda was evidenced by the 242.7% growth to UGX 2.1 billion from UGX 61 million in 2024 (IRA, 2025).

Uganda's economy is dominated by informal workers (Mugoda, Esaku, Nakimu, & Bbaale, 2020), including food market vendors, who remain highly exposed to risks. Food market vendors are defined as informal sector traders operating within designated market premises in Uganda, engaged in the buying and selling of food products including fresh produce, grains, meat, fish, and prepared foods. This population is characterized by irregular income streams, manual occupational activity, and limited access to formal financial services The sudden death or permanent disability of a breadwinner can devastate families that depend on daily vending income, causing financial instability. Microinsurance provides a tailored solution by offering affordable protection against these specific risks, helping vendors and their families maintain resilience or at least survive when faced with such shocks.

1.3 Problem Statement

Food market vendors form a significant portion of Uganda's informal economy, playing a critical role in the country's food supply chain and urban livelihoods. The informal sector accounts for 89.2% of Uganda's employed population (UBOS, 2025) and fresh food market trading represents a substantial component of this informal activity (Nakazi, Nasirumbi Sanya, & Mugisha, 2023). Kampala's gazetted markets alone host well over 60,000 registered vendors, with KCCA-managed

markets such as St Balikuddembe (Owino), Usafi, Busega, Kasubi, and Wandegeya accounting for the bulk of this figure (Naimanye, 2026).

Despite their economic importance, food market vendors face significant financial vulnerabilities, with enrolment in health and life insurance remaining low largely due to low incomes, limited awareness, and distrust of formal systems within the informal sector. In Uganda, market vendors and traders were identified as one of four major informal sector worker categories central to the success of the country's proposed National Health Insurance Scheme, reflecting both their economic significance and their current exclusion from formal insurance mechanisms (Namuhani, Kisakye, & Kiwanuka, 2026). This lack of financial protection leaves vendors and their families exposed to catastrophic financial shocks resulting from death, disability, or critical illness.

Microinsurance schemes in Uganda remain limited, with low coverage caused by high premiums, complex terms, and products poorly tailored to informal workers (FSD, 2022; IRA, 2022). This project sets out to design a unit-linked endowment microinsurance product specifically tailored for food market vendors in Uganda. By incorporating both an investment and risk protection component, the product offers policyholders the opportunity to build savings while securing financial protection for their families. This dual benefit structure is particularly suited to the needs of market vendors, who typically lack access to formal savings mechanisms and pension schemes.

1.4 Objectives

The main objective of this project was to design a unit linked endowment microinsurance product for food market vendors that pays a benefit to the insured in case of permanent disability, death, surrender or on survival to the end of the policy term.

The specific objectives were:

- To design a low-premium unit-linked endowment microinsurance policy affordable to market vendors.
- To ensure the product designed is profitable for insurers through pricing and profit testing.

1.5 Significance

The successful design of this product will contribute to the efforts being made by various insurers to create more products in order to increase the uptake of insurance policies which in turn will increase insurance penetration in Uganda. This is because the project will provide evidence that profitable microinsurance products can be created thereby prompting insurers to increase the product range available for the low-income earners. Furthermore, once this product has been launched to the market, the families of insured vendors will also benefit when claims are made and approved.

CHAPTER TWO: MODEL ASSUMPTIONS

2.1 Introduction

This chapter covers the assumption used in the development of the different sections of the model. These, in more technical terms are referred to as the basis and the exact figures used as well as their sources are highlighted below.

Table 2.1 Assumptions of the model

Assumption	Value
Sum assured	UGX 1,500,00
Initial expenses	15% of premium
Renewal expenses	5% of premium
Initial commission	10% of premium
Renewal commission	7.5%
Mortality	120% of Kenyan mortality
Disability rates	130% Kenyan disability rates
Surrender rate (all years except the first and)	10%
Inflation rate	3.2%
Allocation in first year	95%
Allocation in other years	85%
Bid-offer spread	5%
Unit fund interest rate	15.50%
Management charge	2.0%
Risk discount rate	18.50%
Non-unit fund interest rate	15.50%
Death benefit	Sum assured or unit fund value at year end
Surrender benefit	70% of unit fund value at year end
Maturity benefit	100% of fund vale at the end of final policy year
Disability benefit	110% of unit fund value at year end

2.2 Explanation of assumptions

Unit and non-unit fund interest rates; Unit and non-unit fund interest rates: Both rates are based on the Government of Uganda's 5-year bond issued in May 2026, with a yield of 15.50% (BOU, 2026).

Mortality and disability rates; These were extracted directly from Kenyan Mortality and Disability tables respectively. However, since the product is being designed for food market vendors, a low-income group in Uganda, the mortality rates had to be inflated by a factor of 1.2 i.e. $q^{di*} = (1+\theta)$ where $\theta = 0.2$, to account for the higher mortality faced by market vendors since they are a low-income group which relates to factors such as poor nutrition, limited healthcare and unhygienic working conditions (Chetty et al., 2016).

Surrender rates; Following the enactment of The Insurance Act, 2017 (IRA, 2017), surrender values are required a minimum vesting period of two to three years. The surrender rate is higher than market standard to account for early exits due to certain factors affecting food market vendors such as pressure arising from irregular incomes, low financial literacy, short-term financial thinking among others.

Expenses and Management charge; Expenses were calculated as a percentage of premiums, while a fund management charge of 2.0% per annum of the unit fund value was applied to reflect the typical 1.5% to 2.0% range disclosed by Ugandan unit-linked funds (Allianz, 2026; SECURITIES, 2025).

Commission; The commission rates were set in accordance with the guidelines and reports issued by the Insurance Regulatory Authority of Uganda.

Risk Discount rate: 18.50%, derived as the Government of Uganda 5-year bond yield of 15.50% (BOU, 2026),plus an insurance business risk margin of 3.00%.

Inflation rate: The rate adopted was obtained from May CPI data (UBOS, 2026) which was in line with the Bank of Uganda (BOU) headline inflation (BOU, Feb, 2026).

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter describes how the pricing and profit testing models were developed. It covers the software tools, the mathematical formulas, and the analytical techniques used.

3.2 Model documentation

3.2.1 Overview

Microsoft Excel was initially used to develop a pricing and profit testing model for a single life, a 30-year-old female with a policy term of five years. The same procedure was then carried out in Python 3.13.9 thereby writing a programme that performs the pricing and profit testing as the Excel model for the given ages and policy terms, depending on the input.

The combined model with both male and female probabilities was implemented in a python application called streamlit to make an interactive dashboard for both the pricing and profit testing.

3.2.2 Formulae

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

Table 3.1: Multiple decrements

Output	Formula
$(aq)_x^d$	$q_x^d\,[1 - \frac{1}{2}(q_x^{di}+q_x^W) + \frac{1}{3}(q_x^{di}q_x^W)]$
$(aq)_x^{di}$	$q_x^{di}\,[1 - \frac{1}{2}(q_x^{d}+q_x^W) + \frac{1}{3}(q_x^{d}q_x^W)]$
$(aq)_x^W$	$q_x^W\,[1 - \frac{1}{2}(q_x^{di}+q_x^d) + \frac{1}{3}(q_x^{di}q_x^d)]$
$(ap)_x$	$1-[(aq)_x^d + (aq)_x^{di} + (aq)_x^W]$
${}_{t-1}(ap)_x$	$(ap)_x$ * ${}_{t-1}(ap)_x$ in previous year

Table 3.2: Pricing formulae

Output	Formula
Discount factor	(1/ (1 + risk discount rate)) ^ year
Death benefit	Sum Assured
EPV Death Benefit	Death Benefit * $(aq)_x^d$ * Discount Factor
Survival Benefit	Fund value in final policy year
EPV Survival Benefit	Survival Benefit * ${}_{t-1}(ap)_x$ * Discount Factor
Disability Benefit	110% * Fund at year end
EPV Disability Benefit	Disability Benefit * $(aq)_x^{di}$ * Discount Factor
Surrender Benefit	70% * Fund at year end
EPV Surrender Benefit	Surrender * $(aq)_x^W$ * Discount Factor
EPV Benefits	EPV Death Benefit + EPV Survival + EPV Disability Benefit + EPV Surrender Benefit
Expenses (Initial) Expenses (Renewal)	15% * Premium 5% * Premium * ((1+ inflation rate) ^ year)
EPV Expenses	Initial Expense * ${}_{t-1}(ap)_x$ * Discount Factor Renewal Expense * ${}_{t-1}(ap)_x$ * Discount Factor
Commission (Initial)	10% * Premium
EPV Commission	Commission * ${}_{t-1}(ap)_x$ * Discount Factor
EPV Total Expenses	EPV Expenses + EPV Commission
Premium	Assumed Premium (Before Goal Seek)
EPV Premium	Premium * ${}_{t-1}(ap)_x$ * Discount Factor
Equation of Value	EPV Premium – EPV Benefits – EPV Total Expenses

Table3.3: Profit testing formulae

Output	Formula
Premium Allocated	95% * Premium in the first year for the first-year allocation 85% * subsequent premiums in other years
Bid/Offer spread	5% Allocated Premium
Cost of Allocation	Premium Allocated – Bid/Offer spread
Fund after allocation	Fund at the end of year for previous year + Cost of Allocation
Fund before management charge/ Fund after growth	Fund after allocation * (1+ Unit Fund interest rate)
Management Charge	1.5% * Fund before management charge
Fund at year end	Fund before management charge – Management Charge
Premium less Cost of Allocation	(Premium received – Premium Allocated) + Bid/Offer spread
Initial Expenses	15% * Premium
Renewal Expenses	5% * Premium * ((1+ inflation rate) ^ (year – 1))
Initial Commission	10% * Premium
Renewal Commission	7.5%
Interest gained in Non – unit Fund	Non unit interest rate * (Premium less Cost of Allocation – Expenses – Commission)
Extra Death Cost	max [$(aq)_x^d$ * (Sum Assured – Fund at year end), 0]
Extra Disability Cost	max [$(aq)_x^{di}$ * (Disability Benefit – Fund at year end), 0]
Expected Surrender Penalty	30% * Fund value at previous year end * $(aq)_x^W$
Extra Maturity Cost	5%* Fund value at year end * $(ap)_x$

Output	Formula
Profit vector	(Premium less Cost of Allocation + Interest + Management charge + Expected Surrender Penalty) – (Expenses + Commission + Extra Death Cost + Extra Disability Cost)
Discount Factor (profits)	(1/ (1 + risk discount rate)) ^ year
Discount Factor (premiums)	(1/ (1 + risk discount rate)) ^ (year-1)
Profit Signature	Profit vector * ${}_{t-1}(ap)_x$
PV of profits/ Discounted Profit	Profit signature * Discount Factor (profits)
PV of premiums/ Discounted Premiums	Premiums * ${}_{t-1}(ap)_x$ * Discount Factor (premiums)
NPV of profits	Sum of discounted profits
NPV of premiums	Sum of discounted premiums
Profit Margin	$\frac{\text{NPV of profits}}{\text{NPV of premiums}}$

3.2.3 Description of symbols

q_x^d : independent probability of death

q_x^{di} : independent probability of disability

q_x^W : independent probability of withdrawal/surrender

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

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

$(aq)_x^W$: dependent probability of withdrawal/surrender

$(ap)_x$: dependent probability of survival

${}_{t-1}(ap)_x$: cumulative probability of being in-force at the start of each year

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

In this chapter, the results from both the pricing and profit testing model are presented. Sensitivity analysis is also included to show how the profit margin can be affected by changes in some of the assumptions such as interest rates and expenses.

4.2 Results from the model

The results presented in this chapter are based on a healthy 30-year-old female, with a policy term of five years and a sum assured of UGX 1,500,000.

4.2.1 Multiple decrements

Under this section, the multiple decrement tables for both genders are presented. In these tables, the dependent and independent probability rates are included.

Table 4.1 Multiple decrements for female life

Age(x)	q_x^d	q_x^{di}	q_x^W	$(aq)_x^d$	$(aq)_x^{di}$	$(aq)_x^W$	$(ap)_x$	$_{t-1}(ap)_x$
30	0.001102	0.000793	0.000000	0.001101	0.000793	0.000000	0.998106	1.000000
31	0.001139	0.000819	0.100000	0.001082	0.000778	0.099902	0.898238	0.998106
32	0.001201	0.000845	0.100000	0.001141	0.000802	0.099898	0.898159	0.896537
33	0.001300	0.000897	0.100000	0.001234	0.000852	0.099890	0.898024	0.805234
34	0.001411	0.000949	0.000000	0.001410	0.000948	0.000000	0.997641	0.723119

Table 4.2 Multiple decrements for male life

Age(x)	q_x^d	q_x^{di}	q_x^W	$(aq)_x^d$	$(aq)_x^{di}$	$(aq)_x^W$	$(ap)_x$	$_{t-1}(ap)_x$
30	0.001768	0.000611	0.000000	0.001768	0.000610	0.000000	0.997622	1.000000
31	0.001816	0.000624	0.100000	0.001724	0.000592	0.099883	0.897801	0.997622
32	0.001901	0.000650	0.100000	0.001805	0.000617	0.099877	0.897701	0.895666
33	0.002028	0.000689	0.100000	0.001926	0.000654	0.099869	0.897551	0.80404
34	0.002198	0.000728	0.000000	0.002198	0.000727	0.000000	0.997075	0.721667

4.2.2 Pricing model

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

The pricing results presented are for the 30-year-old female only.

Table 4.3 Expected Present Value of Death and Survival benefits

k (future lifetime)	Amount(s)	Discount	Probability	EPV (for each year)
0	1500000.000000	0.865801	0.001101	1430.095664
1	1500000.000000	0.749611	0.001082	1216.380173
2	1500000.000000	0.649014	0.001141	1110.412041
3	1500000.000000	0.561917	0.001234	1040.307256
4	1500000.000000	0.486508	0.001410	1029.154041
5	1500000.000000	0.421219	0.000000	0.000000
Total				5826.349174
Survival Benefit	1500000.000000	0.486508	0.723119	527704.875530
Final Total				533531.224705

Table 4.4 Expected Present Value of Disability benefits

k (future lifetime)	Amount(s)	Discount	Probability	EPV (for each year)
0	217168.461928	0.865801	0.000793	149.021414
1	440121.605887	0.749611	0.000778	256.550656
2	692482.269534	0.649014	0.000802	360.567596
3	978129.304717	0.561917	0.000852	468.065901
4	1301453.183839	0.486508	0.000948	600.452081
Total				1834.657648

Table 4.5 Expected Present Value of Surrender benefits

k (future lifetime)	Amount(s)	Discount	Probability	EPV(for each year)
0	0.000000	0.865801	0.000000	0.000000
1	0.000000	0.749611	0.099902	0.000000
2	0.000000	0.649014	0.099898	0.000000
3	440670.535158	0.561917	0.099890	24734.831750
4	622445.921183	0.486508	0.000000	0.000000
Total				24734.831750

Table 4.6 Expected Present Value of Initial and Renewal expenses

k (future lifetime)	Amount(s)	Discount	Probability	EPV (for each year)
0	28989.455547	1.000000	1.000000	28989.455547
1	9972.372708	0.865801	0.998106	8617.738232
2	10291.488635	0.749611	0.896537	6916.440817
3	10620.816271	0.649014	0.805234	5550.521501
4	10960.682392	0.561917	0.723119	4453.684264
Total				54527.840360

Table 4.7 Expected Present Value of Initial and Renewal commissions

k (future lifetime)	Amount(s)	Discount	Probability	EPV (for each year)
0	19326.303698	1.000000	1.000000	19326.303698
1	14494.727773	0.865801	0.998106	12525.782314
2	14494.727773	0.749611	0.896537	9741.246418
3	14494.727773	0.649014	0.805234	7575.057896
4	14494.727773	0.561917	0.723119	5889.682657
Total				55058.072983

Table 4.8 Expected Present Value of Premiums

k (future lifetime)	Amount(s)	Discount	Probability	EPV (for each year)
0	193263.036979	1.000000	1.000000	193263.036979
1	193263.036979	0.865801	0.998106	167010.430857
2	193263.036979	0.749611	0.896537	129883.285575
3	193263.036979	0.649014	0.805234	101000.771941
4	193263.036979	0.561917	0.723119	78529.102093
Total				669686.627445

As discussed previously, the equation of value does balance. The EPV income and EPV outgo are both UGX 669,686.63. This implies that the premium of UGX 193,263.04 is the accurate annual premium that the client under consideration has to pay in order to get the insurance policy.

However, to get the actual premium to be paid, an assumed premium is initially used in the model and all the computations are made based on that. The Goal Seek function which performs iterations in the value of a particular cell in order to obtain a specific value in another cell is used to get the actual premium figure, which makes the equation of value balance. Once this has been achieved, all the computations that were initially performed basing on the assumed premium are automatically adjusted to reflect the values based on the actual premium.

4.2.3 Profit testing

In order to determine whether the product designed will be profitable for the insurer, in a way that makes business sense, a profit testing model is developed. This includes a unit fund, non – unit fund and discounted cashflows as shown in the tables that follow.

Table 4.9 Unit Fund

Year	Premium	Allocated premium	B/O spread	Cost of allocation	Fund after allocation	Fund before Mgt charge	Mgt fees	Fund at year end
1	193263.04	183599.89	9179.99	174419.89	174419.89	201454.97	4029.10	197425.87
2	193263.04	164273.58	8213.68	156059.90	353485.78	408276.07	8165.52	400110.55
3	193263.04	164273.58	8213.68	156059.90	556170.45	642376.87	12847.54	629529.34
4	193263.04	164273.58	8213.68	156059.90	785589.24	907355.57	18147.11	889208.46
5	193263.04	164273.58	8213.68	156059.90	1045268.36	1207284.96	24145.70	1183139.26

Table 4.10 Non – unit Fund

Year	Unallocated Premium	B/O spread	Expenses	Commission	Interest	Extra Death Cost	Extra disability cost	Mgt fees	Expected Surrender Penalty	Extra maturity Cost	Profit
1	9663.15	9179.99	28989.46	19326.30	-4568.26	1434.36	15.65	4029.10	0.00		-31461.78
2	28989.46	8213.68	9972.37	14494.73	1974.09	1189.85	31.11	8165.52	19723.26		41377.94
3	28989.46	8213.68	10291.49	14494.73	1924.62	992.87	50.51	12847.54	39970.13		66115.84
4	28989.46	8213.68	10620.82	14494.73	1873.58	753.86	75.73	18147.11	18865.14		50143.84
5	28989.46	8213.68	10960.68	14494.73	1820.90	446.86	112.20	24145.70	0.00	59017.44	-21862.17

Table 4.11 Net Present Value of Profit

Year	Profit	${}_{t-1}(ap)_x$	Profit signature	Discount factor	Discounted profit
1	-31461.776264	1.000000	-31461.776264	0.843882	-26550.022164
2	41377.944604	0.998106	41299.585664	0.712137	29410.946013
3	66115.835364	0.896537	59275.322334	0.600959	35622.047078
4	50143.835386	0.805234	40377.497133	0.507139	20476.984125
5	-21862.171580	0.723119	-15808.951505	0.427965	-6765.677860
Total					52194.277192

Table 4.12 Net Present Value of Premium

Year	Premium	${}_{t-1}(ap)_x$	Discount factor	Discounted Premium
1	193263.036979	1.000000	1.000000	193263.036979
2	193263.036979	0.998106	0.843882	162782.318684
3	193263.036979	0.896537	0.712137	123390.161861
4	193263.036979	0.805234	0.600959	93522.389540
5	193263.036979	0.723119	0.507139	70873.710008
Total				643831.617072

Table 4.13 Profit Margin

Profit Margin	8.1068%

When premium is paid, a portion is allocated to the unit fund. The client is then assigned units equivalent to the value of the money that has been allocated, which is then invested in relatively safe assets in order to generate a return. The other portion is allocated to the non – unit fund, which reflects the profit to be earned from the policy, taking into consideration the expenses and income associated with each particular policy year. The results are presented in Table 4.9 and Table 4.10 respectively.

Finally, the profit margin is determined from the quotient of the NPV of profit and NPV of premium and for this particular model under consideration, the margin is 8.1068% as shown in Table 4.13. This is then compared to the benchmark profit margin set by the insurer to determine whether the policy is viable or not.

4.2.4 Analysis of the results

Under this section, the premiums and profit margins are analysed in order to get an understanding of how the two vary across all age groups and policy terms. This supports decision making as the insurer is able to determine which ages or policy terms are most or least profitable.

4.2.4.1 Premiums

Premiums across all ages and policy terms under consideration range between UGX 60,522.96 and UGX 212,351.90 annually for the 20-60 age range, which translates to between UGX 5,043.58 and UGX 17,695.99 on a monthly basis. The lowest premium is observed for a 20-year-old female with a 10-year term, while the highest premium is observed for a 60-year-old male with a 5-year term. These figures are based on a basic policy with a sum assured of UGX 1,500,000. However, the premium can be recalculated based on an individual client's desired sum assured, and provision for this flexibility is provided in the pricing and profit testing dashboard.

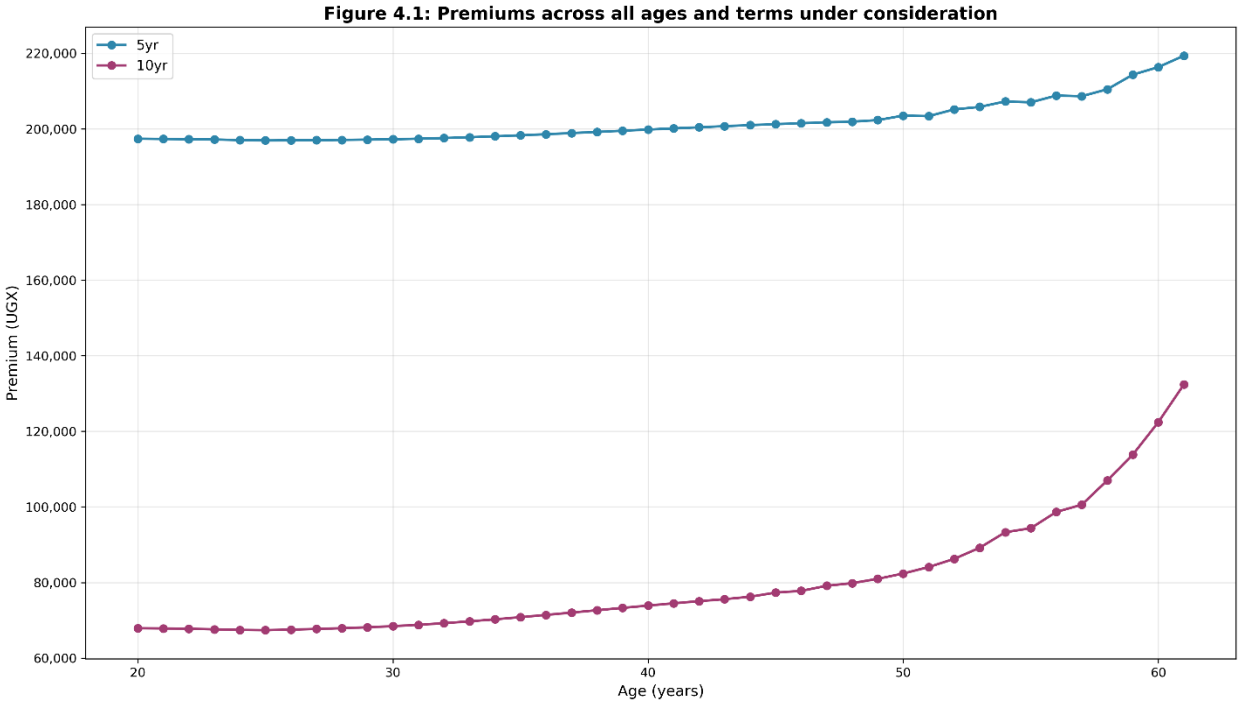


Figure 4.1: Premiums across all ages and terms under consideration

According to figure 4.1 above, the 5–year policy generally has a higher premium than the 10 – year policy. This therefore means that the shorter the terms, the higher the premium paid and the longer the term, the lower the premium paid. It is also clear that premiums tend to generally increase with age regardless of the policy term.

4.2.4.2 Profit Margins

The results show that profit margins range between 4.06% and 15.13% for all ages and policy terms as displayed in Table 4.14 and Figure 4.2**.**

Table 4.14: Profit margin across all ages and policy terms

Age	Term	
	5yr	10yr
	Profit Margin (%)	
20	7.89	14.68
21	7.88	14.69
22	7.89	14.74
23	7.94	14.86
24	8.00	15.03
25	8.04	15.13
26	8.03	15.06
27	8.02	14.99
28	8.00	14.92
29	7.99	14.83
30	7.97	14.72
31	7.94	14.57
32	7.89	14.38
33	7.84	14.16
34	7.77	13.92
35	7.70	13.66
36	7.62	13.39
37	7.54	13.12
38	7.45	12.85
39	7.37	12.60
40	7.29	12.35
41	7.21	12.12
42	7.13	11.90
43	7.06	11.71
44	6.99	11.53
45	6.93	11.41
46	6.87	11.21
47	6.81	11.08
48	6.76	10.84
49	6.72	10.60
50	6.65	10.31
51	6.50	9.94
52	6.30	9.44
53	5.85	8.65
54	5.47	8.15

Age	Term	
	5yr	10yr
	Profit Margin (%)	
55	5.65	8.31
56	5.23	7.59
57	5.49	7.80
58	5.12	7.33
59	4.68	6.71
60	4.06	6.24

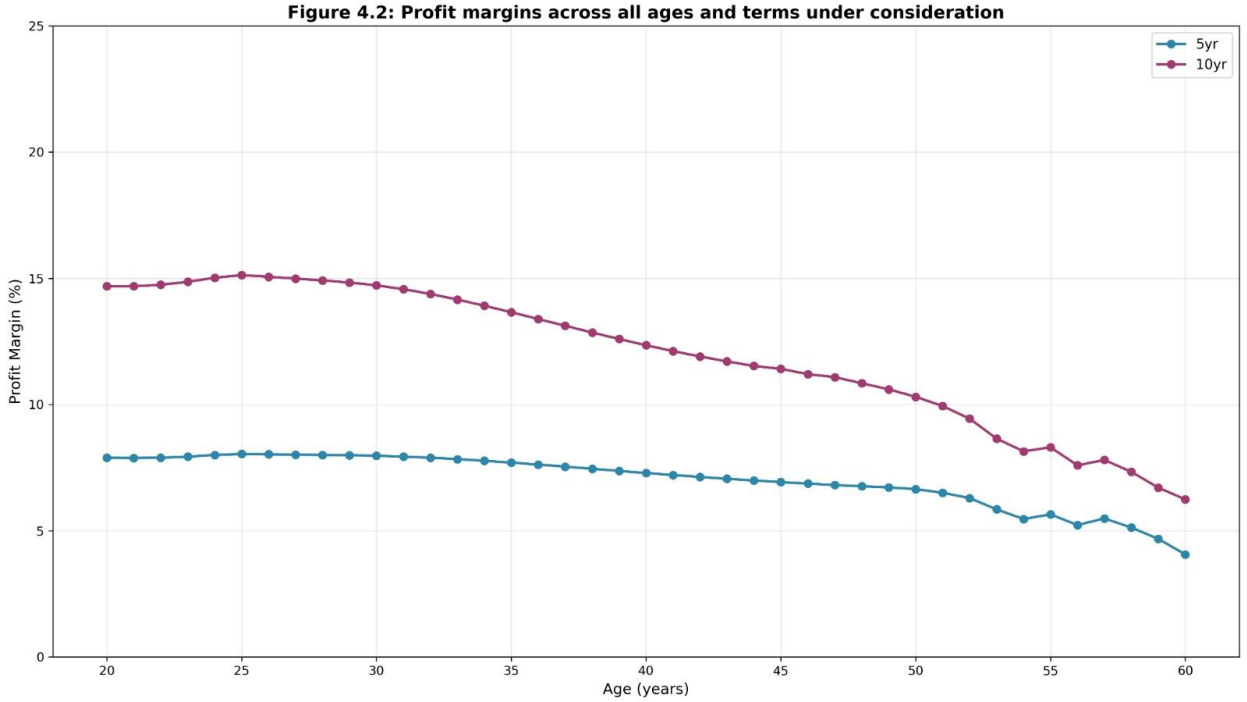


Figure 4.2: Profit margins across all ages and terms under consideration

As illustrated in figure 4.2 above, the 10 - year policy has the highest profit margin across all ages as compared to the 5 – year policy. This implies that generally, the longer the policy term, the higher the profit margin and the shorter the policy term the lower the profit margin thus highlighting the superior sustainability of longer policy terms for microinsurance products**.** However, profit margins also tend to decrease over the long term as the client's age increases.

4.3 Sensitivity analysis

Sensitivity analysis aims to test the responsiveness of the results of the model to changes in certain variables used. This is particularly important because some variables such as interest rates, expenses among others have been assumed and are likely to change frequently, which would then affect the profit margin of the product. The results shown in Table 4.15 below are for a 5 - year policy taken out by a 30-year-old female with an initial profit margin of 8.1068%

Table 4.15 Sensitivity Analysis

Assumption	Change	Profit Margin	Comment
Inflation	+15%	8.07%	A 15% increase in inflation rate leads to a 0.49% decrease in profit margin.
	0	8.11%	Baseline
	-15%	8.14%	A 15% decrease in inflation rate leads to a 0.37% increase in profit margin.
Management charge	+15%	8.80%	A 15% increase in management charge leads to an 8.51% increase in profit margin.
	0	8.11%	
	-15%	7.40%	A 15% decrease in the management charge leads to an 8.75% decrease in profit margin.
Initial expenses	+15%	7.45%	A 15% increase in initial expenses leads to an 8.14% decrease in profit margin.
	0	8.11%	
	-15%	8.76%	A 15% decrease in initial expenses causes a 8.01% increase in profit margin.
Renewal expenses	+15%	7.56%	A 15% increase in renewal expenses leads to a 6.78% decrease in profit margin.
	0	8.11%	
	-15%	8.65%	A 15% decrease in renewal expenses leads to a 6.66% increase in profit margin

Assumption	Change	Profit Margin	Comment
Initial commission	+15%	7.67%	A 15% increase in initial commission leads to a 5.42 increase in profit margin.
	0	8.11%	
	-15%	8.54%	A 15% decrease in initial commission leads to a 5.30% increase in profit margin.
Unit growth rate	+15%	10.00%	A 15% increase in unit growth rate leads to a 23.30% increase in profit margin.
	0	8.11%	
	-15%	6.29%	A 15% decrease in unit growth rate leads to a 22.44% decrease in profit margin.
Risk Discount rate	+15%	10.46%	A 15% increase in risk discount rate leads to a 28.98% increase in profit margin.
	0	8.11%	
	-15%	5.48%	A 15% decrease in risk discount rate leads to a 32.43% decrease in profit margin.

Table 4.15 above shows the results of the sensitivity analysis where one variable at a time was changed from the 8.11% base profit margin, keeping all other variables constant to see the effect.

Inflation, initial expenses, renewal expenses, and initial commission have an inverse relationship with profit margin. For example, when initial expenses increase by 15%, the profit margin drops from 8.11% to 7.45%. Conversely, management charge, unit growth rate, and risk discount rate have a direct relationship with profit margin.

Lastly, it is also evident that the risk discount rate has the highest effect on profit margin, swinging it significantly from 8.11% to 10.46%, while the inflation rate has the lowest effect, causing a negligible shift of only 0.49%.

CHAPTER FIVE: SUMMARY OF THE RESULTS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Under this chapter, final remarks about the project in respect to the objectives made. It includes the summary of results, conclusion and recommendations based on the results obtained from designing the unit linked endowment microinsurance product.

5.2 Summary of results

The main objective of this project was to design a unit-linked endowment microinsurance product that pays a benefit to the insured in case of permanent disability, death, surrender, or on survival to the end of the policy term. The results show that for clients aged between 20 years and 60 years choosing policy terms of either 5 or 10 years, premiums generally range between UGX 60,522.96 and UGX 212,351.90 annually, which translates to between UGX 5,043.58 and UGX 17,695.99 on a monthly basis. The profit margins of the product lie between 4.06% and 15.13% for all ages and policy terms under consideration.

The results also show that the longer the policy term, the higher the profit margins. The 10-year term yields average profit margins of 11.99%, compared to 7.01% for the 5-year term representing a margin increase of approximately 2.3 times. The 10-year term is therefore recommended as the preferred product design for market vendors, as it offers the dual benefits of lower annual premiums and higher profitability for insurers.

Furthermore, although premiums are generally affordable, younger policyholders will pay slightly lower premiums than older ones across all policy terms. This reflects the increasing mortality and disability risks associated with aging, which translate into higher expected claim costs and, consequently, higher premiums.

5.3 Conclusion

In conclusion, the unit-linked endowment microinsurance product designed for food market vendors demonstrates both affordability and profitability for the 20-60 age range. The 10-year term

is recommended as the optimal product design, offering the best balance of low premiums for policyholders and reasonable profit margins for insurers.

5.4 Recommendations

Based on the findings of this study, the following recommendations are made for the successful implementation of the unit-linked endowment microinsurance product for food market vendors in Uganda.

Insurers should prioritize the 10-year policy term as the primary product offering. The results demonstrate that the 10-year term consistently outperforms the 5-year term, delivering average profit margins of 11.99% compared to 7.01% for the 5-year term, while simultaneously offering significantly lower annual premiums that are more accessible to low-income market vendors. This dual advantage makes the 10-year term the optimal choice for both insurers and policyholders.

In addition, insurers should target younger policyholders aged 20-35, as this age group exhibits the highest profit margins and the lowest premium rates. Targeted marketing campaigns through market vendor associations and cooperatives.

Furthermore, to address the challenge of premium collection and product delivery, insurers should leverage existing mobile money platforms and partner with market vendor associations and cooperatives to facilitate group enrollment and automated premium deductions. This approach would reduce administrative costs, improve premium persistence, and enhance the overall customer experience.

Finally, insurers should consider offering flexible premium payment options, including monthly, quarterly, and annual payment frequencies, to accommodate the irregular income patterns characteristic of food market vendors.

REFERENCES

AIO, A. I. O. (2025). <African Insurance Organisation Annual Report.pdf>. *Annual Report 2025*.

Allianz, S. (2026). Sanlam Allianz Uganda Income Fund Fact Sheet. Retrieved from https://edgepub.s3.af-south-1.amazonaws.com/unit-trust/fund-updates/ug/SanlamAllianz_Dollar_Fund_Fact_Sheet.pdf?utm_source=copilot.com

Andoh, C. (2026). Basic Insurance Concepts. In C. Andoh (Ed.), *Fundamentals of Managing Risk and Insurance: A Focus on Frontier Markets* (pp. 21-40). Singapore: Springer Nature Singapore.

BOU. (2026). Government Securities Auctions. Retrieved from https://bou.or.ug/events_calendar_lecture_series#id=government_securities_auctions

BOU. (Feb, 2026). *Monetary Policy Report*. Retrieved from https://bou.or.ug/publications

Browne, M. J., & Kim, K. (1993). An International Analysis of Life Insurance Demand. *The Journal of Risk and Insurance, 60*(4), 616-634. doi:10.2307/253382

Chetty, R., Stepner, M., Abraham, S., Lin, S., Scuderi, B., Turner, N., . . . Cutler, D. (2016). The Association Between Income and Life Expectancy in the United States, 2001-2014. *JAMA, 315*(16), 1750-1766. doi:10.1001/jama.2016.4226

Deloitte. (2025). <Deloitte-Insurance-Outlook-Report-2025.pdf>.

Dionne, G. (2000). *Handbook of insurance* (Vol. 1119): Springer.

FSD. (2022). *A BASELINE ASSESSMENT OF THE MICROINSURANCE NEEDS OF INFORMAL TRADERS IN UGANDA'S MARKETS*. Retrieved from https://fsduganda.or.ug/baseline-assessment-of-the-microinsurance-needs-of-informal-trader-in-uganda/

IRA. (2017). THE INSURANCE ACT. Retrieved from https://ira.go.ug/laws/

IRA. (2022). *ANNUAL INSURANCE MARKET REPORT* Retrieved from https://ira.go.ug/wp-content/uploads/2023/08/Draft-Industry-Market-report-2022.pdf?utm_source=copilot.com

IRA. (2025). Increased coverage, market activity lift Uganda's insurance industry's half year premiums. Retrieved from https://ira.go.ug/increased-coverage-market-activity-lift-ugandas-insurance-industrys-half-year-premiums/

Liedtke, P. M. (2007). What's insurance to a modern economy? *The Geneva Papers on Risk and Insurance-Issues and Practice, 32*(2), 211-221.

Mugoda, S., Esaku, S., Nakimu, R. K., & Bbaale, E. (2020). The portrait of Uganda's informal sector: What main obstacles do the sector face? *Cogent Economics & Finance, 8*(1), 1843255.

Naimanye, A. V. (2026). Order and Fair Trade in Kampala. *Nile Post*. Retrieved from https://nilepost.co.ug/business/323342/kacita-backs-kcca-street-vendor-evictions-calls-for-order-and-fair-trade-in-kampala

Nakazi, F., Nasirumbi Sanya, L., & Mugisha, J. (2023). The effect of COVID-19 containment measures on fresh food market vendors in Uganda. *Journal of Agribusiness in Developing and Emerging Economies, 15*, 789-809. doi:10.1108/JADEE-10-2022-0228

Namuhani, N., Kisakye, A. N., & Kiwanuka, S. N. (2026). Willingness and perceived ability to pay for Uganda's proposed national health insurance scheme among informal sector workers in Iganga and Mayuge districts, Uganda: A contingent valuation method. *PLOS Glob Public Health, 6*(3), e0003603. doi:10.1371/journal.pgph.0003603

Nayak, N., & Mishra, R. K. (2014). Evolution of insurance sector: A global perspective. *Management Review: An International Journal, 9*(2), 4.

Platteau, J.-P., De Bock, O., & Gelade, W. (2017). The Demand for Microinsurance: A Literature Review. *World Development, 94*, 139-156. doi:https://doi.org/10.1016/j.worlddev.2017.01.010

SECURITIES, S. (2025). UMBRELLA UNIT TRUST FUND FACT SHEET. In S. SECURITIES (Ed.).

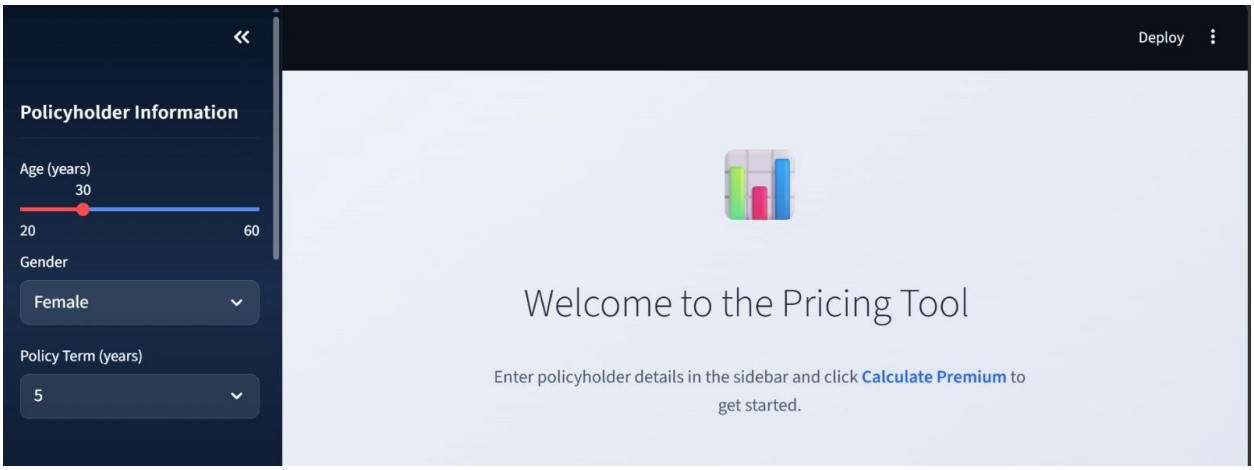
Signé, L., & Johnson, C. (2020). *Africa's insurance potential: Trends, drivers, opportunities and strategies*. Retrieved from

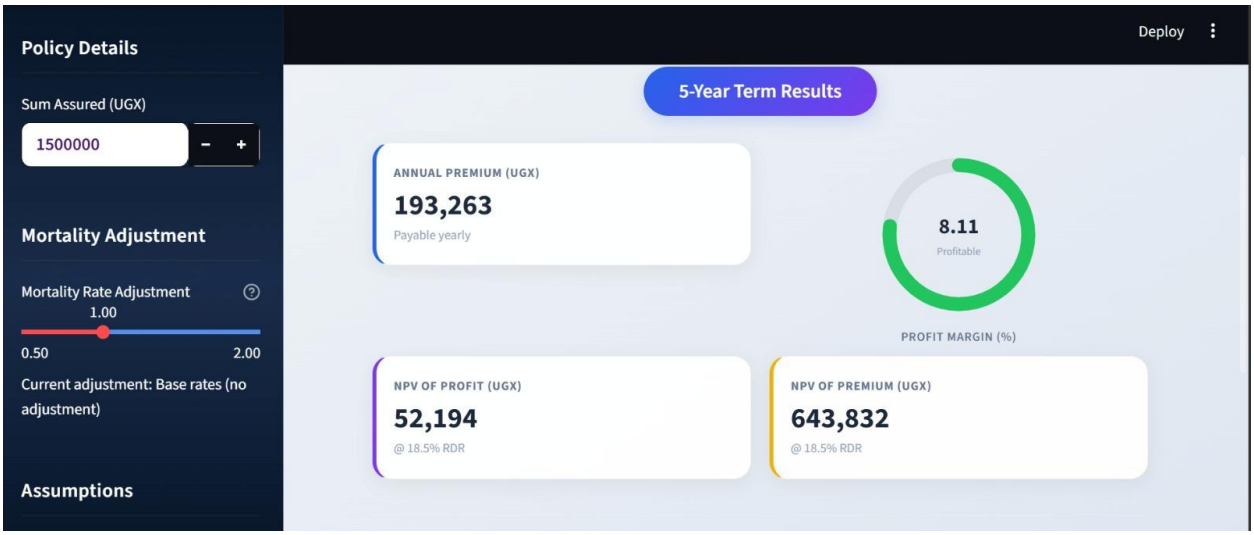
UBOS. (2025). *Labour Market Survey*. Retrieved from https://www.ubos.org/wp-content/uploads/publications/04_2026Presentation_on_the_Labour_Market_Survey_2025_Report_Findings_16th_April_2026.pdf

UBOS. (2026). CONSUMER PRICE INDICES AND INFLATION [Press release]. Retrieved from https://www.ubos.org/consumer-price-index-may-2026/

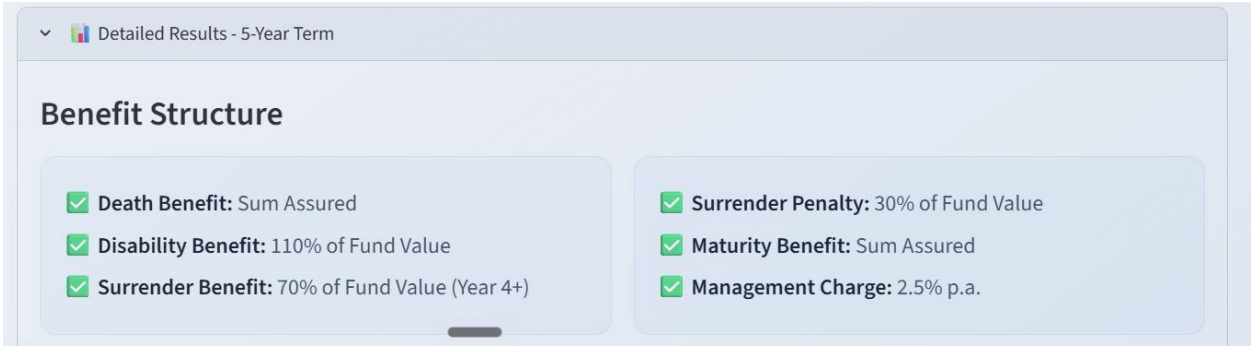
APPENDIX: Python programme output

[Unit-Linked Endowment Microinsurance Pricing Tool · Streamlit]









Multiple Decrement Table

	Age	qd (Death)	qdi (Disability)	qw (Surrender)	ap (Survival)	In-force
0	30	0.001101	0.000793	0.000000	0.998106	1.000000
1	31	0.001082	0.000778	0.099902	0.898238	0.998106
2	32	0.001141	0.000802	0.099898	0.898159	0.896537
3	33	0.001234	0.000852	0.099890	0.898024	0.805234
4	34	0.001410	0.000948	0.000000	0.997641	0.723119

Unit Fund Projection

	Year	Allocated Premium	B/O Spread	Mgt Fees	Fund at Year End
0	1	183,599.88	9,179.99	4,029.10	197,425.87
1	2	164,273.58	8,213.68	8,165.52	400,110.55
2	3	164,273.58	8,213.68	12,847.54	629,529.33
3	4	164,273.58	8,213.68	18,147.11	889,208.46
4	5	164,273.58	8,213.68	24,145.70	1,183,139.26

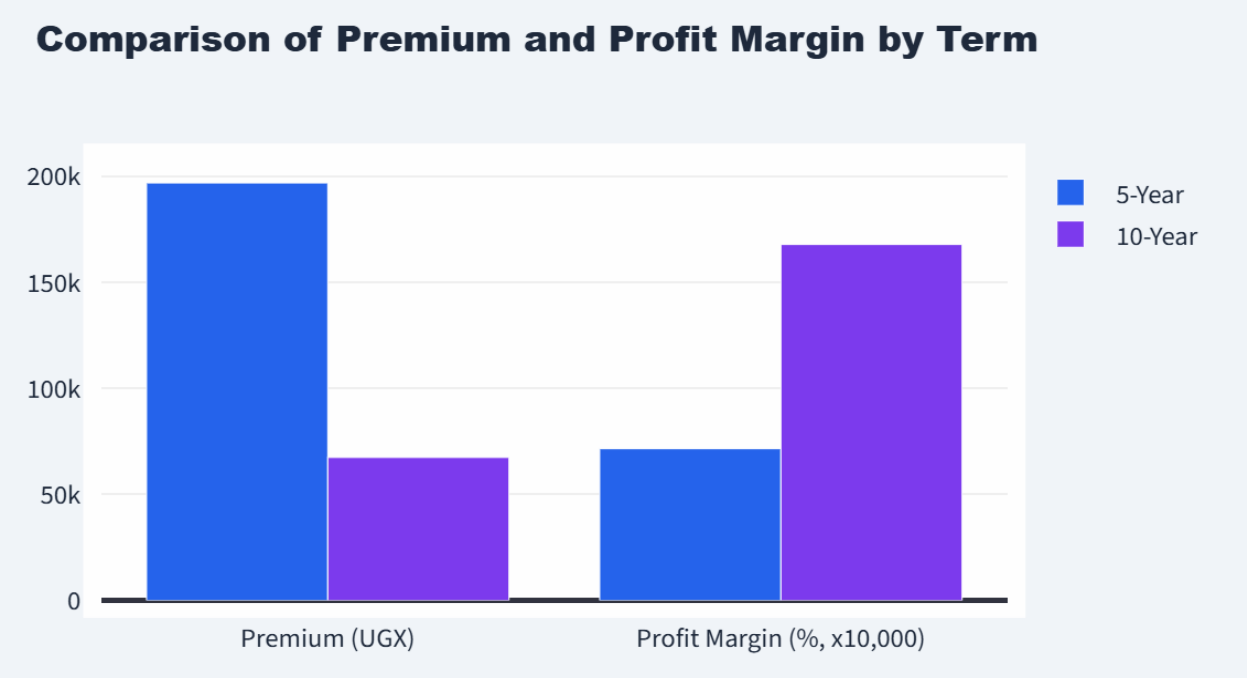
Unit Fund Growth - 5-Year Term



Compare 5-Year vs 10-Year Term

Metric	5-Year Term	10-Year Term
Annual Premium (UGX)	196,842.27	67,399.47
Profit Margin (%)	7.15	16.78
NPV of Profit (UGX)	46,898.92	47,409.43
NPV of Premium (UGX)	655,755.37	282,494.92

Profit margin is scaled ×10,000 on this chart purely so both bars share one axis — read exact values from the table above.



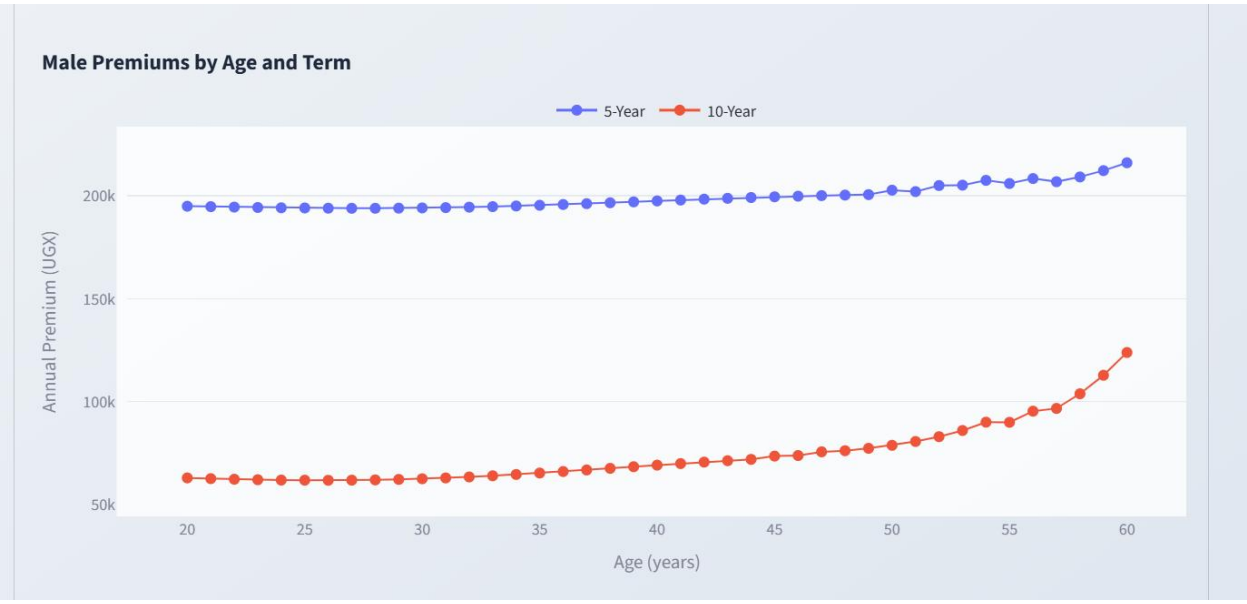
EPV Components

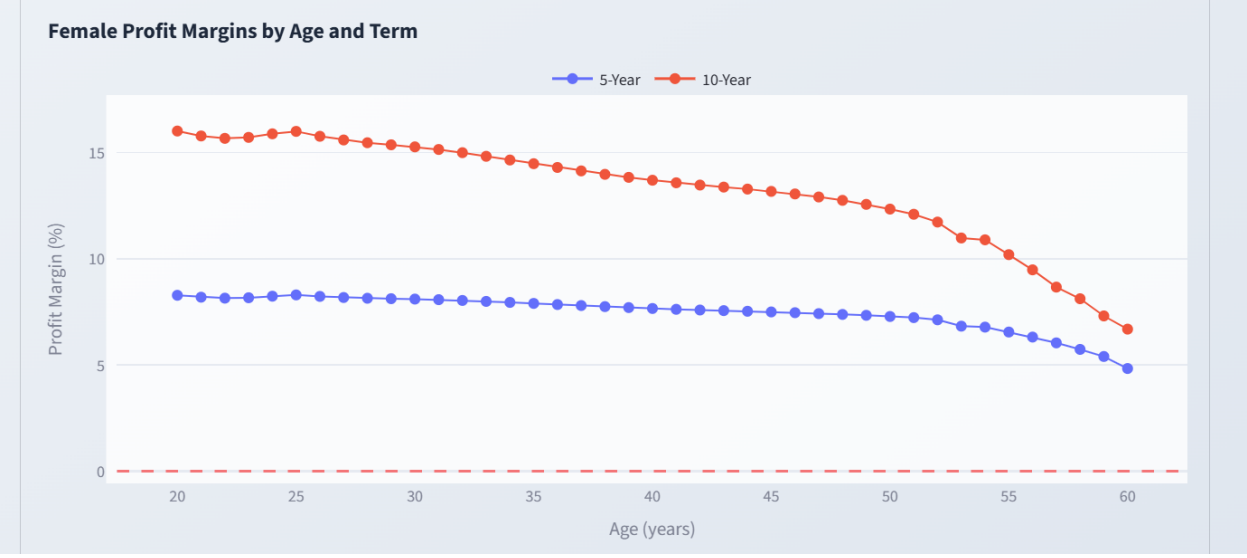
	Component	EPV (UGX)
0	Death Benefits	5,826.35
1	Disability Benefits	1,845.09
2	Surrender Benefits	35,097.46
3	Survival Benefits	527,704.88
4	Total Benefits	570,473.77
5	Expenses	55,537.70
6	Commissions	56,077.75
7	Premiums	682,089.21

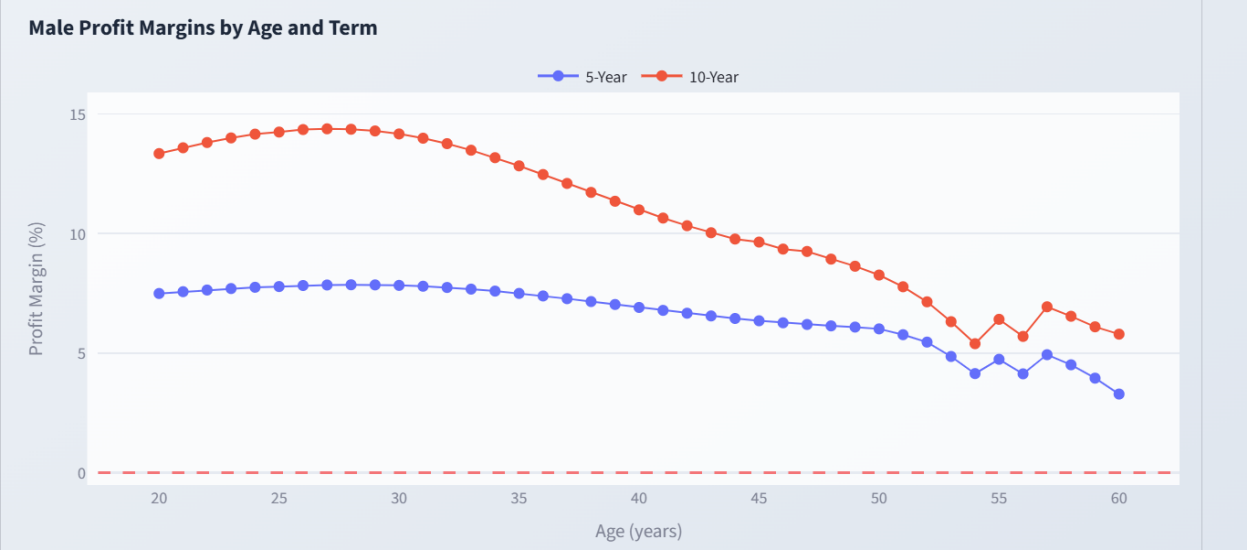
	Year	Profit	Unallocated Premium	B/O Spread	Expenses	Commissions	Interest	Extra Death Cost	Extra Disability Cost	Mgt Fees	Surrender Penalty	Extra Maturity Cost
0	1	-31,461.78	9,663.15	9,179.99	28,989.46	19,326.30	-4,568.26	1,434.36	15.65	4,029.10	0.00	0.00
1	2	41,377.94	28,989.46	8,213.68	9,972.37	14,494.73	1,974.09	1,189.85	31.11	8,165.52	19,723.26	0.00
2	3	66,115.84	28,989.46	8,213.68	10,291.49	14,494.73	1,924.62	992.87	50.51	12,847.54	39,970.13	0.00
3	4	50,143.84	28,989.46	8,213.68	10,620.82	14,494.73	1,873.58	753.86	75.73	18,147.11	18,865.14	0.00
4	5	-21,862.17	28,989.46	8,213.68	10,960.68	14,494.73	1,820.90	446.86	112.20	24,145.70	0.00	59,017.44




Female Premiums by Age and Term
5-Year
10-Year
200k
150k
100k
50k
Annual Premium (UGX)
20
25
30
35
40
45
50
55
60
Age (years)


Male Premiums by Age and Term
5-Year
10-Year
200k
150k
100k
50k
Annual Premium (UGX)
20
25
30
35
40
45
50
55
60
Age (years)


Female Profit Margins by Age and Term
5-Year
10-Year
Profit Margin (%)
15
10
5
0
20
25
30
35
40
45
50
55
60
Age (years)


Male Profit Margins by Age and Term
5-Year
10-Year
Profit Margin (%)
15
10
5
0
20
25
30
35
40
45
50
55
60
Age (years)