doi: 10.21608/esju.2024.318958.1043

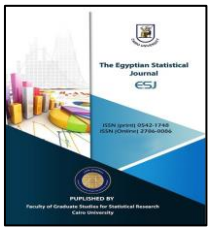
Research Article

The Egyptian Statistical Journal (ESJ), 68 (2): 146-158

Homepage: https://esju.journals.ekb.eg/

The Egyptian Statistical Journal

Print ISSN 0542-1748– Online ISSN 2786-0086



Modeling Pricing and Profit Testing of Chronic Disease's Insurance Policies Using Prostate Cancer Data in Kenya

Cynthia Mwau[1*], Howard Omukami[2]

Received 20 September 2024; revised 28 November 2024; accepted 12 December 2024

Keywords

Chronic; Pricing; Profit testing; Cancer.

Abstract

Chronic diseases have been on the rise globally and more so in the African continent. Treatment of chronic diseases requires lots of finances hence posing a challenge even to those people who are considered financially stable. Chronic diseases are expected to rise even further due to the rapid lifestyle change. In an attempt to mitigate the challenge of accessing treatment for chronic diseases, we develop a model for pricing and profit testing chronic disease insurance policy using the modified equivalence principle. We use the Kenyan mortality tables for the computation as they reflect the true mortality rate of the population considered. Moreover, we developed a prostate cancer insurance policy using real-time prostate cancer data obtained from an oncology centre in Kenya. The estimated premiums between ages 40-90 where prostate cancer is most prevalent are tabulated in table (4) and represented in figure (1). The reserves model can be used to project premiums for chronic diseases if their cost of treatment is determined. The model provides a good fit to data because it projects premiums which are affordable and profitable with a profit margin of the prostate cancer policy at 8.31%.

1. Introduction

The uptake of insurance policies in Kenya has been generally low hence introducing chronic disease policies can accelerate the penetration of insurance policies in Kenya. Very few insurance firms in Kenya offer chronic disease insurance policies. This is attributed to the fact that it is difficult to price and assess the profits of chronic disease policies. The lack of chronic disease insurance policies coupled up with other factors has led to increased mortality of chronic disease patients in Kenya. As of 2022, Liberty Health was the only insurance firm offering chronic disease insurance policies. Insurance uptake in Kenya as of 2021 was at 22% which is quite low compared to other countries. With only one firm offering chronic disease insurance policy the uptake of these chronic illness policies has a negligible share of the overall policy uptake.

Chronic diseases have increased in most parts of the world due to the huge lifestyle changes. There has been a large and alarming increase of roughly 0.5% per year globally in the incidence of chronic diseases (Thomas et al., 2023). The leading contributors of deaths among chronic diseases in Kenya are cardiovascular diseases and cancer which contribute 8.6% and 7% respectively. In Kenya, chronic diseases contribute to over 50% of inpatient admissions and 40%

✉ Corresponding author*: cynthiamwende@kisiiuniversity.ac.ke.
[1] Department of Mathematics and Actuarial Science, Kisii University.
[2]Institute for Educational Development, East Africa, The Aga Khan University.

of hospital deaths. In 2013, out-of-pocket expenditure on health was 45% of the total health expenditure. Developing chronic disease policies and doing a robust sensitization drive can drastically reduce out-of-pocket expenditure on health. As of 2005, 45.8% of the population in Kenya was below the national poverty line and the total dependency ratio was 80% as of 2015 (Onyango and Onyango, 2018). This makes it impossible for most of the patients to afford full treatment of chronic diseases out of their pockets. Kenya drafted the palliative care policy 2021-2030 which is meant to govern institutions offering palliative care in Kenya and also ensure that high standards of palliative care are maintained (Ministry of Health Kenya, 2021). Huguet et al., (2023) investigated the impact that both public and private insurance would have on people with chronic diseases. The main aim of the study was to investigate if these policies would aid in alleviating the financial burden faced by this cohort. This study established that providing health insurance for people with chronic diseases would potentially alleviate their outpatient financial burden.

Insurance companies undertake policies that are profitable and have a high potential penetration rate in the industry. Policies that are correctly priced and well invested increase the profitability of such policies. Insurance firms conduct profit testing of policies considering various factors such as prevailing interest rates on investment, interest on reserves, and expenses incurred (Noel and Vratislav, 2002). Traditional actuarial methods of profit testing involve the use of the expected present value approach which is less flexible. Several studies have been conducted on pricing and profit testing including Kiio (2014) where they tested the relationship between liquidity and profitability of insurance companies in Kenya. The study recommended that a balance should be stricken between profitability and liquidity. Recent research established that the greatest threat to insurance firms' liquidity is receiving a huge number of claims hence they should always monitor their liquidity often and administrator corrective actions if need be (David et al., 2021). Ayieng'a (2016) compared the profitability of general insurance companies and life insurance companies. This study suggested that general insurance companies are more profitable than life insurance companies. Owusu et al., (2016) profit-tested "Keyman" products on insurance companies in Ghana and found out that a premium increase was not enough to increase efficiency and profits. The study recommended that investment rate has a great effect on the profitability of insurance policies. The study by Nathalie et al. had an in-depth look at how health insurance patterns would impact patients with chronic conditions, especially the elderly ones. They employed the difference-in-differences Poisson GEE model to estimate the changes in chronic condition rate by insurance groups pre-to post-Medicare age eligibility. The study concluded that a significant proportion of the patients were diagnosed with new conditions post-Medicare which led to a high burden of disease (Peng and Zhu 2021).

In this paper, we seek to price and test the profitability of chronic disease insurance policies in Kenya by projecting the premiums, investment rates, expense rates to be considered, and reserves to be retained. This paper considered palliative care cost in pricing on chronic diseases policy which is often overlooked leading to policies that are not profitable. The rest of the paper is structured as: section 2 is the methodology where we discuss the estimation of premiums, expenses, reserves, and investment rates. Section 3 discusses the data analysis and the study concludes in Section 4.

2. Methodology

We will develop a data-driven model for pricing and calculating the profitability of chronic disease policies. The parameters considered in the calculation of EPV (Expected Present Value) of expenses and benefits are expenses charged, premiums, diagnosis cost, treatment cost, review cost, and palliative care cost. Actuarial models for calculating premiums are used to price the policies and profit testing methods are used to determine the profitability of the policies. Actuarial models and profit testing models are used to illustrate:

i. Estimation of premiums of chronic diseases.

ii. Testing profitability of chronic diseases.

iii. Investment strategies are required to increase the profitability of the insurance office.

The models developed in this paper are easy to use and quite flexible.

2.1. Estimation of premiums

The premiums are estimated using the gross premium formula where the value of the premiums is equal to the underwriting expense, continuous policy maintenance expense, diagnosis cost, treatment cost/palliative care cost and review cost.

Theorem 1. *Let* $a =$ Annuity paid in advance, *S be the sum assured, Ie = Initial expense, Re = Renewal expense and Z= Profit projection such that the modified equivalence principle is expressed as:*

$$P\ddot{a}_{x:\overline{n}|} = IeP + ReP\ddot{a}_{x:\overline{n}|} + SA_{x:\overline{n}|} + ZP \tag{1}$$

Adjusted the *Ie* to 1 year as considered in the study and explained why term and not whole life in the model limitation section.

Where sum assured is divided into two components which are:

i. *Treatment component and palliative component comprise of; diagnosis cost, treatment cost, palliative care cost, and review cost.*

Therefore equation (1) can be rewritten as:

$$P\ddot{a}_{x:\overline{n}|} = IeP + ReP\ddot{a}_{x:\overline{n}|} + (TC + PC)A_{x:\overline{n}|} + ZP \tag{2}$$

Cancer is a dynamic disease that is triggered by various factors, with age being one of the factors, especially for prostate cancer which is considered in this study. In order to factor in age in actual premium calculation of chronic diseases we will include the probability of getting cancer and the margin of increase in probability of getting cancer for different age groups. Incorporation of age factor in the estimation of premiums is paramount however, this can lead to very high premiums for the advanced ages hence we will incorporate the concept of no claim discount to mitigate this shortcoming. Incorporating this in equation (2) we derive the new premium pricing formula.

Theorem 2: (Chronic disease premium pricing formula). *Let P be the actual premiums* estimated, incorporating probability of getting cancer, margin of increase of cancer and no claim discount model we obtain:

*Adjusted premium = P * {Prob. of getting cancer for the age groups * Margin of increase of prob of getting cancer}*

Where:

i. *Prob of getting cancer*= $\frac{No.of\ Cancer\ patients\ in\ the\ age\ group}{Total\ Cancer\ patients}$

ii. $Margin\ of\ Increase\ of\ prob\ of\ getting\ cancer = \frac{Prob\ of\ getting\ cancer\ at\ age\ set\ n}{Prob\ of\ getting\ cancer\ at\ age\ set\ n-1}$

2.2 Estimation of Reserves

Insurance firms need to keep reserves to cater for possible future payouts with the main aim being bridging the difference between the present value and future liabilities. The reserves are estimated as:

Definition 1: (Reserves). Reserve (tV) in the year t = the PV of future benefits − the PV of future premiums which is expressed as:

$$tV_{x:\overline{n}|} = A_{x+t:\overline{n-t}|} - P_{x:\overline{n}|}\ddot{a}_{x+t:\overline{n-t}|} \quad (4)$$

$$= 1 - \frac{\ddot{a}_{x+t:\overline{n-t}|}}{\ddot{a}_{x:\overline{n}|}} \quad (5)$$

2.3 Profit Testing

Profit testing is a method used by insurance firms to project cash flows relating to policies. Various assumptions are made depending on the types of policies. The assumptions of this study are:

i. No death benefit as the policy mainly focuses on diagnosis, treatment, and palliative care.

ii. No surrender benefits as the policy is meant to cater to cancer treatment. This will discourage people from surrendering the policies ensuring that most of the populations are insured against chronic diseases.

Theorem 3: (In-force expected net cash-flow). The in-force expected net cash flow is calculated as:

$$(CF)_t = (P_t - e_t)(1+i) - \{[q_{x+t-1} * PC] - [p_{x+t-1} * TC]\} * prob\ of\ getting\ cancer \quad (6)$$

Where:

$(CF)_t$= In-force expected net cash flow

TC = Treatment cost

PC = Palliative care cost

P_t =Premium at time t

e_t =Expense paid at time t

q_x = Mortality probability

p_x =Survival probability

Equation (6) can be modified to cater for reserves hence resulting in a profit vector which is the cash that will be transferred from the life fund to the with-profits policyholder at the end of the policy year.

Definition 2: (Profit vector). The profit vector is calculated as:

$$(PRO)_t = (CF)_t + i * (t-1)V - (IR)_t \quad (7)$$

Where:

$(CF)_t$= is as defined in equation (6)

$(IR)_t$= the increase in reserve required

Remark 1: The increase in reserve is calculated as:

$$(IR)_t = p_{x+t-1} * tV - (t-1)V \quad (8)$$

Where:

$(t-1)V$ = reserve one year time lag behind

An important element of profit testing is profit signature which only considers the policyholders who survive for the full policy duration. This is in line with the model developed as it only considers benefits for active and surviving policyholders.

Definition 3: (Profit signature "σ_t"). The profit signature is calculated as:

$$\sigma_t = (t-1)p_x(PRO)_t \quad (9)$$

2.4 Assessment of Profits

Insurance firms usually asses the profitability of policies so that they can be able to project the viability of these policies. Profit can be asses using various methods, however, three major methods are preferred due to their flexibility and precision. These methods are:

i. Internal Rate of Return (IRR)

This is the interest rate where the profit signature gives a net present value (NPV) of zero. It is expressed as:

$$\sum_{t=1}^{n} v^t \sigma_t = 0 \quad (10)$$

ii. Profit Margin

Profit margin is evaluating the NPV of profits with respect to the NPV of premiums as:

$$Profit\ Margin = \frac{\sum_{t=1}^{n} v^t \sigma_t}{\sum_{t=0}^{n-1} P_{t+1} {}_t p_x v^t} \quad (11)$$

Viable policies have a positive profit margin.

iii. Risk discount rate

This is the rate at which the net profits are valued which is usually higher than the IRR and is calculated as:

$$NPV = \sum_{t=1}^{n} v^t \sigma_t \tag{12}$$

This paper will consider profit margin in assessment of profits as it incorporates the other methods hence considered a superior method and is the most preferred method when pricing new policies as it is in this study.

3. Data Analysis, Results and Discussion

In this section, we use data for prostate cancer recorded in Kenya from 2015-2019 obtained from one of the oncology centers in Kenya. The initial expenses are the underwriting expenses and are estimated to be 75% of the first five premiums due to the sensitization and marketing needed as it is a new policy while the renewal expenses are considered to be at 15% of the premium as it is the percentage considered by most insurance companies in Kenya.

The sum assured of the treatment policy is calculated as a summation of the diagnosis cost, treatment cost, and review cost while the palliative care policy will be the summation of the diagnosis cost, palliative care cost, and review cost. The treatment can be in various ways which include; surgery, radiotherapy, chemotherapy, hormontherapy and immunotherapy. Table 1 and Table 2 show the preference for various cancer treatment methods and their descriptive statistics respectively. In summary, the most preferred treatment method for our sample of 986 patients was radiotherapy, chemotherapy, hormontherapy and surgery in that order. Immnotherapy was the least preferred at a staggering 0.3%. 361, 209.4, and 3 were the maximum number, mean, and minimum number respectively.

Table 1. Analysis of preference of cancer treatment methods

Treatment Method	No. of Patients	Percentage (Sample of 986)
Surgery	165	16.73%
Radiotherapy	361	36.61%
Chemotherapy	260	26.37%
Hormone therapy	258	26.17%
Immunotherapy	3	0.3%

Table 2. Descriptive statistics of cancer treatment methods

Statistic	Treatment method
Mean	209.4
Std. Dev.	134.607
Minimum	3
1st Quartile	165
Median	258
3rd Quartile	260
Maximum	361
Inter Quartile Range	95

3.1 Premium and Reserve Estimation

The Kenyan actuarial table estimated by Mbugua (2019) is considered in this research for computation purposes. The sum assured comprises both the treatment package and the palliate

care package. Very few patients underwent immunotherapy hence it was not considered as a treatment method. The diagnosis methods considered are; blood tests, imaging and biopsy while treatment methods include; surgery, hormone therapy, radiation and chemotherapy. Palliative care entails chemotherapy, orchiectomy and radiation medicines while review costs entail doctors' review costs. Previous research by Trogdon et al., (2019) indicated that diagnosis and workup costs were $1664, treatment costs $10; 558 and follow-up cost $242. This costing will used to estimate the premium of cancer patients in Kenya. The age distribution of cancer cases diagnosis is shown in table (3) as:

Table 3. Cancer patient age distribution

Age	20-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
No. of patients	2	2	33	164	371	316	90	7
% of No. of patients	0.2030	0.2030	3.3502	16.6497	37.6649	32.0812	9.1370	0.7106

Most of the cancer patients were between the age 40 years and 90 years hence that is the age considered in this study. The interest rate was the prevailing interest rate of treasury bills in Kenya of 16%. The premiums for prostate cancer insurance policy are estimated as:

$$P\ddot{a}_{x:\overline{n|}} = IeP + ReP\ddot{a}_{x:\overline{n|}} + (TC + PC)A_{x:\overline{n|}} + ZP \tag{13}$$

Where:

Ie=75%, Re=15%, Z=10%, x=40, n=50 and *(TC+PC) = $12464+ $6201= $18665* hence equation (13) becomes:

$$P\ddot{a}_{40:\overline{50|}} = (0.75 * 5) * P \ + 0.15P\ddot{a}_{45:\overline{50|}} + \$18665\ A_{40:\overline{50|}} + 0.1P \tag{14}$$

$\ddot{a}_{45:\overline{50|}}$ This can be estimated as:

$$\ddot{a}_{45:\overline{50|}} = \frac{l_{45}+vl_{46}+\cdots+v^{44}l_{89}}{l_{45}}$$

$$=6.88925 \tag{15}$$

$\ddot{a}_{40:\overline{50|}}$ This can be estimated as:

$$\ddot{a}_{40:\overline{50|}} = \frac{l_{40}+vl_{41}+\cdots+v^{49}l_{89}}{l_{40}}$$

$$= 7.022702 \tag{16}$$

Adjusted accordingly

While $A_{40:\overline{50|}}$ Can be estimated as shown below given that d=discount rate:

$$A_{40:\overline{50|}} = 1 - d\ddot{a}_{40:\overline{50|}}$$

$$= 0.031351 \tag{17}$$

Substituting equations (15), (16) and equation (17) in equation (14) it results to

$$7.022702P = 3.75P \ + 0.15 * 6.88925P + \$18665 * 0.031351 + 0.1P \tag{18}$$

$$P = 273.5341 \tag{19}$$

From theorem (2) the actual premiums for various age sets are tabulated as:

Table 4. Estimated Premiums

t	41	…	51	…	61	…	71	…	81	…
Actual Premiums	$151.24	…	$1738.75	…	$4008.82	…	$6181.16	…	$6860.97	…

The actual premium estimates can be plotted graphically as:

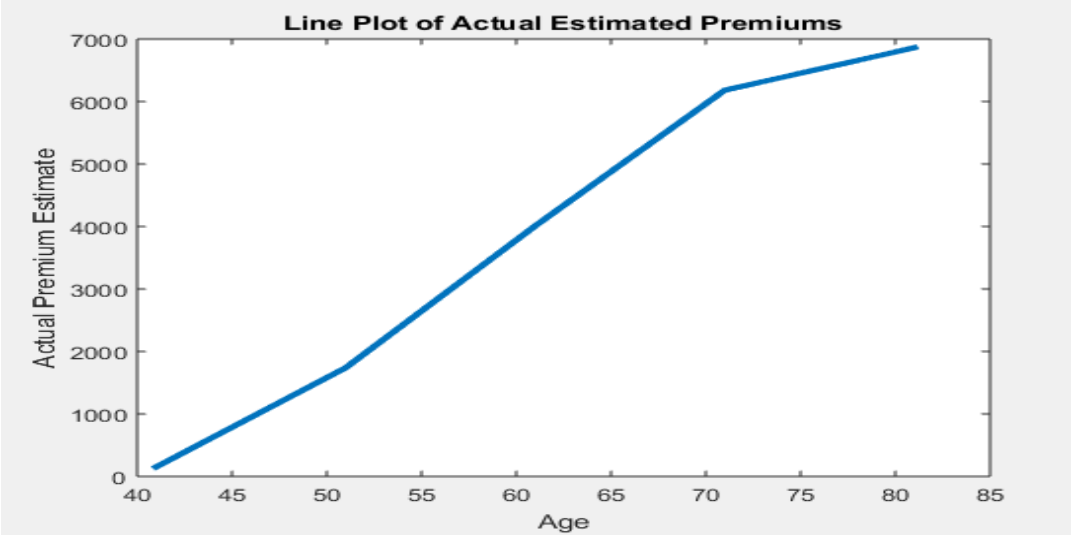


Figure 1. Actual premium estimates

The premiums increase gradually from age 40 to age 90 which is in line with the trend of premiums which increases with age.

The optimum reserving period is 50 years which is the period the policy is expected to be in force. The interest on reserves is 16% which is the prevailing interest of government t-bills. The reserves are estimated as:

$$tV_{40:\overline{50|}} = 1 - \frac{\ddot{a}_{40+t:\overline{50-t|}}}{\ddot{a}_{40:\overline{50|}}} \tag{20}$$

Where $t = 1,2,\ldots,49$

The results obtained from equation (20) are as shown in table (5).

Table 5: Reserve estimates for ages 41 to 89

t	1	2	3	…	47	48	49
Reserve	$37.74	$76.79	$177.44	…	$12843.32	$14167.34	$13349.38

The reserve amount increases gradually over the years as expected except for t = 35 which can be attributed to variation of mortality experience. The reserves drop at age t = 49 because it's the year we truncate our estimates that is year n-1 as it is expected for reserve estimates. The reserve estimated amounts are represented graphically as shown in Figure (2):

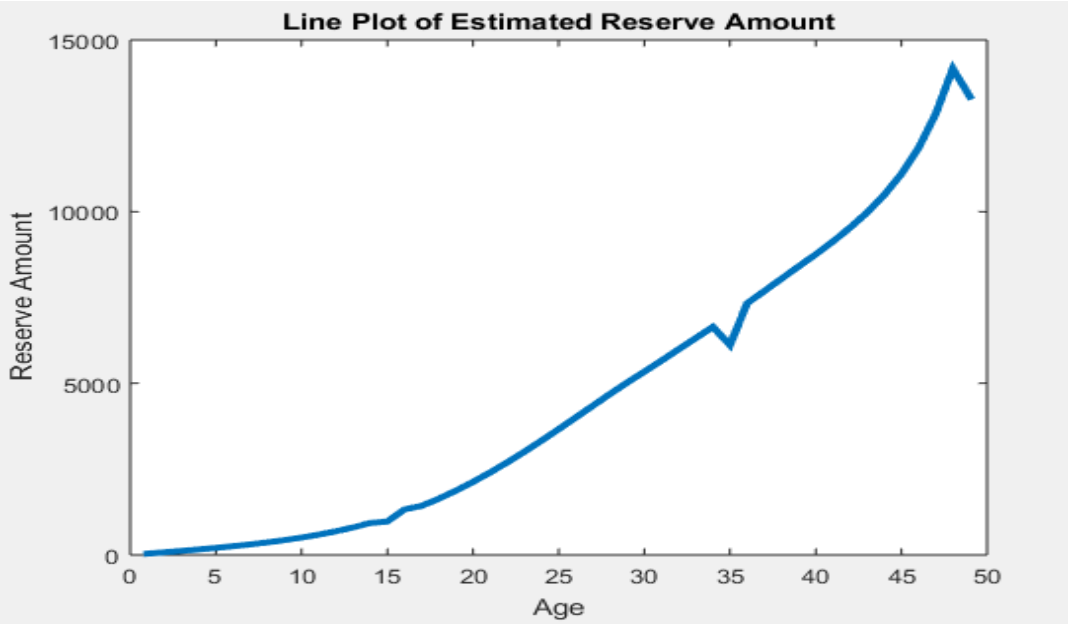


Figure 2: Reserve estimates

3.2 Profit testing of the policy

Profit testing of new policies is paramount as it enables insurance companies to assess the profitability of the policy once rolled out. This policy considers benefits while the policyholder is alive which are used to cater for treatment and palliative care hence the (CF)t formula is modified as shown in equation (6). The probability of getting cancer is computed per the sub-divisions of the age groups.

The in-force expected net cash flow for ages 41-90 is calculated as shown in equation (19)

$$(CF)_t = (P_t - e_t)(1+i) - \{[q_{x+t-1} * PC] + [p_{x+t-1} * TC]\} * prob\ of\ getting\ cancer \quad (19)$$

Where t=1-50.

The values of in-force expected net cash flow for select ages are shown in Table (6)

Table 6: $(\mathbf{CF})_t$ **estimates between ages 41 to 90**

t	**46**	**…**	**56**	**…**	**66**	**…**	**76**	**…**	**86**	**…**
$(\boldsymbol{CF})_t$ **estimates**	\$478.09	…	\$748.86	…	\$462.21	…	\$2618.21	…	\$5755.02	…

The $(CF)_t$ Amounts graphically are presented as:

The policy is not profitable in the first five years because of the huge initial expenses required to introduce the new policy in the market hence not plotted. In the subsequent years, the cash-flows increased gradually except for age 66 which can be attributed to the high incidence of cancer cases and mortality experience.

Policies usually set aside reserves which are used to settle the benefits once due. Accounting for reserves from the $(CF)_t$ we obtain the profit vector as shown in equation (7). The profit vector estimates for ages 41-90 are shown in equation (20).

$$(PRO)_{(1-50)} = (CF)_{(1-50)} + i * ((1-50)-1)V - (IR)_{(1-50)} \quad (20)$$

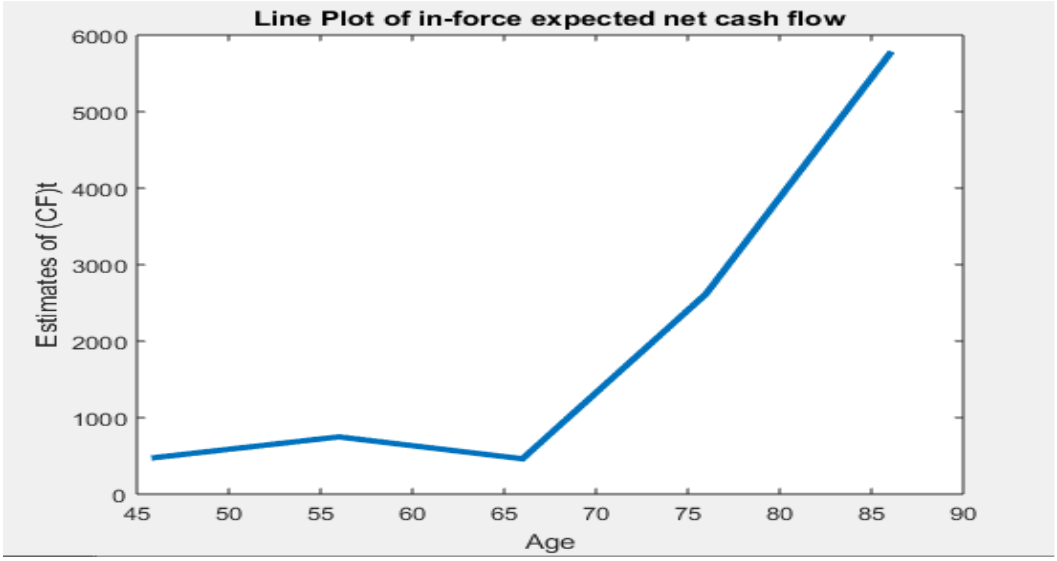


Figure 3: $(\mathbf{CF})_{\mathbf{t}}$ estimates

The values of profit vector obtained from equation (20) are tabulated in table (7) as:

Table 7: Profit Vector Estimates

t	**46**	**…**	**56**	**…**	**66**	**…**	**76**	**…**	**86**	**…**
$(\boldsymbol{PRO})_t$ **estimates**	\$463.45	…	\$542.18	…	\$801.26	…	\$2938.56	…	\$8719.41	…

These profit vector estimates increased with age similar to the trend of premiums. This also satisfies the principle of "high risk high returns" as the profits increase gradually with age which also increases the risk of developing chronic diseases. The profit vector values for the policy are represented in figure (4) graphically as:

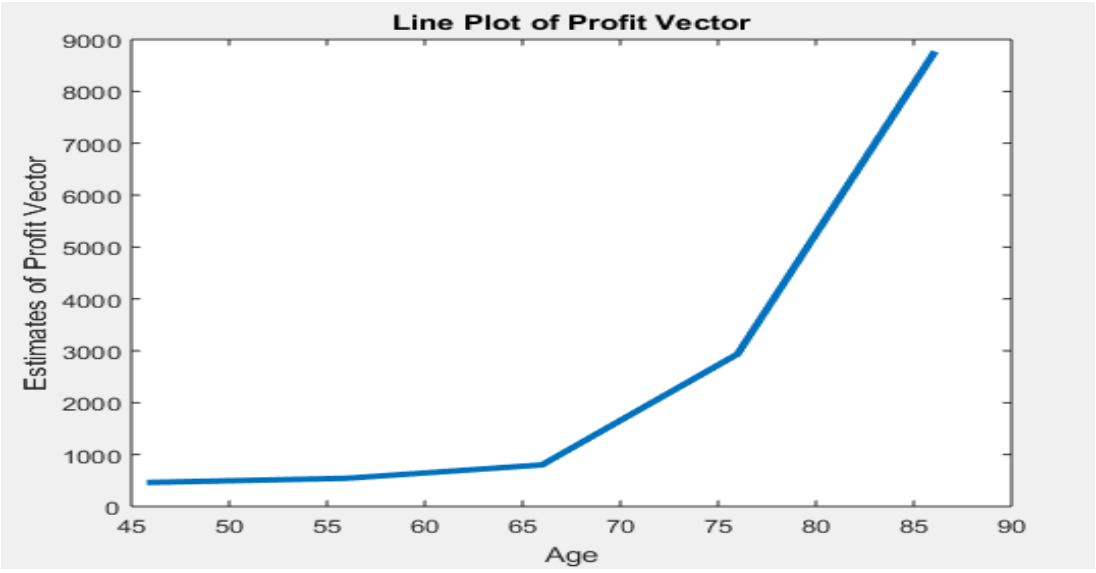


Figure 4: Profit vector estimates

The profit signature for ages 41-90 can be estimated as:

$$\sigma_{(1-50)} = ((1-50)-1)p_x(PRO)_{(1-50)} \tag{21}$$

The values of profit signature obtained from equation (21) are tabulated in table (8) as:

Table 8: Profit Vector estimates for ages 41 to 90

t	46	…	56	…	66	…	76	…	86	…
σ_t estimates	\$454.99	…	\$503.13	…	\$671.85	…	\$1536.59	…	\$1355.38	…

The profit signature estimates increase gradually from age 41 to 76 and reduce gradually as the age advances to 90. This is attributed to the decline in probability of getting prostate cancer as indicated by the data obtained. These values can be represented graphically as shown in figure (5) as:

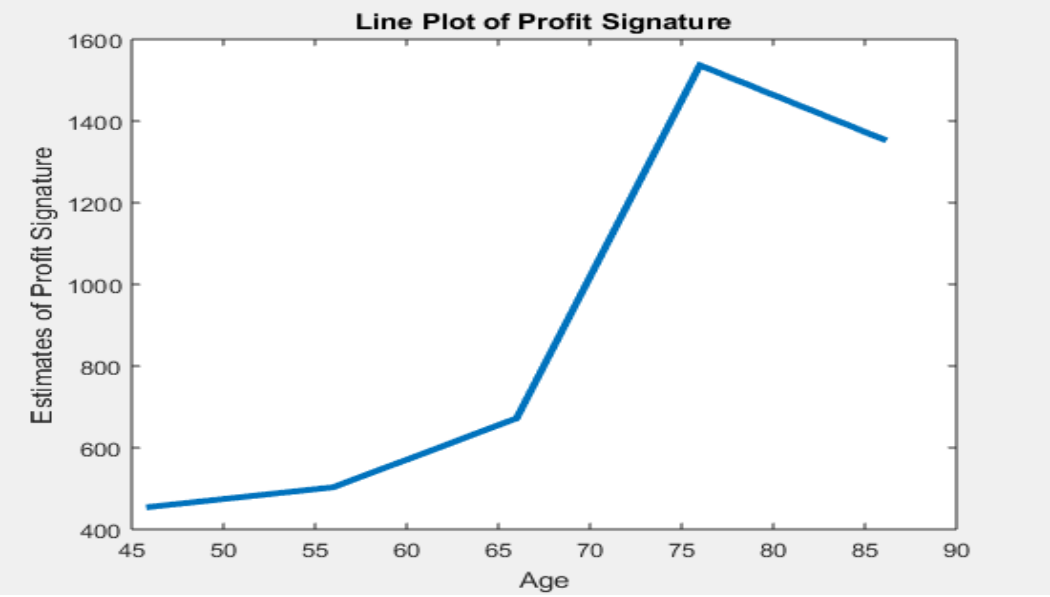


Figure 5: Profit signature estimates

3.3 Assessment of profits

Profits of policies can be assessed using various methods as indicated in subsection (2.4). In this research, we will consider the profit margin method as it is considered a superior method. The profit margins are estimated as:

$$\begin{aligned} Profit\ Margin &= \frac{\sum_{t=1}^{50} v^t \sigma_t}{\sum_{t=0}^{49} P_{t+1} {}_t p_x v^t} \\ &= \frac{630.2269}{7847.669} \\ &= 0.0830752 \end{aligned} \tag{22}$$

The value of the profit margin obtained from equation (22) is 0.0830752 which indicates that this policy is projected to have a return of 8.31% of its premiums as profits. This is quite in the range of the profits assumed for the model of 10% hence indicating a high level of precision and accuracy from the model. This is also within the range of profits assumed by most insurance companies which is between 2% - 10%.

3.4 Limitations of the data and the model

This study considered a data set of 986 patients which is just a fraction of cancer patients in Kenya. This limitation can be mitigated by obtaining a larger population size. The model constructed is for the ages 40-90 years where cancer is most prevalent as indicated by the data we obtained and the patients are considered healthy enough to persevere cancer treatment. More research can be done on a whole life model with appropriate modifications, especially on elderly patients beyond the age of 90 who cannot withstand the harsh cancer treatment procedures. Sensitivity analysis -having considered different premium values for different age groups conducts sensitivity analysis on the model.

4. Conclusion

A model for pricing and profit testing chronic disease insurance policy is developed using prostate cancer data from Kenya. Most insurance firms have shied away from chronic disease insurance policies due to the unpredictable nature of these policies. The policy developed is modified to accommodate the challenges faced by these policies and tested for profitability. Considering both treatment cost and palliative care in modeling this policy ensures that it factors all dimensions of chronic diseases while still maintaining profitability at 8.31%. Factoring the increase in the probability of being diagnosed with cancer in the computation of the premiums ensures that the premiums are age-based and cancer incidence pegged which is quite important as these are major factors affecting chronic diseases.

The proposed policy model can be an important tool in revolutionizing the insurance industry in terms of penetration and coverage. This policy will be particularly useful in helping the insurance industry develop insurance policies for chronic diseases which in return will reduce the mortality associated with chronic diseases as more people will be able to access quality health care within the recommended time.

Data Availability:

The data used to support the findings of this study is available on request.

Conflicts of Interest:

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

Ayieng'a Tabitha, N. (2016). A Comparative Study of Profitability of Life Assurance and General Insurance Companies Operating in Kenya. University of Nairobi, Masters Dissertation. Corpus ID: 169876539.

Kariuki, D. W., Muturi, W., and Njeru, A. (2021). Influence of liquidity on financial performance of insurance companies in Kenya. *Journal of Agriculture Science & Technology*, 20(3): 91-101.

Huguet, N., Hodes, T., Liu, S., Marino, M., Schmidt, T. D., Voss, R. W., Peak, K. D., and Quiñones, A. R. (2023). Impact of health insurance patterns on chronic health conditions among older patients. *The Journal of the American Board of Family Medicine*., 36(5): 839–850. doi: 10.3122/jabfm.2023.230106R1.

Kiio, N. (2014). The relationship between liquidity and profitability of insurance companies in Kenya. *Journal of Business Economics,* Corpus ID:168147984.

Mbugua, F. N. (2019). Kenyan Mortality and Survivorship Tables. University of Nairobi, Masters Dissertation.

Ministry of Health Kenya (2021). Kenya palliative care policy 2021. *Ministry of Health.*

Noel, J. A., and Vratislav, V. (2002). Profit measures in pricing: their use and interpretation. *Society of Actuaries,* 28(1).

Onyango, E. M., and Onyango, B. M. (2018). The rise of non-communicable diseases in Kenya: an examination of the time trends and contribution of the changes in diet and physical inactivity. *Journal of Epidemiology and Global Health,* 8(1): 1-7. doi: 10.2991/j.jegh.2017.11.004.

Owusu, D. A., Appiah, S. K., Omari-Sasu, A. Y., and Berimah, R. T. (2016). Pricing and profit testing of "keyman" life policy of insurance companies in Ghana. *International Journal of Finance and Accounting*, 5(4): 202-208. doi:10.5923/j.ijfa.20160504.05.

Peng, Z., and Zhu, L. (2021). The impacts of health insurance on financial strain for people with chronic diseases. *BMC Public Health*, 21(1012). doi.org/10.1186/s12889-021-11075-2.

Thomas, S. A., Browning, C. J., Charchar, F. J., Klein, B., Ory, M. G., Bowden-Jones, H., and Chamberlain, S. R. (2023). Transforming global approaches to chronic disease prevention and management across the lifespan: integrating genomics, behavior change, and digital health solutions. *Frontiers in public health*, 11. doi: 10.3389/fpubh.2023.1248254.

Trogdon, J. G., Falchook, A. D., Basak R., Carpenter, W. R., and Chen, R. C. (2019). Total medicare costs associated with diagnosis and treatment of prostate cancer in elderly men. *JAMA oncology*, 5(1): 60-66. doi:10.1001/jamaoncol.2018.3701.