Parametric Insurance Proposal for New·World

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TEAM TRIPLE C

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1 Executive Summary

The report dissects into the application of parametric insurance on healthcare and examines new insurance product by NEW·WORLD in combating global health risks in Ambernïa and Palòmïnïa. The report explains a comprehensive product based on parametric model, with actuarial analysis and risk management.

Metabolic syndrome (MetS) is a group risk factor that could develop into chronic heart diseases [31]. Based on the population makeup and other factors, MetS will become a threat to healthcare. This report looks to discern the possible risk for the disease and NEW·WORLD's solution in designing parametric insurance models to help future policyowners. The new parametric model on the policy product will help NEW·WORLD to take a lead in the health insurance industry.

Based on analysis of the data provided by NEW·WORLD on countries data and company financial statements, it shows MetS is a highly insurable risk. This report provides an accurate solution with conservative risk for a new policy based on a parametric model. While there are data limitations and uncertainties that require further analysis and assumptions, we provide references, justifications, supporting calculations, and case-based simulations in the appendices as well as in the attached Excel workbooks. This report will mainly focus on the product benefit, conclusions, limitations, and their impacts on NEW·WORLD.

2 ANALYSIS METHODOLOGY

2.1 Background Analysis

COVID-19 has caused financial disruption to every level of society, due to deceleration in the global economy. Moreover, there has been a **rise in claims and a drop in profit in the health insurance industry**, raising insurer exposure towards financial risks [1].

In tackling these, parametric insurance is considerably the best fit solution due to payout **based on index which is below critical loss level** with **amount based on loss in the index** level, providing lower risk for insurers. In terms of health coverage, parametric becomes reliable. Health insurance only provides 70% coverage with specific areas, while **parametric provides a sum of cash** which can be used for **flexible medication to areas uncovered by health insurance** [2]. **Less budget and process managing third party administrators is needed** due to the nature of being independent auto-payout once activated.

Thus, this type of insurance fits best with diseases which have an index or metric to be considered ill, one of them being Metabolic Syndrome (MetS), **a disease which has to activate 3 out of 5 risk factors** [27].

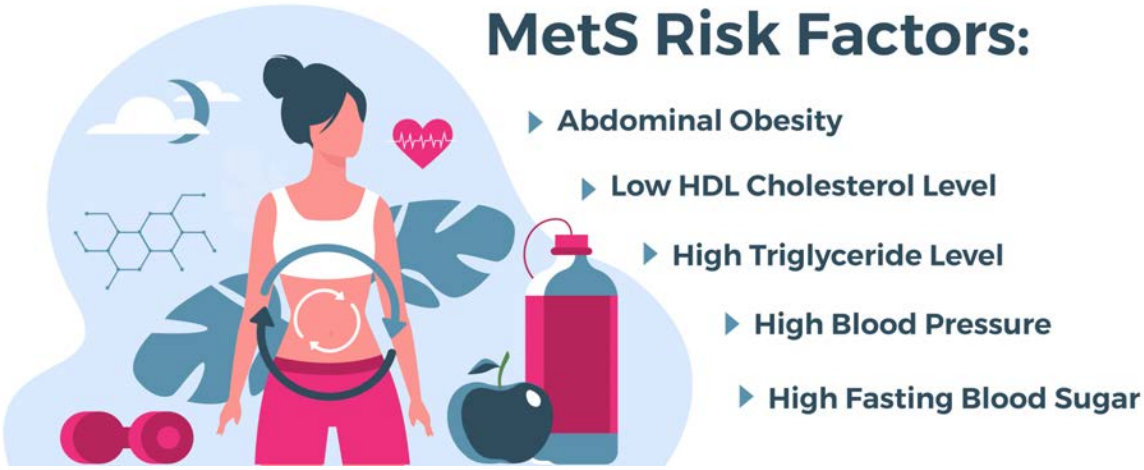


Figure 1. MetS Risk Factors [3]

In the last three decades, there has been a rise in Diabetes (4.09%) and Hypertension (1.62%) which contributes directly to the rise of MetS worldwide, showing a rise in demand for MetS healthcare.

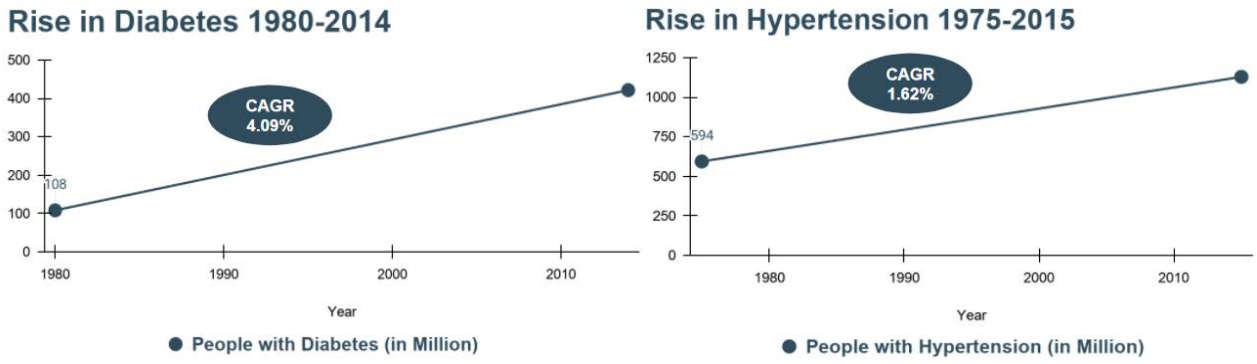


Figure 2. Diabetes and Obesity rate [4]

Ambernïa, advanced economy country, and Palòmïnïa, emerging market economy country, are the main target of market which NEW·WORLD would like to penetrate using the new potential product.

2.2 Product Market

Approximately 200,000 and 47,000 of people in Palòmïnïa and Ambernïa caught **diabetes with annual growth of 1.96% and 0.77% (2011-2020) respectively**, causing **65% more vulnerable towards MetS** [5]. Raising the urgency towards the issue since MetS increases **68% chance of sudden death** [6].

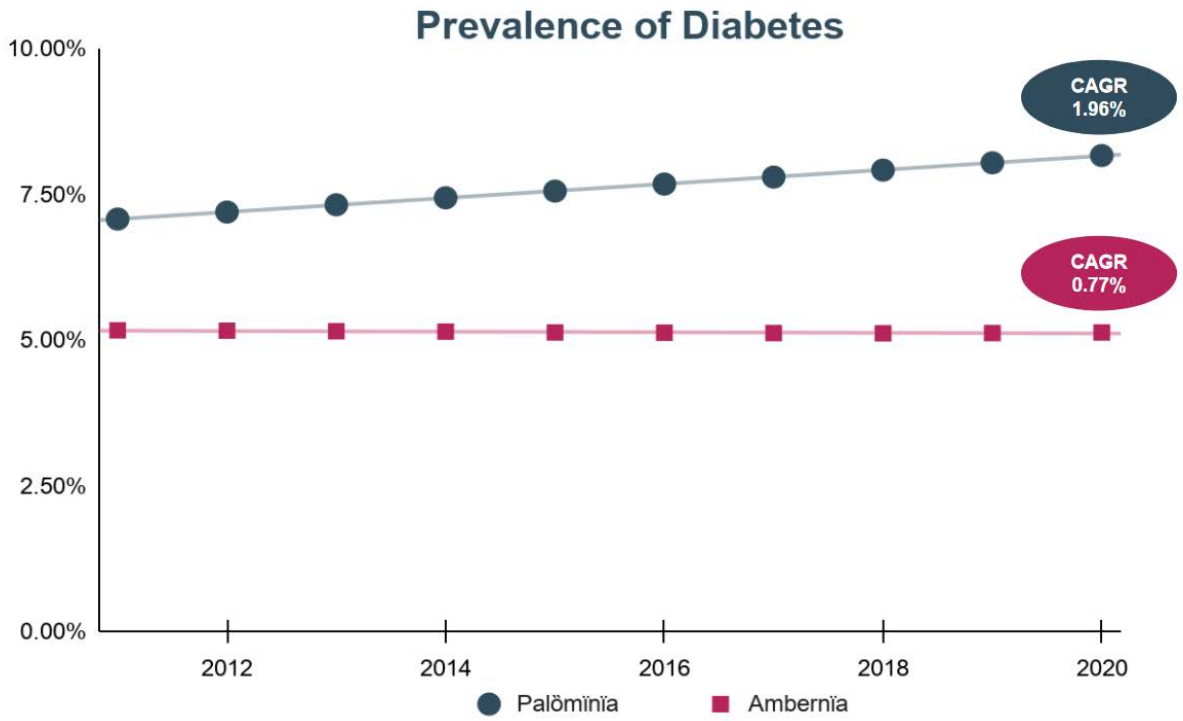


Figure 3. Prevalence of Diabetes 2011-2020 (Appendix C-1)

In filling up MetS protection demand in both countries, we provide a parametric insurance for MetS precaution with two activation triggers, being **diabetes and high systolic level** [7]**.** With parametric insurance, **insureds will gain benefits in forms of expected financial loss given due to MetS before being labeled with it**, creating a **pre-emptive measure.** Total targeted market for MetS products for individual ranging from **20 - 65 years**, specifically **14.8 thousands and 3.23 thousands individuals** for Palòmïnïa and Ambernïa respectively.

Figure 4. Potential Market (Appendix B-14)

2.3 Assumptions

Within the data provided by NEW·WORLD, there are several assumptions required to account for complimenting the given data while referring to global data. These assumptions, data limitations, and justifications are shown in Table 1.

Table 1. Data Limitations and Assumptions

Assumption	Data Limitation	References	Justification
Prevalence of Diabetes by Age	The prevalence of diabetes by age is unknown	Centers of Disease Control and Prevention [CDC], 2016 [24]	Modeling transition probability from healthy state to diabetes state
Mortality Table of Palòmïnïa	The mortality table is unknown	United Nation Life Table 2011 [25]	Common mortality assumption for developing country model
Mortality Table of Ambernïa	The mortality table is unknown	National Vital Statistic, CDC. US Life Table 2017 [26]	Common mortality assumption for developing country model
Lognormal Distribution for Systolic Pressure on population for Hypertension	The distribution of systolic pressure in unknown	Bibliography [8]	Finding population proportion for systolic pressure trigger
Gompertz Model for the prevalence of Hypertension and Diabetes	The prevalence per age for both triggers are unknown	Bibliography [9]	Parameterization needed to evaluate claims probability in continuous time frame
Policy Lapse rate of 7.3%	Lapse history is unknown	Bibliography [10]	Lapse rate is needed for revenue analysis and projection

Based on given data from NEW·WORLD, we also took some assumptions as shown in Table 2.

Table 2. Other Assumptions Based on Data

Assumption	Variables	Justification
Interest rate: Palòmïnïa's i=3%, Ambernïa's i=0.5%	Interest rate	Slightly rounded up 3-month interest rate average of each country from 2010 to 2020. Refer to Appendix B-2
Population: The number of population grows linearly	Population	Population growth greatly fitted with simple linear regression. Population growth used in premium and revenue analysis calculation. Refer to Appendix B-3

Investment interest is 3.06%, average of Palòmïnïa money market interest	Investment interest rate	We assume investment allocated in the Palòmïnïa money market fund due to a higher average of money market interest. Refer to appendix B-4
Healthcare spending per person: the amount of the healthcare spending per person grows linearly corresponding toward inflation rate	Healthcare spending per person	We calculate the healthcare spending per person is increasing as time goes, and a linear regression model suited for the growth. It is noted that the premium and revenue analysis is also being taken for consideration in the calculation. Refer to Appendix B-5
Expense ratio from gross premium is normally distributed	Expense ratio from gross premium	Expense is normally distributed within worst and best case with 95% confidence interval
Reinsurance rate = 10% is the same as existing product(s)	Reinsurance Rate	Existing product(s) reflect company risk profile. Refer to Appendix B-6
Age band proportion is uniformly distributed between 10 years	Age Proportion	Commonly used assumption if the distribution is unknown. Refer to Appendix B-7
Claim rate is binomially distributed with parameter *p* equal to probability of claim	Claim Rate	Commonly used assumption if the distribution is unknown.

2.4 Methodology

To calculate and design the product, we use several methods to design the product.

Table 3. Methodologies

Methodologies	Application	Appendix	Justification
Modified Equivalence Principle	Premium Calculation	Appendix A-1	Basic concept used to define premium and premium reserves
Gompertz Smoothing	Modelling Systolic and Diabetes morbidity table	Appendix B-1	The risks of age-related diseases grow exponentially with age and double at a rate compatible with the Gompertz mortality law [30].
Linear Regression	Forecasting population and Healthcare Spending per Person	Appendix B-5	There has been a general linear uptrend in GDP and Healthcare Spending per person from 2012 to 2020
Monte Carlo Simulation	Revenue Projection and Analysis	Appendix B-8	Used to project revenue based on repeated random sampling on different conditions
Sensitivity Analysis	Risk Management	Appendix B-14	Used to see the effect of change in claim rates

3 PRODUCT PLAN

3.1 Product Design

The product will cover MetS condition with the activated triggers in **the next 8 years with a premium payment period of 5 years.** We believe payment of 5-year period benefits in two ways. For insurers, it is a short term product with **high competitiveness** due to **high payout coverage and low premium**. For insureds, it's short terms of payment with an additional 3-year coverage program, reducing financial assets loss due to MetS for insureds. Assumptions of 8-year coverage comes from risk of **25% diabetes occurrence being in 3-5 years after early symptoms** [11]**.**

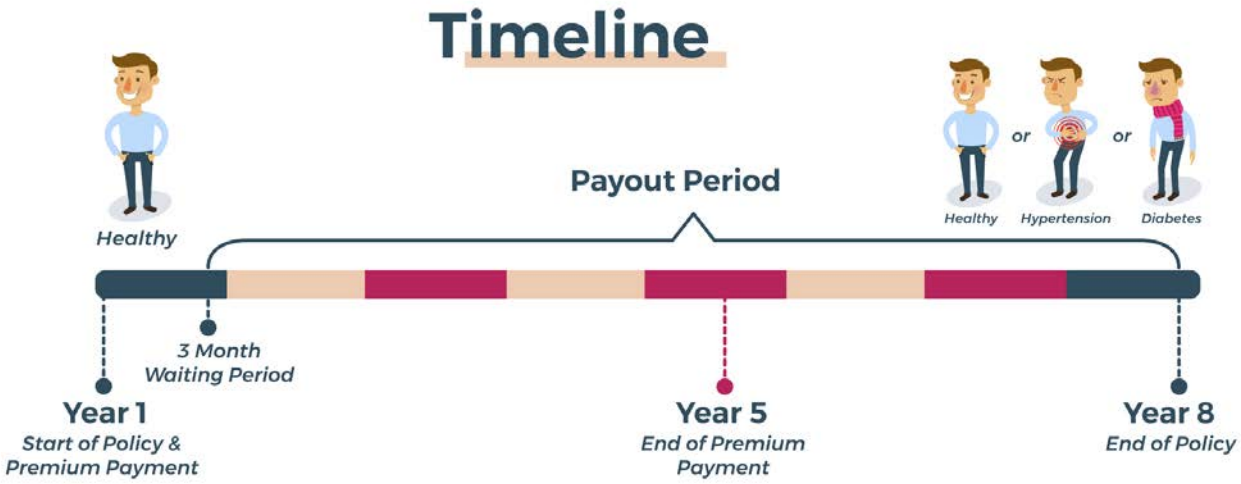


Figure 5. Product Timeline

Moreover, for the entry process, a **Simplified Issue mechanism (SIO)** will be chosen, reducing **complexity during the registration process** for insured. Data tracing done through insured historical social activity with charges for data fraud. There will be a 3-months waiting period after purchase, **lowering risks of undiagnosed risk factors**, where there will be **no payout even with trigger activation**. We recommend our insured to **do a routine annual blood test.** [12].

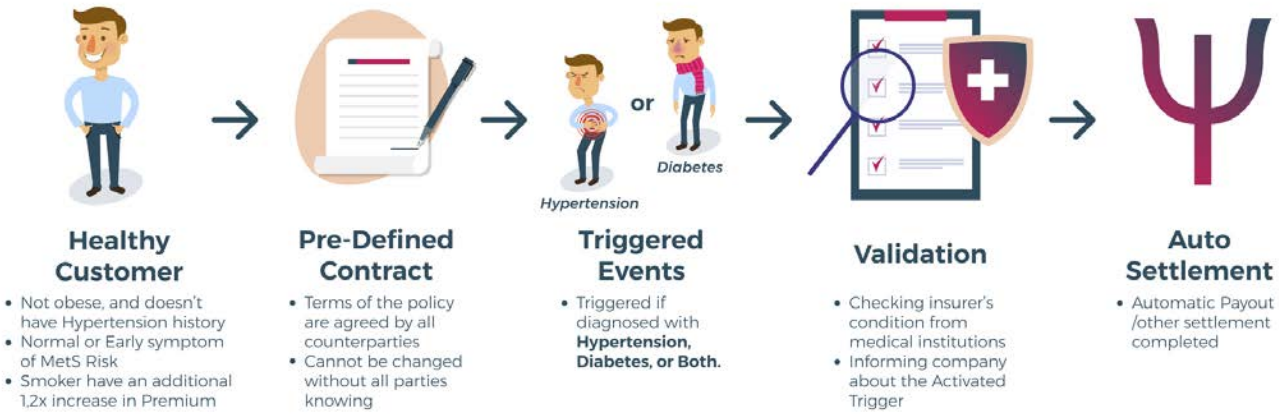


Figure 6. Insurance Flowchart

For insured who would like to repurchase the product, they can easily **renew the product to the company by resetting the year period and less process**. However, there **should only be one active product**, since insured who hold more than one product within the same period will be a loss for NEW·WORLD, due to **twice the risk impact**.

3.2 Design Elements

Within the MetS product, there are several points which needed to be considered, which are:

1. Triggering Events

   Triggering event(s) is a **parameter needed for payout to be claimed** as per contract. Although MetS has 5 risks, we **reduce it into 2 major risks, being diabetes (defined by NEW·WORLD) and high systolic level (>=140mmHg),** due to evidence of **diabetes having high correlation with the other three risks** [13],[14],[15] **and data limitations** for other specific risks prevalence. For every individual with diabetes, there is 68.4% chance of having high blood pressure (hypertension)[16].

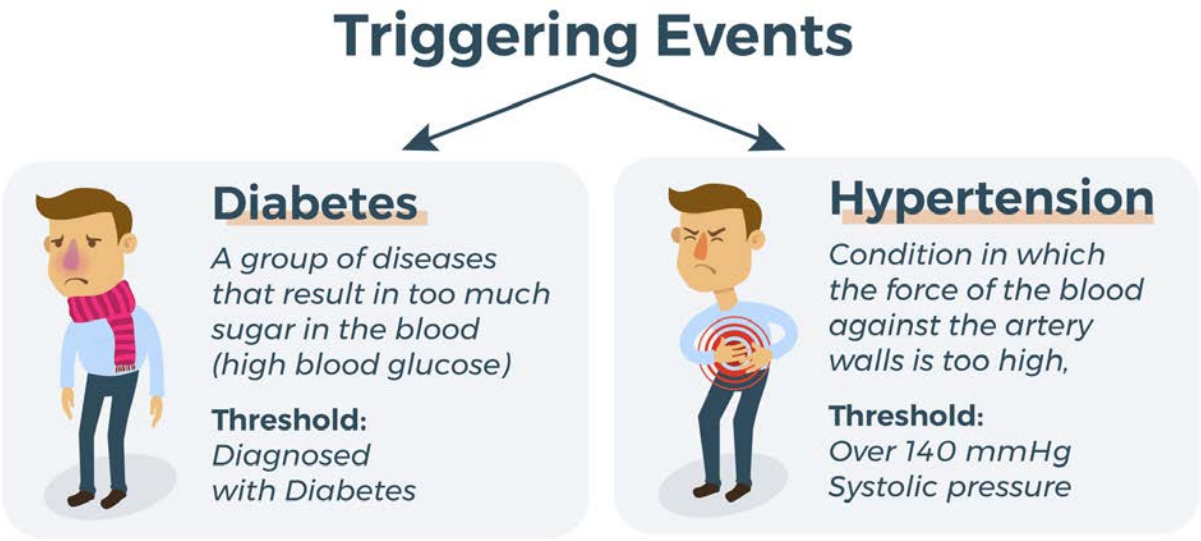


Figure 7. Triggering Events

2. Index Measure

   Index measurement is the numbers needed to be reached to disburse payout. Index checkup will be done by health institutions. We **define the new discrete index as Metabolic Syndrome Risks (MSR)** defined as activation of MetS risks shown before. In insurance term, we would have:

   - Contracting **Diabetes (based on countries consensus level)** as MSR=1
   - **High systolic level (being above >=140 mmHg)** as MSR=1
   - Contracting diabetes and high systolic level **(both)** as MSR=2

3. Payout provision

   Provision cover financial asset loss due to **risks activation medication and future MetS expense** which is assumed to be equivalent to **amount of 1.44x** [17] **of healthcare costs as maximum payout** at the **end of product period (year 8) for the next 8 years**, with **a reduction of 16.67%** at MSR=1 in both countries. Healthcare costs are used as main assumptions due to data limitations of risk cost for the payout..

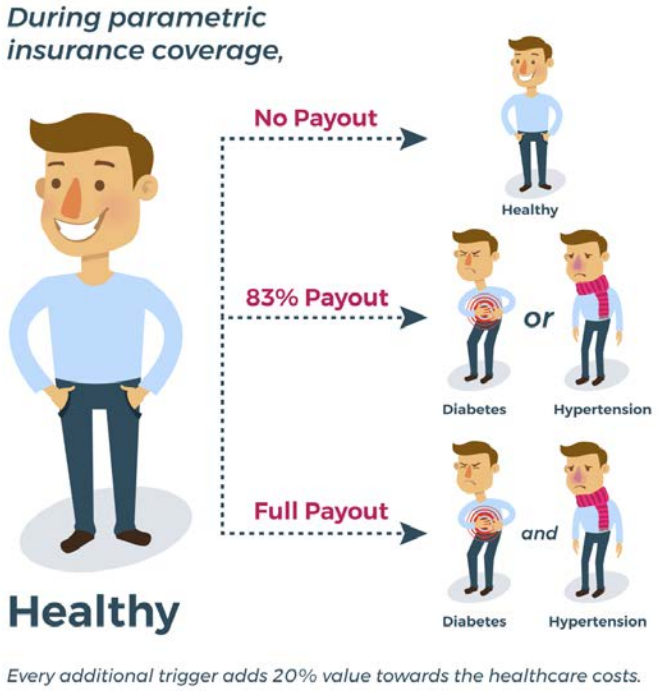


Figure 8. Payout Provision

For the payout mechanism, we provide the insurance term:

- **Entry : MSR=1**
- **Exit : MSR=2**
- Payout:
    - MSR=1 : 83% maximum payout
    - MSR=2 : Maximum payout

Expected payout per year (Appendix A-2) can be seen in the table 4,

Table 4. Expected payout by year of policy start and number of trigger

Palòmïnïa			Ambernïa		
Policy Start	MSR = 1	MSR = 2	Policy Start	MSR = 1	MSR = 2
2021	10,104.69	12,125.63	2021	72,244.80	86,693.76
2022	10,470.75	12,564.91	2022	73,636.93	88,364.32
2023	10,836.82	13,004.18	2023	75,029.06	90,034.88
2024	11,202.88	13,443.45	2024	76,421.20	91,705.44
2025	11,568.94	13,882.73	2025	77,831.33	93,376.00
2026	11,935.00	14,322.00	2026	79,205.46	95,046.56
2027	12,301.06	14,761.27	2027	80,957.60	96,717.12
2028	12,667.12	15,200.55	2028	81,989.73	98,387.68
2029	13,033.18	15,639.82	2029	83,381.86	100,058.24
2030	13,399.25	16,079.10	2030	84,774.00	101,728.80

4 IMPLEMENTATION

4.1 Premium, Revenue and Expense Analysis

4.1.1 Introduction to Model

We use a triple decrements model with the first two being the two triggers, and the third being death (Appendix C-3). Basic premium is calculated with expense-loaded equivalence principle, then the premium rate recalculated by simulating premium prices until a preferable loss rate (Appendix A-1, Appendix A-3). The premium formula for individual age ( ) in two countries:

$$Premium = \frac{Payout \cdot (1.0358) \cdot A^{1,claim}_{x:\overline{8}|}}{\ddot{a}_{x:\overline{5}|} - 47.11\% \cdot \ddot{a}_{x:\overline{8}|}}$$

Figure 9. Premium formula in Ambernïa

$$Premium = \frac{Payout \cdot (1.34654) \cdot A^{1,claim}_{x:\overline{8}|}}{\ddot{a}_{x:\overline{5}|} - 47.11\% \cdot \ddot{a}_{x:\overline{8}|}}$$

Figure 10. Premium formula in Palòmïnïa

Equivalence principle causes change of premium in accordance to age. We will see premium increases due to increasing healthcare costs by inflation. To summarize, we provide premium increase illustration for several percentiles.

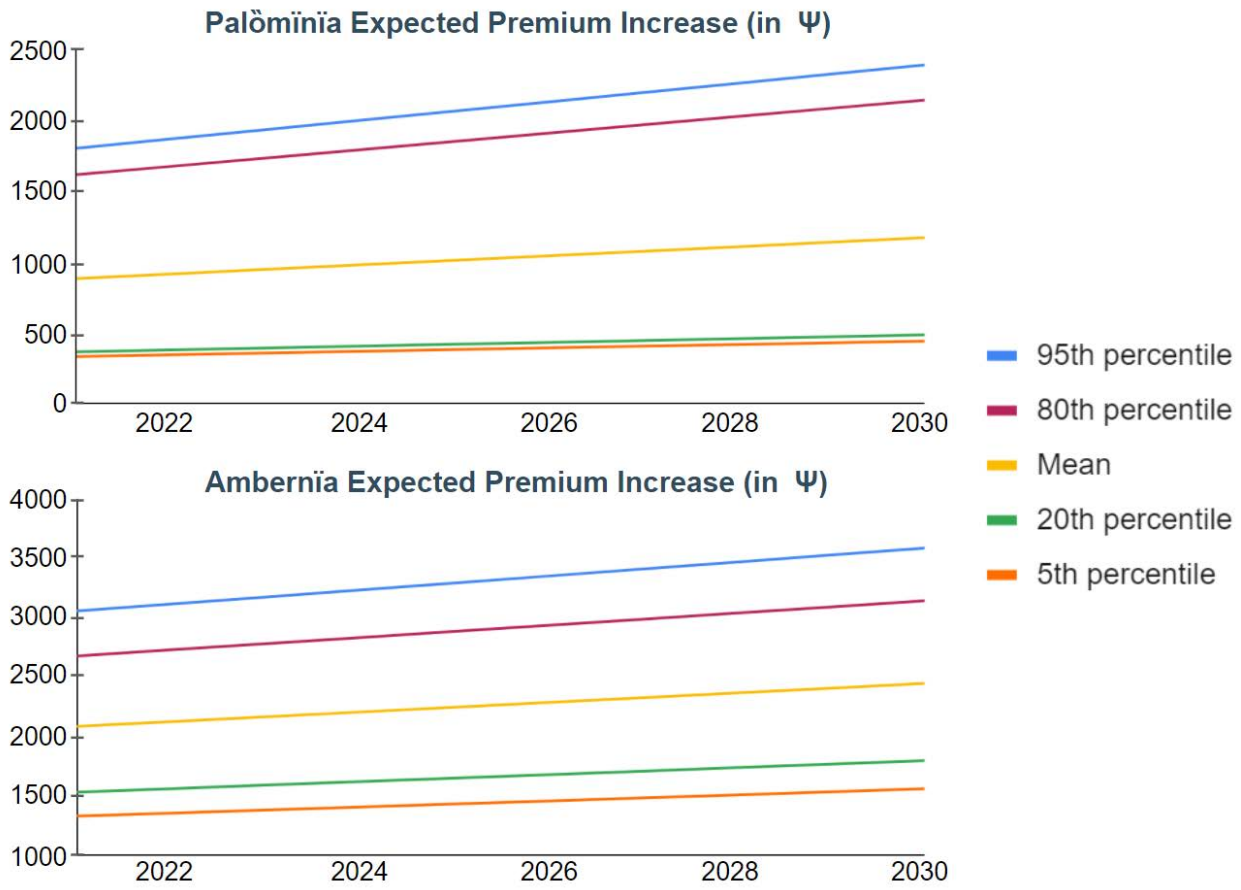


Figure 11. Expected premium increase

Gompertz model fit for morbidity causes high deviations towards premium which annually increases linearly.

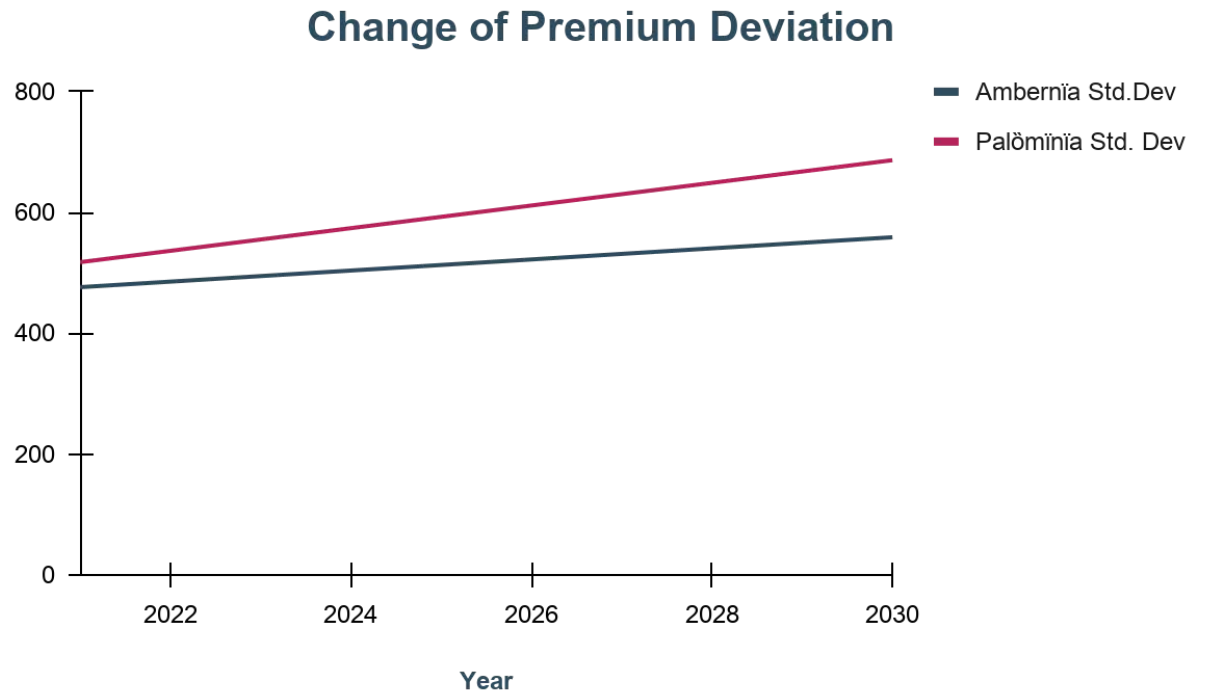


Figure 12. Change of Premium Deviation

For active smokers, we increase premiums due to higher risks towards MetS, with rise of 23.66% and 24.85% in premium for Palömïnïa and Ambernïa respectively [18].

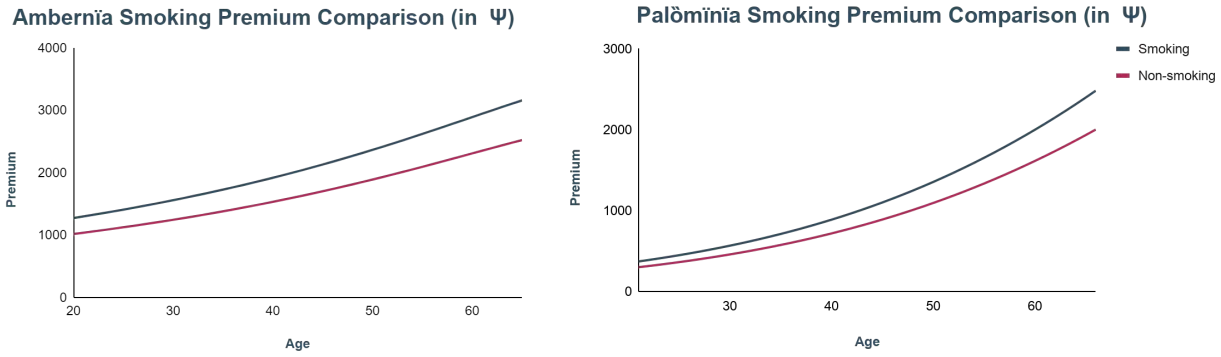


Figure 13. Premium comparison for smoker

Specific values of given numbers above can be seen in Appendix A-3. See figure 14 for premium component breakdown, resulting in **total expense-premium ratio of 47.11%.**

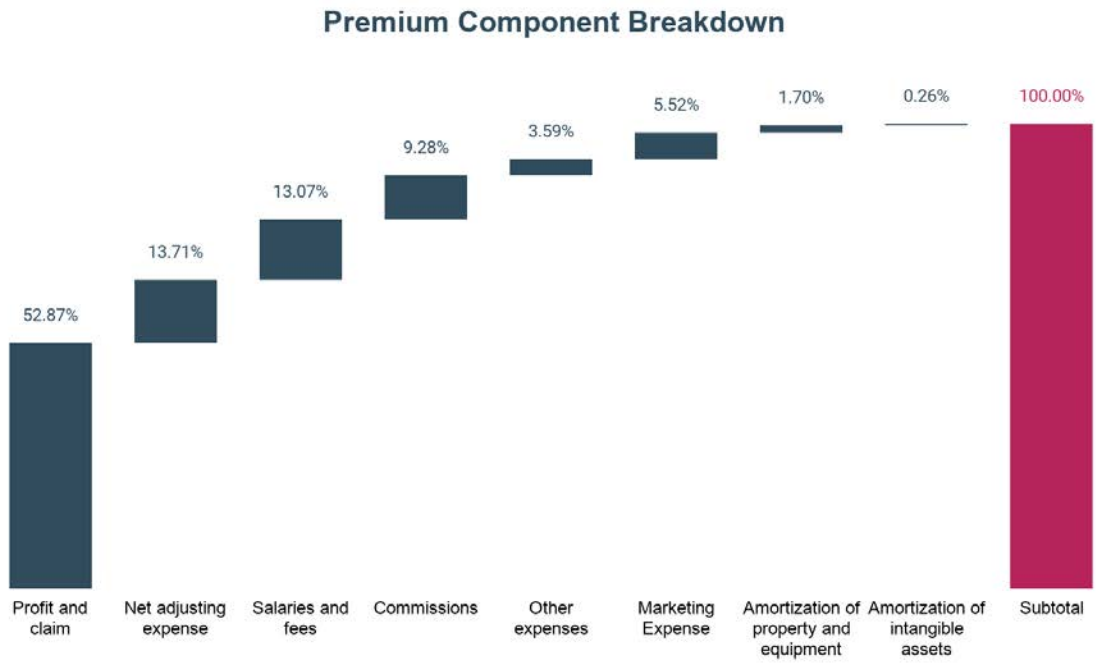


Figure 14. Breakdown of premium component

4.1.2 Expense Analysis

We assume expense is normally distributed with mean of $\mu = 47.13\% \cdot$ and variance of $\sigma^2 = 0.62\% \cdot$ based on best case and worst case scenario. We determine asset growth with formulation of

$$Asset\ at\ year\ n = (Asset\ at\ year\ n-1 \cdot Investment\ Interest\ Rate) + Nett\ income\ at\ year\ n-1$$

Figure 15. Formula of asset growth

In analyzing **expense impact** towards the company, we perform **Monte-Carlo simulation with 1,010 scenarios each year** (Appendix B-9), expense-asset ratio growth as shown in figure 16.

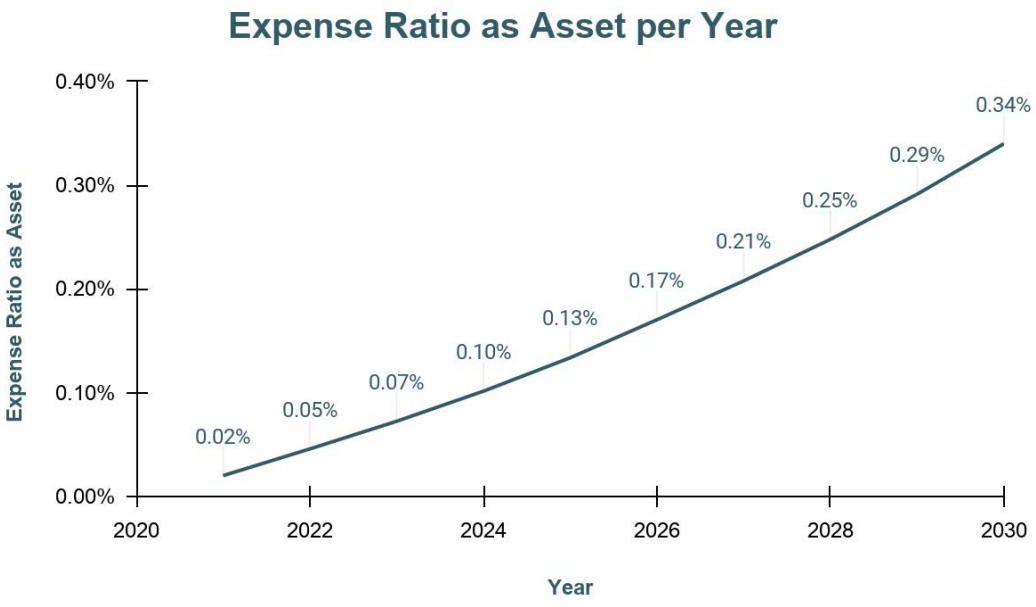


Figure 16. Expense-asset ratio per year

4.1.3 Revenue Analysis

In projecting gain/loss of product, we use Monte-Carlo simulation with 5,050 scenarios for every year with corresponding assumptions.(Appendix B-10)

With full projection of a single policy released in 2021, we expect to get 8,165,703 in revenue with standard deviation of 5,801,734 for the product in Ambernïa, and the probability of loss of 4.93%. See figure 17 below for Ambernïa product revenue distribution.

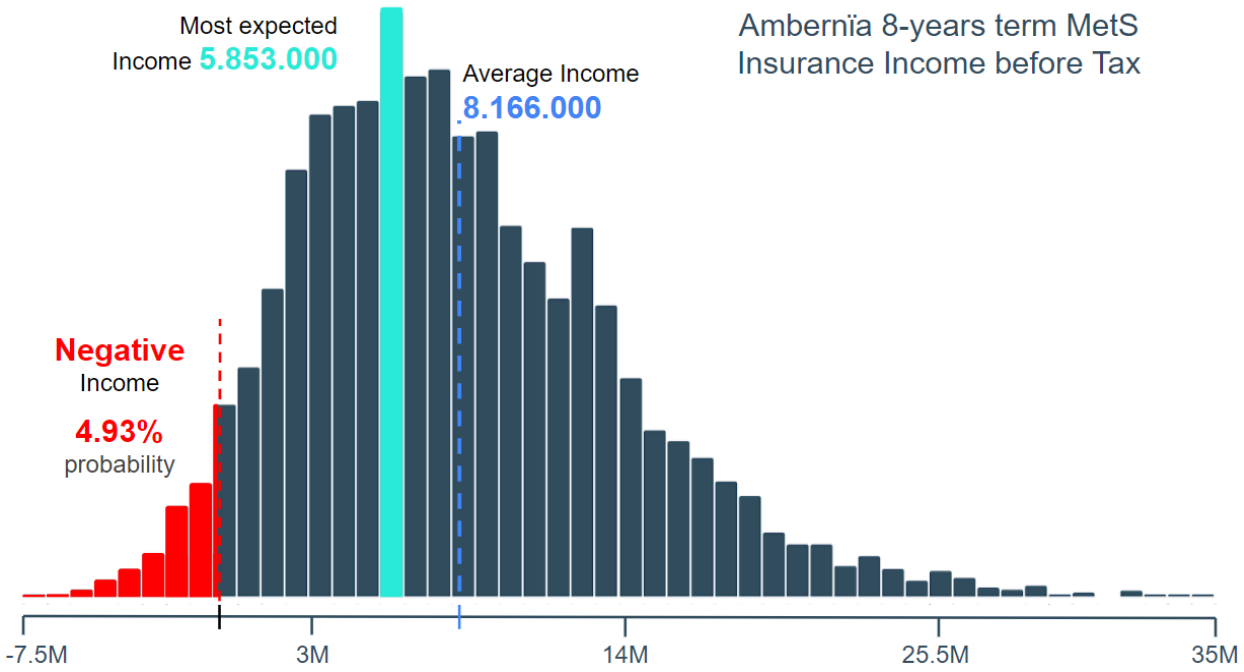


Figure 17. Ambernïa product revenue distribution

For Palòmïnïa, we expect to get 13,072,950 in revenue with standard deviation of 13,353,500 in 2021, and the probability of loss of 15.39%. See figure 18 below for Palòmïnïa product revenue distribution.

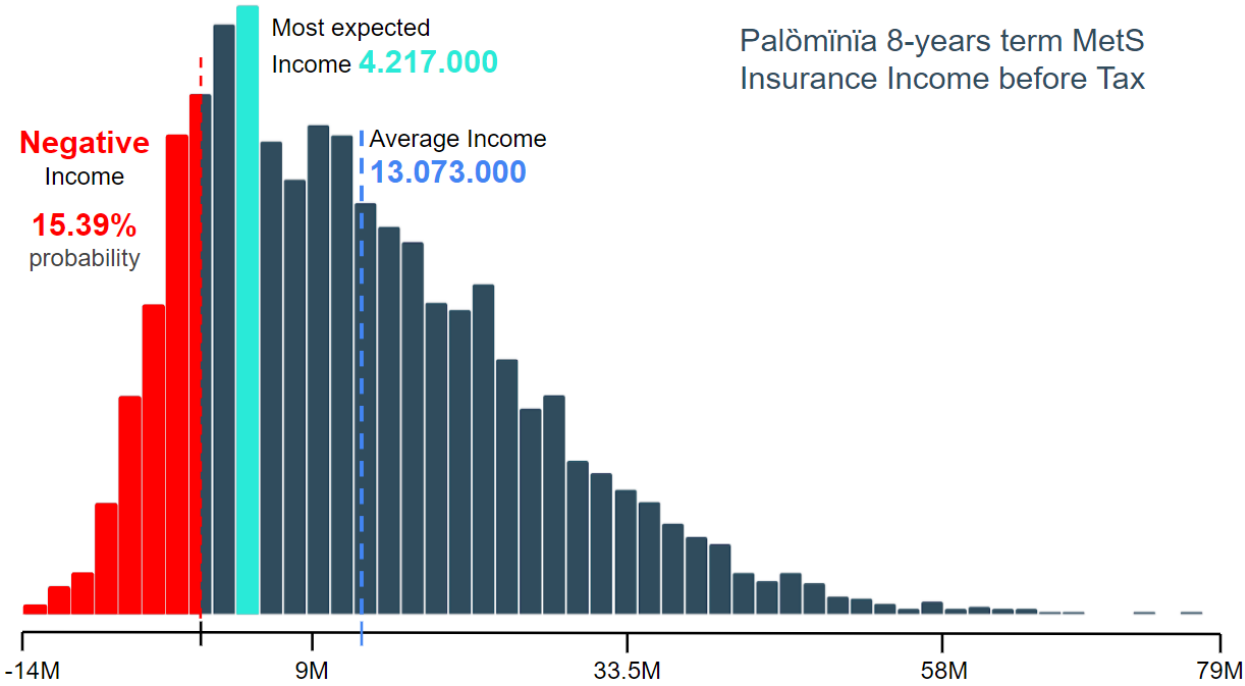


Figure 18. Palòmïnïa product revenue distribution

4.2 Potential Market Analysis

Understanding MetS healthcare cost, it is **considered as expensive**. Limiting the market which could tap into this insurance to those with **better understanding and care towards MetS risk**, which is the **upper market and literate** with the assumptions of the **upper market have higher education level**, meaning aiming only to the tertiary market initially [19].

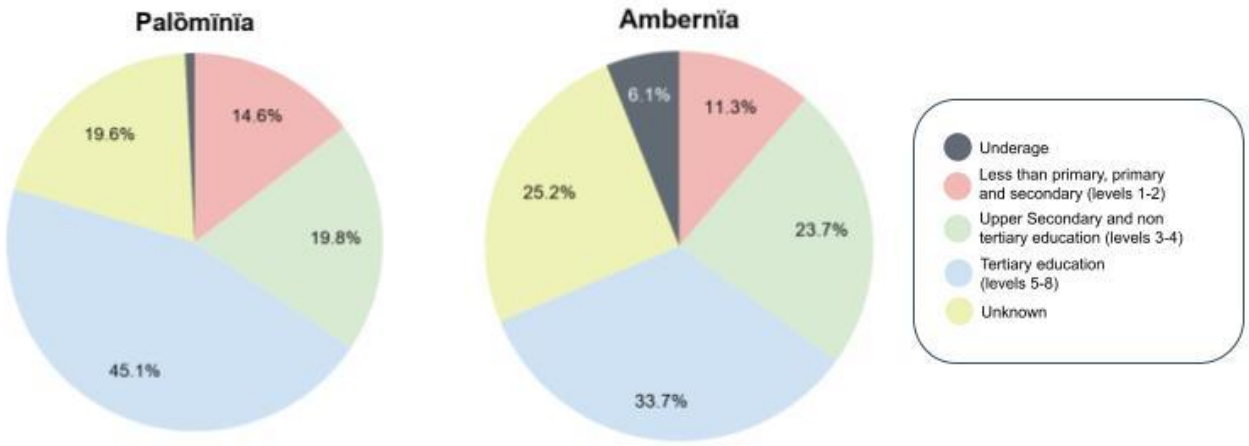


Figure 19. Educational level (Appendix B-13)

Furthermore, in reducing risks, **excluding people with obese** from the potential market, for the fact that there is a 80% probability of obese patient to get diabetes [20].

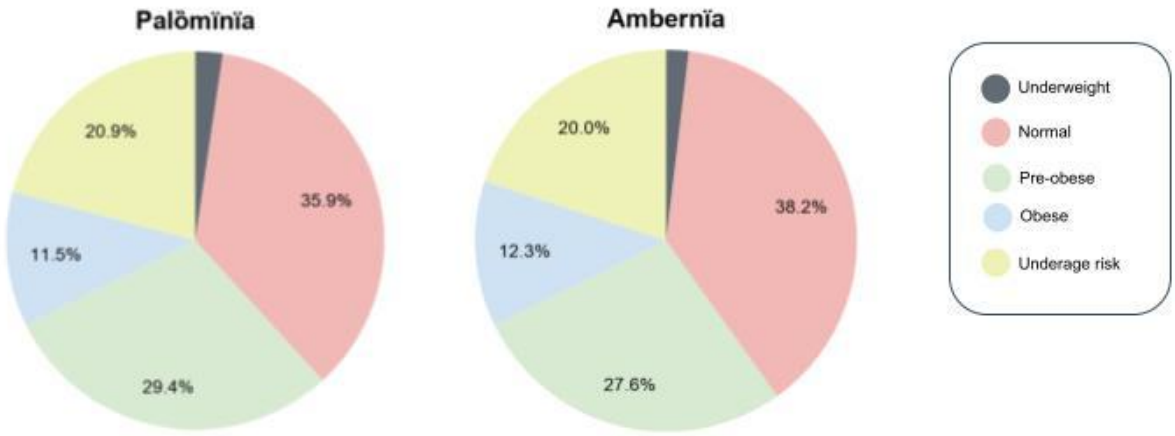


Figure 20. Weight Distribution (Appendix B-13)

Hence, coming with a potential market **with 1% as initial market penetration** as a **conservative assumption** understanding general insurance literacy below 3%.

Figure 21. Total addressable and initial market (Appendix B-14)

From the total addressable market, **aiming towards the persona list**.

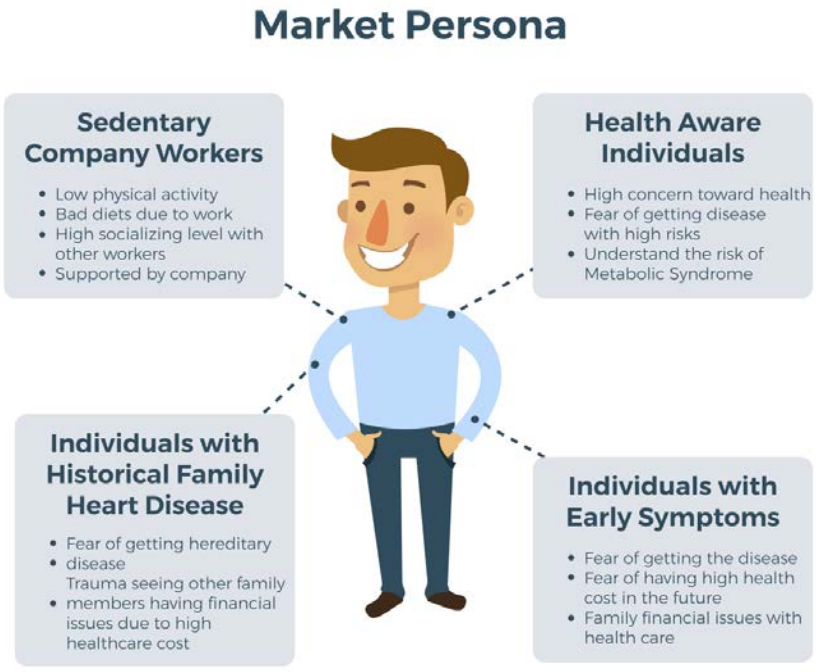


Figure 22. Market persona

4.3 Market Entrance Strategy

Upon entering the new market, where parametric insurance is new, **raising awareness of benefits would be the aim** through **partnerships and collaborations with stakeholders**. Moreover, **A.I development for data analytics** boosts targeted marketing, resulting in higher insured reach.

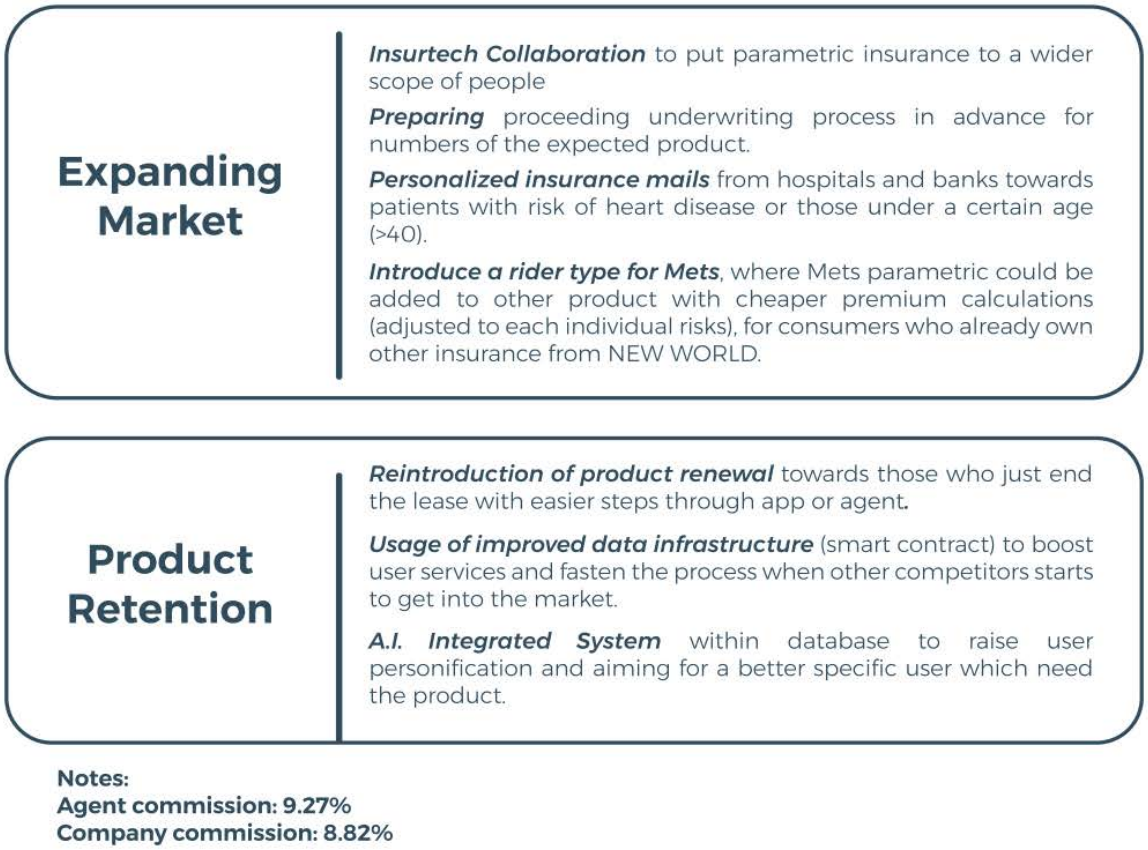


Figure 23. Marketing Strategy Scheme[21]

Commission distribution among main companies and their branches will be in **accordance with the main company regulation and contracts**. NEW·WORLD will only set based on the commission given to them as a whole.

5 RISK MANAGEMENT

5.1 Sensitivity Analysis

We conduct sensitivity analysis (Appendix B-11) to see its revenue sensitivity towards claim change, resulting in likelihood of loss value which is shown in the red area as given below.

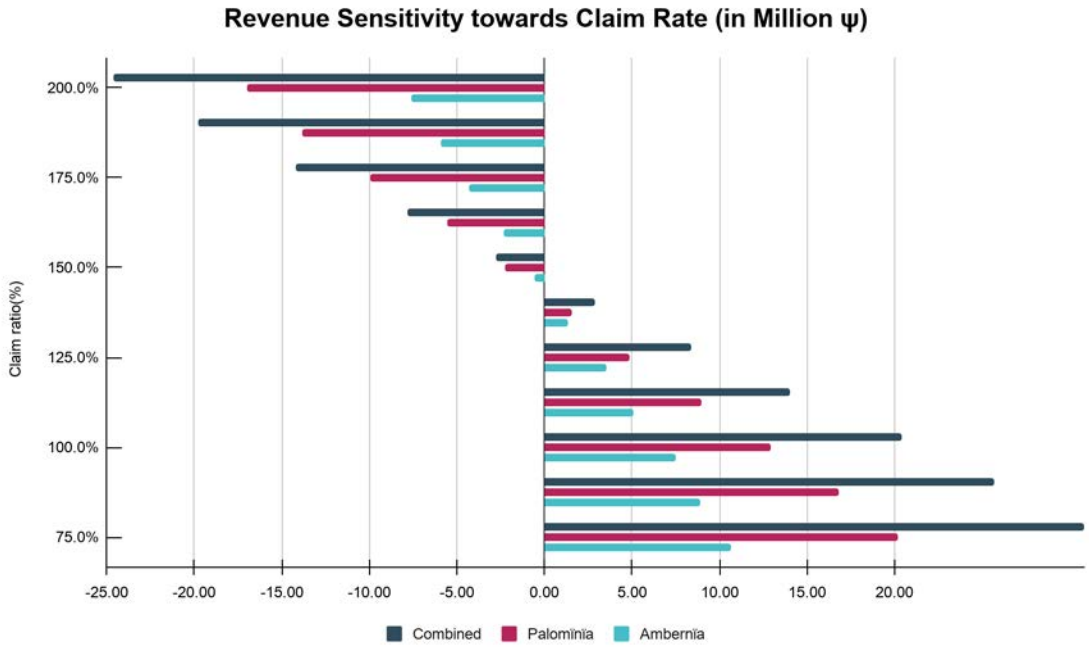


Figure 24. Revenue sensitivity towards claim rate

Loss occurs if claim rates increase more than 40% from the assumptions. In tackling possible loss, **we provide recommendations.**

Table 5. Recommendations based on sensitivity analysis

Recommendation	Benefit	Cost
Renewal data assumptions every years if needed	Recalculating existing risks to create an accurate forecast	There will be some loss in the year before renewal
Reinsurance level exceeding the past assumptions	Risk sharing to prevent loss of unexpected claim rate	Less profit gain due to higher reinsurance
Product testing in Ambernia instead of going for both countries without testing the water	Having better understanding regarding the product assumptions and market situation	Less financial income due to business progression only in one country
Reducing expense salary or commission	Reducing expense towards the product total revenue, covering for the total loss created	Less partner to collaborate in terms of sales due to low level of commission and less employee satisfaction
Monitoring claim rate monthly	Understanding the growth movements of claim and start to do preventive measure when rise above 120%	More works given to the actuary, inefficient way of monitor

5.2 10-Year Projections

We calculate 10-year Projections with assumption of policies underwritten annually with randomized annual insured growth rate (churn and lapse rate). (Appendix-B12)

Table 6. 10-year projections of net income

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Net Income
2021	1										2021 Income
2022	2	1									2022 Income
2023	3	2	1								2023 Income
2024	4	3	2	1							2024 Income
2025	5	4	3	2	1						2025 Income
2026	6	5	4	3	2	1					2026 Income
2027	7	6	5	4	3	2	1				2027 Income
2028	8	7	6	5	4	3	2	1			2028 Income
2029		8	7	6	5	4	3	2	1		2029 Income
2030			8	7	6	5	4	3	2	1	2030 Income
END OF OBSERVATION - EOY 2030											

new police underwritten
premium income paid
no premium income
stable revenue; 3red + 4blue + 1green

No premium income will start in 2026 due to an additional 3 years no premium model, causing declining net income growth. However, the number will stabilize in 2028 to stabilize trend patterns.

From timeline above, we simulate 5,050 random trials, resulting in net income of NEW·WORLD Insurance.

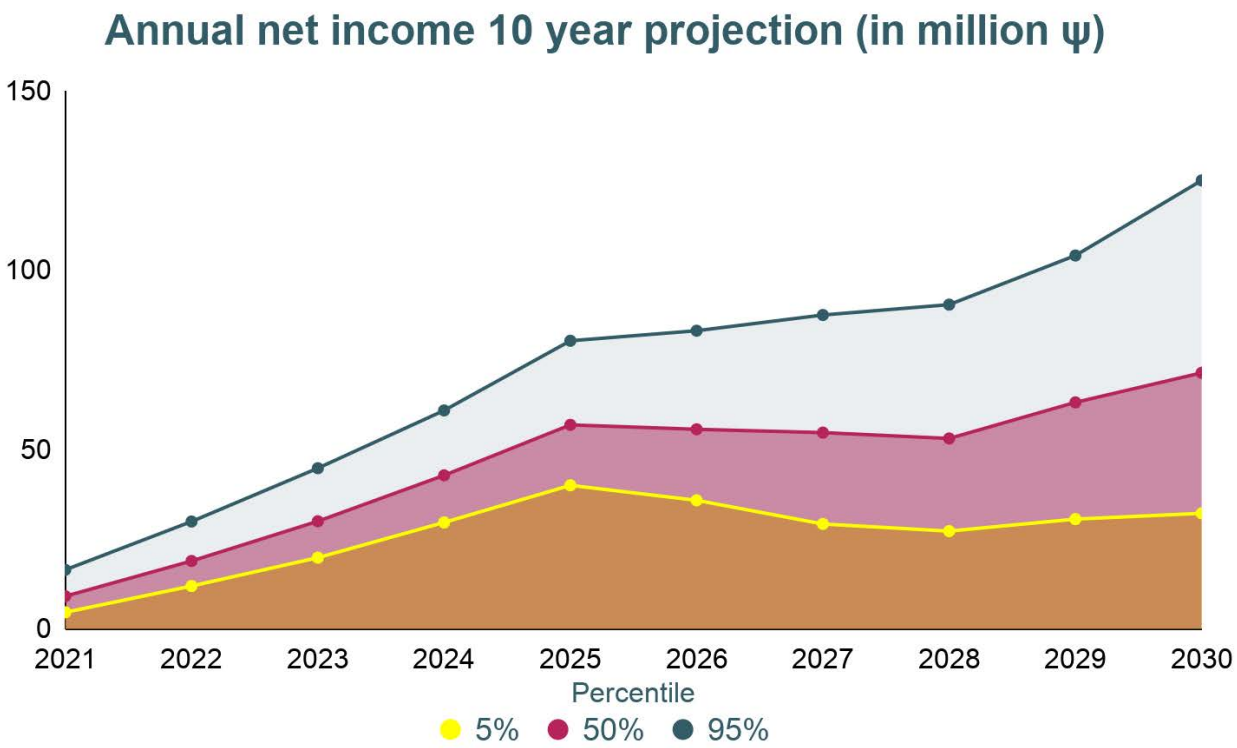


Figure 25. Forecast of net income in 10 years

MetS Insurance income growth will stabilize from 2028. We expect 21.92% annual growth for NEW·WORLD, showing positive positive product growth.

5.3 Risk Mitigation

We identify several risks which might cause harm towards the MetS product, including product risks (sales), claim risks, operational risks, and assumptions risks. The list of risks are compiled into matrix as can be seen below.

Figure 26. Risk Metric

In mitigating existing risks, we create several mitigation strategies. First being **market risks**, risks of the product being highly unattractive due to market perspective and lifestyle changes.

Table 7. List of market risks

No.	Risks	Description	Impact	Mitigation
1	**Trend of healthy lifestyle**	Healthy lifestyle results in good immune system which protects body from diseases and illness	Insurance plans are not favorable. Fewer client led to decrease in revenue and increase risk in company's solvability	Frame the product as a preemptive solutions towards the fear of rising MetS number
2	**Traditional health insurance is deemed more beneficial.**	Competitions with traditional insurance plans. Traditional insurance plans offer more category in healthcare	Client tend to choose traditional insurance over our parametric insurance	Recalculation of product while introducing new payment and services towards insurers
3	**Rising competitions in parametric insurance**	Competitions with another parametric insurance plan in healthcare, especially parametric insurance in MetS	Reduction in market share due to the rising competitions which might have a more likable product	Becoming the most well known MetS product while cutting the channel for other products prior launching

Second, **claim risks**, which focus on the happening of a high number of claims exceeding the assumption numbers made.

Table 8. List of claim risks

No.	Risks	Description	Impact	Mitigation
4	**Rise in sedentary lifestyle and low physical activity**	A sedentary lifestyle is a type of lifestyle involving little or no physical activity like reading, socializing, watching television, playing video games, reading or using a mobile phone/computer for much of the day.	Sedentary lifestyles increase all causes of mortality, double the risk of cardiovascular diseases, diabetes, and obesity, and increase the risks of colon cancer, high blood pressure, depression and anxiety.	Reminder of a healthy lifestyle through email and application or agents
5	**Atherogenic diet (e.g., a diet rich in saturated fat and cholesterol)**	Diet with low fiber, high salt, high sugar, increased cholesterol and fat in local fast food which trigger chronic disease such as stroke, diabetes, hypertension, cancer	Increased risk of atherosclerosis, the build-up of fats, cholesterol plaque and other substances in artery walls, causing obstruction of blood flow. Increasing claim number leading to loss	Reminder of a healthy lifestyle through email and application or agents

Third, **operational risks**, where error occurred during data transmission and other company functionality processes [22],[23].

Table 9.List of operational risks

No.	Risks	Description	Impact	Mitigation
6	**Information (data) delivery issue (error) from medical institution to company**	Patient data not delivered to database due to technical issue, or data version mismatch with database	Lower customer satisfaction	Encoded numbering system within the integrated system, trace back confirmation , insurtech collab to transfer risk to third party
7	**Two trigger being paid as one trigger**	2 clients claim paid as 1 clients claim, so 1 client didn't get paid	Causing loss towards our product, more complex readjustments needs to be done	Renewal of data check every month to crosscheck and reducing human error towards
8	**One trigger paid as two trigger**	1 client claim paid as 2 clients claim	Slander towards the company	Reverification and future reduction towards the next payment
9	**Fraud claim**	Patients committing fraud to gain the payout needed by falsifying the diagnosis results on their own or colluding with the doctor in their own interest.	Financial loss towards company	Using technology while providing double check with correlated hospital with an agreement within the contract; a leading organization used a machine-learning algorithm to pilot improvement in fraud detection in claims reimbursement
10	**Human error during computing process**	During the process of internal data input of claims and premium payment occur errors	Financial loss	Double cross check the inputted data through AI system
11	**Actuary hired by another company**	Actuaries leaving and possibly copying the product plan to the competitors	Increasing competitiveness within the market while losing intellectual assets	Contract based during recruitment process to not be able to provide any insight of product for the next 5 years after leaving
12	**Sudden black out**	Wide scale blackout which causes electricity down and internet interference	Loss of progress data and operational freeze	Generator and UPS for electricity backup, backup recording system
13	**Recorded incidents**	Incomprehensive data input	Financial loss	Initial flag model or label for every input to ease recording process
14	**Unrecorded incidents**	Detected and undetected incidents which failed to be input within the system	Financial loss, projection	Tracking missing data using
15	**Taxonomy risks with no data available**	Not all elements in the risk taxonomy are measured	Financial loss	Labeling system and crosschecking

Lastly, **assumption risks**, where prior assumptions are unfit to the future market due to anomaly occurrence or information limit.

Table 10. List of assumption risks

16	**Misforecasting in the above 5 years**	Miscalculation within the forecasted assumptions rate due to market anomaly and lack of data	Chaotic financing within the upcoming 5 years	Assumption and parameter renewal in fitting the market conditions
17	**Flaw within the use of Compertz model**	Gompertz fitting model low efficiency due to lack of data within two countries	Premium considered too expensive, market loss	Renewal of model and parameter within the next 1 years after seen as problem, while keep promoting the product as something seen as critical
18	**Amount of claims exceeding the assumptions**	Claims number rise exceeding the projected before due to anomaly or ineffective assumptions	Financial loss, negative cash flow	Insuring the product to the reinsurance company
19	**Economic risks**	Economic interest change from central banks due to inflation or crisis	Change in interest and GDP assumptions to be lowered, impacting the whole revenue and premium analysis	Data control in interest or economic variables every 5 years to maintain stability of forecast. Data control if a real crisis happens.

6 Future Insights

6.1 Future Considerations

With **limited data and assumptions**, missed assumptions or change might occur in the upcoming years. In consideration, **conducting data renewal and monitoring annually and 3 years assumptions reformation is essential** in anticipating risks. With experienced dataset improvement, more accurate models could be gained.

6.2 Reporting

For reporting procedure, we provide **key metrics to check in determining gain/loss**. **Monthly checkup** should be done for dataset followed with **annual checkup for change assumptions consideration**.

Table 11. Product Metrics

Metrics	Descriptions	Reasons
Claim Rate	Number of claims occuring within the year	Different real claim rate could impact product revenue and forecast, hence by having it reported we can create a new adjusted claims on field
Product Purchase Number	Number of purchases occuring within the year	Number of purchases reflect how attractive the product is, market being lower than expected could be mean an unattractive product that needs to be refitted
Profit before Tax	Profit of the product in the year	PBIT shows the performance of the assumptions and market, low PBIT might be mean the there's low on demand or huge expense going
Trigger Activations	Number of activations per trigger	Amount of trigger activated for each product could give a different payout, hence we need to assess the number of activated trigger to create a recalculation if the trigger being activated on higher rate
Healthcare Cost	Growth of healthcare cost	Healthcare cost becomes the base of our payout, hence unexpected increases in cost could mean higher payout which might cause loss

7 CONCLUSIONS

In our analysis, we see **MetS as one global health risk which causes critical heart diseases, creating financial loss**. Hence, in reducing loss caused by MetS impacts in Ambernïa and Palòmïnïa, we created a **parametric model for MetS precaution** which is activated when one of the MetS risks trigger is activated. **Preventing insured financial asset loss caused by MetS risks increased health cost and future MetS expenditure**.

APPENDIX A: Program Design

Appendix A-1 Modified Equivalence Principle

For a special 8-year term insurance and premium payable annually of the first 5 years for individual aged ( ), with known variable as:

I. Payout value or benefit
II. Expected Expense is 47.11% of Premium, payable annually
III. Payout delivered when the index has reached certain number(s)
IV. Adjusting Expense is 13.71% of Premium
V. Reinsurance share is 10.13%

Hence the expense loaded equivalence principle is calculated by the following formula:

$$E[_0L] = 0$$

$$Premium \cdot \ddot{a}_{x:\overline{5}|} - Payout \cdot (1 + Adj.Expense - Reas.Share) \cdot A^1_{x:\overline{8}|} - Premium \cdot 47.11\% \cdot \ddot{a}_{x:\overline{8}|} = 0$$

$$Premium = \frac{Payout \cdot (1.0358) \cdot A^1_{x:\overline{8}|}}{\ddot{a}_{x:\overline{5}|} - 47.11\% \cdot \ddot{a}_{x:\overline{8}|}}$$

By revenue simulation, our team decided to increase premium rate for Palòmïnïa to minimize the risk of loss, hence the premium is calculated by the following formula:

$$Premium = \frac{Payout \cdot (1.34654) \cdot A^1_{x:\overline{8}|}}{\ddot{a}_{x:\overline{5}|} - 47.11\% \cdot \ddot{a}_{x:\overline{8}|}}$$

Appendix A-2 Payout Provision

Our team assumes that asset and investment loss are heavily impacted by healthcare costs.

$$Payout\ for\ policy\ released\ at\ year\ n = (1.2)^{MSR}.[\sum_{k=1}^{8} v^k] \cdot Projected\ Healthcare\ Cost\ at\ year\ n+7+k$$

Our team formulate the payout value for policy released at year-n is as below
With is our new defined discrete index.

For excel calculation is at:

Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: C1

Appendix A-3 Premium Calculation

Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: C2

Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: C3

APPENDIX B: Data Limitation, Assumption & Sensitivity Analysis

Appendix B-1 Mortality table for Palòmïnïa and Ambernïa

Palòmïnïa mortality model based on UN Life table 2011, while Ambernïa based on Vital Statistics CDC US 2017. We fit the data before to the Gompertz model, with smoothing and using Excel Solver.

Palòmïnïa Mortality		Ambernïa Mortality	
B	0.00738783	B	0.00001971
C	1.03773316	C	1.10406421

Detailed calculation can be found in excel Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-Sheet:Parameter

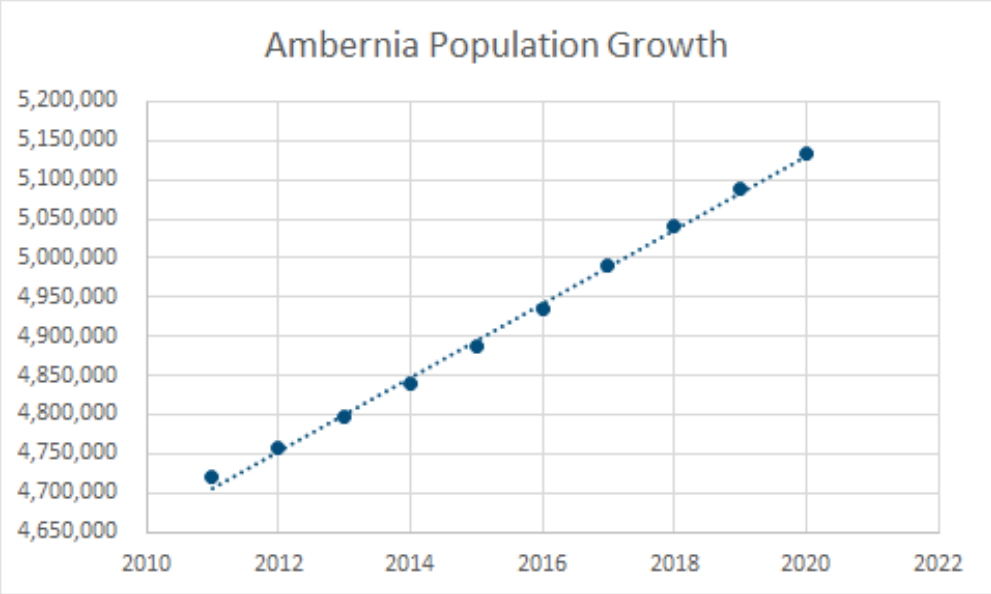
Appendix B-2 Interest rate

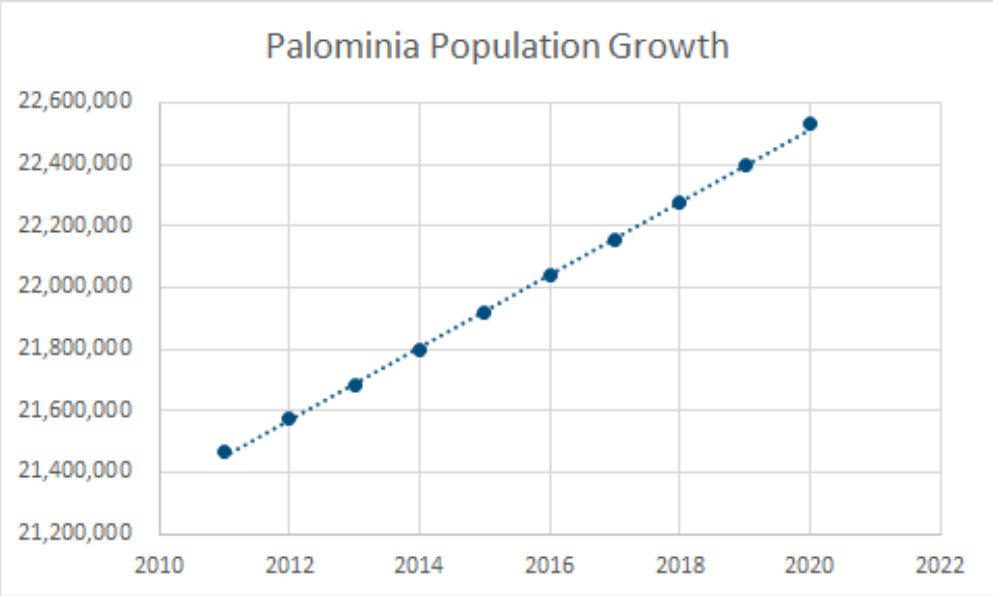
We do not pick the other two interest data, being the market interest and long-term interest. For the market interest, it is due to the quick and instant nature of investment return rate, which does not align with the fluctuating health risks. For the long term-interest, it is being defined as 10-year bond interest, which has the nature of high risks to the unforeseen economic future, especially during the crisis. The volatility of the 3 month interest rate makes our team decide to use the average and round them up. Interest rate as shown in the table below:

3 Month Interest Rates at January 1		
	Palõmïnïa	Ambernïa
1/1/2010	5.73%	0.97%
1/1/2011	4.32%	1.62%
1/1/2012	4.53%	1.81%
1/1/2013	3.65%	0.75%
1/1/2014	1.84%	0.61%
1/1/2015	1.34%	0.18%
1/1/2016	0.90%	(0.18%)
1/1/2017	0.82%	(0.40%)
1/1/2018	1.17%	(0.37%)
1/1/2019	2.26%	(0.20%)
1/1/2020	2.36%	(0.11%)
Average	2.63%	0.43%
Round Up	3%	0.50%

Appendix B-3 Population (excel data analysis)

By using excel's data analysis tool, we get the linear regression model for population. Our team decided to forecast with linear regression due to linear uptrend of population.





B-3.1. Palòmïnïa Population (X Variable as year)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.999703437							
R Square	0.999406962							
Adjusted R	0.999332832							
Standard E	9259.182979							
Observatio	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	1.15583E+12	1.15583E+12	13481.8539	3.38292E-14			
Residual	8	685859755.5	85732469.44					
Total	9	1.15652E+12						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-216578493.7	2054607.816	-105.4111116	7.32827E-14	-221316427.8	-211840559.6	-221316427.8	-211840559.6
X Variable	118364.2364	1019.402495	116.1113857	3.38292E-14	116013.49	120714.9827	116013.49	120714.9827

B-3.2 Ambernïa Population (X Variable 1 as year)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.998732819							
R Square	0.997467244							
Adjusted R Square	0.997150649							
Standard Error	7614.011116							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	1.82651E+11	1.82651E+11	3150.613975	1.12635E-11			
Residual	8	463785322.3	57973165.28					
Total	9	1.83115E+11						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-89915919.04	1689545.048	-53.2190125	1.72295E-11	-93812016.9	-86019821.17	-93812016.9	-86019821.17
X Variable 1	47052.65455	838.2750347	56.13033026	1.12635E-11	45119.58885	48985.72024	45119.58885	48985.72024

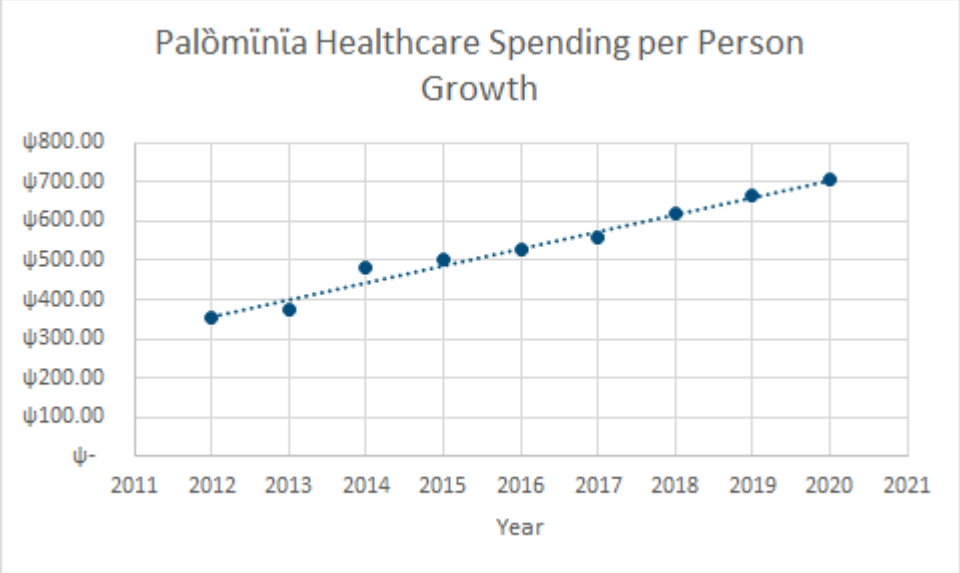
Appendix B-4 Investment interest

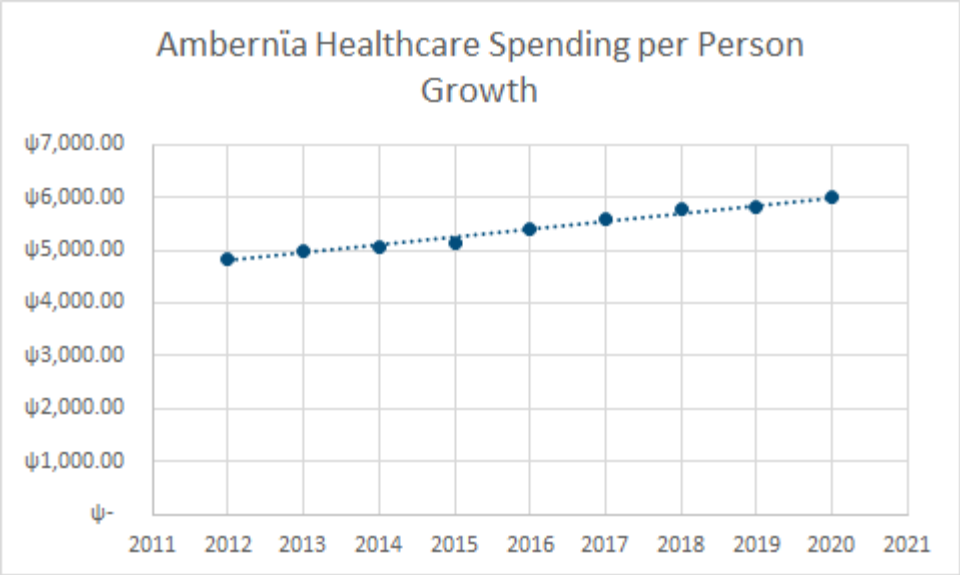
Our team assumes that the safest choice of investment is in Palǒmïnïa's money market due to a higher average than Ambernïa's as shown in the table below:

Money Market Interest Rates at January 1		
	Palǒmïnïa	Ambernïa
1/1/2010	3.87%	0.56%
1/1/2011	3.03%	1.06%
1/1/2012	4.38%	1.13%
1/1/2013	3.58%	0.49%
1/1/2014	2.77%	0.39%
1/1/2015	3.17%	0.01%
1/1/2016	2.89%	(0.31%)
1/1/2017	2.61%	(0.46%)
1/1/2018	3.53%	(0.53%)
1/1/2019	6.26%	(0.44%)
1/1/2020	3.51%	(0.33%)
AVERAGE	3.60%	0.14%

Appendix B-5 Healthcare spending per person

By using excel's data analysis tool, we get the linear regression model for healthcare spending inflation.Our team decided to forecast with linear regression due to the linear uptrend of Healthcare cost inflation.





B-5.1 Ambernïa Healthcare Spending per Person (X Variable 1 as year)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.988030743							
R Square	0.97620475							
Adjusted R Square	0.972805428							
Standard Error	19.86351165							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	113308.0435	113308.0435	287.176357	6.105E-07			
Residual	7	2761.913665	394.559095					
Total	8	116069.9572						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-87075.57733	5169.770787	-16.84321818	6.36587E-07	-99300.143	-74851.01195	-99300.14271	-74851.01195
X Variable 1	43.4565	2.564368327	16.94627856	6.10531E-07	37.392732	49.52026754	37.39273246	49.52026754

B-5.2 Palòmïnïa Healthcare Spending per Person (X Variable 1 as year)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.991534946							
R Square	0.983141549							
Adjusted R Square	0.980733199							
Standard Error	56.85332628							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	1319496.285	1319496.285	408.2220078	1.82247E-07			
Residual	7	22626.10496	3232.300709					
Total	8	1342122.39						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-293562.9551	14796.91359	-19.83947216	2.06653E-07	-328552.096	-258573.8144	-328552.0958	-258573.8144
X Variable 1	148.2956667	7.339732862	20.20450464	1.82247E-07	130.9399563	165.651377	130.9399563	165.651377

Appendix B-6 Reinsurance rate

We formulate reinsurance rate from NEW•WORLD income statement as below:

$$Reinsurance\ Rate = \frac{Less\ Reinsurance\ Ceded}{Gross\ Premium\ Written}$$

By using 2020 NEW.WORLD income statement, we get

$$Reinsurance\ Rate = \frac{1475}{14565} = 10.13\%$$

Appendix B-7 Age Band Proportion

Our team assumes that proportion between the 10 years age band is uniformly distributed. Table proportion show as below:

Population	Palòmïnïa	Proportion to that age group
x < 10	14.60%	1.46%
10 ≤ x < 20	12.50%	1.25%
20 ≤ x < 30	13.90%	1.39%
30 ≤ x < 40	16.20%	1.62%
40 ≤ x < 50	14.40%	1.44%
50 ≤ x < 60	11.60%	1.16%
60 ≤ x < 70	9.70%	0.97%
70 ≤ x < 80	4.90%	0.49%
80 ≤ x < 90	2.00%	0.20%

Population	Ambernïa	Proportion to that age group
x < 10	11.30%	1.13%
10 ≤ x < 20	11.50%	1.15%
20 ≤ x < 30	13.00%	1.30%
30 ≤ x < 40	12.80%	1.28%
40 ≤ x < 50	12.80%	1.28%
50 ≤ x < 60	13.10%	1.31%
60 ≤ x < 70	11.40%	1.14%
70 ≤ x < 80	9.20%	0.92%
80 ≤ x < 90	4.00%	0.40%

Appendix B-8 Monte Carlo Simulation

Monte Carlo Simulation is used in revenue, expense, and sensitivity analysis. Assumptions that our team formulate in simulation are:

1. Market share factor.
   Palǒmïnïa is uniformly distributed within range $(11\%, 19\%)$ of population, and Ambernïa is uniformly distributed within range $(13\%, 21\%)$ of population.

2. Likelihood of Purchase.
   Both country number of customer is uniformly distributed within range $(0.75\% \cdot 1.2^{-2021}, 1.25\% \cdot 1.2^{-2021})$ of market share.

3. Claim Rate.
   Claim rate ~ (, ( )). Probability of claim rate at age ( ) is ( ) = (= 1) + (= 2). Total Probability of claim is formulated as
   $$( ) = \sum_{=20}^{65} ( ) \cdot \cdot ( )^{-1}$$

4. $= 1/ = 2$ ratio.
   Ambernïa MSR ratio ~ (15) and Palǒmïnïa MSR ratio ~ (10)

5. Average Premium per unit that year
   Premium is based on age, randomized uniformly within people aged 30 to 52 or middle 50% of age range.

6. Expense ratio as premium
   Expense is Normally distributed with mean of $\mu = 47.13\% \cdot$ and variance of $\sigma^2 = 0.62\% \cdot$.

7. Investment Interest
   Investment Interest is uniformly distributed within range $(2.61\%, 6.26\%)$.

Monte Carlo simulation for Ambernïa source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: S1

Monte Carlo simulation for Palǒmïnïa source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: S2

Appendix B-9 Monte Carlo Expense as Asset growth

Expense Monte carlo simulation value source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlxs-NAVIGATION: S5

Asset Growth source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlxs-NAVIGATION: S7

Appendix B-10 Monte Carlo for Revenue Analysis

Monte Carlo for Revenue Analysis Source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlxs-NAVIGATION: S3

Appendix B-11 Sensitivity Testing Table

Due to expense is controlled by premium income by design, we conclude that our products are sensitive to the number of claim rates. By increasing our claim rate assumption until 200% and rerunning monte carlo simulation, we get our test result.

Testing result source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx- NAVIGATION: S6

Appendix B-12 Revenue 10-year projection

Triple C NEW·WORLD Parametric Insurance Sheet.xlxs- NAVIGATION: S4

Appendix B-13 Educational level & Weight distribution Table

Education Level	Palòmïnïa	Ambernïa
Underage	1%	11.30%
Less than primary. primary and lower secondary education (levels 0-2)	19.81%	23.67%
Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	45.13%	33.74%
Tertiary education (levels 5-8)	19.61%	25.17%
Unknown	0.84%	6.12%

Weight Distribution	Palòmïnïa	Ambernïa
Underweight	2.34%	1.90%
Normal	35.88%	38.21%
Pre-Obese	29.45%	27.62%
Obese	11.48%	12.32%
Under age risk	20.85%	19.95%

Appendix B-14 Market Share

Using population by educational level section from NEW·WORLD data, we multiply to the total population in 2020. Taking only the tertiary level of education as our primary market, with assumptions of higher education level to higher purchases of insurance and better lifestyle. Limiting only to the age from 20 to 60, since older age will cause tremendous risks to the product claim and revenue rate.

After we get the number of total addressable market for both countries, we deduct it with those in obese state in the weight distribution table, by adjusting age ratio to the age ratio from the educational attainment datas, due to those in the obese state has already actiavted the trigger. If we have more specific information we will reduce those in higher pre-obese state. However, due to data limitations we go with all preobese but need further readjustments.

Market share calculation source:
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: M1

APPENDIX C: Supporting Calculation & Statistics

Appendix C-1 Prevalence of Diabetes by Age

We want to calculate healthy to diabetes probability transitions at every age. First we calculate diabetes percentage on every age using population data and Diabetes US Prevalence from CDC 2016. We take the proper ratio from Palòmïnïa and Ambernïa diabetes prevalence 2026 with 5 year data renewal assumption, and find the probability of individual contracting the diabetes from not, denoted by

$$(\quad | \quad - 1)$$

$$= \frac{\cdot \quad - \quad -1 \cdot \quad -1}{-1 \cdot (1- \quad -1)}$$

then the results are modeled using Gompertz model smoothing.

Palòmïnïa Diabetes transition		Ambernïa Diabetes transition	
B	0.00015142	B	0.00003049
C	1.05521269	C	1.05514695

Detailed calculation can be found in excel
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: P1,P4

Appendix C-2 Model for systolic pressure

Systolic pressure can be modeled using lognormal from Bibliography [8]. We take the probability of systolic pressure higher than 140 mmHg from the lognormal model, which is 18.57%. Then we use population data assuming uniform distribution within age, fitted with the Gompertz model to find every age transition probabilities which sum up to 18.57% using Excel Solver.

Palòmïnïa Systolic pressure prevalence		Ambernïa Systolic pressure prevalence	
B	0.00114809	B	0.00132261
C	1.05276465	C	1.01845572

Detailed calculation can be found in excel
Triple C NEW·WORLD Parametric Insurance Sheet.xlsx-NAVIGATION: P2, P5, P7 and P8.

Appendix C-3 Triple Decrement Table Construction

We can construct our decrement table using data generated from mortality and transition probabilities (healthy to diabetes/triggered systolic). Two Metabolic Syndrome Risks (MSR) is 68.4% healthy to diabetes transition probabilities based on Bibliography [16]. One MSR are probabilities of diabetes and triggered systolic pressure added, minus the Two MSR probability.

Other notation in our table is a standard Actuary Notation used worldwide
For complete table, see
Triple C NEW·WORLD Parametric Insurance Sheet.xlxs-NAVIGATION:D, L1, L2, L3, and L4

Palòmïnïa				PAY 1 MSR	1	PAY 2 MSR	1.2
Age	lx	qx 1 MSR	qx 2 MSR	qx death	qx claim	qx tau	px tau
20	100000	0.0034	0.0003	0.0157	0.0037	0.0193	0.9807
21	98065	0.0036	0.0003	0.0162	0.0039	0.0201	0.9799
22	96091	0.0038	0.0003	0.0169	0.0042	0.0209	0.9791
23	94079	0.0040	0.0004	0.0175	0.0044	0.0218	0.9782
24	92030	0.0042	0.0004	0.0181	0.0046	0.0227	0.9773
25	89945	0.0044	0.0004	0.0188	0.0048	0.0236	0.9764
26	87824	0.0047	0.0004	0.0195	0.0051	0.0245	0.9755
27	85671	0.0049	0.0005	0.0203	0.0054	0.0255	0.9745
28	83485	0.0052	0.0005	0.0210	0.0057	0.0265	0.9735
29	81268	0.0055	0.0005	0.0218	0.0060	0.0276	0.9724
30	79024	0.0057	0.0005	0.0226	0.0063	0.0287	0.9713

Palòmïnïa	Interest	0.03	v	0.9709		
Age	Ax	Ax(1):8	Ax(1):5	addotx	addotx:8	addotx:5
20	0.1300	0.0297	0.0185	15.9598	6.7444	4.5365
21	0.1326	0.0311	0.0195	15.7126	6.7257	4.5294
22	0.1353	0.0327	0.0205	15.4653	6.7063	4.5220
23	0.1381	0.0343	0.0215	15.2179	6.6861	4.5143
24	0.1408	0.0360	0.0226	14.9705	6.6653	4.5063
25	0.1436	0.0378	0.0238	14.7232	6.6436	4.4980
26	0.1465	0.0396	0.0250	14.4762	6.6212	4.4894
27	0.1493	0.0416	0.0263	14.2295	6.5979	4.4804

28	0.1522	0.0436	0.0276	13.9831	6.5738	4.4711
29	0.1552	0.0457	0.0290	13.7373	6.5488	4.4615
30	0.1581	0.0479	0.0305	13.4920	6.5230	4.4514

Glosarium

Metabolic Syndrome

MetS, Metabolic Syndrome is the name for a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke. The term "metabolic" refers to the biochemical processes involved in the body's normal functioning. Risk factors are traits, conditions, or habits that increase your chance of developing a disease.

Diabetes

Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose (or blood sugar), which leads over time to serious damage to the heart, blood vessels, eyes, kidneys and nerves. The most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. However, we define diabetes within this report as high level of blood sugar within individual normal lines in Ambernïa and Palǒmïnïa.

Hypertension

Hypertension, also known as high or raised blood pressure, is a condition in which the blood vessels have persistently raised pressure. Blood is carried from the heart to all parts of the body in the vessels. Each time the heart beats, it pumps blood into the vessels. Blood pressure is created by the force of blood pushing against the walls of blood vessels (arteries) as it is pumped by the heart. The higher the pressure, the harder the heart has to pump.

Metabolic Syndrome Risks (MSR)

In defining if an individual has a metabolic syndrome, he/she needs to have 3 out of 5 risks. Hence, in calculating the risk we create a new terminology for the MetS Risks named as MSR to calculate index and triggering event hit. However, due to limited data in both countries we were only able to use 2 MSR as our triggers, with the most impactful towards MetS itself.

Mean Absolute Percentage Error (MAPE)

Measure of accuracy prediction used in forecasting, resulting in percentage of errors. Small MAPE is defined as a better forecast [28].

Compound Annual Growth Rate (CAGR)

CAGR is a formula to calculate the mean return rate of a certain investment in a certain period. However within this report, CAGR is also used to calculate annual growth rate of certain growth in n-period of time [29].

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