Parametric Policy Proposal for Ambernïa and Palòmïnïa

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SOCIETY OF ACTUARIES

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Executive Summary

This report details how NEW·WORLD can utilize uncertainty about future trends in systolic blood pressure, obesity prevalence, and diabetes prevalence to create and offer a parametric insurance policy that is practical for gym chains and fast-food chains that operate in Ambernïa and Palȍmïnïa. In 2020, US gym revenues plummeted by 28% and US fast-food revenues fell 14%. These two types of businesses, still reeling from the impacts of COVID-19, will find value in a policy that protects them from similar, widespread behavioral changes due to health. Under our policy, significant declines in any of the three metrics listed above will trigger a payout for gyms while significant improvements in the same metrics will trigger payouts for fast food chains.

We will outline payout structures for each of the three health metrics: average systolic blood pressure, obesity prevalence, and diabetes prevalence. All metrics have been age and sex standardized. When one of these triggers occurs, a percentage of the previous year's revenue will be reimbursed. We selected these triggers because they are easily measurable and are three of the four largest contributors to preventable deaths in the world (see Figure 1, opposite). Smoking, despite being the second largest contributor to preventable deaths, was excluded because this individual habit is not necessarily indicative of somebody's overall lifestyle, meaning it will not be as correlated to the success of gyms or fast-food chains. We standardized these triggers to offer a simpler plan with only one triggering metric per risk factor.

This report uses empirical data from 1980-2016 from 184 countries (collected by The Lancet) to determine the expected error of projected values for each of the three triggering events. We used the data of 142 developing countries to compare to Palȍmïnïa and 42 developed countries to compare to Ambernïa. From these expected error values, we derived confidence intervals for the three health metrics while considering the number of years into the future.

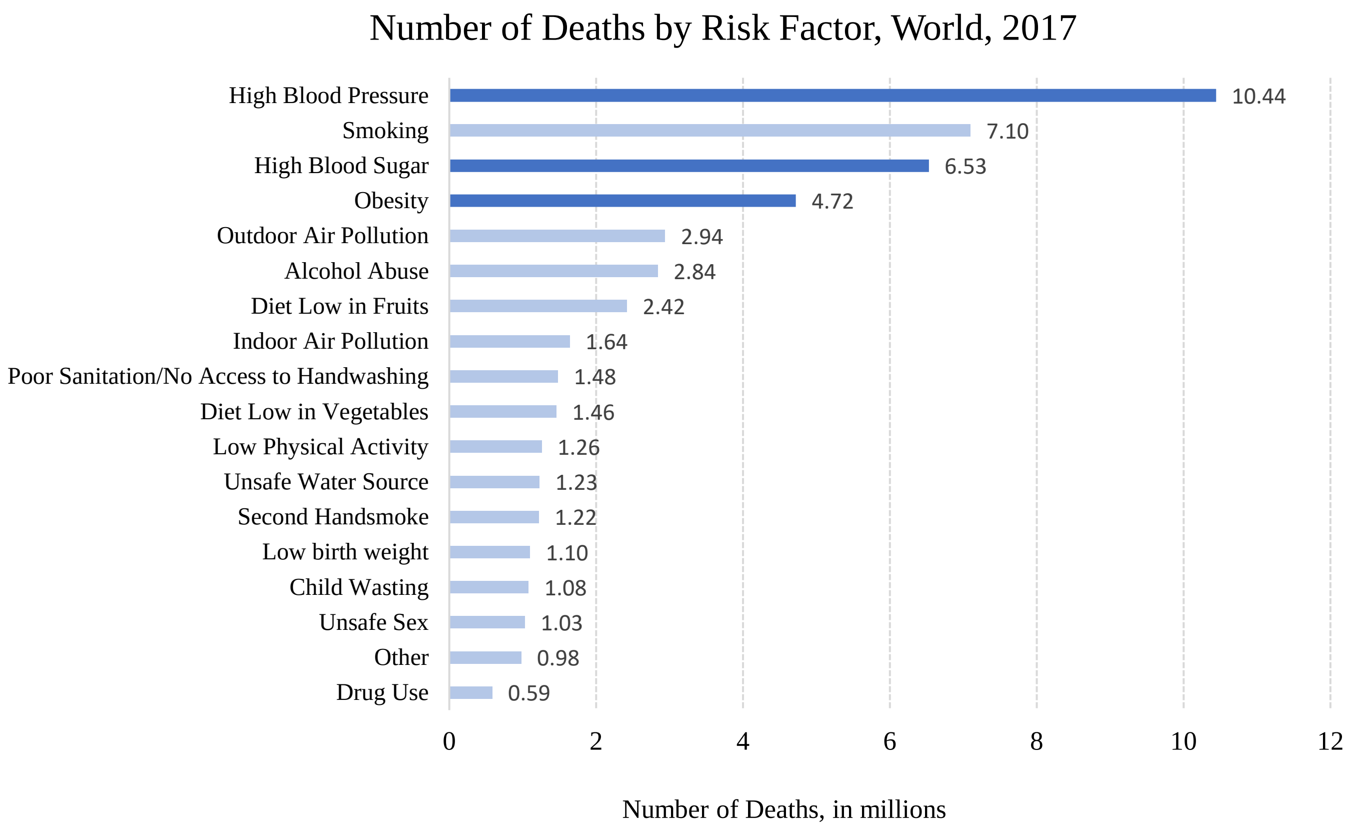


Figure 1: Blood pressure, blood sugar, and obesity are three of the four largest contributors to number of preventable deaths.

Objectives

Both gyms and fast-food chains rely on their customers living certain lifestyles. Gym chains want an active, healthy population, while fast-food chains benefit from a less healthy population that regularly enjoys their products. Both gyms and fast-food chains currently have liability insurance (for property, food poisoning, and exercise equipment malfunctions), property insurance, and business interruption insurance. Our proposal is similar to business interruption insurance in the sense that we would be compensating the company for lost income due to a 'catastrophe.' The fundamental difference between all these policies and a parametric policy is that the payouts of these policies are determined by incurred damages, while a parametric policy is paid out based on a predetermined triggering event.

Because parametric policies are not based on damages, there is increased basis risk, or the possibility that damages are not equitable/correlated to the payout. Further, parametric policies are not intended to be standalone policies. Despite these disadvantages, parametric insurance has been becoming more prevalent because it eliminates claims adjustments and lengthy claims investigations. Instead, claims are usually paid out immediately without any disagreement between the insured and insurer.

There are several factors that will be analyzed in this report to determine the insurability of the three health metrics through a parametric policy. Firstly, there must be a sufficient amount of objective data and a reliable source collecting the data for any health metric to be used. Secondly, there must be evidence that these metrics are closely tied with the performance of gym and fast-food chains, mitigating basis risk. Lastly, we must prove that there can be steady profitability for this plan without a significant chance for major losses that could cause NEW·WORLD's default.

Design Considerations

Triggering Events and Payout Provisions

There are 180 triggering points in this policy, broken down by country, business type, probability, health metric, and year. The health metrics are diabetes prevalence, mean systolic blood pressure, and obesity prevalence. Systolic pressure was selected over diastolic pressure because recent research has shown that it is a better indicator of cardiovascular health. All measures are age and sex standardized so that a more simple, transparent product can be offered to clients of NEW·WORLD with as few trigger points as possible while still offering a comprehensive product.

Premiums are paid to NEW·WORLD annually at the beginning of each year (or March in 2021). Claims to gyms and fast-food chains are also paid annually. When one of the triggers with a 5% probability occurs, 1% of that chain's previous year's revenue will be reimbursed. If any of the triggers with a 3% probability occurs, an additional 1% (2% total) will be reimbursed. Finally, if any of the triggers with a 1% probability occurs, an additional 3% (5% total) of revenue will be reimbursed. If all three 1% probability triggers occurred in one year, a total of 15% of the previous year's revenue would be reimbursed. Any claims for 2021 will be paid out in January of 2022, once there has been sufficient time to aggregate and analyze data. The duration of this policy is five years, with the final claims being paid in January 2026.

Ambernïa Diabetes Prevalence		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	5.155%	5.102%
2022	5.189%	5.081%
2023	5.228%	5.058%
2024	5.277%	5.029%
2025	5.338%	4.992%
3% Probability		
2021	5.158%	5.099%
2022	5.196%	5.073%
2023	5.240%	5.046%
2024	5.295%	5.011%
2025	5.363%	4.967%
1% Probability		
2021	5.165%	5.092%
2022	5.211%	5.058%
2023	5.263%	5.023%
2024	5.328%	4.977%
2025	5.410%	4.920%

Palòmïnïa Diabetes Prevalence		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	8.323%	8.246%
2022	8.482%	8.332%
2023	8.639%	8.421%
2024	8.806%	8.502%
2025	8.980%	8.576%
3% Probability		
2021	8.329%	8.240%
2022	8.493%	8.321%
2023	8.655%	8.406%
2024	8.827%	8.481%
2025	9.008%	8.547%
1% Probability		
2021	8.339%	8.230%
2022	8.514%	8.301%
2023	8.685%	8.376%
2024	8.868%	8.440%
2025	9.063%	8.493%

Ambernïa Systolic Blood Pressure		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	122.684	122.656
2022	122.368	122.283
2023	122.056	121.896
2024	121.757	121.488
2025	121.472	121.057
3% Probability		
2021	122.686	122.654
2022	122.374	122.277
2023	122.068	121.885
2024	121.777	121.469
2025	121.502	121.028
1% Probability		
2021	122.690	122.650
2022	122.385	122.266
2023	122.089	121.863
2024	121.813	121.432
2025	121.558	120.971

Palòmïnïa Systolic Blood Pressure		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	128.767	128.738
2022	128.711	128.621
2023	128.655	128.494
2024	128.605	128.351
2025	128.563	128.191
3% Probability		
2021	128.769	128.736
2022	128.718	128.614
2023	128.667	128.482
2024	128.623	128.333
2025	128.590	128.164
1% Probability		
2021	128.773	128.732
2022	128.730	128.602
2023	128.689	128.460
2024	128.658	128.299
2025	128.640	128.114

Ambernïa Obesity Prevalence		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	15.819%	15.540%
2022	16.237%	15.704%
2023	16.658%	15.864%
2024	17.085%	16.018%
2025	17.516%	16.168%
3% Probability		
2021	15.839%	15.520%
2022	16.275%	15.666%
2023	16.715%	15.807%
2024	17.161%	15.942%
2025	17.613%	16.071%
1% Probability		
2021	15.877%	15.482%
2022	16.347%	15.594%
2023	16.823%	15.699%
2024	17.305%	15.798%
2025	17.796%	15.888%

Palòmïnïa Obesity Prevalence		
	Gym Triggers	Fast-Food Triggers
5% Probability		
2021	15.096%	14.702%
2022	15.639%	14.952%
2023	16.192%	15.191%
2024	16.757%	15.419%
2025	17.337%	15.632%
3% Probability		
2021	15.125%	14.674%
2022	15.688%	14.902%
2023	16.264%	15.120%
2024	16.853%	15.323%
2025	17.459%	15.510%
1% Probability		
2021	15.178%	14.620%
2022	15.781%	14.809%
2023	16.399%	14.984%
2024	17.034%	15.142%
2025	17.690%	15.279%

Figure 2: All 180 trigger points

Insurability

I. Are the health metrics objective?

Each of these health metrics were intentionally selected because they are easily measurable, strictly defined, and are immune to response bias (unlike smoking or physical activity levels). Obesity is characterized by a BMI >= 30. Diabetes is diagnosed when blood sugar >= 126 mg/dL. Systolic blood pressure is measured in mm Hg.

II. Is there a practical method to gather data from the population?

Almost any sampling method to determine these health metrics applied to the entire population would be expensive, logistically challenging, and yield a wide margin of error. Because these triggers are so sensitive to minor misrepresentations of the population, NEW·WORLD would need access to virtually the entire population's medical data. This is possible through a partnership with a major hospital with interoperability capability, meaning that the hospital has access to patients not necessarily in their own system. This represents approximately 30% of hospitals. Buying these three simple metrics each year in both countries should be significantly cheaper than deals that usually involve accessing individual patient records.

III. Is there evidence that gym and fast-food revenues are affected by the health metrics?

There are academic dissertations concluding that more fast-food consumption leads to higher blood pressure, greater likelihood of being obese, and greater likelihood to have diabetes. There are also papers proving that regular exercise prevents obesity, high blood pressure, and diabetes. Each study can be found in the Works Consulted section of this report. While there is no evidence directly correlating revenues to these health metrics, we believe these studies provide sufficient evidence.

Correlation for Suite of Metrics

There are correlations between these health metrics, which are shown below, and were factored into our model. The highest correlation coefficient was between diabetes prevalence and obesity prevalence. These correlations expand the tails, increasing the likelihood of large losses and profits, but do not affect the expected profit for this policy.

Correlation Matrix - @RISK	Diabetes Prevalence	Obesity Prevalence	Systolic Blood Pressure
Diabetes Prevalence	100%		
Obesity Prevalence	80.102%	100%	
Systolic Blood Pressure	-0.293%	6.690%	100%

Figure 3: Correlations between health metrics

Implementation Plan

Purchase Frequency and Likelihood

We derived a demand curve for the policy by first estimating the demand based on gross profit margin, where a 100% demand means that every applicable firm would buy the product once at the beginning of the five year period.

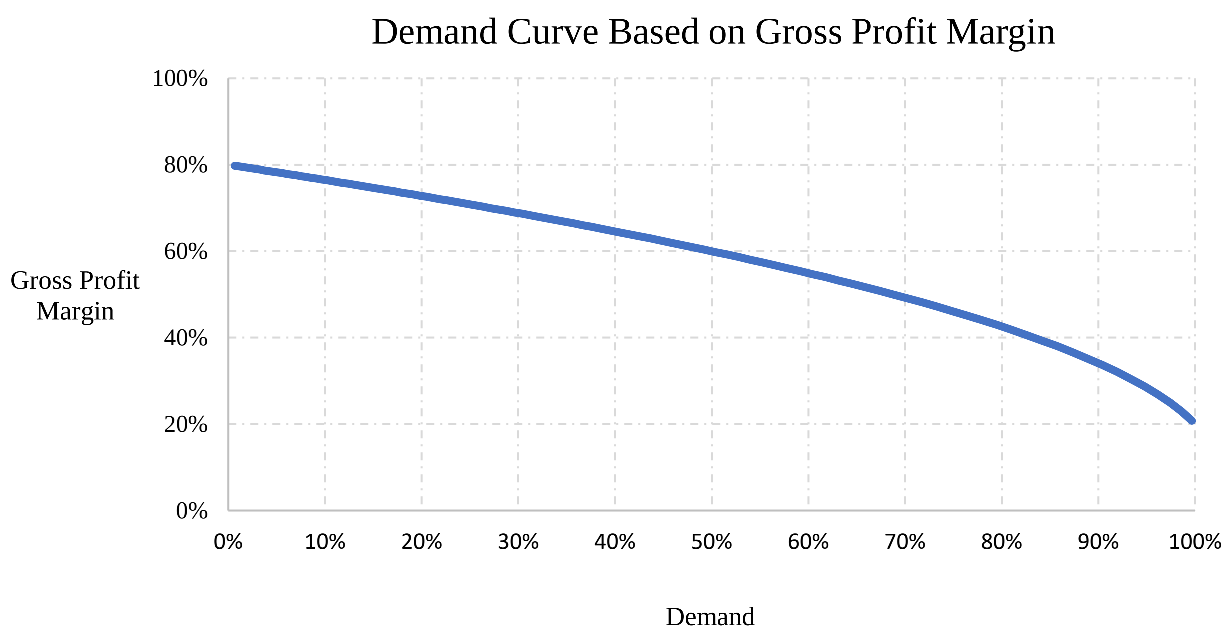


Figure 4: Demand curve based on gross profit margin

After determining that a 0.285% premium of the gym or fast-food chain's previous year's revenue would cover the expected payouts, we found the corresponding demand for each premium, yielding the following demand curve:

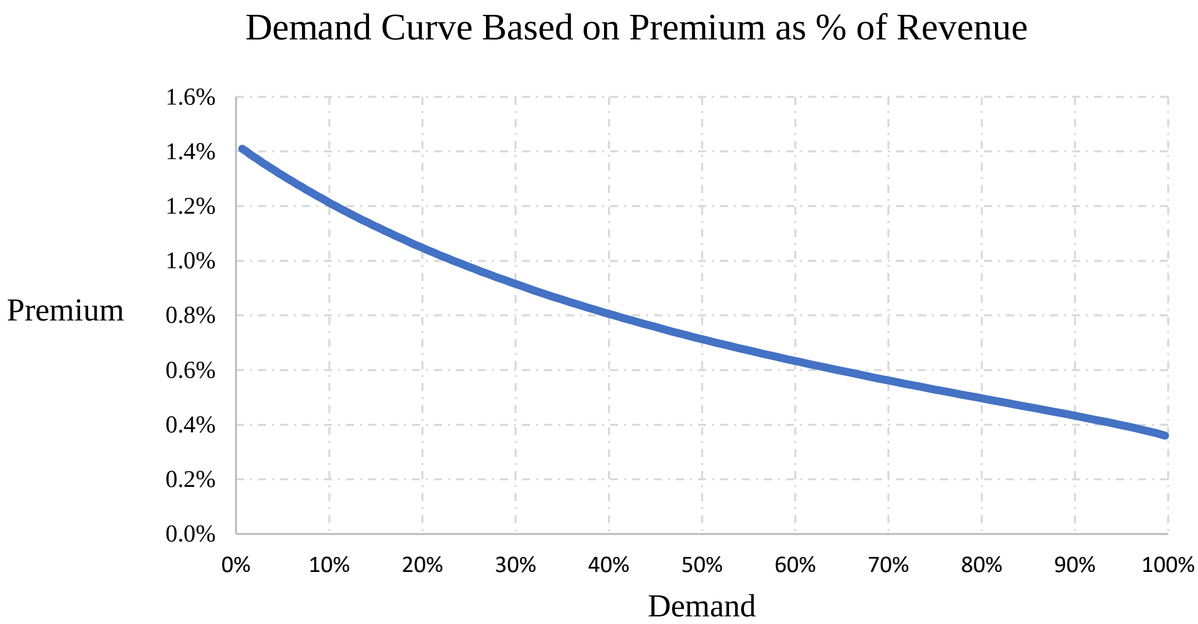


Figure 5: Demand curve based on premium as percentage of revenue

Revenue and Net Income

Through a Monte Carlo model with 500,000 iterations, which simulates future health metrics, payouts, expenses, and demand, we determined that this policy can be expected to yield ~ψ14.5 million in NPV of revenue in 2021 and ~ψ72 million over its five-year duration. The expected net income for the policy is ~ψ4.8 million in year one and ~ψ25.6 million for over the five-year span.

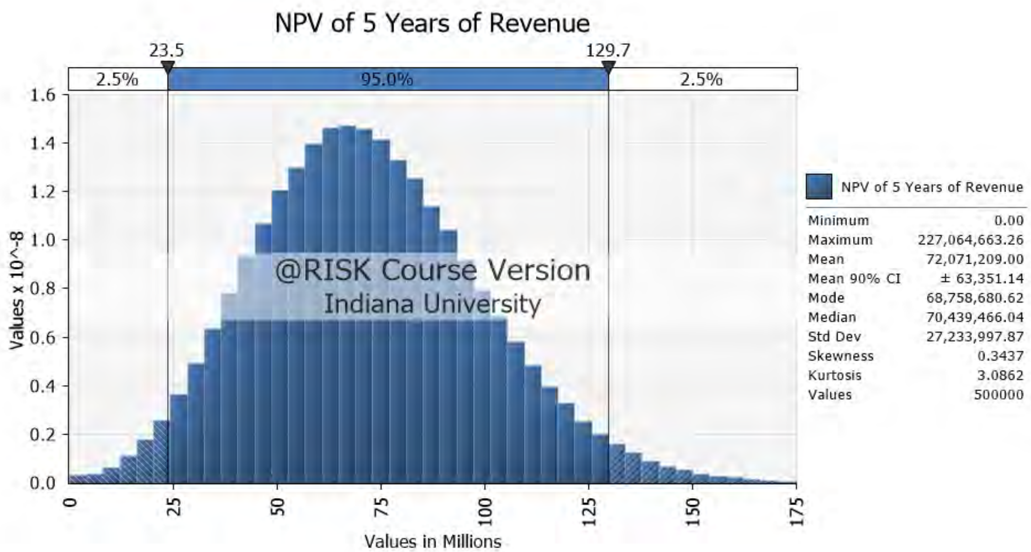


Figure 6: NPV of 5 years of revenue

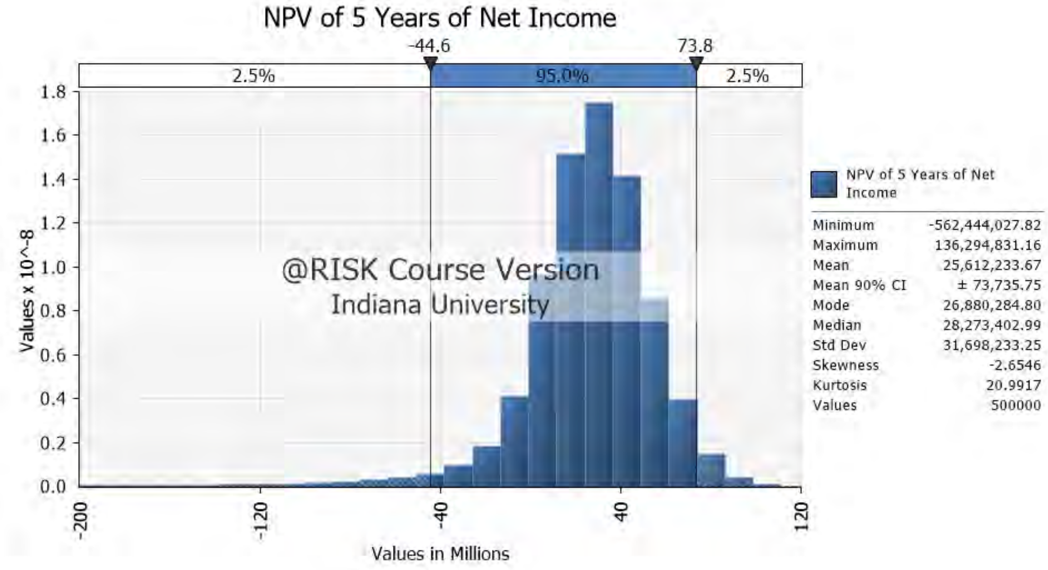


Figure 7: NPV of 5 years of net income

The probability of breaking even is approximately 88%. The net income distribution is skewed left (skew = -2.66). Despite the center of the distribution lying at ~ψ25.6 million, there is only a ~0.1% chance of this policy yielding a NPV net income of over ψ100 million, while there is a ~0.9% chance that there is a NPV loss of over ψ100 million.

Costs

	Parametric Expenses as Percentages of Parametric Revenue							
	Average Claims	Gross Profit Margin	Commisions	Marketing	Salaries	Hospital Partnership	Reinsurance	Net Profit Margin
2021	40.75%	59.25%	2%	1%	5%	10%	18%	23.25%
2022	40.75%	59.25%	0%	0%	5%	10%	18%	26.25%
2023	40.75%	59.25%	0%	0%	5%	10%	18%	26.25%
2024	40.75%	59.25%	0%	0%	5%	10%	18%	26.25%
2025	40.75%	59.25%	0%	0%	5%	10%	18%	26.25%

Figure 8: Parametric expenses as percentages of parametric revenue

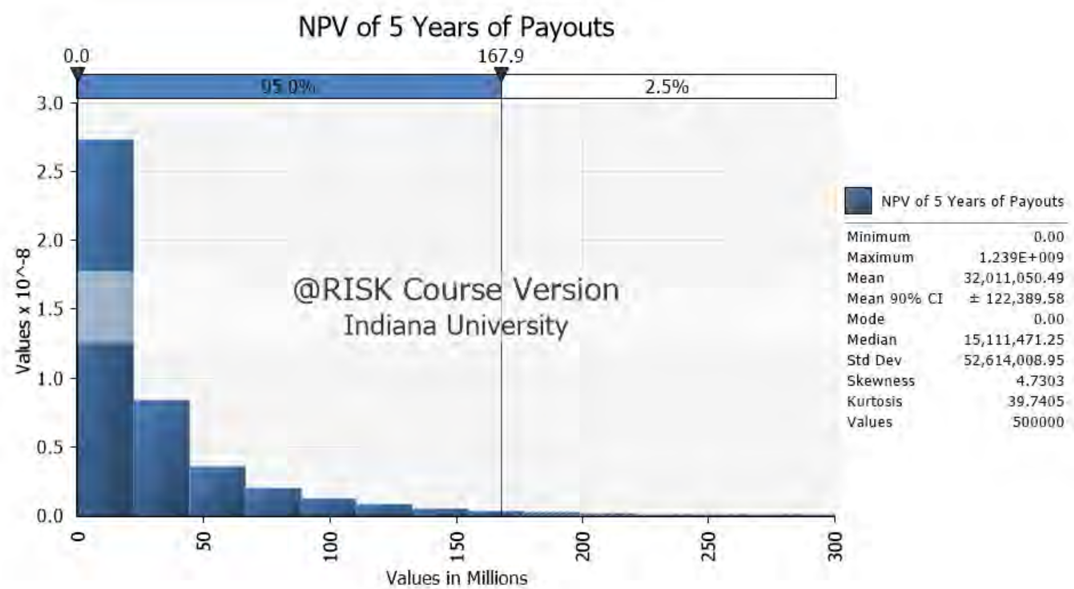


Figure 9: NPV of 5 years of payouts (not adjusted for reinsurance)

While expenses for commission, hospital data, reinsurance, marketing, and salaries fluctuate negligibly, claim payouts vary drastically (see Figure 10). The 2.5th percentile for payouts is no payouts, while the 97.5th percentile is ~0.85% of NEW·WORLD's total expected assets each year.

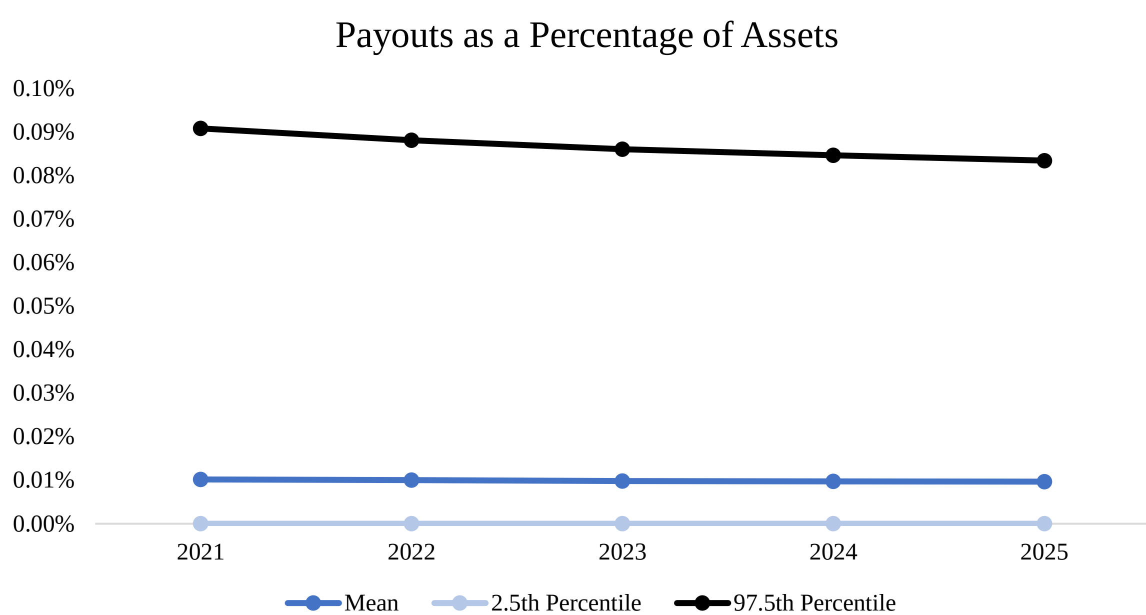


Figure 10: Payouts by year as a percentage of assets

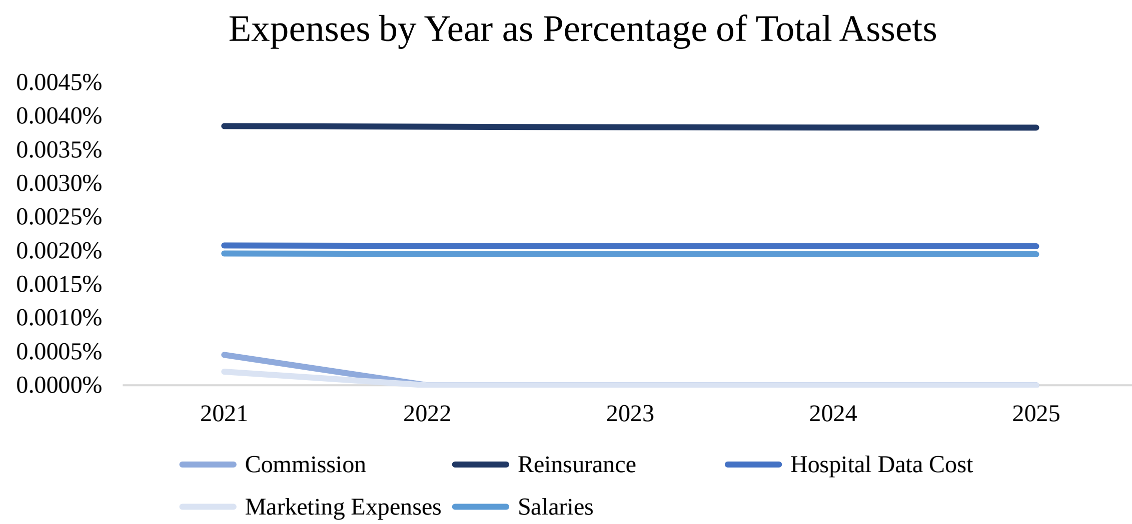


Figure 11: Expenses by year as percentage of total assets

Marketing Strategy

With NEW·WORLD being the first-mover in parametric health policies and offering a never-before-seen product, effective business-to-business marketing is imperative.

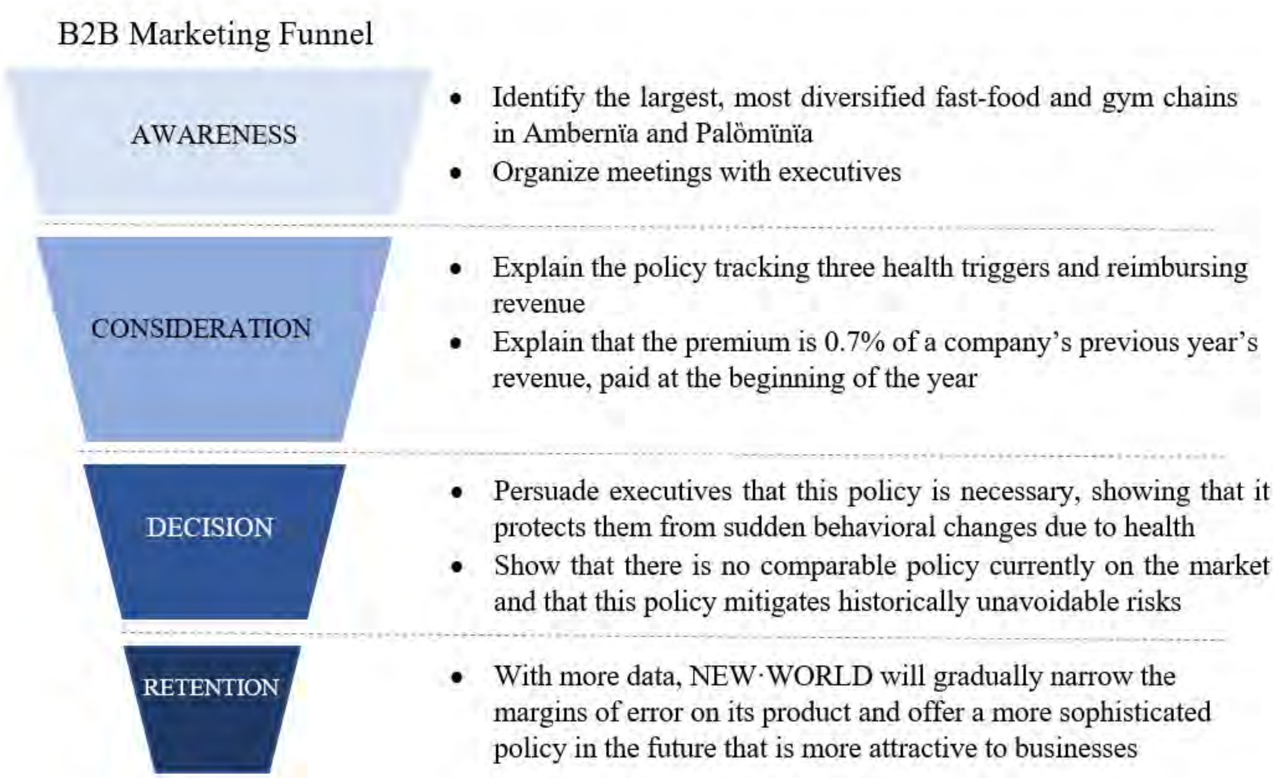


Figure 12: B2B marketing funnel

Assumptions

Key Assumptions

- **GDP Conversions**
  - Assumed that there was an equivalent number of major players in the USA fast-food and gym industries in Ambernïa and Palȍmïnïa (ten and five respectively)
  - Directly applied fast-food and gym revenues of major American players as percentage of US GDP to Palȍmïnïa and Ambernïa
  - Assumed that targeted fast-food and gym chains operate in both Ambernïa and Palȍmïnïa
- **Profit Margin and Demand Relationship**
  - Assumed that demand was strictly based on gross profit margin. To derive a demand curve, we first assumed that 100% of firms will purchase the policy if offered for free. Once the expected gross profit margin was 80%, we assumed 0% of firms would purchase the policy. At a 60% gross profit margin, which is typical for NEW·WORLD's other products, we assumed a conservative 50% demand.
- **Discount Rate**
  - Net income within 10% of projections when discount rate is between 0%-5.9%
  - Used the weighted average GDP growth of Ambernïa and Palȍmïnïa as the value for expected market return
  - Estimated the risk free rate as the long-term interest rate in Ambernïa
  - Utilized industry beta of 0.64 to execute requirements in CAPM Pricing Model

Other Quantitative Assumptions

- **Ambernïa Inflation – 1%**
  - Flatlined from the given case data
  - Model would stay within 10% of expected NPV revenue if between -3% and 5%
- **Palȍmïnïa Inflation – 10%**
  - Flatlined from the given case data
  - Model would stay within 10% of expected NPV revenue if between -8% and 29%

- **Currency Conversion – ψ1.00 = $0.78**
    - Took seven geographically diverse countries that had similar levels of tertiary educational attainment and GNI growth to Ambernïa, and then equated the average GNI/person in dollars to Ambernïa's GNI/person in silons
    - Model would stay within 10% of expected NPV revenue if between $0.71 and $0.85

Other Qualitative Assumptions

- In our quadratic regressions for diabetes prevalence and systolic blood pressure and our linear regression for obesity, we assumed that Ambernïa would closely follow the margin of error shown in the 42 developed countries and that Palòmïnïa would closely follow the distribution of 142 developed countries.
- We assumed that the standard deviations of triggers from 10 years ago will be equivalent in magnitude of deviation from the 2021-2025 triggers.

Risks and Risk Mitigation

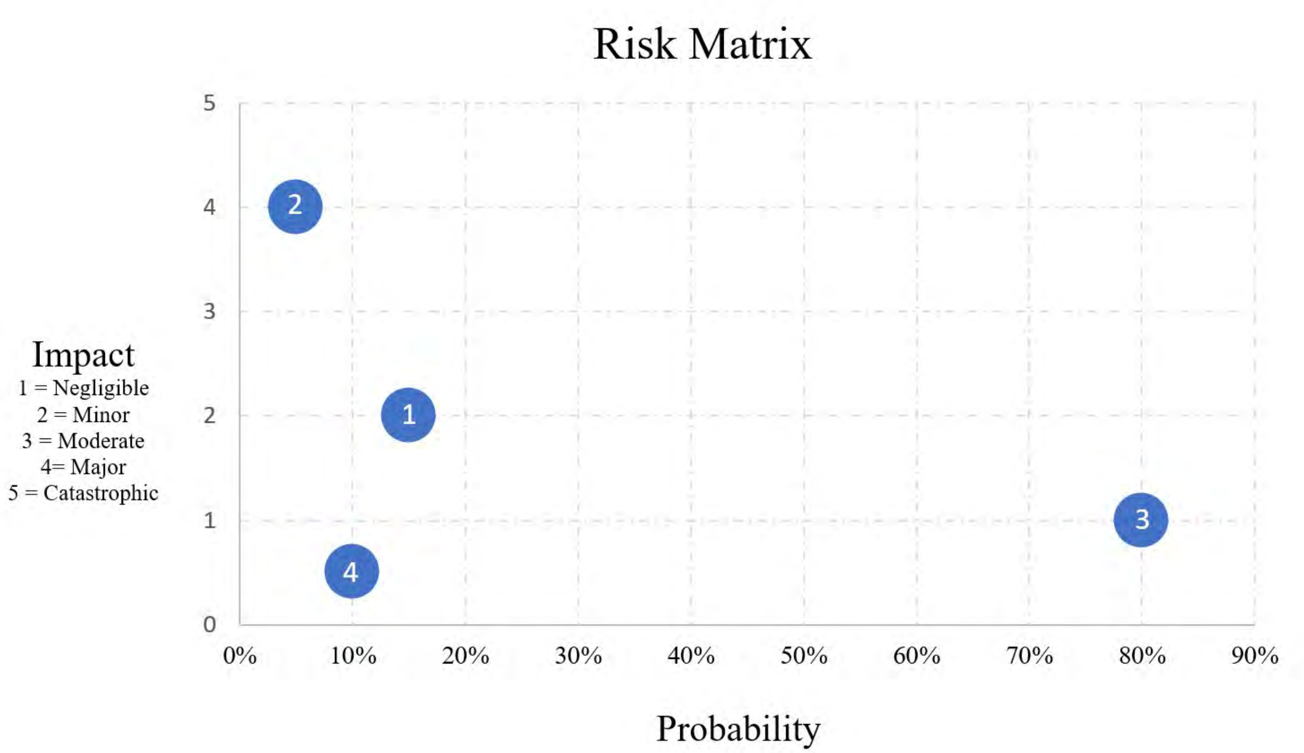


Figure 13: Risk matrix

Basis Risk – Risk 1

I. The inherent risk of parametric insurance is that the payout either drastically exceeds or falls short of the actual damages. If there is a significant change in the trends of several of these metrics without corresponding revenue declines, the policy would need to be discontinued.

II. There may be loyal consumer segments (that are small in proportion to the population) whose gym or fast-food expenditures grow, causing revenues to increase despite national health metrics moving adversely.

Mitigation: Correlation between payouts and damages will be carefully monitored in years after the inception of this policy. Any adverse developments in health metrics for one business should benefit the other type.

Inaccurate, Biased, or Misrepresentative Data – Risk 2

I. The data in either the case materials or Lancet dataset could have been collected in a biased, uncomprehensive manner. This could mean that every trigger point is miscalculated, possibly forcing NEW·WORLD to pay claims for every triggering point for one business type, while never being close to the triggering points for the other business type (which raises ethical concerns).

II. There could be an issue with hospital data, where the unhealthiest individuals are more likely to be in their systems. This could be an especially big issue in Palȍmïnïa, where healthcare may not be as readily accessible to healthy individuals. This would cause the hospital data to represent worse national health than the actual population.

Mitigation: Insuring fast-food chains and gyms simultaneously hedges NEW·WORLD's position, ensuring more revenue even if one side is frequently generating payouts. Check all hospital data against other government sources, such as the World Bank and national censuses.

Misjudged Demand and/or Elasticity– Risk 3

I. Companies suffering financial effects from COVID-19 may not be able to justify this expense.

II. There may not be a firm that buys this policy because its price is too high. This would mean that NEW·WORLD has wasted administrative, actuarial, and marketing resources.

III. Because this is a new product with little competition, it is possible that demand is more inelastic than normal insurance, meaning a higher gross profit margin would correspond to a fractionally higher demand. This would result in NEW·WORLD missing out on potential revenue.

Mitigation: NEW·WORLD's historical gross profit margin was used to justify the demand curve during the policy-making process, which is conservative for a unique policy like this.

The Partnership with the Hospital Does Not Work – Risk 4

I. Selling patient data is heavily regulated in most countries, and certain conditions of anonymity must be maintained. It is possible that a country could bar NEW·WORLD from partnering with hospitals, or hospitals could decline due to ethical reasons.

II. The actual cost of this partnership could vary drastically from estimates since there is no precedent. This data could cost more than the income NEW·WORLD expects to bring in, making the policy impractical.

Mitigation: 10% of yearly parametric revenue was allocated to this partnership in the policy-making process, which is likely a high-end estimate since NEW·WORLD only needs six datapoints each year (one for each health metric and country).

Data to Monitor, Data Limitations, and Sensitivity Analysis

Data Points to Monitor

These values should be reported to NEW·WORLD's senior management on an end-of-year basis:

- Revenue, expenses, and net income
- Data on all 36 health triggers each year in the parametric insurance policy
- B2B marketing success rates as compared to expected demand

- Whether NEW·WORLD should renegotiate for cheaper reinsurance if projected values are closely met in first 2-3 years of policy

Data Limitations

- There was not a substantial breakdown between variable and fixed expenses on NEW·WORLD's income statement. Our expenses were exclusively taken as a percent of parametric revenue based on income statement ratios, so this assumption could be invalid if current fixed expenditures scaled to the added parametric policy.
- It was unusual for a multinational insurance company with over ψ60 billion in assets to not have any debt in their capital structure. We used a sound approach in calculating the company discount rate from a formula perspective, but it is difficult to ascertain the meaning of the discount rate in such an improbable situation.
- We were not given any historical data for obesity prevalence, which forced us to estimate a rate of change and develop trigger points further away from our projected values.
- We do not have breakdowns of NEW·WORLD's typical insurance offerings, target segments, or expenditures. Further, we do not know about the existing relationships or credibility that NEW·WORLD has developed in the industry. We assumed that NEW·WORLD is diversified and can break into most insurance segments.

Sensitivity Analysis

Changing the premium has massive implications on demand and further impacts profit. We assumed a 0.7% premium, implying a 59.3% gross profit margin and 51.6% demand.

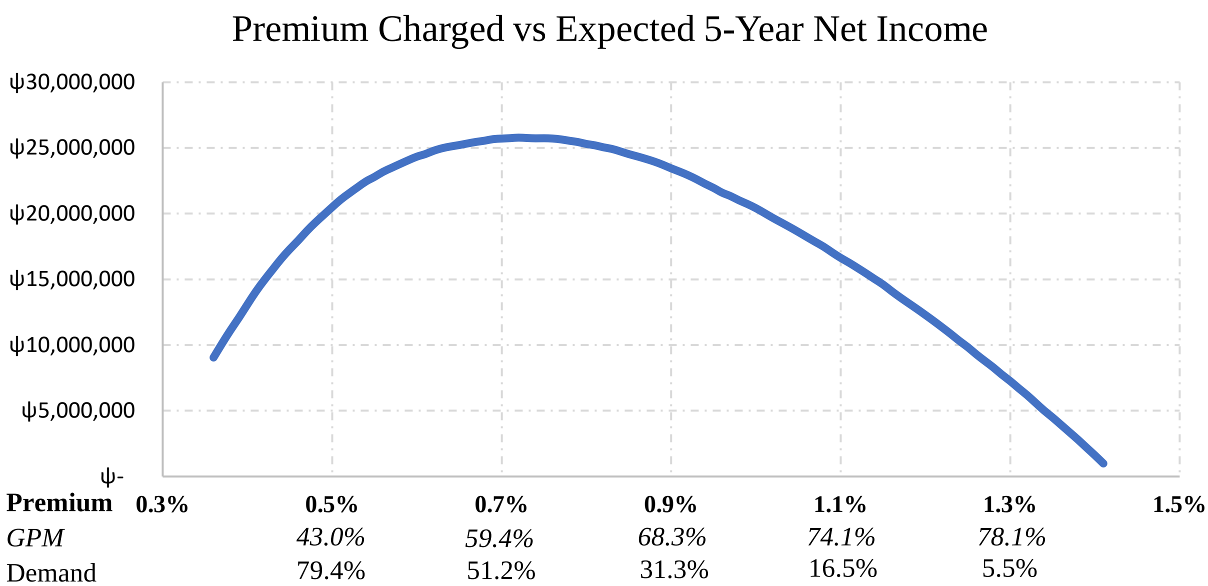


Figure 14: Sensitivity of premium and NPV of net income

Uncertainty of non-fluctuating expenses, such as the hospital partnership, salaries, and reinsurance significantly affects net income (see Figure 15 below). We assumed the total operating expense to be 36% of parametric revenue. There is approximately a ψ3.1 million range in the NPV of total net income when considering discount rates between 0.5% and 4.5% (see Figure 16 below).

		Premium as % of Previous Year's Revenue				
		0.5%	0.6%	0.7%	0.8%	0.9%
Total Operating Expenses as % of Parametric Revenue (Excludes Payouts)	26%	ψ 27,238,545	ψ 31,009,433	ψ 32,147,158	ψ 31,065,983	ψ 28,555,356
	31%	ψ 23,820,395	ψ 27,805,371	ψ 28,865,494	ψ 28,160,238	ψ 25,699,575
	36%	ψ 20,091,548	ψ 24,063,538	ψ 25,576,810	ψ 25,114,268	ψ 23,216,781
	41%	ψ 16,755,752	ψ 20,727,846	ψ 22,358,984	ψ 22,158,274	ψ 20,738,669
	46%	ψ 13,106,624	ψ 17,125,163	ψ 19,073,920	ψ 19,255,517	ψ 18,092,219

Figure 15: Sensitivity of premium and operating expenses

		Premium as % of Previous Year's Revenue				
		0.5%	0.6%	0.7%	0.8%	0.9%
Discount Rate	0.5%	ψ 21,577,650	ψ 25,744,025	ψ 27,251,941	ψ 26,635,622	ψ 24,769,705
	1.5%	ψ 20,707,201	ψ 24,752,171	ψ 26,076,114	ψ 25,624,004	ψ 23,618,955
	2.5%	ψ 20,091,548	ψ 24,063,538	ψ 25,576,810	ψ 25,114,268	ψ 23,216,781
	3.5%	ψ 19,758,356	ψ 23,710,907	ψ 25,031,606	ψ 24,634,802	ψ 22,741,748
	4.5%	ψ 19,117,479	ψ 22,757,657	ψ 24,106,841	ψ 23,511,456	ψ 21,899,344

Figure 16: Sensitivity of premium and discount rate

The graph below shows the relationship between estimated market return and NEW·WORLD's discount rate. As the estimated market return increases, new product offerings must perform better to make the investment worthwhile. An increasing discount rate lowers the NPV of future net income.

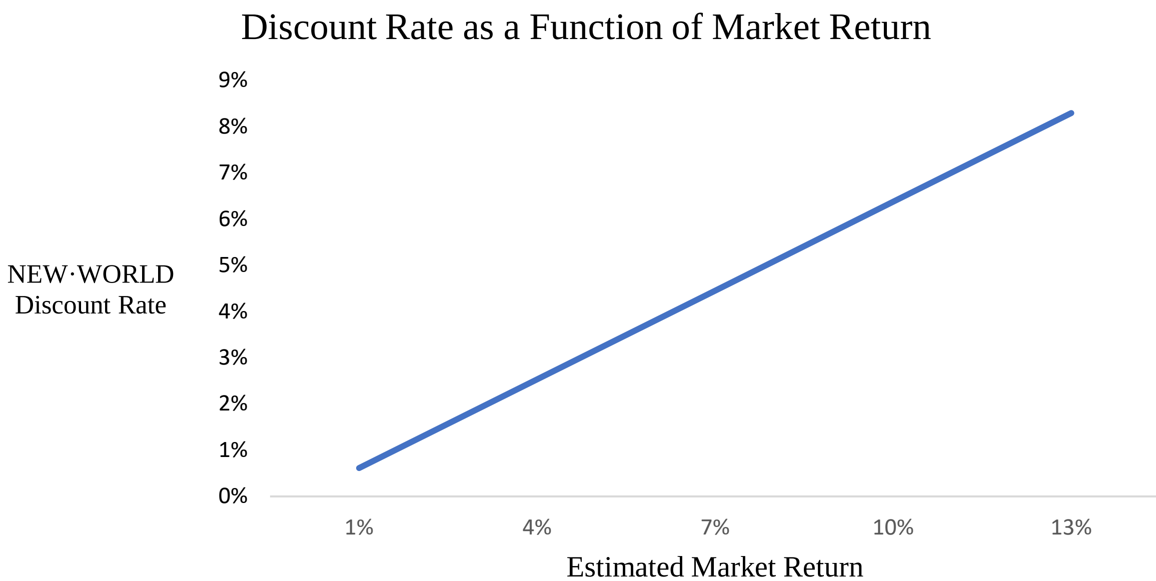


Figure 17: Sensitivity of discount rate and estimated market return

Appendix and Methodologies

Triggering Points Methodology

The triggering points for each of the three health metrics were found using empirical data collected by The Lancet, a scientific journal. After standardizing the data to age and sex, a quadratic regression was run on each of the 42 developed countries (for application to Ambernïa) and 142 developing countries (for application to Palồmïnïa) using data from 2000-2009. We then compared the expected values yielded by these regression coefficients to the actual, observed datapoints from 2010-2014. Finally, we separately calculated the expected standard deviation by year for developed and developing nations, which we could apply to the systolic blood pressure and diabetes prevalence quadratic regression lines of Palồmïnïa and Ambernïa.

However, for obesity, we do not have access to the historical data for Palồmïnïa or Ambernïa. Moreover, we need to find an expected slope and the accompanying error of that slope from the Lancet dataset. We found that there was a correlation between current obesity prevalence and the change per year, which could be used to estimate the rate of change in Palồmïnïa and Ambernïa. However, we found that obesity prevalence rates that were extremely small or extremely large tended to have slopes that were smaller than the expected values on the regression line. Since Palồmïnïa and Ambernïa both exhibit a more average prevalence (~15%), we excluded countries where prevalence was less than 5% or over 35% from our analysis. After deriving an expected value for the true slope from the regression output, we factored in the error of that slope and the error from expected deviations from that slope each year, similarly to what we did with blood pressure and diabetes prevalence.

R CODE (Using data collected by The Lancet)

```
tenyrs_diab_developed = Diabetes_Developed %>%
  filter(Year < 2010, Year > 1999)              #First 10 years of 15 most recent years of data for diabetes prevalence
tenyrs_diab_developing = Diabetes_Developing %>%
  filter(Year < 2010, Year > 1999)
lm_diab_developed = lmList(object = Diab_Prev ~ Year + I(Year^2) | Country, tenyrs_BP_developed)
lm_diab_developing = lmList(object = Diab_Prev ~ Year + I(Year^2) | Country, tenyrs_BP_developing)
#Creating a list that stores simple quadratic regression coefficients by country
Diab_reg_coefficients_by_developed_country = coef(lm_diab_developed)
```

```
Diab_reg_coefficients_by_developing_country = coef(lm_diab_developing)

#Coef() allows user to easily download data to a CLV file

#In Excel, we compared projected values for those 5 years to the observed values, finding an expected standard deviation for each year.
```

Standard Deviations from Expected Future Diabetes		
	Developed	Developing
2021	0.016%	0.023%
2022	0.033%	0.046%
2023	0.051%	0.066%
2024	0.075%	0.092%
2025	0.105%	0.123%

Figure 18: Standard deviations from expected future diabetes

```
tenyrs_BP_developed = Sys_Developed %>%
  filter(Year < 2011, Year > 2000)          #First 10 years of 15 most recent years of data for systolic blood pressure
tenyrs_BP_developing = Sys_Developing %>%
  filter(Year < 2011, Year > 2000)
lm_BP_developed = lmList(object = Systolic ~ Year + I(Year^2) | Country, tenyrs_BP_developed)
lm_BP_developing = lmList(object = Systolic ~ Year + I(Year^2) | Country, tenyrs_BP_developing)
BP_reg_coefficients_by_developed_country = coef(lm_BP_developed)
BP_reg_coefficients_by_developing_country = coef(lm_BP_developing)

#In Excel, we compared projected values for those 5 years to the observed values, finding an expected standard deviation for each year.
```

Standard Deviations from Expected Future Systolic BP		
	Developed	Developing
2021	0.009	0.009
2022	0.026	0.027
2023	0.049	0.049
2024	0.082	0.077
2025	0.126	0.113

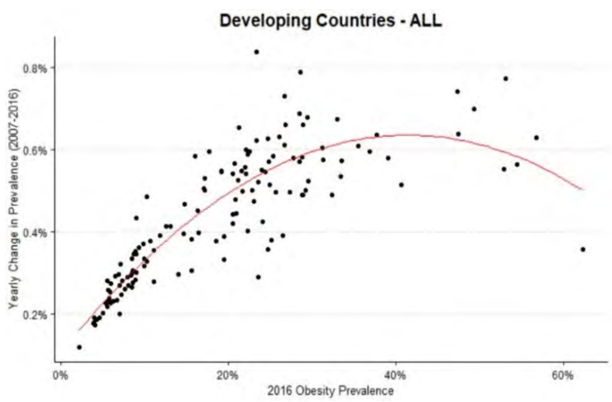
Figure 19: Standard deviations from expected future systolic BP

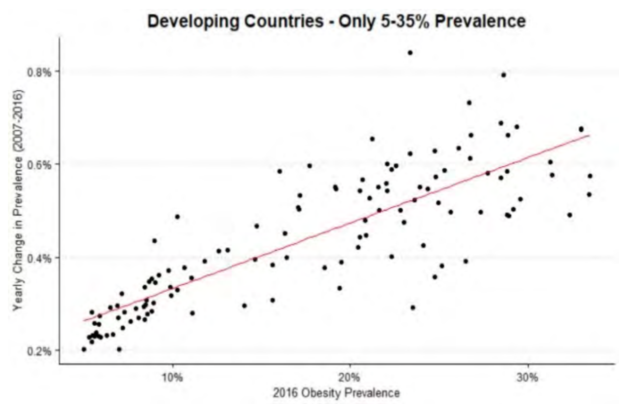
```
tenyrs_obes_developed = Obes_Developed %>%
  filter(Year < 2012, Year > 2001)          #First 10 years of 15 most recent years of data for obesity prevalence
tenyrs_obes_developing = Obes_Developing %>%
  filter(Year < 2012, Year > 2001)
lm_obes_developed = lmList(object = Obesity ~ Year | Country, 10yrs_obes_developed)
lm_obes_developing = lmList(object = Obesity ~ Year | Country, 10yrs_obes_developing)
```

obes_reg_coefficients_by_developed_country = coef(lm_obes_developed)

obes_reg_coefficients_by_developing_country = coef(lm_obes_developing)

#Took the slope coefficients by country to use in a regression function between current prevalence and slope





Figures 20 and 21: Correlations between obesity prevalence and growth per year

#Separated countries with 5-35% prevalence because high and low prevalence countries tend to have slopes below the regression line, as seen above. Also, these countries are distant from the Palòmïnïa and Ambernïa prevalence (both ~15%)

cutdown_obesity_prev_and_slope_developed = obesity_prev_and_slope_developed %>%

filter(Prev > .05 ,Prev < .35)

cutdown_obesity_prev_and_slope_developing = obesity_prev_and_slope_developing %>%

filter(Prev > .05, Prev < .35)

lm_developed_prev_vs_slope = lm(Slope ~ Prev, cutdown_obesity_prev_and_slope_developed)

lm_developing_prev_vs_slope = lm(Slope ~ Prev, cutdown_obesity_prev_and_slope_developing)

#Yields regression coefficients that we applied to Palòmïnïa and Ambernïa , finding their slopes to be ~.4% increase per year and ~.3% increase per year, respectively. Standard errors were .074% for Ambernïa and .082% for Palòmïnïa.

Standard Deviations from Expected Future Obesity		
	Developed	Developing
2021	0.085%	0.120%
2022	0.162%	0.209%
2023	0.242%	0.304%
2024	0.324%	0.407%
2025	0.410%	0.518%

Figure 22: Standard deviations from expected future obesity (After factoring in error from Slope & Deviation)

The Lancet Data Graphs

There is too much data to include in this report, but these graphs represent every datapoint considered:

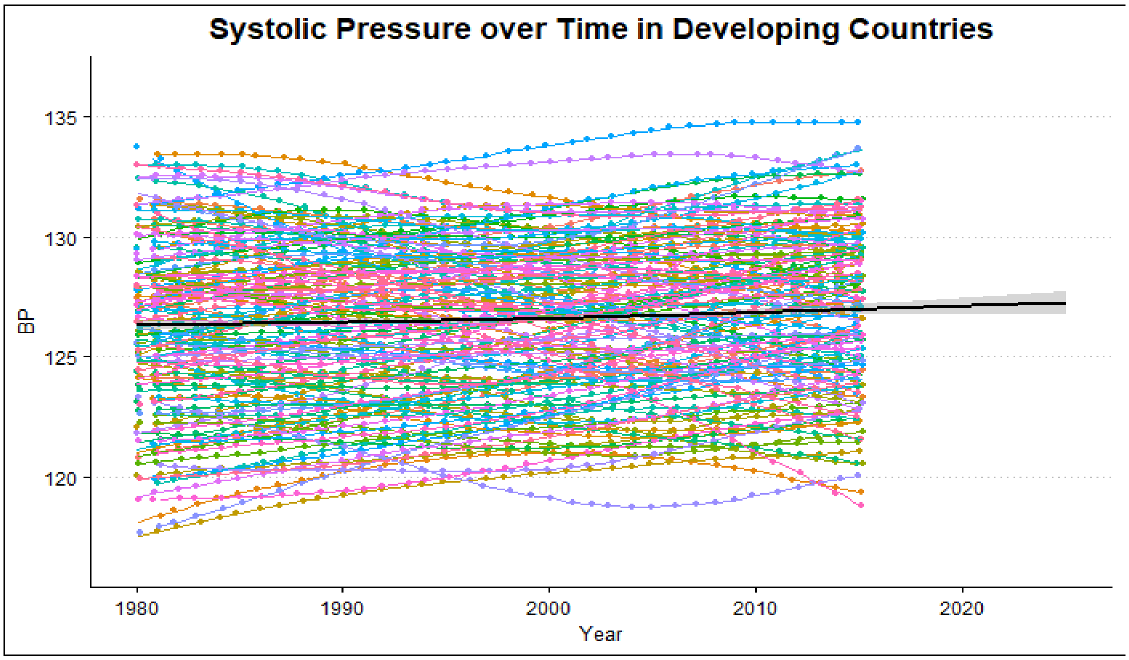


Figure 23: Systolic pressure over time in developing countries

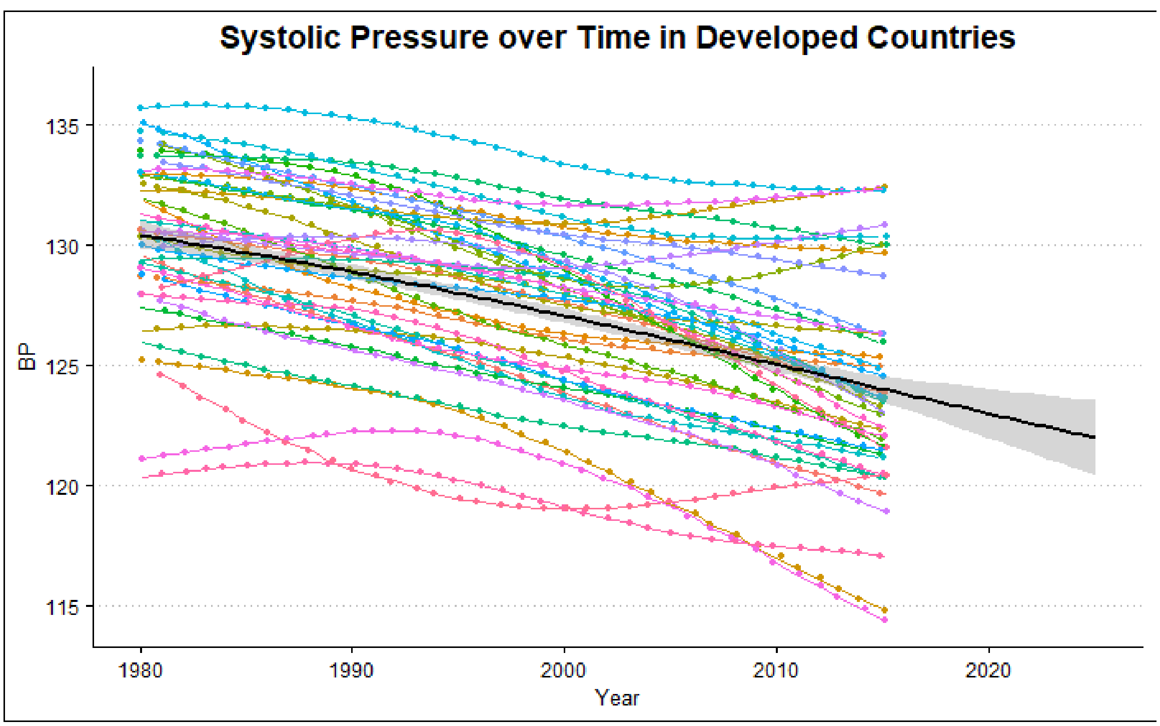


Figure 24: Systolic pressure over time in developed countries

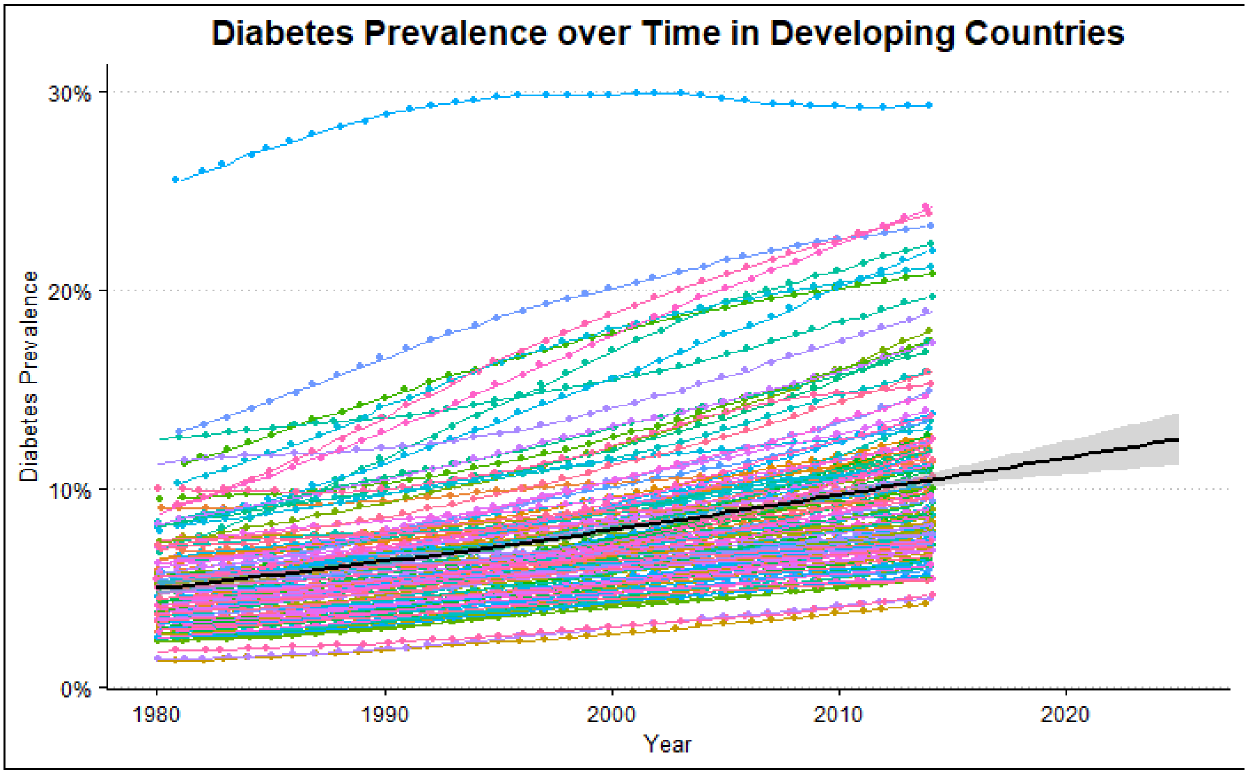


Figure 25: Diabetes Prevalence over time in developing countries

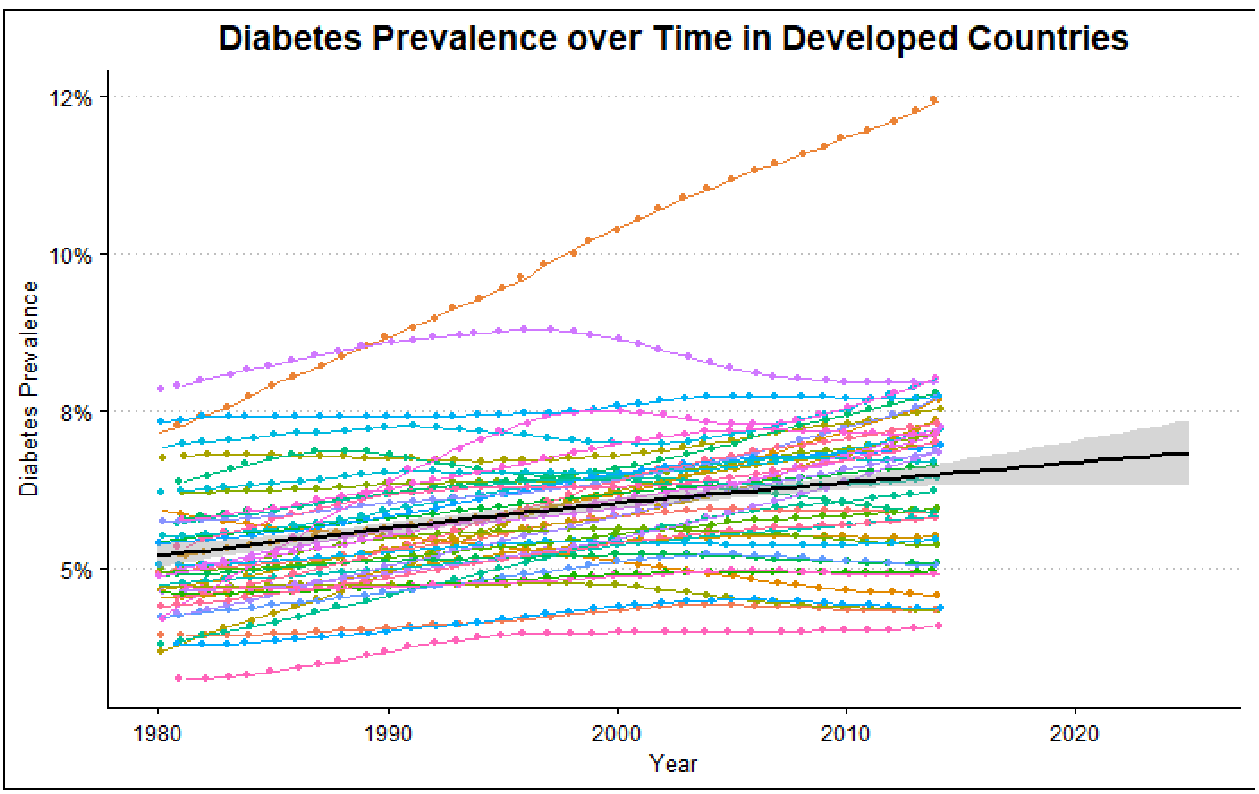


Figure 26: Diabetes prevalence over time in developing countries

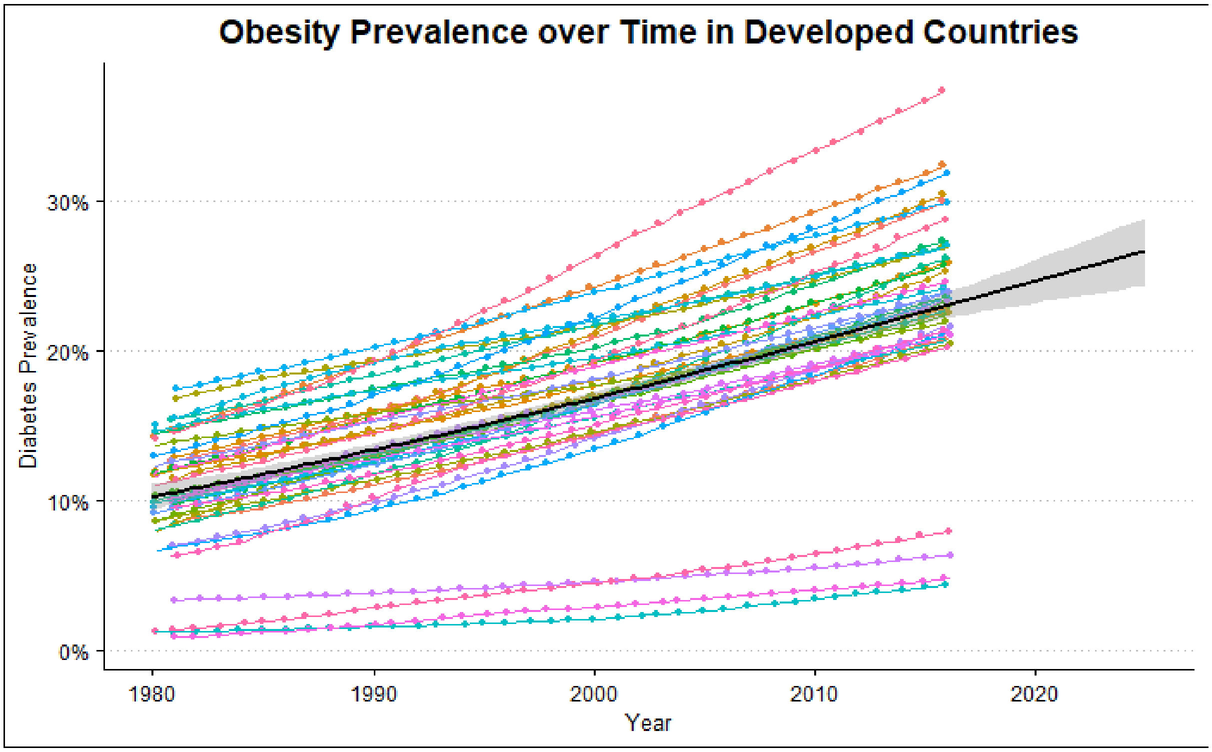


Figure 27: Obesity prevalence over time in developed countries

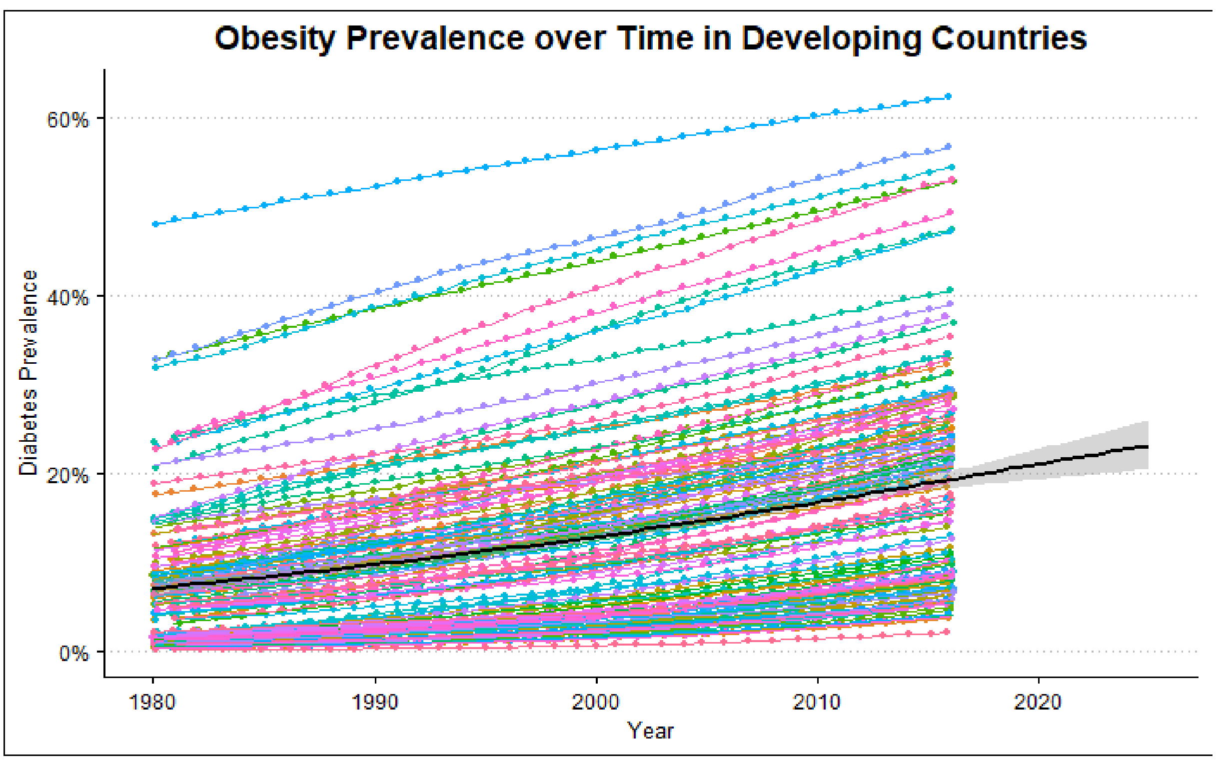


Figure 28: Obesity prevalence over time in developing countries

Monte Carlo Excel Simulation

We used Palisade's @Risk tool to factor in uncertainty to our model and predictions.

- The following formulas were used to randomize the competitive landscape in each iteration assuming ten fast-food chains and five gyms. These numbers were calculated by taking the revenue of major players in the USA, scaling to GDP, and converting dollars to silons.

=RiskNormal(MeanFF, StdDevFF)	=	=RiskNormal(360000000, 286000000)	10 times
=RiskNormal(MeanGym, StdDevGym)	=	=RiskNormal(86500000, 24000000)	5 times

- Revenue was then calculated by multiplying the sum of this revenue by 0.7% (the yearly premium). This revenue calculation included the inflation rates for Palòmïnïa and Ambernïa as well as the discount rate to find the NPV.
- =RiskNormal() was used to randomize the 30 total monitored points over the next five years, with the means as the expected values (see Figure 2), and the standard deviations as calculated (See Figures 18, 19, 22). =NormInv() was used to find triggering events based on probability.
  - Note: For obesity, =RiskNormal() was used twice. It was used once to find a random slope and once to factor in the deviation from this true slope.
- The 180 possible payouts could then be simulated using the following formula (gym ex.):

```
=IF(RiskNormalValue >= Trigger, Reimbursement% * (1 + Inflation) * SUM(CountryRevenue), 0)
```

- =RiskCorrMat(), as seen below, was used within the health metric functions to factor in correlation between diabetes, obesity, and systolic blood pressure (see Figure #3 for the correlations). Correlations were found using =correl() for two arrays of metrics (by country) collected by The Lancet.

```
=RiskNormal(ExpectedHealthMetric ,StdDev, RiskCorrmat(RiskMatrix, 1, 1))
```

- =RiskPert() was used to randomize the weight of sales in Palòmïnïa and Ambernïa for each individual company, with 5% of revenue being in Palòmïnïa as the minimum and 20% as the maximum.
- =RiskBernoulli was used to randomize whether the company purchased the policy, with the demand percentage as the probability.

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