THE FINAL VERSION

Capstone interview

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Project proposal

Overview

What is the background of China?

Rapid Development

Risk and benefit

Why we chose elderly?

Wealth accumulation

Type of risk

How to determine the type of product?

Whole life

Term life

Universal life insurance

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Product Introduction

Product introduction

Products Overview

Target Customers:

Male & Female

65 years old

Benefits & Premium:

Buy Now Pay Now

Paid at the end of each year

Available time:

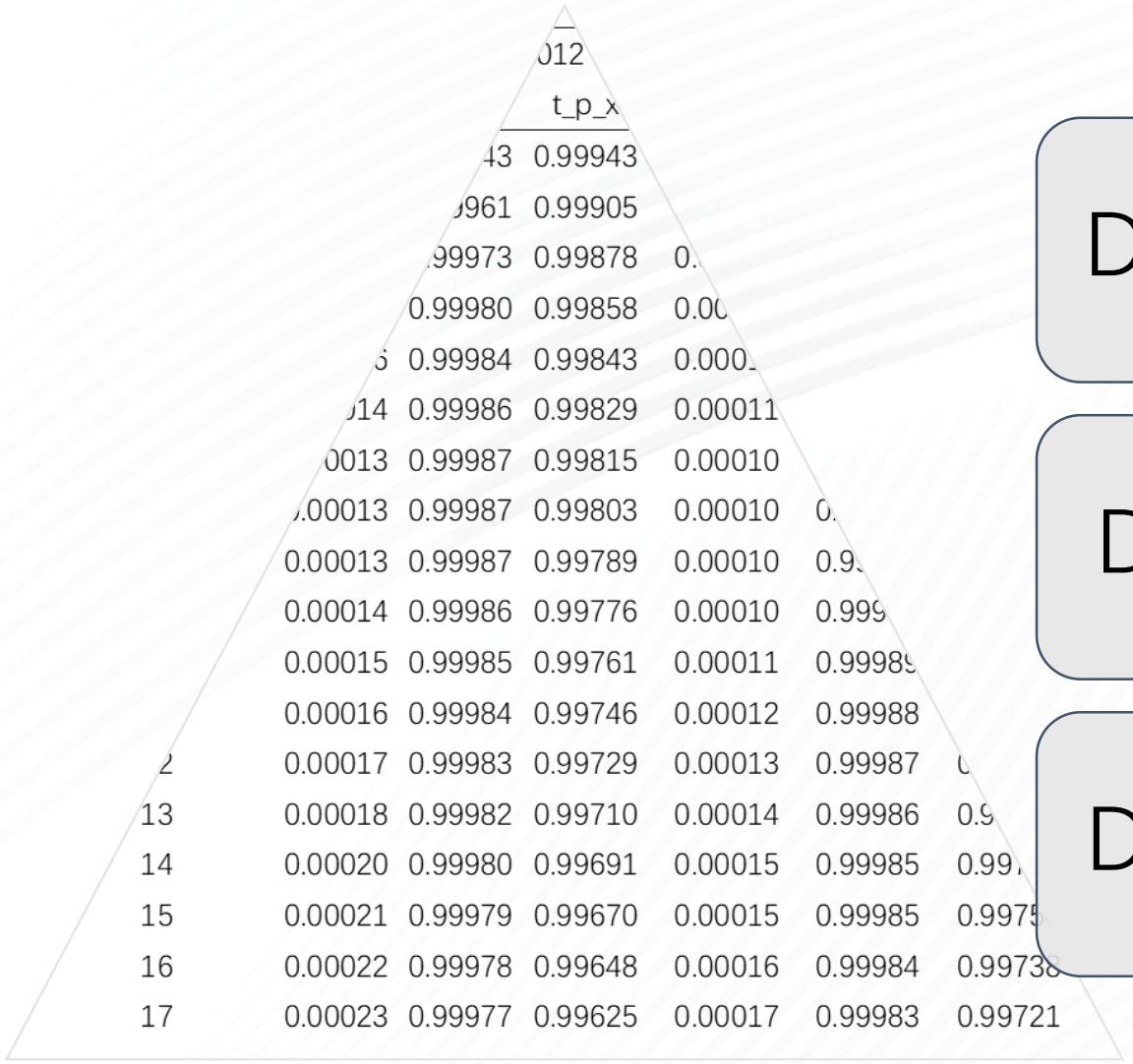
2022/01/01

Pricing Criteria:

Gender & Age

Project Profile

Mortality table development



	012				
	t_p_x				
	43	0.99943			
	961	0.99905			
	99973	0.99878	0.		
	0.99980	0.99858	0.0(		
5	0.99984	0.99843	0.000		
14	0.99986	0.99829	0.00011		
0013	0.99987	0.99815	0.00010		
.00013	0.99987	0.99803	0.00010	0.	
0.00013	0.99987	0.99789	0.00010	0.9	
0.00014	0.99986	0.99776	0.00010	0.999	
0.00015	0.99985	0.99761	0.00011	0.99989	
0.00016	0.99984	0.99746	0.00012	0.99988	
0.00017	0.99983	0.99729	0.00013	0.99987	0
0.00018	0.99982	0.99710	0.00014	0.99986	0.9
0.00020	0.99980	0.99691	0.00015	0.99985	0.99
0.00021	0.99979	0.99670	0.00015	0.99985	0.9975
0.00022	0.99978	0.99648	0.00016	0.99984	0.99738
0.00023	0.99977	0.99625	0.00017	0.99983	0.99721

Data acquisition

[Mortality and Other Rate Tables (soa.org)]

Data prediction

[https://www.macrotrends.net/countries/CHN/china/life-expectancy]

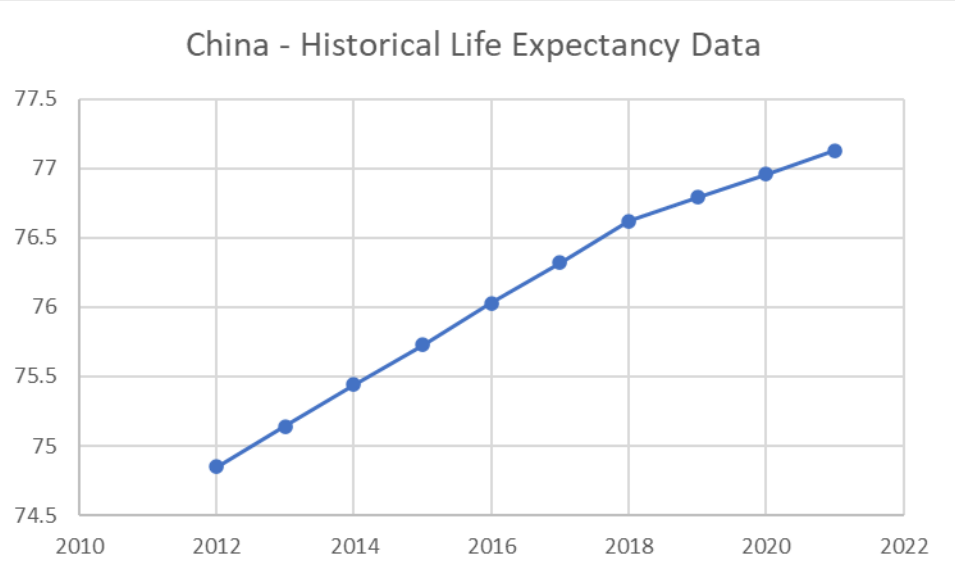
Data calculation

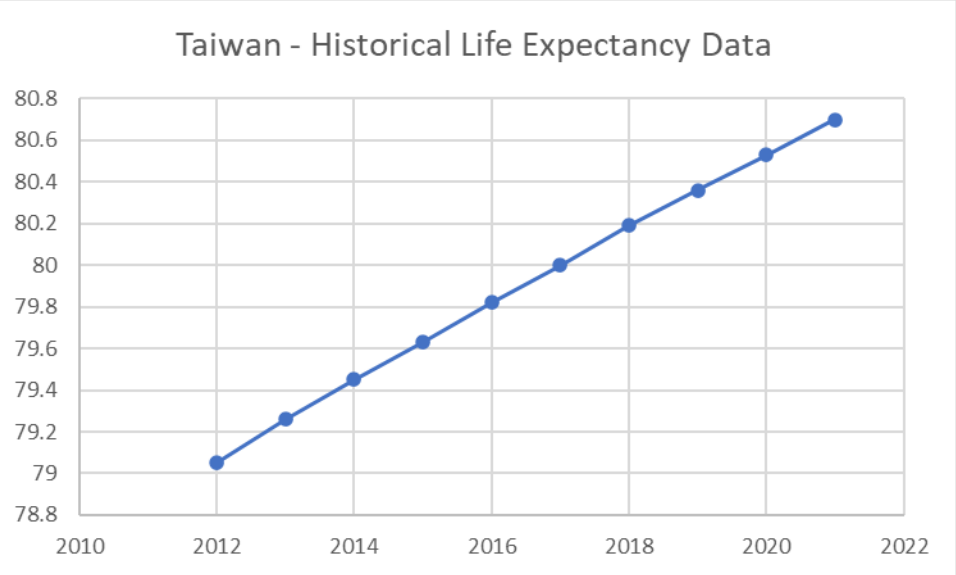
$$tPx = \prod_{t=0}^{n} 1Px$$

$$E(x) = \sum_{t=0}^{\omega} tpx$$

$$q_{x\,(t)} = q_{x(t+n)} \times (1 - \textbf{past mortality imp rate})^{n}$$

Mortality table development





Mortality assumption

Based on Taiwan’s data, we can figure out that China still need at least ten years to match their life expectancy.

Past mortality improvement rate = 10-years average rate.

Discount curve development

	Residual Maturity	Yield			ZC Price			
		Last	Chg 1M	Chg 6M	Last	Chg 1M	Chg 6M	Fx
	1 year	2.126%	-7.9 bp	-41.5 bp	97.92	+0.08 %	+0.41 %	
	2 years	2.543%	-4.3 bp	-17.4 bp	95.10	+0.08 %	+0.34 %	
	3 years	2.589%	-5.5 bp	-16.0 bp	92.62	+0.16 %	+0.47 %	
	5 years	2.717%	-6.0 bp	-19.7 bp	87.46	+0.30 %	+0.97 %	
	7 years	2.868%	-5.0 bp	-14.2 bp	82.04	+0.34 %	+0.97 %	
	10 years	2.912%	-3.2 bp	-20.0 bp	75.05	+0.31 %	+1.96 %	
	15 years	3.107%	-10.6 bp	-26.6 bp	63.19	+1.54 %	+3.93 %	
	20 years	3.437%	-12.5 bp	-14.5 bp	50.87	+2.44 %	+2.83 %	
	30 years	3.474%	-1.6 bp	-15.8 bp	35.90	+0.48 %	+4.70 %	

(http://www.worldgovernmentbonds.com/country/china/)

Interpolation Method

$$R_t = R_a + \frac{(R_b - R_a) \times (t - a)}{b - a}, a \le t \le b$$

Convert to discount curve

$$\mathbf{z[k]} = \left(\frac{\mathbf{1} - \frac{\mathbf{i[k]}}{\mathbf{2}} * \sum_{\mathbf{m=0.5}}^{\mathbf{k-0.5}} \mathbf{v[m]}}{\mathbf{1} + \frac{\mathbf{i[k]}}{\mathbf{2}}}\right)^{-\frac{\mathbf{1}}{\mathbf{k}}} - \mathbf{1}$$

Discount Curve

$$\boldsymbol{v[k]} = (1 + \boldsymbol{z[k]})\text{^} - \boldsymbol{k}$$

The discount rate table will be used as a reference for all subsequent cash flows.

Liquidity premium & Profit Margin

Liquidity premium

- 0.50%
- Can not easy converted into cash

Profit Margin

- 0.70%
- Company profit

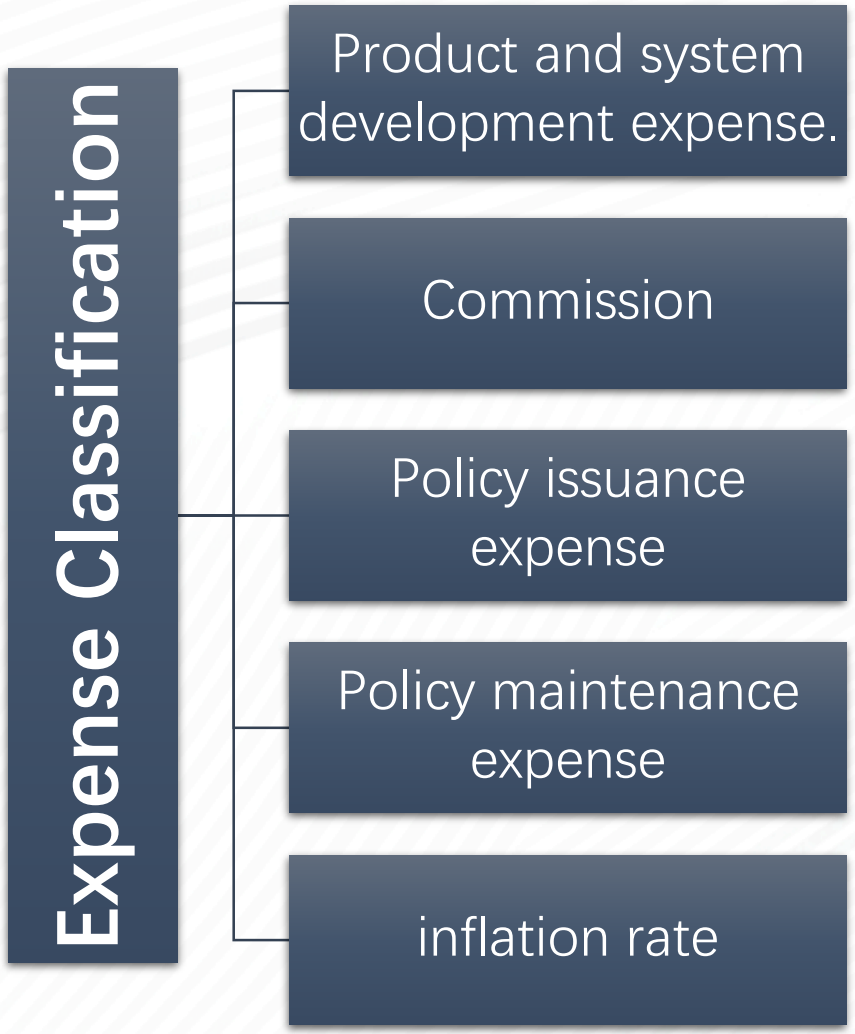
Premium before expense

- $E[Benefits = E[premiums]$
- $Gross\ reserve = EPV(Future\ benefit\ payments) + EPV(Future\ expense\ payments) - EPV(Future\ gross\ premium\ payments)$
- $Net\ reserve = EPV(Future\ benefit\ payments) - EPV(Future\ net\ premium\ payments)$

2022

						2023					
MALE	Gross	17.12386	FEMALE	Gross	18.97697	MALE	Gross	17.22456	Female	Gross	19.06013
	Net	15.73324		Net	17.28732		Net	15.81823		Net	17.35663

Expense loads



Policy Sale Assumption

	50,000	100,000	150,000	Avg size
Male	25%	35%	40%	107,500
Female	40%	35%	25%	92,500

	2022	2023	2024	2025	2026
Total	5,000	10,000	15,000	20,000	25,000
% increase		200%	150%	133%	125%
55% Male	2,750	5,500	8,250	11,000	13,750
45% Female	2,250	4,500	6,750	9,000	11,250

Chinese Inflation rate

[China Inflation Rate | 2021 Data | 2022 Forecast | 1986-2020 Historical | Calendar (tradingeconomics.com)]

Policy issuance expense

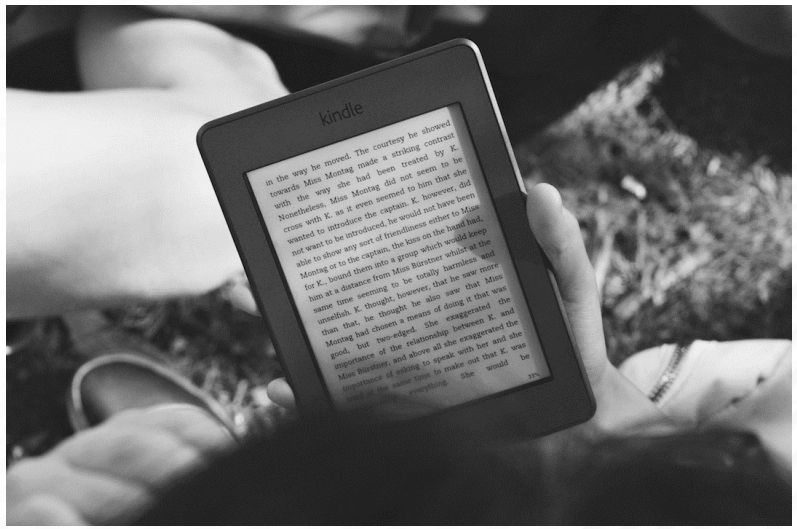
$$Total\ expenses = number\ of\ policy * Policy\ issuance\ expens$$

Policy maintenance expense

$$Total\ expense = number\ of\ policy * gross\ premium * increasing\ factor * duration$$

Commission

$$\frac{\boldsymbol{Premium\ Expense\ Load}}{\boldsymbol{pv(all\ premium)}} = \frac{\boldsymbol{pv(loading\ premium)}}{\boldsymbol{pv(all\ premium)}} + \boldsymbol{commission}$$



system development expense.

$$Total\ expenses = number\ of\ policy * Product\ and\ system\ development\ expenses$$

Risk management

GAAP reserves

What is GAAP reserves?

the aggregate amount of reserves, funds or provisions for losses, liabilities, claims, premiums, benefits, costs and expenses in respect of obligations attributable to the Policy Liabilities

Why we need that?

To ensure that financial reporting is transparent and consistent from one organization to another

When we need that?

Different amounts at different times

How to calculate?

0V = Et=0[PV of Future Benefits] –

Et=0[PV of Future Premiums]

GAAP reserves

Cash flow

$$\boldsymbol{Avarage\ price} = \frac{\sum_{n=1}^{3} \boldsymbol{p_1} * \boldsymbol{number\ of\ policy(n)}}{\boldsymbol{total}}$$

$$nth\ years'\ maintenance = maintenance * (1 + inflation)\text{^}n$$

$$V_{2022}(BOY) = V_{2021}(EOY)$$

End of year:

Benefits

Maintenance fees

2022

Beginning of year:

Gross premium $\boldsymbol{Avarage\ price} * \boldsymbol{Premium} * (\boldsymbol{1} + \boldsymbol{expense\ loading\ factor})$

Acquisition fee

Commission $\boldsymbol{commission} = \boldsymbol{Premium} * \boldsymbol{commison\ factor}$

Negative Reserve & K factor

- Negative Reserve is a large sum of money in the first year for premiums.
- The k factor is used for the profit reserve which is a special reserve we designed as a negative balance of the original GAAP reserve, the profit reserve is used to amortize the liability we have.

Solvency requirements

Operational Risk

At the beginning of the sale of a product, due to economic depression or the company's own mismanagement. This often leads to a poorer than expected number of sales of their products. Which is a factor on GAAP reserves.

Interest Rate Risk

Interest rates on cash flows from assets and cash flows from liabilities are often not the same in life. At the same time, interest rates may also be subject to shock due to unforeseen events.

Mortality Risk

The number of claims is not as accurate as the assumption. Occasionally, there are too many claims which is much more than the original mortality table. Therefore, we need a stressed mortality table.

Credit risk / investment risk

Any company needs to take the credit risk of the insured person as well as the in-investment risk of the profits made. These are all things that insurance companies must take. However, these risks are not considered in the pricing criteria.

Solvency requirements

$$= tPx_{best\ estimate} \times \left(\frac{CROSS\ Reserve}{CROSS\ tPx} - \frac{GAAP\ Reserve}{GAAP\ tPx}\right)$$

$$= \text{Int\_rate shock} \times \text{duration mismatched} \times (\text{Reserve}_{GAAP} - \text{Expected CF}_{GAAP})$$

$$= \text{Operational risk rate of 1\%} \times (\text{Reserve}_{GAAP} - \text{Expected CF}_{GAAP})$$

Adding up risks

Calculation of risks

Mortality Risk Required Capital

Interest Rate Risk Required Capital

Operational Risk Required Capita

The technique for calculating risk correlation is similar to that for calculating variance using the matrix multiplication function.

Based on the Mortality Risk, Interest Rate Risk, and Operational Risk correlation matrix, those required capitals adjusted by the tax rate charged, taking the worst case tax factor into consideration, can be developed as CROSS risk capital required.

	Mort Risk	Int Rate Risk	Oper Risk
Mort Risk	1	0	0.5
Int Rate Risk	0	1	0.25
Op Risk	0.5	0.25	1

Sensitivity analysis

- Talk it later

PROFIT METRICS

Pricing metrics

Pricing metrics

Market consistent value(MCVNB)

- definition

Two method

- using higher return rate for higher risk
- discount the cash flow

Duration

- $\frac{\sum t*CF(t)/(1+r)\^{}t}{P}$
- $implied\ duration = \frac{PV(CFlp)-PV(CFlp\&1bp)}{PV(CFlp)*0.0001}$

Pricing metrics

$$\text{Cost of capital} = \text{cost of capital excess over } r_f \times \text{Target CROSS capital} + \text{cost of financing balance sheet strain} \times \text{Redundant Reserve}$$

Balance sheet strain

- Assets
- Redundant reserve 1%
- Solvency requirements10%

Cash flow pay-back period

- Before tax
- After tax
- Profit less Strain>0
- t_p_x ratio to GAAP

Result

male

- MCVNB: 27281
- MCVNB % 1.45%
- Cash flow pay-back year 15

Female

- MCVNB: 26052
- MCVNB %1.48%
- Cash flow pay-back year 15

Sensitivity analysis

At the end of the product design, we need to consider the impact of some possible unknown changes on the product (for MCVNB).

Female percent*MCVNB%(female)+male percent* percent*MCVNB%(male)

Sensitivity analysis

Rate of change	Margin of CFs	MCVNB%
0.00%	0.50%	1.47%
40.00%	0.70%	1.38%
40.00%	0.30%	1.55%
442.00%	2.71%	0.00%

Rate of change	Liquidity premium	MCVNB%
0.00%	0.50%	1.47%
40.00%	0.70%	1.30%
40.00%	0.30%	1.64%
228.00%	1.64%	0.00%

Rate of change	Spread	MCVNB%
0.00%	0.70%	1.47%
28.57%	0.90%	3.19%
28.57%	0.50%	-0.28%
24.29%	0.53%	0.00%

Rate of change	Commission rate	MCVNB%
0.00%	3.00%	1.47%
33.33%	4.00%	1.41%
33.33%	2.00%	1.51%
384.47%	14.53%	0.00%

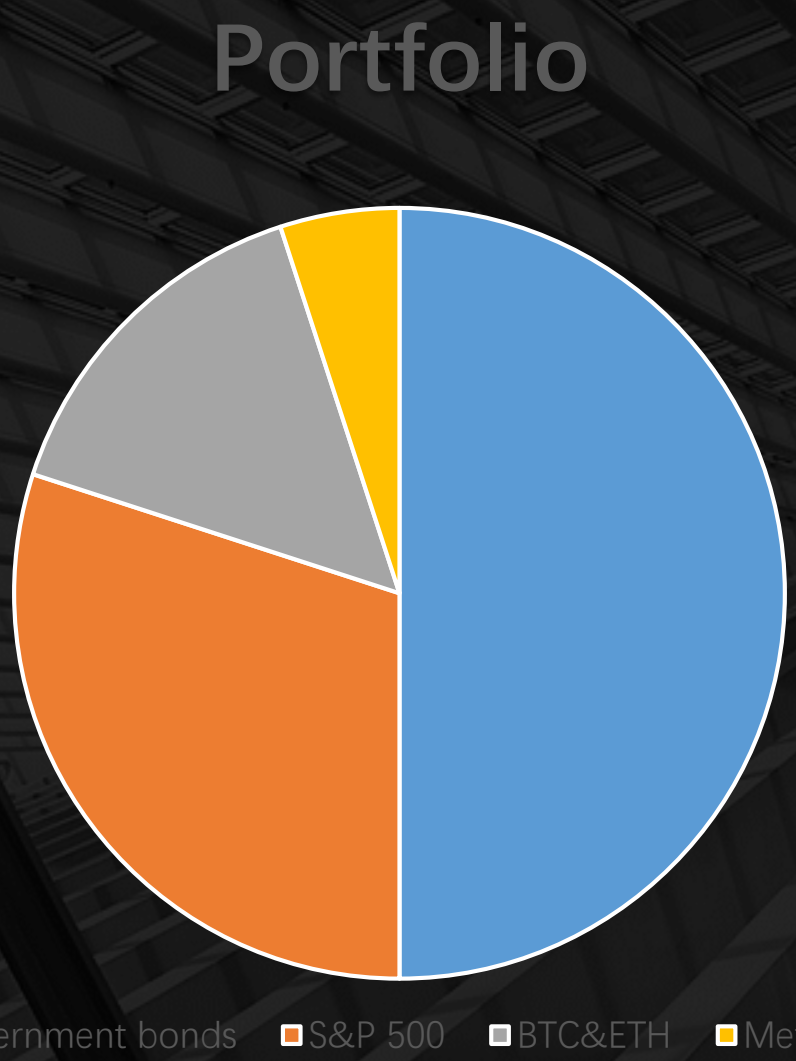
Rate of change	inflation rate	MCVNB%
0.00%	2.00%	1.47%
50.00%	3.00%	1.46%
50.00%	1.00%	1.47%
960.50%	21.21%	0.00%

Rate of change	Mort Future improvement	MCVNB%
0.00%	2.75%	1.47%
40.00%	3.85%	1.74%
40.00%	1.65%	1.17%
90.18%	0.27%	0.00%

Financials Prediction

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Premium	9,403.9	18,807.8	28,211.8	37,615.7	47,019.6	54,072.6	59,479.8	63,643.4	66,189.1
Investment income	331.8	975.7	1,912.8	3,124.7	4,594.1	6,221.1	7,936.6	9,689.5	11,418.5
Reserve change	(8,584.1)	(16,658.5)	(24,240.3)	(31,346.5)	(37,994.4)	(42,056.0)	(44,320.7)	(45,256.3)	(44,596.7)
System costs	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)				
Commissions	(282.1)	(564.2)	(846.4)	(1,128.5)	(1,410.6)	(1,622.2)	(1,784.4)	(1,909.3)	(1,985.7)
Acqusition expenses	(2.5)	(5.0)	(7.5)	(10.0)	(12.5)	(14.4)	(15.8)	(16.9)	(17.6)
Maintenance expenses	(0.5)	(1.5)	(3.1)	(5.2)	(7.8)	(10.8)	(14.2)	(17.8)	(21.7)
Benefits	(501.6)	(1,502.7)	(3,000.8)	(4,993.4)	(7,477.8)	(10,325.8)	(13,447.1)	(16,773.0)	(20,214.8)
Pre-tax income	363.9	1,050.7	2,025.5	3,255.9	4,709.6	6,264.5	7,834.1	9,359.5	10,771.2
Taxes	(91.0)	(262.7)	(506.4)	(814.0)	(1,177.4)	(1,566.1)	(1,958.5)	(2,339.9)	(2,692.8)
After tax income	272.9	788.0	1,519.2	2,441.9	3,532.2	4,698.4	5,875.6	7,019.7	8,078.4
BOY Required Capital	501.9	1,488.5	2,946.2	4,861.7	7,221.7	9,887.9	12,763.8	15,776.7	18,835.6
Return on Req Cap	54.4%	52.9%	51.6%	50.2%	48.9%	47.5%	46.0%	44.5%	42.9%
Return on AVG Req Cap	13.7%	17.8%	19.5%	20.2%	20.6%	20.7%	20.6%	20.3%	19.8%

Investment portfolio



Conclusion

Advantages:
long-term validity (Mortality & Discount rate)

Easy to control risk (Reserves & Sensitivity)

Easy adjustment(Control table)

Drawbacks:
Small profit margin(Cash flow pay-back year & Finance table)

Investment of assets (Reserves & profits)


Thank you!