

**CAA Mortality Investigation Office** 

# Introduction of China's 3<sup>rd</sup> set Life Insurance Mortality Tables(2010-2013)

London Sep8th 2016





# Content

# 1. Background

- 2. Data
- 3. Development of Mortality Tables
- 4. Comparison of Mortality Tables
- 5. Features of the new Mortality Tables





#### History of china's industry mortality tables

- By the end of 1995, China issued the first Life Insurance Mortality Tables(1990-1993), symbolizing the commencement of the construction of infrastructure of China insurance industry
- At the end of 2005, China issued the Life Insurance Industry Mortality Table (2000-2003), laying a solid foundation for the healthy development of the life insurance industry in recent years.
- Along with the rapid development of the life insurance industry in China in the last ten years, there is a strong demand both within and outside the industry for revising and developing a new mortality table









#### **Necessity of developing 2010-2013 mortality tables**

#### Outer causes

- Demographic change:
  - The development of the country in areas like economics, medicine, environment has created new change in the population's mortality
- The new "State Ten Opinions":
  - Insurance risk database need to be established; Mortality/morbidity tables need to be revised
- Reference for population policies
  - Communication with other functions such as national bureau of statistics, national health, social security etc.. to provide reference for national population policies.



#### Necessity of developing 2010-2013 mortality tables

#### Inner causes

- Customers:
  - The development in past 10 years caused the change of customer base. The difference between insured and population also changed.
- Companies:
  - Along with the development of insurance industry and increased life insurers, product variety increased significantly, which requires more detailed pricing base. Otherwise it's hard for insurers to develop proper products to satisfy abundant needs of customers
- Regulators:
  - New mortality rates are needed to ensure companies have sufficient reserve and their products are priced reasonably.
- Historical experience:
  - Sufficient data, accumulated knowledge for table construction technique and project management from past projects, things are ready





Develop new mortality tables according to insurance products
Compare the mortality tables with local and abroad, population and industry
Analyze causes of death in detail and compare the result with that of the health system
Derive valuable experience study

results, providing pricing reference for the industry :

- By region
- By Urban & Rural
- By profession
- By main cause of death
  - By Sum Assured



#### Data plan ( 2014.4-10 )

- Data collecting plan, Product information form(standardized)
- Data verification plan(Seriatim level), Data summary form

#### Data collecting and cleaning (2014.11-2015.4)

- **D** 1-province data as sample being tested first
- □ National data submitted twice thereafter, Data error rate<0.1%
- Claim data cleaning

#### Data processing and table construction(2015.5-10)

- Drafted table construction plan: face to face meeting with each participating company, Shenzhen seminar set the tone.
- 4 technical groups: causes of death analysis, trend study, graduation and extrapolation, database
- Developing new tables: 2 rounds of development, 2 rounds of test
- □ Comprehensive experience analysis:
- □ Writing report

#### Review and release (2015.11-2016.7)

- Face to face discussion meetings and teleconference with experts from schools, SOA, insurance industry and government researchers
- 2016.7.22 Officially reviewed by a 7-expert review panel and successfully passed.

Overall process



#### **10** Companies

9 insurance companies+1 reinsurance company

#### 23 members

13 centralized sessions+5 meetings

### **1,096** products

340m policies, covering 180m population, 1.85m claims

#### **Company name**

- 01 China Life Insurance Company
- 02 Ping An Life Insurance Company
- 03 China Pacific Life Insurance Company
- 04 New China Life Insurance Company
- 05 Tai Kang Life Insurance Company
- 06 AIA Insurance(China)
- 07 Tai Ping Life Insurance Company
- 08 PICC Life Insurance Company
- 09 Funde Sino Life Insurance Company
- 10 China Life Reinsurance Company

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#### 2.Data--Overview of data preparation





### 2.Data---Data vendors

# Policies collected from 9 data vendors, accounting for **93%** of the whole industry

Company Code	Company Name :
01	China Life Insurance Company Ltd.
02	Ping An Life Insurance Company of China, Ltd.
03	China Pacific Life Insurance Company Limited
04	New China Life Insurance Co., Ltd.
05	Taikang Life Insurance Co., Ltd.
06	AIA Shanghai Branch
07	Taiping Life Insurance Co., Ltd.
08	PICC Life Insurance Company Limited
09	Funde Sino Life Insurance Co., Ltd.





#### 2.Data---Time scope

≻Observation period: Jan 1<sup>st</sup>, 2010 to Dec 31<sup>st</sup>, 2013

≻Claim is calculated on the time of occurrence of insured event





# 2.Data--Policy scope

Policies with death coverage which have been once valid during the observation period no matter how short it is.

#### ≻ <u>Include:</u>

Polices issued before the observation period and valid as of the start of the observation period;

Policies issued before the observation period and renewed within the observation period although once invalid at the start of the observation period;

> Policies coming into effect within the observation period.

#### ≻<u>Exclude:</u>

- >Waiver of premium products(Policyholder);
- >Joint life insurance products;
- >Basic policies with no death benefits;
- >Universal riders (e.g. survival benefits will be counted in AV);
- ≻Lapses in cool-off period.





## 2.Data--Product scope

#### No. Product types

- 1 Health insurance(e.g. critical illness)
- 2 Accident insurance
- 3 Term life insurance
- 4 Whole life insurance
- 5 Endowment insurance without scheduled return
- 6 Endowment insurance with scheduled return(high liability for existence)
- 7 Endowment insurance with scheduled return(low liability for existence)
- 8 Annuity insurance(high longevity risk)
- 9 Annuity insurance(low longevity risk)

Life policies with more than 1 year policy term issued in 1996-2013, are classified into 9 product types

Type 5, 7 are collected according to the size of business (with the following criteria)
 No. of inforce policies > 50,000 at the beginning or end of the period;
 Or

No. of claims in the observation period >
 100.

> The rest are all collected.





### 2.Data--Data collecting plan

#### **Reporting forms**

## Product information form

➢Product level info

>33 fields
 ✓ Basic information
 ✓ Basic or rider
 ✓ (multiple) accident
 liability
 ✓ Annuity related

Optimize data structure Increase calculating efficiency Policy information form

➤Seriatim level

Four forms 80 fields
 Basic 30 fields
 Rider 22 fields
 Alteration 7 fields
 Claim 21 fields





# 2.Data--Data collecting plan

#### **Operation process**



#### Data extraction

✓ For "Basic information form", "Rider information form" and "Alteration information form". Data are supposed to be extracted from database at the time of Dec  $31^{st}$ , 2009 and Dec  $31^{st}$ , 2013.

✓ "Rider information form" should be consistent with " Basic information form"

✓For "Claim information form", data must be extracted from the latest business database.

#### Data verification and submission

✓ Logic check and amount check

#### Claim data cleaning

✓All data vendors should ensure the claim data fields of "claim record" and "review comments" are usable by contrasting with other related fields(e.g. ICD code)



#### 2.Data---Data verification plan

#### Data logic check(Seriatim level)

- Inside-table check (include but not limited to)
  - Value scope error
  - policy code is not in the defined range
  - Regular claim amount must be more than 0
- Between-table check (include but not limited to)
  - Validate date is not within the range of product launch date and termination date
  - Alteration/claim information inconsistent with policy information

#### Data amount check(Overall level)

- Compare the extracted data with **alternative data source** (e.g. financial report) in term of product types, distribution channesl etc..=>ensure the completeness
- Conduct **initial A/E analysis** on extracted data, compare that with company' s internal experience analysis result of past years=>ensure the reasonability



- Claim data:
  - ✓ Key words searching
  - Natural language processing and sophisticated semantic analysis techniques to analyze and categorize text

>Program cleaned up **96.7%** claims, the rest is done by naked eyes





> Causes of death categorization: 5 tiers, around 130 specific causes



- ICD-10
- Compared to the original record of claim conclusion















#### 2. Data--Data format and criteria

			<b>36</b> analytical angle					
No.	Dimension name	No.	Dimension name	No.	Dimension name			
1	Accounting year	13	Payment period band	25	Standard			
2	Issue year	14	Payment type	26	Underwriting status			
3	Policy year	15	Smoking status	27	Health check status			
4	Policy age	16	Occupation	28	Sales channel			
5	Policy age band	17	Annuity payment period	29	Payment type			
6	gender	18	Payment guarantee	30	Cause of death			
7	Product type code	19	Elimination period status	31	Cause of claim 1			
8	Company	20	Premium coefficient	32	Cause of claim 2			
9	Region	21	Product type	33	Cause of claim 3			
10	Death caused by illness sum assured band	22	Insurance type	34	Cause of claim 4			
11	Weighted death sum assured band	23	Main insurance/ rider classification	35	Cause of claim 5			
12	Policy period band	24	Accident liability times	36	Termination of CI			
9 analytical criteria								
No.	Dimension name	No.	Dimension name	No.	Dimension name			
1	No. of claims	4	Exposures by policy	7	Expected occurrence by sum assured			
2	Claim amount	5	Exposures by sum assured	8	Expected occurrence by policies 2			
3	Amount actually paid	6	Expected occurrence by policies	9	Expected occurrence by sum assured 2			





#### 2. Data--Data format and criteria

- Data criteria
  - "Region" is subject to the administrative division issued by NBS, categorized into province level, city level and county level
  - "Occupation" is subject to the Great Dictionary of Occupation Classification, categorized into 8 major groups, 380 specific occupations





#### 2. Data--Calculating platform

- Data processing platform
  - Developed on SAS database platform. 1 server, 12 PCs.
  - High data processing speed: run through 300m data within 7 hours

     5 analytical themes
     30 analytical angles
     9 analytical criterias







## 2. Data--Four work groups





### 2. Data--Summary

#### Data collection completed successfully

- Administrative support from CIRC and CAA,
- High emphasis from each participating company
- Members of project team devoted a lot of efforts
- 1,096 products, 340m exposures, 1.8m claims collected
- Improved data quality, meet the data check requirement of the project

# Sufficient and good-quality data has laid a solid foundation for analysis and table construction

- Well begun, half-done.
- More time for comprehensive experience analysis, expert review, face-to-face discussion of table construction results





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# 3. Development of Mortality Tables-Framework

	Tables split to 3		2 tables retained			
Product types	Plan1.1	Plan1.2	Plan2.1	Plan2.2	Plan2.3	Plan2.4
Critical Illness	А	А	Х	Х	excluded	excluded
Term life insurance	А	В	Х	Х	Х	Х
Whole life insurance	А	В	Х	Х	Х	Х
Endowment insurance without scheduled return	В	В	Х	Х	Х	Х
Endowment insurance with scheduled return (high liability for existence)	С	С	Y	Х	Y	Х
Endowment insurance with scheduled return (low liability for existence)	В	В	Х	Х	Х	Х
Annuity insurance (high longevity risk)	С	С	Y	Y	Y	Y
Annuity insurance (low longevity risk)	В	В	Х	Y	Х	Y

- A, B, C represent 3-table framework classifications
- X, Y represent 2-table framework classifications



## 3. Development of Mortality Tables-Structure









Volatility adjustment

#### 97.5% confidence level, 15% upper/lower limit

- Calculate standard deviation of crude rate on 97.5% confidence level
- Set 15% of crude rate as the upper and lower limit

Mortality Table	Method
Protection type	Increase
Saving type	Unchanged
Annuity type	Decrease





**Mortality improvement** 

#### **Consider trend factors comprehensively**

- Research of general population improvement (1997-2012)
- Research of mortality trend abroad
- □ Research of insured data(2006-2013)
- Lee-Carter Model







**Mortality improvement** 





**Mortality improvement** 

Population mortality improvement 2000-2007							
Country	0	1-19	20-34	35-64	65-84	85+	
US	0.76	1.29	-0.68	-0.14	2.37	2.68	
Canada	0.17	1.39	1.29	0.35	2.21	2.06	
UK	1.53	1.14	1.79	1.51	2.86	2.17	
Australia	2.84	4.86	4.97	1.02	2.37	1.82	
Japan	3.36	4.54	1.17	1.34	1.01	0.96	
Russia	6.76	3.85	1.7	1.84	0.61	1.63	
Bulgaria	4.98	2.01	0.74	0.2	-0.28	1.37	
China	17.79	5.18	0.98	5.12	4.24	5.96	

#### Mortality improvement factors applied

	Protection table		Saving	y table	Annuity table	
Age	Male	Female	Male	Female	Male	Female
0-20	3%-1.5%	3.5%-2%	2.5%-1%	3.0%-1.5%	2%-0.5%	2.5%-1%
20-59	1.5%	2%	1%	1.5%	0.5%	1%
59-69	1.5%-2%	2%-2.5%	1%-1.5%	1.5%-2%	0.5%-1%	1%-1.5%
69-105	2%-1%	2.5%-1%	1.5%-0.5%	2%-0.6%	1%-0%	1.5%-0.1%



**Graduation and extrapolation** 

Graduation

 Graduate the mortality of the 0-75 age group

□ Cubic spline & whittaker method

$$q_x^{(3)} = \begin{cases} q_1(x), & x_1 \le x < x_2 \\ q_2(x), & x_2 \le x \le x_3 \\ \dots & \dots \\ q_{k-1}(x), & x_{k-1} \le x \le x_k \end{cases}$$

$$M = F + h \cdot S = \sum_{x=1}^{n} w_{x} \cdot (v_{x} - u_{x})^{2} + h \cdot \sum_{x=1}^{n-z} (\Delta^{z} v_{x})^{2}$$

Ages 76-90 : eight-parameter method vs national mortality data
 Ages 90-105 : eight-parameter method

$$\frac{q_x}{p_x} = A^{(x+B)^{C}} + De^{-E(\ln x - \ln F)^{2}} + GH^{x}$$





#### **Graduation**



- No significant difference between two methods
- Whittaker will retain more information of observed data (Sufficient sample data), smoothness is slightly worse.





#### **Extrapolation**

- Common methods reviewed and compared by pro and cons,
  - Heligman & Pollard 8 parameter model
  - Kannisto
  - Gompertz, Weibull, Coale-kisker etc..
  - Most are parametic model.
- Model could be easily fitted, but there's a key question to ask?
  - How should the mortality rates look for the older ages?
- Conclusion from papers:
  - the increasing rate of mortality on older ages are faster than population morality, maybe also faster than it should be?
- Expert opinion:
  - Mortality of insured people should be convergent to population on extreme ages, e.g. 90+





**Extrapolation** 

1<sup>st</sup> Extrapolation-before population adjustment

2<sup>nd</sup> Extrapolation -after population adjustment





## 3. Development of Mortality Tables-Calibration

#### Thoughts

- Compare CL90-93、CL00-03 Mortality Tables with National Mortality Tables of the same time(4<sup>th</sup> and 5<sup>th</sup> census)
- Calibrate the CL10-13 tables result with the 2010 National Mortality Tables(6<sup>th</sup> census)

#### **Application**

Protection type : +15%
Saving type : unchanged
Annuity type : -5%







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## **4.Comparison of Mortality Tables**





# **4.Comparison of Mortality Tables**

#### Comparison of CL10-13 Combined Table and CL00-03 Non-Annuity Table



#### Comparison of CL10-13 Pension Table and CL00-03 Annuity Table



– Male – – Female





# **4.Comparison of Mortality Tables**





# 4. Comparison of Mortality Tables-Life expectancy

China		Life Expecta	ancy (Age 0)		
		Male	Female		
	Non-annuity	76.7	80.9		
CL00-03	Annuity	79.7	83.7		
	Protection	76.4	81.7		
CL10-13	Saving	80.3	85.4	Male	Female
	Combined	77.5	82.5	0.8	1.6
	Annuity	83.1	88.1	3.4	4.4
5th Census	Whole nation	70.4	74.0		
	Urban	74.4	78.6		
	Rural	68.7	72.0	Male	Female
6th Census	Whole nation	75.4	80.1	5.0	6.1
	Urban	79.4	83.4	5.0	4.8
	Rural	72.9	78.2	4.2	6.2





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#### Key Features

- 1. Sizable data : 340million policies
- 2. Table split : 3 sets based on product features
- 3. A real sense Pension product table
- 4. Considerable analysis variables
- 5. Application of big data techniques
- 6. Mortality trend analysis
- 7. Graduation and age extension
- 8. Mortality database



#### 1.Sizable data

340million policies, the biggest data volume to construct mortality table so far



#### NO OF POLICIES(MILLION)











#### 3.A real sense Pension product table







#### 4.Considerable analysis variables

#### Policy

- Region, Province, Urban/Rural
- Product type, distribution channel

#### Customer

- Occupation
- Underwriting type

#### Claim

- Claim reason: 5 tiers, breakdown into 130 categories
- e.g. Could derive mortality table by certain specific accident type









#### -- ICD10

- Multiple Calibration :
- -- check with multiple payment on accidental cause
- --check with raw claim record



#### 6.Mortality trend analysis

- Research of general population improvement (1997-2012)
- □ Research of mortality trend abroad
- □ Research of insured data(2006-2013)
- Lee-Carter Model









Ages 76-90 : eight-parameter method vs national mortality data
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$$\frac{q_x}{p_x} = A^{(x+B)^{C}} + De^{-E(\ln x - \ln F)^{2}} + GH^{x}$$





8.Mortality database

Data Source

Data Type

- SOA, CMI, etc..
- Regulator website
- WHO website

- Mortality
- Morbidity
- Disability
- Others

Country ( region )

**Filters** 

- Data type
- Insured/Population
- > Observation period
- Annuity/Non-annuity
- Smoker/Non-smk
- > ALB/ANB
- Gender/Age/Policy year

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**CAA Mortality Investigation Office** 

# Thanks ! Questions?