King Saud University
College of Science
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Basic non-life insurance and reserve methods

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Introduction

Saudi Arabia's insurance market is now one of the largest in the Middle East. It has been growing significantly over the last number of years and all indicators suggest that it will follow the same pattern in the future. Actuaries are very important to the insurance company and they have many important functions to do, including: calculating legal reserves, premiums, assessing risks and reinsurance. For these reasons, I decided to take my internship in the insurance field.

Training company:

The Company for Cooperative Insurance (Tawuniya) is a Saudi Joint Stock Company established in Riyadh, Saudi Arabia in 1986. It is the biggest insurance company in the Kingdom of Saudi Arabia with more than 25 years of experience in the Saudi market. Its principal lines of business include motor, medical, marine, fire, engineering, energy, aviation, takaful, and casualty insurance.

In 2016, Tawuniya registered more than 8 billion SR of Gross written premiums and a net income of 727 million' SR. With this performance beaten by nobody, the actuarial department must have played a big part in achieving this success.

Training Department:

Due to the shortage of actuaries in the motor insurance department, I have been placed there with the very experienced and helpful Actuary Ghadi Hayek (Associate of the Society of Actuaries "ASA") as a professional supervisor. In Saudi Arabia, motor insurance has a share in the market of a more than 30%, second only to the medical insurance.

Important terms and definitions:

- **Gross written premiums (GWP):**

The total premiums written by the insurance company before any deductions for reinsurance.

- **Net written premiums (NWP):**

Net written premiums equal the gross written premiums after deducting the reinsurance share.

- **Net earned premiums:**

It is the portion of a policy's premium that applies to the expired portion of the policy. For a one year policy with the risk spread uniformly over the period, it equals to the premium for the policy multiplied by (Days elapsed over 365 days).

- **Loss ratio:**

Loss ratio = Total incurred claims/Net earned premiums

- **Expense ratio:**

Expense ratio = Total expense/Net earned premiums

- **Combined ratio:**

Combined ratio = Loss ratio + Expense ratio

- **Reserves:**

There are many types of reserves for the actuaries to calculate. However, we will only mention the two main reserves in the Saudi market:

1- Claims reserve:

At the end of the fiscal (financial) year insurance companies must hold a reserve for the incurred but not reported claims (IBNR), and must also hold reserve for the incurred but not enough reported claims (IBNER), re-opened claims and future changes in known claims for that year.

2- Premium reserve:

a- Premium deficiency reserve (PDR):

If the premium taken is not expected to cover the future claims, the insurance company must hold a reserve. This reserve is called PDR.

b- Unearned premium reserve (UPR):

The unearned portion of the premium that has been paid is kept as an unearned premium reserve.

For example, a policy with 365 day to expiration where the risk is spread uniformly over the policy period, after 20 days of issue the company earn only (20/365) of the premium, the rest is kept as an Unearned premium reserve.

Research Case:

As mentioned before, one of the most important functions required from the actuary is calculating the legal reserves. Saudi Arabian Monetary Agency (SAMA) requires from each company to set aside a reserve that is calculated based on a theoretical and reasonable methods for the possible upcoming claims.

Claims reserving methods:

A- Chain ladder method:

The chain ladder method is the one of the most used methods in the world. It uses only the historical loss data to project the future losses. The underlying assumption in the CLM is that claims recorded to date will continue to develop in a similar manner in the future.

Best used:

1- When there is large and reliable historical loss data.
2- The method is particularly suitable for high-frequency, low-severity lines with stable and relatively timely reporting of claims.
3- When the presence or absence of large claims does not greatly distort the data. (will distort the age-to-age factors)

Limitations:

1- The chain ladder method can be used only if the loss development pattern in the past will continue in the future.
2- Data from past loss experiences must be accurate.
3- Cannot be used if there are any changes to the insurer's operations: (for example, a change in policyholder deductibles)
4- Environmental changes can also invalidate the primary assumption of the development technique.

B- Expected loss ratio method:

The expected loss ratio method assumes that the actuary can better estimate future losses based on an a priori (or initial) estimate than from claims experience observed to date.

Best used:

1- When an insurer enters a new line of business or a new territory.
2- When the insurance company lacks historical loss data.
3- Operational or environmental changes make recent historical data irrelevant for projecting future claims activity for that cohort of claims.

Limitations:

1- The method does not consider real claims experience.
2- The expected loss ratio is based on the actuary's judgment and does not follow a theoretical basis.

C- Bornhuetter-Ferguson method:

The Bornhuetter-Ferguson method is one of the most widely methods, second only to the chain ladder method. The BF method is essentially a mixture of the chain ladder and expected loss ratio methods. Bornhuetter-Ferguson method assumes that unreported claims will develop based on expected claims.

Best used:

1- If the data is extremely thin or volatile or both. (new line of business)
2- If actual reported losses do not provide a good indicator of IBNR.
3- For long-tail lines of insurance.

Limitations:

1- Require historical data for development factors.
2- Highly dependent on expected loss ratio or pure premium.
3- Expected loss ratio is judgmental.

D- Cape Cod method:

This method is similar to the Bornhuetter-Ferguson method. Instead of requiring an a priori loss ratio, it estimates one with the help of a measure of exposure and claims to date.

Best used and limitations:

The same as the B-F method. The only difference is that the Cape Cod method is not necessarily as appropriate as the Bornhuetter-Ferguson method if the data is extremely thin or volatile or both.

E- Frequency-Severity method:

Frequency-severity method uses historical data to estimate the average number of claims and the average cost of each claim. The method multiplies the average number of claims by the average cost of a claim.

Best used:

1- When you have a stable line of insurance.
2- When you want an insight into the claims process.
3- When you have paid claims data only.

Limitations:

1- This method cannot be used when there is small size data.
2- Changes in the definition of claim counts, claims processing, or both can invalidate the underlying assumption that future claim count development will be similar to historical claim count development.
3- This method relies on the mix of claims to be relatively consistent.

Note: The projected ultimate claims from a frequency-severity technique are often valuable to the actuary as an alternative expected claims estimate for the Bornhuetter-Ferguson technique. An actuary working closely with management and in particular with representatives from the claims department may feel more comfortable selecting frequency and severity values than an expected claim ratio value.

Practical Case:

The research problem, as mentioned before is calculating the legal reserve. So here we will first build paid claims triangles and then calculate the legal reserve using chain ladder and Bornhuetter-Ferguson methods, two of the most used claim reserving methods.

Note: The data used here is unreal but nothing will change if you apply an actual data.

Earned premium:

Year	Earned Premium
2009	4572
2010	5397
2011	6192
2012	6872
2013	7534
2014	9219
2015	10328
2016	12358

Table (1): Earned premium for the period between 2009 and 2016

Table (1) shows the premium earned yearly for the years from **2009 to 2016.**

Triangles:

Now in order to build triangles, we collected paid claims data based on their accident year in **Table (2)** from which we will evaluate the claims payment with their corresponding accident year.

Accident year	Paid claims Amount
2009	3963
2010	4975
2011	5873
2012	6401
2013	6563
2014	6358
2015	4918
2016	3072

Table (2): Paid claims amount for the period between 2009 and 2016

Incremental paid claims								
Accident year	Development year							
	0	1	2	3	4	5	6	7
2009	1232	946	520	722	316	165	48	14
2010	1469	1201	708	845	461	235	56	
2011	1652	1416	959	954	605	287		
2012	1831	1634	1124	1087	725			
2013	2074	1919	1330	1240				
2014	2434	2263	1661					
2015	2810	2108						
2016	3072							

Triangle (1): Incremental paid claims for the period between 2009 and 2016

Triangle (1) shows the incremental paid claims for every accident year with the development year shows the time lags in years between the accident and the payment (settlement of the claim).
For example, for accident **year 2012** with development **year 2** it shows the amount of claims paid for the accidents that happened in **2012** and has been settled in **2014** (which is 1124).

Cumulative paid claims								
Accident year	Development year							
	0	1	2	3	4	5	6	7
2009	1232	2178	2698	3420	3736	3901	3949	3963
2010	1469	2670	3378	4223	4684	4919	4975	
2011	1652	3068	4027	4981	5586	5873		
2012	1831	3465	4589	5676	6401			
2013	2074	3993	5323	6563				
2014	2434	4697	6358					
2015	2810	4918						
2016	3072							

Triangle (2): Cumulative paid claims for the accident for the period between 2009 and 2016

In **Triangle (2),** the cumulative paid claims is the total amount settled up to that development year, i.e. it is the sum of the incremental claims paid up to that date. We cumulated the paid claims so that we can comfortably build the development factors triangle (also called age-to-age factors), which will show us the yearly development for the claims settlements over the years and help us understand the pattern of the data.

Paid claims development factors								
Accident year	Development interval in years							
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7+
2009	1.768	1.239	1.268	1.092	1.044	1.012	1.004	
2010	1.818	1.265	1.250	1.109	1.050	1.011		
2011	1.857	1.313	1.237	1.121	1.051			
2012	1.892	1.324	1.237	1.128				
2013	1.925	1.333	1.233					
2014	1.930	1.354						
2015	1.750							
Weighted Average	1.851	1.314	1.242	1.120	1.049	1.012	1.004	
Average	1.849	1.305	1.245	1.113	1.049	1.012	1.004	
Last 3 yrs Wtd Avg	1.860	1.339	1.235	1.120	1.049	1.012	1.004	
Last 3 yrs Average	1.868	1.337	1.236	1.120	1.049	1.012	1.004	
Selected DF	1.857	1.324	1.240	1.117	1.049	1.012	1.004	1.001
Cumulative DF	3.625	1.952	1.475	1.190	1.066	1.016	1.004	1.001

Triangle (3): Paid claims development triangle for the period between 2009 and 2016

The upper part of **Triangle (3)** shows the evolution of the claims paid between every year calculated from the cumulative paid claims triangle. For every accident year, it is basically the cumulative paid claims in development year **(k)** divided by the cumulative paid claims in development year **(k-1)**.

The lower part of **Triangle (3)** shows some averages taken to help selecting the development factors which will be used to estimate the claims that will be paid in the upcoming years.

We calculated the cumulative paid claims' development factors by successive multiplications beginning with the last selected development factor (also called tail factor).

For example, the CDF for the **4^{th}** year is = **1.001*1.004*1.012*1.049*1.117 = 1.190** .

The cumulative paid claims' development factor projects the total growth over the remaining valuations. Cumulative development factors are also known as age-to-ultimate factors and claim development factors to ultimate.

Finally, now we can say that we are ready to calculate the reserve using the Chain ladder and Bornhuetter-Ferguson methods.

1- Using the Chain ladder method:

As mentioned before, the chain ladder method relies only on historical data to project the future claims. Therefore, projecting the reserve will depend only on the development factors.

Accident Year (1)	Earned premium (2)	Actual paid (3)	Cumulative DF (4)	Est. Ultimate Losses (5)	IBNR (6)	Loss ratio (7)
2009	4572	3963	1.001	3965	2	86.72%
2010	5397	4975	1.004	4995	20	92.55%
2011	6192	5873	1.016	5966	93	96.36%
2012	6872	6401	1.066	6820	419	99.25%
2013	7534	6563	1.190	7810	1247	103.67%
2014	9219	6358	1.475	9379	3021	101.73%
2015	10328	4918	1.952	9602	4684	92.97%
2016	12358	3072	3.625	11137	8065	90.12%

Table (4): Calculating the reserve using Chain ladder method

- (5) = [(3) * (4)]
- (6) = [(5) – (3)]
- (7) = [(5)/(2)]

In **Table (4),** we estimated the ultimate losses by multiplying the paid claims to date by the cumulative development factor. After that we calculated the reserve (IBNR) by subtracting the paid claims from the ultimate losses. The loss ratio is simply the ultimate losses divided by the earned premium. We can see that the loss ratio started at a reasonable rate and then started to increase until it passed the **100%** barrier then decreased to **90%**.

As we saw, the Chain ladder method relies solely on the historical data which can be misleading if there was a change to the insurer's operations or if the claims will not develop in a similar manner in the future. Therefore, actuaries sometimes feel more comfortable working with the Bornhuetter-Ferguson method.

2- Using the Bornhuetter-Ferguson method:

Bornhuetter-Ferguson method is a mix of the Chain ladder and expected loss ratio methods. Therefore, a priori loss ratio is needed. Worth mentioning that there is no typical way of calculating the priori loss ratio in the Bornhuetter-Ferguson method and it differs from one actuary to another.

Accident year (1)	Earned premium (2)	Actual paid (3)	Cumulative DF (4)	Expected loss ratio (5)	Expected losses (6)	IBNR factor (7)	IBNR (8)	Est. Ultimate losses (9)	Loss ratio (10)
2009	4572	3963	1.001	85%	3886	0.05%	2	3965	86.72%
2010	5397	4975	1.004	85%	4587	0.40%	18	4993	92.52%
2011	6192	5873	1.016	85%	5263	1.57%	82	5955	96.18%
2012	6872	6401	1.066	85%	5841	6.15%	359	6760	98.37%
2013	7534	6563	1.190	85%	6404	15.97%	1023	7586	100.69%
2014	9219	6358	1.475	85%	7836	32.21%	2524	8882	96.34%
2015	10328	4918	1.952	85%	8779	48.78%	4282	9200	89.08%
2016	12358	3072	3.625	85%	10504	72.42%	7607	10679	86.41%

Table (5): Calculating the reserve using Bornhuetter-Ferguson method

- (5) Is the priori loss ratio.
- (6) = [(5) * (2)]
- (7) = [1 – 1/(4)]
- (8) = [(7) * (6)]
- (9) = [(3) + (8)]
- (10) = [(9) / (2)]

In **Table (5)** we estimated the reserve by first estimating a priori loss ratio of **85%** then we calculated the expected losses in column **(6)** by multiplying the priori loss ratio by the earned premium. After that we calculated the percentage of claims yet to be paid in column **(7)**. In column **(8)** we calculated the reserve **(IBNR)** by multiplying the percentage of claims yet to be paid by the expected losses. Then we estimated the ultimate paid losses in column **(9)** by adding the **IBNR** to the actual paid losses and finally we calculated the loss ratio in column **(10).**

Comparison between the two methods:

Chain ladder method			Bornhuetter-Ferguson method		
IBNR	Est. Ultimate Losses	Loss ratio	IBNR	Est. Ultimate Losses	Loss Ratio
2	3965	86.72%	2	3965	86.72%
20	4995	92.55%	18	4993	92.52%
93	5966	96.36%	82	5955	96.18%
419	6820	99.25%	359	6760	98.37%
1247	7810	103.67%	1023	7586	100.69%
3021	9379	101.73%	2524	8882	96.34%
4684	9602	92.97%	4282	9200	89.08%
8065	11137	90.12%	7607	10679	86.41%

Table (6): Comparison between Chain ladder and B-F methods

Table (6) shows a comparison between the values generated from each method for the IBNR, estimated ultimate losses and the loss ratio. At the beginning, we can see that the values for each method are close to each other. After that it starts to differ as the time goes by. That is because of the nature of Bornhuetter-Ferguson method. As experience matures, the Bornhuetter-Ferguson method gives more weight to the actual claims and the expected claims calculated from the priori loss ratio become gradually less important.

An actuary can use either of these methods depends on the situation he is facing. If the business is stable and there is no change to the insurer's operation or no environmental change, one may expect the Chain ladder method to be more accurate than the B-F method.

But if the insurance company faces a new situation or entered a new line of business it would not be wise to base your estimation on historical data only. Therefore, you may be more comfortable using a method that does not rely only on historical data such as the Bornhuetter-Ferguson method.

The difference between university and the actuarial work in the insurance field in Saudi Arabia:

In university, life insurance was the center of attention, while most of the insurance in Saudi Arabia is non-life insurance. Therefore, there was a big distance between my knowledge and the real actuarial work in the insurance field in Saudi.

Thankfully, this distance was reduced by the very professional and friendly actuaries of Tawuniya. They were very friendly and explained everything I asked. I also had several lectures on how the work is done by the actuary, what are the problems that the actuary faces and I understood some important terms and definitions.

Acknowledgment:

I would like to give a special thanks to those who supported me not only in my training but in my whole time as a student at King Saud University, Dr. Souhail Chebbi, Dr. Mhamed Eddahbi, Dr. Mostafa Bachar and Dr. Abdelkarem Berkaoui. I could not have done it without your support and believe in me. I would like also to thank the head of mathematics department Dr. Badr Al-Qahtani and the whole staff at the college of science. My time at the college passed quickly because of the dedication and positivity that you spread along the students.

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Thank you from the bottom of my heart and GOODBYE.

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