Basic insurance formulary

Justas Mundeikis

Last update:
Sunday 2nd July, 2017

Contents

1 Introduction

Here comes the introduction about non-life insurance...

2 The example 1

Assume the following situation: you have 5 friends, with each owing a car. They have approximately the same car, and their driving behaviour is pretty the same, as they are siblings. As none of them wants to be left out in the rain, in case of an car accident, they decide to share the risk and to by an insurence policy. Your task is to define the price for their insurance give the following information:

- 5 cars
- each cars' new market value is 10.000
- you estimate, that probability to have an accident is equal to 40 percent
- you know that the average size of claim for such cars is 2500 euro
- you face operating expances of 100 euro per policy
- due to reduce your risk, you decide to reinsure your policies for claims that are higher then 10000 euro. Reinsurance costs per policy are 150 euro
- your goal is to earn 50 euro profit per policy (to cover your alternative capital income costs of putting your money into a bank account)

3 Definitions

3.1 Time

Any time spot is denotet with a letter t, where as the subscript of denotes the exact time spot.

- t_S - is the agreed date when the policy becomes effective
- t_E - is the agreed date when the policy expires
- t_C - is the the premature date of expiration on behalf of incurance company or policy holder
- t_T - is the the date of insurance termination. Which is the output of the function $\min(t_E; t_C)$ (see 3.4)
- t_n - is the actual date of calculation. In this example, it is set to 2017.07.15, so t_n is equivalent to $t_{(2017.07.15)}$

3.2 Premium

- **WP** (Written Premium) - is the ampount the insured must pay in order to get insurance coverage in exchange. There are different methods how to calculate the WP, but in generall the WP has to equal the expected pay outs of the insurance company and has the following form:

$$WP = \mu + \sigma + OE + RC + U$$

where mu is the expected loss, σ is the variability of expected loss, OE are the operting expences, RC is the reinsurance cost, U is the profit and $TotExp$ as the proportion of $OE + RC + U$ of WP

It is common to represent expenses and profit as a proportion of "pure risk premium", hence the formula can be expressed as:

$$WP = \frac{\mu + \sigma}{1 - \frac{TotExp}{WP}}$$

- **CP** (Canceled Premium) - is the premium amount that has been or has not been paid in for the the period between cancelation and policy end date. Is calculated as:

$$CP = \frac{END - CANCEL + 1}{END - START + 1} \times WP$$

$$CP_A = \frac{2017.12.31 - 2017.10.30 + 1}{2017.12.31 - 2017.01.01 + 1} \times 2400 = \frac{61}{365} \times 2400 = 401.10$$

3.3 Claims

- CLAIMS - is defined as the monetary value already paid out for policy holder / beneficiery person in a reported claim event
- RESERVES - is defined as the monetary value reserved to be possibly paid out in a reported claim event
- IBNR (Incurred But Not Reported) - are reserves for losses that have happened but have not been reported yet, in other words, IBNR is the expected pay out in the future.
- REGRESS - is defined as a monteray value regressed (regained) in a reported claim event.

3.4 Functions

- NA is the equivalent of "missing value", ar an empty cell in a spread sheet
- Function $\min(a, b)$ chooses the smallest value bewteen a and b. So function $\min(21, 12)$ returns 12 as the result. If function $\min(10, NA, 12)$ evaluates the smallest vallue, out of three entries, then NA will not be evaluated so that this function returns 10 as the smallest value.

4 Formulas

1. **GWP** (Gross Written Premium) - is the difference between written premium (WP) and canceled premium (CP) at the end of the insurance period.

$$GWP = WP - CP$$

If the policy is not canceled, then $CP = 0$ and $GWP = WP$.

It can also be expressed as $GWP = EP + UPR$

2. **UPR** (Unearned Premium Reserve) - is the ammount of premium that is reserved as not yet earned and if policy is cancelled, this amouont would be returned to policy holder/payer.

$$UPR = \frac{t_T - \min(t_T, t_n)}{t_T - t_S + 1} \times (WP - CP)$$

with

$$\frac{UPR}{GWP} \in [0, 1]$$

Means that UPR must be equal from 0 to 1 (0-100 % of GWP depending on period when the calculation is done (TODAY)).

$$UPR_C = \frac{2017.11.10 - \min(2017.11.10, 2017.05.10)}{2017.11.10 - 2017.01.01 + 1} \times (2400 - 341.9) =$$

$$= UPR_C = \frac{2017.11.10 - 2017.07.15}{2017.11.10 - 2017.01.01 + 1} \times 2058.1 =$$

$$= UPR_C = \frac{118}{314} \times 2058.1 = 773.4$$

3. **EP** (Earned Premium) - is the ammont of earned premium to date of cancelation.

$$EP = GWP - UPR$$

$$EP_B = (2400 - 335.34) - 901.91 = 1162.75$$

4. **IY** (Insurance Years (TODAY)) is the ....

$$IY = \frac{(\min(END, CANCEL, TODAY) - START + 1}{365}$$

5. **CIY** (Contract Insurance Years) is the ...

$$CIY = \frac{\min(END, CANCEL) - START + 1}{365}$$

6. **IL** (Incurred Losses) -

$$IL = CLAIMS + RESERVES - REGRESS + IBNR$$

important to note here, that IBNR changes over times, with its maximum at t_S and with 0 at t_E

7. **LR** (Loss Ratio) - is the ratio between total claims and total premium collected. LR changes over time, as IL can decrease with decreasing IBNR and EP increasestowards the end of insurance period.

$$LR_t = \frac{IL_t}{EP_t}$$

8. **CC** (Claims Count) - is the number of claims occured

9. **AC** (Average Claim) - is the average claim size of all claims occured.

$$AC_t = \frac{IL_t}{CC_t}$$

10. **CF** (Claim Frequency) - $CF = \frac{CC}{IY}$
11. ∅ **EP** (average Earned Premium)- ∅ $EP = \frac{EP}{IY}$
12. ∅ **GWP** (average Gross Written Premium)- $\varnothing GWP = \frac{GWP}{CIY}$
13. **BC** (Burning Cost) - Average claim x Claim frequency
14. **TLR** (Target Loss Ratio) - is mannualy set every year, for example "66.2"
15. **TP** (Target Premium) - $TP = \frac{BC}{TLR}$
16. Price increases are needed if: $LR > TRL$ or if $TP > \varnothing GWP$

5 Example file

Table 1: My caption

Attribute	Policy A	Policy B	Policy C	Policy C	Policy D	SUM
t_S	2017-01-01	2017-01-01	2017-01-01	2017-03-01	2017-01-01	
t_C		2017-05-10	2017-11-10		2017-01-01	
t_E	2017-12-31	2017-12-31	2017-12-31	2017-09-30	2017-12-31	
t_T	2017-12-31	2017-05-10	2017-11-10	2017-09-30	2017-01-01	
t_n	2017-07-15	2017-07-15	2017-07-15	2017-07-15	2017-07-15	
SUM INSURED	10,000	10,000	10,000	10,000	10,000	50,000
CLAIM FREQUENCY	40.00%	40.00%	40.00%	40.00%	40.00%	40.00%
WP	2,400.0	2,400.0	2,400.0	1,407.1	2,400.0	11,007.12
CP	0.0	1,551.8	341.9	0.0	2,400.0	4,293.70
GWP	2,400.0	848.2	2,058.1	1,407.1	0.0	6,713.42
UPR	1,111.2	0.0	901.9	506.3	0.0	2,519.45
EP	1,288.8	848.2	1,156.2	900.8	0.0	8,487.68
IY	0.5	0.4	0.5	0.4	0.0	1.81
CIY	1.0	0.4	0.9	0.6	0.0	2.81
CLAIMS	0.0	0.0	6,000.0	1,000.0	0.0	7,000.00
RESERVES	0.0	0.0	0.0	3,000.0	0.0	3,000.00
IBNR	1,863.0	0.0	1,515.9	1,457.9	0.0	4,836.88
REGRESS	0	0	0	0	0	0.00
IL	0	0	6000	4000	0	10,000.00
LR	0.00%	0.00%	518.95%	444.04%	0.00%	117.82%
CC	2.00	2.00	2.00	2.00	2.00	2.00
CF	1.11	1.11	1.11	1.11	1.11	1.11
AC	5,000	5,000	5,000	5,000	5,000	5,000
YEP	2,319	2,319	2,319	2,319	2,319	2,319
YGWP	2,393	2,393	2,393	2,393	2,393	2,393
BC	2000	2000	2000	2000	2000	2000
TLR	66.20%	66.20%	66.20%	66.20%	66.20%	66.20%
TP	3,021	3,021	3,021	3,021	3,021	3,021