# The Application of Historical Burn Analysis to Determine Adjusted Triggers and Tiered Adjusted Triggers for a Specific Gross Premium

## Historical Burn Analysis on Index Insurance

Historical burn analysis is a method that calculates the expected value of claims using historical data from a certain period to come up with an expected pure premium. The method is developed by IRI Columbia University (Ariyanti, Riaman and Irianingsih, 2020).

In index insurance, historical burn analysis is used to determine a trigger value. A trigger is a benchmark that determines the policyholder’s claim, i.e., for a water deficit index insurance if the actual rainfall falls below the trigger, the policyholder will get a claim.

## Adjusted Trigger and Tiered Adjusted Triggers on Index Insurance

Index insurance is an insurance product that has different specifications for every location and cover period. Thus, it is very hard to scale up the product. One of the solutions is to create an autonomous model that will create a specification for every location and cover period using excel or programming languages. The model is built using methods, such as Historical Burn Analysis. However, the model usually has many flaws, for example:

1. Every cover period and location have different gross premiums
2. Trigger in the dry season is too low

The flaws in the model could be eliminated using adjusted triggers and tiered adjusted triggers. Adjusted triggers are triggers that have a uniform pure premium rate. Tiered adjusted triggers have the same concept to adjusted triggers. The only difference is that tiered adjusted triggers have a uniform claim increment per mm.

The method of adjusted triggers is made to solve different gross premiums for every cover period and location.

A uniform increment in uniform claim per mm is to solve the low trigger in the dry season. By having these tiered triggers and tiered claims per mm, we can control the claim values and simultaneously increase the trigger to a certain minimum value.

Below are the method to the adjusted triggers and tiered adjusted trigger on drought cover index insurance.

## Adjusted Trigger Assumptions

For adjusted triggers calculation, there are a few assumptions that we are going to use. The assumptions are:

1. Putting different weightage covers per phase

## Adjusted Triggers Calculation

Adjusted triggers can be calculated using burning historical burn analysis. We can search for a particular trigger that fits the total pure premium per phase (, given the gross premium and the loadings. The idea is to search the range of pure premium among the historical trigger and from that range search for the adjusted trigger.

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Where,

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And,

, where is phases

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, where is phases

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Using historical burn analysis we know that

, where is the trigger, RF is the accumulation of rainfall, and n is the number of historical years

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And,

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Given that each k-year in sorted historical accumulation data becomes a temporary trigger (,

Equation (5) will become

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Then, combine equations (7) and (8)

, where n is the number of historical years and k-years sorted historical accumulation

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From equations (5) and (6), create a range of historical pure premium .

To search for the adjusted trigger, condition needs to be met. Then, put -years in a sorted historical position according to equation (9) to get the adjusted trigger.

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## Tiered Adjusted Trigger Assumptions

For adjusted trigger calculation, there are a few assumptions that we are going to use. The assumptions are:

1. We are using historical burn analysis
2. Putting max triggers () and min triggers ()
3. Putting different weightage covers per phase
4. Putting 2 tiered claims per mm and
5. There are 2 coverage, Full Cover is full coverage or 100% sum insured and Total Cover is partial coverage/ less than 100% sum insured
6. Trigger benchmark () is a benchmark in which below this trigger total cover is applied
7. If trigger1 ( is below , then trigger2 , where is a percentage of trigger1
8. The y-axis is the sum insured and the x-axis is the trigger

## Tiered Adjusted Triggers Calculation

### Normal Triggers and Tiered Triggers Comparison

The relation between normal triggers and claim is as the graph describe,

Sum Insured

Chart, line chart

Description automatically generated

t

a

Trigger

graph

This model will create two major problems in the dry season:

1. In the dry season the trigger will be too low, thus claim per mm will be too high
2. If a claim were to happen in a low trigger, the claim value will be very high

Looking at graph 1, claim per mm or the slope or the gradient of a ( will be bigger the smaller the trigger . The problem with this model is that when , means that if , then the claim per mm is 50%, and if the actual rainfall is 0.1mm less than the trigger then the claim value will be 5%. In comparison, if , then the claim per mm is 2% and it will take 2.5mm less than the trigger to reach a 5% claim.

Also, the probability of getting 2mm rain in a coverage duration of more than 20 days in the dry season is relatively quite high. If we were to make the trigger in the dry season bigger, the claim value will be very high.

The relation between tiered triggers (line b and line c) and the claim is as the graph describes,

Sum Insured

Chart, line chart

Description automatically generated

c

b

Trigger

t

a

graph

Line b and line c from graph 2 show the claim value will always be lower than line a for every actual rainfall below .

Using historical burn analysis, the pure premium is calculated by dividing the historical claim value by the number of years. With this method, it is possible to reach a higher trigger since we can control the claim value.

From graph 2 we get, |, where is the slope of line b, is the slope of line c, and is the slope of line a.

### Historical Claim and Historical Pure Premium Calculation

We need to find the range of pure premium just like to search for the normal adjusted trigger. But first, we need to determine the slope of line a and line b ( and ).

Since , we can make and a ratio of .

, where

, where

Where and is calculated by assuming t = 100 and SI = 100%

Given that each k-years in sorted historical accumulation data needs to be adjusted to become trigger1 .

, where is k-years sorted historical accumulation

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To calculate trigger2 , we need to know the linear equation of line b and line c.

Linear equation of line b:

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Substitute into equation (12) to search its constant

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Substitute from equation (13) into equation (12)

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Linear equation of line c:

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Substitute into equation (15) to search its constant

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Subtitute from equation (16) into equation (15)

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Trigger2 is the x-coordinate of the interception of and .

, where x-coordinate is trigger2

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Trigger2 also needs some adjustment, because when the trigger is low will exceed at some point. To avoid this, we need a trigger benchmark (last assumption). One of the reasons is to keep the tiered claim uniform for every product.

Hence,

, where b is a percentage of

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After getting the adjusted trigger1 and trigger2, the next step is to calculate the historical claim and pure premium.

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Or it is also possible to calculate the claim using the linear line b (14) and line c equation (16) with the condition of .

Historical pure premium ( using equation (6).

, where n is the number of historical years

### Tiered Adjusted Trigger Calculation

The pure premium range will be used to get tiered adjusted triggers. There is two calculation that is going to be used depending on the condition.

The calculations are based on the coverage type which is assumed on assumption 5.

Chart, line chart

Description automatically generated

Full Cover

graph

Chart, line chart

Description automatically generated

Total Cover

graph

#### Full Cover Calculation

FC calculation uses the graph on graph 3. It follows linear lines b (14) and lines c (16).

The calculation involves dividing the adjusted historical rainfall accumulation that falls below list into 2 lists by trigger2. The first list is any historical rainfall accumulation that is lower than and the second list is any historical rainfall accumulation that is higher than . The idea is to make a simple calculation of claims using the equation below

, where p is the number of years in and q is the number of years in

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Suppose where k-years sorted historical accumulation, and where is the upper temporary trigger2 that divides the list into and is the lower temporary trigger2 that divides the list into .

To breakdown the claim equation, we need to have in terms of .

From equation (19) when we get

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Further breakdown of equation (21)

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Substitute equation (22) to (23)

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From equation (7) we have

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#### Total Cover Calculation

TC calculation uses graph 4. It only follows the linear line b (14).

The method is similar to FC calculation. The only difference is

, where b is a percentage of trigger1

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Substitute equation (26) into (23)

From equation (7) we have

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#### Conditions

The main condition to use FC calculation and TC calculation is the position of . If is higher than , then FC calculation is applied but if it is lower than , TC calculation is applied.

Other big adjustments need to be made, such as:

* If there are adjusted triggers that fall between and . Such that, it cannot be in either the and list, it makes the FC calculation and TC calculation useless. To solve this issue, we need to create another temporary list using that particular adjusted trigger as and then create a pure premium list to create a range of pure premium. Then proceed as the usual method.

Other small adjustments that need to be made won't be discussed here, because different datasets could create new small adjustments that I didn’t think of.

References

Ariyanti, D., Riaman, R. and Irianingsih, I., 2020. Application of Historical Burn Analysis Method in Determining Agricultural Premium Based on Climate Index Using Black Scholes Method. *JTAM | Jurnal Teori dan Aplikasi Matematika*, 4(1), p.28.