Estimation Claims Reserving Based on Archimedean Copula

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Abstract. The problem of how to estimate appropriate incurred but not reported (IBNR) claims reserving has always been among critical problem in general insurance. Estimating of claims reserving is required to increase the optimal service for policyholders. This value should always be available during the period of payment of claims. Its imprecision estimates could destabilize the insurance company. In general, the process of settlement a claim always appear time-lag among claims occurrence, claims reporting and claims payment. Different time-lags formed into the matrix of the Run-off Triangle. Practitioners still perform the chain-ladder method, one of the oldest actuarial literature. This condition is not realistic because the two investigated variables are claim size and time from the moment when claim occurred to the moment when the payment has been reported are correlated. The aim of this study is therefore to use the Archimedean Copula to estimate outstanding IBNR claims reserving. This method gives the estimated value of which is more suitable for fire insurance than the chain-ladder method classics.

1. Introduction

There has been significant time and effort spent by researchers and also actuaries in the development of models and quantifying variability in loss reserve estimates i.e. an estimate of the value of a claim or group of claims not yet paid (see, e.g., [3], [5], [13], [14], [15], [18], and [19]). Loss reserving is the function of the actuary because it is an estimation process that involves the current financial evaluation of future contingent events. These contingencies apply to obligations that have already been assumed by the company through the insurance contract. They are future developments on claims already reported, and future claims to be reported, based on events that have already occurred.

The Indonesian Financial Services Authority (Otoritas Jasa Keuangan - OJK) performs its regulatory and supervisory duties over financial services activities in insurance sectors. Based on OJK circular No. 27 /SEOJK.05/2017 provides the latest guidance on establishing technical reserves for insurers and reinsurers. With regard to the reserve for claims, the technical reserve in the form of claim reserve shall be calculated at least in the total amount of reserve for claims that are in process of settlement, reserve for claims that have occurred but have not yet been reported, and reserve for claims that are approved and the benefit is not paid at once. This circular is issued in concerning financial soundness of insurance companies and reinsurance companies, such that it is necessary to stipulate implementation provisions concerning guidelines for formation and also on creation of technical reserve for insurance companies and reinsurance companies with sharia principles in the form of an OJK circular.
A reserve for approved claims which are not immediately paid needs to be included as one of the components of the claim reserve, in addition to reported but not admitted (IBNR) and incurred but not reported (IBNR) reserves. The IBNR claim is a classic problem extensively studied in the actuarial literature. The IBNR is very important to be estimated because it determines a picture of a company’s financial condition. Estimating of claims reserving is required to increase the optimal service for policyholders. This value should always be available during the period of payment of claims.

In general, the process of settlement a claim always appear time-lag among claims occurrence (accident period) and claims payment (development period). Different time-lags formed into the matrix of the Run-off Triangle. We have to estimate the values of the lower right triangle based on the values of the upper left triangle. A loss triangle is the primary method in which actuaries organize claim data that will be used in an actuarial analysis. The reason it is called a loss triangle is that a typical submission of claim data from a client company shows numeric values forming a triangle when viewed. Practitioners still perform the chain-ladder method, one of the oldest actuarial literature (see, e.g., [9]). This condition is not realistic because the two investigated variables are amount of claim and time from the moment when claim occurred to the moment when the payment has been reported (development time) are correlated. There are the dependencies between times from the moment when claim occurred to the moment when the payment has been reported.

Many actuaries believe that the basic assumption underlying the model is the future development of losses is dependent on losses to date for each accident year. They used copula to model claim loss reserving (see, e.g., [6],[16], [17] and [21]). Correlation coefficients measure the overall strength of the association, but give no information about how that varies across the distribution. Through the choice of copula, a good deal of control can be exercised over what parts of the distributions are more strongly associated. In this paper we study modelling IBNR claim reserve based on copula according to ( [17] and [19])’s references. To fit the copula’s model, he used the Genest-Rivest approximation [7] while we used the AIC (Akaike’s Information Criterion) and the copula’s parameter is estimated through the maximum likelihood estimation. More precisely the paper is organized as follows. In Section 2 we review the chain-ladder method, i.e. a description of the structure of the data used in the methods of loss reserving. Section 3 defines the copula and modelling IBNR claim reserve based on chain-ladder and copula is derived in section 4. Finally, Section 5 is the conclusions.

2. The Chain-Ladder Method.

The chain-ladder method, also known as the weighted loss development method, is the most commonly used actuarial technique for loss reserving and setting liabilities for property/casualty insurers. We consider a portfolio of risks and we assume that each claim of the portfolio is settled either in the accident year or in the following $n$ development years. The portfolio may be modelled either by incremental losses or by cumulative losses.

- To model a portfolio by incremental losses, we consider a family of random variables $\{Z_{i,k}\}_{k=0,1,\ldots,n}$ and we interpret the random variable $Z_{i,k}$ as the claims occurrence or loss of accident year $i$ which is settled with a delay of $k$ years and hence in development year $k$ and calendar year $i+k$. We refer to $Z_{i,k}$ as the incremental loss of accident year $i$ and development year $k$.

- To model a portfolio by cumulative losses, we consider a family of random variables $\{S_{i,k}\}_{k=0,1,\ldots,n}$ and we interpret the random variable $S_{i,k}$ as the loss of accident year $i$ which is settled with a delay of at most $k$ years and hence not later than in development year $k$. We refer to $S_{i,k}$ as the cumulative loss of accident year $i$ and development year $k$, to $S_{i,n}$ as a cumulative loss of the present calendar year $n$, and to $S_{i,n}$ as an ultimate cumulative loss.

The cumulative losses are obtained from the incremental losses by letting
\[ S_{i,k} := \sum_{t=0}^{k} Z_{i,t}, \]

and the incremental losses are obtained from the cumulative losses by letting

\[ Z_{i,k} := \begin{cases} S_{i,0} & \text{if } k = 0 \\ S_{i,k} - S_{i,k-1} & \text{else} \end{cases} \]

for all \( k \in \{0,1,\ldots,n\} \). We shall switch between incremental and cumulative losses as necessary.

We assume that the incremental losses \( Z_{i,k} \) are observable for calendar years \( i+k < n \) and that they are non-observable for calendar years \( i+k > n+1 \). Accordingly, we assume that the cumulative losses \( S_{i,k} \) are observable for calendar years \( i+k < n \) and that they are non-observable for calendar years \( i+k > n+1 \). The observable cumulative losses are represented by the following run-off triangle. We have to find the values below the diagonal from the upper right corner to the lower left corner.

**Table 1. The cumulative losses**

| Accident Year | Development Year |
|---------------|------------------|
| 0             | 1                |
| \( S_{0,0} \) | \( S_{0,1} \)    |
| \( S_{0,k} \) | \( S_{0,n-i} \) |
| \( S_{0,n-i} \) | \( S_{0,n} \) |
| \( S_{1,0} \) | \( S_{1,1} \)    |
| \( S_{1,k} \) | \( S_{1,n-i} \) |
| \( S_{1,n-i} \) | \( S_{1,n} \) |
| \( \vdots \) | \( \vdots \)     |
| \( \vdots \) | \( \vdots \)     |
| \( n-k \)    | \( S_{n-k,0} \) |
| \( S_{n-k,1} \) | \( S_{n-k,n-i} \) |
| \( S_{n-k,n-i} \) | \( S_{n-k,n} \) |
| \( \vdots \) | \( \vdots \)     |
| \( \vdots \) | \( \vdots \)     |
| \( n-1 \)   | \( S_{n-1,0} \) |
| \( S_{n-1,1} \) | \( S_{n-1,n-i} \) |
| \( S_{n-1,n-i} \) | \( S_{n-1,n} \) |
| \( n \)     | \( S_{n,0} \)    |
| \( S_{n,1} \) | \( S_{n,n-i} \) |
| \( S_{n,n-i} \) | \( S_{n,n} \) |

Age-to-age factors, also called loss development factors (LDFs) or link ratios \( \{f_{i,k}\} \), represent the ratio of loss amounts from one valuation date to the next, and they are intended to capture growth patterns of losses over time. These factors are used to project where the ultimate amount losses will settle and averages of the age-to-age factors \( \{f_{i,k}\} \) as follows:

\[ f_{i,k} = \frac{S_{i,k}}{S_{i,k-1}}, \quad i = 0,1,\ldots,n-1; \quad k = 1,2,\ldots,n \]  

\[ f_{k} = \frac{\sum_{i=0}^{n-k} f_{i,k}}{n-k}. \]

The chain-ladder method assumes that

\[ E \left[ S_{i,k+1}|S_{i,1},S_{i,2},\ldots,S_{i,k}\right] = S_{i,k}f_{k}. \]

We can determine Estimated Ultimate Losses (EUL) which is the multiplication of Losses Paid-to-Date (LDP) with Loss Development Factor as follows:

\[ \hat{U}_t^{CL} = (\text{Losses Paid-to Date}) \cdot \prod_{k=n-i+1}^{n} f_k. \]

where

\[ \text{Losses Paid-to-Date}_i = S_{i,n-i}. \]

The loss reserve is obtained by:

\[ R_t^{CL} = \hat{U}_t^{CL} - \text{LPD}_t. \]
The chain-ladder method consists of seven basic steps.

Step 1: Compile claims data in a development triangle
Step 2: Calculate age-to-age factors
Step 3: Calculate averages of the age-to-age factors
Step 4: Select claim development factors i.e. represents the growth anticipated in the subsequent development interval. When selecting claim development factors, actuaries examine the historical claim development data, the age-to-age factors, and the various averages of the age-to-age factors. It is also common practice to review the prior year’s selection of claim development factors
Step 5: Select tail factor. A "tail factor" is selected to project from the latest valuation age to ultimate.
Step 6: Calculate cumulative claim development factors by successive multiplications beginning with the tail factor and the oldest age-to-age factor. The cumulative claim development factor projects the total growth over the remaining valuations. Cumulative claim development factors are also known as age-to-ultimate factors and claim development factors to ultimate.
Step 7: Estimate ultimate claims based on the reported claim development method are equal to the latest valuation of reported claims multiplied by the cumulative reported claim development factors.

3. The Copula

Copulas provide a convenient way to express joint distributions of two or more random variables. A copula separates the joint distribution into two contributions: the marginal distributions of the individual variables, and the interdependency of the probabilities. The word copula was first used in 1959 for Theorem of Sklar. Technically, copulas are joint distributions of unit uniform variates. In application, the unit uniform variates are viewed as probabilities from some other variates. Then the joint distribution of those variates is produced from those probabilities using their individual inverse distribution functions. Copulas thus provide a ready method for describing joint distributions and simulating correlated variables. Quite a few copulas are available, with differing characteristics that lead to different relationships among the variables generated.

The distribution function of randomized variables that have been combined to form a joint distribution function in the copula form is called as the marginal function of the copula. This marginal function spreads uniformly \((0, 1)\) (Nelsen, 2006). For each continuous random variable, the density function of copula is related to the joint density function of random variables in the copula, ie \((x_1, x_2, ..., x_d)\). The relationship of the two functions can be described canonically as follows:

\[
f(x_1, x_2, ..., x_d) = (F_1(x_1), F_2(x_2), ..., F_d(x_d)) \prod_{i=1}^{d} f_i(x_i)
\]

3.1 Sklar’s theorem

If \(H\) is a distribution function having \(d\) dimension with a cumulative distribution function \(F_1, F_2, ..., F_d\), then will appear a copula for all \(x\) in \(\mathbb{R}^d\), the copula associated with \(F\) is a function distribution \(C\): \([0,1]^d \rightarrow [0,1]\) with margin \(U(0,1)\), as follows:

\[
H(x_1, x_2, ..., x_d) = C(F_1(x_1), F_2(x_2), ..., F_d(x_d)).
\]

If \(F\) is a continuous \(d\)-variate distribution function with univariate margins \(F_1, ..., F_d\), and quantile functions \(F_1^{-1}, ..., F_d^{-1}\), then

\[
C(u) = F \left(F_1^{-1}(u_1), ..., F_d^{-1}(u_d)\right), \quad u \in [0,1]^d.
\]

If \(F\) is the \(d\)-variate distribution of discrete random variables (in general, some are continuous and partly discrete), then copula is the only unique part of that collection Range \((F_1) \times ... \times\) Range \((F_d)\).
Based on Sklar’s theorem, Ran $F_1 \times \text{Ran } F_2 \times \cdots \times \text{Ran } F_d$ are combination of all possibility margin value $F_i$. If $F$ is the d-variate distribution of some or all of the discrete random variables, then the copula associated with $F$ is not unique. If $H$ is non-continuous or discrete univariate cdf and $Y \sim H$, then $H(Y)$ has no distribution $U(0,1)$. The copula of equation (10) becomes un-unique. Copula will only be unique in the range $(F_1) \times \cdots \times \text{range } (F_d)$, since $C$ on equation (10) will only be needed for defined in this set. Like $C$ must satisfy $C(1,\ldots, 1, u_j, \ldots, 1) = u_j$ where $u_j \in \text{Range } (F_j)$ for $j = 1, \ldots, d$; and $C$ can be extended to multivariate distribution with margin $U(0,1)$.

According to the Sklar’s theorem, it can be seen that copula has the following properties:

- $\text{Dom } C = I^n = [0,1]^n = [0,1] \times [0,1] \times \ldots \times [0,1]$
- $C(u_1, \ldots, u_n) \text{ is non-decreasing function for all component } u_i$
- $C(0, \ldots, 0, u_i, 0, \ldots, 0) = 0 \text{ for each } i \in \{1, \ldots, n\}$, $u_i \in [0,1]$
- $C(1, \ldots, 1, u_i, 1, \ldots, 1) = u_i \text{ for each } i \in \{1, \ldots, n\}$, $u_i \in [0,1]$
- For all $(a_1, \ldots, a_n)$, $(b_1, \ldots, b_n) \in [0,1]^n$ with $a_i \leq b_i$ be valid with $\sum_{i=1}^{n} (-1)^{i+1} + \sum_{i=1}^{n} \text{C}(u_{a_1}, \ldots, u_{b_n}) \geq 0 \text{ where } u_{j1} = a_j \text{ and } u_{j2} = b_j, j \in \{1, \ldots, n\}$.

Family of Copula is broadly divided into several families based on the structure of dependencies that are formed, for example: Archimedean, Marshall-Olkin, Elliptical, Farlie-Gumbel-Morgenstern, and Extreme Value. Archimedean class of copula has used in the research before to model bivariate insurance claim data (see, e.g., [16], and [17]). This paper, therefore uses archimedean to fit IBNR claims data.

### 3.2 The Archimedean Copula

Let $X$ represents amount of claim and $Y$ constitutes development factor be a bivariate random variable and let $u = F_X(x)$ and $v = G_Y(y)$ be a margin distribution function, respectively. Then, $U$ and $V$ are uniformly distributed random variables. One of the bivariate Archimedean copula theorems widely used is as follows [12; 14]:

$$C(u, v) = \varphi^{-1}(\varphi(u) + \varphi(v)), \quad (12)$$

where $\varphi^{-1}$ denotes a pseudo inverse of $\varphi$, $\varphi$ is a continuous, strictly decreasing from interval $[0,1]$ to $[0,\infty)$ such that $\varphi(1) = \infty$, then $\varphi^{-1} = \varphi^{-1}$. Proof of Equation (12) in detail can be found in Naifar (2016). There are a large number of generator functions to construct copula function, but a few of the functions are widely used in flood frequency analysis which is presented in Table 2. Copula families in Table 2, are deduced using Equation (12) and $\theta$ indicates the parameter of copula function.

| Family               | $\varphi(t)$                                                      | $C(u,v)$                                                                 |
|----------------------|------------------------------------------------------------------|--------------------------------------------------------------------------|
| Frank                | $\ln \left[ \frac{\exp(\theta - t) - 1}{\exp(\theta) - 1} \right], \theta \neq 0$ | $\frac{1}{\theta} \ln \left[ 1 + \frac{(\exp(\theta - u) - 1)(\exp(\theta - v) - 1)}{\exp(\theta - 1)} \right]$ |
| Gumbel-Hougaard      | $(-\ln(t))^{\theta}, \theta \in [-1, \infty)$                   | $\exp \left( -[(-\ln u)^{\theta} + (-\ln v)^{\theta}]^{\frac{1}{\theta}} \right)$ |
| Clayton              | $t^{\theta} - 1, \theta > 1$                                    | $(u^{\theta} + v^{\theta})^{\frac{1}{\theta}}$ |

Based on [11] copula families in Table 2 have different structure dependences. Frank’s copula is symmetric copula, and they are only radially symmetric Archimedan copulas, and it does not have lower or upper tail dependence either. Gumbel-Hougaard has upper tail dependence. Gumbel-Hougaard is always a positive dependence. Lower tail dependence, but upper tail dependence is not characterized by Clayton family.
3.3 Goodness of Fit Test

There are a large number of function copulas, but there is only one that fit the data. Therefore, it is necessary to select one of them using specific procedures. One of the procedures in this study uses Cramer-von Mises statistics defined as:

\[ S_n = \sum_{j=1}^{n} \{ C_n(U_j) - C_{\theta_n}(U_j) \}. \]  \hfill (13)

This statistics has the poor statistical properties, because it has no asymptotic properties. [8] propose a procedure that applies bootstrapping to compute p-value that it is a very powerful procedure in most cases. Functions of \( C_n(U_j) \) and \( C_{\theta_n}(U_j) \) show the empirical and theoretical copulas. If statistic value of (13) gets larger, that means a poor fit and leads to the rejection of null hypothesis copula.

4. Modelling IBNR Claim Reserve

4.1 Modelling IBNR Claim Reserve Based on Chain-Ladder

First, losses (either reported or paid) are compiled into a triangle, where the rows represent accident years and the columns represent development year or valuation dates as follows.

Table 3. The incremental losses

| Accident Year | Development Year (IDR) |
|---------------|------------------------|
|               |                      0   | 1   | 2   | 3   | 4   |
| 2013          | 5,643,671,768         | 4,085,527,063 | 1,972,448,891 | 1,919,799,720 | 284,892,166 |
| 2014          | 3,165,634,447         | 6,589,737,582 | 1,529,197,557 | 1,272,228,484 |
| 2015          | 830,929,981           | 9,655,641,014 | 9,094,683,362 |
| 2016          | 3,775,435,070         | 22,982,658,878 |
| 2017          | 22,525,130,233        |

For example, 6,589,737,582 represents loss amounts related to claims occurring in 2014, valued as of 24 months. Finally, according to seven basic steps, it will be obtained as follows.

Table 4. The estimated loss reserve (IDR)

| Accident Year | Estimated Ultimate Losses (\( \hat{U}^{CL}_i \)) | Losses Paid-to-Date (LDP) | Estimated Loss Reserve (\( \hat{R}^{CL}_i \)) |
|---------------|-----------------------------------------------|---------------------------|-----------------------------------------------|
| 2013          | 13,906,339,607                               | 13,906,339,607            | -                                            |
| 2014          | 12,819,423,126                               | 12,556,798,070            | 262,625,056                                  |
| 2015          | 22,291,328,180                               | 19,581,254,356            | 2,710,073,824                                |
| 2016          | 37,700,003,913                               | 26,758,093,948            | 10,941,090,965                               |
| 2017          | 138,041,113,819                              | 22,525,130,233            | 115,515,983,586                              |
| Total         | 224,758,208,646                              | 95,327,616,214            | 129,430,592,432                              |

The estimation of claim reserves for 2018 is IDR 129,430,592,432.

4.2 Modelling IBNR Claim Reserve Based on Copula

Amount of claim and development factor (measures time from the moment when claim occured to the moment when claim has reported) are the variables that form the basis calculation IBNR claim reserves. As they are correlated we need to take into account both variables in the modelling process. Copula methodology was used to model joint variable distribution of the variables. Several classes of
Archimedean copulas like Clayton, Frank, Gumbel were used, other than that, several classes of elliptical copulas like Gaussian and t-student were used too. The best model was found by the least square method.

### Table 5. Copula parameter

| Copula   | Parameter | Log-Likelihood | AIC     | BIC     |
|----------|-----------|----------------|---------|---------|
| Gaussian | -0.2050443| 9.866376       | -17.73275 | -13.20187 |
| t-student| -0.2083119| 8.907985       | -13.81597 | -4.754215 |
| Clayton  | -0.3437297| 11.30664       | -20.61327 | -16.0824 |
| Gumbel   | -1.166827 | 10.21094       | -18.42189 | -13.89101 |
| Frank    | -1.264726 | 12.98248       | -23.965  | -19.4341 |

Frank is the best copula used in combining the distribution of marginal amount of claim and development factor. The selection of the best copula is based on the largest Log-Likelihood value, the smallest AIC and BIC value. Copula contour of the data is as follows.

4.2.1 *Simulation Processes*. Simulation processes to calculate IBNR reserves are as follows:

- Determine the marginal univariate distributions
- Find appropriate copula model for the given data
- Calculate the average amount of claim in each development time unit using appropriate copula that has been found before
- Find number of claims occurred in each used time unit
- Calculate Reserves
4.2.2 Fitting distribution of data and characteristics of data. The result of fitting distribution of amount of claim, development factor, and number of claim are as follows:

- Fitting of amount of claim to lognormal distribution reached value $\mu = 5.1576$, $\sigma = 1.1486$. The corresponding value of Kolmogorov-Smirnov test statistic is 0.06629 with the 5% critical value 0.10908.
- Fitting of development factor to Cauchy distribution reached value $\mu = 0.97541$, $\sigma = 0.36217$. The corresponding value of Kolmogorov-Smirnov test statistic is 0.24713 with the 5% critical value 0.35185.
- Fitting of Number of claim to Normal distribution reached value $\mu = 41.6$, $\sigma = 0.36217$. The corresponding value of Kolmogorov-Smirnov test statistic is 0.18149 with the 5% critical value 0.56328.

| Characteristics | Claim size | Development factor | Number of claim |
|-----------------|------------|--------------------|-----------------|
| Min.            | 105        | 0                  | 9               |
| 1st Qu.         | 1500000    | 0                  | 20              |
| Median          | 21920328   | 1                  | 42              |
| Mean            | 138961540  | 0.7143             | 41.6            |
| 3rd Qu.         | 110534755  | 1                  | 61              |
| Max.            | 4505988916 | 4                  | 76              |
| Skewness        | 6.774412   | 1.035539           | 0.042786        |
| Kurtosis        | 58.73836   | 0.5266818          | -1.48629        |

4.2.3 Estimating IBNR. 688 points were simulated 10 times from the Frank copula and average amount of claim for each development factor time obtained. These averages are shown in Table 7 as follows. Average number of claims happening in each year of origin is then found by multiplying the value of the normal density function for the number of claims happening in each year of origin by the average number of claims happening in a year and also the average plus 1, 2 and 3 standard deviations which will be represented by Dev, Dev 1, Dev 2 and Dev 3 respectively and by the length of the interval (in our case 1 year). Results are shown in Table 8.
Table 7. Simulated average amount of claim for each development factor

| Development Factor | Average Amount of Claim |
|--------------------|------------------------|
| 0                  | 2,634.67               |
| 1                  | 3,535.00               |
| 2                  | 3,391.25               |
| 3                  | 2,115.01               |
| 4                  | 1,786.55               |

Table 8. Average number of claims for the three variations

| Development Factor | PDF*Dev 1 | PDF*Dev 2 | PDF*Dev 3 |
|--------------------|-----------|-----------|-----------|
| 0                  | 0.044027337 | 0.041745513 | 0.039633237 |
| 1                  | 0.009500563 | 0.009374998 | 0.009254088 |
| 2                  | 0.005420958 | 0.005388997 | 0.005357996 |

IBNR reserves are then calculated by multiplying the simulated average claim size in each development time by the average number of claims in each development time unit and to the number of time units for all the four variations. The results are shown in Table 9 below.

Table 9. Estimated IBNR reserves using the Frank Copula (IDR)

| Development Factor | PDF*Dev 1 | PDF*Dev 2 | PDF*Dev 3 |
|--------------------|-----------|-----------|-----------|
| 0                  | 20,855,345,810.42 | 4,500,329,454.97 | 2,567,857,948.13 |
| 1                  | 14,413,457,815.95 | 3,236,902,020.04 | 1,860,657,019.47 |
| 2                  | 17,390,456,645.69 | 4,060,551,796.49 | 2,351,006,379.51 |
| 3                  | 3,232,758,430.34 | 784,040,063.29 | 457,152,274.08 |
| 4                  | 4,773,800,441.98 | 1,201,429,891.31 | 705,337,273.35 |
| Total              | 60,665,819,144.39 | 13,783,253,226.10 | 7,942,010,894.53 |

The most estimated IBNR reserve is in the development factor 0, the claim was reported in the same year when the event occurred. as for the gap between events and reporting but still below one year.

5. Conclusion

In this paper, we keep as a starting point with the result concerning loss reserving from [10] and [19]. To fit the copula’s model, we used the AIC (Akaike’s Information Criterion) and the copula’s parameter is estimated through the maximum likelihood estimation. The role of actuaries and researcher in determining loss reserving is becoming increasingly important. Estimating risk-adequate loss reserves is a complex process requiring in-depth knowledge of current best practice in the insurance industry. The implementation of best practice processes as detailed throughout various areas of a company forms an important part of solvency.

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