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Solvency capital requirement for a temporal dependent losses in insurance

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ABSTRACT

This article addresses the appropriate modeling of losses for the insurance sector. In fact, solvency 2 framework has suggested some formulas to evaluate losses and solvency capital using an internal approach. However, these formulas where derived under the assumption of independent losses. Thus, the amount of capital may be inaccurate when losses are dependent, which is the case in practice. The aim of this paper is to investigate temporal dependence structure among claim amounts (losses). For that, a novel model named autoregressive conditional amount (ACA) model handling the dynamic behavior of claim amounts in insurance companies is proposed. Results show that ACA models allow to predict accurately the future claims. Moreover, a measure of risk namely value at risk (VaR) ACA that could hedge daily dependent losses is provided. By backtesting techniques, empirical results show that the new VaR ACA can efficiently evaluate the coverage amount of risks.

1. Introduction

Insurance plays an important role in the financing of economies, because it provides funds that are relevant to capital market development. Thanks to its investments, it contributes to economic growth. For instance, the insurance industry has contributed in the economic growth of Malaysia and increased employment opportunities. Moreover, it should be noted that the amount of premium received in the general insurance industry in Malaysia increased from RM1979 million in 1990 to RM13.596 million in 2011 (see Chen et al., 2014).

In order to participate in the economic growth, insurance companies must evaluate an economic capital, that allows them to participate in the capital market development and to cover their engagements toward the policyholders. In fact, insurance is considered as a transfer of risks from the insured to the insurer. It must have a level of capital, which enables it to absorb unfavorable risks and to be solvent in future years. Also, serious companies should have a quick response time, be adept at handling claims and have excellent customer service. In order to evaluate the suitable capital for the companies, solvency 2 framework requires insurance companies to develop their internal models.

In the context of non-life insurance, internal models consider principally the modeling of the microeconomic variables: the claim amounts that are used to cover accident costs and offer protection against risks. In this configuration claim amounts seem to be an economic problem that requires modeling. Indeed, finding the best model for claim amounts allows insurance companies to improve their pricing policies, to evaluate the adequate reserves for claims and most importantly to evaluate the solvency capital requirement.

In this configuration, much actuarial research has focused on how to find the best parameterized model which could fit claim amounts, over a given time period. Several distributions are used to model insurance losses process: the lognormal model (Kremer, 1982), the negative binomial model (Richard, 2000), and generalized beta of the second kind (GB2) (Cummins et al., 1990). Mikosch (2006) has shown that the exponential family distributions are adequate to

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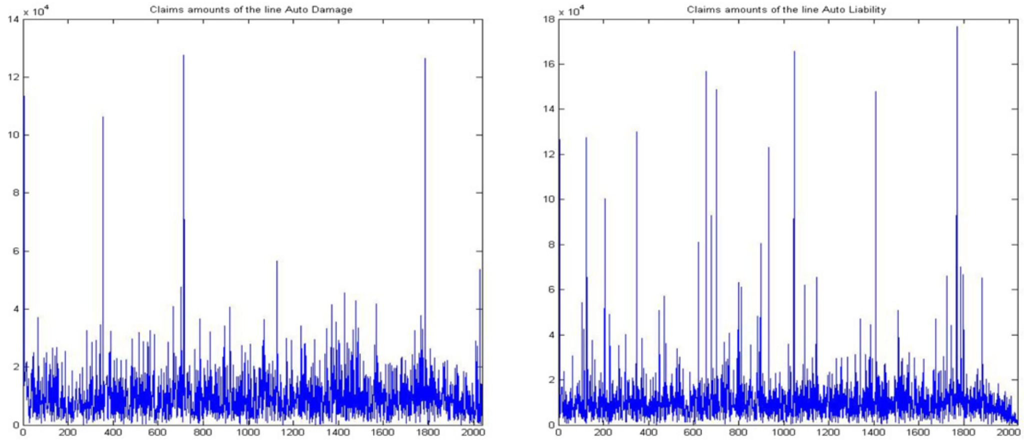

Fig. 1. The plots of the lines Auto Damage and Auto Liability.

model losses. Cooray and Ananda (2005) have modeled actuarial data with a composite Lognormal Pareto Distribution.

The common shortcoming of these models is that they ignore the temporal dependence that may exist between claim amounts. In the actuarial science, these claim amounts are generally considered as a sequence of independent and identically distributed (iid) variables (see Bühlmann,1996 and Rolski et al.,1999). However, in most situations, this assumption may be unrealistic. For instance, a car accident may involve several policyholders at once in a collision, and can simultaneously hit several policies. Also, a bad weather (rainy, snowy) may induce a large number of claims in the same period. For that, it has been pointed out that methods enabling modeling of temporal dependencies among claim amounts, are required.

In actuarial science, actuaries seem to believe that identifying the temporal dependence of claim amounts improves their prediction in the future. One approach is the use of time series to model the dynamic effect of claims over time. Little attention has been granted to this area. The early papers by Gerber (1982) and Cummins (1985), and the more recent ones by El-Bassiouni and El-Habashi (1991) are examples of introducing time series in modeling temporal dependence of claims in insurance. In addition, Promislow (1991) and Zhang (2005) have determined the ruin probability expression of the claims, under a linear time series model, they have modeled claims using the moving average and the autoregressive models.

In actuarial literature, modeling temporal dependence is a more common practice when developing credibility models. Frees et al. (1999) have introduced a longitudinal data model to analyze and forecast future claims. Bolancé et al. (2003) tested, and estimated an autoregressive specifications for time dependent random effects in a frequency claim models. They have shown that this statistics tool is relevant to determine the dynamics of the data. Boucher et al. (2008) have presented an overview of models where time dependence between contracts of the same insured is modeled.

This paper aims the following: to investigate the temporal dependence of claim amounts in order to improve their prediction in the future, and to evaluate the impact of this temporal dependence on the evaluation of the Solvency capital requirement. In this paper, a new model handling temporal dependence between daily claim amounts is proposed. For that purpose, an autoregressive conditional amount (ACA) framework is used. This model takes into account the dependence between claim amounts. Moreover, an alternative model called generalized extreme value autoregressive conditional amount (GEVACA) model is introduced to forecast the large losses. Furthermore, a parametric Value at Risk ACA measure is derived to assess the coverage amounts of claims.

This paper is organized as follows: Section 2 presents the autoregressive conditional amount model. Section 3 presents the VaR ACA measure. Section 4 reports the empirical results, followed by concluding remarks in Section 5.

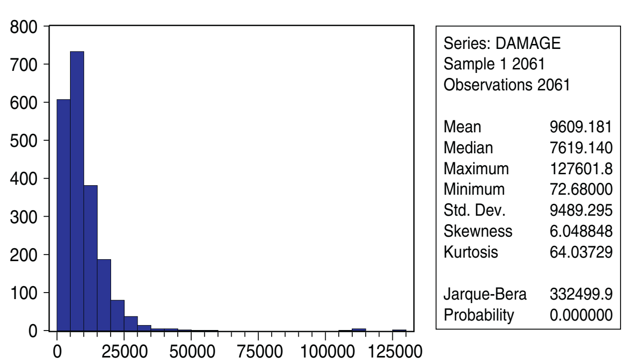

Fig. 2. Histogram and descriptive statistics of the line Auto Damage.

2. Autoregressive conditional amount (ACA) models

Engle and Russell (1998) introduced the autoregressive conditional duration (ACD) model, which presents a new way for modeling irregularly spaced financial transaction data. They used the similar idea of the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to develop the ACD model based on exponential (EACD) and Weibull (WACD) distributions rather than symmetric distributions such as the Gaussian one. Their explicit objective is to model the intertemporally correlated durations. At present, this model is considered as the most powerful tools, provided by several applications to real financial data (Engle and Russell, 1998; Engle, 2000; Engle, 2002).

Bauwens and Giot (2000) introduced the log-ACD model, which implies a non-linear relation between the durations and their lags. Grammig and Maurer (2000) developed an ACD model based on the Burr distribution.[1] They have shown that their model provides

[1] A random variable t follows a Burr distribution if it has the following probability density function:

$$f(t) = \frac{\mu \chi t^{\chi-1}}{(1+\sigma^2 \mu t^{\chi})^{\frac{1}{\sigma^2}+1}} t > 0, \mu > 0, \chi > 0, \quad (1)$$

where μ and χ are the shape parameters and σ is the scale parameter.