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Research on solvency measurement and prediction-based on the analysis of financial indicators of insurance companies

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Abstract: *In this paper, we use the factor analysis model, and get the prediction function of the solvency of insurance companies. In order to verify the feasibility of the model, we have adopted Accumulated Local Effects Plot. It is proved that the solvency of an insurance company is positively correlated with its monetary funds, term deposits and owner's equity, negatively related to its own liabilities, and that the two indicators of monetary capital and insurance company liabilities are factors that have a high marginal contribution to predicting the solvency of insurance companies.*

Keywords: *Factor analysis model, Accumulated Local Effects Plot*

1. Introduction

As the main body of operating risks, the insurance company plays an important role in stabilizing social development and ensuring economic operation.The operation mode of debt operation of insurance companies must attach great importance to the management of financial risk, especially to improve their solvency to policy holders.The solvency of insurance companies directly affects whether the rights and interests of policy holders and whether the interests of insurance investors can be guaranteed and realized, and thus affects the operation of the whole financial system. Therefore, at present, insurance regulators in various countries have issued different policies to strictly regulate the solvency of insurance companies.Since the 1960s, there have been insurance companies due to bankruptcy due to insufficient solvency. The typical case is the bankruptcy of seven life insurance companies in Japan at the end of the 20th century, sounding the alarm to insurance regulators in all countries.

2. Data collection and processing

We collected information from the insurance Yearbook database on the assets, liabilities, gains and losses, personnel structure of insurance companies, and according to the indicators provided by the insurance Yearbook database, we divided their solvency into two categories: strong solvency and weak solvency.

We constructed the insurer solvency dataset based on the data collected that covers information for each year of 2010-2016 and chose a time period of approximately a full economic cycle in terms of solvency evolution.

In this paper, we selected six insurance companies represented by PICC during the seven years period 2010-2016 and calculated their solvency adequacy ratio within seven years to analyze their trends as shown in Figures 3-1.

3. Model establishment, demonstration, and improvement

3.1 Model establishment

3.1.1 Solvency analysis of insurance companies based on the factor analysis model

Factor analysis models reflect the vast majority of the information of the original variables with fewer mutually independent factors.A variable was set and the mean of 0 and standard deviation of 1. Now each original variable is represented by a linear combination of factors (normalized values), there are:

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$$\begin{cases} x_1 = a_{11} f_1 + a_{12} f_2 + a_{13} f_3 + \cdots a_{1k} f_k + \varepsilon_1 \\ x_2 = a_{21} f_1 + a_{22} f_2 + a_{23} f_3 + \cdots a_{2k} f_k + \varepsilon_2 \\ x_3 = a_{31} f_1 + a_{32} f_2 + a_{33} f_3 + \cdots a_{3k} f_k + \varepsilon_3 \\ \vdots \\ x_p = a_{p1} f_1 + a_{p2} f_2 + a_{p3} f_3 + \cdots a_{pk} f_k + \varepsilon_p \end{cases}$$

We selected the operating conditions of 16 insurance companies in 2010-2016, and selected some indicators to analyze the economic indicators of insurance companies: monetary funds, time deposit, fixed assets, total liabilities and owner equity, quantified them as impact factors, and used the factor analysis model to study the impact of these indicators on the solvency of insurance companies.

By substituting our variables, we quantified the evaluation factors that can calculate credit risk as:

$$\begin{cases} x_1 = a_1 f_1 + a_2 f_2 + a_3 f_3 + a_4 f_4 \\ x_2 = b_1 f_1 + b_2 f_2 + b_3 f_3 + b_4 f_4 \\ x_3 = c_1 f_1 + c_2 f_2 + c_3 f_3 + c_4 f_4 \\ x_4 = d_1 f_1 + d_2 f_2 + d_3 f_3 + d_3 f_4 \end{cases}$$

The correlation coefficient analysis table is obtained as follows:

Table 1: Correlation coefficient analysis Table

Variables	Coefficients	Error	T values	P values
C	1.62	0.5752	2.8164	0.0016
X1	0.38	0.0077	49.3506	0.0125
X2	0.22	0.0722	3.0471	0.0033
X3	-0.27	0.1006	-2.6839	0.0005
X4	0.19	0.0532	3.5714	0.0024

We get the relevant equation for the solvency of the insurance company as follows:

$$Y = 1.62 + 0.38x_1 + 0.22x_2 - 0.27x_3 + 0.19x_4$$

This shows that among many financial indicators, insurance company solvency is mainly affected by monetary funds(x_1), time deposits(x_2), total liabilities(x_3), owners' equity(x_4).With the increase of monetary funds and time deposits, the size of the insurer increases and the solvency increases; the greater the liabilities, the greater the pressure of the solvency, and the solvency of the insurer.

3.2 Inspection and improvement of the model

To test the accuracy of the model, we introduce Accumulated Local Effects Plot to test the dependence of insurer solvency on variables.

3.2.1 Product Effect Estimate by Accumulated Local Effects Plot

Cumulative local effects (ALE Accumulated Local Effects Plot) describe how feature averaging affects the predictions of the machine learning model.ALE plots are a faster and more unbiased alternative to PDP.Partial dependency plots (PDP) greatly affect the estimated feature effects when calculating average predicted data involving instances of artificial data unlikely to occur in reality.So to avoid this, we used the cumulative local effect (ALE) to examine the impact of the insurance company's eight financial indicators on its solvency adequacy ratio.

Figures below are the conditional expectation plots of the 8 influencing factors of transaction financial assets, guarantee household pledge loan, time deposit, policy dividend payable, long-term equity investment, policy dividend expenditure, pending compensation reserve and capital accumulation fund. The 8 figures are shown below:

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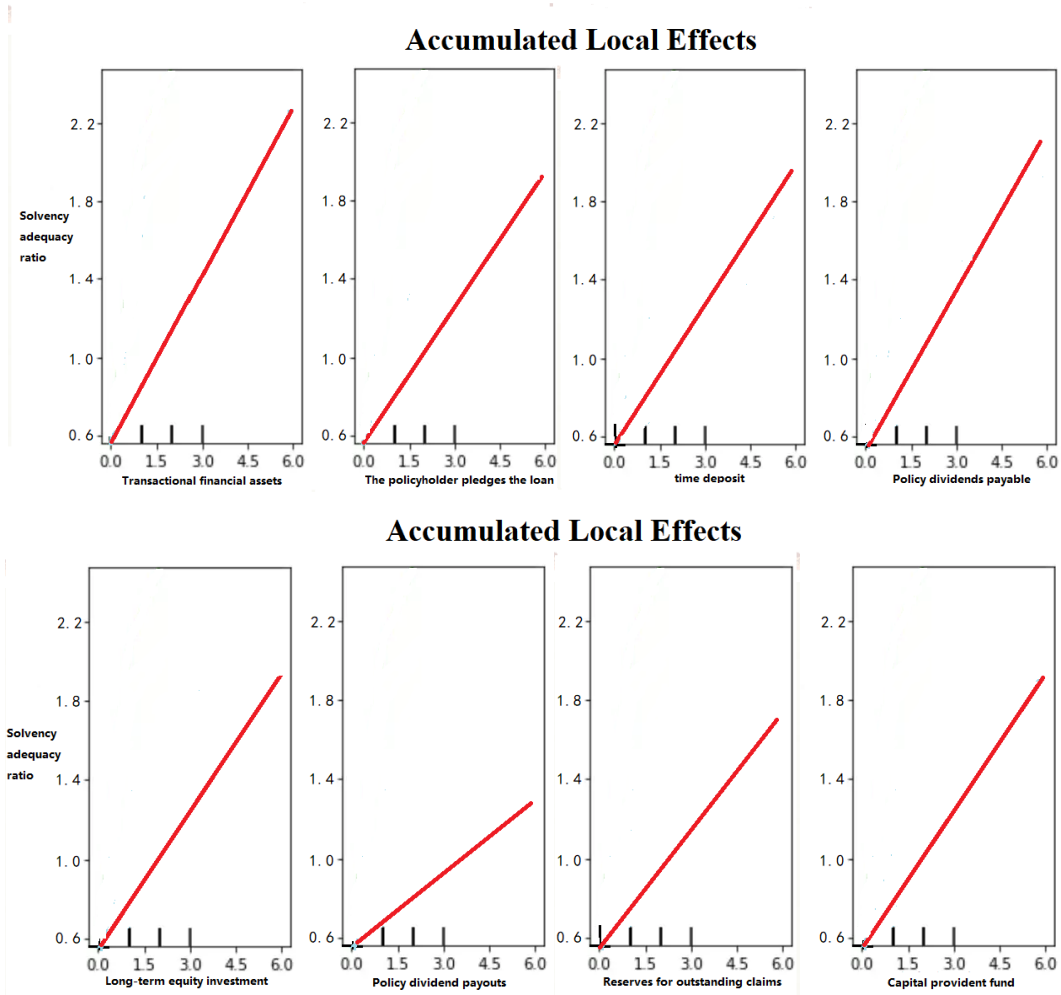

Figure 1

We take Figure 1 as an example. We can see that the positive correlation between trading financial assets and insurance company solvency adequacy ratio in terms of cumulative effect. When the growth ratio of trading financial assets increases from 0 to 6, the growth ratio of solvency adequacy ratio rises from 0.6 to 2.2.

4. Model summary and development prospects

In this paper, we present a holistic approach to an insurer solvency prediction model based on a factor analysis model .In this model, we choose the most important insurer financial indicators to test its solvency.We can believe that the insurer solvency prediction model has a high goodness-of-fit to the solvency prediction of insurance companies.

Our results show that the solvency of insurance companies is positively related to the company's monetary funds, time deposit, owner's equity, and their own liabilities, and the two indicators of monetary funds and insurance company liabilities are factors with high influence in predicting the solvency of insurance companies.

References

[1] Goel Anubha, Mehra Aparna. A bivariate Markov modulated intensity model: applications to insurance and credit risk modelling [J]. Stochastics, 2021, 93(4).
[2] Hample Kelsey C.Foral insurance for the informally insured: Experimental evidence from Kenya [J]. World Development Perspectives, 2021, 22.
[3] Lu Yang, Li Yongli. A novel data-driven method for maintenance prioritization of circuit breakers based on the ranking SVM [J].International Journal of Electrical Power and Energy Systems, 2021, 129.

ISSN 2616-5902 Vol. 3, Issue 9: 20-23, DOI: 10.25236/AJBM.2021.030905

[4] Zhang Lei. Stock Market Trend Analysis and Prediction Research Based on Support Vector Machine [D]. Nanjing University of Posts and Telecommunications, 2020.