The application of KMV model in China's insurance market during the COVID-19

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Abstract. In 2020, the COVID-19 has a certain impact on the credit risk of China's listed insurance companies. This paper selects relevant data of four China's listed insurance companies from the first quarter of 2019 to the third quarter of 2020, and then uses revised KMV model to measure the credit risk of these four insurance companies. The empirical results show that in the season of the outbreak, the default distance of China's listed insurance companies has decreased to varying degrees, indicating that the epidemic has caused a temporary increase in the credit risk of the insurance industry.

1. Introduction
On December 1, 2019, the first COVID-19 case in Wuhan had occurred. Then, the COVID-19 spread around the world. On March 12, 2020, the WHO officially declared a global pandemic of the COVID-19 pandemic. The impact of this outbreak on China is enormous and extensive. But the financial sector has become one of the few industries that can sustain growth, even achieve a 6% increase over the same periods last year. The insurance industry is an important part of the financial industry, which played an important role in the stability of the national economy during the epidemic period. However, during the epidemic, the credit risk management of China's insurance industry also received severe challenges. Therefore, it is of great significance to study the impact of the epidemic on the credit risk of China's insurance industry to enhance the ability of China's insurance industry to resist risks. At the same time, it can provide a certain reference basis for the formulation of financial stability policy.

2. Literature review
Most of the existing literature on the impact of the epidemic on China's insurance industry is based on macro-level analysis and point out the impact of the epidemic on China's insurance industry. Li Hongmin and Zhang Lu (2020) suggested that the development of the credibility of China's insurance industry is relatively backward, and the outbreak has exposed the lack of credibility of China's insurance industry [1]. Zhai Baogang and Guo Jialong (2020) point out that the epidemic has brought shock to China's insurance industry, but also brought opportunities for the insurance industry to optimize asset allocation from the perspective of capital and debt [2]. Yang Xia, Wang Baichuan and Li Yi (2020) used the difference-in-difference model to review and analyze the SARS outbreak, proving that there was no significant change in the demand for life insurance and property insurance during the outbreak. That is to say, the impact of the epidemic on the demand side of the insurance industry was more limited [3]. However, Zhu Junsheng (2020) pointed out that the insurance industry's life insurance business suffered a huge impact, which caused the overall decline of the insurance business and increased small and medium
-sized insurance institutions cash flow risk and loss pressure, while the economic downturn makes the use of insurance funds market risk and credit risk increased [4].

Although many scholars have carried out research on the impact of the epidemic on China's insurance industry, but most lack of data and model support, and focus on the macro-level qualitative analysis. Just few scholars from china's listed insurance companies study the impact of the epidemic on China's insurance industry from the credit risk perspective.

There are many methods to measure the credit risk of enterprises, and Zhou Weifan (2009) revised the KMV model for China's listed insurance companies [5]. Then Yan Wei (2012) [6], Yu Xuejun (2015) [7], Liu Xinyuan (2018) [8] and many other scholars have used the revised KMV model to measure the credit risk of insurance companies, and the results show that this model is more applicable to the credit risk measurement of China's insurance companies.

Considering the existing research results of the previous years, this paper will study the impact of the epidemic on the credit risk of China's insurance industry in depth based on the micro-level of China's listed insurance companies, and apply the revised KMV model to carry out a series of empirical analysis to fill the gap in this research neighborhood.

3. Empirical analysis

3.1. Variable description

In order to use the KMV model, we must first obtain the relevant indicators of the research object. The relevant indicators used in this paper are as follows:

1. Risk free interest rate \( r \), this paper selects the interest rate of one-year treasury bonds as the risk-free interest rate \( r = 2.2\% \).

2. Equity value \( V_E \), calculated by the number of tradable shares and non-tradable shares, daily closing price and daily net assets.

3. Market value of corporate liabilities \( \sigma_E \), which takes the logarithm of the ratio of the closing prices of the tradable shares before and after the two days in each quarter, and then finding the variance.

4. The market value of corporate debt \( D \), which is selected from the total market value of liabilities in the financial statements disclosed by the company every quarter.

5. Default point \( D_P \), which is calculated by using the modified formula of default distance. \( D_P = CL + 0.8PR + 0.5LL \). Where, \( CL \) is the current liabilities of the enterprise, \( PR \) Reserve for life in insurance and long-term health insurance, \( LL \) It refers to non-current liabilities excluding life insurance reserve and long-term health insurance liability reserve.

3.2. Data source

The original data comes from the financial statements disclosed by enterprises and the software called “tonghuashun”. Considering the availability of data and the representativeness of insurance companies, the data which is selected in this paper includes the relevant financial indicators of PICC, China Life Insurance, China Taiping Insurance and Xinhua Insurance (including A+H-share listed companies) listed in A-share market. The time span is from September 30, 2019 to September 30, 2020.

3.3. KMV model analysis

The function between equity value and the asset value is constructed as follows:

3.3.1. The first step is to calculate asset value of the company, \( V_A \), and volatility of firm returns, \( \sigma_A \). KMV model is based on Black-Scholes model and regards the assets of listed companies as European call options. Therefore, call option pricing model can be used to calculate the overall asset value of listed companies. The equity value of the company and the volatility of equity returns that determines is:

\[
V_E = V_A N(d_1) - e^{-rT} DN(d_2)
\]
$\sigma_E = \frac{V_A N(d_1) \sigma_A}{V_E}$  \hspace{1cm} (2)

\[ d_1 = \frac{\ln\left(\frac{V_A}{D}\right) + (r + 0.5\sigma_A^2)T}{\sigma_A \sqrt{T}} \]  \hspace{1cm} (3)

\[ d_2 = d_1 - \sigma_A \sqrt{T} \]  \hspace{1cm} (4)

Where, $r$ is the risk-free rate, $T$ is debt maturity, $N(*)$ is a cumulative standard normal distribution function, $V_E$ is the equity value, $\sigma_E$ is the volatility of equity returns, $D$ is the face value of debt.

Both $V_A$ and $\sigma_A$ are unknown and others in this paper are observed. In other words, these two unknown variables need to be solved finally.

3.3.2. The second step is to calculate the default distance of the company $DD$. The default distance can be used to measure the credit risk of the company. With the decrease of the default distance, the market value of the company will be closer to the default point, resulting in greater credit risk. The calculation formula is as follows:

\[ DD = \frac{E(V_A) - DP}{E(V_A) \sigma_A} \]  \hspace{1cm} (5)

Where, $E(V_A)$ denotes the expected growth rate of asset values, $DP$ is the default point.

3.3.3. The third step is to calculate the expected default frequency of the company $EDF$. Because the historical default database of China’s companies is not perfect, there is not enough data to map the default distance and default probability. So, it is difficult to use the default distance to estimate the default probability. Therefore, this paper directly uses the default distance to analyze the credit risk, and no longer calculates the default probability.

3.4. results and analysis

According to the basic steps of KMV model, we can calculate the asset value, asset volatility and the most important default distance of each insurance company, as shown in Table 1:

**Table 1.** The calculation results of KMV model. (Note: the unit of asset value is 100 million CNY).

| corporate name | Variable | Q1 2019 | Q1 2020 | Q2 2020 | Q2 2020 | mean value |
|----------------|----------|---------|---------|---------|---------|------------|
| NCI            | $V_A$    | 9077.1  | 9449.1  | 9522.8  | 9875.9  | 9481.225   |
|                | $\sigma_A$ | 0.0146  | 0.0229  | 0.0146  | 0.0491  | 0.0253     |
|                | $DD$     | 18.639  | 10.9643 | 18.5147 | 6.1269  | 13.561225  |
| PICC           | $V_A$    | 10691   | 11255   | 11894   | 11807   | 11411.75   |
|                | $\sigma_A$ | 0.0318  | 0.0314  | 0.0142  | 0.043   | 0.0301     |
|                | $DD$     | 8.2566  | 7.9156  | 17.3482 | 5.877   | 9.84935    |
| China Life     | $V_A$    | 40756   | 40354   | 41408   | 45915   | 42108.25   |
|                | $\sigma_A$ | 0.0301  | 0.0327  | 0.0228  | 0.0828  | 0.0421     |
|                | $DD$     | 10.8116 | 9.012   | 13.0657 | 4.2173  | 9.27665    |
| CPIC           | $V_A$    | 16083   | 16239   | 16939   | 17662   | 16730.75   |
|                | $\sigma_A$ | 0.0198  | 0.0271  | 0.0207  | 0.0334  | 0.02525    |
|                | $DD$     | 14.9484 | 9.7566  | 12.6421 | 8.1194  | 11.366625  |
It can be seen from table 1 that the asset volatility of various insurance companies did not change much before and after the epidemic, and the change of asset value was not obvious at the same time. It can be considered that the assets of listed insurance companies in China performed relatively well under the impact of the epidemic and had good anti-risk ability.

The change trend of the default distance of insurance companies is basically the same, which is that they all experienced different degrees of decline in the first quarter of 2020, and then return to the previous level in the second quarter, which shows that the epidemic has significantly affected the credit risk of China's insurance companies and led to the rise of credit risk of insurance companies in China in the short term. However, the credit risk of China's insurance companies quickly returned to the level before the outbreak of the epidemic, indicating that the ability of these companies to resist credit risk is strong. Despite the impact of rare public health and safety events, causing a short-term rise in credit risk, insurance companies have played an important role in the stability of China's financial industry and the national economy.

4. Conclusion
To sum up, the credit risk of China's insurance companies has been impacted to a certain extent by the outbreak of COVID-19, but the duration is short. Only in the second quarter of the outbreak of COVID-19, the credit risk of insurance companies in China dropped to the level before the outbreak of the epidemic, indicating that China's listed insurance companies are in stable operation and have good risk resistance ability, it has played an important role in the stability of the national economy during the epidemic period.

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Reference
[1] Li H, Zhang L, Reflection on the credibility of insurance industry under the new crown pneumonia epidemic situation, China Insurance, vol.393, 2020, pp. 40-43,
[2] Pei B, Guo J, Impact of X pneumonia on insurance asset allocation in China, China Insurance, 2020, pp. 47-51
[3] Yang X, Wang B, Li Y, Research on the impact of major public health events on China's Insurance Industry -- Based on the SARS and NCP epidemic situation, Financial economics research, vol.35, 2020, pp. 28-39
[4] Zhou Y, Credit risk measurement of Chinese listed insurance companies based on KMV model, Insurance research, 2009, pp. 77-81
[5] Yan Q, Research on credit rating of listed insurance companies in China, Tianjin University of Finance and economics, 2012
[6] Yu X, Research on credit risk measurement of insurance companies in China based on KMV model, Ocean University of China, 2015
[7] Liu X, Sensitivity analysis of credit risk of Pacific Insurance Company, Northwest Normal University, 2018
[8] Wang X, Zhou J, Research on the applicability of risk measurement of China's listed insurance companies -- Based on the application comparison of Z model and KMV model, Friends of accounting, vol.2018, 599, pp. 84-88