

Comparative Research on Credit Risk of Hang Seng Bank Before and After COVID-19 Based on KMV Model

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ABSTRACT

The COVID-19 outbreak can be described as a giant 'black swan' which has shattered the stabilization of the Hong Kong economy since 2019. To study how exactly the COVID-19 pandemic has really affected Hong Kong's macro economy, this article selects Hang Seng Bank, the most representative index issuing company in Hong Kong stock market, as a case study, and use the KMV model, which is relatively mature and has now become one of the world's most popular credit risk measurement model, to calculate the Hang Seng Bank's probability of default. Thus further draw the conclusion, which is the change of the probability of default of Hang Seng Bank is roughly consistent with the trend of the financial environment, and give some suggestions to reduce the bank credit risk.

Keywords: COVID-19, Credit risk, KMV model, Default distance, Hang Seng Bank.

1. INTRODUCTION

Credit level is the external embodiment of credit risk, and an institution with lower credit risk will mean higher credit level, namely higher credit rating [1]. In terms of risk analytic, credit risk has always been the most important factor in the function of financial markets and has a potentially significant impacts on economies at both the macro and micro level.

Foreign scholars studied the KMV model earlier than China. Chinese scholars began to discuss the KMV model gradually in 2000, and the articles they produced included the theoretical research and empirical analysis of the KMV model, and achieved good results.

This essay mainly adopts the literature research method, comparative analysis method and empirical analysis method to study the credit risk of Hang Seng Bank from 2017 to the first half of 2021[2]. During this period especially, people should be concerned about the solvency of banks affected by the pandemic. Therefore, it is of great practical significance for banks and consumers alike to measure the credit risk of the major bank like Hang Seng Bank and find out the basic factors which stand to affect it's credit risk.

2. OVERVIEW OF THE KMV MODEL

KMV takes the Black-Scholes-Merton model as the basis of its construction, while takes the company's financial data and the stock market information as the input.

The KMV model assumes that the expected probability of default is related to the asset volatility and asset value of the enterprise, and also holds that the value of the company can be obtained from the value estimate that the company shows in the stock market, so it is applicable to the credit risk evaluation of listed companies[3].

For KMV model only needs the basic situation of the company, including stock market price, number of shares and a small amount of financial data, and the information disclosed by the listed companies is accurate and easy to obtain. After obtaining the data, one can calculate the default distance, which is the number of standard deviations between the mean of the asset distribution at maturity and the debt, of the research object.

The theory behind the KMV model holds that the actual asset value of an enterprise is related to the equity market value reflected in the stock market. Therefore, when using the KMV model, it is necessary to organize and calculate the stock market data of the evaluated of the

enterprise in question, thus examining its equity value and volatility[4]. Its equity market value and volatility can be thus used as the basis for estimating the actual asset value and the significance of changes. Then, the debt component of the financial data of the enterprise is processed to calculate an indicator called the ‘default point’. Default happens when the value of company's asset falls below ‘default point’, which also means ‘value of the debt’. And finally, based on estimated enterprise asset value and volatility, the default distance index is obtained, which as mentioned is related to the company default probability[5]. The reverse relationship between the default distance and the default probability is that greater the default distance is, the lower the risk of default comes, and vice versa. Moreover, the relationship between the default distance and the default probability is calculated based on the default database, and based on this analysis, the last calculated default distance can be used to extrapolate the default probability.

The calculation of the KMV model can generally be divided into three steps, as follows:

First, the Default Point (DP) of the enterprise during the evaluation period is calculated. The financial data to be collected in the calculation includes current liabilities and non-current liabilities. Then, the equity value and equity value volatility are calculated based on the stock market data. Finally, the equity market value of the enterprise is assumed as a buy option, while the debt part of the enterprise is used as the sale option, and the underlying asset is the asset value of the object evaluated[6]. At this point, the equity market value estimation of the enterprise assets value can be realized according to the Black-Scholes-Merton model, and the formula is as follows:

$$V_E = V_A N(d_1) - De^{-rt} N(d_2) \tag{1}$$

$$\sigma_A = \frac{V_E \sigma_E}{V_A N(d_1)} \tag{2}$$

Where

$$d_1 = \frac{\ln\left(\frac{V_A}{DP}\right) + \left(r + \frac{\sigma_A^2}{2}\right)T}{\sigma_E \sqrt{T}} \tag{3}$$

$$d_2 = d_1 - \sigma_A \sqrt{T} \tag{4}$$

Secondly, Default Distance (DD) is calculated with the following formula:

$$DD = \frac{V_A - DP}{V_A \sigma_A} \tag{5}$$

Where

$$DP = STD + \frac{LTD}{2} \tag{6}$$

In order to calculate the default probability corresponding to a certain default distance, it is necessary to establish a mapping relationship between the default distance and the default probability, so that the

corresponding expected default rate can be found by the default distance, the formula is as follows:

$$EPF = 1 - N(DD) \tag{7}$$

Table 1. Explanation of Each Symbol

Symbol	paraphrase	state
V_E	Enterprise equity market value	Known
T	Time horizon	Known
D	Book value of corporate debt	Known
σ_E	The volatility of corporate equity value	Known
N	Standard normal distribution cumulative function	Known
r	Risk-free rate	Known
V_A	Enterprise asset value	Unknown
σ_A	Assets value volatility of enterprise	Unknown
STD	Corporate current liabilities	Known
LTD	Corporate non-current liabilities	Known

3. APPLICATION OF THE KMV MODEL TO HANG SENG BANK.

3.1. Introduction of Hang Seng Bank.

Established on 3 March 1933, Hang Seng Bank Limited is a Hong Kong and Mainland China focused bank. It is the largest locally incorporated listed bank in Hong Kong. Its long-term goal is to become a leading regional bank in greater China, focusing on south China and the Yangtze River Delta. Hang Seng Bank is also responsible for calculating the Hang Seng Index, the reference index for the Hong Kong stock market.

3.2. Data collection

The following table shows the indicators of Hang Seng Bank from 2017 to the first half of 2021, based on semi-annual reports, with HKD as the original currency. Among them, the number of non-tradable shares are 0. The time horizon was set this way because the pandemic occurred at the end of 2019. The credit risk performance of Hang Seng Bank in the previous two years before the epidemic occurred can be seen. Compared with the performance after 2019, the impact of COVID-19 on the

credit risk of Hang Seng Bank can be seen more intuitively.

In addition, for banks, securities, insurance and other financial enterprises, some assets or liabilities cannot be strictly divided into current assets and non-current assets,

so they are not distinguished between current liabilities and non-current liabilities when writing financial statements. Therefore, in this case, the default point is equal to the total liabilities of the enterprise. (Data source: Wind Database).

Table 2. Hang Seng Bank indicators data

Time	Volatility of equity value (%)	Hong Kong stocks (Thousands of stocks)	The closing price	Net asset per share	Gross liabilities/Default Point (Ten thousand HKD)	The value of equity (Ten thousand HKD)
2017.6.30	12.7135	191,184.2736	163.3000	75.7594	125,644,400.0000	31220391.88
2017.12.31	12.9784	191,184.2736	194.0000	79.5201	132,633,900.0000	37089749.08
2018.6.30	19.6874	191,184.2736	196.2000	81.4058	137,894,800.0000	37510354.48
2018.12.31	20.7632	191,184.2736	175.8000	84.7779	140,919,000.0000	33610195.3
2019.6.30	16.5550	191,184.2736	194.5000	90.3427	148,381,400.0000	37185341.22
2019.12.31	22.2900	191,184.2736	161.0000	93.5276	149,807,400.0000	30780668.05
2020.6.30	46.1325	291,478.3467	17.7000	31.8024	74,171,500.0000	5159166.737
2020.12.31	23.5241	191,184.2736	133.7000	95.7715	157,659,200.0000	25561337.38
2021.6.30	19.6339	191,184.2736	155.1000	96.0733	161,644,800.0000	29652680.84

3.3. The data processing

According to the calculation formula mentioned in the previous chapter, MATLAB program is used to

calculate, and the following table can be obtained. For the risk-free rate, this paper adopts the yield of Hong Kong 10-year Treasury bonds as the risk-free rate.

Table 3. KMV model running results

Time	risk-free rate	Value of the asset (Ten thousand HKD)	Asset value volatility	Default distance	Default probability
2017.6.30	0.01602	154868005.6	0.025629597	7.362584970	9.01913E-14
2017.12.31	0.01673	167523142.5	0.028734275	7.247971715	2.11529E-13
2018.6.30	0.02095	172546309.4	0.042799024	4.692265972	1.35098E-06
2018.12.31	0.02283	171348460.7	0.040727254	4.360425958	6.49048E-06
2019.6.30	0.01723	183032028.9	0.033633628	5.628728713	9.07713E-09
2019.12.31	0.0146	178416768.6	0.038454982	4.169845812	1.52403E-05
2020.6.30	0.00987	178934574.1	0.045409231	2.873005025	0.002032938
2020.12.31	0.00579	182310325.7	0.032982702	4.099579033	2.06951E-05
2021.6.30	0.01179	189402879.3	0.030738592	4.767809207	9.312E-07

3.4. Analysis of calculation results

In order to more intuitively see the probability of default and default distance of Hang Seng Bank from

2017 to the first half of 2021, the data in the table are plotted as two curves, as shown in the figure 1 and figure 2 below.

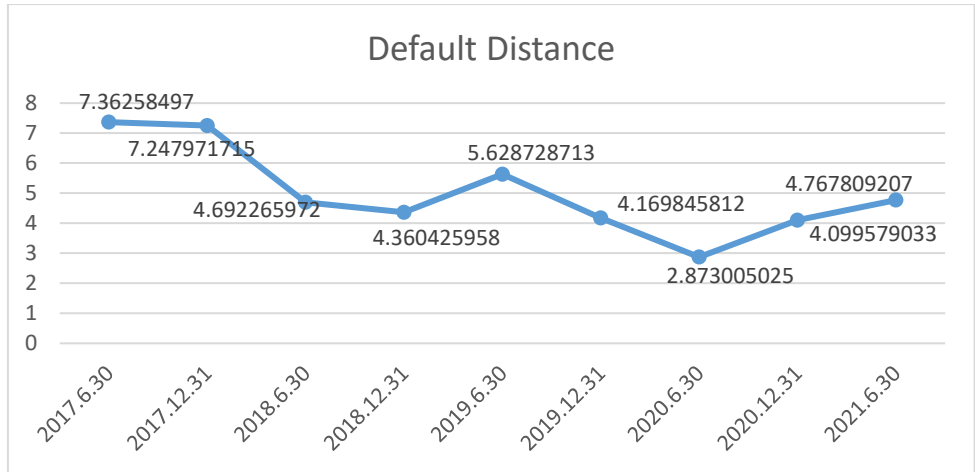


Figure 1 Break line chart of Hang Seng Bank's default distance before and after the covid-19

(X= Year; Y=The distance between the current market value of a company and the point of default)

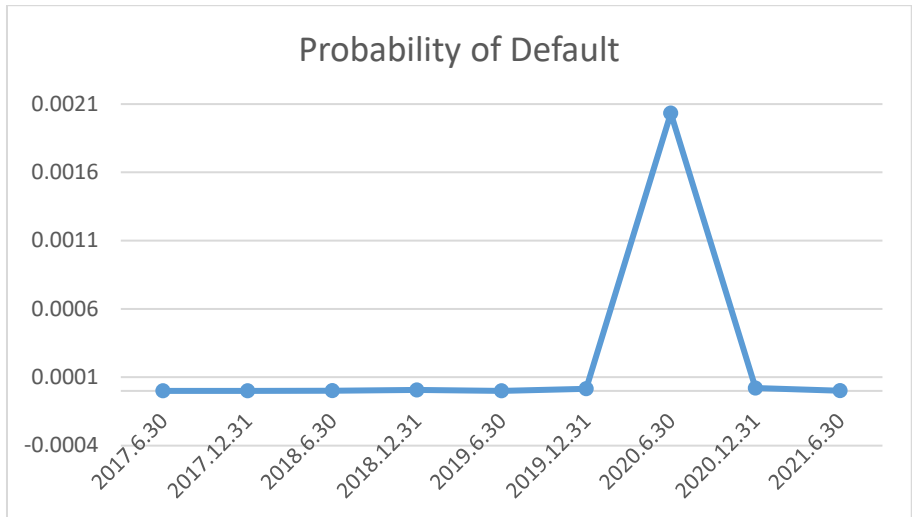


Figure 2 Break line chart of Hang Seng Bank's Default Probability before and after the covid-19

(X= Year; Y= %)

3.5. Results analysis

3.5.1. Chart interpretation

In terms of default distance, the larger the distance, the smaller the probability of default. Therefore, it can be seen from the figure that in the first half of 2017, the default distance of Hang Seng Bank was the largest, which was 7.36. But since then, it has been declining year by year until the first half of 2019, when it recovered to 5.63. Unfortunately, Hang Seng Bank's default distance dropped dramatically from the second half of 2019 to 2.88 in the first half of 2020, the lowest default distance in the chart. Since then, although the default distance has gradually increased, it has not recovered to the previous state. In the first half of 2021, the default distance of Hang Seng Bank is 4.77, which is 2.59 lower than the data in the first half of 2017.

The default probability chart is a little bit more

intuitive. From 2017 to 2019, the default probability of Hang Seng Bank is infinitely close to zero, but from 2020, the default distance increases sharply to around 0.002, and then decreases somewhat at the end of 2020. Finally, it dropped to 9.312E-07 in the first half of 2021.

3.5.2. Causes analysis

From the perspective of consumption, the outbreak of the pandemic and its prevention and control work are concentrated in the prime consumption period of the whole year, which is the Spring Festival holiday in 2020. Therefore, the negative impact is very obvious. During the epidemic broke out, residents' spending on food, clothing, entertainment and tourism declined significantly compared with previous years, leading to a sharp drop in sales revenue of related industries such as accommodation and catering, retail, film and entertainment, transportation and passenger transportation, and even almost zero in some industries.

The epidemic has also had a negative impact on daily business operations.

From a tourism point of view, over the past decade or so, Hong Kong's economy has benefited from a large number of mainland visitors, providing significant support to inbound tourism-related retail, accommodation services, catering services and cross-boundary passenger transport services. The pandemic is an indirect blow to the service industry. Since the "revised regulations" in Hong Kong in 2019, the number of mainland tourists to Hong Kong has sharply decreased to nearly 10%, at which time the source of tourism has become mainly foreign tourists. With the spread of the epidemic in the world, many countries have taken a negative attitude towards their citizens going abroad, and the number of foreign tourists to Hong Kong has sharply decreased. The tourism industry is in a near-depression, and the downturn in the tourism market has directly affected the turnover of shops and restaurants. Hong

Kong has long been known as a shopping paradise, and those shops and restaurants that rely on tourists to spend money in the "shopping paradise" city have suffered a lot. In addition to the impact of Hong Kong's "revised regulations" on mainland tourists to Hong Kong, the service industry has almost reached the lowest point in a year.

In terms of investment, the three major components of investment -- manufacturing, real estate and infrastructure investment -- have stalled due to the pandemic and its prevention and control efforts. At the same time, even if the resumption of work, in the flow of people, logistics, capital flow and other reasons for the smooth operation of the situation, the vast majority of enterprises to restore the normal level of production is still some time. Therefore, in the first quarter of 2020, the decline in the growth rate of the whole society's fixed asset investment was certain.



Figure 3 Hang Seng index trend chart (data resource: investing.com)

(X= Year; Y= Hang Seng index)

As can be seen from the trend of Hang Seng Index, from the second half of 2019, the index has been a dramatic downward trend, until January 2021 gradually eased, which shows how severe the COVID-19 has hit the Hong Kong economic market.

3.5.3. Suggestions on improving the credit level of Hang Seng Bank

Hang Seng Bank's credit level has a significant relationship with the level of the credit risk it faces. If Hang Seng Bank's funds are used reasonably and safely,

the credit risk it faces will be significantly reduced. The reasonable and safe capital operation of banks is an important factor for the safe and reliable capital service objects of Hang Seng Bank [7]. If supervisors can effectively identify potential risks to the safety of the service object and bank, it will greatly reduce the credit risk faced by bank, thus improve the level of bank credit. In order to achieve this goal, the Hang Seng bank should play a leading role, the joint of the rating agencies both at home and abroad, focusing on building effective and conform to the actual conditions of the credit rating system in Hong Kong, to regularly with business enterprise credit level test and establish the corresponding database for information storage, as the basis of system improvement in the future. The construction of high quality credit level evaluation system will be beneficial to improve the efficiency and effectiveness of Hang Seng Bank's prior investigation. This will be beneficial to reduce the possibility of default event from the initial stage, reduce the credit risk of Hang Seng Bank, so as to achieve the purpose of improving the credit level.

In addition, at present, the collection of corporate credit default data in Hong Kong is still in the initial stage, and the speed of development is relatively slow. If Hang Seng Bank can form effective cooperation with other banks to collect and share relevant data, it will greatly reduce the difficulty and cost of data collection and greatly improve the overall development speed. At the same time, information sharing can reduce losses caused by information asymmetry to banks, and also reduce the possibility of individuals or enterprises exploiting loopholes between different banks. The existence of the default database can promote model at the same time[8]. The test results of KMV model, for example, the Hong Kong market because of a lack of credit default data, so in the use of KMV model to measure credit risk, it is difficult to effectively do the default distance and probability of default effective mapping, thus, the results of the model are affected. If the database can be successfully established, it will allow the mapping of the KMV model to be more accurate, allowing the risk to be detected earlier.

4. CONCLUSION

This article first has carried on the simple introduction of KMV model, including the origin of the model, using conditions and the calculation process, and then apply it to one of the most famous bank in Hong Kong, which is Hang Seng bank, selected the COVID - 19 before and after the outbreak of the data for comparison, analysis of hang seng bank credit risk, finally obtained the main conclusion is as follow:

The change of the default probability of the bank in the case is roughly consistent with the trend of the financial environment. It is calculated that the default

probability of Hang Seng Bank reached its peak in the recent 5 years when COVID-19 broke out at the end of 2019, and then declined rapidly in 2020, returning to a lower level.

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