

Research on Chinese stock market based on CAPM: pre and post Covid-19 pandemic

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Abstract. The outbreak of COVID-19 has had a huge impact on China's economy. In order to study the specific impact, this paper uses the capital asset pricing model (CAPM) to make a comparative analysis of four assets in the two years before the epidemic (January 1, 2018 - January 31, 2019) and the two years after the epidemic (January 1, 2020.1-2021.13.31): A market composite index of stocks, bonds, gold, and oil. Firstly, the market portfolio is obtained by using capital market line (CML) analysis. On this basis, the following conclusions are drawn from the analysis. Firstly, the emergence of COVID-19 had a considerable impact only on the stock market in early 2020. Secondly, this paper again confirms that the CAPM model is not particularly suitable for the application of China's stock market. By all these analyses above, this paper aims to provide a reference for investors on whether to enter the Chinese stock market for investment in the influence of the COVID-19.

Keywords: CAPM; COVID-19; China's stock market; CML; Sharpe ratio.

1. Introduction

The background information on the Chinese stock market is distributed at the beginning of this paper. The establishment of China's stock market is due to the reform of China's economic market by the Chinese government in 1990s. From a highly centralized planned economy to a flexible market economy. China's stock market consists of two exchanges. Among them, Shanghai Stock Exchange (SSE) was founded on November 26, 1990, and began trading on December 19, 1990. The other is the Shenzhen Stock Exchange (SZSE), which was founded on December 1, 1990 and began trading on July 3, 1991. The Chinese government has given the Shanghai and Shenzhen stock exchanges different characteristics. Most of the companies listed on the SSE are large state-owned enterprises, so that the SSE is insulated from fluctuations in the world economy[1]. By contrast, companies listed on the SZSE tend to be small export-oriented companies. Therefore, the SSE index had been chosen, since this paper is investigating the economic performance of China.

This paper collected and read research on the market analysis of the Chinese economy since the outbreak of COVID-19 and found it was quite different from what the conclusion was initially expected. So first, these three studies are the impact of COVID-19 on the Chinese stock market.

Study 1: The impact of COVID-19 on China's stock market has shown a significant leverage effect and imposed a major impact on stock market volatility[2].

Study 2: By collecting data on stock value performance 50 days before and during the coronavirus outbreak, results showed that the average stock value of the China Stock Exchange Composite Index during the pandemic was significantly higher than that before the pandemic. The Shanghai Composite Index was highly resilient to the COVID-19 pandemic[3].

Study 3: The Shanghai composite index is only seriously affected in the short term, while the long-term index shows an upward trend as a whole. This is a sign that drastic measures by the Chinese government to contain the COVID-19 outbreak have restored confidence in the Shanghai stock market[4].

Based on these three research reports, conclusion was that the China's stock market does not have a long-term trend of being severely affected by the epidemic. On the other hand, the index was showing an upward trend thanks to the Chinese government's rapid response.

Since this paper has chosen to apply CAPM to China's stock market before and after the epidemic, some articles about the application of CAPM in China's stock market had been read and summarised as follows.

Study 1: The results showed that there was a negative linear relationship between regression and β [5].

Study 2: The monthly returns of 20 stocks in the SSE A-share market were selected as research data to verify the applicability of CAPM from January 2010 to May 2015. The conclusion was that the application of CAPM in this market is very weak[6].

Study 3: Select the stocks from SZSE, and find that the stock portfolio of SZSE was the same as the individual stock portfolio, but the β was more easily increased by the risk of the SZSE stock portfolio[7].

Study 4: 44 stocks of Shenzhen Stock Exchange and Shenzhen Stock Exchange were selected as samples to observe their market data in the past ten years. The conclusion showed that the time value of stocks was negative, which indicated that most investors in China's stock market are speculative investors. Second, the relationship between expected return and risk is not linear positive. That is, the relationship between expected return and risk of a stock is positive, but it is linear positive with CAPM expectation[8].

However, due to the research gap in comparing China's stock market before and after the epidemic with CAPM, this paper decided to use CAPM to study China's stock market before and after the epidemic for two years. It is hoped that the results of this paper can help analyze the resilience of China's stock market to the COVID-19 outbreak. By finding out the changes in the optimal investment portfolio before and after the epidemic, the reasons for the decrease and increase of indicators and the underlying logic behind them are analyzed. Thus, to give investors advice on how to change their portfolios to improve returns during the pandemic.

This paper will begin by introducing the two research methods used this paper. Firstly, the Sharpe ratio and Capital Market Line are introduced to calculate the Market Portfolio for 2018-2019 and 2020-2021. Then the two market portfolios before and after the epidemic were put into CAPM respectively to compare the risk and return rate. The influence of the epidemic on China's stock market was analyzed by analyzing the changes in the proportion of each index, the average return of the portfolio, and their risks.

To be more specific, section 2 analyzes the theoretical basis used in this paper and the results of selected data. Section 3 discusses two questions raised by the previous results. 1) Applicability of CAPM to the data selected in this paper. 2) Why is the average return rate of the market portfolio higher after the epidemic than before? Section 4 gives the results of the performance of China's stock market during the endemic, considers the applicability of CAPM, and the conclusion of this paper.

2. Method And Data

2.1 The sharpe ratio

The sharpe ratio is a concept that introduced the expected excess return per unit of risk as a measure of investment performance[9,10]. The formula of Sharpe ratio is:

$$SharpeRatio = \frac{E(Rp) - Rf}{\sigma_p} \quad (1)$$

Where $E(Rp)$ is the expected return of the portfolio, Rf is the risk-free interest rate, σ_p is the covariance of the extra return of the portfolio.

Under the assumption, investors will choose the portfolio with high Sharpe ratio since it is worth investing in. The reason is simply that when taking the same risk, the return of the higher Sharpe ratio portfolio will be higher.

Modern Portfolio Theory[11], illustrates that the portfolio on the mean-variance efficient frontier maximizes the Sharpe ratio. The tangency portfolio (market portfolio) this paper mainly talked about in the following article will refer to the intersection point of the Capital Market Line and mean-variance efficient frontier, to be more specific, Capital Market Line is tangent to the frontier. (CML

is a theoretical representation of different combinations of a risk-free asset and a market portfolio for a given Sharpe Ratio). This portfolio will be the highest Sharpe ratio portfolio within this fixed market circumstance because the gradient equals to Sharpe ratio. This paper will figure out the market portfolio for the index that has been chosen later.

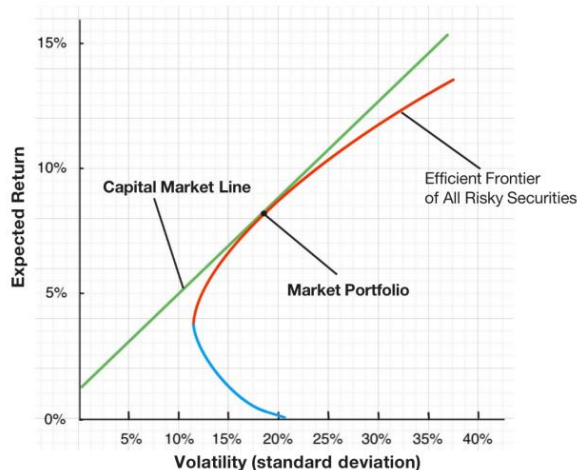


Figure 1 Relationship between CML, Market Portfolio and Efficient Frontier

2.2 The CAPM and its assumptions

According to the definition of CAPM, it is a model describing the relationship between expected return and market investment risk. The formulation is [12]:

$$Ra = Rrf + [Ba \times (Rm - Rrf)] \quad (2)$$

Where Ra is the expected dividend from investment, Rf is the risk-free rate, Ba is the beta factor of the underlying transaction, $(Rm - Rf)$ is the current market risk premium

Here are some core assumptions for CAPM to perform well. For example, investors can trade all market funds at competitive market prices. Beyond that, loans are tradable at risk-free interest rates. [13] Since this paper is using CPAM as an evaluating tool rather than observing its limitation, so the assumption is that all the above core assumptions hold.

2.3 Data

All indexes are all coming from the RESSET database[14].

There are in total five indexes, consisting of one risk-free index: The national debt index of China and four risky indexes: Shanghai securities composite index, the One-year Index of Chinese bonds, West Texas Intermediate (WTI), Gold Ounces(XAU). A four-year data for these five indexes had been taken and used R code to figure out the common time data for a fair comparison. Data had been divided into two groups, the first group is the data before the outbreak of COVID-19, indicated by the data of 2018.01.01-2019.12.31, and the second group is the data during the spread of the COVID-19, which is the data from 2020.01.01-2021.12.31. Thus, the following comparisons are all based on the comparisons of these pair of two-year period data.

3. Results

3.1 pre COVID-19 epidemic (2018-2019)

The following three diagrams are the image output from the RStudio, corresponding data 1-4 are XAU, Shanghai securities composite index, WTI, and the One-year Index of Chinese bonds.

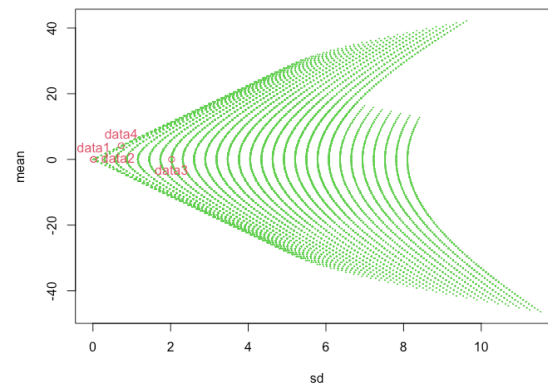


Figure 2 Possible portfolios in year 2018-2019

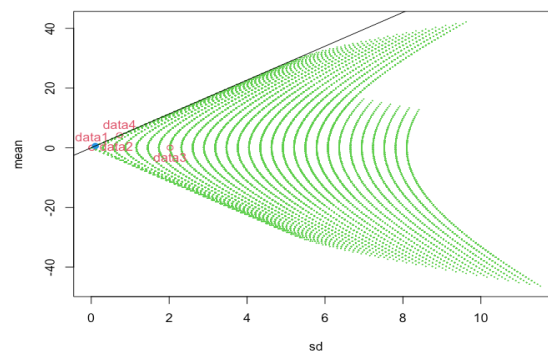


Figure 3 Figure 2 with CML and market portfolio

From the diagram, the market portfolio is lying on the capital market line, between data 1 and 4. The detailed weight of each index is 28.6% for XAU, 57.1% for the Shanghai securities composite index, 0% for WTI, and 14.3% for the One-year Index of Chinese bonds. The mean of the 18-19 portfolio is equal to 60.3% and the standard deviation is equal to 10.6%.

3.2 post COVID-19 epidemic (2020-2021)

The following three diagrams are the image output from the RStudio, corresponding data 1-4 are XAU, Shanghai securities composite index, WTI, and the One-year Index of Chinese bonds.

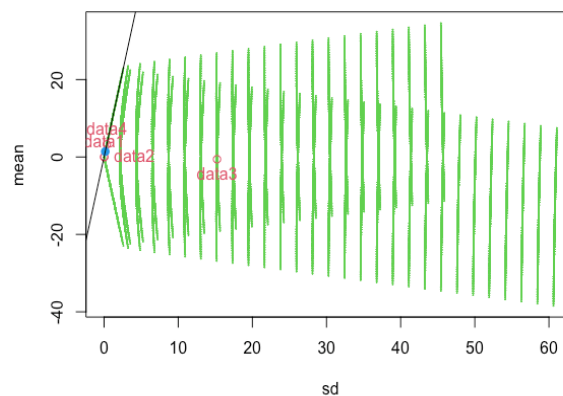


Figure 4 Possible portfolios in year 2020-2021

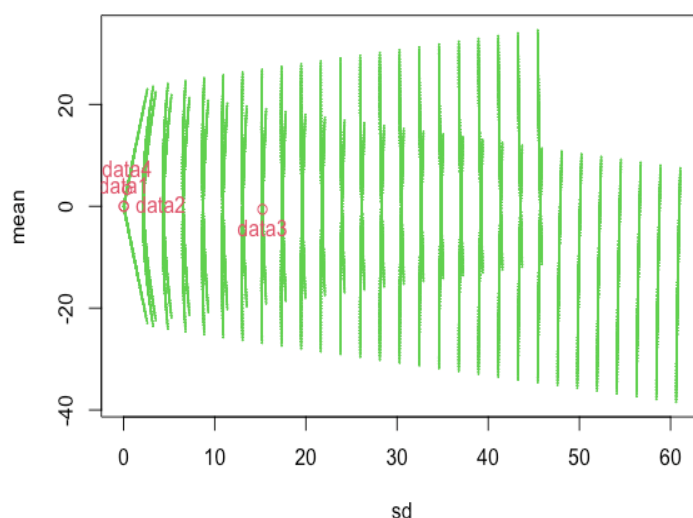


Figure 5 Figure 5 with CML and market portfolio

From the diagram, the market portfolio is lying on the capital market line, between data 1 and 4. The detailed weight of each index is 28.6% for XAU, 28.6% for the Shanghai securities composite index, 0% for WTI, and 42.8% for the One-year Index of Chinese bonds. The mean of the 18-19 portfolio is equal to 140.6% and the standard deviation is equal to 15.9%.

3.3 Analysis of the change of weight of two market portfolio

With the outbreak of the COVID-19, the weight changed on only two indexes, which were a decrease in the weight of the Shanghai securities composite index and an increase in the weight of the One-year Index of Chinese bonds.

So several conclusions can be derived from these results; Firstly, the decrease in the Shanghai securities composite index indicated that the general economic performance of the Chinese economy had been affected by the outbreak of the COVID-19. Since the Shanghai securities composite index is a composite index of the china stock market, the spread of the epidemic caused the overall stock price of the majority of the industries in China to fall. Secondly, the increased weighting of the One-year Index of Chinese bonds means that during the epidemic, when stock markets floated, it was better to invest in more stable one-year debt. Thirdly, the other two indexes; XAU and WTI, haven't changed because gold is a relatively stable long-term investment and the global gold index doesn't get very volatile from the economic impact of China. Crude oil is a volatile investment option in both portfolios. So crude oil is not taken into account when the maximum Sharpe ratio was calculated. Fourthly, On April 20, 2020, the bank of China crude Oil bao [15] US crude 2005 contract appeared to negative settlement price, some customers of crude oil Bao not only lost the principal but also made up the margin to the Bank of China. Some of The bank's customers said it had problems with product design and risk control and would Sue. The incident might be one reason why some Chinese investors have opted not to add crude oil to their portfolios.

3.4 Analysis of CAPM

Figure 6 and 7 are the CAPM constructed by the data above. According to the position of market portfolio in the two models, the performance of the market portfolio after the epidemic is better than that before the epidemic.

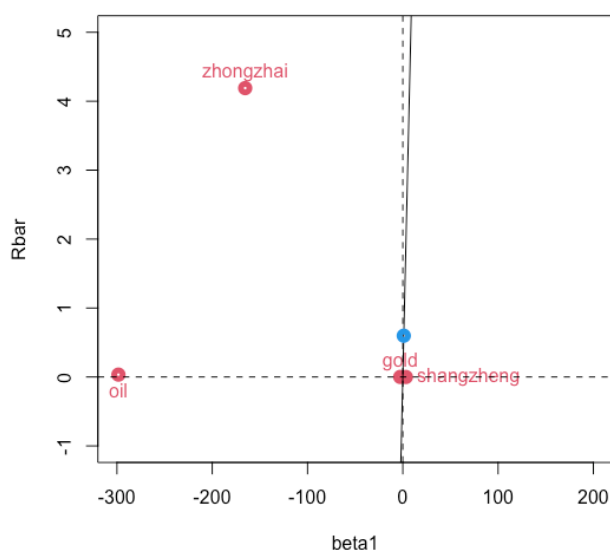


Figure 6 CAPM of year 2018-2019

Before the epidemic, the beta of the other three indexes except the Shanghai compose Index was negative, and the beta of the Market Portfolio was also negative. Indicating that these three indexes and the portfolio before the epidemic were not related to market changes (beta approaching zero) or were negatively related (large negative beta) before the epidemic.

After the outbreak of the epidemic, the beta of all indicators turned into positive numbers, which immediately showed that the epidemic did have an impact on the overall economy and China's stock market. At this time, the market portfolio could help to better avoid risks and obtain higher interest rates.

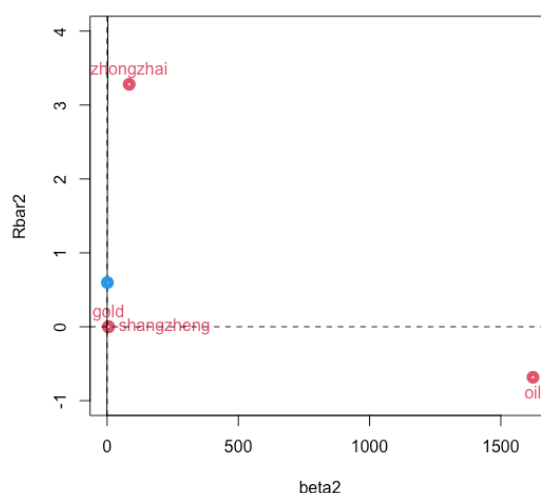


Figure 7 CAPM of year 2020-2021

4. Further Discussion

In this section, two main concerns are illustrated. Firstly, the results and patterns of the CAPM in this paper is quite different from the normal model. Secondly, Post-pandemic portfolios have higher interest rates.

4.1 Applicability of CAPM to the data selected in this paper

To answer the first question, several assumptions that CAPM holds should be reviewed.

a) Investors select portfolio assets by evaluating expected returns and variances b) The market must be perfect. c) The market is balanced. For example, The Chinese stock market is not perfect,

and transaction costs in the Chinese stock market are much higher than in mature western markets. In addition, because of the large number of non-tradable shares, it is difficult to find a suitable indicator as a proxy for the market portfolio. Thus, the reasons for the low applicability of CAPM in China's stock market are listed above. To sum up, as China's stock market is still in an emerging and immature stage, The applicability of CAPM in today's Chinese stock market is not very strong. Moreover, investors do not have full information about the portfolio they are investing in in the real market. They may take higher risks to recover losses already incurred.[16] All of this leads to differences in portfolio selection, a good example will be speculators. They won't follow the pattern of regular investors. They will only purchase some short-term and high-risk funds, and the return in a short time cannot be predicted by the model.

4.2 Higher average return rate of the market portfolio after the epidemic than before

For the second question, line graphs of cumulative returns for the Shanghai securities composite index in the period of 2018.01.01-2020.12.31 and 2021.01.01-2022.12.31 can be considered.

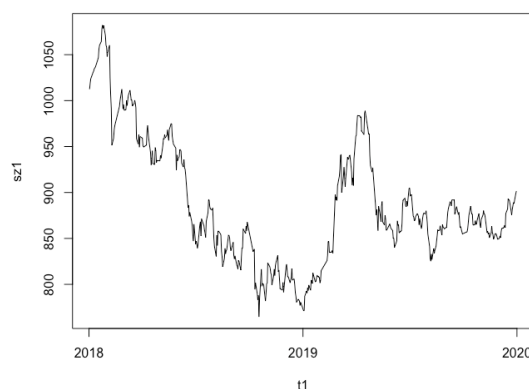


Figure 8 The Shanghai Composite Index in 2018-2019 earnings trend chart

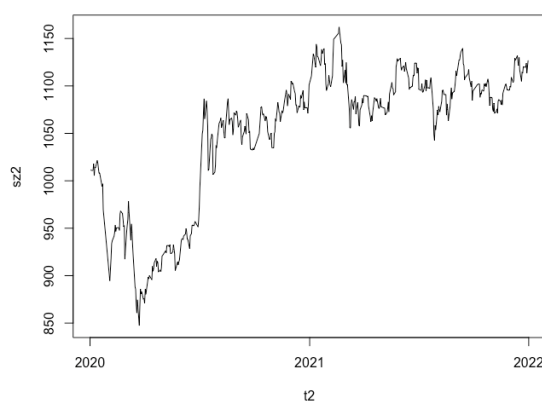


Figure 9 The Shanghai Composite Index in 2020-2021 earnings trend chart

From the comparison of data before and after the epidemic, the impact of COVID-19 on China's stock market was only concentrated in the first half of 2020. The composite index in the second half of 2020 and the whole year of 2021 had relatively stable positive returns. Therefore, the post-epidemic portfolio has a higher average return, since the impact of the epidemic on The Chinese stock market only lasted for half a year.

5. Conclusion

This paper uses the mean-variance approach and CAPM to study the impact of COVID-19 on China's stock market. First of all, the emergence of COVID-19 had a considerable impact on the stock

market in early 2020, but a series of measures taken by the Chinese government and the confidence of market investors made most of the impact gradually recovered in the second half of 2020. Secondly, this paper again confirms that the CAPM model is not particularly suitable for the application of China's stock market, the fundamental reason is that the assumptions required for the establishment of CAPM are not valid in China. This paper aims to help Chinese investors analyze the impact of the epidemic on China's stock market, as investor confidence has been reduced due to the arrival of the epidemic. A very positive result can help investors regain the confidence to choose their portfolio against the analysis of other investment indicators. Investors investing their money in the stock market can further boost the development of China's stock market and quickly recover from the impact of the epidemic.

References

- [1] K. Khan, H. Zhao, H. Zhang, H. Yang, M.H. Shah, A. Jahanger, The impact of COVID-19 pandemic on stock markets: An empirical analysis of world major stock indices, *The Journal of Asian Finance, Economics, and Business*, 7(7), 2020, pp.463-474. DOI: <https://doi.org/10.2991/icmess-18.2018.302>
- [2] X. Gao, Y. Ren, M. Umar, To what extent does COVID-19 drive stock market volatility? A comparison between the US and China, *Economic Research-Ekonomska Istraživanja*, 2021, pp. 1-21. DOI: <https://doi.org/10.1080/1331677X.2021.1906730>
- [3] C.C. Ngwakwe, Effect of COVID-19 pandemic on global stock market values: A differential analysis, *Acta Universitatis Danubius Oeconomica*, 2020, pp. 255-269.
- [4] K. Khan, H. Zhao, H. Zhang, H. Yang, M.H. Shah, A. Jahanger, The impact of COVID-19 pandemic on stock markets: An empirical analysis of world major stock indices, *The Journal of Asian Finance, Economics, and Business*, 7(7), 2020, pp.463-474. DOI: <https://doi.org/10.2991/icmess-18.2018.302>
- [5] J. Mao, Empirical test of the CAPM on Shenzhen Stock Exchange, *Academic Journal of Jimei University*, vol. 7, 2004.
- [6] Z. Wei, X. Ying, An empirical study on capm based on shanghai a-share market, *Journal of Guizhou Commercial College*, (In Chinese) vol. 28, pp. 5-10, 2015.
- [7] W.U. Yu-Dong, Empirical study of camp model based on shenzhen stock market, *Journal of Harbin* (In Chinese), University of Commerce(Natural Sciences Edition), vol. 27, 2011, pp.182., DOI : 10.19492/j.cnki.1672-0946.2011.02.015
- [8] Y. Gao, X. Yang, A Study on the Relationship Between CAPM and China Stock Market, Atlantis Press, *Advances in Social Science, Education and Humanities Research*, vol. 176, 2018.
- [9] W.F. Sharpe, Mutual fund performance Sharpe W.F.J. *Bus.*, 39, 1966, pp. 119-138.
- [10] W.F. Sharpe, The Sharpe ratio Sharpe W.F.J. *Portf. Manag.*, 21, 1994, pp. 49-58.
- [11] H.J. Markowitz, Portfolio selection Markowitz H.J. *Financ.*, 7, 1952, pp. 77-91.
- [12] W.F. Sharpe, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance*, vol. 19, 1964, pp. 425-442.
- [13] J. Berk, P. DeMarzo, *Corporate Finance*, Pearson, 2010, pp. 417-418.
- [14] Available at <http://www.resset.com>
- [15] Available at http://www.xinhuanet.com/money/2020-04/24/c_1125902581.htm
- [16] Curtis, Gregory, Modern Portfolio Theory and Behavioral Finance, *Journal of Wealth Management*, 2009, pp. 16-22.