

The impact of COVID-19 epidemic on Chinese stock market: based on the capital asset pricing model and Fama-French Three-Factor Model

Letian Li*

SINO-FRENCH engineer school, Nanjing University of Science and Technology, Nanjing, Jiangsu,
210094, China

*Corresponding author: llt254107804@njust.edu.cn

Abstract. According to macroeconomic theory, most investors usually focus on two factors when making investments: one is investment income, and the other is investment risk. In the research on the trade-off between risk and return, CAPM (capital asset pricing model) and Fama-French three-factor model are one of the representative research results in the history of financial development. This article will use these two models to analyse China's A-share market before and after the epidemic, and then study the impact of COVID-19 on China's capital market

Keywords: Fama-French Three-Factor Model, CAPM model, Chinese A Stock Market, COVID-19 Epidemic

1. Introduction

Capital asset pricing has always been a hot topic in contemporary finance study. Among the numerous research and theoretical results, the Capital Asset Pricing Model (CAPM) Sharpe (1964) [1], Lintner (1965) [2] and Black (1972) [3] introduced, as one of the most important theoretical cornerstones in the financial field, has experienced countless empirical tests in recent decades.

There're some assumptions about CAPM [4], 1. Diversified portfolios are held by investors. 2. Transactions with a single-period time frame 3. A risk-free rate of return is available to investors who want to borrow and lend money. 4. The assumption of a perfect capital market is that all assets are valued accurately and that their returns will plot on to the SML. In a perfect capital market, there would be no taxes or transaction fees, and all investors would have identical expectations as a result of having unfettered access to perfect information. All investors must also be risk averse and rational in their desire to maximise their own utility. Finally, there must be an enormous number of buyers and sellers in the market to make it perfect.

Natural disasters, significant disasters, and public health events all have the potential to have an impact on financial markets. Early literature used case study methodologies and event study methods to examine the impact of public emergencies on financial markets [5]. For example, A study conducted by Ragin and Halek [6], using the event study approach, examined the 43 disasters that resulted in the most significant insured damages since the early 70s. They discovered that insurance brokers received anomalous returns on their stock holdings on the day of the disaster. Many researchers have undertaken study on the impact of emergencies on financial markets using advanced econometric models as a result of the ongoing development of current approaches. For example, Bai [7] investigated the effects of rare disasters on a general equilibrium model with heterogeneous firms, and discovered that the CAPM model that took unexpected shocks into account was more accurate in describing share prices; Lanfear's [8] researchs have shown that such contingencies related to aggregate consumption growth can have a significant effect on the share market. Judging from the above research results, there are few research results in China on the impact of a certain emergency, especially a new outbreak on stock prices. At the same time, the Covid-19 epidemic is destructive, sudden and persistent, and the impact on society and the financial economy is huge. The research uses the A-share stock index to establish relevant models and make retrospective predictions, and analyses the impact of the epidemic on various industries in China at different stages, in order to provide investors and relevant decision makers with more useful information and theoretical basis.

2. Construction of Capital Asset Pricing model

The CAPM is a model for pricing an individual security or portfolio, thus:

$$E(R_i) - R_f = \beta_i(E(R_m) - R_f) \quad (1)$$

The Capital asset pricing model formula shows that the return on our investment portfolio and β have a linear connection. The approach of hedging is most commonly used by institutions in the actual investment process to counter the systemic risks posed by the broader market in order to generate profits on the portion of the portfolio that outperforms the broader market.

2.1 Practical application of CAPM

In the process of practical application, Jensen [9] introduced α Parameters, as a result, the CAPM model can be expressed as follows: $R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \epsilon_{it}$. The subscript "it" represents that this is the sequence data, and the last item represents the error item. In the previous formula, all yield data are values of expectation. In practical application, we trend to use Jensen's formula to solve it α and β . α represents the part where the yield is better than the market.

This paper selects the five most representative stocks in the A-share market, and reflects the impact and changes of the five industries of transportation, insurance, express delivery, manufacturing, and medicine under the impact of the epidemic.

2.2 The Fama-French three-factor model theory

It has been demonstrated in numerous empirical investigations and applications of the CAPM model, that the market risk premium is insufficient to explain the returns of individual risky assets. Consequently, a large number of researchers began to look into additional factors, such as company market value, PE (price-earnings ratio), leverage ratio, book-to-market value ratio, etc.

They conducted a thorough investigation into the effects of various factors in combination. [10] When β is used alone or combined with several other factors, the β 's power of explanation is very weak; when market capitalization, PE leverage ratio are used alone, BM (book-to-market ratio, the inverse of PB) has a strong explanatory power for returns.

Afterwards, Fama and French identified three important parameters and constructed a linear model with the rate of return as the dependent variable, similar to CAPM. The formula of Fama-French Three-Factor Model:

$$E(R_{it}) - R_f = \beta_i[E(R_{mt}) - R_f] + s_iSMB_t + h_iHML_t \quad (2)$$

3. Empirical Data Analysis

3.1 Data selection

The data selected in this paper are the daily trading data of five stocks on the Shanghai Stock Exchange as the research object, and the China Securities A-share index as the market benchmark. The data source is *tushare*, which is obtained online using Python. The selected time interval is the transaction data from December 20, 2018 to December 20, 2019(one year before the outbreak) and December 20, 2019 to December 20,2020(one year after the outbreak), and the risk-free yield is the current three-year treasury bond interest rate.

3.2 Construction of Fama-French Three-Factor Model

First, according to the company's market value and book value ratio, six combinations are formed, namely SL, SM, SH, BL, BM, and BH. The expression formula is as follows:

$$SMB_t = \frac{1}{3}(SL_t + SM_t + SH_t) - \frac{1}{3}(BL_t + BM_t + BH_t) \quad (3)$$

$$HML_t = \frac{1}{2}(SH_t + BH_t) - \frac{1}{2}(SL_t + BL_t) \quad (4)$$

3.3 Analysis of regression results

A summary of cumulative abnormal returns and standard deviation is given in Table1 and Table2. By comparing those two sets of data, there're some important findings in the understanding of influences that the COVID epidemic brought to those five sections. First comes the insurance industry. The cumulative abnormal return has suffered a significant decline during the epidemic, and the standard deviation also raised approximately one third. Then as it is shown in the linear regression fitting results, R square equals 0.387 and 0.408, the fitting effect isn't too well. The constant terms are both close to 0, which shown that the stock trend basically keeps pace with the entire market. The betas are 1.0954 and 1.31, increased nearly one third, as the whole market shows a downward trend, the overall performance of the entire industry is not good, and the investment risk is relatively very high. The outcome also leads to the following conclusion: 1. The epidemic has a significant impact on the growth of the life insurance business as well as the income of intermediary employees as well as the stability of their employment. 2. The existing business of property insurance will be impacted to a limited extent, but the incremental business will most likely suffer a significant reduction in volume. 3. As a result of the downturn in business, some small and medium-sized insurance companies have seen their cash flow risk and loss pressure increase significantly. Despite the fact that insurance pay-outs will increase, the overall pressure on the system will be minimal. 5. The use of insurance funds has resulted in an increase in market and credit volatility.

Also, due to the epidemic, the transportation industry has been more impacted. "China Railway Rolling Stock Corporation" became the only stock to gain negative cumulative abnormal return among the five stocks selected. R square equals 0.576, the fitting effect is relatively fine. The constant terms are both negative, means that its own value generated an additional loss of approximately 0.0018. Both beta values are less than 1 and shown a downward trend. That's a good thing in the overall market downturn. The results lead to similar conclusion where as a major emergency, the COVID epidemic occurred during the spring festival railway travel rush. The event lasted and will continue existing for a long time and had the most significant impact on the development of railway capacity of transportation in the short term; from an overall perspective, it had little impact on railway freight development and infrastructure investment; and the shock varies regionally, but surely not for long. In the short term, the demand for railway transportation during the spring festival will be significantly suppressed. During the 40-day period of spring festival, as crowded places, once there is an epidemic in stations and carriages, the consequences will be unimaginably bad. The conclusion can be drawn from this that there is a statistically significant positive association between the demand for railway passenger transport and the spread of the epidemic. In the medium term, there may be a brief rebound in rail travel demand. It is expected that as the epidemic enters a period of recession and extinction, there will be a short-term rebounded in railway transportation, and the rebound areas will mainly be concentrated in provinces, cities, and regions with relatively developed economies and good operated high-speed rail network. The transportation department predicts that by the end of the spring festival travel on February 18, there will be at least 150 million people on travel across the country. In the long term, the digitalization of railway transportation service will accelerate. Although the epidemic has a certain negative impact on railway transportation, it can also be seen that the event is accelerating the development of railway transportation in the direction of digitization. The COVID epidemic brought some challenges, but also provided with the potential of the explosive rebound of the stock price. Risks and opportunities coexisted.

YTO express is one of the most famous and also one of the biggest courier companies in China. Obviously, the epidemic has had a huge negative effect on YTO express as the cumulative abnormal return turned from positive to negative during the epidemic. R square equals 0.238, which shows

that the fitting has lost its effect. CAPM model has lost its function. For express business, the biggest hindrance at present comes from the impacts of epidemic lockdowns in key areas and traffic control. Also due to the epidemic, a large number of front-line staff were unable to come back to work and the resumption rate of express service point was affected to a certain extent. Three main problems have been concluded: 1. The package of express delivery is at risk of contamination with virus. During the initial stages of the outbreak, the infection mechanism was not clear enough to make sure that the express delivery is completely safe, in which case many areas stopped banned the delivery service entirely, which is a great impact to the whole industry. 2. Lack of resources. The supply of consumable such as masks and disinfectants are seriously insufficient, resulting in resumption of work after Spring Festival. 3. Due to the needs of virus prevention, nearly all communities are under closed management. The courier could not enter the community. With the continuous improvement of the situation dealing with the epidemic, the lives of more residents have gradually returned to normal, and the demand for delivery increased significantly. How to ship the package to the client became the major problem. The risk of spreading virus; the possibility of package loss; the huge number of pieces... Finding solutions to deliver accurately became an unavoidable problem. All in all, Express industry has become riskier than ever, coupled with the fierce competition in the domestic of express industry and the harsh living environment, it's hard to be optimistic about the future of current enterprises in the domestic.

Mao tai is a kind of traditional Chinese grain wine and also one of the most famous of its kind. The price of Mao-tai has skyrocketed in recent years, and it appears that the tendency will continue.

There's no exaggeration saying that it has become more than a commodity, more value stable than actual money. As it's shown in the data table, for commodities with a huge disparity between supply and demand and high premiums, the epidemic seemed not to bring much price fluctuations in a short period of time. But with the Fed raising interest rates and all similar actions taken place, these kinds of commodities will keep going up.

Finally come to the industry most closely related to the epidemic - medical and biological. The stock of SINOPHARM is the leading stock of the entire stock block, which is able to represent the whole industry well. The R square only values 0.067 after the epidemic took place. The fitting fails. Using the three-factor model, we will be able to properly evaluate the effect that the epidemic brought to the industry. There is an important finding in the understanding of the pharmaceutical industry. After the opening of the stock market during the spring festival, the impact of the epidemic on the market was not as severe as expected at first. It's obvious that the market will be optimistic about the pharmaceutical block of stock since there was an infectious disease outbreak in the county and it's deeply related to the public health. However, this upward trend did not last for more than a week. In order to control the spread of the virus, minimize the scale of the epidemic, the government delayed the date that the enterprises back to work, and the economy was affected by the non-operation of enterprises. The COVID virus was well taken control of a few weeks later. Many enterprises returned to work around march. The Shanghai Composite Index raised about 5.51%, some of the top tier companies raised even faster than the whole market. Most of the investors were optimistic about the market's future.

However, the epidemic went out of control outside of China since March. The number of confirmed now COVID patients in Italy and the United States has risen sharply, and the prices of global capital markets, including gold and oil, continued to fall due to the epidemic, triggering the circuit break mechanism of the US stocks for several times. All countries affected by the virus have announced the suspension of work and international routes. The global economy was greatly, negatively affected. In addition, due to the phenomenon of global integration, the number of imported cases from abroad has continued to increase, and China is not an exception. The declining trend in China's economy is becoming more and more clear with each passing day.

Table 1. Capm model fitting results

Name of the stock	Stock code	β_i		s_i		h_i		α_i		R^2	
		Before	After	Before	After	Before	After	Before	After	Before	After
China Life Insurance Company Limited	601628.SH	1.3755	1.5628	-	-	0.5140	0.514	0.001	0.0023	0.5950	0.5390
CRRRC Corporation Limited	601766.SH	0.7828	0.8404	-	-	0.5426	0.5426	-	0.0013	0.6420	0.6730
Kweichow Moutai Group	600519.SH	0.9258	0.7516	-	-	0.9648	0.9648	-	0.0014	0.5680	0.5130
YTO Express	600233.SH	0.9860	0.8941	-	-	0.1477	0.1477	0.0005	0.0008	0.3470	0.2390
SINOPHARM	600056.SH	1.0780	0.3106	-	-	0.2173	0.2173	-	0.0004	0.6210	0.0900
CNI Index of A-share	399317.SZ	-	-	-	-	-	-	-	-	-	-

Table 2. Fama-French three factor model fitting results

Name of the stock	Stock code	Cumulative abnormal return		standard deviation		α_i		β_i		R^2	
		Before	After	Before	After	Before	After	Before	After	Before	After
China Life Insurance Company Limited	601628.SH	0.59065	0.14602	0.02327	0.03043	0.0009	-0.0003	1.0954	1.310	0.387	0.4080
CRRRC Corporation Limited	601766.SH	-0.2150	-0.2288	0.01257	0.01460	-	-0.0017	0.7226	0.6529	0.576	0.4400
Kweichow Moutai Group	600519.SH	1.0133	0.61270	0.01930	0.01811	0.0021	0.0013	0.8133	0.7819	0.310	0.410
YTO Express	600233.SH	0.2236	-0.0459	0.02254	0.02692	-	-0.0008	0.9993	0.8861	0.343	0.238
SINOPHARM	600056.SH	0.0428	0.1692	0.01743	0.02275	-	0.0004	1.0313	0.3984	0.611	0.0670
CNI Index of A-share	399317.SZ	0.2899	0.2478	0.01321	0.01483	-	-	-	-	-	-

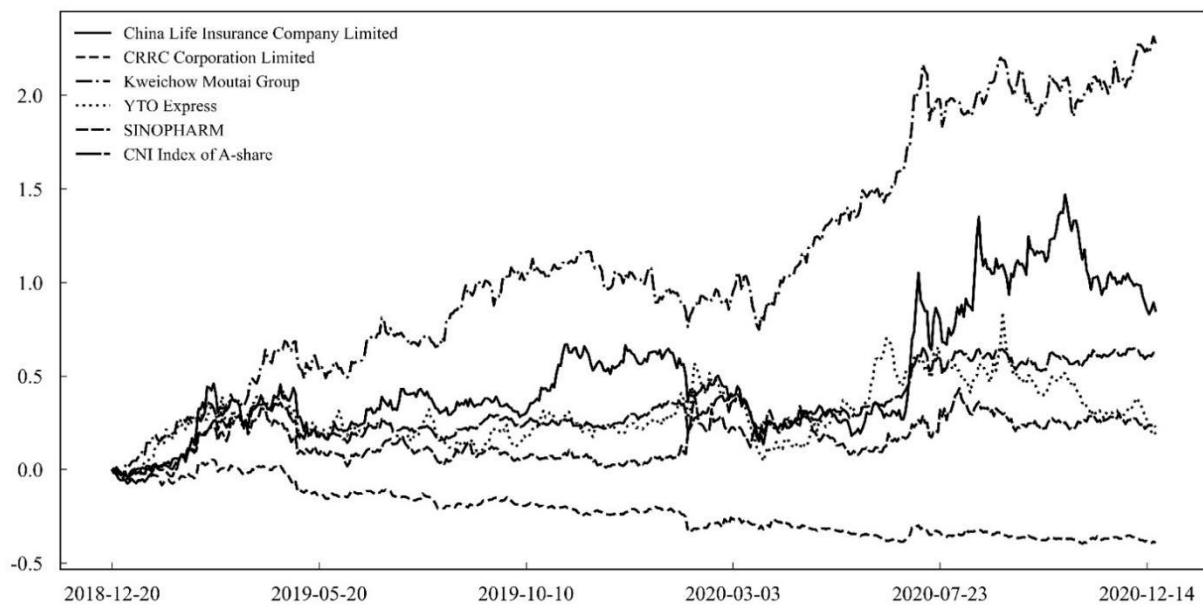


Figure 1 Cumulative abnormal return4. CONCLUSIONS

In the context of the emergency of the new crown epidemic, this study conducted a time series analysis of the returns of five representative stocks selected, and performed linear fitting with the CAPM model and the Fama-French Three-Factor model and then studied the impact of the epidemic on China's various industries. Judging from the experimental results, the impact of the COVID-19 epidemic on various industries in China has been long, and the impact has been strong and won't end anytime soon. The epidemic has varied effects on different micro-individuals. Private companies have a greater influence than state-owned enterprises, small and micro businesses have a greater impact than major corporations, and migrant workers have a greater impact than normal employees. Employee pay is directly proportional to the company's operational efficiency. When the efficiency of the company reduces, the salaries, bonuses and employment of employees will be seriously affected, especially in the industry that has been hit hard: insurance, manufacturing, transportation and other industries and small and medium-sized enterprises. For the pharmaceutical industry, the impact was mostly positive, and the tendency will continue for a long time

However, in the financial market, there so are many factors affecting stock price changes, such as political and legal factors, macroeconomic changes and even the impact of other emergencies. In addition, whether companies in various industries are doing well is also an inseparable factor from their stock prices. Therefore, in the forecasting research of stock price, more control variables need to be considered and more accurate models need to be studied.

References

- [1] W. F. Sharpe, 1964, Capital asset prices: a theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425- 442.
- [2] J. Lintner, 1965, The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics* 47, 13- 37. [3]C. Baier, J-P. Katoen, *Principles of Model Checking*, MIT Press, 2008.
- [3] M. Kwiatkowska, G. Norman, D. Parker, Stochastic model checking, in: M. Bernardo, J. Hillston (Eds.), *Proceedings of the Formal Methods for the Design of Computer, Communication and Software Systems: Performance Evaluation (SFM)*, Springer, Berlin, Heidelberg, 2007, pp. 220–270. DOI: https://doi.org/10.1007/978-3-540-72522-0_6
- [4] D. Watson, and A. Head, (2016) *Corporate Finance: Principles and Practice*, 7th edition, Pearson Education Limited, Harlow pp.258-9
- [5] M. Chesney, G. Reshetar. M.Karaman, 2011, "The Impact of Terrorism on Financial Markets: An Empirical Study", *Journal of Banking and Finance*, Vol.35,pp.253~267.
- [6] M.A. Ragin, and M. Halek, 2016, "Market Expectations Following Catastrophes: An Examination of Insurance Broker Returns", *Journal of Risk and Insurance*, Vol.83, pp.849~876.
- [7] H. Bai, K. Hou, H. Kung, E. X. Li., and L. Zhang, 2019, "The CAPM Strikes Back? An Equilibrium Model with Disasters", *Journal of Financial Economics*, Vol.131, pp.269~298.
- [8] M.G. Lanfear, A. Lioui, and M.G. Siebert, 2019, "Market Anomalies and Disaster Risk: Evidence from Extreme Weather Events", *Journal of Financial Markets*, Vol.46, pp.100477.
- [9] M.C. Jensen, "The Performance of Mutual Funds in the Period 1945-1964," *Journal of Finance* 23, 1968, pp. 389-416.
- [10] E. F. Fama K. R. French, 1993. "Common risk factors in the returns on stocks and bonds". *Journal of Financial Economics*. 33: 3–56. CiteSeerX 10.1.1.139.5892.doi:10.1016/0304-405X(93)90023-5.