Evaluation of CAPM and Three-factor Model During the COVID-19: Evidence from Chinese Catering Industry

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Abstract. In 2019, the COVID-19 pandemic emerged in China and rapidly disseminated worldwide, causing a greater-than-expected impact on the global economy. Most countries' stock markets were not optimistic, and stocks from different industries have elicited varying social reactions. The paper selects the stocks of 12 hotel and catering industry companies from 2019 to 2022 as research objects to explore the fluctuations experienced by the hotel and catering industry's stock market during the epidemic. The aim is to test the explanatory and predictive capabilities of the CAPM and the Fama-French-Three-Factor (FF3F) Model on the returns and excess returns of the hotel and catering industry's stock, and further compare the performances of the two models. The research findings indicate that the Three-Factor Model surpasses the CAPM model in both explanatory and predictive capabilities. These results shed light on the guiding significance of these two models for listed companies in the catering industry to carry out market value management or for investors in choosing investment projects.

Keywords: CAPM, Fama-French Three-Factor Model, Stock returns, Hotel and catering industry stocks.

1 Introduction

The CAPM and the FF3F Model are critical topics in the financial field and are still widely accepted and used in the industry today [1]. The CAPM model is an earlier theoretical model, but various empirical studies have repeatedly shown unsatisfactory explanations, leaving room for improvement. The FF Three-Factor Model was formed by adding extra ratio factors to the CAPM model.

Comparative results of empirical tests between the CAPM and the FF3F Model in different industry market stocks have been a popular research topic. A study of Chinese A-share market oil stocks from January 2011 to December 2021 showed that the FF3F Model was superior to the CAPM in both explanatory power and the ability to predict asset returns [1]. A study of sample data from October 2015 to September

F. Balli et al. (eds.), *Proceedings of the 2023 2nd International Conference on Economics, Smart Finance and Contemporary Trade (ESFCT 2023)*, Advances in Economics, Business and Management Research 261,
https://doi.org/10.2991/978-94-6463-268-2_10

2020 in the pharmaceutical industry also produced the same result, with the FF Three-Factor Model performing significantly better than the CAPM model [2]. In a study of Mongolian mining company stocks, the value of parameter β in the CAPM model was adjusted to improve the explanatory power in the evaluation of corporate equity assets [3]. Previous research has shown that the CAPM model has limitations compared to the FF model in many industries. However, there is no relevant research on the empirical test of the two models in the hotel and catering industry, especially in the context of significant international public health events. China's economic environment has been greatly impacted by the COVID-19 outbreak and associated policies. In the environment, whether the two Models can still demonstrate results like previous research is a question worth studying [4-6].

The COVID-19 epidemic originated in Wuhan in December 2019. The epidemic was gradually stabilized under national control and treatment until April 2020. From the end of 2020 to the end of 2022, there have been various degrees of recurrence in different regions, and some areas have even experienced multiple epidemic recurrences. In the first half of 2022, there was another large-scale nationwide epidemic recurrence. Under policy intervention, China has repeatedly experienced the process of lockdown and reopening. During the entire epidemic, the lockdown measures caused a considerable impact on the real economy, while different levels of reopening policies led to a phased recovery of the economy, which has been in an unstable fluctuation state. Eventually, the country lifted the lockdown completely at the end of 2022, and the economy and industry began to gradually recover. The outbreak of the epidemic in 2019 had a significant impact on China's social and economic activities. Business operations decreased, social consumption weakened, most listed companies' performance was affected, and investors' investment sentiment also showed a panic trend. In the economic environment, investors' risk preferences decreased, and risk-averse sentiment increased [7-10]. The hotel and catering industry's stock market faced instability amidst the epidemic. Moreover, due to the influence of China's One Country, Two Systems policy, the stock market reactions of the hotel and catering industry in the inland and Hong Kong regions were not entirely consistent.

The paper aims to analyze the variations in the stock market responses of the Chinese hotel and catering industry and to test the explanatory power and expected return rate of the two models for stocks with excess returns during the epidemic outbreak. Relevant data were obtained from the official website of Nanjing Securities and were used as the sample data of the time-series data of the listed stock returns in the Chinese catering and hotel industry (2019-2022) for empirical testing. The paper selects six stock data from the catering industry in the mainland and Hong Kong stock markets separately from 2019 to 2022 for analysis and research, conduct an empirical study on the applicability of the two selected models, and further compares the empirical results of the two models.

2 Data & Method

2.1 Data

The data used in this article is obtained through multiple channels. This article obtains market value and yield information of six mainland stocks through Nanjing Securities, and obtains corresponding information of Hong Kong stocks through Flush. This article obtains the market yield and risk-free interest rate values through the Oriental Wealth Choice website. Among the mainland stocks, Huatian Hotel, Jinling Hotel, Quanjude and Xi'an Catering adopt the Shenzhen Composite Index yield as the market yield; The two stocks of Jinjiang Hotel and Capital Travel Hotel use the Shanghai Composite Index yield as the market yield. Hong Kong stocks use the AH-Share A-Index yield as the market yield. In addition, for all R_f in this article, the yield of ten-year treasury bond is used. Due to the small number of listed companies in the hotel and catering industry in mainland stocks, only six stocks were found to be available for research after a search. Therefore, in terms of mainland stocks, all six stocks were included in the research scope, and based on the value of these stocks, six stocks with equivalent market capitalization in Hong Kong stocks were identified as research objects. The size factor SMB and value factor HML are constructed based on the monthly market value and book yield obtained from the official website of Nanjing Securities for the period 2019 to 2022. Firstly, according to the market value scale of listed companies during the last five years, stocks are divided into two groups on average, namely, the small group and the Big group. The benchmark for division is the median market value of all companies in the market during this period. According to the book yield, the stocks on the market are divided into three groups from small to large, with the first 30% being the Growth group, the middle 40% being the Neutral group, and the last 30% being the Value group. The calculation is based on the weighted average of the monthly returns of stocks in each group.\

2.2 CAPM

In 1964, American scholars William Sharp, Ritter, Trino, and Mosin developed the CAPM, which analyzes the correlation between the anticipated returns of securities in the market and the associated risks of assets. The model is developed using asset portfolio theory and capital market theory. The core content of the CAPM model is in an efficient market. The CAPM model makes some assumptions about investment, such as the variance or standard deviation of the return on investment is used for investment risk; expected returns and risks are main factors that influence investment decisions; and investors tend to choose high-return securities under similar risk level, and low-risk securities under similar rate of return.

2.3 Three-factor models

Under the premise of linear time series, the expression of the FF3F model is：

$$E(R_i) - R_f = \beta_{i,m}[E(R_m - R_f)] + \beta_{i,HML}F_{HML} + \beta_{i,SMB}F_{SMB} \quad (1)$$

Here, the HML factor in the model is used to measure the value effect of the stock. The SMB factor is used to measure the size effect of the stock, and the value of the SMB factor is obtained by subtracting the return rate of the stock with a large market value from the return rate of the stock with a small market value.

3 Empirical Analysis

3.1 CAPM model

The expression of the CAPM model:

$$E(R_i) = R_f + \beta_{i,m}[E(R_m - R_f)] \quad (2)$$

Here, $E(r_i)$ represents the expected return rate of asset i, r_f is the risk-free interest rate; $\beta_{i,m}$ is the systematic risk of asset i, $E(r_m)$ is the expected return rate of market m; $E(r_m - r_f)$ represents the risk premium, which is the difference between the expected market rate of return and the risk-free rate of return. The linear regression expression of the CAPM model:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,m}(R_{m,t} - R_{f,t}) + \varepsilon_{i,t} \quad (3)$$

In the paper, i represents one of the 12 stocks. $R_{i,t}$ is the rate of return of asset i at time t; $R_{f,t}$ is the coupon rate of the one-month government bond at time t; $\varepsilon_{i,t}$ is the unsystematic risk of asset i at time t; α_i is the abnormal return of asset i, which is the discrepancy between the anticipated surplus excess return and the real value. Assuming the validity of the CAPM model is valid, α_i is equal to zero, which means that the excess returns of individual stocks are premium compensation for market risks. In the paper, the selected twelve stocks are calculated through the regression modeling calculation of Excel, and the confidence intervals of all models are 95%. Table 1 and Table 2 list the regression results of mainland China stocks and Hong Kong stocks respectively. The CAPM theory suggests that the increased returns can be completely accounted by the premiums of market risk. If the CAPM model holds true, then the regression analysis should indicate a statistically significant zero value of the α.

Table 1. Regression Results of CAPM model (Chinese mainland).

	$\beta_{i,m}$	α_i	The P-value ofα_i	R Square
Huatian Hotel	0.017185143	-0.027802899	3.36057E-28	5.39881E-05
Jinling Hotel	0.722657604	-0.007847705	3.12727E-05	0.139644465
Jinjiang Hotel	1.089146601	0.003751953	0.083284752	0.207177489
Quanjude	0.692089572	-0.008575009	4.84832E-08	0.177301473
Shoulv Hotel	1.221787548	0.007136756	0.001828706	0.228007963
Xi'an Diet	0.773356265	-0.005106488	0.029113954	0.106954082

Table 2. Regression Results of the CAPM model (Hong Kong).

	$\beta_{i,m}$	α_i	The P-value ofα_i	R Square
Binshi International	0.453393236	-0.017773576	5.70563E-05	0.012762712
Dali Food	0.406389226	-0.018191388	7.2052E-32	0.074231495
Sizhou Group	0.063657851	-0.028945133	8.22807E-56	0.002259007
Tianchang Group	0.583887772	-0.011473084	0.003280958	0.027094535
Tongtian Liquor Industry	0.29778349	-0.020531364	5.68469E-07	0.005752267
Yefeng Group	0.440951236	-0.017167665	6.74754E-05	0.013771787

Observing the two tables provided above, the result noticed that the p-values of α_i are below 0.1, indicating that the correlation of the model is acceptable. While the value of R Square is not high, α_i is not significantly zero, indicating that the effectiveness of the CAPM model is not very good. This is also in line with the expectations of this article. The CAPM model only considers two factors, and its model is not accurate in predicting and interpreting the market without optimization.

3.2 Fama-French Three-Factor Model

The linear regression expression of the Fama-French three factors:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,m}\left(R_{m,t} - R_{f,t}\right) + \beta_s SMB_t + \beta_h HML_{t+}\varepsilon_{i,t} \quad (4)$$

Here, $R_{f,t}$ is the risk-free rate of return at time t; $R_{m,t}$ is the market rate of return at time t; $R_{i,t}$ is the rate of return of asset i at time t; $R_{m,t} - R_{f,t}$ representsis the market risk premium; SMB_t represents the simulated portfolio return rate of the market value factor at time t; HML_t represents the return rate of the simulated portfolio of the book-to-market value ratio factor at time t. Table 3 and Table 4 show the regression results of the FF3F model. The p-value ofα_i represents the statistical significance ofα_i. Among the six mainland stocks, β are estimated to range from 0.017 to 1.222, and β values of Shoulv Hotels and JinJiang Hotels are relatively high, indicating that Shoulv Hotels and JinJiang Hotels are more sensitive to changes in overall market returns. Among the six Hong Kong stocks, the estimated range of β is 0.064-0.584. Unlike the mainland stocks, the β value of Hong Kong stocks has no part higher than 1. In terms ofα_i coefficients, most of the 12 stocks are negative, which indicates that stocks underperform the market after adjusting for risk exposure. In Table 3 and Table 4, the p values ofα_i are both less than 0.001, indicating that theα_i coefficients are highly statistically significant, and the market has not fully digested the risks associated with stocks. Through the above comparative analysis of mean square error and correlation, the following conclusions can be drawn: After adding the two risk factors of SMB and HML, the predictive ability of the model is more reliable, and the credibility of the prediction of future stock returns is also higher rise.

Table 3. Regression Results of the Fama-French Three-Factor Model (Chinese mainland).

	β_(i,m)	α_i	P-value of α_i	R Square
HuatianHotel	0.017185143	-0.029632937	8.3308E-207	0.00132289
Jinling Hotel	0.722657604	0.006600254	7.08681E-05	0.432205306
JinjiangHotel	1.089146601	0.003751953	3.8267E-262	0.215093741
Quanjude	0.692089572	-0.022143691	9.1593E-132	0.177733161
Shoulv Hotel	1.221787548	-0.02535778	1.8205E-306	0.294023859
Xi'an Diet	0.773356265	-0.009539281	0.00016547	0.124611504

Table 4. Regression Results of the Fama-French Three-Factor Model (Hong Kong).

	β_(i,m)	α_i	P-value of α_i	R Square
BinshiInternational	0.453393236	-0.027202366	1.95251E-12	0.474639574
Dali Food	0.406389226	-0.021464844	3.83185E-33	0.086930864
Sizhou Group	0.063657851	-0.028422453	7.59018E-57	0.068693302
TianchangGroup	0.583887772	-0.017264508	1.89799E-07	0.49616059
TongtianLiquorIndustry	0.29778349	-0.017276093	1.87082E-07	0.541997338
Yefeng Group	0.440951236	-0.02273961	3.01998E-09	0.387712947

3.3 Comparison

The difference observed in the paper is between inland stocks and Hong Kong stocks. The estimated values ofα_i and β coefficients of inland stocks are more volatile than Hong Kong stocks. In addition, the β coefficients of inland stocks are higher, indicating that the inland stocks' 6 stocks are more sensitive to market fluctuations. Theα_i coefficients of mainland stocks and Hong Kong stocks are mostly negative, but the statistical significance ofα_i coefficients vary from stock to stock.

Another difference observed in the paper lies in theR^2 values of the two models. The higher theR^2 value, the better the model can explain the variability of the dependent variable. In the regression results of the CAPM model shown in Table 1 and Table 2, theR^2 value is in the range of 0.000054-0.228, while theR^2 value of the three-factor model is between 0.001-0.542. By comparing the above four tables, theR^2value of the three-factor model is generally large and concentrated. Therefore, the fitting degree of the three-factor model to the data is generally better than that of the capital asset pricing model. In addition, the three-factor model shows a significant numerical improvement over the CAPM model when comparing results for the same stock. The results show that the FF3F is more appropriate than the CAPM to explain the stock return rate, and the variability of stock return can be better captured by adding the two factors of SMB and HML to the three-factor model.

4 Conclusion

In summary, this study uses asset pricing and three-factor models to examine the stock data of 12 hotel and catering companies in China during the COVID-19 pandemic and conducts a comparative analysis based on the test results. By comparing the reliability of predicting stock expected returns with the two models, the three-factor model is found to be more explanatory in terms of excess returns on stocks after adding size and value factors, and more reliable in predicting stock investment returns. The empirical study in this article also has limitations. The data collected for this study covers only 12 hotel and catering companies from 2019 to 2022 and cannot fully represent the direction of the entire industry. In addition, stock data is lagging and does not have certainty when used to predict the future. Regarding the three-factor model, overfitting might occur. The FF3F Model is not the end of the CAPM, and there are imperfections in the FF3F Model. Although the existing models for predicting stock returns cannot fully match reality, they can provide ideas for hotel and catering listed companies to carry out market value management, and for investors to select investment projects. For further research, more convincing variables will be added to the model to make it more fit the market. Overall, the asset pricing model evaluated in this study provides useful guidance for market capitalization management of listed companies in the hotel and catering industry and provides reference significance for investors seeking to identify high-performing investment prospects.

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