Analysis of Games Industry during COVID-19 Based on Fama-French Five-factor Model
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Abstract. Since the 1960s, asset pricing model has become the core research field of modern finance. It has been widely used in financial market, consumption and investment decision-making, monetary policy and even macroeconomic estimation and prediction. Scholars have done a lot of research on the theory and application of CAPM model, and achieved dramatic results. With the improvement of the stock market, CAPM model has gradually lost its convincing explanatory power when describing the relationship between stock return rate and risk. In 1992, Fama and French proposed a three-factor model to enhance the explanatory power of CAPM, and proposed that factors such as the total market value of a company and the book-to-market ratio could better explain the difference of stock returns on the cross section. In 2013, Fama and French improved the original three-factor model by adding profitability factor and investment mode factor to the three-factor model, and proposed a five-factor model, so as to better explain the difference in cross-sectional returns of stocks. COVID-19 caused a big black swan event and the impact is very dramatic that the economy has a huge impact. Therefore, this paper takes the game and entertainment industry as an example. Based on the Fama-French five-factor model and multiple linear regression, the changes of factor coefficients before and after the epidemic are analyzed, and some investment suggestions are given for reference. It is found that because of the emergence and outbreak of COVID-19 the game industry is more sensitive to the fluctuations of the market economy, and small businesses with a high book-to-market ratio are worth investing in.

Keywords: Games Industry; COVID-19; Fama-French Model.

1. Introduction

The study of asset pricing has always been the focus of academic financial research. Scholars explore the laws of market operation in various ways to find a reasonable way to quantify and show the complex relationship between returns and risks, and to find pricing models that can effectively explain the prices of future financial assets, which is of great significance to regulate the market and help establish investment decisions.

The study of asset pricing originated from Markowitz's average-variance portfolio theory, on which Sharpe, Lintner and Mossin proposed a capital asset pricing model (CAPM) [1-4]. However, because asset pricing is based on a series of perfect assumptions, and there is a gap with the reality, so scholars have made improvements and expansion of the CAPM model. Fama and French studied the impact of market, size (market value), valuation (book market value ratio B/P), financial leverage, and price-to-earnings ratios on average earnings [5]. Based on the CAPM model, the scale factor SMB and valuation factor HTML are added, and the famous Fama-French (FF) three-factor model is proposed. The Fama-French three-factor model has a stronger interpretation of the expected rate of return of the cross-sectional stock portfolio than the previous "average-variance" theory and the CAPM theory. However, with the further study of asset pricing theory, scholars have found that the Fama-French three-factor model does not explain the part of stock yield that is related to profitability and investment style. Fama and French then added profit factor (RMW) and investment style factor (CMA) to the original three-factor model [6] based on the dividend discount model proposed by
Miller and Modigliani in the 1930s to become the new Fama-French five-factor model to better explain the average yield of the cross-sectional stock portfolio. The applicability of the five-factor model has been tested in foreign markets, so that people's understanding of stock market returns and risks has been raised to a new level.

The applicability of the FF factor model was tested in the stock markets of developed countries in North America, Europe, Asia Pacific and Japan [7, 8]. It is found that, in addition to the Japanese stock market, the FF factor model has a strong explanatory ability to the stock market in the other three regions. For China's stock market, Gao Chunting found that earnings and investment factors were more pronounced in the smaller grouping of listed companies, and that the five-factor model was better suited to China as a whole [9]. James Foye found that in three regions, Eastern Europe, Latin America and Asia, the book value ratio factor was significant and the investment factor was redundant [10]. Stefan Koch, Christian Westheide applied the conditional method of Pettengill, Sundaram and Mathur to the main model of asset pricing Fama-French three-factor model, found that all three risk factors drive asset returns horizontally [11, 12]. In addition, he extended Freeman and Guermat tests to multifactorial models, and tested whether the risk premium is priced in the conditional method [13]. His tests led to the same quality results as Fama-MacBeth tests [14], thus confirming its effectiveness. Stanisław Urbański compared the Modified and Classic Fama-French Model for the Polish Market [15]. The factors of the modified model are widely perceived by portfolio managers compared with HML and SMB. Simulation results show that large institutional investors are more likely to use this pricing application. Foye used a sample of 18 countries in three emerging regions to study the applicability of the five-factor model in emerging markets [16]. It is concluded that the five-factor model performs well in European and American markets, and some factors are not significant in Asian markets.

COVID-19 caused a big black swan event. The impact is very dramatic, and the economy has a huge impact. The U.S. stock market meltdown four times in ten days. In the face of the epidemic, people go out less; holidays are extended; school and work are delayed, and the offline real industry suffers a serious blow. However, Toys, house audiovisual equipment, amusement and recreation service, and other games industry have ushered in new development opportunities. Therefore, this paper takes the game recreation industry as an example and uses the Fama-french five-factor model to analyze the changes in factor coefficients before and after the epidemic, and gives some investment suggestions for reference.

2. Methods

2.1 Fama-French model

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size. If you are using US letter-sized paper, please close this file and download the Microsoft Word, Letter file. On the basis of Markowitz's portfolio theory, William Sharpe and other scholars put forward the widely used classical theory - capital asset pricing model (CAPM). The theory holds that the systematic risk of any portfolio and the expected return $E(r)$ can be function relationship, which is:

$$E(r_i) - r_f = eta_i[E(r_m) - r_f]$$

It mainly studies the relationship between the expected return rate of assets and risky assets in the securities market and how equilibrium price is formed. It is the pillar of modern financial market price theory and is widely used in investment decision-making and corporate finance. CAPM assumes that all investors invest according to Markowitz's asset selection theory. And the estimated expected return, variance and covariance are exactly the same, so investors can borrow freely. Based on this assumption, the focus of the capital asset pricing model is to explore the quantitative relationship between the return of risky assets and the risk, that is, to compensate for a certain degree of risk, how
much return should investors get. When the capital market reaches equilibrium, the marginal price of risk is constant, and the marginal effect of any investment that changes the market portfolio is the same, meaning that the compensation for adding a unit of risk is the same.

From the late 1970s, a large number of empirical studies have found that the CAPM model cannot effectively depict stock returns. All the research evidence shows that the CAPM model cannot effectively describe the real stock price return. This approach, which classifies the return on assets as the sum of risk-free returns and market risk premiums, looks perfect, but in fact, does not measure the true return on the market portfolio, which means that the market risk premium is always biased. Above all, the CAPM model must be improved. Fama and French use time-series and cross-sectional regression methods to demonstrate. After adding the indexes of scale, income price ratio, debt equity ratio and book market value ratio to the CAPM model, the explanatory ability of the model to the stock return rate is greatly increased, but the reasonable theoretical basis is lacking to incorporate these factors into the model [5]. To give a reasonable reason, Fama and French draw on the factor theory of Ross arbitrage pricing theory and propose a three-factor model [5, 17]:

$$R_{it} - R_{Ft} = a_i + b_i (R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + e_{it}$$  \hspace{1cm} (2)

Novy-M Marx demonstrate a close correlation between expected profitability and average return, while finding that FF three-factor model largely fails to account for changes between profitability and average return associated with investment [18]. To make up for these two defects, Fama and French add profitability and investment factors to the FF three-factor model and construct a new FF five-factor model [6]:

$$R_{it} - R_{Ft} = a_i + b_i (R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it}$$ \hspace{1cm} (3)

where $R_{it}$ is the return on security or portfolio $i$ for period $t$; $R_{Ft}$ is the riskfree return rate; $R_{Mt}$ is the return on the value-weight (VW) market portfolio. $R_{Mt} - R_{Ft}$ reflects the market risk premium. $SMB_t$ is the return on a diversified portfolio of small stocks minus the return on a diversified portfolio of big stocks. $HML_t$ is the difference between the returns on diversified portfolios of high and low B/M stocks. $e_{it}$ is a zero-mean residual. $RMW_t$ is the difference between the returns on diversified portfolios of stocks with robust and weak profitability. $CMA_t$ is the difference between the returns on diversified portfolios of the stocks of low and high investment firms, which we call conservative and aggressive.

FF five-factor model not only has the theoretical basis as the support, but also makes a reasonable explanation for the unadopted liquidity factor and momentum factor.

2.2 Data selection and processing

The data in this paper is taken from the database of Kenneth R. French's web, which is based on the information of U.S. stock market by French, the founder of Fama-French model. Based on the market capitalization of listed companies, they are divided into small-capitalization size stocks and large-capitalization size stocks, each with 50%, and then divided into H (high book-to-market ratio), M (medium book-to-market ratio), and L (low book-to-market ratio), each with 33%, based on the year-end book-to-market ratio of listed companies. The crossed stocks were obtained as portfolio SL, SM, SH, BL, BM, BH.

| Table 1. Factor composition patterns |
|--------------------------------------|
|                                      |
| S (50%, Small Market Cap)            | S/H  | S/M  | S/L  |
| B (50%, Large Market Cap)            | B/H  | B/M  | B/L  |
3. Results

Data were divided into pre-epidemic (2019.7.1-2020.2.28) and post-epidemic (2020.3.1-2020.8.31). Fama-French model was employed to process the Games industry data, and after multi-regression multiple linear regression, the results of pre- and post-epidemic were obtained, as shown below.

| Table 2. Before the epidemic |
|-----------------------------|
| **Coefficients** | **t Stat** | **P-value** |
| Mkt | 0.84 | 16.28 | 0.00 |
| SMB | 0.56 | 5.37 | 0.00 |
| HML | -0.19 | -1.88 | 0.06 |
| RMW | 0.38 | 2.16 | 0.032 |
| CMA | 0.05 | 0.22 | 0.83 |

| Table 3. After the epidemic |
|-----------------------------|
| **Coefficients** | **t Stat** | **P-value** |
| Mkt | 0.91 | 15.06 | 0.00 |
| SMB | 0.85 | 5.19 | 0.00 |
| HML | 0.49 | 3.56 | 0.00 |
| RMW | 0.21 | 0.75 | 0.46 |
| CMA | -1.80 | -4.77 | 0.00 |

As shown in Table 2 and Table 3, Mkt and SMB coefficients increased, HML and CMA changed from non-significant to significant, and RMW changed from significant to non-significant due to the emergence and outbreak of the epidemic.

4. Discussion

This paper analyzed the validity study of the Fama-French five-factor model for the Games industry before and after the epidemic to assess the impact of epidemic on Games industry. The analysis compared the coefficients and significant differences in the Games industry over different periods, and derived the reasons for these differences in the Games industry and COVID-19 to provide a reference for investors.

The epidemic influences the coefficient Mkt larger and closer to 1, indicating that the games industry is more sensitive to the fluctuations of the overall market economy, which is more strongly influenced by the market, and more consistent with the changes of the economic cycle. Before the emergence of the epidemic, the overall audience of the games industry was relatively fixed. However, with the emergence and outbreak of the epidemic, the offline brick-and-mortar industry has been hit hard. Countries have taken home orders and other restrictive measures. More and more people tended to buy toys, household audiovisual equipment, and play all kinds of games, stimulating the overall development of the Games industry, and making it more active and more bound to the overall economic changes. According to App Annie, both Google Play and iOS stores saw a 10% increase in revenue in 2020. At the same time, the share of games in downloads increased to 40%. On Google Play, they accounted for 45% of all downloads, up 5% year-over-year, but maintained a 30% share on iOS. In addition, $0.71 of every dollar spent in both app stores was spent on games. Game downloads, user hours, and user spending are all at record highs.

The fact that βSMB becomes larger after the outbreak indicates that the market prefers smaller companies and that investing in smaller companies yields higher returns. During the epidemic, we can find that the stock returns of small companies significantly outperformed large companies.
Madison Square Garden (MSG) is a company engaged in the sports, entertainment and media business within the United States, corresponding to the three main businesses of MSG Entertainment, MSG Sports and MSG Media. The company owns and operates sporting goods concessions and owns various arenas, including venues for sporting events. As a result of the outbreak, Madison Square Garden Entertainment's (MSGE) earnings for the quarter ended on March 31 took a hit as expected, with a 20% decline in revenue and a write-down of its investment in its restaurant and nightlife businesses. MSGE suspended all concerts on March 12 due to the spread of the coronavirus, and its revenue fell from $250 million to $199.9 million. Hit by the COVID-19 epidemic, Gold's Gym, a 55-year-old gym, filed for Chapter 11 bankruptcy protection in early May, and 24-Hour Fitness, a large fitness chain, was acquired by Asian consortium IBA after closing 130 gyms directly operated in the US. And a once unheralded, interactive fitness Internet company, has seen explosive growth. Since the beginning of this year, Peloton's share price has risen by 362%, while the Nasdaq Composite Index has risen by about 30.55% over the same period, and its market capitalization has so far approached $38 billion.

Through observing the variable HML before epidemic, we can find that the HML of the game industry is a negative number, which means that the companies with lower Book-to-market ratio of the game industry are favored by more investors. After the epidemic, the HML value becomes positive and more sensitive to the fluctuation of the whole market economy. In the whole game industry, the Book-to-market ratio of the generally emerging game companies is relatively high, while the Book-to-market ratio of traditional companies, such as musical instrument manufacturing is relatively low. The former received greater market opportunities during the epidemic, such as the Internet fitness company mentioned above, while the latter was seriously affected by the epidemic, such as the sharp decline in the stock price of Yamaha (the world's largest musical instrument manufacturer) during the period from January to March [19].

In the Fama-French five-factor model, the sensitivity of RMW in the game industry changed from significant to insignificant because of the COVID-19. The reason could be, during the epidemic, there was a serious crisis throughout the Games industry and the stock price is greatly affected, so the profit factor becomes insignificant. According to CNN reports, Warner Bros. announced on December 3, that its 17 films, which will be released in 2021 in North America, will simultaneously land HBO Max (Warner's streaming platform) [20]. This means that the yard window is canceled, North American cinema release day at the same time online streaming media. It is understood that Warner Media announced the cancellation of the window period of films including "Matrix 4", "Suicide Squad 2", "Sand Dunes" and other films. Affected by this message, America's largest theater operator AMC shares fell more than 15 percent, CNK's shares fell more than 21% in the U.S.'s third-largest Cinemark. And affected by the COVID-19, America's second-largest cinema, Regal Cinemas, announced its indefinite closure in October. Under the epidemic, the film and television industry has suffered, and the decline in passenger flow has kept the film industry's share prices low. The share price is depressed, so we need to reduce investment in these industries. The game industry's profit factor coefficient is also reduced. Thus, discreet investment is suggested for the risk of the stock market.

The coefficient changed from insignificant to significant, indicating that the CMA was a redundant factor in the five-factor model of the Games industry before the epidemic, and there was no validity in the calculation of the return on investment. After the epidemic, CMA becomes significant. Under the impact of the COVID-19 epidemic, the industry has a serious decline. At this time, companies with sufficient cash flow will use more radical methods of investment and acquisition, further expand market share and will also be sought after by investors.

5. Conclusion

The asset pricing model established the relationship between capital risk and return. Fama and French used empirical data to revise the model, tried to find other factors to test the model instead of
the market, and established a three-factor model. It is essential to explore the difference caused by the epidemic. Therefore, it is of great significance to study the model. Through the research, it is found that due to the emergence and outbreak of COVID-19, the Games industry is more sensitive to the fluctuations of the market economy, and small-scale enterprises with a high book-to-market ratio are more worthy of the investment. We’re going to look at these data in more detail.

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