The Application of Asset Pricing Models in the Capital Market

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Abstract. With the development of China's financial and capital markets, more and more investors will choose to use different asset pricing models to analyze the effectiveness of their investments. Under the background of efficient markets hypothesis (EMH), this paper will use Fama-French three-factor model, GARCH family model and Heston model to analyze the validity and feasibility of these three commonly used models in Chinese market. Through empirical analysis, descriptive statistics and other research methods, it is found that all three models are effective but have certain limitations. It is found that the Fama-French three-factor model is too dependent on the market. The establishment of the GRACH family model is too complicated due to too many influencing factors in the market; and the time lag of the Heston model. All three models require investors to include more model analysis to get the optimal investment strategy. Therefore, this paper draws the definition of behavioral finance at the end of the paper, according to which investors' decisions can be further analyzed.

Keywords: Fama-French Three-Factor Model; GARCH Family Model; Chinese Stock Market; Option Pricing.

1. Introduction

The Efficient Markets Hypothesis (EMH) was proposed and deepened by Eugene Fama, a famous American economist, in 1970. The EMH has a questionable premise assumption that investors participating in the market are sufficiently rational and are able to react quickly and reasonably to all market information. The theory is that in a stock market that is legally sound, well-functioning, transparent and competitive, all valuable information has been reflected in stock price movements in a timely, accurate and adequate manner. Unless there is market manipulation, it is impossible for an investor to analyze past prices to obtain excess profits above the market average. The EMH assumes that the market is highly efficient and investors cannot easily take advantage of information asymmetry to gain excess profits. However, there are also controversies and criticisms about the EMH, and some investors believe that there are still some opportunities to make excess profits. The proposed EMH has become a popular topic in empirical research of the securities market, and also has a wide range of applications in asset pricing, investment strategy and financial regulation. The EMH is believed to be based on the assumption of rational man, but actual investor behavior often receives the influence of emotions and cognitive biases, leading to irrational decisions and excessive market volatility. In addition to this, flaws such as incomplete disclosure, markets that are not perfectly competitive and empirical challenges continue to limit the EMH. The asset pricing model used next in this paper is in the context of this hypothesis, and by making certain hypotheses, many minor factors can be excluded, so that the model can be built, which can enable investors to build their own investment decisions more rationally. Investors should consider the challenges in making investment decisions in order to develop more robust and sustainable investment strategies.

2. Fama-French Asset Pricing Model

The Fama-French three-factor model assumes that the return of a stock is also related to its market value. In a series of subsequent studies, a series of indicators such as book-to-market ratio and inverse price-earnings ratio have been found to explain the movement of stock prices, that is, stock prices are related to a series of risk factors. Zhao et al. used Chinese stock market data to test the validity of the five-factor model proposed by Fama-French, and found that the empirical results are contrary to the

United States, and the three-factor model is more applicable to the Chinese capital market than the five-factor model [1]. So next the researchers will use this model to derive the effectiveness of the model on stock selection in the Chinese A-share market from the two aspects of the impact of corporate governance level on stock pricing and whether corporate growth affects stock returns.

The level of corporate governance has been the key to the development of the company. Qi et al. screened samples from listed companies included in the SSE All-Share Index for the three years from 2015 to 2017 [2]. They added the corporate governance factor EMD to the Fama-French three-factor model. The conclusions can be drawn from the data grouping of the explanatory variables, the construction of the premium factor, and the calculation of the explanatory variables defined as the return of each portfolio. Among firms of the same size, stock portfolios with approximately better governance have higher returns, proving that corporate governance can provide a premium to returns. In addition, the return of stock portfolio decreases with the increase of company size, and the decreasing trend is more obvious in the dimension of book-to-market ratio than the dimension of corporate governance.

By analyzing the regression results, it is found that the intercept terms of the three-factor model and the four-factor extended model considering the corporate governance factor EMD are not significant, indicating that the constructed premium factor can explain the systematic risk well [2]. The model has validity: in terms of comparison R^2, the four-factor extended model is slightly higher than the three-factor model, which indicates that the level of corporate governance has some explanatory power for stock returns, but this explanatory power is not outstanding [2].

A high level of corporate governance does provide a return premium to firms, but the addition of the corporate governance factor EMD to the Fama-French three-factor model reveals that its marginal contribution to stock portfolio returns is not significant when compared to the size factor SMB and the value factor HML [2]. After adding the corporate governance factor EMD to the three-factor model, the extended model shows limited improvement compared to the original three-factor model [2].

Company growth is another issue that investors are more concerned about. Common sense suggests that investors believe that companies with better growth are worth investing in, and such companies have a higher return on investment. Xia studied the effectiveness of the new Fama-French four-factor model by adding the growth factor Gt to the Fama-French three-factor model and taking the listed companies in the five years from 2015 to 2020 as the sample size. Based on the descriptive statistics analysis, it is known that the portfolio with the growth factor is able to get higher returns [3].

The regression model analysis of the Fama-French three-factor model and the new four-factor model considering the corporate growth factor Gt found that the intercept term is significant, which proves that there are other factors influencing China's A-share market. The market factor is significant, which proves that China's A-share market is more affected by systematic risk. The newly added growth factor Gt is significant, which indicates that since 2015 the growth in the significant level of China's A-share market is outstanding [3]. The inclusion of the growth factor increases the return in the portfolio that can be explained, indicating that the level of company growth has a prominent influence on the return of stocks [3]. The validity of this new model is proved to be derived and the growth factor is outstanding in the Chinese A-share market from 2015, which can be used to compensate for the reduction in portfolio returns caused by the size factor and the value factor [3].
The market recognizes the value attributes of China's A-share market as well as the growth of listed companies in this market. The above study shows that the explanatory power of Fama-French's new four-factor extended model with the addition of the growth factor Gt is significant in China's A-share market. A high level of corporate growth can bring better earnings and return premium to companies [3].

Through the above two different aspects of the study, due to the rapid development and complexity of China's A-share market, next on the basis of the Fama-French three-factor model to study the validity and adaptability of the model in China's A-share market is significant or not. According to

the results of empirical analysis, the effectiveness of the Fama-French three-factor model for China's A-share market needs to be further strengthened. China's stock market is ever-changing, and the risk factors that cause the changes are also different, and the Fama-French three-factor model only takes into account the three factors, which is not perfect enough [4]. Since the Fama-French three-factor model requires the use of a large amount of data, the inaccuracy of the data can also lead to a reduction in the validity of the model. According to the data of Shanghai and Shenzhen A-share market from 2000 to 2022 to analyze the regression results of different factors in the Fama-French three-factor model, it can be concluded that China's A-share market has a low degree of fit with the model, and it does not have much adaptability [5].

The Fama-French three-factor model has a greater reliance on the market environment, the factors included are not complete enough, and there are limitations in analyzing different market environments. Different investors like to change their investment behaviors and switch roles according to different situations, and the Fama-French three-factor model needs to reconstruct a new model for different influencing factors, and most investors prefer a model that can be used directly for reference.

3. GARCH Model

In financial markets, moderate volatility in the stock market helps that market can be better for resource allocation and financing, while excessive volatility can disrupt the market and cause adverse effects. Therefore, volatility is one of the key parameters for most of the investment decisions. Volatility is defined as the best risk indicator for reliably predicting returns in a financial market, and also refers to the magnitude of uncertainty associated with changes in asset prices. The ARCH model accurately simulates changes in the volatility of time-series variables. The GARCH model, called the generalized ARCH model, is an extension of the ARCH model and was developed by Bollerslev. The GARCH family model has become a standard method for modeling the volatility of financial time series data. Research has proved that GARCH family model can better simulate the characteristics of stock market volatility and also better predict stock market volatility [6]. Next, researchers use this model to categorize the special period (COVID-19) into the pre-mid-period and post-mid-period, expanding from the study of the market volatility of the Chinese stock market before the COVID-19 to the change of the volatility of the global financial market during the period of the COVID-19.

The Chinese stock market has become the second largest stock market in the world. As one of the most volatile stock markets in the world, its volatility is a concern for every investor. Since investors in Chinese stock market are mainly concentrated in retail investors, most of them are short-term investors, which increases the investment risk and also the volatility changes.

Yu et al. selected the stock market data from 2006 to 2018. After analyzing the model using the GRACH family model, it can be concluded that there is an asymmetry in the volatility of China's stock prices [7]. According to the residual sequence diagram of the model, it can be found that the volatility of China's stock prices has the phenomenon of volatility aggregation [7].

In Wang's study, it was found that the correlation between China's stock market volatility and correlation and economic policy uncertainty was significantly existed and generally showed positive correlation, i.e., the rise of economic policy uncertainty would increase the volatility of China's stock market to a certain extent and contribute to the increase of correlation among stock markets [8].

Because of COVID-19, the global financial markets have generated huge volatility. Khan et al. examined six major financial markets (Bitcoin, Euro, S&P 500, Gold, Crude Oil and Sugar) and found through an empirical study utilizing three different GRACH family models that all the financial markets exhibited high levels of volatility persistence during the epidemic [9]. Due to the COVID-19 Epidemic, the financial market has seen several crashes and high volatility, as well as negatively affecting financial investors around the world and increasing the risk of financial investments. The stock market, crude oil market, and metal market are more significantly affected and have higher

volatility, while the impact on cryptocurrency, exchange rate, and agricultural market is less and the volatility is smoother [9].

The researchers investigated the volatility of the financial market during the COVID-19 period by applying three different GARCH models: GARCH (1, 1), GJR-GARCH (1, 1), and EGARCH (1, 1). It is concluded that the GARCH (1, 1) model best describes the volatility of gold and sugar, the GJR-GARCH (1, 1) model best describes the volatility of crude oil and the S&P 500 index, and the EGARCH (1, 1) model best describes the volatility of bitcoin and the euro [9]. The results of the application of these models also show that the EGRACH model is the most effective model to capture the market volatility before the COVID-19 epidemic, while each of the GRACH family models is able to uniformly simulate the volatile behavior of several major financial product markets during and throughout the period of the COVID-19 epidemic [9].

All the above chosen models are considered effective in estimating the volatile behavior related to financial returns, but the aspects of market volatility in the COVID-19 epidemic are challenging, so the researchers suggest that investors can use another model for further research [9].

4. Heston Model

Option pricing, the Black-Scholes model is commonly used in the financial industry for pricing, but due to the many assumptions of the BS that are inconsistent with the real market, the Heston model has been developed. The Heston model is a stochastic volatility model that has been widely used in the financial field, and it was proposed by Steve L. Heston in 1993 [10]. It not only explains and predicts the implied volatility observed in financial markets, but also allows for a more accurate assessment of the prices of complex derivatives. Next the researchers will use this model to study the pricing of two major option products in China (CSI 300 ETF and SSE 50 ETF).

The creation of SSE 50 ETF proved that China began to officially have an option market. The introduction of this option satisfied investors' investment needs and hedging needs, promoting the multi-level development of China's capitalist market. By using the Heston model to price the SSE 50 ETF options, Zhang et al. analyze the sensitivity of the option to the parameters of the Heston model on the basis of the pricing to obtain a more realistic pricing result, which provides a reference for hedgers [11]. The results of their empirical analysis show that the Heston model is more reflective of the price movements of assets in China's capital market, and its pricing of assets is more in line with the actual situation in China [11]. Regarding the results of Delta hedging, it can be seen that the combination of assets and options consisting of SSE 50 ETF funds and bonds are almost identical in terms of price movements, and the combination of options and underlying assets in actual hedging can avoid the risk brought by the price changes of the underlying assets. Regarding the results of Delta-Gamma hedging, it can be seen that based on the Heston model, the Heston model can be used to realize the SSE 50 ETF options' Delta and Gamma risk hedging functions [11].

Xiong based on the Merton model, Heston model, Bates model to empirically analyze the SSE 50ETF option data found that although the Heston model in the pricing of SSE 50ETF options can achieve better results, the parametric model for the increase in parameters, the flexibility of the reduction, So more accurate option pricing needs to incorporate other nonparametric methods for the next step of study [12].

CSI 300 ETF options is the second ETF options in China after SSE 50 ETF options, which is larger in scale. The listing of CSI 300 ETF options will further satisfy the market's demand for hedging tools and play an important role in improving the risk management system of the capital market and better serving the development of the capital market. The listing of CSI 300 ETF options provides investors with more trading opportunities for arbitrage strategies, especially risk-free arbitrage opportunities formed with stock index futures combinations.

Yu et al. study the pricing of CSI 300 ETF options based on the Heston model, using different measures to determine whether the model is more accurate than the B-S model. The empirical analysis found that the pricing of the Heston model is closer to the real situation of the market, while the

pricing of the B-S model is relatively low and differs from the market value [13]. When the price of the underlying asset fluctuates significantly, the B-S pricing results are more accurate than Heston's model pricing, which may be due to the fact that Heston's model comes with the process of mean reversion in the formula, and the reversion tends to have a specific duration [13]. Investors need to be aware that when the underlying asset suddenly faces large fluctuations, the use of the Heston model takes time to react to the pricing, and there is a time lag [13].

5. Conclusion

All models are implemented under the EMH. This study found that the Fama-French three-factor model is more dependent on the market environment, the factors included are not complete enough, and there are limitations in analyzing different market environments. Investors prefer to choose models that can be used directly avoiding the need to re-include factor analysis themselves. Meanwhile, because of the impact of the New Crown epidemic, although all the GRACH family models can analyze the market volatility, the GRACH family models cannot generalize all of them because there are too many types of influencing factors, and investors should use a variety of models to improve their investment decisions. For option pricing, although the Heston model is more applicable to China's capital market, the flexibility of the model decreases when the parameters increase, so it is necessary to include non-parametric methods for analysis; and when the underlying asset suddenly fluctuates significantly, the Heston model has a time lag and needs time to react. In reality, most investors are irrational, and the EMH relied on in this paper possesses limitations. In order to better analyze the deviation of financial market subjects in market behavior in anomalies, researchers extend behavioral finance. Behavioral finance explains, researches and predicts the development of the financial market from the micro-individual behavior as well as the psychological and other motives that produce such behavior, seeks for the characteristics of business philosophy and decision-making behavior of different market players in different environments. It strives to establish a descriptive model that can correctly reflect the actual decision-making behavior of market players and the market operating conditions.

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