

# The Effectiveness of CAPM and Fama-French Three-Factor Models in Healthcare and Real Estate Industries

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**Abstract.** As the world's largest economy and an important hub for cross-border capital flows, monetary policy adjustments in the U.S. will affect the cross-border capital flows and the structure of net international investment positions. From the 1990s to the present, the U.S. has experienced four rounds of interest rate hike cycles as domestic inflationary pressures fluctuate. In this paper, we analyze the changes of KML, SMB, HML and other factors of the stocks of leading companies in the medical and real estate industries based on regression analysis. Specifically, to investigate the applicability of the CAPM model and FF3 model in the medical and real estate industries in the context of the Fed's interest rate hikes, we construct regression models and fit the corresponding coefficients in the CAPM model and FF3 model, respectively. According to the analysis, the FF3 model has a better performance in most cases and can better explain the impact of the Fed's interest rate hike on the healthcare and real estate sectors compared to the CAPM model. On this basis, it can still be used as an effective tool for asset valuation and resource allocation after the Fed's interest rate hike. These results shed light on guiding further exploration on asset pricing.

**Keywords:** Federal Reserve interest rate hike; CAPM model; Fama-French three-factor model; Validity.

## 1. Introduction

The asset pricing model has undergone continuous improvements to better predict the potential returns of asset portfolios in the stock market. At first, Markowitz put forward the portfolio theory, which uses the mean variance analysis method to determine the optimal portfolio. In contrast, Sharp quoted the concept of market portfolio and assumed the linear relationship between asset returns and market portfolio. Afterwards, Lintner and Mosin introduced the Capital Asset Pricing Model (CAPM) [1]. The core idea is that the expected return rate of a single asset or securities portfolio is linearly related to systemic risk [2]. By continuous research and practice, it is proved that the beta value of the CAPM model can effectively explain the stock return rate [3].

The Sharpe and Lintner proposed mean-variance capital asset pricing model (CAPM) postulates a linear tradeoff between expected return and beta [4, 5]. In the first test of the model, Douglas finds the estimated relationship between average excess return and beta is too flat. Miller and Scholes conclude that this is primarily a consequence of measurement error in beta. Black et al., Blume and Friend and Fama and MacBeth, employing grouping to reduce measurement error, find that the estimated relationship between average excess return and beta is near linear, but the slope is still less than it should be and the intercept is positive. In the post 1963 period Fama and French find that the relationship is much too flat and statistically insignificant [6]. Subsequently Fama and French develop a three-factor alternative to the CAPM and extensively test both models employing multivariate time-series tests [7].

Fama and French's [8] seminal three-factor model has become widely used by academics and practitioners alike for estimating cross-sectional equity returns. The model is motivated by two

empirical regularities that CAPM leaves unexplained: the size premium and the value premium. The three-factor model aims to capture these two well-known premiums by augmenting CAPM with additional factors to proxy size and value [9].

Medical industry and real estate industry are selected as investigation target in this paper. The pharmaceutical industry is an important part of China's national economy, closely related to the health of the people, is an important industry related to the construction of a harmonious society. Contemporarily, the government have introduced a series of industrial policies to encourage the development of the pharmaceutical industry; the increase in the income of residents to promote the development of the industry; the increase in the aging of the population, pulling the growth of the market demand for chronic disease drugs. The real estate industry, as a new growth point of the national economy, has contributed to the rapid growth of China's economy. Nowadays, it continues to develop: the trend of urbanization level steadily increases, forming an increasingly high demand for housing; population growth and population movement promote the growth of demand for new residential buildings; the increase of residents' consumption level; the renovation of old cities, increasing the residents' demand for residential buildings, deepening reform and market development of the promotion of the demand for housing.

This article uses the Fed rate hike as a backdrop. A Fed rate hike is a decision by the Board of Governors of the Federal Reserve System to adjust monetary policy by raising the federal funds rate after a rate meeting in Washington. Simply put, a rate hike is a tightening monetary policy in which the Fed responds to the current economy by raising interest rates. A general interest rate hike raises bank interest rates, thus reducing the money supply and the dollar will appreciate. In addition, a rate hike raises the dollar exchange rate will have an impact on the economy, e.g., after the dollar appreciates, the price of gold will fall and people will be more willing to hold the dollar; other countries' currencies will depreciate, etc.

Since the 20th century, the Federal Reserve has experienced a total of three interest rate hike cycles. They were the rate hikes from 1996 to 2000 in the context of curbing the Internet bubble, the rate hikes from 2004 to 2006 in the context of the housing bubble, and the rate hikes from 2015 to 2018 in the context of monetary policy normalization. With the phasing out of fiscal subsidies during the epidemic, the bipartisan stalemate over U.S. infrastructure investment funding, the accelerated tapering of the Federal Reserve's asset purchase program, and the continued supply chain disruptions and high inflation, the major financial markets have come out of a "perfect market", i.e., the -U.S. stock, bond, currency and digital asset markets are moving against macroeconomic fundamentals, showing new characteristics of the digital financial era. The traditional asset pricing models represented by CAPM model and Fama-French three-factor model are gradually being impacted. The impact of Fed interest rate hike on the traditional asset pricing models has also become a hot topic for discussion in academia.

As far as the current research results are concerned, scholars have focused on collecting annual and monthly data on the stock market since the Fed's interest rate hike cycle, conducting comparative empirical studies on the applicability of the three-factor model, the one-factor CAPM model and the Fama-French three-factor model to explain the return of a single stock in the capital market grouping data, as well as comparing the applicability of the three-factor CAPM model and the Fama-French three-factor model as a key concept and parameter that correlates asset portfolios with the overall market. We also conduct an empirical study on the beta coefficient, which is an important concept and parameter associated with asset portfolios and the overall market, and use data from several listed companies in the stock market to examine the stability and trend of the beta coefficient under tight monetary policy and to determine the correction method that should be made if the current beta coefficient is used as a forecast for the future beta coefficient. Due to the impact of the new crown epidemic and the continued high temperature of the real estate market in major economies around the world, this paper takes the medical industry and the real estate industry as the research entry point. On the basis of summarizing previous research on the impact of the Fed's interest rate hike on traditional asset pricing models, it elaborates its own research methodology and aspects of empirical testing, and finally draws conclusions with a view to contributing to the selection of risk measurement methods for

the stock market under the impact of this policy. The conclusions are intended to be useful for the selection of risk measures in the stock market under the influence of this policy. This paper will compare the effectiveness of the CAPM and FF3 models before and after the Fed rate hike.

The rest part of the paper is organized as follows. The Sec. II will explain the CAPM model and the FF3 model systematically and show our treatment of the above models. The Sec. III will sort out the results of model processing and data analysis. The Sec. IV will analyze the multivariate impact factors of individual stocks in healthcare industry and real estate industry with different models as classification criteria. The Sec. V will summarize the research results of this paper in a systematic way.

## 2. Methodology

### 2.1 Data

In this paper, we mainly obtained the stock data through the tushare module in Python. We selected three stocks from the pharmaceutical industry and the real estate industry in the a-share market, six in total: 600196.SH 600276.SH 000538 for medical industry stock selection and 600606.SH 000002.SZ 600048.SH. for Real estate industry stock selection. For these six stocks, we selected two time periods before and after the Fed rate hike, 2011.12.1-2014.12.31 and 2015.12.1-2018.12.31. We imported data for six years before and after the six stocks using tushare and processed them for analysis. The main data that were used in the stock import were the daily increase and decrease of the stock.

### 2.2 CAPM model

As the largest theoretical achievement of modern financial market price theory, the Capital Asset Pricing Model (CAPM), or the Capital Asset Price Determination Model, is currently used in the field of investment decisions and corporate finance. The initial research of this financial theory can be traced back to the theory of portfolio selection in a complete market in 1952, i.e., the mean-variance analysis theory invented by Markowitz. Subsequently, Tobin proposed the separation theorem to investigate the relationship between mean-variance analysis and expected utility maximization, and proved that changing the investment ratio of portfolio and risk-free assets at the cut point would satisfy the utility of all types of investors. In the 1960s, Sharpe, et al. proposed and developed the CAPM model as the basis of general equilibrium theory, based on the modern portfolio theory system. The model assumes that systematic risk is the only indicator of a portfolio's return and that the corresponding portfolio should contain all risky asset types including stocks, bonds and elimination of unsystematic risk of individual securities, and is often used to determine the necessary rate of return in valuation analysis.

The CAPM model considers a functional relationship between the expected return on a given asset  $i$  and the expected return on a market portfolio. The basic form of the model is

$$E(r_i) = r_f + \beta_{im}[E(r_m) - r_f] \quad (1)$$

$$\beta_{im} = \frac{\text{Cov}(r_i, r_m)}{\text{Var}(r_m)} \quad (2)$$

Where  $E(r_i)$  is the expected return of asset  $i$ ,  $r_f$  is the risk-free return,  $\beta_{im}$  is the systematic risk factor of asset  $i$ ,  $E(r_m)$  is the expected return of the market portfolio  $m$ , and  $E(r_m) - r_f$  is the market risk premium. The model is based on a series of idealistic assumptions represented by the assumption of homogeneous expectations, which holds that all investors can borrow or lend funds without restriction at risk-free rates, and all seek to maximize the expected utility of wealth in a single period, and make portfolio selection based on the expected return and standard deviation of each alternative portfolio.

If the CAPM model holds, the market portfolio and the cut-point portfolio coincide and all portfolios must lie on the capital market line and the stock market line. The separation theorem suggests that any investor will hold a portfolio consisting of both a market portfolio and an asset at risk that maximizes expected utility.

### 2.3 Fama-French three-factor model

Contemporarily, empirical studies have shown that the CAPM model does not validate historical investment returns in practice and that the model assumptions of the CAPM are too idealistic. Based on the possibility of setting error of the model in CAPM theory, multi-factor models represented by the Fama-French three-factor model have been born. As one of the improved forms of capital asset pricing models in modern financial markets and a sample application of arbitrage pricing theory, the model was designed by Fama and French based on the empirical findings of historical returns of U.S. stocks, with a view to providing theoretical support for explaining the risk premium factors affecting the average return of the stock market, and used by some scholars to explain GDP growth rates and bond market returns. It has the basic form as follows:

$$r = r_f + \beta_3(r_m - r_f) + bs * SMB + bv * HML + \alpha \quad (3)$$

$$SMB = \frac{Small\ Value + Small\ Neutral + Small\ Growth}{3} - \frac{Big\ Value + Big\ Neutral + Big\ Growth}{3} \quad (4)$$

$$HML = \frac{Small\ Value + Big\ Value}{2} - \frac{Small\ Growth + Big\ Growth}{2} \quad (5)$$

Here,  $r$  is the expected return of the market portfolio,  $r_m$  is the return of the market portfolio, and  $\beta_3$  is the coefficient to be estimated for the three variables to measure the impact of changes in the risk premium, size premium, and P/E premium on the expected return of the market portfolio. The difference between a positive coefficient on the size premium is generally considered to indicate that a portfolio composed of small-cap companies will generate high returns with high risk. HML is the price-to-net premium, which describes the difference in returns between a portfolio composed of companies with high book-to-market ratios and a portfolio composed of companies with low book-to-market ratios.  $\alpha$  is the excess return ratio, i.e., the ideal condition under which excess returns of the portfolio can be fully explained by the three factors. The rest of the factors have the same explanatory significance in the CAPM model.

Some scholars have shown that the Fama-French three-factor model is a country-specific model and has limitations. However, the model is able to use portfolios segmented by companies with different P/E ratios and sizes, combine historical data to calculate the level of premiums for each of the three factors, and calculate the regression coefficients by means of linear regression. Since the regression coefficients of this model have a considerable degree of statistical significance, it can be assumed that the Fama-French three-factor model can effectively explain information that is not yet explained by the CAPM model.

### 2.4 Model processing

In the preliminary preparation, the Tushare module in Jupyter notebook is used as the data platform. After setting the token and initializing the pro interface, the stock data and index data of six leading companies are selected from A-shares. Fosun Pharmaceutical, Hengrui Pharmaceutical and Yunnan Baiyao were selected from the medical sector, and Greenland Holdings, Vanke A and Poly Real Estate

were selected from the real estate sector, and then the data were imported for analysis. It should be noted that the dates of the selected data are December 1, 2011 to December 31, 2014, and December 1, 2015 to December 31, 2018, respectively, using the period before and after the Fed's interest rate hike as the date interval.

In the model processing, considering the lack of SSB and HML factors in the Tushare data platform, the overall data of A-shares are combined with the model statistics library (statmodels), the calculation variables are defined, the starting and ending dates of the data period are used as variables to define the function to obtain stock data, as well as to obtain all stock data and daily  $R_m - R_f$ , SMB, and HML data in the selected time interval. HML data, finally importing the data, slicing the daily rise and fall of three stocks of medical and three stocks of real estate, adding FFDATA and calculating the expected portfolio return using a two-way cycle, and then performing the cycle.

In terms of result acquisition, the  $r_{mean}$ ,  $R_m - R_f$ , SMB and HML data from the regression model slice FFDATA are used to fit the coefficients of  $R_m - R_f$  and the beta coefficients of  $R_m - R_f$ , SMB, and HML in the CAPM model and FF3 model, respectively, and the beta coefficients of  $R_m - R_f$ , SMB, and HML are finally obtained to calculate the regression results as well as the coefficients of determination. It should be noted that the above link CAPM models are not required to obtain SMB and HML data.

### 3. Results

#### 3.1 Medical industry

After obtaining the relevant data from the tushare module, we performed a linear regression analysis using Python and obtained the coefficients of the CAPM and Fama French three factor model by model fitting, as shown in the following Tables. I~IV.

**Table 1.** CAPM Of Medical Industry Before the Rate Hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.464       | 19.214 | 0.000   |
| $R^2 = 0.334$ |             |        |         |

**Table 2.** CAPM of Medical Industry after the rate hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.515       | 17.252 | 0.000   |
| $R^2 = 0.333$ |             |        |         |

**Table 3.** FF3 of Medical Industry before the rate hike

|               | coefficient | t       | p-value |
|---------------|-------------|---------|---------|
| MKT- $R_f$    | 0.430       | 18.833  | 0.000   |
| SMB           | -0.254      | -5.206  | 0.000   |
| HML           | -0.614      | -12.132 | 0.000   |
| $R^2 = 0.449$ |             |         |         |

**Table 4.** FF3 OF MEDICAL INDUSTRY AFTER THE RATE HIKE

|               | coefficient | t       | p-value |
|---------------|-------------|---------|---------|
| MKT- $R_f$    | 0.549       | 18.571  | 0.000   |
| SMB           | -0.619      | -13.480 | 0.000   |
| HML           | -0.605      | -11.336 | 0.000   |
| $R^2 = 0.524$ |             |         |         |

For the factor MKT of the FF3 model, we find that it also remains less than 1 before and after the fed rate hike and conclude that it is consistent with CAPM. The size factor SMB, which is the result obtained by subtracting large scale firms from small scale firms, is -0.2 before hiking and -0.6 after the hiking, and the fact that  $\beta_{SMB}$  is less than 0 indicates that the market for the entire health care industry is skewed towards large firms. In addition to this, a negative value factor HML before and after the fed rate hiking implies that the health sector favors companies with lower book-to-bill ratios, thus indicating that the health sector has better growth prospects, lower investment risk, and therefore higher returns.

### 3.2 Real Estate Industry

Similarly, we used Python's linear regression model to analyze the relevant data after obtaining them and obtained the factor coefficients of CAPM and FF3 as shown in the following Tables. V~VIII.

**Table 5.** CAPM of Real Estate Industry before the rate hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.753       | 20.692 | 0.000   |
| $R^2 = 0.436$ |             |        |         |

**Table 6.** CAPM of Real Estate Industry after the rate hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.699       | 15.269 | 0.000   |
| $R^2 = 0.278$ |             |        |         |

**Table 7.** FF3 of Real Estate Industry before the rate hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.825       | 23.457 | 0.000   |
| SMB           | -0.177      | -2.449 | 0.015   |
| HML           | 0.483       | 5.754  | 0.000   |
| $R^2 = 0.512$ |             |        |         |

**Table 8.** FF3 of Real Estate Industry AFTER the rate hike

|               | coefficient | t      | p-value |
|---------------|-------------|--------|---------|
| MKT- $R_f$    | 0.925       | 20.203 | 0.000   |
| SMB           | -0.485      | -8.577 | 0.000   |
| HML           | 0.498       | 6.634  | 0.000   |
| $R^2 = 0.411$ |             |        |         |

For CAPM's MKT factor, it is 0.75 before the rate hike and 0.69 after the rate hike. Both of which are less than one, indicating that the real estate industry is less sensitive to market volatility due to rate hikes and has lower risk than market risk.

Regarding to the MKT factor of FF3, it is 0.82 before the rate hike and 0.92 after the rate hike, yielding results consistent with the CAPM. The SMB factor is -0.17 before the rate hike and -0.48 after the rate hike.  $\beta_{SMB} < 0$  and the large fluctuations indicate that the real estate market favors larger firms. Moreover, The HML factor is 0.48 before the rate hike and 0.49 after the rate hike, with less volatile values.  $\beta_{HML} < 1$  indicates that the real estate industry tends to favor companies with high book-to-bill (P/E) ratios. The real estate industry has lower investment value and lower profit margin potential in the context of interest rate hike.

## 4. Discussions

### 4.1 Medical industry

Before the rate hike, the market factor (MKT-Rf) was 0.46, and it was 0.51 after the rate hike. The medical industry is less vulnerable to the overall market economy's changes induced by interest rate hikes, and the risk is smaller than the market. The rate hikes have little impact on the healthcare business. This could be attributed to increased demand and excessive healthcare spending. The impact of interest rate hikes on the medical industry is being weakened by the aging of the population, an increase in disposable income, and the protection of national programs.

To begin with, the population of China is enormous and aging rapidly. The elderly has a high prevalence of morbidity, require lengthy medical treatment, and are frequently afflicted with comorbidities. The elderly, on the other hand, suffer from chronic ailments and require long-term care and medicine, making them a large consumer of medical services. The aging of the population will almost certainly result in a rise in the demand for medical services.

Second, as citizens' disposable income and the demand for consumer medical care per capita rise, disposable income has risen steadily year after year, with an annual growth rate of around 9%. The expansion of payment capability aids in the release of demand. Total health spending has risen year after year, with personal health spending increasing by double digits from 2016 to 2018. The rise in personal health-care costs means that residents' demand for consumer medical care is gradually increasing, resulting in the medical industry's steady growth.

Finally, the medical industry's regulatory system has been gradually enhanced. With the enactment of regulations for the medical industry in China, the reform of the medical and health systems has been actively supported, with a focus on ensuring drug supply, improving quality control, and stimulating corporate innovation. Policy dividends include quicker review and approval, accelerated procurement with volume, and a higher volume of innovative products for companies with specified R&D competencies and cost management capabilities. The pharmaceutical sector's and commerce's concentration is projected to continue to rise, and companies are expected to gain from this trend. Overall, the size of China's pharmaceutical market continues to grow, the pharmaceutical business stays steady, and interest rate hikes have less of an influence.

For the SMB factor, we find that its beta changed from -0.25 to -0.61 before and after the Fed's rate hike, and it is worth noting that in this context the positive and negative beta coefficients of the factor did not change, but remained negative, indicating that investors favored large-scale medical companies in the market before and after the Fed's rate hike, which is more in line with the actual situation. Since healthcare is closely related to people's health, large healthcare companies are favored by investors owing to their stable market size and industry-leading technology.

In addition, SMB has decreased before and after the Fed's rate hike, which means it's more negative, meaning investors are more favorable to large healthcare companies in the market compared to smaller healthcare companies in the context of the Fed's rate hike. The direct reason for this is that the Fed's massive interest rate hike has led to the return of global U.S. hot money to the U.S., which will bring enormous pressure on the Chinese capital market, especially the stock market. Besides, it will also bring panic to investors, hence the majority of investors in medical companies in the market will put their money into large-scale companies at this time to avoid certain risks [10].

Another point worth noting is that this point may not be directly related to the Fed rate hike. With the passage of time, people pay more and more attention to their own health. According to the World Health Organization statistics, close to 75% of the world's people are in a state of sub-health, only 5% of people are close to complete health, and they usually in hospitals or pharmacies can buy medical products with a better reputation. The vast majority of the medical products they can buy in hospitals or pharmacies are from large-scale medical enterprises, so more and more investors, who are also the demanders of medical products, will subjectively prefer to invest in large-scale medical enterprises. Moreover, these investments will allow those large-scale medical enterprises to have more sufficient funds for R&D, forming a virtuous cycle of investment in the medical industry [11].

For the factor HML, its beta coefficient did not change much before and after the Fed rate hike, it was maintained at around -0.6, maintaining its positive and negative nature. the  $\beta_{HML}$  is less than 0 indicating that investors in the market prefer to invest in medical companies with low B/M, i.e., medical companies with lower investment risk and greater investment value, generally such will have better investment prospects as time goes by and the world The population keeps aging, people pay more and more attention to medical care, and in many developed countries, the medical industry accounts for a significant proportion of the national GDP (about 15% in the United States). On the other hand, more and more technology companies are also investing in the development of healthcare, such as some wearable devices for monitoring health, or many new functions and software related to exercise and health on cell phones. All of these results denote that health is being taken more and more seriously, and they also confirm the conclusion of our analysis that medical companies have lower investment risks and better investment prospects.

Before and after the Fed's interest rate hike, the HML factor basically did not change. The reason is probably attributed to the less impact of the background on the pursuit of health of mankind. In other words, this background may change the way people invest in the medical industry, but it will not change the behavior and enthusiasm to invest in the medical industry as elaborated above, which is consistent with our analysis.

#### 4.2 Real Estate Industry

For the MKT factor of CAPM, it is 0.75 before and 0.69 after the rate hike, both of which are less than 1, indicating that the real estate industry is less sensitive to the market volatility caused by the rate hike and has lower risk than the market risk. For the MKT factor of FF3, it is 0.82 before and 0.92 after the interest rate hike, which yields the same result as CAPM. In terms of culture, real estate is closely related to people's lives, and can even be said to be the "immediate need" of Chinese people. Affected by the traditional Chinese culture, most Chinese people buy a house before getting married. Meanwhile, on account of the growing urbanization, the number of urban populations is increasing and the demand for real estate is also increasing. In the macro context, the state has continuously emphasized the "stable growth" of the real estate industry, and in recent years has introduced policies such as centralized land supply, requiring proof of self-sustaining capital, and classifying real estate enterprises into "three categories" according to three red lines. Among them, the three red lines are one of the indicators to measure the capital security of real estate enterprises, all of which meet the criteria of sound and abundant cash flow of real estate enterprises as a whole. The more they "step on the line", the more financing pressure they face. In order to win financing and consumer favor, real estate companies will try to become "green gear" to reduce their liquidity risk and debt risk. As an important part of the Chinese economy, the real estate industry has a natural and relatively stable character in the Chinese market.

The SMB coefficient for the real estate sector was -0.17 before the Fed's rate hike and -0.48 after the rate hike, with an overall beta  $SMB < 0$ , indicating better returns from investing in large companies. As far as the policy level is concerned, with the increase in lending rates following the Fed's rate hike, the cost of buying a home will increase accordingly. Coupled with the low effective demand from young buyers for real estate that requires full payment, the global housing market is at risk of losing young potential buyers. In terms of buyer demand, as housing demand is immediate, the lost young buyers will rent instead of buying, thus making the rental market oversupplied and the market heats up. Global housing prices will fall in the short term after the interest rate hike, but will remain in dynamic equilibrium or even have some upward trend in the long term. In terms of market players, the real estate industry will have 658.94 billion yuan of bonds maturing in 2022, ushering in the peak of debt service, of which 53.0% is overseas debt and 47.0% is credit debt. Credit debt is concentrated in March-September, and the peak of overseas debt service is concentrated in the first half of the year. With the Fed's interest rate hike, there is no doubt that the pressure of debt repayment will increase and some real estate enterprises will face liquidity risk. In addition, the size of the trust issue in 2020 is 923.10 billion yuan, and also faces greater repayment pressure in 2022. As a capital-

intensive industry, real estate companies may face huge debt pressure. Therefore, investors firmly believe that large-scale real estate companies holding relatively strong capital will hold more leverage to deal with the debt crisis and loss of customers due to the Fed's interest rate hike.

Statistically, a correlation coefficient greater than 0.3 is considered to be moderately correlated. By looking at the HML variable, it is clear that the HML coefficient of the real estate industry is 0.48 before the Fed's rate hike and 0.49 after the rate hike, with less overall volatility. The negative HML of the real estate industry indicates that investors prefer value stocks of companies with high book-to-market ratios, and the development of the whole industry tends to be mature, with lower investment value and less room for arbitrage. As one of the world's largest industries and an important engine of global economic development, the total value of the global real estate industry will reach \$450 trillion by 2021. However, in retrospect of the history of the world's real estate development, it is inevitable to enter the development phase with stock as the carrier after experiencing rapid incremental development. The whole real estate development has roughly undergone a shift from rough large-scale renovation to gradual renewal. Then it faces from focusing on small-scale regional housing renovation to housing renovation with master planning and regional subdivision renewal combined with the overall functions of the city. Eventually, it experienced from hardware renewal simply to enhance efficiency to comprehensive renewal that takes into account social values, the interests of the people and sustainable development. With the emergence of the world's population aging crisis, the birth rate of newborn babies is less than expected, there will be few young home buyers in the future, poor market circulation, housing prices will maintain an inflated state in the absence of effective demand, especially in areas of population outflow, e.g., Eastern Europe, Latin America, northeast China, the few population in this part of the world concentrated in the countries of emerging economies, concentrated population inflow, strong willingness to purchase homes, there is circulation. Besides, with fewer houses and more demand, housing prices do not fall easily. In general, as a highly indebted industry, the real estate market has long been saturated and the possibility of a large number of companies with low book value and growth stocks is not high, but there are still a large number of real estate companies whose stock prices do not reflect their true fundamental value well. As the market regulates and stabilizes, the market will slowly come to grips with the value of these companies with "discounted" stock prices. In addition, value stocks do not emphasize growth for investors. In this case, even if the stock does not appreciate, investors can usually benefit from dividends, and value stocks may be less risky than growth stocks because of their limited upside potential. Therefore, investing in companies with high book-to-market ratios is not a reasonable investment choice.

### 4.3 Limitations

The CAPM model does not fit well, the degree of deviation between the data and mathematical expectations is high, and the large variance and dispersion create difficulties for comparing the mean values before and after the rate hike. For the medical industry, the  $R^2$  values in the CAPM model are 0.334 and 0.333, which are average fits; the  $R^2$  values in the FF3 model are 0.449 and 0.524, which are relatively good fits, but the two added factors (especially the book-to-market ratio) are not significant. For the real estate industry, the  $R^2$  values in the CAPM model are 0.436 and 0.278, which are relatively poorly fitted after the interest rate increase. The  $R^2$  in the FF3 model are 0.512 and 0.411, which improves after the addition of the two factors, but the overall significance of the model is also not high after the interest rate increase. Moreover, the data in this paper comes from six representative stocks, but it does not fully explain the overall situation and has certain limitations.

## 5. Conclusion

In summary, this paper investigates the effectiveness of CAPM capital asset pricing model and FF3 capital asset pricing model in the healthcare and real estate sectors based on the background of Fed rate hike. Specifically, based on the research results at this stage, we believe that the health care

industry sector is less sensitive to the volatility of the market economy due to interest rate hikes, and the industry risk is lower than the market risk, favoring larger size and companies with lower book-to-bill P/E ratios. Therefore, the industry has better growth prospects as well as predictability, lower investment risk, and higher investment returns. The real estate industry sector is less sensitive to market volatility due to interest rate hikes and has lower risk than market risk. The market favors larger companies with high P/E ratios, and predictably, the real estate industry has lower investment value and lower margin potential in the context of Fed rate hikes. According to the analysis, the CAPM model cannot explain the stock data volatility of the medical and real estate industries well. Regarding to the FF3 model, it has a stronger overall significance and better fit, which provides a reasonable and effective explanation for the impact of the stocks in the above industries by the Fed's interest rate hike. In the future, The FF3 model has the potential to be an effective tool for investigating the pricing of industry-specific assets and with resource allocation. Overall, these results offer a guideline for industry research and financial quantitative investment.

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