IOSR Journal of Economics and Finance (IOSR-JEF)
e-ISSN: 2321-5933, p-ISSN: 2321-5925.Volume 14, Issue 1 Ser. III (Jan. – Feb. 2023), PP 50-59
www.iosrjournals.org

Research on the Applicability of the CAPM Model and Fama-French Three-Factor Model - Based on Chinese Listed Banks

Jie Li Yunyi Mou*
SILC Business School, Shanghai University

Abstract: Background:*The outbreak of Covid-19 has caused financial markets worldwideto fluctuate to varying degrees. And the system and structure of Chinese capital market are growing mature.*
Objective:*The paper aims to analyze the factors influencing the pricing of listed bank shares in this context and test the effectiveness and applicability of CAPM theory and the Fama-French three-factor model to explain stock pricing.*
Methods:*The paper uses the time series data regression to estimate the regression β, and calculates definition β^0 through the definition formula. Then the regression β and the definition β are weighted to obtain the comprehensive β. Finally, the paper studies the linear relationship between the comprehensive β coefficient and the stock return rate.*
Results:*In the regression of the market value factor with the bank's stock yield premium,nearly 50 % of the results of the model are not significant. And the average explanation degree of CAPM is only 26.8 %, while thecounterpartof Fama-French modelincreases to 41.4 %. In the cross-sectional regression of the comprehensiveβwith stock returns,the statistical significantmodels account for 37.9 % and 27.6 % respectively.*
Conclusion: *The market value factor in the Fama-French model does not have a significant impact on stock returns. Then, compared with CAPM, Fama-French model is more efficient in pricing Chinese stock market. Finally, there is no significant linear relationship between the comprehensive β and the stock price because the two models have a high unexplained part of the stock return volatility.*

Keywords: *CAPM model, Fama-French three-factor model, time series, cross-sectional regression*

Date of Submission: 11-02-2023 Date of Acceptance: 22-02-2023

I. Introduction

Since the outbreak of the epidemic in 2020, the rapid spread of Covid-19 has caused financial markets worldwide to fluctuate to varying degrees. The volatility of prices and yields makes investors in various countries may suffer huge losses, so the degree of risk aversion rises sharply**Error! Reference source not found.**. Therefore, the classic question of the factors affecting the price changes of the capital market, especially the stock market, has once again aroused the thinking of many scholars. As a classic answer to this question, the asset pricing model CAPM and the three-factor model, further extended from the asset pricing model, are worthy of our further study on the applicability in the current context and whether it can effectively explain the volatility of stock returns. As a bridge between the funding demand side and the funding supply side, banks are the most important financial institutions in the financial market. Therefore, the research on the bank's stock price decision and its return volatility interpretation plays an vital role in the stability of the entire financial market and the control of systemic risks[2]. In summary, based on the volatility of bank stock prices and returns in Chinese Shanghai A-shares, this paper studies and analyzes the effectiveness and applicability of CAPM theory and the Fama-French three-factor model to explain stock pricing.

II. Related Literature

As one of the fundamental theories of modern finance, the capital asset pricing model (CAPM) proposes that the systematic risk of a stock can be described by the time series curve composed of stock return and market risk. Excess returns are the only factor explaining their expected returns (Sharpe, 1964)[3]. However, some scholars have proved that β cannot fully explain the changes in stock returns through the actual data of the stock market (Fama & French, 1992)[7]. One of the most important reasons is that the actual market is not as perfect as Sharp assumes.

During the continuous development of asset pricing theory, there have also been some other classical pricing theories, such as the intertemporal capital asset pricing model (Merton, 1973)[5] and arbitrage pricing theory (Ross, 1976)[6]. Then, Gregory Connor(1988) improved arbitrage pricing theory through using an asymptotic principal components technique to estimate the pervasive factors influencing asset returns and to test the restrictions imposed by static and intertemporal equilibrium versions APT based on a multivariate regression model[7]. However, these theories do not propose specific factors that explain or affect asset pricing until Fama and French (1993) proposed a three-factor pricing model including market factors, company size factors, and the book-to-market equity ratio[8]. The empirical results show that the three-factor model can better explain the changes in stock returns than the CAPM model. Therefore, the three-factor model gradually replaces the CAPM model andis more and more widely usedin economic research.

In the research on stock pricing and yield changes based on the Chinese stock market, many scholars have reached different conclusions. Liao and Shen (2008) used the Fama-French three-factor model to test the stock price changes of Chinese listed companies after the non-tradable shares reform[9]. The authors multiply the number of shares outstanding at the beginning of each year by the share price and take the results as the size of the enterprise. Through sorting, the enterprises are divided into large-scale and small-scale enterprises by median value, and finally, the scale factor is constructed. Further, Liao and Shen divided stocks into three groups based on the book-to-market ratio factor. Among them, the return on the portfolio is weighted by the market value of the tradable shares, implying the assumption that the portfolio only includes tradable shares. In examining the explanatory power of the Fama-French three-factor model for Chinese bond yields, Liu and Yang (2010) found that SMB and HML factors contribute little to explaining Chinese bond yields[10]. Yang Qilin et al. (2020) used the CAPM model and multi-factor model to test the yield of the Chinese securities market and found that more factors can bring about an increase in explanatory power[11],which shows that the determinants and influencing factors of asset pricing in the Chinese securities market are complex. In the study of the applicability of the Fama-French three-factor model to the Chinese stock market, Shi Haotian (2022) innovatively constructed the ST factor to test the impact of risk warning on the excess returns of different portfolios, providing a new perspective for asset pricing theory[13].

III. Data And Methodology

3.1 Research ideas

To verify whether the CAPM model and the Fama-French three-factor model are effective in explaining the changes in the stock returns of Chinese banks, this paper selects 21 listed bank companies as research samples, obtains the comparable prices of the daily closing prices of 21 banks every Friday from 2017 to 2022, considers cash dividend reinvestment, and eventually acquire a total of 295 observations by calculating the weekly returns of individual stocks. In terms of the weekly return rate of individual stocks, the market value factor SMB and the book-to-market ratio factor HML are calculated by comparing the size and book-to-market ratio of 21 banks through the financial statements of enterprises. In addition to the corresponding risk-free rate of return and market benchmark interest rate, the time series data regression is used to estimate the β^1andβ^2 coefficients corresponding to the CAPM model and the Fama-French model from the 21 stocks. The β^0 value is calculated by the definition formula to analyze the sensitivity of listed banks to systemic risk. To comprehensively measure the impact of systemic risk on stock return of listed banks, the regression β and the definition β are weighted to obtain the comprehensive β① and β② [14]. Then the paper consider the comprehensive beta as the independent variable and consider the stock return rate as the dependent variable to study the linear relationship between the comprehensive β coefficient and the stock return rate. Finally, this paper concludes whether the CAPM model and Fama-French three-factor model could apply to Chinese listed banks in the changes of stock return.

3.2 Model Construction

According to the general theory of CAPM, a basic model to calculate regression β^1 is build:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it} \qquad (1)$$

Where, $R_i$represents the weekly stock yield of the bank I; R_f represents risk-free interest rate; R_m represents the benchmark interest rate of the market, reflecting the change of systemic risk; ε_i is an error term; β_i is estimated parameters; Further step,

based on the general theory of the Fama-French model, construct a model to calculate regression β^2:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it} \qquad (2)$$

where SMB_trepresents the market value factor; HML_t represents the book-to-market ratio factor.

To test the explanatory degree of the comprehensive beta β_i (i represents each enterprise)to the stock return rate, the following cross-sectional regression equation is constructed:

$$R_{it} = \gamma_0 + \gamma_1 * \beta_i + \varepsilon_{it} \qquad (3)$$

3.3 Sample selection

This paper selects 21 listed banks from the A-share market of the Shanghai Stock Exchange. The specific information is shown in Table 1. And the paper uses the comparable price of the daily closing price considering cash dividend reinvestment from the fourth week of 2017 to the forty-fourth week of 2022 to calculate individual stock returns. All data comes from CSMAR.

Table 1. Sample name, code, and number

Bank Name	Stock Code	Subscript i	Bank Name	Stock Code	Subscript i
SPD Bank	600000	1	Bank of Shanghai	601229	11
Hua Xia Bank	600015	2	ABC	601288	12
Minsheng Bank	600016	3	Bank of Communication	601328	13
China Merchants Bank	600036	4	Industrial and Commercial Bank	601398	14
Bank of Wuxi	600908	5	Everbright Bank	601818	15
Bank of Jiangsu	600919	6	China Construction Bank	601939	16
Bank of Hangzhou	600926	7	Bank of China	601988	17
Bank of Nanjing	601009	8	Guiyang Bank	601997	18
Changshu Bank	601128	9	China CITIC Bank	601998	19
Industrial Bank	601166	10	Jiangsu Suzhou Rural Commercial Bank.	603323	20
Bank of Beijing	601169	--			

3.4 Variable description

3.4.1 Time interval of the sample

The selection of sample time intervals needs to comprehensively consider the advantages and disadvantages of short and long time intervals. For short time interval samples, they can obtain a large number of instances, but excessively frequent observation will make the samples affected by the noise fluctuation of other non-bank enterprises themselves so that the data can not accurately reflect the relationship between yield and beta value; For long time interval samples, they can effectively eliminate the impact of noise, but the sample size is limited, and excessively long intervals can not effectively reflect changes in yields. In summary, this paper takes the week as the spacing length to select the data sample, and the specific time is set to the closing price of Friday. If the statutory holiday makes the Friday data missing, the closing price of the trading day closest to Friday is selected as the replacement. Finally, 295 sample observations from Week 4, 2017, to Week 45, 2022, were included.

3.4.2 Market benchmark interest rate

In general literature research, stock index returns are usually used to replace market returns and reflect the overall price level of the stock market. However, the selection of enterprises in the stock index is often some large and well-performing enterprises, rather than some poor-performing enterprises, so it cannot comprehensively reflect the changes in the overall yield of the entire market. Therefore, this paper selects the total weekly gain of Shanghai and Shenzhen A&B shares with the same time range and the same time interval as the market benchmark interest rate. Market return rate refers to the weighted average return rate of all stocks in the whole market. The calculation methods of its weight are the equal weight average method, circulation market value-weighted average method, and total market value-weighted average method. This paper uses the market return based on the total market value weighting method. The calculation formula is as follows :

$$R_t = \frac{\sum_i^n w_{it} r_{it}}{\sum_i^n w_{it}} \tag{4}$$

Where, w_{it} represents the total market value weight value of enterprise I at time t; r_{it} represents the weekly stock return rate of the bank I considering cash reinvestment income at time t; Market benchmark interest rate is defined as R_{mt}

3.4.3 Risk-free yield

A risk-free interest rate refers to the rate of return on investment in a risk-free asset, which means that the return is certain. However, in reality, there do not exist pure risk-free assets, so only approximate risk-free assets can be selected to replace them. In the study based on mature western capital markets, scholars tend to choose short-term treasury yields to approximate risk-free interest rates, because treasury bonds have national credit endorsement. However, in the Chinese bond market, due to the non-uniform demand, unreasonable term structure, and unreasonable bond pricing, short-term bond yield is not the optimal choice. Some scholars also use the three-month fixed deposit rate as an approximation of the risk-free interest rate because savings are the most basic and huge investment method for Chinese residents, and large commercial banks also have extremely low default risk. However, savings are not a tradable asset and do not have the attributes of a general tradable asset, so there may be unobservable heterogeneity compared with the ideal risk-free interest rate. Instead, this paper selects the Shanghai Interbank Offered Rate SHIBOR with one week as the approximation of a risk-free interest rate, defined as $\mathrm{R_{ift}}$. That is because, with the fast development of the Chinese interbank lending market, the interbank lending rate has been relatively mature and stable in recent years. At the same time, short-term interbank lending has extremely low risks, and the determination of lending rates also has a mature market-oriented mechanism.

3.4.4 Stock yield

The yield of the stock is not only reflected in the change in the stock price, but also reflected in the cash dividend, and the reinvestment of the cash dividend also obtains a return. Therefore, to more comprehensively reflect the yield of the stock, the paper uses the weekly stock return rate which considers the reinvestment of the cash dividend to measure the stock return rate, defined as $\mathrm{R_{it}}$. The calculation formula is as follows :

$$R_{it} = \frac{P_{it}}{P_{i,t-1}} - 1 \tag{5}$$

Where $\mathrm{P_{it}}$ is the comparable daily closing price of bank I on the last trading day of week t considering cash dividend reinvestment.

3.4.5 Market value factor

The market value factor is a variable that measures changes in stock returns due to differences in firm size, denoted as SMB. By ranking the total market value of enterprises into large-scale (B) group and small-scale (S) group, with ten banks in each group, the value of the market value factor equals the small market value group average weekly stock yield minus the average weekly stock yield of large market value group. The calculation formula is as follows :

$$SMB_t = \bar{R}_{S,t} - \bar{R}_{B,t} \tag{6}$$

In the division of the size of the group, the market value of the enterprise ranking in a short period is relatively stable, so this paper uses the 13th week of the bank’s market value ranking to replace all weeks ranking in the first half of a year and uses the 39th week of the bank’s market value ranking to replace all weeks ranking in the second half of a year, a total of 12 sortings and grouping. Then the groups are divided, and the SMB values for each week are calculated. Table 2 shows some of the ranking results.

Table 2. Chinese Shanghai A-share bank market value factor ranking

Stock Code	2017-13 (week)	2017-39 (week)	2018-13 (week)	Stock Code	2017-13 (week)	2017-39 (week)	2018-13 (week)
600000	14	14	14	601229	7	5	7
600015	9	9	9	601288	17	18	18
600016	12	11	11	601328	15	15	15
600036	16	16	16	601398	20	20	20
600908	2	4	2	601818	10	10	10
600919	6	7	6	601939	19	19	19
600926	4	3	4	601988	18	17	17
601009	8	8	8	601997	5	6	5
601128	3	2	3	601998	13	12	12
601166	11	13	13	603323	1	1	1

By comparing the changes in the ranking of the market value of the enterprises in the first half of a year, it is not difficult to find that the overall fluctuation is not significant, and the changes in the banks' ranking included in the large and small scale groups are more minor. Therefore, using 13 weeks of large and small-scale grouping and 39 weeks of large and small-scale grouping to replace the grouping of the first half and the second half respectively will not bring significant calculation errors.

3.4.6 Book-to-market ratio factor

The book-to-market ratio factor is a variable that measures the change in stock returns caused by the difference in the book-to-market ratio of enterprises, which is recorded as HML. The calculation of the book-to-market ratio factor is to divide the enterprise into three groups: high book-to-market value group (H), medium book-to-market value group (M), and low book-to-market value group (L) through the ranking of the book-to-market ratio of the enterprise. Each group takes 6,8 and 6 banks, accounting for 30 %, 40 %, and 30 % respectively. Then use the average weekly stock yield of the high book value group (H) to subtract the average weekly stock yield of the low book value group (L). The calculation formula is as follows :

$$HML_t = \bar{R}_{H,t} - \bar{R}_{L,t} \quad (7)$$

Similarly, this paper uses the bank book-to-market ratio ranking of the 13 th week of each year to replace the book-to-market ratio ranking of the whole week of the first half of the year and replace the second half of the book-to-market ratio ranking with the 39th week of the bank book-to-market ratio ranking, a total of 12 sorting and group. Then, the HML values equal the average return of the H group minus the average return of the L group. Through the change of sorting, it is found that the grouping interval error is also very tiny, which will not lead to significant errors.

IV. EMPIRICAL RESULT

4.1 Stability test

When calculating the β coefficient corresponding to the CAPM model and the Fama-French three-factor model by regression, the data used are all time series data, and stationarity is the basis and premise of analyzing and estimating the time series data. Only when the time series data is stable, the conclusions obtained by analysis and estimation can be extended and used, and the findings of the research are practical. Therefore, this paper tests the stationarity of the weekly return, weekly market return, market value factor, and book-to-market ratio factor of 20 stocks.

Firstly, the fluctuation diagram of the original data is drawn to observe the fluctuation of the time series. Figure 1 shows part time series diagrams of 20 stocks' risk premium.

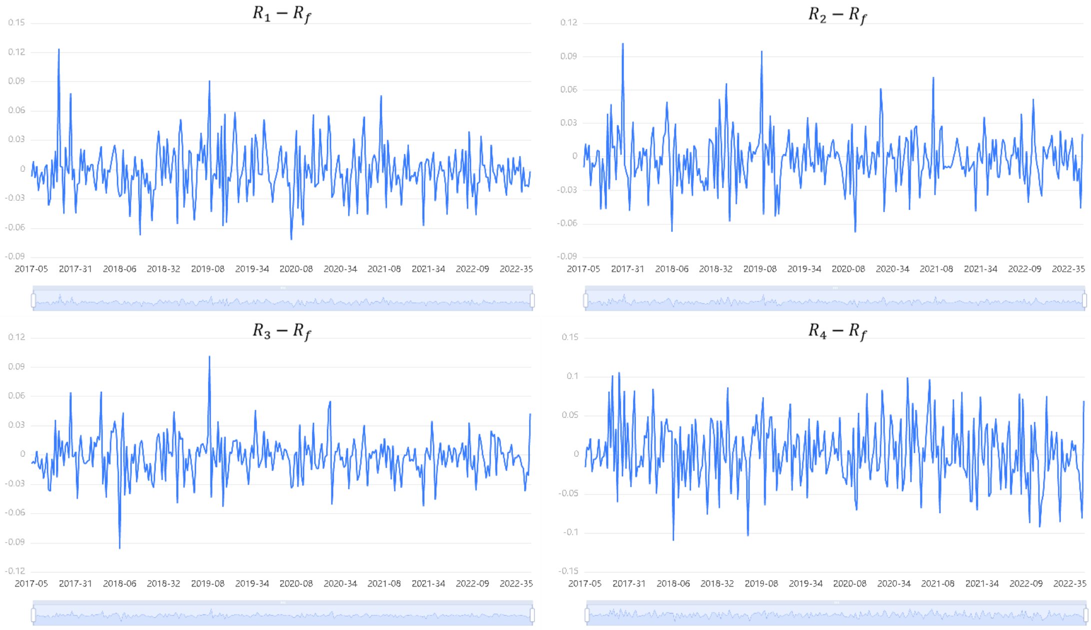

Fig.(1). Volatility diagram of risk premium

By observing the fluctuation of each time series data over time, it can be found that the yield of individual stocks fluctuates around zero value over time, and the overall fluctuation range is relatively stable, which can preliminarily judge the stability of time series data.

Furthermore, Table 3 shows the quantitative unit root test of time series data to obtain more accurate stationary results.

Table 3 Unit root test statistics of Risk premium

ADF Test			
Variable	**t**	**Variable**	**t**
$R_1 - R_f$	-11.784***	$R_{13} - R_f$	-13.689***
$R_2 - R_f$	-18.306***	$R_{14} - R_f$	-7.253***
$R_3 - R_f$	-17.673***	$R_{15} - R_f$	-6.888***
$R_4 - R_f$	-13.323***	$R_{16} - R_f$	-14.016***
$R_5 - R_f$	-15.851***	$R_{17} - R_f$	-13.231***
$R_6 - R_f$	-13.681***	$R_{18} - R_f$	-19.089***
$R_7 - R_f$	-18.488***	$R_{19} - R_f$	-18.398***
$R_8 - R_f$	-13.086***	$R_{20} - R_f$	-17.477***
$R_9 - R_f$	-18.459***	$R_m - R_f$	-17.535***

$R_{10} - R_f$	-5.745***	SMP	-3.659***
$R_{11} - R_f$	-20.152***	HTML	-16.171***
$R_{12} - R_f$	-13.577***		

The above statistical values are the results of the ADF test on the original sequence data, without any difference processing, and all the statistical values are significant. Therefore, the assumption that the time series is not stable can be rejected. That is, all the time series data meet the requirements of stability, and further analysis can be carried out based on the time series data.

4.2 Beta of definition formula(β^0)

The beta coefficient is an important indicator for measuring systemic risk. It reflects the deviation between the return rate of assets or portfolios and the market return rate. The calculation formula is :

$$\beta^0 = \frac{COV(R_i, R_m)}{\sigma_m^2} \tag{8}$$

Table 4 shows the β^0 of the 21 banks which are calculated through Excel's COVAR function and VAR function.

Table 4 Beta of definition formula in Chinese listed banks

Stock Code	β^0	Stock Code	β^0
600000	0.612	601229	0.590
600015	0.611	601288	0.346
600016	0.548	601328	0.397
600036	0.900	601398	0.421
600908	0.914	601818	0.591
600919	0.643	601939	0.575
600926	0.761	601988	0.370
601009	0.778	601997	0.737
601128	0.810	601998	0.613
601166	0.787	603323	0.886
601169	-0.014		

From the table above, the calculated β^0 of 601169, representing Beijing Bank, is less than 0, contrary to the theoretical basis. Such a situation may be due to the irrational factors of the market and statistical error and other factors, to be removed as an abnormal sample. And according to the results, the stock yield premium is positively correlated with market risk.

4.3 Beta of CAPM model regression(β^1)

Based on Model (1), the time series regression of the risk premium of individual stock yield and market yield risk premium of 20 banks is carried out to obtain the corresponding β^1 of CAPM. And combined with the β^0 of the definition formula, this paper obtains the comprehensive beta(β①), which is the weighted average of the two above. Table 5 shows the regression results.

Table 5 Regression of the CAPM model in Chinese listed banks

	CAPM Regression					Comprehensiveβ①
Sample	β^1	**Adjust R2**	**P value**	**F value**	**Observation**	$(\beta^0+\beta^1)/2$
SPD Bank	0.577	0.332	0.000***	145.883	295	0.595
Hua Xia Bank	0.636	0.403	0.000***	199.472	295	0.624
Minsheng Bank	0.629	0.393	0.000***	191.549	295	0.589
China Merchants Bank	0.556	0.306	0.000***	130.772	295	0.728
Bank of Wuxi	0.421	0.174	0.000***	63.076	295	0.667
Bank of Jiangsu	0.508	0.256	0.000***	102.011	295	0.575
Bank of Hangzhou	0.452	0.202	0.000***	75.326	295	0.607
Bank of Nanjing	0.537	0.286	0.000***	118.583	295	0.658
Changshu Bank	0.408	0.164	0.000***	58.586	295	0.609
Industrial Bank	0.532	0.281	0.000***	115.67	295	0.659
Bank of Shanghai	-0.016	-0.003	0.779	0.079	295	--
ABC	0.568	0.32	0.000***	139.629	295	0.579
Bank of Communication	0.415	0.169	0.000***	60.99	295	0.381
Industrial and Commercial Bank	0.513	0.261	0.000***	104.736	295	0.455

Everbright Bank	0.41	0.165	0.000***	59.302	295	0.415
China Construction Bank	0.522	0.27	0.000***	109.533	295	0.556
Bank of China	0.482	0.23	0.000***	88.836	295	0.528
Guiyang Bank	0.497	0.244	0.000***	95.972	295	0.434
China CITIC Bank	0.607	0.367	0.000***	171.231	295	0.672
Jiangsu Suzhou Rural Commercial Bank.	0.523	0.271	0.000***	110.282	295	0.568
Bank of Shanghai	0.517	0.265	0.000***	106.8	295	0.701
Average	--	0.268	--	122.412***	295	--

By observing the CAPM time series regression results, it is found that the β values of the remaining 20 banks are significant apart from the β coefficient of the Bank of Beijing, and the overall models are significant as well, which indicates that the risk premium of individual stock returns has a significant linear relationship with the risk premium of market returns. It means that the CAPM model holds in Chinese listed banks. However, it is found that the average adjusted R2 of the 20 regression models is only 0.268, which means that the CAPM model can only explain 26.8 % of the risk premium of individual stock returns. Therefore, there is still 73.2 % of the unexplained part. To sum up, CAPM is statistically tenable in listed banks in China, but its explanatory power is not high, it cannot be used as a determinant of the risk premium of individual stock returns, and it is difficult to provide an effective reference for investment decisions.

4.4 Beta of Fama-French three-factor model(β^2)

Model (2) is a multiple regression model, and the explanatory variables are market risk, market value factor, and book value ratio factor respectively. To avoid the distortion and invalidity of the regression results caused by multicollinearity, the multicollinearity test is carried out to calculate the variance expansion factor, as shown in Table 6.

Table 6 Multicollinearity test of three-factor variables

	$\mathbf{R_m - R_f}$	**SMB**	**HML**
VIF	1.125	1.389	1.307

The variance inflation factor of each variable is significantly less than 10, so it is not considered that there is a multicollinearity problem in Model (2).

Based on Model (2), time series regressions are performed on the stock yield risk premium, market yield risk premium, market capitalization factor (SMB), and book-to-market ratio factor (HML) of the 20 banks to obtain the corresponding β^2 of the Fama-French three-factor model. And combined with the β^0 of the definition formula, this paper obtains the comprehensive beta (β②), which is the weighted average of the two. The regression results are shown in Table 7.

Table 7. Regression of the Fama-French three-factor model in Chinese listed banks

	Fama-French Regression					**Comprehensive β②**
Sample	$\boldsymbol{\beta^2}$	**si**	**hi**	**Adjust R2**	**Observation**	**($\boldsymbol{\beta^0+\beta^2}$)/2**
SPD Bank	0.536***	0.071	-0.278***	0.39	295	0.574
Hua Xia Bank	0.57***	0.174***	-0.276***	0.459	295	0.591
Minsheng Bank	0.619***	-0.01	-0.157***	0.415	295	0.584
China Merchants Bank	0.504***	0.064	-0.437***	0.471	295	0.702
Bank of Wuxi	0.277***	0.59***	0.076*	0.545	295	0.595
Bank of Jiangsu	0.352***	0.518***	-0.309***	0.45	295	0.497
Bank of Hangzhou	0.243***	0.677***	-0.461***	0,551	295	0.502
Bank of Nanjing	0.385***	0.426***	-0.545***	0.534	295	0.582
Changshu Bank	0.216***	0.7***	-0.175***	0.537	295	0.513
Industrial Bank	0.455***	0.172***	-0.416***	0.411	295	0.621
Bank of Shanghai	0.49***	0.25***	-0.183***	0.366	295	0.540
ABC	0.411***	-0.06	-0.241***	0..239	295	0.379
Bank of Communication	0.498***	-0.006	-0.203***	0.298	295	0.448
Industrial and Commercial Bank	0..4***	-0.056	-0.306***	0.273	295	0.410
Everbright Bank	0.429***	0.261***	-0.322***	0.354	295	0.510
China Construction Bank	0.467***	-0.041	-0.321***	0.342	295	0.521
Bank of China	0.495***	-0.052	-0.186***	0.285	295	0.433
Guiyang Bank	0.504***	0.334***	-0.232***	0.449	295	0.621

China CITIC Bank	0.492***	0.063	-0.191***	0.295	295	0.552
China CITIC Bank	0.376***	0.564***	0.042	0.584	295	0.631
Bank of Shanghai	--	--	--	0.414	295	--

First, by observing the F value of the model regression, we find that the three-factor regression models of 20 banks are significant statistically, which means that the Fama-French three-factor model is tenable in Chinese listed banks. However, the regression coefficient is reflecting the contribution of the market value factor (SMB) to the stock return rate is not significant in the nine models, so the explanatory power of the market value factor to the stock return rate of Chinese listed banks is not significant. The book-to-market ratio factor is significantly negatively correlated with stock returns, which means that the greater the book-to-market ratio is, the lower the stock returns become. Finally, through the results of statistics, it is found that the average adjusted R2 of the 20 regression models is 0.414, which means that the Fama-French three-factor model explains 41.4 % of the risk premium of the stock yield in Chinese listed banks. Therefore, there are still 58.6 % of the parts that cannot be explained, which is consistent with the current mainstream view. There are still many unexplained parts in the three-factor model, such as short-term reversal, medium-term momentum, volatility, skewness, gambling, and other factors. However, compared with the degree of interpretation of the CAPM model, the explanatory power of the Fama-French three-factor model has still been significantly improved, which can more comprehensively describe and interpret the risk premium of individual stock returns, and provide a more reliable judgment standard for related investment decisions as well.

4.5 Effectiveness analysis of comprehensive beta(β①&β②)

Based on the model (3), this paper uses the comprehensive beta value (β①&β②) to conduct cross-sectional regression with the weekly stock returns of Chinese listed banks and analyzes the explanatory power of the comprehensive beta value on the changes in stock returns. This paper draws five sets of samples per year from 2017 to 2022, a total of 30 sets of samples for cross-sectional regression.

4.5.1 Heteroscedasticity and sequence autocorrelation test

In using OLS for cross-sectional regression, the sample data may have heteroscedasticity, serial error autocorrelation, and other issues contrary to the traditional assumptions of OLS, so OLS is not an unbiased and effective estimator. Therefore, to make the regression more convincing and reliable, this section will use the White test to test whether the sample has heteroscedasticity problems; and use the DW test to identify whether the sample has an error sequence autocorrelation problem. Table 8 shows the results of the partial identification test.

Table 8. The results of the White test and DW test

	Comprehensive β①					**Comprehensive β②**			
Date	**White test**	**P**	**DW test**	**P**	**Date**	**White test**	**P**	**DW test**	**P**
2017-05	15.199	0.000	1.569	0.132	2017-05	13.723	0.001	1.568	0.134
2017-15	2.791	0.247	2.290	0.715	2017-15	2.917	0.232	2.202	0.644
2017-25	4.473	0.106	2.092	0.541	2017-25	4.981	0.083	1.923	0.391
2017-35	1.838	0.398	2.121	0.568	2017-35	1.911	0.384	1.999	0.460
2017-45	1.942	0.378	2.689	0.938	2017-45	1.556	0.459	2.712	0.946
2018-04	1.145	0.563	2.035	0.489	2018-04	1.392	0.498	1.852	0.330
2018-14	1.599	0.449	2.140	0.585	2018-14	1.397	0.497	2.161	0.608
2018-24	1.439	0.486	2.327	0.744	2018-24	1.468	0.479	2.221	0.661
2018-34	1.751	0.416	1.729	0.230	2018-34	2.166	0.338	1.825	0.307
2018-44	0.056	0.972	2.350	0.761	2018-44	0.011	0.994	2.415	0.808
2019-04	2.379	0.304	2.316	0.735	2019-04	2.573	0.276	2.313	0.736
2019-14	2.092	0.351	1.543	0.119	2019-14	1.846	0.397	1.370	0.056
2019-24	2.472	0.290	1.407	0.065	2019-24	2.916	0.232	1.395	0.063
2019-34	1.165	0.558	1.565	0.129	2019-34	2.424	0.297	2.146	0.595
2019-44	2.475	0.290	2.162	0.606	2019-44	2.794	0.247	1.596	0.149

Observing the test statistics above, it is found that, in the 30 groups of samples, onlythe '2017-05' sample hasthe problem of heteroscedasticity, and the remaining samples do not have abnormal differences and sequence autocorrelation problems. Therefore, this paper eliminates the ' 2017-05 ' sample without using the weighted least squares method or the generalized least squares method for special processing.

4.5.2 CAPM & Fama-French cross-sectional regression analysis

To analyze the degree of interpretation of the comprehensive beta value on the weekly stock yield changes of listed banks in China, β① and β② are used as independent variables to conduct cross-sectional regression with the stock yield of listed banks. Table 9 shows the results of 29 cross-sectional regression models.

Table 9. Cross-sectional regression of comprehensive beta and stock returns

	β①		β②			β①		β②	
	Coefficient	**R2**	**Coefficient**	**R2**		**Coefficient**	**R2**	**Coefficient**	**R2**
2017-15	0.121	0.015	0.007	0	2020-14	-0.354	0.125	-0.153	0.023
2017-25	0.117	0.014	0.311	0.096	2020-24	-0.319	0.102	-0.235	0.055
2017-35	0.542**	0.293	0.397*	0.158	2020-34	0.169	0.029	0.179	0.032
2017-45	0.536**	0.287	0.488**	0.238	2020-44	-0.302	0.091	-0.095	0.009
2018-04	-0.24	0.058	-0.096	0.009	2021-04	0.25	0.063	0.285	0.081
2018-14	0.401*	0.161	0.478	0.143	2021-14	-0.432*	0.187	-0.301	0.09
2018-24	-0.305	0.093	-0.161	0.026	2021-24	-0.326	0.106	-0.168	0.028
2018-34	0.302	0.091	0.307	0.094	2021-34	-0.133	0.018	-0.176	0.031
2018-44	0.553**	0.306	0.479**	0.23	2021-44	-0.278	0.077	-0.162	0.026
2019-04	-0.04	0.002	0.045	0.002	2022-04	0.457**	0.209	0.346	0.12
2019-14	0.5**	0.25	0.42*	0.177	2022-14	0.362	0.131	0.211	0.045
2019-24	0.434*	0.188	0.593***	0.352	2022-24	0.578***	0.334	0.407*	0.166
2019-34	0.486**	0.236	0.614***	0.377	2022-34	-0.265	0.07	-0.239	0.057
2019-44	0.122	0.015	-0.007	0	2022-44	-0.624***	0.39	-0.473**	0.224
2020-04	-0.354	0.126	-0.326	0.107					

According to the results of the 29 groups of cross-sectional regression: only 11 groups of return results are significant statistically among the cross-sectional regression of β① as the independent variable with the bank's weekly stock return rate, which means that β①doesn't have a significant linear relationship with the bank's weekly stock return rate. Therefore, the comprehensive beta (β①) obtained based on CAPM cannot effectively explain the change in the bank's weekly stock return rate.In the cross-sectional regression of β② as the independent variable with the bank's weekly stock yield, onlyeight groups of return results are significant.Therefore, the conclusion that the β② has a significant linear relationship with the bank's weekly stock yield cannot be drawn. And the β② value obtained based on Fama-French cannot effectively explain the changes in the bank's weekly stock yield.

The resultsabove show that there are still many influencing factors that the CAPM and Fama-French model can not explain and cover in the change of stock returns of listed banks in China, such as investor sentiment, that is, investor irrationality. Therefore, changes in stock returns or prices are not limited to the sensitivity of companies' systemic risks, the size of companies, and the impact of book-to-market ratios. To sum up, China still needs to improve the capital market further, foster the investment level of investors and make the market return to rationality.

V. Conclusion

In the unpredictable Chinese stock market, this paper makes a regression analysis of 295 weekly sample data of 21 banks in Shanghai A-share from 2017 to the present. It is found that there is a significant positive correlation and negative correlation between the risk premium of the bank's stock yield and the risk premium of thecomprehensive market yield,and the book-to-market ratio factor, respectively. However, the market value factor is insignificant in the regression results of nearly 50 % of the bank's stock yield premium. Therefore, we can not conclude that there exists some relationship between the two variables. Through statistics, it is found that the average explanation degree of CAPM is only 26.8 %, while the average explanation degree of Fama-French three factors is increased to 41.4 %, which can better explain the influencing factors of individual stock yield risk premium. However, since both models have more than 50 % of the unexplained part, in the cross-sectional regression of the comprehensive β①and comprehensive β②, based on CAPM and Fama-French respectively, with stock returns, the models with significant regression results only account for 37.9% and 27.6%, respectively. Therefore, it cannot be concluded that there is a significant linear relationship between the comprehensive beta value and the bank's stock returns. We need to improve the Chinese capital market further and explore other factors and theoretical explanation models that determine changes in stock returns.

CURRENT & FUTURE DEVELOPMENTS

With the late establishment and development of Chinese capital market, the market is full of non-institutional investors. Coupled with the imperfect system and market, the capital market is in a number of purely irrational. This is an important reason for the low explanatory rate of CAPM and FAMA-French models based on the yield of listed bank stocks. But with the multi-level capital market, listing and delisting system, and the establishment of investment thresholds, Chinese capital market will become more mature. Therefore, it is necessary to further calculate and evaluate the interpretation rate of these two models based on a more mature capital market in the future. At the same time, irrational factors such as investor sentiment should also be added to the model to explain the stock risk premium, so as to more fully describe the fluctuation of stock price. Finally, in the cross-sectional regression of the comprehensive β value and the stock return rate, the sample size used is relatively small, so it may not be statistically convincing. Therefore, in the follow-up study, the sample size can be increased to observe whether the significance of the explanatory model of comprehensive β on stock returns has changed to further improve the research.

Reference

[1]. N. F. Chen, “Economic Forces and the Stock Market”, The Journal of Business, vol. 59, no. 3, 1986, pp. 383–403. JSTOR, http://www.jstor.org/stable/2352710. Accessed 15 Nov, 2022.
[2]. A. Mirzaei, and M. Saad, and A. Emrouznejad, “Bank stock performance during the COVID-19 crisis: does efficiency explain why Islamic banks fared relatively better?”, Ann Oper Res, 2022,https://doi.org/10.1007/s10479-022-04600-y.
[3]. W. Sharpe, “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk”, Journal of Finance 19 (3): 425-442, 1964.
[4]. E. F. Fama, and K. R. French, “The Cross-section of Expected Stock Returns”, Journal of Finance, 47 (2): 427–465, 1992.
[5]. R. C. Merton, “An Intertemporal Capital Asset Pricing Model”, Econometrica: Journal of the Econometric Society, 41, 867-887,1973.
[6]. S. A. Ross, “The Arbitrage Theory of Capital Asset Pricing”, Journal of Economic Theory, 13 (3): 341–360, 1976.
[7]. C. Gregory, and A. K. Robert, “Risk and return in an equilibrium APT: Application of a new test methodology”, Journal of Financial Economics, Volume 21, Issue 2,1988, Pages 255-289, ISSN 0304-405X.
[8]. E. F. Fama, and K. R. French, “Common Risk Factors in the Returns on Stocks and Bonds”, Journal of Financial Economics, 33 (1): 3–56, 1993.
[9]. L. Liao, and H. B. Shen, “Fama-French Three Factors Model and the Effect of the Split-share Structure Reform”, The Journal of Quantitative and Technical Economics 9: 117-125, 2008. (in Chinese).
[10]. G. M. Liu, and C. Yang, “Application of Fama-French multi-factor model in China’s bond market during recent financial crisis”, Journal of Zhejiang University(Science Edition), 09:117-125, 2010.
[11]. Q. L. Yang, and et al, “Comparison of Fama-French Multi-Factor Model with CAPM Model: Evidence from the Chinese Market”, Management & Technology of SME, 2020,(06),86-87 (in Chinese).
[12]. H. T. Shi, “Research on the applicability of Fama-French three-factor model and the impact of risk warning on portfolio excess returns-An empirical study based on Shanghai Stock Exchange main board data”, Modern Business Trade Industry, 2022,43(01).
[13]. B. N. Lehmann, and D. M. Modest,”The Empirical Foundations of the Arbitrage Pricing Theory”, Journal of Financial Economics, 21 (2): 213–254,1988.
[14]. Y. Wang, and K. L. Yang, “The Empirical Study of the CAPM Model Applicability and the Yield Factors on Listed Securities-Trader Stocks”, Journal of Chongqing University of Technology(Natural Science), 2019,33(01):193-200.

Jie Li Yunyi Mou. “Research on the Applicability of the CAPM Model and Fama-French Three-Factor Model - Based on Chinese Listed Banks.” *IOSR Journal of Economics and Finance (IOSR-JEF),* 14(1), 2023, pp. 50-59.