An Empirical Test of Asset Pricing Factor Models in China Stock Market

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Abstract

This paper mainly investigates the efficiency and explanatory capability of the Capital Asset Pricing Model, the Fama-French Three-Factor Model and the Fama-Fench Five-Factor Model in China stock market, in the meanwhile, figures out the key factors. Before the empirical tests, this paper constructs twenty five portfolios and observes that both the size and value are significantly correlated with the returns. Based on the the OLS time-series regressions and the statistical significance tests, it is found that the market factor contributes a great effort to explain the excess returns. Additionally, both the “size effect” and the “value effect” have significant impacts on interpreting the relation with portfolio’s returns. On the contrary, the effect of the profitability could be explicated by other four factors and the influence of the investment level appears low significance in the model. Combining all the information obtained from tests, this paper concludes that the Fama-French Three-Factor Model is the most suitable and efficient asset pricing model for China stock market .

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Chapter 1

Introduction

The Stock markets win unprecedented attention in China recently. According to China Statistical Yearbook-2016, more than 0.21 billions Chinese (approximately 15.3 percent of people in China) were active in stock investments during 2015, showing the influence and attractiveness of stock in financial markets. Investors always try to find the key to the question: How does a given share price affect the returns in the future? However, the prices of financial instruments change variably and the trend of future price is difficult to predict. Reviewing the history of finance, modern financial theories were gradually formatted and developed in the process of continuously answering the question mentioned before. Before the early 1950s, theories called classical micro-finance supported to solve financial decision-making problems under certain conditions, which mainly depended on the "supply and demand equilibrium method" from the Economics. Nevertheless, since the economy were continuing developing and more complex financial activities appeared, the financial theories could not match with the reality at that time. After the 1950s, the reform of these theories led to the foundation of modern micro-finance theory. With the help of modern information technology, mathematical model analysis methods and quantitative analysis, this new theory are able to manage the financial decisions with uncertain conditions.

The modern financial theories mainly study how to weigh the risks and returns with uncertain future payoff. Moreover, the core issue of these theories is how to form a reasonable equilibrium price system (Cao 2006). Asset pricing especially the stock pricing is the prerequisite for all financial decisions. Therefore, asset pricing theory is the core content and has undergone a long-term development. Retrospecting the entire process, different pricing theories and methods were improved step by step in order to improve the explainable ability of returns. In the late of the 20th century, the rapid development of computer technologies and the abundant financial transaction data contributed to the verification of theories. Modern portfolio theory was firstly introduced by Markowitz (1952) and he created a "mean-variance model". On the basic of Markowitz, Sharpe (1964), Lintner (1965) and Black (1972) constructed the Capital Asset Pricing Model, though empirical results did not support it well. Afterwards, Fama and French (1993) established a three-factor model referring to arbitrage pricing theory (Ross 1976) and efficient market theory. In addition, the Fama-French Five-Factor Model were constructed by adding two new factor into three-factor model by Fama and French (2015). According to these created models, scholars have done plenty of empirical research in the mature capital markets, especially the US capital market, but the test results are mixed.

Research Questions and Objectives

After the Capital Asset Pricing Model having been proposed, many scholars in domestic and abroad continually argue for the results with the reality. Compared with the mature capital markets in the West, China's capital market is special, which shows in three aspects: First, it exists many imperfections, for example, individual investors are the main body in the market; Secondly, the lack of mechanism of exiting market leads to the difficulties in eliminating some bad-performance companies; Finally, the stock market is highly impacted by government policies, for example, unique political and economic system cause that the number of publicly traded outstanding shares accounts for only two-thirds of the total. Moreover, China security market is more complicated and it may be not enough to interpret the yield of stock simply depending on systematic risk. Therefore, the results may be different from the European and American markets, when using China stock data to experiment different pricing models.

The asset pricing models may be not efficient in the China stock market. This demonstrates the necessary of studying the applicability of these models. Nevertheless, with China's securities market gradually connecting with international markets, the living space of speculators is greatly compressed and the market tends to be improved . In this context, trying to test the traditional CAPM model, the Fama-French Three-Factor Model and the Fama-French Five-Factor Model in China's emerging securities market becomes meaningful. Meanwhile, there is a high demand for rational investment in China. Through these empirical research, we may reveal the significant factors of returns and obtain a strong support of rational investment strategy.

In this paper, the aim is to analyze whether the Capital Asset Pricing Model, the Fama French Three-Factor Model and the Fama-French Five-Factor Model with data from China stock market are efficient and it is necessary to discover which one is the most appropriate model for China market. The questions as follows will be discussed in this research paper:

1. How do the Capital Asset Pricing Model, the Fama French Three-Factor Model and the Fama-French Five-Factor Model perform in China Stock Market?
2. Which one among the Capital Asset Pricing Model, the Fama French Three-Factor Model and the Fama-French Five-Factor Model is the most explainable of China Stock market?
3. Which factors in these models could efficiently explain the excess returns in the China Stock Market?

In order to test asset pricing models with Shanghai and Shenzhen Stock Market, a list of stock shares data will be downloaded from a software and the correlation between beta and monthly returns are tested with methods of time-series regressions.

After the empirical research having been done by this paper, matching with the aims and the research questions, some findings are showing as following. According to these regressions and tests, the market factor shows a good ability of explaining the excess returns in China stock market, in the meanwhile, both SMB and HML factors are explainable when interpreting the premium of stock returns. This paper contradicts some research results of the explainable capabilities of two extra factors in the five factor model comparing to the three-factor model. The factor CMA could be explicated by other four factors and the coefficients of RMW appears low significance under the level of 5% in the model after regressions. Finally, this paper draw a conclusion that the Fama-French Three-Factor Model is most explanatory for China stock market and the market factor, the SMB and the HML have a significant influence on the average premiums.

Paper Structure

This paper is in the structure of six sections. Except the section1 as the introduction of this paper with the research objects, section2 provides a review of asset pricing theories and a series of previous research on China stock market. For the section3, it conducts some detailed explanations of models, some empirical methods, and the data description. Section4 states numerical results and findings of share prices regression for CAPM, Fama-French Three-Factor Model and Fama-French Five-Factor Model. Based on these results, some analysis and discussions will be shown, in the meanwhile, this paper will link back to the research objectives and declares research aim's achievement. There is an conclusion in section 6 and a reference list is in the following. Finally, all the programming codes are added in the Appendices.

Chapter 2

Literature Review

The Asset Pricing is mainly for explaining the value of asset's future payoff with some uncertain factors (Liu & Baek 2016). The assets usually are some financial instruments or securities and the price of payoff specially refers to the market equilibrium price decided by the market demand and supply. It is found that the lower price of asset is often with the higher yield. In other words, the asset pricing theory is considered to explain why the payoff of some assets is higher than the others.

There are plenty of ways to price financial products in the capital market and they can be divided into two categories: induction (Fama-French factors Model) and deduction (CAPM) according to the different logic of their formation processes (Wang 2008). Inductive approach is mainly for predicting a trend of price changes in the financial products (fuzzy pricing) while deductive method is for precise pricing.

Induction

This is a kind of bottom-up inference method that is a reasoning process from the individual to the general, technical analysis and artificial intelligence as the representative. Additionally, the stock price series model based on volume is a new development of asset pricing theory under induction.

Deduction

This is a kind of top-down inference method praised by mainstream economics and deduction is the perfect opposite of induction which has a reasoning process from the general to the individual. Deductive method puts forward the applicable scope of the theory with a series of hypothesizes and conditions firstly and a pricing model or theory will be obtained through the rigorous mathematical derivation as well as on the basic of the economic theory. Thus, within the scope of application of the assumptions, this model is universally applicable to price any financial assets. Moreover, modern asset pricing theory and its new developments are belong to the category of deduction, such as cash flow discounted model, MPT, CAPM and APT.

Since the formation of models can be arranged in the time order, this paper will first introduce the deductive model CAPM and will start this part from some basic knowledge as follows.

2.1 The Modern Portfolio Theory (MPT)

Markowittz published a paper entitled "Portfolio Selection" in the financial journal in 1952 and created a complete analysis framework of mean-variance, which stands for the beginning of modern financial theory. As one of the asset pricing theory's cornerstone, modern portfolio theory significantly directs at analyzing investment risk's possibility and it mainly solves the problems that how investors measure the different investment risks and how they rationally allocate their own funds to obtain the maximum revenue. MPT claims that a special correlation is between the risk and the asset portfolio return, meanwhile, the diversification of investment risk has a regulation (Markowitz 1952).

Assumptions constructed in MPT:

1. This is a perfect capital market: There is no transaction cost and no income tax; All assets can be infinitely broken down and can be traded without any obstacles; The market has a large number of traders and the behavior of each traders will not affect the price of securities (perfectly competitive market); Individuals and enterprises have the same ability and opportunity to enter the market; It is free to access to information and market is efficient; All people have the same expectations for the future (homogeneous expectation), which means that investors are seeking for maximizing the expected utility; The inflation does not exist and there is an unchanged discount rate.

2. Investment risk is represented by investing yield's variance (or standard deviation), in the meanwhile, expected return and risk are two core factor affecting the investment decision-making.

3. Investors are risk aversion: Investors choose the portfolio on the basic of the expected rate of return (mean) and the financial asset's risk (standard deviation). If they need to bear a greater risk, they must be compensated for higher expected returns.

4. Investors obey the dominance rule, which means that they will choose higher yield of securities with the same level of risk and choose lower risky of financial products with the same return.

5. The return of assets are relevant: The distribution of return obeys normal distribution, which is knew by all investors in advance.

6. Asset return's both mean and variance are in the one period

The model constructed by Markowitz is the first step of finding the optimal portfolio , which is confirming valid portfolio set (effective frontier of risky assets). The core principle of portfolio of risk assets is that investors focus only on the highest expected return of portfolios for any risk levels.

Markowitz (1952) states that the best portfolio selection choice for investors gains a given expect return with a minimum of portfolio return's variance. Moreover, after the frontier built, risk-free assets should be added into these portfolios. When the capital allocation line of a risk-free asset is tangent to the effective frontier, the tangentive point is the optimal risk portfolio.

Markowitz's mean-variance theory is the first time to raise the opinion of quantifying risk and return with variance and an average yield of a certain period of time (Fama and French 2004). However, Markowitz did not solve the problem of how to formulate the decision of holding efficient portfolios. Sharpe (1964) claims more on portfolio selection that the risk should be divided into two parts: systematic and unsystematic. He also mentions that investment diversification only has the ability of reducing the unsystematic risk but systematic risk will still exist. Investors should avoid investing in assets with highly correlation and simply considering diversified investments is not enough for reducing risks. Two critical assumptions added in Markowitz's theory by both Sharpe (1964) and Lintner (1965) in order to identify whether the portfolio is mean-variance-efficient. Firstly, the complete agreement among investors that asset returns in a single time period is in joint distribution. Moreover, all the investors are able to lend and borrow with risk-free rate and there is no influence on the amount of money borrowed or lent.

2.2 The Efficient Market Hypothesis (EMH)

Capital asset pricing model, as one content in standard financial pricing theory, was not proposed from the rational person hypothesis and from the general equilibrium of the framework. Through continuous development, scholars have carried on a general equilibrium analysis to construct CAPM's general economic equilibrium model. According to equilibrium pricing theory, the efficient market shows that the the equilibrium price reflects all the relevant information and the securities price should remain unchanged if there is no new information arriving.The rational expectation equilibrium is expressed by this condition. CAPM has a homogeneous expectation which is possible only if the price completely discloses private information. Therefore, the research of CAPM's theory and model must be strongly linked to the efficient market hypothesis (EMH).

Since some research from Samuelson (1965), Fama (1965) and Mandelbrot (1966) referred efficient market hypothesis, EMH was gradually integrated into mainstream of economics and became a new-classical finance research paradigm. Samuelson (1965) and Mandelbrot (1966) explain the fair game model is correlated with random walk by mathematical proofs. They theoretically interpreted the corresponding connection between the efficient market and the fair game model, which offers the theoretical foundation for the EMH. Fama's paper (1970) represents the format establishment of the efficient market hypothesis and he systematically summarized EMH from an empirical point of view. Fama (1970) reaffirms the three forms of market efficiency, states a complete theoretical framework of studying EMH and puts forward a generally accepted definition of efficient market – if the price adequately reflects all the relevant information, then the market is efficient.

An information-efficient market is a market that can quickly reflect and disseminate price information. When the cost of finding and analyzing information is very high, it is expected that investment analysis will be able to cover this expense through high yields. Grossman and Stiglitz (1980) claim if the analysis of new information can bring high returns, then investors are willing to spend time to finish it. In the market equilibrium, the effective information collection behavior should be useful. Bodie, Kane and Marcus (2014) states that EMH can usually be divided into three forms based on different definitions of “all available information”: weak-form, semi-strong form and strong-form.

Three Forms:

1. Weak-Form EMH: The stock price has revealed whole information obtained from data of market transactions. Weak form of EMH declares that if the historical data can transmit a trustworthy signal of performances in the future which can be used by investors. As following, this purchase signal can lead to the stock price growing up immediately.

2. Semi-Strong Form EMH: All information knew by everyone about firm’s prospects must have been shown in the price of stock and semi-strong form believes. If the market is in this kind form of efficiency, analyzing past share price, earnings or price growth forecasts has no use for predicting future price.

3. Strong Form EMH: The stock price can reflect all the market-related information, even the business intelligence only knew by the company’s internal staff. In other words, studying any information (private or public) is useless for providing advantage at the margin.

However, some anomalies of studying on fundamental analysis has not been revealed, including the price-earnings ratio effect, the small company’s January effect, the neglected corporate effect, the reverse effect and the book/market value ratio effect. It remains in dispute that whether these effects represent the inefficiency of the market or the risk premium that is difficult to understand.

2.3 The Capital Asset Pricing Model (CAPM)

According to Markowitz’s Modern Portfolio Theory, CAPM was created and developed by some researchers represented by Sharpe (1964), Lintner (1965) and Mossin (1966) which is a mainstay of the modern asset price theory and is widely used in the corporate decision-making. The Capital Asset Pricing Model gives a relatively accurate forecast of the relationship between asset risk and its expected return, contributing to provide a benchmark rate of return for assessing investments and help investors to make a reasonable estimate of the expected return on assets not been listed. The validity of CAPM is based on some assumptions that is not only naturally included the hypothesis of MPT but also some additional assumptions.

Additional Assumptions:

1. It is possible for investors to borrow or lend with no restriction at the discount rate of risk-free discount.

2. The entire group of investors agree on the probability distribution of return on securities, so there is only one efficiency frontier in the market.

3. the price of risk assets is decided by systemic risk rather than the total risk, which shows a different concept in CAPM from Markovitz. (Cao 2006)

Due to these assumptions ignoring the complex phenomenon in the real world, it is able to study the importance of the security market equilibrium. Based on the hypothesis of equilibrium relationship of assumed portfolios and investors, some detailed expositions of CAPM are showing as follows, which is according to Bodie, Kane and Marcus (2014):

1. All investors replicated their risk portfolios proportionally to the market portfolio (M) on account of the market portfolio containing all tradable assets. The proportion of every stock in this portfolio is equal to the ratio of this share's market value to the summing of all stocks' value in the market.

2. Market portfolio is not only on the efficient frontier but also tangible with the portfolio's optimal capital allocation line, which is possible to be achieved by the capital market line (an extension line starts from a point of risk-free rate through the market portfolio). Each of investors has chosen to own these market portfolios standing for their most risky portfolios, with the unique difference between the amount of investing in optimal risk portfolios and the amount of investments in risk-free assets.

3. The risk premium of market portfolio and the degree of market risk is proportional to the risk aversion of investors, which can be shown as a mathematical equation: $E(r_M) - r_f = \overline{A}\sigma_M^2$. In this equation, σ_M^2 is market portfolio's variance as well as $\overline{A}$ represents the level of investor's risk aversion. As the entire market portfolio is optimal, the combination of stocks effectively diversifies systemic risk across the market.

4. The risk premium for a single asset is positively proportional to that of the market portfolio M, additionally, the market portfolio is also proportional to the security's coefficient β. Beta (β) is used to measure the extent of co-varience between returns of each stock and the market returns: $\beta_i = \frac{Cov(r_i, r_M)}{\sigma_M^2}$.

5. Therefore, the risk premium for a single security is $E(r_i) - r_f = \frac{Cov(r_i, r_M)}{\sigma_M^2}\left[E(r_M) - r_f\right] = \beta_i\left[E(r_M) - r_f\right]$.

In summary, CAPM explains that conditions of market equilibrium will be formed when investors manage their investment as portfolios on the security market line. Meanwhile, expected return on assets is positively correlated with the measure of this asset risk called beta. In other worlds, any assets required yield is equal to a sum of risk-free rate and a risk premium (risk price multiplied by the amount of risk).

Sharpe-Lintner CAPM model is established on the basis of strict assumptions resulting in the difficulty in empirical validation and detaching from the reality. For this reason, economists began to modify assumptions. In former CAPM model, the assumption of using risk-free rate without limit when borrowing and lending is unpractical. Thus, Black contributed to a new version called "zero-beta model" and made some changes in the assumption (Liu & Baek 2016). Black (1972) claims the key result of market investment portfolio being mean-variance efficient can take the usage of risk asset's unlimited short sales at risk-free rate. Meanwhile, some results given by Black (1972) reveal that the beta's premium is positive owing to the expected market return must be more than asset's expected return without the influence of market. However, Black's adding condition is still unrealistic as Sharpe-Lintner model based on Fama and French (2004). Another scholar called Mayers (1972) tried to model the asset pricing with the condition of no trading.

The CAPM model has widespread use in many aspects, for example estimating the performance of properly selected portfolios and the calculating corporation's cost of capital (Fama & French 2004). Nonetheless, modern portfolio theory and the Capital Asset Pricing Model remain a problem of assuming investors merely to construct one-period investment decision. Merton (1973) supposes that time is continuous and he creates an Inter-temporal Capital Asset Pricing Model (ICAPM) including more than one beta. It is proved by Merton (1973) that demand for riskier assets contains both requirement of mean-variance efficient and the need of defensing the negative influence of investment opportunities. Breeden (1979) coordinated the ICAPM and the CAPM by emphasizing dichotomy of investment and consumption and gained a Consumption-based Capital Asset Pricing Model (CCAPM) which reveals assets expected rate of return is linearly correlated with average growth rate of consumption. He gives the opinion that asset pricing should be based on the future consumption in place of the marginal contribution of wealth.

2.4 The Fama-French Factor Model

Different from the CAPM derived mainly based on the theories, the multi-factor model such as the Fama French Three-Factor Model and the Fama-French Five-Factor Model are captured from some finding of market anomalies, although these two factor models are still based on some asset pricing theories, for example, the Efficient Market Hypothesis. In other words, they can be treated as induction model. The development from the simple single factor model to the five factor model, more relevant aspects are considered by scholars. for example, the size and growth of firms, the liquidity of stocks, the momentum effects, company's profitability and others. The foundation of multi-factor models is because the CAPM mentioned the former section faced plenty of challenges and questions.

On the one hand, the CAPM model can not explain the variation of asset returns when the firms' sizes are different (the size effect), which is that there is a negative relationship between excess returns of assets and the size (Banz 1981, Reinganum 1981, Keim 1983). The phenomenon that market risk premium has a weaker ability of explaining than the size value of companies is common in many exchange stock markets around the world (Hawawini and Keim, 2000). On the other hand, Stattman (1980) and Chan et al. (1991) claim that the CAPM also has no capability of explaining the the positive correlation between Book-to-Market ratio and the yield of assets (the Value Effect). Some scholars including Fama and French (1992), Lakonishok et al. (1994) and Davis (1994) discovered that the firms' current stock price, value of equity, earnings per share are able to explain the stock's future yields. Thus, the CAPM is gradually developed to the multi-factor models.

2.4.1 The Fama-French Three-Factor Model

The Fama and French Three-Factor Model (1993, 1996) is incorporates previous studies on the basic of CAPM, adding the factor SMB to explain the size effect and the factor HML for interpreting the value effect. An important feature of this model is that the SMB and HML represent the difference between different asset portfolios rather than the direct value of firm's size and Book-to-Market ratio. This construction of factors became the standard way for the follow-up studies. Afterwards, Fama and French (1998) extended the three-factor model to a global perspective and presented the risk premiums of global markets, the SMB as well as the HML for global markets. They compared the three-factor model with the CAPM model and found that the three-factor model is more explanatory, which causes the widespread concern in academia. Thereupon, more scholars began to test the Fama-French Three-Factor Model in numerous country's exchange markets. Griffin (2002) test this model with data from Japan, the UK. and Canada and he found that the model was able to effectively explain the difference in stock portfolio returns, however, the model performed better with data from the domestic market than the global market. Moreover, Cao et al. (2005) conducted a comparative between the CAPM model and the Fama-French Three-Factor Model with data from the China stock markets and states that three-factor model is more suitable for China markets. Similarly, Zhu and He (2002) as well as Wu and Xu (2004) validated the applicability of the three-factor model in China stock market. Nonetheless, it is stated by Pan and Xu (2011) that the price-earnings ratio instead of Book-to-Market ratio in the three-factor model has a better ability to explain.

2.4.2 The Fama-French Five-Factor Model

The three-factor model is constructed for solving problems of anomalies occurred in the empirical test on the CAPM, but a great number of new anomalies appear in the market. In addition to the accruable earnings, the net issuance of stocks, the momentum and the others, the most important anomalies in Fama-French Three-Factor Model are investment and profitability (Shen 2015). Theoretically, the value of company depends on the present value of the equity's future cash flow (Zhap,Yan and Zhang 2016). From the point of view of practical experience, the firm with strong profitability tends to have higher returns, while the company with high level of investment seems to have lower returns. Plenty of scholars consider the issue of asset pricing from the perspective of corporate operating. Fama and French (2006, 2008) illustrated the expected return, the expected investment and the Book-to-Market ratio could explain and predict the stock yield in the future, with the help of dividend discount model. Moreover, Cooper et al. (2008) claims that the growth rate of total asset can predict the U.S. stock returns and it is both statistically and economically significant. In addition, Arharnoi et al. (2013) arguers that the high level of investments and high returns on investing increase the value of the company's future total asset , but the high level of investment will lower the current total assets' value. Thus, the investment decisions affect the value of a firm. Similarly, Titman et al. (2004) found that investment has a significant negative impact on the firm's stock returns, especially for the companies with low cash flows and low leverage ratios. Combining all the research aforementioned, the investment and the profitability have become the factors in the subsequent asset pricing model, in other words, the Fama-French Five-Factor Model created by Fama and French in 2015.

2.5 Research in the China Market

The result of existing research about fitting asset pricing models in China stock market is various.

Shi (1996) was the first Chinese scholar who experimented the CAPM model with 50 A share in Shanghai stock market. He obtained a linear negative relationship between the systematic risk and the expected return of the Shanghai stock, which has an opposite relationship of the CAPM model. Afterwards, Yang and Xing (1998) conducted a research about the price behavior of China's stock market and they concluded that the correlation of risk and return in China's stock market was not as expected as the CAPM theory since systemic risk was not the only decision factor. Similarly, it was found by Chen and Sun (2000) that the β coefficient had no ability of explaining the yield in China stock market after controlling the size of the capital. On the ground of Jin and Liu (2001), the conclusion of their testing models is similar with Yang and Xing's research, however, it is efficient of market composite index's mean-variance represented by market portfolios.

On the contrary, Xiang (2001) states that the Shanghai stock market can accept the CAPM model based on her experiment on 170 Shanghai stocks. According to Li (2002), it is proved bye empirical analysis and empirical evidence that β-value of stocks in Shanghai stock market has the power on explaining earnings. Likewise, Xu and Zhang (2005) provided an empirical experiment on 37 stocks in Shanghai stock market. Their results show that β coefficient is positively and linearly correlated with stock returns. To some extent, the CAPM is able to measure the relationship between the risk and return but non-systematic risk has a significant influence on returns (Li 2005). Zhu (2010) indicates that a positive correlation between the average excess return rate of 100 A-share stocks and systematic risk shows during the period from August 1, 2003 to July 31, 2006 with no significant linear relationship of non-systematic risk, which is consistent with the expectation from the CAPM model.

Recently, researchers begin to turn more attention to the three-factor model testing and the results of research unexpectedly tend to be highly similar. Fan and Yu (2002) researched monthly returns of all A-shares from 1995.07 to 2000.06. They demonstrates that the stock market has significant market effect, book-to-market effect, price-earnings effect and price effect, in the same time, they also refers that the three-factor model gives a good explanation of the difference between many indices in China's stock market. Yang and Chen (2003) shows the similar results and emphasizes this phenomenon is especially significant in firms with small corporate size and relatively high book value of shareholders' equity. Moreover, it is mentioned by Xiong (2015) that the factors of the Fama French Three-Factor Model prominently improve the fitting degree of the CAPM and China stock market's yield.

Chapter 3

Methodology

3.1 The Basic Model of Asset Pricing

3.1.1 Consumption-based Model

Asset price theory is basically to discover the worth of a stream discounted cash flow returning to investors in the future (Cochrane, 2005). To value the asset, time and risk are two main factors which should be account for. Especially risk is a much more decisive element influencing the asset's value, which makes it more challenging. Consequently, this is the reason for building a small model to understand the connection between risk aversion and time insurance. According to Cochrane (2005), the asset pricing theory is explained by a single concept: price equals expected discounted payoff: $P = E[Mx]$ (P is the price of asset, E[.] refers to expected value and X is the payoff). For constructing a mathematical model to connect present price and future payoff and evaluate asset's price, this paper starts with finding out the investor's consumption requirements firstly and calculating the payoff (X_{t+1}) at time t. Grounded on economic theories, utility is a estimation of people's preference and willingness to pay for different goods and services (Wikipedia, 2016). We assumes that investor always prefers more consumption in the future and the marginal value of additional consumption will decrease with the increase tendency of consumption (Cather, 2010). Thus, **utility function** is used to quantify consumer psychology by valuing consumption over current and future:

$$U(C_t, C_{t+1}) = U(C_t) + \beta E_t[U(C_{t+1})] \tag{3.1.1}$$

where C_t means consumption happening on time t and β is called as subjective discount factor which is used to discount for investor's impatience. $C_{t+1}$is uncertain and random due to investor's aversion to risk and delay of cash flows. Moreover, **power function** is a typical function form and is more convenient to explain the utility referring to consumption (we will use this equation in later section):

$$U(C) = \frac{C^{1-\gamma} - 1}{1 - \gamma}, U^{'}(C) = C^{-\gamma} \tag{3.1.2}$$

Where γ measures investor's risk aversion and the marginal utility ($U^{'}(C)$) shows the degree of people's consumption preference. The increase of γ will cause the utility function more curved, which means investor is more risk aversion. In addition, when marginal utility is high, additional consumption creates much less happiness than the scenario when marginal utility is low. In this stage, we continue calculating payoff with the basic knowledge with utility function. Suppose that investor can buy and sell the assets optionally as much as the wished price (P_t) and payoff (X_{t+1}), we define e as the initial consumption level and ξ as the amount of already bought assets. Hence, for working out the value of payoff and price, we need to solve the **utility maximum problem** in advance by applying the constrains ($C_t = e_t - \xi P_t$ and $C_{t+1} = e_{t+1} + \xi X_{t+1}$) into the objective equation($maxU(C_t) + E_t[U(C_{t+1})]$) and setting the first-order derivative with ξ equal to zero on it. Then, we obtain this formula:

$$P_t U'(C_t) = E_t[\beta U'(C_{t+1}) X_{t+1}] \tag{3.1.3}$$

Equation (3) shows the optimal standard marginal condition that the decrease in utility when investor buys a unit of the asset is expressed by $P_t U'(C_t)$ while the growth measured in utility due to investor's gain from the payoff at time t+1 is performed as $E_t[\beta U'(C_{t+1})X_{t+1}]$. The marginal loss will finally equals to the marginal gain if the investor carry on with buying and selling the asset. Therefore, on the basics of all previous preparation, a central formula called as consumption-based model for asset pricing is stated by Cochrane (2005) which explains that asset's price should be equal to the expected value of its future payoff discounted by the investor's marginal utility:

$$P_t = E_t[\beta \frac{U^{'}(C_{t+1})}{U^{'}(C_t)} X_{t+1}] = E_t[\beta (\frac{C_{t+1}}{C_t})^{-\gamma} X_{t+1}] \tag{3.1.4}$$

Discussing further on equation (4), we separate the consumption-based pricing equation into two parts and set m_{t+1} as the stochastic discount factor :

$$P_t = E_t(m_{t+1} x_{t+1}), \tag{3.1.5}$$

$$m_{t+1} = \beta \frac{u'(c_{t+1})}{u'(c_t)} \tag{3.1.6}$$

Cochrane (2005) claims that equation (5) has transferred into a generalized form and explains more further that the defined single stochastic discount factor m_{t+1} could be set as incorporating all risk corrections. This means that almost all asset pricing models are in different ways to create a relationship between $m_{t+1}$to data and $P_t = E_t(m_{t+1} x_{t+1})$ will still be valid although the utility function has been changed. (All the derivation processes of formulas are based on Cochrane's work (2005).

3.1.2 Classic Issues in Finance – Introduced by Basic Pricing Equation

We can formulate some changes of $P = E(mx)$ in order to perform a institutional introduction to some classic issues in finance. (All the derivation processes of formulas are based on Cochrane's work (2005).

3.1.2.1 Risk-Free Rate

Risk-free rate has the connection with discount factor by equation (7) in term of risk-free rate given in advance.

$$R^f = 1/E(m) \tag{3.1.7}$$

This is based on the equation of $1 = E(mR^f)$ since risk-free assets refers to no certain factors and we can move it outside of the $E(.)$ function. If followed by the power utility function $u'(c) = c^{-\gamma}$ to escape the uncertainty, we draw risk-free rate into this formula: $R^f = \frac{1}{\beta}(\frac{C_{t+1}}{Ct})^{\gamma}$. According to this equation, it clearly evince some economics behind real interest rate (Cochrane, 2005):

1. With people are impatient (at this time, it means β is low), real interest rate will be high since people are not likely to wait for consuming only when the interest rate is high enough to persuade them saving money in the bank.
2. With a high growth of consumption ($\frac{C_{t+1}}{C_t}$), real interest rate will be high as well. People are willing to reduce consumption to save money and spend more money in the future.
3. If the power parameter (γ) is large, real interest rate will have more sensitivity of consumption growth. It is necessary to provide a much larger interest rate change, thus people may be persuaded to increase consumption.

Given log-normal consumption growth and power utility, we can transfer real risk-free rate into this form for the purpose of doing some research of the behavior of interest rate with some uncertainty :

$$r_t^f = \delta + \gamma E_t(\triangle lnc_{t+1}) - \frac{\gamma^2}{2}\sigma_t^2(\triangle lnc_{t+1}) \tag{3.1.8}$$

where the log risk-free rate (r_t^f) is $r_t^f = lnR_t^f$ and subject discount rate (δ) is $\beta = e^{-\delta}$, and denoting the first difference operator ($\triangle$) as $\triangle lnc_{t+1} = lnc_{t+1} - lnc_t$. In the form as equation (8), the effects of δ , growth of consumption and γ are similar with equation (7). Additionally, the new parameter σ^2 indicates precautionary savings since people with this utility function prefer higher consumption when the consumption is not stable.

Risk Corrections We can rewrite $P = E(mx)$ as equation (9) underlying co-variance's definition $cov(m, x) = E(mx) - E(m)E(x)$ and the equation (7) of risk-free rate:

$$p = \frac{E(x)}{R^f} + cov(M, X) \tag{3.1.9}$$

where $\frac{E(x)}{R^f}$ is the time element which is called as standard discounted present-value formula when utility is linear and $cov(M, X)$ is the risk element responsible for risk adjustment. The price of an asset has the same change trend (increase or decrease) as the co-variation (positively or negatively) between its payoff and discount factor. If we follow the utility function and replace the m still based on consumption, equation (9) can be written as $p = \frac{E(x)}{R^f} + \frac{cov[\beta u'(c_{t+1}), x_{t+1}]}{u'(c_t)}$. For understanding risk adjustment, we focus in the second part of this equation and find that marginal utility $u'(c)$ falls down as c rises. Moreover, we move to expected return owing to it is often used in Finance and Economics. Cochrane (2005) states that expected return is in proportion to the co-variance of returns using discount factors. We start from a special case of $1 = E(mR^i)$ again that the payoff is expressed as return and the price equals to 1. On account of asset pricing model mentioning that it should always be the same for expected discount returns, we apply co-variance decomposition ($1 = E(m)E(R^i) + cov(m, R^i)$) and use risk-free rate equation ($R^f = 1/E(m)$) for gaining the expected discount return:

$$E(R^i) - R^f = -R^f cov(m, R^i) \tag{3.1.10}$$

Expected Return-Beta Relationship This is an affection of the Capital Asset Pricing Model (CAPM) which shows a proportional correlation between security risk premiums and beta and it also indicates the connection performed in the security market line between return and systematic risk (Lee & Lee, 2006). On the basic of expected return equation (10), rewriting $P = E(mx)$ gives a beta pricing model in continuous case as:

$$E(R^i) = R^f + \beta_{i,m}\lambda_m = R^f + \frac{cov(m, R^i)(-var(m))}{var(m)} \tag{3.1.11}$$

where $\frac{cov(m,R^i)}{var(m)} = \beta_{i,m}$ is the regression coefficient of the return R^ion m which is also interpreted as the quantity of risk in each asset and λ_m is the market price of risk that apparently indicates the dependence on the volatility of discount factor m. Market price of risk is an estimation of the extra return or risk premium used for bearing risk for investors (Lee & Lee 2006). For all the assets, coefficient λ_m will be constant while the $\beta_{i,m}$ will change varying from this asset to that asset.

If we refer to $m = \beta(\frac{C_{t+1}}{C_t})^{-\gamma}$ again and make use of Taylor approximation of second term of equation (11), the expected returns become linearly increase when the beta, a coefficient of R^i on consumption instead of marginal utility, grows:

$$E(R^i) = R^f + \beta_{i,\triangle c}\lambda_{\triangle c}, \tag{3.1.12}$$

$$\lambda_{\triangle c} = \gamma var(\triangle c)$$

Risk aversion (γ) and volatility of consumption $var(\triangle c)$ determine the factor risk premium ($\lambda_{\triangle c}$), which expresses that making investor hold a more risky assets with higher beta need to pay a larger expected return premium in a riskier environment.

Mean-Variance Frontier The boundary of given asset's returns with means and variances on all portfolios is the mean-variance frontier whose characterization is that the variance will be the minimum with a given mean return. All returns of assets in the portfolio lie on or inside the mean-variance frontier, especially, the correlations among each other from these assets are perfect. The discount factor can be constructed by any frontier return. In the meanwhile, frontier return is still used as a factor for expected return-beta representation. An interesting finding in asset pricing is that there is a limitation of means and variances. The discount factor m should be obedient to:

$$\left|E(R^i) - R^f\right| \leq \frac{\sigma(m)}{E(m)}\sigma(R^i) \tag{3.1.13}$$

On the basic of a given asset return $R^i$and the basic consumption model ($1 = E(mR^i) = E(m)E(R^i) + \rho_{m,R^i}\sigma(R^i)\sigma(m)$), we can construct the equation as $E(mR^i) = R^f - \rho_{m,R^i}\frac{\sigma(m)}{E(m)}\sigma(R^i)$. The reason of equation (13) is that the correlation coefficients (ρ_{m,R^i}) should be less than or equal to 1.

A famous ratio called Sharpe ratio subjects to the volatility of the discount factor as $\left|\frac{E(R)-R^f}{\sigma(R)}\right| \leq \frac{\sigma(m)}{E(m)} \approx \gamma\sigma(\triangle lnc)$, which implicates that the maximal risk-return trade-off will be sharper due to more risk. The largest available of $\frac{E(R)-R^f}{\sigma(R)}$ is the slope of the mean-standard deviation frontier, from which we can ascertain people will gain more mean return if they bearing slightly more volatility of assets.

3.2 The Factor Model

Although it can be consider that the consumption-based model has the ability of solving almost every pricing problems in general,, it performs not well in the reality (Cochrane 2005). It is more practical to connect the discount factor with some real financial data, which is the reason for linear factor pricing models' popularity in the world and the continuing empirical work by thousands of scholars. Single and multiple factor pricing model adopt a linear form of marginal utility increase instead of expressing with the consumption-based form mentioned before, the formula is $m_{t+1} = a + b^{'} f_{t+1}$ and it is similar with this model $E(R_{t+1}) = \gamma + \beta'\lambda$, where all a, b, γ and λ are free parameters and the β' stands for every factor's (f) coefficients for explaining the returns R during different time period in the multiple factor regression. The forming process of each factor model means that how many factors and what factors need to be figure out based on the real world situation. For example, Cochrane (2005) claims that this variable is a meaningful replacement of the increment in marginal utility: $\beta\frac{u'(c_{t+1})}{u'(c_t)} \approx a + b' f_{t+1}$. In other words, the factors in the model are some aspects of the invested securities concerned by the investors all over the world, which signifies that these factors may have great impact on the variation of portfolio's returns and are able to give the explanations. Summarily, every factor model is the derivative of consumption-based model and this paper concentrates the three most famous models: Capital Asset Pricing Model, Fama-French Three Factor Model and the update version – Fama-French Five-Factor Model.

3.2.1 The Capital Asset Pricing Model

The foundation and the development of CAPM has been stated in the literature review and the model's equation is

$$m_{t+1} = a + bR^W_{t+1} \tag{3.2.1}$$

,in which m denotes the discount factor for pricing assets such as the market returns $1 = E(mR^W)$. Sometimes in the reality, there may be no enough and reliable data of returns on the whole market for empirical study. It is suggested that some equally-weighted indexes may be good proxies of R^W for the stock portfolio's returns. Moreover, the most used type of CAPM's equation is in the form of expected return with beta:

$$E(R^i) = \gamma + \beta_{i,R^W} \left[E(R^W) - \gamma\right] \tag{3.2.2}$$

This form of CAPM shows the aim of exploring the correlation between the rate of expected return and the risky assets and is committed to discover the formation of equilibrium prices. In the meanwhile, the most common regression model for CAPM is

$$R^p_t - R_{f,t} = \alpha_p + \beta^M_p (R_{M,t} - R_{f,t}) + \epsilon^p_t \tag{3.2.3}$$

, where the α means the intercepts or pricing errors in the regressions, β denotes the coefficient of the market excess returns factor $(R_{M,t} - R_{f,t})$ and the ϵ^p_t is the residual of this regression model.

In terms of how to gain this model from the basic model, the detailed process are stated as followings. This paper followed one derivation of CAPM from the consumption-based model according to Cochrane's idea (2005), which is called "Two-Period Quadratic Utility", equivalent to the squared preference of investors only existing in two periods. Thus, a formula present the meaning referred before is

$$U(c_t, c_{t+1}) = -\frac{1}{2}(c* - c_t)^2 - \frac{1}{2}\beta E\left[(c* - c_{t+1})^2\right] \tag{3.2.4}$$

, based on which, the marginal rate of substitution can be calculated by the equation of $m_{t+1} = \beta\frac{u'(c_{t+1})}{u'(c_t)} = \beta\frac{(c* - c_{t+1})}{(c* - c_t)}$. There is an assumption in squared utility equation that the its marginal utility contains a linear relation in the consumption. This shows the similarity with the factor model in the aspect of linearity. Since this paper assumes investors can not gain any income from their working, they will own the total asset with the value of W_t at the beginning . N number of assets (each is worth in p^i_{t+1}) are provided to investors for investing and the payoff is defined as x^i_{t+1}, in the same time, $R^i_{t+1}$is used as reutrns. The consumption of these investor in the whole period is separately treated as $c_t$and c_{t+1}, meanwhile, the weight of every portfolio is denoted by w_i. Therefore, there are some constrained conditions in the investor's budget that

$$\begin{aligned} c_{t+1} &= W_{t+1}, \\ W_{t+1} &= R^W_{t+1}(W_t - c_t) \\ R^W_{t+1} &= \sum_{i=1}^{N} w_i R^i_{t+1}, \sum_{i=1}^{N} w_i = 1 \end{aligned} \tag{3.2.5}$$

, where the yield of total asset is represented by R^W. In the time of this two period, all the investors only can purchase anything during the second part of time, so that the total consumption can be substituted by the value of the whole assets with their returns. This means that the second aspect of defining the factor is implemented:

$$m_{t+1} = \beta \frac{c* - R^W_{t+1}(W_t - c_t)}{c* - c_t} = \frac{\beta c*}{c* - c_t} - \frac{\beta(W_t - c_t)}{c* - c_t} R^W_{t+1} \tag{3.2.6}$$

and finally the equation of CAPM is derived as $m_{t+1} = a_i - b_t R^W_{t+1}$.

3.2.2 The Fama-French Factor Model

The Fama-French Three-Factor Model Although CAPM performed well in pricing asset in a long time period with the help of only sigle factor, . Since Merton (1971, 1973) mentions that it seems to require adding more factors into the asset pricing models and study with more knowledge of risk premium, in ordet to explain the reason for the better yield of partial stocks. The Fama-French Models are popular in the terms of empirical study over the world. After implementing some empirical test on cross-section returns in 1992, the three-factor model was constructed by Fama and French in 1993 followed by some detailed interpretations and market proof in 1996.

Generally, some scholars started to research for new explainable factor from a great number of market anomalies, in particular, Fama and French. It can be sorted as "Value" stock with lower market value and higher book value and "Growth" stock performing on the contrary. Fama and French discovered this pattern of stocks and naturally considered that the stocks sorted into some groups based on the similar signals may be better in the market, which is the step of finding anomalies in the market.

Firstly, Fama and French respectively separated all sample data collected from the stock market in the United States into ten groups based on the some criteria including coefficient β, size, Book-to-Market ratio, Debt-to-Price ratio and Earnings-to-Price ratio. They calculated the weighted-average monthly returns on stocks for each portfolio and proceeded the regressions on these returns with each criterion of classification. Some conclusions are draw by Fama and French (1992) that there is no reliable relationship between average returns and coefficient β while the size of company and the B/M ratio are significantly correlated with average returns on stocks. Additionally, the effect of D/P ratio and E/P ratio can be explained by size and B/M ratio. On the basic of these findings, Fama and French proposed a model called "A Parsimonious Model" and a classical test equation for that model:

$$R_{it} = a + b_{1t}\beta_{it} + b_{2t}ln(ME_{it}) + b_{3t}(BE/ME_{it}) + e_{it} \tag{3.2.7}$$

, which can be treated as the initial form of Fama-French Three-Factor Model. Afterwards, they expanded the research objects from only choice of stocks to more kinds of assets such as bonds in 1993. Moreover, Fama and French sorted stocks into twenty–five portfolios according to two dimensions of size and B/M ratio, which has been implemented by this paper in the same way. The results are encouraging that five factor involving three stock factors: the market factor, the size factor and the B/M ratio factor with two bond factors. Thus, the common format of three-factor model is

$$E(R_i) - R_f = b_i[E(R_M) - R_f] + s_iE(SMB) + h_iE(HML) \tag{3.2.8}$$

and the regression equation used to test Fama-French Three-Factor Model is

$$R_t^p - R_{f,t} = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + \epsilon_t^p \tag{3.2.9}$$

The Fama-French Five-Factor Model Similarly, several empirical research has been conducted by different scholars and a great number of anomalies appeared in the market which could not be explained by the three-factor model. Novy-Marx (2013) claims that a good method to solve the problems of anomaly is adding new factors into the three-factor model. After the great efforts of not only Fama and French but also other scholars who put forward some objections of three-factor model, a five factor model was constructed by Fama and French in 2015, which contains new adding factors: profitability and investment. The Fama-French Five-Factor Model are showing as following:

$$R_t^p - R_{f,t} = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + \beta_p^{RMW}RMW_t + \beta_p^{CMA}CMA_t + \epsilon_t^p \tag{3.2.10}$$

, where R_{it} denotes the i^{th} portfolio's return at time t, $R_{f,t}$ means the risk-free rate ate time t, $R_{M,t}$ is the returns on the market portfolio at time t, SMB_t represents the difference of returns between the portfolio including firms with low market value and the portfolio involving high market value companies at time t, HML_t stands for the difference of returns between the portfolio of value firms with high B/M ratio and the portfolio of growth companies with low B/M ratio at time t, RMW_t defines the difference of returns between the portfolio containing high profitability firms and the portfolio with low profitability firms at time t, RMW_t signifies the difference of returns between the portfolio with low level of investment companies and the portfolio having high level of investment companies at time t and ε_{it} is the residual of this model at time t. It is worth mentioning that the profitability at time t is calculated by this equation

$$\frac{OperatingIncome_{t-1} - OperatingCost_{t-1} - SalesCost_{t-1} - FinancialCost_{t-1} - ManagementCost_{t-1}}{TotalEquity_{t-1}/BookValue_{t-1}}$$

and the investment level is constructed by

$$Investment_t = \frac{IncrementOfTotalAssets_{t-1}}{TotalAssets_{t-2}}$$

3.3 The Regressions

Based on these existed linear models, testing can be implemented into two steps with firstly estimation of parameters and secondly statistical tests on parameters. Choices of econometric techniques to measuring and valuing asset pricing models are varied and there are some objects focused on by every technique, for example, parameters or standard errors of these parameters (Cochrane 2005). Both time series regression and cross sectional regression are the fundamental of all these econometric approaches and time series regression is treated as cross sectional regression's limiting case, according to Cochrane (2015). Through the regressions, the relationship between stock returns and some explainable factors is able to work out and it becomes possible to test that whether these asset pricing model is efficient in China market.

3.3.1 The Multiple Regression Model

Regression analysis actually is the equal of constructing a mathematical model with tests. Generally, there will be a assumption that a group (or groups) of data changes in a certain function relationship with the variation of another group (or groups). The regression analysis is aimed at measuring the strength degree of this correlation based on strictly following some test criteria. Simple regression, multiple regression, linear regression and non-linear regression are all included in regression analysis. As all the asset pricing models required be test in this paper are linear models and the simple linear regression is similar with the multiple regression model, it is direct to discuss the detailed methodology of the multiple one. Extending the linear regression model with single variable to involve other regressors creates the multiple linear regression model. According to Stock and Watson (2012), the multiple regression model is

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_n X_{ni} + u_i, i = 1, \ldots, k. \tag{3.3.1}$$

, in which the i^{th}finding of these dependent variables is represented by Y_i, β_0 is an intercept and the expected value of Y on the basic of every$X$'s is equal to zero, $X_{1i}, X_{2i}, \cdots, X_{ni}$ stand for the i^{th}observations on every n regressors and $u_i$means for regression errors. Particularly, each one from β_1 to β_n denotes X's slope coefficient which shows every change in X_{ni} causes the expected change in Y_i with the constant of other X. The item of error will be homoscedastic if it is independent of the value of Xs as well as the conditional distribution of every error u_i's variance given $X_{1i}, \cdots, X_{ki}$ is constant.

3.3.2 Time-Series Regression

With a simple example of a single variable pricing model, comparing the model with only factor of excess return $R_t^{ei} = \alpha_i + \beta_i f_i + \varepsilon_t^i$ and its expectation $E(R^{ei}) = \beta_i E(f)$ as well as $E(f) = 1 \times \lambda$, the only connotation has been revealed that the value of every intercept should be zero (Cochrane 2015). By the approach of running time-series regressions for every asset waiting for testing, the risk premium can be estimated to this variable's sample mean $\hat{\lambda} = E_T(f)$, which is advised by Black, Jensen and Scholes (1972). Afterwards, on the basic of fitting to the distribution with some theories supporting, the common method called standard OSL formulas is implemented, in order to figure out the fitting line which has the minimum distances of each return point.

In this case, the OLS time-series linear regression model tends to calculate the coefficients of every factors and it should be followed by some tests to confirm the goodness of fit. It is efficient to draw support from the $t - test$ to examine whether the errors of pricing (intercept α) are equal to zero The errors appearing in regression should be homoskedastic with no relations between every two errors ($cov(\alpha_i, \alpha_j) = 0$) and the. In addition, it is necessary to understand whether the joint value of all intercepts is zero, since the the assumption in these tests with classic form is that auto-correlation or heteroskedasticity are not existed. Commonly, the test introduced by Gibbons, Ross, and Shanken (1989) works for checking whether a group of observed objects are joint zero. through the formula: $\frac{T-N-1}{N}\left[1+\left(\frac{E_T(f)}{\hat{\sigma}(f)}\right)^2\right]^{-1}\hat{\alpha}'\widehat{\sum}^{-1}\hat{\alpha} \sim F_{N,T-N-1}$. To be specific, the F-distribution contains a requirement that errors ε should in normal form with no-relations and homoscedasticity. As described above, the same normal form of $\hat{\alpha}$ is integrated with the independent Wishart $\widehat{\sum}$.

Example. A small example of how proceeding a regression on the CAPM with the help of "Python". In this example, twenty five portfolios are used for calculating and the data are downloaded from Fama and French's websites.

Listing 3.1: Regression Example of CAPM

```
import pandas as pd
import csv
import numpy as np
import statsmodels.formula.api as sm
import matplotlib.pyplot as plt

### read the data
data = pd.read_csv("exampleData.csv", header = None)
rmrf = data.loc[:,1]
data = list(data)
rmrf = np.array(rmrf)
```

```
rmrf = rmrf[0:6]
data = pd.read_csv("example25Portfs.csv", header = None)
portERet = data.loc[:,1:25]
portERet = np.array(portERet)
portERet = portERet[0:6]

### regeression
alpha = []
beta = []
for i in range(25):
 result = sm.OLS(portERet[:,i], np.c_[np.ones(len(rmrf)), rmrf]).fit()
 alpha.append(float(result.params[0]))
 beta.append(float(result.params[1]))
result = sm.OLS(portERet, np.c_[np.ones(len(rmrf)), rmrf]).fit()

### plot
colMeans = np.mean(portERet,axis=0)#calaulate E(portERet)/colomn
x = [0+i/10 for i in range(31)]#i is the number from 0 to 13
y = [np.mean(rmrf)*x_i for x_i in x]#E(rmrf)
l1, = plt.plot(beta, colMeans,'bo')
l2, = plt.plot(x, y, color='red')
plt.axis([0, 3, -3, 3.5])
plt.xlabel(r'$\beta$')
plt.ylabel(r'$E[R^{ei}]$, % per year')
plt.grid(True)
plt.show()
```

3.4 Data Collecting and Handling

This paper will focus on China A stock market as the object of studying asset pricing models, with the help of database “WIND” and “CSMAR”. WIND contains China’s leading financial data and is cited by a great quantity of Chinese or International media, research reports and academic papers (Wind Info 2017). In addition, CSMAR is a reliable database for doing research which is the only database provider in the Wharton Research Services System (WRDS) in China (CSMAR 2017). More than five hundred well-known universities and over ten thousand scholars accept CSMAR’s database services.

3.4.1 The Time Period

All the research samples in the portfolios are located in the time period from January 1^{st}, 1999 to December 31^{st}, 2016, since this paper tries to reach the goal of containing more stocks as sample with a longer research time period. After querying the database, it is found that the development time of

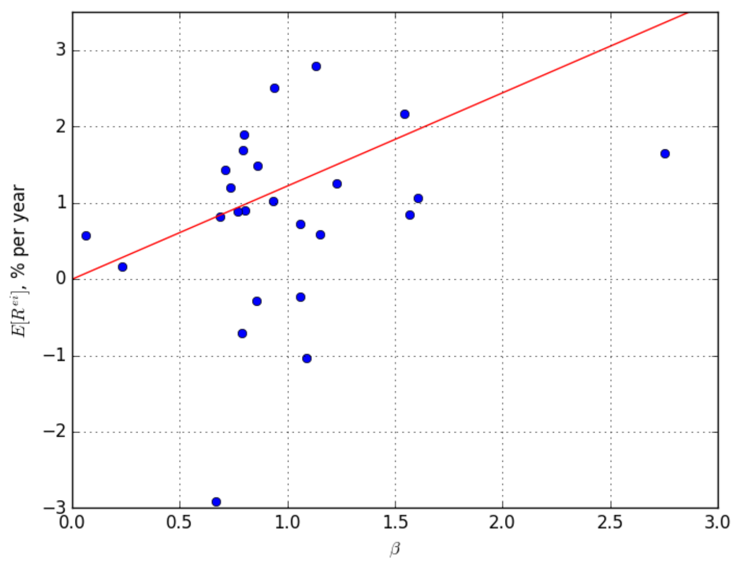

Figure 3.3.1: The Result of Regression of Example CAPM

China stock market is short and the number of shares issued before 1999 is relatively small. Moreover, it is claimed by Chen et al. (2015) that there was an high volatility in the early developing stage more than sixty percentage in the period of one month, but the market showed a relatively status after 1997. Additionally, Gao and Zhou (2016) state that government implemented a new institution of "Price Limit" at the end of 1996 which is indicated by Chen et al. (2015) as well.

3.4.2 The Monthly Yield

Monthly closed price of 665 stocks are selected which were listed in the market before 1999 and were excluded from those stocks with missing or incorrect data. All stock price data has been transformed to right price in order to avoid data distortion induced by ex-dividend and ex-rights. The choice of monthly stock data is based on the level of and the duration of China stock market's development. According to Wang (2009), the daily data may cause the problem of non-synchronous transaction and the weekly data may lead to a reduction of available data due to the requirement of dropping the part of stocks with no trades in two or more weeks. Besides, it is recognized that monthly data and annual data exist equilibrium because of the relatively small degree of deviation from expected price to equilibrium price in case of large samples, which is beneficial to testing these models.

3.4.3 The Risk Free Rate and Market Portfolio

The risk free rate is represented by the three-month fixed deposit interest rates from WIND and it will be transformed into monthly interest rate to match with the monthly yield. For the market return, this paper applies the average of Shanghai Composite Index's yield and Shenzhen Composite Index's yield to stand for, which is a calculating method borrowed from Jin and Liu (2001). They have found that the market portfolio expressed by the market index mentioned before is valid and reasonable. Moreover, the reason, for not using those indexes which treat the whole China market as sample data, is that the available time period of these indexes can not match with the time line of stock chosen.

3.4.4 The Financial Data

It is needful to capture the size, B/M(book-to-market), profitability and investment pattern. If the time of price data is assumed as year t, all financial data matched with price data is at the end of $t-1$, according to Fama and French (1992). They suggested that fiscal variables should be realized ahead of the returns for explaining. Since there is no direct data, each stock price at the end of year $t-1$ multiplied by its number of outstanding shares denotes the size of each company, meanwhile, the B/M ratio is calculated by the sum of shareholder's equity at the end of year $t-1$ divided by this company's total market capitalization (the same as firm's size). According to Fama and French (2015), the operating profitability means the ratio of the residue of annual income (subtracted by cost of merchandise sold, interest expense and the fee of sales and general management) to book value. Instead, this paper will use the ratio of operating profit (in the profit statement at the end of year $t-1$) to book value as proxy variable.

3.4.5 The Factors in the Model

This report is for the assignment in Module of Final Year Project and the time for finishing is limited, thus there is no enough time to build the factors of asset pricing model. Fortunately, the CSMAR research team follows the design concept and the method of fama french three or five models (Fama and French 1993, 2015) and provides parameters in factor model based on China stock market (CSMAR 2017). All these parameters are calculated on the basic of all A-stock data in China and every factor's calculation of monthly yield is depended on the weighted value of market capitalization. This paper chooses the monthly data with the 2*3 form of weighting returns according to Zhao, Yan and Zhang's (2016) testing results, which means that stocks are grouped into investment portfolios in the form of 2*3 when calculating portfolio returns to construct parameters. Since the calculations of market excess returns are done based on the data mentioned before (risk free and market index), this paper will not use the risk premium data from the factor database.

In Table1, some statistical characteristics of both three and five factors are listed, in particular, Panel A shows the mean and standard deviation and Panel B illustrates the correlations between every two factors. Concentrating on the correlation with the value of Pearson coefficients in the Table.

Table 3.4.1: Basic Characteristics of Three and Five Factors (January 1999 - December 2016)

Panel A: Basic Statistical Summary of Factors								
	Three Factors			Five Factors				
	$R_M - R_f$	SMB	HML	$R_M - R_f$	SMB	HML	RMW	CMA
Mean	0.0085	0.0097	0.0017	0.0085	0.0098	0.0014	-0.0015	0.0019
Standard Deviation	0.0847	0.0526	0.0321	0.0847	0.0469	0.0320	0.0317	0.0237

Panel B: Correlations of Factors							
Three Factors			Five Factors				
	SMB	HML		SMB	HML	RMW	CMA
$R_M - R_f$	0.2132	-0.2045	$R_M - R_f$	0.1735	-0.1947	-0.3448	0.1876
	[0.002]^{1}	[0.003]^{1}		[0.011]^{5}	[0.004]^{1}	[2.1426e-07]^{1}	[0.006]^{1}
SMB		-0.4539	SMB		-0.4710	-0.7805	0.4785
		[2.5179e-12]^{1}			[2.8417e-13]^{1}	[2.4139e-45]^{1}	[1.0524e-13]^{1}
			HML			0.2322	0.0734
						[0.0006]^{1}	[0.2841]
			RMW				-0.7237
							[3.7218e-36]^{1}

The values in "[ ]" stand for the significant level of correlation coefficient. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%.

3.5 Limitations

3.5.1 Problems of Asset Pricing Model

The assumptions in the models are highly rigorous and cause some gaps between the reality and the model. Additionally, the establishment of the models is based on the Efficient Market Hypothesis (EMH) while China security market is a weak-efficiency market. The transaction costs of portfolio investment is not considered in the asset pricing models, however, ignoring the the unilateral transaction costs in China stock market may lead to non-effective of portfolio investment.

3.5.2 Assumptions of Market Proxy

Commonly, the market returns is replaced by some market indexes since they are calculated from the weighted-average values of some groups of stocks. However, the market portfolio theoretically should include all the securities and choosing the indexes instead of market portfolio may increase the sensitive of returns. Moreover, the Shanghai and Shenzhen Composite Index are calculated according to the total share capital of the listed companies. Yet the equity structure's defects cause that the listed company's share price do not truly reflect the intrinsic value.

3.5.3 The selection of Risk-Free Rate

The improper selection of data to represent the risk-free rate may lead to the value of intercepts in regressions with significance of non-zero (Yang and Teng 2003). In this paper, the three-month fixed deposit interest rate is used as the risk-free rate. Nonetheless, there may be liquidity risk in bank's fixed deposit and it also can not completely reflect the supply and demand in the real capital market due to the unified adjustment by the central bank in China. In addition, the fixed deposit rate may not change for several months, which may lead to the difficulty of reflecting the unstable market changes.

3.5.4 Problems of OLS Regression

This paper only applies the OLS linear regression on asset pricing models. This kind of method will be strongly influenced by the multiple col-linearity among factors. When implement the OLS regression model, it automatically admits the assumption of returns are fitting the normal distribution while the real stock returns perform differently.

3.5.5 Problems of China Stock Market

Compared to European and the United States mature financial markets, stock market in China is emerging and has more problems, for instance, the total capital is quite little while the volatility of is considerably large (Duan 2014). In order to ensure the settlement of normal securities , the Chinese government published some regulations such as controlling risk and prohibiting the transaction of short selling, which violates the assumptions in asset pricing models. Furthermore, the pattern of China stock returns does not fit in normal distribution, which is against one assumption in asset pricing model. The reason is claimed by Dai & Xu (2000) that the China stock market has a phenomenon called "fat tail" in its distribution of return, resulting in a large sample variance. Therefore, the accuracy of experiment may be poor.

Chapter 4

Numerical Results and Discussion

4.1 The Construction of Portfolios

4.1.1 Uni-variate Sorted Portfolios

According to Chen et al. (2015), finding the potential influences of size and B/M ratio should be the first step, based on their performances in China. Differently, this paper equally divides all A-share listed firms in China exchange markets into five groups instead of ten, based on the criteria of size or B/M ratio, for the purpose of easier calculations. All the financial data (for the firm's size and B/M ratio) is provided between 1998 to 2015 matching with the period of stock returns from 1999 to 2016. The point that need be referred that only one-year-period data is used for portfolios in every year and the grouping is changing yearly. The attributes of each portfolio except for the β^M are equal to the simple arithmetic mean of all individual stocks in this portfolio. Table 4.1 shows some properties of the five portfolios grouped by the uni-variate (Size or B/M ratio).

Sorted on Size In the situation of portfolios sorted on Size, there is a strong ties between size and portfolio's return, specifically, return seems steadily decline with no strictly monotonic while the size of firms is increasing from the smallest group (1.45 billion) to the largest (16.49 billion), which is illustrated in Panel A from Table 2. A difference of portfolio's return between the smallest (2.36%) to the largest (0.96%) is 1.40% per month giving a 1% significant level. The standard deviation of each portfolio has the same decreasing trend as return when the size of companies rises up, revealing the information that investing in small size firms are riskier. In addition, the slope coefficients of market monthly excess returns β^M obtained from constructing time-series regressions with some asset pricing models is contained in the Panel A. It is noteworthy that there is a similar occurrence with Chen et al. (2015) that no significant relationship existing between size and β^M among three models, providing a status varying from Fama and French's (1992) findings in the United States Stock Market. This result involves the possibility that the size of companies may be one of the factors influencing excess return's steady.

Sorted on B/M Ratio On the contrary to the negative correlation of size and return, this paper observes that a positive relationship indwells between B/M ratio and portfolio's excess return that the returns possess an total 0.37% per month increment with no statistical significant from the smallest portfolio (1.40%) to the largest (1.77%), which is laid out in Table 4.1's Panel B. However, Chen et al. (2015) indicate the difference that returns of portfolios grouped by B/M ratio show no clear trendy, when they checked the stock data in the period of 1997 to 2013 in China. Compared with the characteristics of portfolios formed on size, the standard deviations of each group sorted by B/M ratio perform almost no changes with the lowest value of 0.0989 and the highest value of 0.1006. This implies that B/M ratio may have a little effect on the risk of portfolio excess returns. It is also different from size groups that β^M nearly rises up with the B/M ratio of portfolios increasing except for the second group in CAPM's and Fama-French Five-Factor's regression. Based Chen et al. (2015) claim that companies with low B/M ratio normally own a low market value while a high book value.

Table 4.1.1: Properties of Portfolios Formed on Size and Book-to-Market Ratios (January 1999 - December 2016)

Panel A: Portfolios Formed on Size

Variables	Small	2	3	4	Big	Big-Small
Mean (Return)(%)	2.3644^{1}	1.7770^{5}	1.4561^{5}	1.2665^{10}	0.9601	-1.4043^{1}
Std(Return)	0.1057	0.1041	0.1022	0.0987	0.0909	-0.0148
Size(Billion)	1.4469	2.3234	3.4797	5.6390	17.9339	16.4870
B/M ratio	0.2817	0.3964	0.4363	0.4296	0.4429	0.1612
β^M **(CAPM)**	1.0740	1.1014	1.1155	1.1070	1.0389	-0.0351
β^M **(3 factors)**	0.9607	1.0126	1.0485	1.0612	1.0426	0.0819
β^M **(5 factors)**	0.9286	0.9911	1.0269	1.0502	1.0267	0.0981
N	133	133	133	133	133	

Panel B: Portfolios Formed on B/M Ratio

Variables	Low	2	3	4	High	High-Low
Mean (Monthly Return)(%)	1.3970^{5}	1.5025^{5}	1.5097^{5}	1.6483^{5}	1.7667^{5}	0.3697
Std(Monthly Return)	0.0990	0.0989	0.0989	0.1004	0.1006	0.0016
B/M ratio	0.0828	0.2666	0.3735	0.4993	0.7647	0.6819
Size(Billion)	5.2853	5.9445	5.9354	6.2136	7.4441	2.1588
β^M **(CAPM)**	1.0615	1.0921	1.0857	1.0975	1.0999	0.0384
β^M **(3 factors)**	0.9621	1.0177	1.0232	1.0429	1.0797	0.1176
β^M **(5 factors)**	0.9514	1.0070	1.0023	1.0187	1.0442	0.0928
N	133	133	133	133	133	

Five portfolios are grouped with data in every year during 1999 to 2016, based on two dimensions: firm's size and the book-to-market ratio relating to a specific stock. Both mean (is in percentage) and standard deviation are calculated with portfolios' returns which are the equal weighting value of monthly stock returns belonging to this portfolio group. Size counted in billions is the equal weighting value of firms' market capital in the form of Renminbi (RMB) belonging to this portfolio group. B/M ratio is the book-to-market ratio referred in data description. There are three forms (CAPM, Fama-French Three-Factor Model and Fama-French Five-Factor Model) of β^M gained from different OLS time-series regressions due to different number of factors containing. N means the number of stocks being part of one portfolio. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%.

4.1.2 Two-variate Sorted Portfolios

According to Fama and French (1993, 2015) and Chen er al. (2015), it is general to construct twenty-five portfolios for proceeding a linear regression on asset pricing models. The whole process of creating portfolios are given below in a Figure and the details will be explained in the following. As the Figure 4.2 shows, this paper firstly classifies all A-stocks in China Stock Market into five sizes and carries on the same process for five B/M ratio quintiles in each year t from 1999 to 2016. Secondly, this paper treats the overlap section in both size groups and B/M ratio groups as the sources for forming twenty-five portfolios with no changes during the beginning to the end of year t. Excess returns of all the portfolios are calculated from simple arithmetic average value of individual stock excess returns in each group.

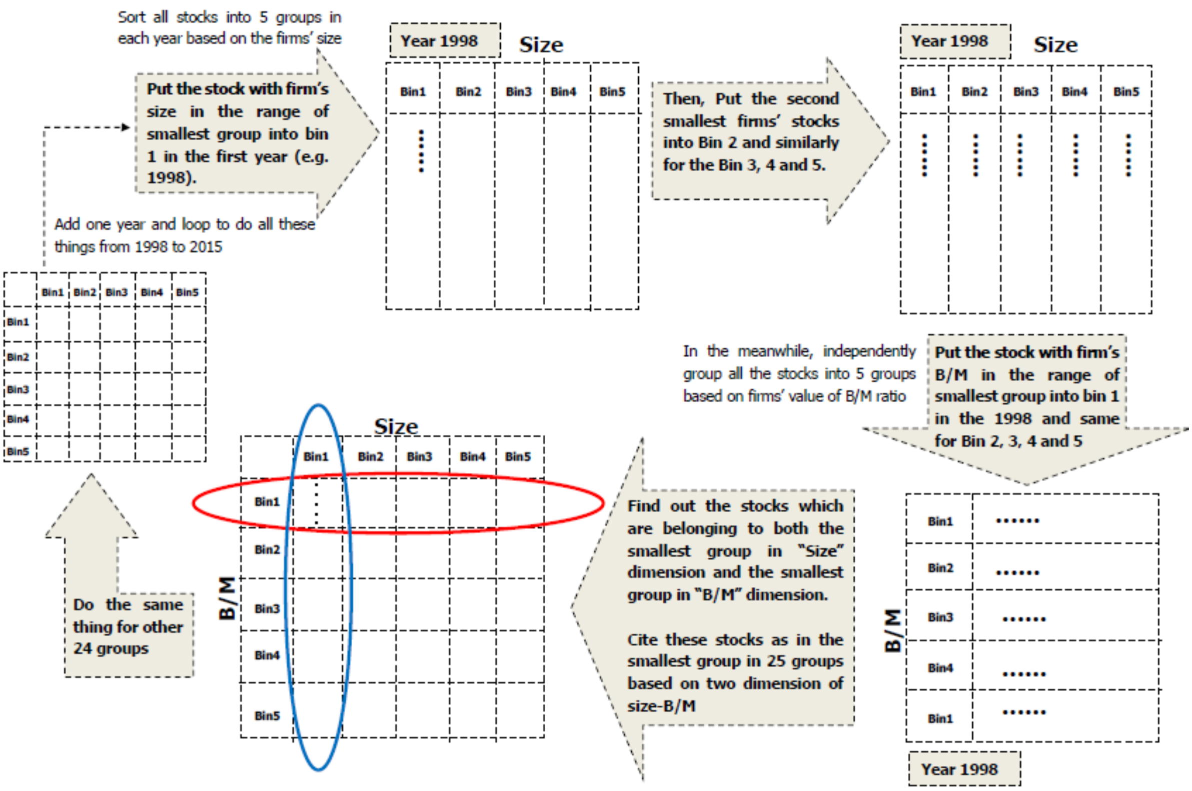

Figure 4.1.1: The Process of Creating 25 Portfolios Based on Size-B/M

After checking the summary statistics for twenty-five portfolios in Table 4.2, it is interesting that a negative correlation is still existed between the excess returns of portfolios and the size when the whole set of excess returns showing a dispersion from 0.47% to 2.41%. However, the changing trend of excess returns with different level of B/M ratio becomes not pronounced in twenty-five portfolios comparing to five portfolios, although it overall remain an increasing tendency apart from the smallest-size row of data. For the part of company size, the largest portfolio's average firm size (18.68 billion) is the fourteen times of the smallest portfolio's (1.34 billion) as well as the extreme value of B/M ratio has the difference of seventy-six times (1.04 and 80.30).

Table 4.1.2: Summary Statistics For 25 Portfolios Formed on Size and Book-to-Maket Ratios (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Excess Returns of Portfolios					**Size (Billion)**				
Small	2.3612^{1}	2.3029^{1}	2.4114^{1}	2.2968^{1}	2.2396^{1}	1.3438	1.4633	1.4869	1.5323	1.5559
2	1.5979^{5}	1.5344^{5}	1.6407^{5}	1.9729^{5}	2.0647^{1}	2.2899	2.3109	2.3355	2.3462	2.3365
3	0.9494	1.6542^{5}	1.4290^{5}	1.4603^{5}	1.7165^{5}	3.4432	3.4951	3.4741	3.5102	3.4717
4	0.6100	1.1977^{10}	1.2237^{10}	1.5594^{5}	1.6290^{5}	5.6276	5.6261	5.7462	5.5749	5.6125
Big	0.4652	0.7825	0.9743	1.1160^{10}	1.3938^{10}	19.2920	17.2715	16.5280	17.8320	18.6832
	β^M (CAPM)					**B/M ratio**				
Small	1.0136^{1}	1.0948^{1}	1.0815^{1}	1.1300^{1}	1.0903^{1}	1.0367	26.6235	37.0925	49.512	71.5037
2	1.1162^{1}	1.0626^{1}	1.0878^{1}	1.1136^{1}	1.0946^{1}	5.297	26.547	37.1395	49.9067	73.7229
3	1.0792^{1}	1.1529^{1}	1.0699^{1}	1.1326^{1}	1.1244^{1}	12.6478	26.6519	37.4494	50.1570	75.8739
4	1.0966^{1}	1.0876^{1}	1.1149^{1}	1.1135^{1}	1.1228^{1}	14.8183	26.8683	37.4846	49.9101	76.6788
Big	1.0294^{1}	1.0628^{1}	1.0729^{1}	1.0026^{1}	1.0725^{1}	14.8820	26.6972	37.5517	49.9705	80.2991

Size (Billion), B/M ratio and β^M(CAPM) have been defined in Table 4.2. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%.

4.2 Time-series Regressions

This paper is aimed at testing three existing asset pricing model in the China Stock Market and finding the most applicable model of China's stock market through researching the determinants of asset pricing in stock market. Generally, it is necessary to examine which quality level does the linear pricing models perform when fitting the whole data set of stock excess returns, based on some test criteria. Since there are some constraints of article length and research time, only a formal method - "OLS time-series" regression is applied for testing pricing models and it is also on the basic of Jensen, Black and Scholes (1972) as well as Fama and French (1993). For different models, the excess returns of twenty-five portfolios need to be regressed with different factors. After regression of these models and obtaining some numerical results, statistical test is applied in two dimensions including the fitting degree of model and the significance of regression model. Four test criteria will be taken by this paper to make a judgment of which model best:

1. **How is the model's explanatory ability of portfolio excess returns? – adjusted R^2.** This item needs to test the models' fitting degree of sample data, in other words, the model

should be able to describe the realities of sample data at least with a good level. In statistics, it usually determined by the value of adjusted R^2which is called as "coefficient of determination" and the model works better when adjusted R^2 is closer to one. When it is a financial model, it is advisable to additionally confirm the credibility of every factor's coefficient rather than insisting on a blind pursuit of a higher adjusted R^2.

2. **Is the model able to significantly explain the changes in portfolio excess returns?** $-\ F-test$. Before testing the significance of each factor's coefficient, it is necessary to check model's overall significance level. This paper proceeds a F-test firstly to figure out whether the linear relation of regression equation is significant. To some extents. implementing a F-test has the same meaning of testing the coefficient of determination's significance level. If the model has a higher fitting degree of sample data, it is most likely to pass the F-test.

3. **Is every factor in the model able to significantly explain changes in portfolio excess returns?** $-\ t-test$**.** T-test is for figuring out the significant level of each factor's coefficient. If the factor is significant in the model, then regression coefficient should be statistically significant from non-zero. It is common to compare the p-value of t-statistic with a given significant level and the coefficient is significant if the p(t) is smaller than the given level of significance.

4. **How is the combined factors' explanatory ability of portfolio excess return's cross-section? – estimated intercepts** α. For the practical meaning of asset pricing model, the intercepts in the regression equation represent the part of stock's excess returns which can not be explained by the factors in the model. Commonly, it is convenient to check the significance level of each stocks or portfolios regression intercept, in order to confirm about the explainable capability of the model.

4.2.1 Regression on CAPM

For the single factor model "CAPM", this paper utilizes the regression equation () on twenty-five portfolios grouped by size-B/M, providing a summary of regression results. In Table 4.3, it illustrates that all adjusted R-squares of CAPM's regression are over 0.5 and are positively correlated with the size of firms, drawing the conclusion on size may having an impact on the model's fitting degree. Compared to size, the variations of adjusted R-square based on B/M ratio dimension is small within 0.078. Thus, a good capability of explaining portfolios' excess return is displayed by the adjusted R-square. Moreover, CAPM performs well in the aspect of F-test , specifically, the significance of F-statistic in all portfolios is extremely close to zero and obviously lower than 5%, which indicates a clear linear relationship is existed between excess returns of portfolios and excess returns of the market.

Table 4.2.1: Evaluation on Regression of CAPM (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Adjusted R^2					**Prob (F-statistic)**				
Small	0.670	0.730	0.720	0.736	0.724	2.42e-53	9.08e-63	5.15e-61	8.07e-64	1.05e-61
2	0.726	0.772	0.776	0.780	0.776	4.99e-62	1.53e-70	2.32e-71	4.14e-72	2.96e-71
3	0.772	0.820	0.818	0.827	0.837	1.32e-70	2.07e-81	6.73e-81	2.15e-83	4.26e-86
4	0.827	0.847	0.887	0.876	0.854	2.92e-83	5.85e-89	3.76e-103	1.45e-98	3.11e-91
Big	0.826	**0.904**	0.888	0.882	0.859	5.36e-83	9.20e-111	1.88e-103	3.68e-101	9.25e-93

Numbers in bold form means that this value of a particular group is the largest one among twenty-five portfolios.

In Table 4.4, it is apparent that all coefficients of market β contain strong significance of 1% and their t-values vary from 20.85 to over 45. Chen et al. (2015) claims that the market βs in United State's market estimated from 25 portfolios fluctuate in a wide range, which is different from the China market with more smooth changes. Significantly, there is no clear change trend of β^M having been perceptible when the size or B/M ratio rise up. Therefore, it can be concluded that the excess return of stock portfolios is able to be explained with the help of market factor. Considering the intercepts α of regressions on all size-B/M formed portfolios in Table 4.4, four of the whole set of α show 5% significance of $\alpha = 0$ as well as other four are 10% statistically significant. This means that the CAPM may be not perfectly efficient when implemented in China. In summary, CAPM gives a good explanatory power of China A-stock market but it is not perfectly effective due to some significant intercepts.

Table 4.2.2: Results of Regressions on CAPM (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Abnormal return: α_p					**Coefficients of $R_M - R_f$: β_p^M**				
Small	**0.0150**	0.0138	0.0149	0.0134	0.0132	1.0136^{1}	1.0948^{1}	1.0815^{1}	1.1300^{1}	1.0903^{1}
	[3.632]	[3.558]	[3.814]	[3.409]	[3.365]	[20.850]	[24.100]	[23.480]	[24.475]	[23.723]
2	0.0065	0.0063^{10}	0.0072^{5}	0.0103	0.0114	1.1162^{1}	1.0626^{1}	1.0878^{1}	1.1136^{1}	1.0946^{1}
	[1.636]	[1.889]	[2.117]	[2.991]	[3.322]	[23.837]	[26.941]	[27.250]	[27.535]	[27.210]
3	0.0003	0.0068^{5}	0.0052^{10}	0.0050^{10}	0.0076	1.0792^{1}	**1.1529^{1}**	1.0699^{1}	1.1326^{1}	1.1244^{1}
	[0.102]	[2.155]	[1.779]	[1.663]	[2.648]	[26.966]	[31.212]	[31.002]	[32.033]	[33.176]
4	-0.0032	0.0028	0.0028	0.0062^{5}	0.0068^{5}	1.0966^{1}	1.0876^{1}	1.1149^{1}	1.1135^{1}	1.1228^{1}
	[-1.095]	[1.027]	[1.207]	[2.523]	[2.512]	[31.978]	[34.416]	[41.060]	[38.817]	[35.423]
Big	-0.0041	-0.0012	0.0007	0.0027	0.0048^{10}	1.0294^{1}	1.0628^{1}	1.0729^{1}	1.0026^{1}	1.0725^{1}
	[-1.482]	[-0.589]	[0.294]	[1.250]	[1.919]	[31.868]	**[45.004]**	[41.210]	[40.064]	[36.111]

The values in "[ ]" stand for the t-value after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means the value of this group is the largest one among portfolios. If the value of each item is negative, then these values will be in the red.

4.2.2 Regression on Fama-French Three-Factor Model

In terms of the Fama-French Three factor model, the regression equation () is applied on twenty-five portfolios grouped by size-B/M. Table 4.5 reveals a macro observation of three-factor model, with these adjusted R-squares varying from 0.864 to 0.928 and much larger than that in CAPM, which signifies that three-factor model is likely to fit China stock market better due to the new added two factors. In addition, it is different from the results found in the former part that there is no significant relation between adjusted R-square and either size or B/M ratio. For the F-test of each portfolios' regression, it is similar with CAPM that all the p-values of F-statistic almost equal to zero. It can be definitely said that the excess returns of portfolios sorted by size-B/M obtain a obvious linear correlation with $R_{M,t} - R_{f,t}$, SMB_t and HML_t factors, meanwhile, Fama-French Three-Factor Model explains the changes in excess return.

Table 4.2.3: Evaluation on the Regression of Three-Factor Model (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Adj. R^2					**Prob (F-statistic)**				
Small	0.889	0.908	0.921	0.910	0.864	6.83e-101	1.01e-109	1.03e-116	7.88e-111	1.27e-91
2	0.870	0.905	0.914	0.931	0.904	8.38e-94	2.07e-108	1.21e-112	8.11e-123	6.19e-108
3	0.897	0.903	0.919	0.914	0.906	1.67e-104	2.85e-107	2.00e-115	1.48e-112	1.72e-108
4	0.903	0.918	**0.928**	0.916	0.901	4.13e-107	4.37e-115	1.37e-120	9.79e-114	2.56e-106
Big	0.870	0.905	0.896	0.901	0.904	1.14e-93	3.49e-108	6.35e-104	3.55e-106	9.52e-108

Numbers in bold form means that this value of a particular group is the largest one among twenty-five portfolios. If the value of each item is negative, then these values will be in the red color to distinguish from the other.

Observing the results showing in Table 4.6, the performance of market β in three-factor regression is consistent with its status in CAPM that every β^M is 1% significant. None of the market coefficients are below zero, leading to a summary that the portfolios' returns are positive related with the market excess returns. The difference of β^M's t-value is a bit smaller than that in CAPM, varying from 30.58 to 47.62. Similarly, the flat change pattern of β^M remains different from the U.S. market and the market coefficient obtains no correlation with either size or B/M ratio, which shows the same conclusion stated by Chen et al. (2015) that the β^M may not be able to completely explain the changes in portfolios' excess returns when the size or B/M ratio varies.

Moreover, nearly all the coefficients of SMB are statistical significant and these β^{SMB}s present an evident declining trend only when the size grows up. The difference of slopes on SMB is relatively great between the smallest portfolio (0.97) and the largest non-significant group (-0.04), associating with the $t - value$ having a large variation of 28.54. While the HML factor is not significant as SMB with showing a positive correlation with B/M ratio, to be specific, only around a half of β_p^{HML} is distinctly different from zero. This indicates that the factor HML is insufficient in the aspect of explain portfolios' average returns while the SMB performs much better in that case. In addition, the fluctuation range of HML's coefficients is from -0.67 to 0.71 which is larger than SMB.

In the aspect of intercepts in time-series regression, 24% of α_ps contain statistical significance given at least 5%. Comparing with CAPM, three-factor model contains relatively less proportion of average excess return having not been explained. Additionally, the values of intercepts change without regulars whether there are increments or decrements in firms' size or B/M ratio. On the basic of the findings mentioned before, there may be other factors existing which are not included in the model, in other words, it could be said that the factors in Fama-French Three-Factor Model are not completely capture the cross-section returns. It is also claimed be Gao and Zhou (2015) that the explainable capability of three-factor model is not perfect due to the results of significance tests, while Zhao, Yan and Zhang (2015) support that the three-factor model is more suitable for China market because of the GRS test.

Table 4.2.4: Results of Regressions on Three Factors (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Abnormal return: α_p					**Coefficients of $R_M - R_f$: β_p^M**				
Small	**0.0066**^{1}	0.0057^{5}	0.0064^{1}	0.0051^{5}	0.0047^{10}	0.8902^{1}	0.9817^{1}	0.9621^{1}	1.0161^{1}	1.0110^{1}
	[2.667]	[2.463]	[3.005]	[2.173]	[1.654]	[30.575]	[35.892]	[38.159]	[36.581]	[30.332]
2	0.0006	-0.0003	-0.0007	0.0019	0.0030	0.9997^{1}	0.9700^{1}	1.0064^{1}	1.0258^{1}	1.0337^{1}
	[0.202]	[-0.116]	[-0.307]	[0.978]	[1.311]	[30.040]	[37.028]	[39.403]	[43.941]	[38.192]
3	-0.0053^{5}	0.0020	-0.0010	-0.0015	0.0014	0.9809^{1}	1.0689^{1}	0.9993^{1}	1.0728^{1}	1.0897^{1}
	[-2.274]	[0.850]	[-0.507]	[-0.699]	[0.619]	[35.337]	[38.265]	[42.086]	[41.600]	[40.959]
4	-0.0066	-0.0016	-0.0011	0.0016	0.0016^{1}	1.0154^{1}	1.0176^{1}	1.0693^{1}	1.0834^{1}	1.1085^{1}
	[-2.932]	[-0.795]	[-0.586]	[0.769]	[0.698]	[38.313]	[42.742]	**[47.616]**	[44.531]	[41.158]
Big	-0.0021	-0.0016	–0.0013	-0.0001	0.0025	0.9829^{1}	1.0522^{1}	1.0739^{1}	1.0051^{1}	**1.1174**^{1}
	[-0.878]	[-0.782]	[-0.606]	[-0.039]	[1.180]	[34.092]	[43.336]	[41.442]	[42.405]	[44.239]
	Coefficients of SMB: β_p^{SMB}					**Coefficients of HML: β_p^{HML}**				
Small	**0.9714**^{1}	0.9147^{1}	0.9688^{1}	0.9352^{1}	0.8687^{1}	0.0662	0.1019	0.1129	0.1267	0.4596^{1}
	[18.853]	[18.899]	**[21.712]**	[19.025]	[14.727]	[0.786]	[1.289]	[1.550]	[1.578]	[4.771]
2	0.7553^{1}	0.7493^{1}	0.8228^{1}	0.8788^{1}	0.8148^{1}	-0.2141^{5}	0.0846	0.3544^{1}	0.3671^{1}	0.6048^{1}
	[12.826]	[16.161]	[18.204]	[21.272]	[17.011]	[-2.225]	[1.117]	[4.800]	[5.440]	[7.730]
3	0.6906^{1}	0.5822^{1}	0.6682^{1}	0.6656^{1}	0.5820^{1}	-0.0885	-0.0896	0.2295^{1}	0.3633^{1}	0.5456^{1}
	[14.057]	[11.776]	[15.902]	[14.584]	[12.362]	[-1.103]	[-1.110]	[3.344]	[4.874]	[7.094]
4	0.4652^{1}	0.5166^{1}	0.4214^{1}	0.4376^{1}	0.4485^{1}	-0.2529^{1}	-0.0208	0.1303^{5}	0.3594^{1}	0.5805^{1}
	[9.919]	[12.261]	[10.603]	[10.164]	[9.410]	[-3.300]	[-0.302][	[2.007]	[5.110]	[7.456]
Big	-0.0424	0.0594	0.1558^{1}	0.2131^{1}	0.0781^{10}	-0.6719^{1}	-0.0353	0.2780^{1}	0.3954^{1}	**0.7119**^{1}
	[-0.831]	[1.382]	[3.398]	[5.080]	[1.748]	[-8.063]	[-0.503]	[3.712]	[5.771]	[9.749]

The values in "[ ]" stand for the t-value after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means the value of this group is the largest one among portfolios. If the value of each item is negative, then these values will be in the red.

Since the Fama-French Three-Factor Model has two more factor than CAPM and it seems that the three-factor model fit China stock market better than the single factor model, this paper tries to distinguish the role of each factor in the whole model and evaluate how they contribute to the efficiency of the model. Starting from testing the solo market factor to explain excess returns of twenty-five portfolios, it can be found in Table 4.7 that approximately a half of intercepts generated from regression is strongly significant, lower than 5%. Compared with the excess returns of portfolios in Table 4.2, a similar finding with Chen et al. (2015) indicates that the values of $R_M - R_f$'s α seems lower, among which sixteen of all intercepts including a largest value of 1.5% per month, are both positive and significant. It contains the meaning of these stock prices may being undervalued.

If transforming the singe factor into SMB, it is encouraging to find that the non-significance (under 5% test) of differing from zeros are owned by all intercepts except two, but no evident pattern of αs are showing in both of two dimensions (size and B/M ration). Only two intercepts are negative and the remained αs are all positive involving the highest one being 1.19% every month. Adding the market factor $R_M - R_f$ to combine with SMB, the intercepts displayed in the corresponding part of Table 4.7 are under the influence of two factors and nearly 30% of αs give a 5% significance of none-zeros, which illustrates that the number of $\alpha$with statistical significance obviously increases compared with the situation of singe factor SMB. However, contrasting the result of singe market factor, two factors obtain a better explainable capability of cross-section excess return because of the SMB factor's join. Aggregating all the intercepts in this case, there are six negative α including one is -0.57% at 5% significance and another one is -0.2% at 10% significance level.

Tend to the single factor HML, more than 80% of intercepts are statistically significant when given the 5% level. Even the market factor $R_M - R_f$ joins in, there are still around 60% of α showing the significance of non-zeros, which can be drawn a conclusion that HML performs worse on explaining cross-section returns in China stock market. Unexpectedly, the combination of SMB and HML factors seem to be much more efficient that only three number of α have significance with level of 5%, which conducts similarly with the situation of regression with singe factor SMB and even performs better than the group of $R_M - R_f$ and SMB. Gathering all the information having been known, it is apparent that the most effective and considerable factor in the field of researching into the cross-section return in China stock market is SMB.

Table 4.2.5: Evaluation on Three-Factor Model Based on Intercepts (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	$R_t^p = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + e_t^P$					$R_t^p = \alpha_p + \beta_P^{SMB}SMB_t + e_t^P$				
Small	0.0150^{1}	0.0138^{1}	**0.0150**^{1}	0.0134^{1}	0.0132^{1}	0.0114^{5}	0.0112^{10}	**0.0119**^{5}	0.0109^{10}	0.0119^{10}
	[3.632]	[3.558]	[3.814]	[3.409]	[3.364]	[2.024]	[1.845]	[2.001]	[1.739]	[1.853]
2	0.0065	0.0063^{10}	0.0072^{5}	0.0103^{1}	0.0114^{1}	0.0048	0.0051	0.0061	0.0088	0.0110^{10}
	[1.636]	[1.889]	[2.117]	[2.991]	[3.322]	[0.743]	[0.855]	[0.990]	[1.428]	[1.730]
3	0.0003	0.0068^{5}	0.0052^{10}	0.0050^{10}	0.0076^{1}	-0.0007	0.0071	0.0051	0.0056	0.0094
	[0.102]	[2.155]	[1.779]	[1.663]	[2.648]	[-0.109]	[1.080]	[0.849]	[0.860]	[1.419]
4	-0.0032	0.0028	0.0028	0.0062^{5}	0.0068^{5}	-0.0024	0.0036	0.0050	0.0087	0.0098
	[-1.095]	[1.027]	[1.207]	[2.523]	[2.512]	[-0.386]	[0.574]	[0.775]	[1.341]	[1.461]
Big	-0.0041	-0.0012	0.0007	0.0027	0.0048^{10}	1.37e-06	0.0037	0.0054	0.0068	0.0114^{10}
	[-1.482]	[-0.589]	[0.294]	[1.250]	[1.919]	[0.000]	[0.573]	[0.833]	[1.124]	[1.686]
	$R_t^p = \alpha_p + \beta_p^{HML}HML_t + e_t^P$					$R_t^p = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + e_t^P$				
Small	0.0255^{1}	0.0249^{1}	**0.0260**^{1}	0.0248^{1}	0.0236^{1}	0.0069^{1}	0.0062^{1}	**0.0069**^{1}	0.0057^{5}	0.0067^{5}
	[3.787]	[3.543]	[3.731]	[3.432]	[3.254]	[2.827]	[2.693]	[3.277]	[2.441]	[2.313]
2	0.0182^{5}	0.0170^{5}	0.0177^{5}	0.0211^{1}	0.0216^{1}	-0.0004	0.0001	0.0010	0.0036^{10}	0.0058^{5}
	[2.586]	[2.551]	[2.554]	[2.983]	[3.035]	[-0.146]	[0.060]	[0.427]	[1.737]	[2.256]
3	0.0114^{10}	0.0184^{1}	0.0156^{5}	0.0158^{5}	0.0180^{5}	-0.0057^{5}	0.0016	3.20e-05	0.0001	0.0039
	[1.705]	[2.631]	[2.357]	[2.237]	[2.544]	[-2.475]	[0.684]	[0.016]	[0.060]	[1.575]
4	0.0080^{5}	0.0136^{5}	0.0135^{5}	0.0165^{5}	0.0169^{5}	-0.0077	-0.0017	-0.0005	0.0032	0.0042^{10}
	[1.228]	[2.078]	[2.026]	[2.428]	[2.407]	[-3.411]	[-0.855]	[-0.274]	[1.500]	[1.682]
Big	0.0006	0.0089	0.0104	0.0117	0.0139^{5}	-0.0020^{10}	-0.0018	-5.65e-05	0.0017	0.0058^{5}
	[1.093]	[1.407]	[1.595]	[1.894]	[2.062]	[-1.897]	[-0.873]	[-0.025]	[0.813]	[2.277]
	$R_t^p = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_p^{HML}HML_t + e_t^P$					$R_t^p = \alpha_p + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + e_t^P$				
Small	**0.0164**^{1}	0.0150^{1}	0.0163^{1}	0.0146^{1}	0.0135^{1}	0.0126^{5}	0.0123^{5}	**0.0129**^{5}	0.0119^{10}	0.0115^{10}
	[4.180]	[4.052]	[4.348]	[3.872]	[3.448]	[2.197]	[2.003]	[2.158]	[1.884]	[1.764]
2	0.0083^{5}	0.0074^{5}	0.0077^{5}	0.0109^{1}	0.0113^{1}	0.0073	0.0063	0.0061	0.0088	0.0099
	[2.253]	[2.278]	[2.281]	[3.183]	[3.283]	[1.132]	[1.036]	[0.981]	[1.409]	[1.552]
3	0.0017	0.0080^{1}	0.0058^{5}	0.0052^{10}	0.0073^{5}	0.0012	0.0092	0.0057	0.0057	0.0087
	[0.528]	[2.673]	[1.989]	[1.739]	[2.537]	[0.203]	[1.387]	[0.929]	[0.862]	[1.300]
4	-0.0018	0.0037	0.0032	0.0060^{5}	0.0062^{5}	0.0002	0.0052	0.0061	0.0089	0.0090
	[-0.696]	[1.421]	[1.383]	[2.463]	[2.323]	[0.039]	[0.840]	[0.937]	[1.341]	[1.327]
Big	-0.0026	-0.0010	0.0003	0.0021	0.0033	0.0045	0.0055	0.0059	0.0067	0.0100
	[-1.081]	[-0.499]	[0.117]	[1.008]	[1.580]	[0.720]	[0.849]	[0.892]	[1.083]	[1.471]

The values in "[ ]" stand for the t-value after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means the value of this group is the largest one among portfolios. If the value of each item is negative, then these values will be in the red.

4.2.3 Regression on Fama-French Five-Factor Model

Finally, this paper tends to test the five-factor asset pricing model put forward latest by Fama and French (2015). The linear equation () is ready to conduct the OLS time-series regression on size-B/M formed portfolios. For evaluating five factor model, it has the highest average value of adjusted R-square contrasted with CAPM and three-factor model, which is over an interval between 0.87 and 0.94 showing in Table 4.8. Since there are two more factors added again (RMW and CMA), this paper has the unanimous agreement with the opinion insisted by Gao and Zhou (2015) that five factor model is most likely to fit the China stock market best and has a good ability to explain the average excess return of portfolios, due to the highest fitting degree. Additionally, it may caused by the increment in the number of factors that the relationship between adjusted R-square and company's size is not existed in five factor model, which is the same result as what happened in three-factor model. From the aspect to analyze whether the model performs well in predicting the stock's excess return based on a linear relation, it seems that all three asset pricing models having been tested are all deliver the information that the p-vale of F-statistic is extremely close to zero. This means that all these three models are in the form of linear models with a few admissible errors and they may be possible to speculate the changes in stock average excess returns.

Table 4.2.6: Evaluation on the Regression of Five-Factor Model (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Adj. R^2					**Prob (F-statistic)**				
Small	0.917	0.930	0.932	0.925	0.894	8.34e-112	1.62e-119	5.20e-121	1.39e-116	9.72e-101
2	0.884	0.910	0.924	**0.940**	0.913	1.07e-96	2.12e-108	7.33e-116	8.52e-127	7.65e-110
3	0.895	0.907	0.917	0.925	0.921	2.19e-101	1.20e-106	4.85e-112	3.27e-116	5.33e-114
4	0.899	0.913	0.924	0.918	0.909	5.94e-103	1.29e-109	1.07e-115	3.45e-112	6.15e-108
Big	0.871	0.904	0.903	0.901	0.922	8.17e-92	3.54e-105	1.01e-104	6.78e-104	1.67e-114

Numbers in bold form means that this value of a particular group is the largest one among twenty-five portfolios. If the value of each item is negative, then these values will be in the red color to distinguish from the other.

The outputs of coefficients generated from regressions are presented in Table 4.9. Reviewing the results of market beta $R_M - R_f$ firstly, the similar situation that can be tracing back to the former models appears again that all the coefficients are strongly significant under the level of 1%. It may be confirmed that the market factor has the necessity of existence, directed against the explanation of average excess returns. The largest value of β^M is 1.075 while the smallest one is 0.85, showing no apparent differences among three asset pricing models. No evident relationship between size or B/M ratio dimensions and all kinds of factors apart from SMB as well as HML, but it is clear that the market factor is positively relevant to portfolios' excess returns.

As for the slopes of SMB, twenty-one of total (86%) portfolios contain a significance with a level of 5%, signifying that this factor contributes to explicate stock returns. In the remaining non-significant part , the two of them, located in the intersection of the largest size and the first two of the lowest B/M ratio, are also non-significant in the three-factor model, which seems not be caused by the type of model. Generally, factor SMB and CMA illustrate a positive linear relation with excess returns, on the contrary, factor HML and RMW tends to show a negative relationship. Moreover, while others have no clear change trend, the coefficient of SMB has a negative correlation with the size and the slope of HML is positively correlated with the B/M ratio, presenting the same result as three-factor model. The degree of significance with level 5%, revealed by both β^{HML} and β^{RMW}, is nearly the same. 40% of each factor's coefficients are significant and most of these portfolios are concentrated in the groups with larger B/M ratio, which indicates a weaker explainable ability of returns. However, factor CMA seems to put more efforts into explaining when the model operating with more than 60% of β^{CMA}s being 5% significant.

If checking the regression results of intercepts in Table 4.9, more than 30% αs illustrate a significance under the level of 5%, which states a slightly more numbers of significant intercepts than three-factor model and CAPM. This can be suspected that there may be some problems among five factors, such as high similarity between each other. As mentioned before, no regulations between intercepts and size or B/M ratio. Based on all the results has found, market factor and SMB are strongly efficient but the other three seems still have some abilities of working in the model. Nevertheless, comparing with the three-factor, it is unexpected that five factor model appears no such an improvement in the remaining part of unexplained stock returns, even worse than before.

Table 4.2.7: Results of Regressions on Five Factors (January 1999 - December 2016)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	Abnormal return: α_p					**Coefficients of** $R_M - R_f$**:** β_p^M				
Small	**0.0080**^{1}	0.0070^{1}	0.0071^{1}	0.0060^{1}	0.0075^{1}	0.8546^{1}	0.9536^{1}	0.9454^{1}	0.9920^{1}	0.9591^{1}
	[3.588]	[3.294]	[3.412]	[2.684]	[2.863]	[31.476]	[36.966]	[37.447]	[36.220]	[30.221]
2	0.0005	0.0008	0.0013	0.0031	0.0042^{10}	0.9937^{1}	0.9500^{1}	0.9722^{1}	1.0050^{1}	1.0130^{1}
	[0.182]	[0.344]	[0.620]	[1.591]	[1.823]	[29.286]	[34.504]	[37.547]	[42.870]	[32.367]
3	-0.0054^{5}	0.0034	-0.0007	0.0008	0.0035	0.9811^{1}	1.0448^{1}	0.9959^{1}	1.0342^{1}	1.0563^{1}
	[-2.174]	[1.402]	[-0.352]	[0.370]	[1.607]	[32.479]	[35.341]	[38.478]	[39.753]	[40.146]
4	-0.0059^{5}	-0.0015	-0.0005	0.0025	0.0037	1.0074^{1}	1.0201^{1}	1.0653^{1}	1.0714^{1}	**1.0752**^{1}
	[-2.472]	[-0.683]	[-0.267]	[1.158]	[1.626]	[34.542]	[38.415]	[42.827]	[41.220]	[38.665]
Big	-0.0017	-0.0013	0.0011	0.0010	0.0057^{1}	0.9809^{1}	1.0552^{1}	1.0371^{1}	0.9922^{1}	1.0703^{1}
	[-0.680]	[-0.602]	[0.504]	[0.487]	[2.823]	[31.667]	[40.003]	[38.402]	[38.834]	[43.437]
	Coefficients of SMB**:** β_p^{SMB}					**Coefficients of** HML**:** β_p^{HML}				
Small	0.6945^{1}	0.6436^{1}	**0.7909**^{1}	0.7337^{1}	0.4452^{1}	-0.1160	-0.1279^{10}	-0.0316	-0.0075	0.1825^{10}
	[8.373]	[8.167]	[10.225]	[8.769]	[4.592]	[-1.431]	[-1.660]	[-0.419]	[-0.092]	[1.925]
2	0.6313^{1}	0.5715^{1}	0.5249^{1}	0.6569^{1}	0.6050^{1}	-0.3968	-0.0074	0.1826^{5}	0.1942	0.4418
	[6.091]	[6.794]	[6.636]	[9.172]	[7.110]	[-3.916]	[-0.090]	[2.361]	[2.775]	[5.311]
3	0.6270^{1}	0.3630^{1}	0.5785^{1}	0.3386^{1}	0.2713^{1}	-0.1441	-0.2187^{5}	-0.1179^{10}	0.1740^{5}	0.3057^{1}
	[6.794]	[4.020]	[7.317]	[4.261]	[3.375]	[-1.597]	[-2.477]	[2.085]	[2.239]	[3.891]
4	0.3444^{1}	0.4698^{1}	0.3193^{1}	0.2890^{1}	0.1689^{5}	-0.3082^{1}	-0.0444	0.0503	0.2320^{1}	0.4155^{1}
	[3.866]	[5.790]	[4.202]	[3.640]	[1.988]	[-3.539]	[-0.560]	[0.677]	[2.989]	[5.004]
Big	-0.1153	0.0178	-0.1319	0.0721	-0.2948^{1}	-0.7392^{1}	-0.0855	0.1408^{10}	0.2896^{1}	**0.4843**^{1}
	[-1.218]	[0.220]	[-1.599]	[0.923]	[-3.917]	[-7.991]	[-1.086]	[1.746]	[3.795]	[6.582]
	Coefficients of RMW**:** β_p^{RMW}					**Coefficients of** CMA**:** β_p^{CMA}				
Small	-0.4277	-0.2317^{10}	-0.2578^{10}	-0.3545^{5}	-0.4818^{1}	0.5427^{1}	0.7633^{1}	0.4666^{1}	0.4019^{1}	0.7530^{1}
	[-2.965]	[-1.690]	[-1.922]	[-2.436]	[-2.857]	[3.993]	[5.910]	[3.692]	[2.931]	[4.739]
2	**0.0600**	-0.3731^{5}	-0.4508^{1}	-0.2392^{10}	-0.2219	**0.7717**^{1}	0.1690	0.3865^{1}	0.5501^{1}	0.5207^{1}
	[0.333]	[-2.550]	[-3.276]	[-1.920]	[-1.499]	[4.543]	[1.226]	[2.982]	[4.687]	[3.734]
3	-0.1254	-0.3378^{5}	-0.1179	-0.4386^{1}	-0.2187	0.2096	0.2567^{10}	0.2701^{5}	0.4186^{1}	0.6917^{1}
	[-0.781]	[-2.150]	[-0.857]	[-3.173]	[-1.564]	[1.386]	[1.734]	[2.085]	[3.214]	[5.251]
4	-0.2237	-0.1385	-0.0894	-0.0811	-0.3208^{5}	0.0857	0.0209	0.2116^{10}	0.3972^{1}	0.3889^{1}
	[-1.444]	[-0.981]	[-0.676]	[-0.587]	[-2.171]	[0.587]	[0.157]	[1.699]	[3.052]	[2.793]
Big	0.0079	0.0450	-0.3789^{1}	-0.0869	-0.3188^{5}	0.1184	0.1041	0.1887	0.2579^{5}	0.4766^{1}
	[0.048]	[0.321]	[-2.640]	[-0.640]	[-2.435]	[0.763]	[0.788]	[1.396]	[2.016]	[3.863]

The values in "[ ]" stand for the t-value after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means the value of this group is the largest one among portfolios. If the value of each item is negative, then these values will be in the red.

Describing the data obtained from regression, the explainable capabilities of portfolios' excess returns for each factor in Fama French Five-Factor Model remain unclear. This paper attempts to evaluate the role of factors in the five factor model separately with the help of checking the significance of different factor models' intercepts. Since the performance of market factor and SMB is remarkable either in three-factor or five factor, particularly market factor is a essential factor, this paper will treat the combination of market factor and SMB as the basic factors and gradually add in other factors one by one, in order to figure out their efficiency. For results of the basic factors showing in Table 4.10, almost a quarter of intercepts show statistical significance under 5% level and the value of all intercepts changes from 0.84% to 0.64% consisting of nearly a half are negative. The basic factors seems not perfectly explain all the information in the excess returns.

Trends to the basic associated with a single factor HML (the same as three-factor model), the proportion of significant intercepts sharply decrease to 12%, sating that the new adding factor contributes to the unexplained part in the basic factor model and improves the model more closer to the change trend of excess returns in China stock market. The highest value of αs in the second model is a bit lower than that in the basic model. If transforming the singe added factor HML into RMW or CMA, it is obvious that the number of αs with 5% significance greatly grows up to fourteen and twelve, correspondingly. This means that these new three-factor models can not completely account for the cross-section returns of portfolios, even reducing the working efficiency of the original model, when factor $R_{M,t} - R_{f,t}$, SMB with RMW or CMA in a model. A point to be mentioned is that the only function of single joined factor RMW seems to lower the number of negative intercepts.

Table 4.2.8: Evaluation on Five-Factor Model Based on Intercepts (January 1999 - December 2016) (1)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	(1) $R_t^P = \alpha_p + \beta_p^M (R_{M,t} - R_{f,t}) + \beta_P^{SMB} SMB_t$*					**(2)** $R_t^p = \alpha_p + \beta_p^M (R_{M,t} - R_{f,t}) + \beta_P^{SMB} SMB_t + \beta_p^{HML} HML_t + e_t^P$				
Small	0.0053^{5}	0.0049^{5}	0.0056^{5}	0.0043^{10}	0.0059^{10}	0.0047^{10}	0.0042^{10}	**0.0048**^{5}	0.0034	0.0035
	[2.234]	[2.100]	[2.588]	[1.851]	[1.950]	[1.944]	[1.782]	[2.217]	[1.462]	[1.195]
2	-0.0016	-0.0009	9.72e-05	0.0027	0.0050^{10}	-0.0008	-0.0015	-0.0018	0.0007	0.0020
	[-0.577]	[-0.40]	[0.041]	[1.212]	[1.900]	[-0.276]	[-0.651]	[-0.786]	[0.342]	[0.830]
3	-0.0067^{1}	0.0008	-0.0007	-0.0004	0.0036	-0.0065^{1}	0.0012	-0.0020	-0.0023	0.0009
	[-2.836]	[0.341]	[-0.326]	[-0.186]	[1.403]	[-2.685]	[0.476]	[-0.913]	[-1.013]	[0.395]
4	-0.0084^{1}	-0.0023	-0.0008	0.0030	0.0041	-0.0072^{1}	-0.0022	-0.0014	0.0012	0.0013
	[-3.587]	[-1.105]	[-0.409]	[1.349]	[1.599]	[-3.117]	[-1.066]	[-0.723]	[0.581]	[0.546]
Big	-0.0053^{10}	-0.0016	0.0001	0.0019	**0.0064**^{5}	-0.0019	-0.0013	-0.0012	4.51e-05	0.0031
	[-1.910]	[-0.779]	[0.052]	[0.872]	[2.545]	[-0.793]	[-0.622]	[-0.539]	[0.022]	[1.443]
	(3) $R_t^p = \alpha_p + \beta_p^M (R_{M,t} - R_{f,t}) + \beta_P^{SMB} SMB_t + \beta_p^{RMW} RMW_T + e_t^P$					**(4)** $R_t^p = \alpha_p + \beta_p^M (R_{M,t} - R_{f,t}) + \beta_P^{SMB} SMB_t + \beta_p^{CMA} CMA_T + e_t^P$				
	0.0084^{1}	0.0078^{1}	0.0079^{1}	0.0068^{1}	**0.0104**^{1}	0.0058^{1}	0.0055^{1}	0.0059^{1}	0.0047^{5}	0.0066^{1}
	[3.782]	[3.550]	[3.828]	[3.106]	[3.822]	[2.694]	[2.695]	[3.013]	[2.171]	[2.603]
	-0.0004	0.0011	0.0034	0.0056^{1}	0.0083^{1}	-0.0013	-0.0006	0.0006	0.0032^{10}	0.0056^{5}
	[-0.140]	[0.506]	[1.585]	[2.758]	[3.320]	[-0.470]	[-0.300]	[0.275]	[1.693]	[2.417]
	-0.0059^{5}	0.0025	0.0009	0.0029	0.0071^{1}	-0.0066^{1}	0.0010	-0.0004	4.85e-05	0.0042^{5}
	[-2.435]	[1.057]	[0.408]	[1.338]	[2.992]	[-2.796]	[0.437]	[-0.207]	[0.023]	[1.983]
	-0.0078^{1}	-0.0017	0.0003	0.0049^{5}	0.0074^{1}	-0.0083^{1}	-0.0022	-0.0006	0.0034	0.0046
	[-3.268]	[-0.825]	[0.134]	[2.251]	[3.032]	[-3.566]	[-1.080]	[-0.321]	[1.628]	[2.008]
	-0.0064^{5}	-0.0016	0.0025	0.0035	0.0100^{1}	-0.0055^{5}	-0.0016^{5}	0.0004	0.0022	**0.0070**^{1}
	[-2.268]	[-0.782]	[1.140]	[1.649]	[4.366]	[-1.996]	[-0.767]	[0.199]	[1.062]	[3.281]

The values in "[ ]" stand for the t-value of this item after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means that this value of a particular group is the largest one among twenty-five portfolios. If the value of each item is negative, then these values will be in the red color to distinguish from the other.

*: In this case, although the regression equation is the same when testing with three factors, factor's data used to test is different since the final value of constructing different numbers of factors is also different.

[Continue...]

Instead of only adding a single factor to the basic model, this paper continuously tries some four factor models to further explore the each factor effects and abilities of explaining excess returns and displays the results in Table 4.11, mainly according to the intercepts calculated from regressions. Among these four factor models having been tested, apart from the market factor and SMB, if the model contains the factor HML, the proportion of αs being 5% statistically significant will have an obvious decline, for example, the basic model combining with HML and RMW lower the percentage of significant intercepts from 56% to 36% (the situation of the model without HML). This means that factor HML is important in the model and contains the ability of analyzing excess returns with the basic factors and the collaboration of $R_{M,t} - R_{f,t}$, SMB and HML is more effectively. On the contrary, the basic factors grouped with RMW and CMA remains a worse performance, due to the relatively high proportion (52%) of intercepts with 5% significance, which signifies that the major part of intercepts are greatly different from zero. The contribution of these two new adding factors to the whole model is very small with weak capabilities of explanation. This similar summary is also obtained by Zhao, Yan and Zhang (2015), when they attempt to figure out which model is better in the range of three-factor model and five factor model. However, it is different from the research opinion put forward by Fama and French (2015) that RMW and CMA have great impact on the model and work well with explaining the market, because these two factors respect the growth of companies such as the firm in the newly establishing stage having a high profit with a low investment level.

Finally, this paper turns to the five factor model and analyzing with all the information referred in this section. Unexpectedly, the Fama-French Five-Factor Model gains worse response to interpreting the China stock market, which is against the experimental results of the financial market in the United State. Associating RMW and CMA to the three-factor model leads to a consequence that the percentage of intercepts with 5% significant level rises up from 12% to 32%. In other words, the join of two more factors results in more unexplained parts appear in the portfolios' excess returns. According to Zhao, Yan and Zhang (2015), the factors of RMW and CMA are redundant and they does not contain any different information with HML, or the content of other information is limited. If contrast the performance of five factor model with the four factor model without HML, it is clear that the scale of significant intercepts under the level of 5% substantially falls down from 52% to 32%, proving the importance of HML.

Table 4.2.9: Evaluation on Five-Factor Model Based on Intercepts (January 1999 - December 2016) (2)

	B/M Quitile									
Size	Low	2	3	4	High	Low	2	3	4	High
	(5)$R_t^P = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + \beta_p^{RMW}RMW_T + e_t^P$					**(6)**$R_t^P = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + \beta_p^{CMA}CMA_T + e_t^P$				
Small	**0.0086**^{1}	0.0078^{1}	0.0076^{1}	0.0065^{1}	0.0083^{1}	**0.0063**^{1}	0.0061^{1}	0.0061^{1}	0.0046^{5}	0.0056^{5}
	[3.738]	[3.437]	[3.566]	[2.839]	[3.041]	[2.878]	[2.949]	[3.004]	[2.110]	[2.172]
2	0.0014	0.0010	0.0017	0.0037^{10}	0.0047^{5}	0.0007	-0.0007	-0.0005	0.0021	0.0033
	[0.471]	[0.428]	[0.810]	[1.825]	[2.020]	[0.277]	[-0.311]	[-0.215]	[1.133]	[1.486]
3	-0.0052^{5}	0.0037	-0.0004	0.0013	0.0042^{10}	-0.0059^{5}	0.0021	-0.0012	-0.0009	0.0026
	[-2.080]	[1.516]	[-0.209]	[0.578]	[1.854]	[-2.456]	[0.876]	[-0.590]	[-0.442]	[1.246]
4	-0.0058^{5}	-0.0015	-0.0003	0.0029	0.0041^{10}	-0.0068^{1}	-0.0020	-0.0009	0.0022	0.0025
	[-2.442]	[-0.675]	[-0.151]	[1.342]	[1.791]	[-2.928]	[-0.964]	[-0.455]	[1.044]	[1.101]
Big	-0.0016	-0.0012	0.0013	0.0013	0.0062^{1}	-0.0017	-0.0011	-0.0004	0.0007	0.0045^{5}
	[-0.630]	[-0.551]	[0.598]	[0.621]	[2.995]	[-0.692]	[-0.540]	[-0.171]	[0.335]	[2.253]
	(7)$R_t^P = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{RMW}RMW_T + \beta_p^{CMA}CMA_T + e_t^P$					**(8)**$R_t^P = \alpha_p + \beta_p^M(R_{M,t} - R_{f,t}) + \beta_P^{SMB}SMB_t + \beta_p^{HML}HML_t + \beta_p^{RMW}RMW_T + \beta_p^{CMA}CMA_T + e_t^P$				
Small	0.0073^{1}	0.0063^{1}	0.0069^{1}	0.0060^{1}	**0.0085**^{1}	**0.0080**^{1}	0.0070^{1}	0.0071^{1}	0.0060^{1}	0.0075^{1}
	[3.359]	[3.007]	[3.405]	[2.728]	[3.303]	[3.588]	[3.294]	[3.412]	[2.684]	[2.863]
2	-0.0017	0.0007	0.0023	0.0041^{5}	0.0066^{1}	0.0005	0.0008	0.0013	0.0031	0.0042^{10}
	[-0.607]	[0.333]	[1.112]	[2.167]	[2.790]	[0.182]	[0.344]	[0.620]	[1.591]	[1.823]
3	-0.0062^{5}	0.0022	8.89e-05	0.0018	0.0052^{5}	-0.0054^{5}	0.0034	-0.0007	0.0008	0.0035
	[-2.543]	[0.906]	[0.043]	[0.836]	[2.371]	[-2.174]	[1.402]	[-0.352]	[0.370]	[1.607]
4	-0.0076^{1}	-0.0017	-0.0003	0.0038^{10}	0.0060^{5}	-0.0059^{5}	-0.0015	-0.0005	0.0025	0.0037
	[-3.174]	[-0.815]	[-0.132]	[1.770]	[2.558]	[-2.472]	[-0.683]	[-0.267]	[1.158]	[1.626]
Big	-0.0059^{5}	-0.0018	0.0019	0.0026	0.0084^{1}	-0.0017	-0.0013	0.0011	0.0010	0.0057^{1}
	[-2.065]	[-0.841]	[0.873]	[1.246]	[3.878]	[-0.680]	[-0.602]	[0.504]	[0.487]	[2.823]

The values in "[ ]" stand for the t-value of this item after the time-series regression. ^{10}, ^{5} and ^{1} denote different levels of statistical significance, respectively corresponding to 10%, 5% and 1%. Numbers in bold form means that this value of a particular group is the largest one among twenty-five portfolios. If the value of each item is negative, then these values will be in the red color to distinguish from the other.

Table 4.12 shows that the factor CMA can be explained by other four factors.

Table 4.2.10: Statistic descriptions about factors (January 1999 - December 2016)

Analysis of Factors on Regressions

	Regression on $R_M - R_f$ factor				
	Intercept α	SMB	HML	RMW	CMA
β	0.0148[1]	-0.7880[1]	-0.6128[1]	-1.8625[1]	-0.3286
	[2.660]	[-3.869]	[-3.038]	[-5.423]	[-0.953]
	Adjusted R^2 = **0.178**		P (F-statistic) = 3.60e-09		

	Regression on SMBfactor				
	Intercept α	$R_M - R_f$	HML	RMW	CMA
β	0.0095[1]	-0.0844[1]	-0.4608[1]	-1.1682[1]	-0.0829
	[5.507]	[-3.869]	[-7.747]	[-13.134]	[-0.734]
	Adjusted R^2 = 0.713		P(F-statistic) = 1.23e-56		

	Regression on HML factor				
	Intercept α	$R_M - R_f$	SMB	RMW	CMA
β	0.0056[1]	-0.0687[1]	-0.4823[1]	-0.1269	0.4799[1]
	[3.010]	[-3.038]	[-7.747]	[-1.036]	[4.329]
	Adjusted R^2= **0.353**		P (F-statistic) = 7.01e-20		

	Regression on RMW factor				
	Intercept α	$R_M - R_f$	SMB	HML	CMA
β	0.0039[1]	-0.0600[1]	-0.3861[1]	-0.0401	-0.5564[1]
	[3.810]	[-5.423]	[-13.134]	[-1.036]	[-10.606]
	Adjusted R^2 = 0.793		P (F-statistic) = 1.89e-71		

	Regression on CMA factor				
	Intercept α	$R_M - R_f$	SMB	HML	RMW
β	0.0011	-0.0131	-0.0309	0.1707[1]	-0.6269[1]
	[0.987]	[-0.953]	[-0.734]	[4.329]	[-10.606]
	Adjusted R^2 = 0.580		P(F-statistic) = 2.54e-39		

	Regression on RMW **factor with Three Factors**			
β	0.0051[1]	-0.0901[1]	-0.5665[1]	-0.2074[1]
	[4.008]	[-6.099]	[-19.116]	[-4.751]
	Adjusted R^2 = 0.683		P(F-statistic) = 4.39e-53	

	Regression on CMA **factor with Three Factors**			
β	-0.0021	0.0434[1]	0.3243[1]	0.3008[1]
	[-1.539]	[2.766]	[10.308]	[6.490]
	Adjusted R^2 = 0.358		P(F-statistic) = 8.34e-21	

Chapter 5

Conclusions

The purpose of this paper is to find an asset pricing model which is the most appropriate in the China stock market among the CAPM, the Fama-French Three-Factor Model and the Fama-French Five-Factor Model with some reasonable explanations. Since China stock market is far more different from the west stock market, it is necessary and attractive to observe how the classic models work with stock data from the China imperfect market. To obtain the conclusion, some famous financial theories (such as modern portfolio theory and efficient market hypothesis) and three kinds of asset pricing models are applied in the process of research , as well as some useful testing method (for example, time-series regression based on the classical BJS method). The empirical result indicates that the size effect, the value effect and the market excess returns contains a good ability of explaining the portfolio's monthly excess returns. However, the worse performance of the other two factors in the Fama-French Five-Factor Model illustrates that the situation of China is completely different from the United States. In other words, this states the dissimilarities of investors' investment strategies in this two kinds markets. For the China stock market, the investors pay more attention to the estimated value of firms rather than the development prospect or the growth space. It is clear that the investment philosophy of investors and the market information transmission mechanism in the China market contain differences with the United States. To conclude, the Fama-French Three-Factor Model is the most suitable and efficient for China stock market and the market factor, the SMB and the HML have a significant influence on the average premiums due to the good explainable capability.

Chapter 6

Reference

Aharoni, G., Grundy B., and Zeng, Q. (2013). Stock Returns and the Miller Modigliani Valuation Formula: Revisiting the Fama French Analysis. *Journal of Financial Economics.*Vol.110, No.2, pp. 347- 57.

Banz, R. W. (1981). The Relationship Between Return and Market Value of Common Stocks. *Journal of Financial Economics.* Vol. 9, pp. 3-18.

Black, F. (1972). Capital Market Equilibrium with Restricted Borrowing. *The Journal of Business.* Vol. 45, No. 3, pp. 444-455.

Bodie, Z., Kane, A. and Marcus, A. (2014). *Essentials of Investments.* (9^{th}edn). United States of America: McGraw-Hill Education.

Breeden, D. T. (1979). An International Asset Pricing Model with Stochastic Consumption and Investment Opportunities. *Journal of Financial Economics.* Vol. 7, pp. 265-296.

Cao, P. (2006). Historical Evolution of Financial Asset Pricing Theory. *Productivity Research.* Vol. 16, pp. 144-147.

Cao, Q., Leggio K. B., and Schniederjans, M. J. (2005). A Comparison between Fama and French's Model and Artificial Neural Networks in Predicting the Chinese Stock Market. *Computers and Operations Research.* Vol.32, No.10, pp. 2499-512.

Cather, D.A. (2010). A Gentle Introduction to Risk Aversion and Utility Theory. *Risk Management & Insurance Review.* Vol. 13, No. 1, pp. 127-145.

Chan, L. K. C., Hamao, Y., and Lakonishok J. (1991). Fundamentals and Stock Returns in Japan. *Journal of Finance.* Vol.46, No. 5, pp.1739-64.

Chen, C., Hu, X., Shao, Y., and Wang, J. (2015). Fama-French in China: Size and value factors in Chinese stock returns. *University of Hong Kong Working Paper.*

China Statistical Yearbook-2016. (2017). Available at http://www.stats.gov.cn/tjsj/ndsj/2015/indexch.htm [Accessed 20 Feb. 2017].

Chen, Y. and Sun, A. (2000). The Validity Test of CAPM in China Stock Market. *Journal of Peking University*. Vol. 4, pp. 28-37.

Cochrane, J. H. (2005). *Asset Pricing.* (#Revised) US: Princeton University Press.

Cooper, M. J., Gulen, H., and Schill, M. J. (2008). Asset Growth and the Cross-section of Stock Returns. *Journal of Finance*.Vol.63, No.4, pp.1609-1651.

CSMAR. (2017). *About us*. Available at http://cn.gtadata.com/Register/Aboutus [Accessed 11 March, 2017].

Dai, G. and Xu, L. (2000). An Empirical Study on the Characteristics of Fluctuation and Steady-state for Exchange Rate and Its Implications. *Finance and Economics*.Vol. 6, pp. 3-9.

Davis, J. I. (1994). The Cross-section of Realized Stock Returns: The Pre-Compustat Evidence. *Journal of Finance*. Vol.49, No. 5, pp.1579-1593.

Duan, L. (2014). The Empirical Research of the Capital Asset Pricing Model in Shanghai Security Market. *World Economic Research*. Vol. 3, pp. 18-27.

Elton, E.J., Gruber, M.J., Brown, S.J. and Goetzmann, W.N. (2014). *Modern portfolio theory and investment analysis.* (9^{th}edn). United States of America: Lightning Source publisher.

Fama, E. F. (1965). The Behavior of Stock-Market Prices. *Journal of Business*. Vol. 38, No. 1, pp. 34-105.

Fama, E.F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*. Vol. 25, No. 2, pp. 383-417.

Fama, E.F. and French,K.R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance*. Vol. 7, No.2, pp. 427-465.

Fama, E.F. and French,K.R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*. Vol.33, pp. 3-65.

Fama, E.F. and French,K.R. (1996). Multi-factor Explanations of Asset Pricing Anomalies. *The Journal of Finance*. Vol. 51, pp. 55-84.

Fama, E.F. and French,K.R. (1998). Value versus Growth: The International Evidence. *Journal of Finance*. Vol.53, No.6, pp.1975-1999.

Fama, E.F. and French,K.R. (2004). The Capital Asset Pricing Model: Theory and Evidence. *The Journal of Economic Perspectives*. Vol. 18, No. 3, pp. 25-46.

Fama, E.F. and French,K.R. (2006). Profitability, Investment, and Average Returns. *Journal of Financial Economics*.Vol. 82, No. 3, pp.491-518.

Fama, E.F. and French,K.R. (2008). Dissecting Anomalies. *Journal of Finance*. Vol.63, No.4, pp.1653-1678.

Fama, E.F. and French,K.R. (2015). A five-factor asset pricing model. *Journal of Financial Economics.* Vol.116, pp.1-22.

Fan, Z. and Yu, S. (2002). Three - Factor Model of China 's Stock Market. *Journal of Systems Engineering*. Vol. 17, No. 6, pp. 537-546.

Gao, C. and Zhou, X. (2016). Corporate Profit, Investment and Asset Pricing: An Empirical Study Based on China 's Stock Market. Journal of Industrial Engineering. Vol.30, No.4, pp.25-33.

Gibbons, M.R., Ross, S.A. and Shanken, J.A. (1989). A Test of the Efficiency of a Given Portfolio. *Econometrica*. Vol. 57, No.5, pp. 1121-1152.

Griffin, J. M. (2002). Are the Fama and Factors Global or Country Specific?. *Review of Financial Studies*. Vol.15, No.3, pp.783-803.

Grossman, S.J. and Stiglitz, J.E. (1980). On the Impossibility of Informationally Efficient Markets. *The American Economic Review*. Vol. 70, No. 3, pp. 393-408.

Hawawini, G. and Keim, D. (2015). *The Cross Section of Common Stock Returns: A Review of the Evidence and Some New Findings*. Available at http: //ssrn.com/abstract = 40640 [Accessed 25 Oct. 2016].

Jensen, M.C., Black, F. and Scholes M.S. (1972) The capital asset pricing model: Some empirical tests. *Social Science Electronic Publishing*. Vol. 94, No. 8, pp.4229-4232.

Jin, Y. and Liu, L.(2001). An Empirical Study of CAPM in China Stock Market. *Journal of Financial Research*. Vol.7, pp. 106-155.

Keim, D. (1983). Size-related Anomalies and Stock Return Seasonality: Further Empirical Evidence. *Journal of Financial Economics*. Vol. 12, No. 1, pp.13-32.

Lakonishok, J., Shleifer, A. and Vinshny, R. (1994). Contrarian Investment, Extrapolation and Risk. *Journal of Finance*. Vol. 49, No.5, pp.1541-1578.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics*. Vol. 47, No. 1, pp. 13-37.

Lee, C.F. and Lee, A.C. (2006). *Encyclopedia of Finance*. US: Springer, .

Li, J. (2002). An Empirical Study of the Capital Asset Pricing Model (CAPM) on Shanghai Stock Market. *Statistics of Jiangsu Province*. Vol. 6, pp. 12-17.

Li, J. (2005). Empirical Study on the Capital Asset Pricing Model (CAPM) for Shanghai Stock Market. *Social Scientist*. supplement, pp. 355-356.

Liu, T. and Baek, J (2016). Asset Pricing Models in China Stock Market. Available at: http://ssrn.com/abstract=2' [Accessed 14 Nov. 2016].

Mandelbort, B. B. (1965). Forecasts of Future Prices, Unbiased Markets, and "Martingale" Models. *The Journal of Business*. Vol.39, No.1, pp. 242.

Markowitz, H. M. (1952). Portfolio Selection, *Journal of Finance*. Vol. 7, No. 1, pp.77-91.

Mayer, S.C. (1972). The Application of Finance Theory to Pubulic Utility Rate Cases. *Bell Journal of Economics and Management Science*. Vol. 3, pp. 58-97.

Merton, Robert C. (1971). Optimum Consumption and Portfolio Rules in a Continuous Time Model. *Journal of Economic Theory*. Vol.3, pp.373-413.

Merton, R. C. (1973). An Inter-temporal Capital Asset Pricing Model. *Econometrica*. Vol. 41, No. 5, pp. 867-887.

Mossin, J. (1966). Equilibrium in a Capital Asset Market. *Econometrica*. Vol. 34, No. 4, pp. 768-783.

Novy-Marx, R. (2013). The Other Side of Value: The Gross Profitability Premium. *Journal of Financial Economics*. Vol.108, pp.1-28.

Pan, L. and Xu, J. (2011). The Risk and the Eigenfactor in A-stock Market. *Journal of Financial Research*. Vol.10.

Reingaum, M. R. (1981). Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings' Yields and Market Values. *Journal of Financial Economics*. Vol.9, No.1, pp.19-46.

Ross, S. A. (1976). The Arbitrage Theory of Capital Asset Pricing. *Journal of Economic Theory*. Vol.13, pp. 341-360.

Samuelson, A. P. (1972). Proof That Properly Anticipated Prices Fluctuate Randomly. *Industrial Management Review*. Vol. 6, No. 2, pp. 41–49.

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*. Vol. 19, No. 3, pp. 425-442.

Shen, Y. (2015). The Five-Factor Asset Pricing Model: Evolution and Further Research Direction. *Journal of Financial Research*. No.6, pp.17-30.

Shi, D. (1996). An Empirical Study on the Risk of Shanghai Stock Market. *China Academic Journal Electronic Publishing House*. Vol. 10, pp. 43-48.

Stattman, D. (1980). Book Values and Stock Returns. *The Chicago MBA: A Journal of Selected Papers*. Vol. 4, pp.25-45.

Stock, J.H. and Waston, M.M. (2012). *Introduction to Econometrics*. (#3^{rd} Global edn). United Sates: Pearson Education.

Titman, S., Wei, K. and Xie, F. (2004). Capital Investments and Stock Returns. *Journal of Financial and Quantitative Analysis*. Vol. 39, No. 4, pp.677-700.

Wang, Y. (2008). Analysis on Development and Application of Financial Asset Pricing Theory. *Journal of Guangxi University of Finance and Economics.* Vol. 21, No. 3, pp. 59-61.

Wang. Y. (2009). Research on the Testing Methods of CAPM and Its Assumptions. *Statistics & Information Forum.* Vol.24, No.6, pp.8-11.

Wikipedia (2016) Available at https://en.wikipedia.org/wiki/Utility [Accessed 25 Oct. 2016].

Wind Info. (2017). About us. Available at http://www.wind.com.cn/en/about.html [Accessed 20 Feb. 2017].

Wu, S. and Xu, N. (2004). The Comparative Research Between Rational Asset Pricing Model and Irrational Asset Pricing Model: Empirical Test on China Stock Market. *Journal of Economic Studies.* Vol. 6, pp.
105-116.

Xiang, F. (2001). Tests on the Capital Asset Pricing Model (CAPM). *Mathematical Statistics and Management*. Vol. 3, pp. 32-33.

Xiong, M. (2015). Application of the Fama French Three-Factor Model in China's Stock Market - An Empirical Test Based on A - Share Market. *Contemporary Economy.* Vol. 26, pp. 130-131.

Xu, D. and Zhang, Y. (2005). Capital Assets Pricing Model and Empirical Analysis of Shanghai Stock Market. *Journal of Nanchang University*. Vol. 2, pp. 142-145, 150.

Yang, X. and Chen, Z. (2003). An Empirical Study on Three-Factor Asset Pricing Model in China 's Stock Market. *Quantitative and Technical Economics*. Vol. 12, pp. 137-141.

Yang, X. and Teng, Z. (2003). An Analysis of the Characteristics of Chinese A-Share Portfolio and the Fama-French Three-Factor Model. *School of Economics and Management in Tsinghua University.* No.2, pp.15-19.

Yang, Z. and Xing, J. (1998). Empirical Test of CAPM in Shanghai Stock Market. *Journal of Shanghai Jiaotong University.* Vol. 3, pp. 59-64.

Zhao, S., Yan, H. and Zhang, K. (2016). Does Fama-French Five-Factor Model Outperform Three-Factor Model? Evidence from China's A-Share Market. *Nankai Economic Studies.* No.2, pp.41-39.

Zhu, S. (2010). An Empirical Test of the Capital Asset Pricing Model CAPM in China's Capital Market. *Statistics & Information Forum.* Vol. 24, No. 8, pp. 95-99.

Zhu, X. and He, Z. (2002). The Empirical Research on The Value of β and The Book-to-Market Ratio Related with Stock Returns. *Journal of Financial Research.* Vol. 4, pp. 71-79.