

STATISTICAL ANALYSIS AND INTERPRETATION OF SHANGHAI STOCK EXCHANGE 50 USING CAPM

Yue You

*Suzhou highschool of Jiangsu province
699 Renmin Road, Gusu District, Suzhou, Jiangsu Province, China
215008*

ABSTRACT. *The Covid-19 pandemic exerted huge influences upon various aspects of the society, including stock markets. It is interesting to investigate various stocks during the Covid-19 pandemic. Will the stock market act differently from before? In this paper, we will conduct an analysis of stocks in SSE50 from 2019 to 2020 with a special focus on their dependency on the market and potential risks. The general method will be using CAPM standard equation and linear regression to compute the residual returns of different stocks, and then using sample variance to get the variance of the residual return. Based on collected market data, the quantitative linear relationship between stock expected return and potential risk will be estimated and interpreted, which helps to easily figure out how risky an asset is, how fluctuant the actual excess returns of the portfolio are, and how hard for the risk of a stock to be explained by the market.*

KEYWORDS: *Acknowledgement , goals, Research Methods*

1. Introduction

1.1 Acknowledgement

I would like to express my special thanks of gratitude to my professor M'arton Habcicsek and assistant teacher Sarah Ni who gave me the golden opportunity to do this wonderful project on the topic Statistical Analysis and Interpretation of Shanghai Stock Exchange 50 Using CAPM, which also promoted me to do a lot of research and I came to know about so many new things.

I also want to thank my readers for reading my project carefully. Hope you can gain some useful insights.

1.2 Big Picture

With the deepening of the marketization of Chinese economy, increasing people start to invest in the stock market in order to gain the return of the asset. Therefore, it is an important question to find the correct stock which can offer investor stable and high return. This paper will study the Chinese stock market, the stock index of the top 50 companies on Shanghai Stock Exchange (SSE 50), to analyze the stock behaviors of different kinds of companies. Since risk and expected return are the key players in active portfolio management, Capital Asset Pricing Model (CAPM) can be a suitable model to illustrate the relationship between expected return and systematic risk for different assets, and has been applied mainly to stocks. This model can find out the excess return of each stock to measure how risky an asset is within the market and its interpretability by the market. Therefore a comparison between stocks of different kinds in the market will become more apparent.

1.3 Introduction to Topic

SSE 50 Index consists of 50 most representative stocks from the Shanghai security market chosen by scientific and objective methods. The objective is to reflect the complete picture of those good quality large enterprises, which are most influential in the Shanghai security market. In our case, we use the index of SSE50 as an approximation of the market portfolio.

As mentioned in 1.1, CAPM is an excellent model that shows the relationship between expected return and systematic risk for different assets. It is used throughout finance to price risky securities and portfolios, and helps to generate expected returns for assets when taking into account the inherent risk of assets. we apply this model to our research on the behavior of the Shanghai Stock Exchange, SSE50. The time value and risk of money, two different types of compensation needed by the investors, is the main idea supporting CAPM. The risk-free interest rate in the formula below illustrates that currency's value changes over time and helps to determine the compensation received by investors who invest in any

investment over a certain period. In our investigation, the risk-free assets will be China's one-year bond.

What's more, according to the standard equation of CAPM:

$$r_p = \beta_p \cdot r_m + \theta_p$$

where

- r_p is excess return of portfolio p
- β_p is dependence of the return of the portfolio p
- r_m is excess return of the market portfolio
- θ_p is residual return of the portfolio

Risk measure (β) represents how risky an asset is and the volatility of the asset. And for the excess return, it is the return of the market after subtracting the return of the risk-free asset. After knowing these things, we can reach our goal, which is to find low-risk stocks of the SSE50 in order to maximize profits and limit potential losses. This will be done through the fields of linear algebra, statistics, and finance.

1.4 Introduction to goals

Our goal is to compare stocks of different kinds in the market. In order to achieve this, it is important to understand the categories of companies. An industry is a group of companies that are related based on their primary business activities. Individual companies are generally classified into an industry based on their largest sources of revenue. For instance, transportation is a large and massive industry that includes airline, trucking, training, and car manufacturing. Figure 1.3.1 following shows the overall categorical industries of SSE50 and Figure 1.3.2 lists the top 10 by weight.

Sector Breakdown

As of:2020-10-23

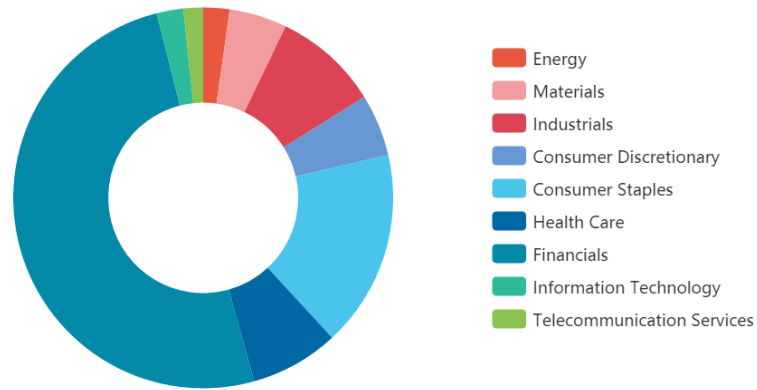


Figure 1.3.1

Top 10 by Weight

As of:2020-10-23

Code	Name	Sector	Weight(%)
601318	Ping An Insurance (Group) Company of China Ltd	Financials	13.68
600519	Kweichow Moutai Co Ltd	Consumer Staples	13.04
600036	China Merchants Bank Co Ltd	Financials	6.43
600276	Jiangsu Hengrui Medicine Co Ltd	Health Care	4.95
600030	CITIC Securities Co Ltd	Financials	3.88
600887	Inner Mongolia Yili Industrial Group Co Ltd	Consumer Staples	3.71
601166	Industrial Bank	Financials	3.45
601888	China Tourism Group Duty Free Corporation Limited	Consumer Discretionary	2.85
601012	Longi Green Energy Technology Co., Ltd.	Industrials	2.71
601398	Industrial and Commercial Bank of China Ltd	Financials	2.68

Figure 1.3.2

From the pie chart, we can easily observe that in China, particularly for SSE50, most (50.37%) companies are classified in the financial industry. Also, Figure 1.3.2 demonstrates that the stock of Ping An Insurance Company of China Ltd from the financial industry weighs the largest proportion. But for this paper, we focus mainly on bank companies and construction companies.

2. Research Methods

The first step is to collect the historical data of SSE50 in the last 12 months (from August 6th, 2019 to August 6th, 2020) and based on these closing prices and index, the Capital Asset Pricing Model and linear regressions are applied to obtain β and residual returns of each stock. For this investigation, the closing prices of SSE50 on working days during the last 12 months and the SSE50 index will be used as our research data sample.

2.1 Daily excess return of the portfolio

The excess return of the portfolio (r_p) is the total return deduced by the return of the risk-free assets. The total return from one day to another one is the percentage change of the closing price between the two days. Here the total return is calculated by the daily percentage change of the closing price by using the equation:

$$\frac{\text{new price} - \text{old price}}{\text{old price}}$$

For example, the stock closing price of China State Construction Engineering Corporation Limited on the October 22nd 2020 is RMB 5.05 and RMB 5.11 on the next day, so the total return of the October 23rd 2020 is:

$$\frac{5.11 - 5.05}{5.05} = 0.01188119$$

2.2 Daily return of the risk-free asset

The risk-free asset here is the treasury bond which is a debt security issued by a government with a fixed interest rate. Since the bond pays you an interest rate regularly and that interest is not reinvested, it could be said that the bond pays simple interest and does not compound.

Thus the daily return of China 1-year treasury bond can be obtained by yearly interest rate divided by 365, which is 0.00677863. By knowing both the daily return of the risk-free asset and the total return, we can know each stock's excess return, so we can get r_p and r_m in the CAPM formula.

2.3 Beta and residual return

Until now, after processing all the data, we have the excess returns of the market portfolio and each stock respectively. Then we use linear regression to calculate the estimate of beta for each stock which shows the dependency of individual stock on the market. "In statistics, linear regression is a linear approach to modeling the relationship between a scalar response (or dependent variable) and one or more explanatory variables (or independent variables)." Through regression lines, the betas and residual returns can be obtained by looking at the gradient and y-intercept respectively.

For example, the linear regression line of Jiangsu Hengrui Medicine Co., Ltd.(from August 6th, 2019 to August 6th, 2020) is $y=0.7206x-0.0009$ just as the following graph is shown. So the beta and residual return are 0.7206 and -0.0009 respectively.

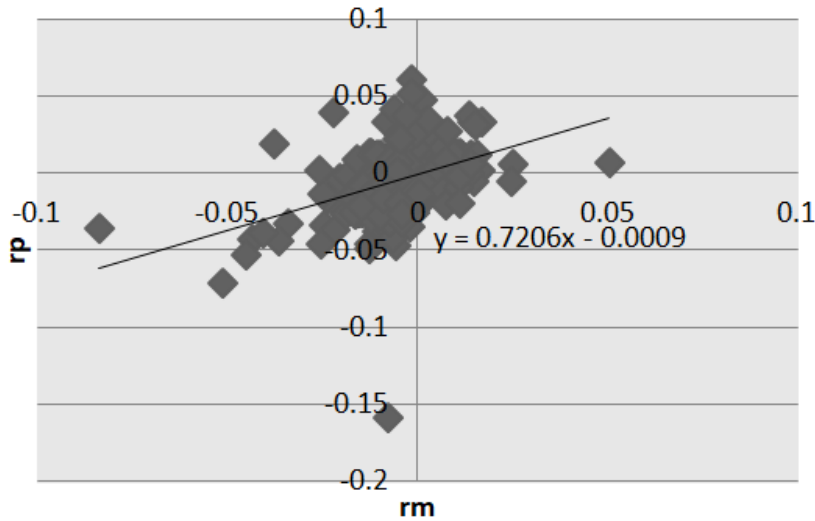


Figure 2.3.1

2.4 Variance of the market portfolio

The portfolio variance is the total risk of the stock that measures the fluctuation of the actual excess returns of the portfolio. We calculate the portfolio variance by calculating the variance of the portfolio excess return.

We use the sample variance formula since the data we have is a sample generated from a large population.

$$S^2 = \frac{\sum (x_i - \bar{x})^2}{n - 1}$$

- S^2 = sample variance
- x_i = the value of the one observation
- \bar{x} = the mean value of all observations
- n = the number of observations

2.5 Calculation of the variance of the residual return

The residual variance is the unsystematic risk that cannot be explained by the market. Larger the residual variance means they are harder to be explained by the market. Conversely, smaller residual variance means it is more explainable by the market.

$$\sigma_p^2 = \beta_p^2 \sigma_m^2 + \omega_p^2$$

The formula above is the formula to calculate the residual variance using the portfolio variance and the variance of the market, $\beta_p^2 \sigma_m^2$, which is the risk explained by the market.

We first find out the total portfolio variance of the stock, then we subtract the square of beta multiplied by the variance of the market, we get the residual variance.

3. Results

By using the method above, we compute Bank Companies' and Construction Companies' beta, which shows how risky an asset is in comparison to the overall risk of the market, portfolio variance, which measures the fluctuation of the actual excess returns of the portfolio, and residual variance, which demonstrates the idiosyncratic risk that cannot be explained by the market. The data obtained is listed below:

Bank Company	β	σ^2	ω^2
600000 Shanghai Pudong Development Bank	0.8836	0.000226	8.86E-05
600016 China Minsheng Bank	0.6638	0.000134	5.64E-05
600036 China Merchants Bank	1.0896	0.000318	0.000109
601166 Industrial Bank	0.9997	0.000271	9.51E-05
601288 Agricultural Bank of China	0.5549	0.000101	4.68E-05
601328 Bank of Communication	-0.015	0.000107	0.000107
601398 Industrial and Commercial Bank of China	0.5796	0.000122	6.29E-05
601658 Postal Savings Bank of China	0.5253	0.000217	0.000168
601818 China Everbright Bank	0.9466	0.000309	0.000151
601988 Bank of China	0.5344	0.000095	4.47E-05

Construction company	β	σ^2	ω^2
601186 China Railway Construction	1.0011	0.000372	0.000196
601668 China State Construction Engineering	0.9446	0.000274	0.000117

From the two graphs containing the calculation results of bank company and construction company, though their behaviors are quite similar, in general, the beta, portfolio variance and residual variance of the construction company will be larger than that of the bank company in general. This means that stocks of construction companies are riskier and their excess returns fluctuate widely. Moreover, their larger residual variance means they are harder to be explained by the market. As a result, it is better for investors to invest in bank companies like Bank of Communication because of low risk, relatively high stability, and interpretability of the stock market.

4. Proofs

Since investing the stocks of bank companies is less risky and has a slightly greater chance of making money than construction companies, more investors will invest in them to make money. Therefore, we took China Railway Construction Corporation and China Merchants Bank as examples to search the turnover of various stock markets. The trading volume of China Railway Construction to date (October 27, 2020) is 293,100, while that of China Merchants Bank is 45.88. This just reassures the result of our data.

5. Future Discussion

This paper mainly focus on the residual return of a stock and compare some different kinds of stocks in the market. In the future, time series model can be used to predict whether to invest or not in the stock market.

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