An Empirical Test of CAPM: Application in Apple and Tesla Stocks

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Abstract. It is crucial for investors to select the investment portfolio in the market. Risk and return are long-standing paradoxes for investors, and the higher risk may indicate a higher return than other portfolios. This article uses the stock price of Apple stock and Tesla stock from 2017 to 2022 as a sample, the CAPM model was applied to conduct regression analysis on the overall return and individual stock return of the securities market, where the return influenced by the beta coefficient. Comparing the beta coefficient in Apple stock and Tesla stock, a higher beta was regressed in Apple stock, which means that some risk-averse will choose to buy some Tesla stock into their investment portfolio. However, after analysing the output and examining the regression model, CAPM may fail to be applied in Tesla stock.

Keywords: CAPM · Beta coefficient · Investment preference · Regression analysis

1 Introduction

1.1 Research Background and Motivation

Asset pricing theory is an important part of financial theory. Since the Capital Asset Pricing Model (CAPM) was put forward to make predictions, it has received extensive attention from academia. In recent years, asset pricing research has been very active. There are more and more studies applying the Capital Asset Pricing Model to the stock and capital market. Effective pricing of stock market returns can reduce the market risk of investors to a certain extent. Expected return on equities can be affected by many factors, one determinant would be the industry in which the company engage [1]. For example, in the United States, the pharmaceutical industry sector grew by over 14.55 per cent in 2021, whereas the Air Transport sector fell more than 27.28 per cent during the same period [2]. This figure will raise the following question: 'does the higher return given by the pharmaceuticals industry mean that all the investors would prefer this investment related to the Air Transport sector? For a long time, a research area of risk and return trade-off has been a significant and major issue in the Finance field. When individuals invest, they are effectively selecting between unpredictably high profits and potentially high dangers, therefore this article will discuss how people should choose the combination of return and risk when deciding to invest in securities.

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1.2 Literature Review

This essay will review the development process of CAPM based on the existing research results and summarise in detail the aspects, which include the assumptions and drawbacks respectively.

The Capital Asset Pricing Model (CAPM) was built on the mean-variance portfolio model (MPT), which was created by Harry Markowitz in 1952. In this theory, Markowitz recognized the importance of portfolio diversification, and investors can diversify the risks into different securities in his theory [3]. However, there are some criticisms of MPT because some assumptions are not realistic. For instance, the assumption that investors can generate the perfect information is unrealistic. The information is asymmetric in the world, the inside traders can always get superior information compared to normal investors [4]. As a result, it is important to find a model which can observe and test the prediction of risk and return [5]. CAPM was first created and promoted by Williams Sharp (1964) and John Lintner (1965), which won the Nobel Prize for Sharp in 1990. The most crucial theory in CAMP is the Security Market Line, which recognised that the investors would encounter the systematic risk in a capital market, and the systematic risk cannot be diversified by investing in different securities [6]. The initial CAMP is widely accepted and used because of its simplicity and ease to understand. Starting from the 1970s, numerous empirical tests of CAPM are undertaken because of advanced computer technology. People take many real stock data into computers for validating the existence of a security market line. Consequently, many criticisms of CAPM have emerged, and the most famous critics are Fama and French. He found that there did a positive correlation between risk and return in the real equity market, but the relationship is weak [7]. In addition, they found that the beta (β) in the formula is not sufficient for explaining the expected return in empirical tests [8]. But in some specific regions, such as Germany, the CAPM works well as an indicator to make asset pricing before the twenty-first century [9]. As a consequence of numerous criticisms, many authorities proposed the improved models of simple CAPM. Lucas proposed that the original market betas can be replaced by the consumption betas [10]. However, the consumption beta has been challenged by many people because the level of consumption is uncertain when people invest their money into risky securities. In 1973, a new extension model called Arbitrage Pricing Model (APT) was primarily developed and improved by Ross [11]. APT betas measure the sensitivity to multiple risk factors instead of a single market factor. However, it is difficult to specify the factors in the real security markets [12]. In 1993, Fama and French developed the APT Model and created the Three-Factor Model which uses different indicators to represent the expected market risk premium [13]. Then, two additional factors were added to the Three-Factor Model for improving the accuracy of the model in 2015 [14].

1.3 Research Contents and Framework

This essay will verify the applicability of the CAMP model with two different stocks in United States' capital market, especially testing how does the beta coefficient perform in the company stocks. In this paper, we choose Apple and Tesla stock markets as examples and apply CAPM models to regress their overall stock market returns and

individual stock returns for the past five years. The framework of this paper is set out below. The first section is the introduction, including the background and the motivation to the research as well as the literature review has been delivered; the second part is the methodology, including the basic principles of the model and the sources of data and model construction; the third part is the analysis of the results, and finally the conclusion.

2 Methodology

2.1 Fundamentals of the Model

According to the frequent argument among economists, the expected return on an specific asset can be represented as the sum of the risk-free rate with some compensation for an investor, for assuming the non-diversifiable risks associated with the stock market (which is known as the risk-premium). And the expected return of an security should be positively correlated to its beta.

The relationship between beta and expected return can be arranged as the next equation, namely the CAPM model:

$$E[R_i] = R_f + \beta \times (E[R_M] - R_f) \tag{1}$$

where R_i is the expected return on a security *i*; R_f is the risk-free interest rate, which is usually expressed as the interest rate on treasury bonds with a maturity of one year;

β is the coefficient of asset *i*. The beta coefficient can be used to evaluate the risk that is systematic of investing in a certain asset. R_M can be explained as the rate of expected return on a market securities portfolio; $E[(R_M)-R_f]$ is the difference between expected rate of market return and the risk-free rate, which is also known as the market risk-premium in finance.

Some explanation of the beta coefficient in CAPM expression:

(1) If β equals to 0, then it means that the movement in the return on investment in the asset and the movement in the market portfolio return have no link.
(2) If β equals to 1, then it indicates that when doing an investment, the movement in the asset's return is consistent with the movement in the market's portfolio return and the investment in the asset provides the average market rate of return.
(3) If $0 < \beta < 1$ then it means the asset is considered to be defensive if the movement in the return on investing in it would be is less than the movement on market portfolio return changes and indeed the anticipated return on investing in it is below the average level of the market return.
(4) If $\beta > 1$ then it means that the asset is characterised as an aggressive asset if the change in return on investment more than the movement in overall market portfolio return, further more the predicted return on investment performs better than the level of average return on the market.

Beta here as leverage for investors, for instance, who can take more risk would choose the portfolio with higher beta ($\beta > 1$).

The expected return can be mainly determined by two risks: unsystematic risk can be diversified through investment portfolios, while the remaining part is the risk which is called the systematic risk. In modern finance, systematic risk usually uses the beta coefficient to represent in the CAPM model. Now, this essay will focus on the beta coefficient, which is a measurement of the non-diversifiable risk of an asset and shows how sensitive an asset's return is performing to market fluctuations.

The essential objective of this essay is to examine the validity of the CAPM Model in a specific company through regression analysis and give investors suggestions according to the output given by excel.

2.2 Empirical Research

2.2.1 Data

This essay has selected the close stock price from 1 July 2017 to 30 April 2022 in Apple and Tesla respectively. These two companies are with good traded for nearly five years, so they can be well-represented technology-based businesses around the world. Regarding the risk-free rate and return in the market, this research will use the monthly T-bill return provided by Ibbotson and Associates in the United States. The necessary empirical data on stocks and indices were obtained from the Yahoo Finance Website and Kenneth R. French Data Library [15, 16]. To select the monthly data for all variables is because, daily return, will bring serious measurement problems - asynchronous transactions, which themselves generate endogenous errors and therefore biased coefficient. If annually data were used, the longer duration will also make it difficult to conclude the relationship among risk and return. The monthly rate of return can be calculated using the close price at the end of each month divided by the close price at the end of the preceding month, finally, use that outcome minus 1. After processing, there are 58 R_i in total for each company, accordingly, we can get 58 sets of excess returns as the dependent variables in the following model.

2.2.2 Model Analysis

According to the CAPM theory, the relationship between excess return $\left(R_i - R_f\right)$ and risk-premium $(R_m - R_f)$ can be represented in the following regression. In this model, the independent variable is the gap between return on the whole market and the rate of risk-free assets. It can also use the risk premium to express the difference above; for the explanatory variables, the excess return has been calculated already in the appendix.

$$\left(R_i - R_f\right) = \beta\left(R_m - R_f\right) + \alpha_i \tag{2}$$

R_i is the rate of return on Apple stock or Tesla stock; R_f is the risk-free assets' return from T-bill; R_m is the return on the market; α_i is the residual variance which represents the unsystematic risk; The above regression model can estimate the expected return by using the OLS method and test the significance level at 5% using the T-test as well as the R-squared.

3 Results and Discussion

By using the regression analysis in Table 1, the results obtained have been shown in Table 3 and Table 4. From the output, the estimated beta coefficient is 0.01375, which indicates that with an additional unit added in $(R_m - R_f)$, the estimated excess return on Apple stock will increase by 1.375%; however, the intercept in this model indicates that the average actual excess returned is 6.9477% less than the average estimated return in Apple stock. Compare with the coefficient the intercept is not a very practical and significantly statistic in this empirical research. Moreover, if the beta is positive then it means that the stock Apple has a higher risk than the average risk in the market. From a statistical point of view, the study should reject the null hypothesis at 5% significance level as the |t| is 5.17 higher than 1.98, the T-test suggests that the risk-premium has an obvious significantly impact on the expected return on Apple stock. Furthermore, the Adjusted R^2 shows that specific (2) in the Apple stock has explained 31.113% of the variation of the independent variable to the expected return. That figure notes that there are other factors influencing the levels of the explanatory variables.

For the regression output on the stock in Tesla, the estimated beta coefficient is 0.00717 approximately. That figure can be interpreted that a 1 unit increase in the $(R_m - R_f)$ could increase the excess return an investor gets from the Tesla stock by 0.717%. Moreover, for the intercept, it means the average actual excess return will be greater than the estimated expected given by this model by 10.8377%. Compared with the Apple stock data, the |t| statistic in the Tesla example is 1.57, which is less than the critical value of 1.98. That T-test suggests this study cannot reject the null ($\beta = 0$) at the 5% significance level the statistically. On the economic front, the CAPM has not performed perfectly as a prediction model to get the expected return in Tesla stock.

Through the beta coefficient based on the CAPM model including some outside information on Apple and Tesla, a set of suggestions could be delivered to investors. Firstly, during the period from 1 July 2017 to 30 April 2022, the beta coefficients in Apple and Tesla stocks are both less than 1, which indicates they are both defensive stocks. That suggests investors have relatively less risk in investing in Tesla shares than in Apple shares. Concerning expected return, If the CAPM is valid then it can be expected that a fair return for the risk taken on, on average, stocks with low betas should deliver low returns because they contain less "rewardable" risk [17].

Table 1. Regression Statistics of Apple and Tesla

Apple summary output				
Coefficients	Intercept	t Stat	Adj R Square	Observations
0.01375009	−0.06947719	5.171483266	0.311130291	58
Tesla summary output				
Coefficients	Intercept	t Stat	Adj R Square	Observations
0.007174945	0.108377276	1.572991994	0.025212849	58

4 Conclusion

As a result, this essay aims to compare the risks of an investment in Apple and Tesla, and then give some recommendations to investors. This paper first has reviewed the meaning of beta and the traditional measures, using the recent five years' stock closing price to calculate the coefficient in CAPM for Apple and Tesla. Then discussed based on which the debate on beta combining with the investment preference. To be concluded, both Apple and Tesla are defensive stocks, which represents the two stocks are less risk than others in whole market. By using the CAPM, it can be concluded that investing the stocks of Apple are risker than Tesla. For risk tolerance, they will choose to invest Apple because they could get higher return than investing Tesla. In contrast, risk aversion will choose Tesla for their money. However, it is not convincing to use only a single method (CAPM) for determine the investors' preference. Investors also need to be aware the financial performance of companies based on financial reports. For instance, investors could calculate the P/E ratio to understand the growth prospect for better investment. Some restrictions like insufficient rigour, including how to measure a fair return for risk and other underlying risks need to be considered. The data selected for this test is the monthly closing prices of stocks over the last 5 years. The period of the test may be short and there are occasional fluctuations in individual stocks. CAPM is one model that suggests what a fair return for risk should be. In general, it may not be appropriate or valid for a particular investor as some prediction under CAPM may not be true in real capital market. For example, it is not possible to be existed permanently in risk-free rate and market portfolio, and that model doesn't have taken the taxation into account. In the current stage, this research is calculating betas by using the recent past return figures, implicitly presuming that the relationships between asset's return and market return have been used widely. The use of beta to refine portfolios and the use of beta to assess fund performance could be implemented in the future.

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