AMERICAN UNIVERSITY OF BEIRUT

TESTING THE VALIDITY OF CAPM USING THE NYSE:NASDAQ-100

by
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ABSTRACT
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There have been countless empirical studies conducted to test the validity of the Capital Asset Pricing Model（CAPM) since its naissance. However, few have considered the New York Stock Exchange Market. The purpose of this paper is to test the CAPM to see if it holds true in the New York Stock Exchange (NYSE) using the index NASDAQ-100. I use daily stock returns for the three stocks, Amazon Inc. (AMZN), Apple Inc. (AAPL) and Tesla Inc. (TSLA) that are listed under the Nasdaq-100 index (NYSE:Nasdaq-100) during the period 1 January 2015 to 1 January 2020. The same stocks were tested using the Fama-French model and the Arbitrage Pricing Theory (APT) model. The outcomes of the utilized tests showed that the Fama-French model is the best for explaining the excess stock returns for 2 out of these 3 stocks and the CAPM model was able to interpret the excess stock returns for one of these 3 stocks. Furthermore, it was concluded that the APT model had zero effect on the excess stock returns of all three stocks. According to the findings of the empirical test, we conclude that the Capital Asset Pricing Model does not give a firm valid description of the New York Stock Exchange using Nasdaq-100 during 2015.1.1 to 2020.1.1.

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ABBREVIATIONS

1. CAPM: Capital Asset Pricing Model
2. APT: Arbitrage Pricing Theory
3. NYSE: New York Stock Exchange

CHAPTER I

INTRODUCTION

In the Introduction part, I give a short introduction about the CAPM and its important position in the financial world, and also a short introduction about the United States economy.

A. Background

1. Short introduction of CAPM

The CAPM is an asset pricing model which uses beta as its only measure of risk; therefore, it is usually referred to as a single index model. The model is built on modern portfolio theory developed and formalized by Markowitz in 1952. The standard version of the CAPM, as developed by Sharpe (1964) and Lintner (1965), relates the expected rate of return of an individual security to its beta risk. One property of the CAPM is that investors are compensated with a higher expected return only for bearing beta risk. Thus, the CAPM suggests that higher-beta securities are expected to give higher expected returns than lower-beta securities because they are riskier (Elton and Gruber, 1995).

2. Short introduction of the US economy

The U.S. experienced one of the biggest recessions in the world in 2008 as a consequence of the 2006 mortgage crisis and the 2007 banking crisis. The annual GDP numbers hid the damage shown in the quarterly numbers. The economy contracted 8.4% in the fourth quarter. Furthermore, the true destruction wasn't known in 2008. The

Bureau of Economic Analysis (BEA) revised the level of contraction throughout 2008. Initially, it seemed the economy only contracted 3.8%. Revisions in subsequent years revealed the extent of the suffering.

As of 2019, the U.S. economy expanded at a better-than-expected clip of 2.1% during the final three months, bringing real gross domestic product growth through the entirety of 2019 to a respectable 2.3%. However, it contracted 3.5% in 2020, the first drop since the 2008 financial crisis and the largest in 74 years. An economic recovery began in the third quarter of 2020, but growth in the third and fourth quarters was inadequate to make up for the large downturn in the second quarter when containment measures were taken again in response to COVID-19, which contributed further for slowing down the economy recovery. The economy grew 1% in the last quarter. But escalating COVID cases have threatened any recovery, and the economy continues to struggle into the first quarter of 2021. Consumer spending dropped heavily in November and December because many areas compelled containment measures. Services suffered the most. Layoffs in lodging, restaurants, and bars followed in January. Sustainable drops in consumer spending have delayed and even reversed the recovery because consumers contribute nearly 70% to GDP.

3. Background about the New York Stock Exchange

The New York Stock Exchange (NYSE) is the largest securities exchange in the world, presenting 82% of the S&P 500, as well as 70 of the biggest corporations in the world. It is a publicly-traded company that provides a platform for buying and selling over nine million corporate stocks and securities a day. This Exchange houses some of the nation's largest publicly-traded corporations, including Amazon, Apple, McDonald's and Walmart. These large corporations make up what are known as blue chip stocks; companies that have achieved a level of success and stability reflected in the slow, but fairly reliable rise in stock value. Blue chip stocks are viewed as conservative investments on the NYSE. The majority of stock trading at the NYSE is done face-to-face on the Exchange's New York City trading floor.

The New York Stock Exchange’s three most broadly followed indices by both the media and investors are S&P500, Dow Jones I.A and Nasdaq Composite. The S&P 500 Index or the Standard & Poor's 500 Index is a market-capitalization-weighted index with 500 of the top companies in the U.S. Stocks. This index represents approximately 80% of the total value of the U.S. stock market and in general gives a good indication of movement in the U.S. market as a whole. The second index is Dow Jones I.A. It is one of the oldest, most well-known, and most frequently used indexes in the world. It includes the stocks of 30 of the largest and most influential companies in the U.S. The DJIA is a price-weighted index. The DJIA represents about a quarter of the value of the entire U.S. stock market, but a percent change in the Dow should not be interpreted as a definite indication that the entire market has dropped by the same percent. This is because of the Dow's price-weighted function. And the thirds index that I will be using is the Nasdaq Composite Index. The Nasdaq Composite Index is the market capitalization-weighted index of over 2,500 common equities listed on the Nasdaq stock exchange. The Index's composition is nearly 50% technology, with consumer services, health care and financials the next most outstanding industries. It is indeed one of the most widely-watched indexes in the world and is often seen as a stand-in for the technology sector, due to its heavy weighting in technology.

B. Purpose of study

The specific objective of this paper is to examine whether the CAPM holds true in the U.S. stock market using Nasdaq-100 index in specific, i.e. Whether the variations in the return on a stock is only a function of the risk premium factor i.e. excess return of the market portfolio, as oppose to multi-factor pricing models such as the Fama French Three factor model (1993) and the Arbitrage Pricing Theory (1976) which will also be tested in this study to compare the respective results.

CHAPTER II

LITERATURE REVIEW

The CAPM is built on the modern portfolio theory which was initially developed by Markowitz (1952) and Tobin (1958). As developed by Sharpe (1964) and Lintner (1965), the CAPM imitates the equilibrium expected return on an asset as a positive linear function of its beta risk. Because systematic risk cannot be diversified away, it is the only relevant risk measure in the CAPM world. This risk associated with any security is compensated with a proportional return. Beta measures the volatility of a share or a share portfolio and thus estimates how the returns on the share or portfolio will move relative to the movements in the market portfolio (Moyer et al., 2001; Jones, 1998).

By definition, the market portfolio has a beta of one. The beta of a portfolio is the weighted average of the betas of all securities contained in the portfolio. Therefore, portfolios with greater systematic have betas greater than one. Thus, by adding securities with betas that are higher to a portfolio, the systematic risk increases and hence the shares, or share portfolios with high betas should demonstrate high returns (Elton and Gruber, 1995).

A. 20th century evidence on CAPM

1. Evidence in support of the CAPM

Black et al. (1972) test the validity of the CAPM for the period 1922-1966 using all the stocks listed on the NYSE. Based on monthly return data and an equally-weighted portfolio of all stocks traded on the NYSE as their proxy for the market portfolio, they find evidence in support of a significant positive linear relation between beta and expected return. Fama and Macbeth (1973) provide confirming evidence based on a two-pass regression approach. The two-pass regression approach (FM approach) has become a dominant methodology in empirical tests of the CAPM. Further supporting evidence is provided by Blume and Friend (1973), who confirm linearity of the beta risk-return relation on the NYSE over three different periods of the WWII.

In later tests of the CAPM, Dowen (1988) concludes that security prices are determined by beta because all unsystematic risk would be eliminated by diversification. Although he agrees that there is no acceptably large portfolio that could terminate non-systematic risk, his results still support the CAPM, and further propose that portfolio managers may use beta as a tool, but not the only tool. Furthermore, he approves the linear relation between beta risk and return.

In 1995, Kothari et al. modernized the risk-return relation using a longer measurement interval of returns and substitute market data (the S&P industry portfolios). They show evidence that average returns in fact resemble substantial compensation for beta risk, provided that betas are measured at an annual interval.

2. Evidence against the CAPM

In the 1990s, a number of researches that questioned the applicability of the CAPM aroused. In 1993, Cheung et al. ran a test on CAPM in the Asian markets, particularly the Korean and the Taiwan market (Taiwan Stock Exchange). The results showed that the CAPM beta predictions on average stock returns are weak and exhibits no linear relationship between risk and return which made them conclude that the CAPM fail to hold in both markets.

Another study that contradicts the supporting arguments was done by Michailidis et al. (2006). The test was done on the Athens Stock Exchange using weekly returns of 100 listed companies. Test evidence showed no support of the prediction that higher risk should yield a higher return. Furthermore, because the intercept had a value of about zero, this also proved that the zero beta CAPM is invalid.

According to Shiller (2013), we cannot dismiss the theory; instead the test findings should be viewed with caution, as the researcher's study might not even be a true test of the CAPM. This leads to a discussion of empirical problems that make the CAPM challenging, if not impossible, to evaluate.

B. 21st century evidence on CAPM

Despite the criticism of the model in the 1990s, it is still considered as the base of modern-day pricing theory for financial markets and has wide empirical applications in corporate finance and investment management. Some empirical studies find proof that contradicts the CAPM, whereas others tend to support the model's principals.

1. Evidence in support of the CAPM

According to Laubscher (2002), the CAPM is effective in explaining the risk-reward relationship on the Johannesburg Stock Exchange (JSE). However, he proceeds to advice investors against using the model to measure investment performance as other variables could be more useful in explaining share returns.

Another study was done on the Bangladesh Stock Exchange for the period from January 2005 to December 2009 by Hasan et al. (2013). The all share price index (DSI) is used as the proxy for the market portfolio and the Bangladesh 3-month government treasury bill as the risk-free asset. The coefficients of squared beta and unique risk show that the expected return-beta relationship in portfolios is linear, and firm specific risk has no effect on the portfolios' expected return. The portfolios' intercept terms are not drastically different from zero. These results support the validity of CAPM.

The CAPM holds on the Istanbul Stock Exchange, as per Koseoglu and Mercangoz (2013). They show that the beta risk-return relationship is linear. They further discover that the measured models' alpha constants are equal to the risk-free rate.

2. *Evidence in against the CAPM*

Mateev (2004) examines the CAPM's validity on the Bulgarian Stock Exchange (BSE). The study shows that beta, size, and the B/M value were all priced on the BSE using the Fama and Macbeth cross sectional method. As a result, in addition to beta, other variables that played a significant role in explaining Bulgarian stocks were identified. The additional variables are assumed to be proxies for certain firm-specific properties that beta doesn't completely absorb, as well as proxies for certain risks (other than systemic risk) and costs. The findings observed on the BSE suggest that the conventional CAPM does not accurately and sufficiently reflect price behavior in the Bulgarian stock market.

The CAPM was brutally criticized by Fama and French (2004). The two avid critics of the CAPM make strong remarks about the validity of the model's application and claim that many anomalies have been confirmed in the majority of developed markets. They further argue that the observed relationship between beta risk and return is enforced even in studies that validate the model.

Data from Romania, Hungary, Bulgaria, Serbia, Poland, Turkey, the Czech Republic, and Bosnia and Herzegovina was used by Dzaja and Aljinovic (2013) to test the CAPM. They used monthly returns from January 2006 to December 2010 in their study. According to the regression analysis, higher yields do not imply higher beta. They also evaluate the efficient frontier for each market using the Markowitz portfolio theory, and discover that stock market indexes do not lie on the efficient frontier, and thus cannot be used as a good proxy for the market portfolio, as is popularly thought. The authors conclude that the CAPM beta is not a reliable risk indicator on its own.

Some recent studies have proved that skewness and kurtosis are relevant in predicting stock returns. Conrad et al. (2013), for example, found that the skewness and kurtosis of individual securities are significantly related to future returns.

C. Empirical issues in testing the CAPM

The empirical shortcomings of the CAPM, according to Jaganathan and Wang (1993), are often due to simple choices and assumptions researchers make the model easier and more convenient for the empirical study. These include choices related to the proxy market portfolio, the testing interval, and the beta estimation process. Contradictory evidence on CAPM has also been a consequence of differences, not only in sampling part, but also decision criteria. Some claim that every CAPM test involves both the efficient markets hypothesis and the CAPM equilibrium pricing relation.

1. Problems with market portfolio

The CAPM measures a security's systematic risk in comparison to a wide "market portfolio," which should include not only tradable financial assets such as stocks and bonds, but also non-tradable assets like fixed property, consumer durables, and human capital (Fama and French, 2004). The market risk premium is calculated by subtracting the risk-free rate from the expected return on the market portfolio. This market portfolio, which is unobservable in nature, should contain both tradable and non-tradable properties. Since the market portfolio yields the highest return for a given level of risk in each investment opportunity package, and thus it is not possible to further diversify away risk, all investors will select the optimal market portfolio, which is the market portfolio.

The effects of an inaccurately specified proxy for the market portfolio is explained by Roll (1977). These effects are: (i) the beta computed for alternative portfolios would be incorrect because the market portfolio is inappropriate, (ii) the Security Market Line (SML) obtained would be incorrect because it goes from the risk-free rate through the falsely stated market portfolio. Furthermore, when the performance of the portfolio managers is compared to the "benchmark" portfolios, the factors above will tend to overvalue the performance of portfolio managers as the true market portfolio such that slope of the SML will be underestimated.

Fama and French (2004) argue that if the market proxy problem disapproves the tests of the model, it also disapproves most applications which usually borrow the market proxies used in empirical tests. And so, to overcome this issue, researchers like Hou (2003) used a hypothetical market portfolio which has the GDP as its dividend, while others decided to use a broader set of assets to represent their market portfolio.

In regards to the critique above, a number of scholars claim that even though the equally weighted stock market index does not genuinely reflect the market portfolio, it should be significantly correlated with the true market portfolio (Shanken, 1987; Kandel and Stambaug, 1987). Nevertheless, even those who have tried to use wider set of assets like bonds and properties, amongst others, to build a market proxy, still find insufficient evidence to support CAPM.

2. Sample period and estimation interval

The sample period used when testing the model has an impact on the outcome, so researchers must be aware of it when interpreting results, specifically if it is short. Choudhary and Choudhary (2010) and Diwan (2010) provide evidence of this.

Both studies examine the validity of CAPM on the Bombay Stock Exchange in India, however their conclusions differ. The study uses a time frame of 53 weeks to regress the weekly returns of the listed stocks on the weekly returns of the SENSEX30 index. Diwan (2010) uses weekly stock returns for the period from November 2004 to October 2009. When the tests for non-linearity are conducted, the results show that the CAPM sufficiently explains excess returns. Therefore, the study verifies the linear structure of the CAPM equation; consequently, the work concludes that the CAPM holds on the BSE.

Choudhary and Choudhary (2010), on the other hand, conducted a study based on 278 companies listed on the exchange from January 1996 to December 2009. Despite proof that the CAPM does explain excess returns and supports the linear form of the CAPM equation, the results show that the CAPM does not hold on the BSE. They agree with the theory's prediction that intercept should equal zero and the slope should equal the excess returns on the market portfolio.

According to Reilly and Brown (2011), beta is an unpredictable short term measurement. Therefore, some short-term studies provide that the beta-return relationship is negative. This argument suggests that: (i) Investors that bears more risk in some short-term periods are insignificantly compensated; (ii) In the long term, investors don’t receive enough compensation for bearing more risk and are rewarded for holding securities with minimal risk; and (iii) Some systematic risk is being valued by the market in all periods.

Consequently, the period used in the testing of the CAPM should be long enough to avoid all short-term unpredictable changes, for beta coefficients to take long-term values or for beta coefficients to modify to their long-term values.

3. Problems with estimation of Beta

The most significant term is an asset's beta, which captures the component of investment risk that cannot be terminated by diversification. Historical betas are used to predict future betas in several experiments, so some would wonder if they are good estimates to use in an expectations model. This is because it is possible to argue that history does not repeat itself in the same manner.

It has been discovered that beta is typically volatile for individual stocks but stable for portfolios of stocks over a long period (Grinblatt and Titman, 2002). Miller and Scholed (1972) emphasized on the statistical issues experienced when using individual securities in testing the validity of the CAPM, while Fama and French (2004) claim that beta estimates for individual assets are inaccurate and thus generate a measurement-error problem when used to interpret average returns. Therefore, the use of portfolios rather than individual securities has been confirmed to yield better outcomes on the stability of beta and enhance the accuracy of the CAPM beta. The portfolios are organized by the order of their betas, with the first portfolio consisting of the assets with the lowest betas and the last consisting of those with the highest betas. Lau et al (1974) discovered that such arrangement minimized the standard errors on both the slope of the regression and the intercept.

The debate between Fama and French (1996) and Kothati et al. (1995) adds a unique dimension to the beta estimation argument. Although Kothati et al. (1995) argue that annual returns generate better beta estimates, Fama and French (1996) claim that there is no reason to assume that annual returns are superior to monthly returns. Nevertheless, monthly returns have become standard in studies.

CHAPTER III

DATA AND METHODOLOGY

A. Data

The first step in the estimation process for testing the validity of the CAPM is collecting the data for the dependent variable as well as the independent variables that will be used in the cross-sectional regression. In this paper, I collected the data of daily return for 3 companies listed on Nasdaq-100. The companies are Tesla Inc. (NASDAQ: TSLA), Amazon Inc. (NASDAQ:AMZN), and Apple Inc. (NASDAQ: AAPL) and the data will be covering the period from January 1st, 2015 to January 1st, 2020. Thus, I utilize a total of 1,825 against daily return observations for each of the companies in the sample. The data is collected from Yahoo Finance for the daily data for the respective companies used, and from the World Bank website and the Fred database for the APT independent variables, as well as Kenneth R. French Data for the Fama French model regression. This approach assumes that the Nasdaq-100 index is a significant proxy for the Market Portfolio since it's the stock market index that is covering the respective companies used.

The reason I'm using the NASDAQ-100, also known as US Tech 100, is because it is one of the largest indices in the NYSE. Along with the Dow Jones Industrial Average and S&P 500 Index, it is one of the three most-followed stock market indices in the United States. The Nasdaq-100 is one of the world's superior large-cap growth indexes. It includes 100 of the largest domestic and international non-financial companies listed on the Nasdaq Stock Market based on market capitalization. The companies used are Tesla Inc., Amazon Inc. and Apple Inc. where all three are listed under Nasdaq-100. As of 2020, the mentioned companies were among the 10 most popular stocks on Nasdaq.com in 2020 and among the 20 best-performing stocks of 2020 under Nasdaq-100.

B. Specification of variables

For the CAPM regression, we use daily returns on the stocks as the dependent variable is the cross-sectional regression model. I collected the daily returns for each company, the Nasdaq-100 daily return and the US 3-month treasury bill from Yahoo Finance. The use of daily returns is significantly better than yearly data because yearly data would mean that only a few data pointes would be used (since data is only available for 5 years), and this would result in poor estimation results from the regression. The first set of regressions in this study estimates stock betas using cross section data on stocks and the market index. According to this model, stock returns are formulated to depend linearly on market returns. If CAPM holds, Beta is the only determinant of returns.

As for the Fama-French model, I obtained the set of data of the associated independent variables, SMB (Small minus Big), HML (High minus Low) from Kenneth R. French data library. We don't test for another anomalies such as P/E ratios and the book-to-market value effects due to data challenges. Lastly, for the Arbitrage Pricing Theory, the independent factors that I will be utilizing are the term structure known as the unexpected changes in the interest rate and the inflation rate. The US 10-year treasury bill and the US 3-month treasury bill are retrieved from Yahoo finance, and the daily 5-year breakeven inflation rate used to construct the inflation factor was obtained from the Fred Economic Data website.

C. Methodolgy

First, using the "Adj Close" price from the historical data extracted, I get the companies' stock price and then I will generate a new series, which is the stock i return calculated as the change in price of the stock:

$$Return_{stock\ i} = \frac{P_{stock\ i,t} - P_{stock\ i,t-1}}{P_{stock\ i,t-1}}$$

These series are denoted as "r_amazon", "r_apple" and "r_tesla" in the Eviews files presented.

After getting the data for the risk-free rate, which is the 3 months US treasury bill, I proceed by computing each stock's excess return denoted as "er_amazon", "er_apple" and "er_tesla" as the following:

$$Excess\ return_{stock\ i} = Return_{stock\ i} - UStb3m$$

Where UStb3m is the risk-free rate.

The market rate of return is represented by the return on the Nasdaq-100 index, which is calculated by:

$$Return_{nas100} = \frac{P_{nas100,t} - P_{nas100,t-1}}{P_{nas100,,t-1}}$$

And finally, the market risk premium is then calculated by subtracting the risk-free rate from the market rate of return or the Nasdaq-100 return.

$$Excess\ return_{market} = Return_{nas100} - R_f$$

After conducting the CAPM regressions on the stocks and obtaining the results, I will utilize the Fama French three-factor model. The Fama-French three-factor model is an extension to CAPM that aims to report stock returns through 3 factors, and they are: market risk, outperformance of small-cap companies relative to large-cap companies and finally the outperformance of high book to market companies versus low book to market companies.

To run the Fama French model, we gather the data for the small minus big (SMB) stocks which represent the market capitalization and the high minus low (HML) which in return represent the Book to Market value stocks also for the same period mentioned above and we run the following regression:

$$Excess\ return_{stock\ i} - UStb3m = \alpha + \beta_1 RMRF + \beta_2 SMB + \beta_3 HML + \varepsilon$$

I will also be validating the CAPM by estimating the APT model. Arbitrage pricing theory (APT) is a multi-factor asset pricing model based on the idea that an asset's returns can be predicted using the linear relationship between the asset's expected return and a number of macroeconomic variables that capture systematic risk. The additional factors that I will use are the term structure and the inflation rate, and I will be running the following regression:

$$Excess\ return_{stock\ i} = \alpha + \beta_1 + \beta_2 \Delta term_t + \beta_3 \Delta inflation_t + \varepsilon_t$$

where the term factor is the difference between US 10-year treasury bill and US 3-month treasury bill, and the inflation factor is constructed using the 5-year breakeven inflation rate.

CHAPTER IV

ESTIMATION RESULTS AND EMPIRICAL ANALYSIS

A. Estimating the CAPM model

To test the validity of the CAPM, I will begin with estimating the model using E-views for each of the stocks. The CAPM model for simple OLS is run using the following formula:

$$Return_{stock\ i} = R_f + \beta(R_m - R_f)$$

There are a set of assumptions of CAPM that are considered:

1. Perfect capital markets (information is efficient, perfect competition, investors are utility maximizers etc.)
2. Homogenous expectations of asset returns
3. Complete markets: assets are tradable
4. There is a risk-free asset (in our model is represented by UStb3m)
5. Normal distribution of asset return

The above formula is equivalent to:

$$Return_{stock\ i} - UStb3m = \alpha + \beta(R_m - UStb3m)$$

In the E-views file, the left-hand side is referred to as the **ER stock i** and the right-hand side (Risk premium) is referred to as the **ER Nas100**

$$ER_{stock\ i} = \alpha + \beta(ER_{nas100}) + \varepsilon$$

ERstock i: Rstock i – Ustb3m

ERnas100: Rnas100 – Ustb3m

The daily returns CAPM estimations for the respective stocks, Amazon Inc. (AMZN), Apple Inc. (AAPL) and Tesla Inc. (TSLA) on E-views are the following:

Figure 1 Estimation of the CAPM for Amazon Inc.

Dependent Variable: ERAMAZON
Method: Least Squares
Date: 03/18/21 Time: 20:50
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.268558	0.043082	6.233704	0.0000
ERNAS100	1.186231	0.025581	46.37111	0.0000

R-squared	0.633128	Mean dependent var	-0.895851
Adjusted R-squared	0.632834	S.D. dependent var	2.040936
S.E. of regression	1.236690	Akaike info criterion	3.264356
Sum squared resid	1905.636	Schwarz criterion	3.272576
Log likelihood	-2034.958	Hannan-Quinn criter.	3.267446
F-statistic	2150.280	Durbin-Watson stat	1.904620
Prob(F-statistic)	0.000000		

Figure 2 Estimation of the CAPM for Apple Inc.

Dependent Variable: ERAPPLE
Method: Least Squares
Date: 03/18/21 Time: 20:56
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.085891	0.035387	2.427196	0.0154
ERNAS100	1.058759	0.021012	50.38782	0.0000

R-squared	0.670800	Mean dependent var	-0.953391
Adjusted R-squared	0.670536	S.D. dependent var	1.769728
S.E. of regression	1.015806	Akaike info criterion	2.870843
Sum squared resid	1285.699	Schwarz criterion	2.879063
Log likelihood	-1789.406	Hannan-Quinn criter.	2.873933
F-statistic	2538.933	Durbin-Watson stat	1.880525
Prob(F-statistic)	0.000000		

Figure 3 Estimation of the CAPM for Tesla Inc.

Dependent Variable: ERTESLA
Method: Least Squares
Date: 03/18/21 Time: 20:56
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.056730	0.089036	0.637160	0.5241
ERNAS100	1.057081	0.052868	19.99463	0.0000

R-squared	0.242915	Mean dependent var	-0.980905
Adjusted R-squared	0.242307	S.D. dependent var	2.936213
S.E. of regression	2.555843	Akaike info criterion	4.716242
Sum squared resid	8139.287	Schwarz criterion	4.724462
Log likelihood	-2940.935	Hannan-Quinn criter.	4.719333
F-statistic	399.7853	Durbin-Watson stat	2.020922
Prob(F-statistic)	0.000000		

As previously indicated, CAPM is initially a test to indicate if the market portfolio is an efficient portfolio, and to check if CAPM holds or not we need to check for two condition:

1. If the intercept $\alpha_{i,t} = 0$
2. If the coefficient of the risk premium $\beta_{m,i} > 0$

Therefore, for the first condition, we test the following hypothesis:

H_0: $\alpha = 0$

H_1: $\alpha \neq 0$

In this OLS result for Amazon Inc., we get the probability of the coefficient for the α is 0.000. which is less than 0.05, yielding alpha significant, and thus we reject the null hypothesis. This also indicates that there have been abnormal returns from investing in the Amazon Inc. stock.

As for the results of Apple Inc., the probability of the coefficient for the α is 0.0154 which also indicates that we reject the null hypothesis and that there have been abnormal returns from investing in the Apple Inc. stock.

The results for Tesla Inc. indicates that the probability of the coefficient for the α is 0.5241 proposing that we do not reject the null hypothesis. Therefore, this means that there have been no abnormal returns from investing in the Tesla Inc. stock.

For the second condition, we test the following:

H_0: $\beta_{m,i} = 0$

H_1: $\beta_{m,i} > 0$

From the CAPM results for the Amazon Inc. stock it is shown that the beta coefficient is 1.1862, showing that this stock is an aggressive stock. By looking at the p-value of the risk premium coefficient which is 0.0000, and evaluating at a 5% significance level, we can conclude that it is highly significant.

In the results for Apple Inc., we can also see that the p-value of the risk premium coefficient is 0.0000. which also concludes that it's highly significant.

Furthermore, The p-value of the risk premium coefficient for the Tesla Inc. estimation results is also 0.0000 indicating that it is highly significant.

B. Estimating the Fama-French model

After obtaining the CAPM results I will run the Fama French model to compare the two models. I regressed the independent variables, the risk premium (ERnas100-UStb3m), small minus big (SMB) stocks which represent the market capitalization and the high minus low (HML) which in return represent the Book-to-Market value stocks also for the same period mentioned above on the respective stocks. The regression is the following:

$$ER_{i,t} = \alpha_{i,t} + \beta_1 ER_{nas100} + \beta_2 SMB + \beta_3 HML + \varepsilon_t$$

Now prior to conducting the Fama-French model, we conduct some econometrics tests that are crucial for determining if the dependent variable and the independent variables are a good fit:

1. Testing for Heteroskedasticity

Hypothesis test: H_0: Variance is constant ($=\sigma^2$) homoscedastic

H_1: Variance is $\neq \sigma^2$: heteroskedastic

Figure 4 Heterskedasticity test for Amazon Inc.

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.691635	Prob. F(9,1238)	0.0863
Obs*R-squared	15.16125	Prob. Chi-Square(9)	0.0866
Scaled explained SS	250.5140	Prob. Chi-Square(9)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/22/21 Time: 21:27
Sample: 1/05/2015 12/31/2019
Included observations: 1248

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.788632	0.350020	5.110082	0.0000
ERNAS100^2	0.180883	0.079441	2.276947	0.0230
ERNAS100*SMB	-0.222378	0.332357	-0.669096	0.5036
ERNAS100*HML	0.165495	0.334471	0.494796	0.6208
ERNAS100	0.879953	0.272292	3.231648	0.0013
SMB^2	0.206349	0.637158	0.323859	0.7461
SMB*HML	-0.087643	0.791478	-0.110734	0.9118
SMB	-1.113840	0.615092	-1.810852	0.0704
HML^2	0.107701	0.460573	0.233841	0.8151
HML	0.625769	0.592259	1.056581	0.2909

R-squared	0.012148	Mean dependent var	1.484190
Adjusted R-squared	0.004967	S.D. dependent var	8.562908
S.E. of regression	8.541616	Akaike info criterion	7.135758
Sum squared resid	90323.48	Schwarz criterion	7.176858
Log likelihood	-4442.713	Hannan-Quinn criter.	7.151210
F-statistic	1.691635	Durbin-Watson stat	1.875790
Prob(F-statistic)	0.086251		

By conducting the White Test for Heteroskedasticity for the Amazon Inc. stock, we can see in Figure 4 that the P-value is 0.0863, which is higher that the 5% significance. This result shows that there is no Heteroskedasticity therefore; I don't reject the null, and conclude that it is homoscedastic.

Figure 5 Heteroskedasticity test for Apple Inc.

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	3.769303	Prob. F(9,1238)	0.0001
Obs*R-squared	33.28565	Prob. Chi-Square(9)	0.0001
Scaled explained SS	146.4955	Prob. Chi-Square(9)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/22/21 Time: 21:30
Sample: 1/05/2015 12/31/2019
Included observations: 1248

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.801376	0.124153	6.454719	0.0000
ERNAS100^2	0.055780	0.028178	1.979551	0.0480
ERNAS100*SMB	-0.305117	0.117888	-2.588188	0.0098
ERNAS100*HML	-0.252758	0.118638	-2.130497	0.0333
ERNAS100	-0.011025	0.096583	-0.114151	0.9091
SMB^2	0.057520	0.226002	0.254512	0.7991
SMB*HML	0.045941	0.280740	0.163644	0.8700
SMB	-0.097392	0.218175	-0.446394	0.6554
HML^2	0.067121	0.163367	0.410858	0.6812
HML	-0.164175	0.210076	-0.781503	0.4347

R-squared	0.026671	Mean dependent var	1.027628
Adjusted R-squared	0.019595	S.D. dependent var	3.059870
S.E. of regression	3.029742	Akaike info criterion	5.062813
Sum squared resid	11364.02	Schwarz criterion	5.103913
Log likelihood	-3149.195	Hannan-Quinn criter.	5.078265
F-statistic	3.769303	Durbin-Watson stat	1.956081
Prob(F-statistic)	0.000107		

In Figure 5, The P-value for the heteroscedasticity test of Apple Inc. is 0.0001 < 5% significance. This means that I reject the null, therefore it is heteroskedastic.

Figure 6 Heteroskedasticity test for Tesla Inc.

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.738166	Prob. F(9,1238)	0.0760
Obs*R-squared	15.57308	Prob. Chi-Square(9)	0.0764
Scaled explained SS	64.49450	Prob. Chi-Square(9)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/22/21 Time: 21:31
Sample: 1/05/2015 12/31/2019
Included observations: 1248

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.002875	0.765192	6.538064	0.0000
ERNAS100^2	-0.043286	0.173669	-0.249244	0.8032
ERNAS100*SMB	0.161845	0.726577	0.222750	0.8238
ERNAS100*HML	-0.067222	0.731200	-0.091934	0.9268
ERNAS100	-1.001231	0.595269	-1.681982	0.0928
SMB^2	2.549746	1.392914	1.830512	0.0674
SMB*HML	-0.458935	1.730280	-0.265237	0.7909
SMB	-2.338510	1.344675	-1.739089	0.0823
HML^2	-0.258381	1.006877	-0.256616	0.7975
HML	-1.158297	1.294758	-0.894605	0.3712

R-squared	0.012478	Mean dependent var	6.482072
Adjusted R-squared	0.005299	S.D. dependent var	18.72282
S.E. of regression	18.67314	Akaike info criterion	8.700030
Sum squared resid	431673.6	Schwarz criterion	8.741130
Log likelihood	-5418.819	Hannan-Quinn criter.	8.715482
F-statistic	1.738166	Durbin-Watson stat	1.720646
Prob(F-statistic)	0.075968		

The White Heteroskedasticity test for the Tesla Inc. in Figure 6 shows that it is homoscedastic since the P-value is 0.0760 > 5% which means I don't reject the null.

2. Testing for Multicollinearity

This is crucial because it serves as a tool to predict if there exists a perfect relationship between the predictor variables, consequently, unable to come up with reliable estimates of their individual coefficients.

Figure 7 Multicollinearity test for Amazon Inc.

Correlation				
	ERAMAZON	SMB	HML	ERNAS100
ERAMA...	1.000000	0.035188	-0.277442	0.795693
SMB	0.035188	1.000000	-0.083981	0.085697
HML	-0.277442	-0.083981	1.000000	-0.234568
ERNAS...	0.795693	0.085697	-0.234568	1.000000

In Figure 7, the results show that the correlation between ERAmazon and ERNas100, SMB and HML is 0.7956, 0.0351 and -0.2774, which is a moderate positive relationship. Hence, there is no perfect multicollinearity between the independent variables and the dependent variable.

Figure 8 Multicollinearity test for Apple Inc.

Correlation				
	ERAPPLE	ERNAS100	HML	SMB
ERAPPLE	1.000000	0.819024	-0.198291	0.042771
ERNAS...	0.819024	1.000000	-0.234568	0.085697
HML	-0.198291	-0.234568	1.000000	-0.083981
SMB	0.042771	0.085697	-0.083981	1.000000

In Figure 8, the results show that the correlation between ERApple, ERNas100, SMB and HML is 0.8190, -0.1982 and 0.0427, which shows a moderate positive relationship. Therefore, there is no perfect multicollinearity between the independent variables and the Apple Inc. stock.

Figure 9 Multicollinearity test for Tesla Inc.

Correlation				
	ERTESLA	ERNAS100	HML	SMB
ERTESLA	1.000000	0.492864	-0.148133	0.103250
ERNAS...	0.492864	1.000000	-0.234568	0.085697
HML	-0.148133	-0.234568	1.000000	-0.083981
SMB	0.103250	0.085697	-0.083981	1.000000

In Figure 9, the results show that the correlation between ERTesla, ERNas100, SMB and HML is 0.4928, -0.1481 and 0.1032, which shows a moderate positive relationship. Therefore, there is no perfect multicollinearity between the independent variables and the Tesla Inc. stock

3. Testing for Autocorrelation

To test for autocorrelation, I decided to look at the Least Squares test and obtain the autocorrelation from the Durbin-Watson stat.

Hypothesis test: H_0: No autocorrelation

H_1: there is autocorrelation

Figure 10 Autocorrelation test for Amazon Inc.

Dependent Variable: ERAMAZON
Method: Least Squares
Date: 03/18/21 Time: 21:11
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.231853	0.043089	5.380778	0.0000
ERNAS100	1.156753	0.026026	44.44662	0.0000
SMB	-0.163933	0.070501	-2.325259	0.0202
HML	-0.363178	0.064187	-5.658137	0.0000

R-squared	0.643402	Mean dependent var	-0.895851
Adjusted R-squared	0.642542	S.D. dependent var	2.040936
S.E. of regression	1.220230	Akaike info criterion	3.239156
Sum squared resid	1852.269	Schwarz criterion	3.255596
Log likelihood	-2017.234	Hannan-Quinn criter.	3.245337
F-statistic	748.1747	Durbin-Watson stat	1.917252
Prob(F-statistic)	0.000000		

In Figure 10, the Durbin-Watson stat result shows that there is in fact no autocorrelation since it's 1.917 which is between 1.8 and 2.2. This leads to accepting the null hypothesis that there is no correlation.

Figure 11 Autocorrelation test for Apple Inc.

Dependent Variable: ERAPPLE
Method: Least Squares
Date: 03/18/21 Time: 21:11
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.084802	0.035854	2.365181	0.0182
ERNAS100	1.059320	0.021656	48.91609	0.0000
SMB	-0.101093	0.058663	-1.723278	0.0851
HML	-0.026907	0.053410	-0.503779	0.6145

R-squared	0.671624	Mean dependent var	-0.953391
Adjusted R-squared	0.670832	S.D. dependent var	1.769728
S.E. of regression	1.015349	Akaike info criterion	2.871541
Sum squared resid	1282.480	Schwarz criterion	2.887981
Log likelihood	-1787.842	Hannan-Quinn criter.	2.877722
F-statistic	848.1142	Durbin-Watson stat	1.888255
Prob(F-statistic)	0.000000		

In Figure 11, the Durbin-Watson stat result shows that there is in fact no autocorrelation since it's 1.888 which is between 1.8 and 2.2. This leads to accepting the null hypothesis that there is no correlation.

Figure 12 Autocorrelation test for Tesla Inc.

Dependent Variable: ERTESLA
Method: Least Squares
Date: 03/18/21 Time: 21:12
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.032652	0.090049	0.362601	0.7170
ERNAS100	1.030852	0.054389	18.95319	0.0000
SMB	0.354409	0.147335	2.405462	0.0163
HML	-0.160797	0.134140	-1.198726	0.2309

R-squared	0.247534	Mean dependent var	-0.980905
Adjusted R-squared	0.245719	S.D. dependent var	2.936213
S.E. of regression	2.550081	Akaike info criterion	4.713327
Sum squared resid	8089.625	Schwarz criterion	4.729768
Log likelihood	-2937.116	Hannan-Quinn criter.	4.719508
F-statistic	136.4102	Durbin-Watson stat	2.032637
Prob(F-statistic)	0.000000		

In Figure 12, the Durbin-Watson stat result shows that there is in fact no autocorrelation since it’s 2.03 which is between 1.8 and 2.2. This leads to accepting the null hypothesis that there is no correlation.

Now that we’ve established that the dependent variables ERAmazon, ERApple and ERTesla and the three independent variables ERNas100, SMB and HML are ready to test the Fama-French model, I will regress the independent variables on the three stocks.

C. Fama-French Estimation results

Figure 13 Estimation of the Fama French model for Amazon Inc.

Dependent Variable: ERAMAZON
Method: Least Squares
Date: 03/18/21 Time: 21:11
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.231853	0.043089	5.380778	0.0000
ERNAS100	1.156753	0.026026	44.44662	0.0000
SMB	-0.163933	0.070501	-2.325259	0.0202
HML	-0.363178	0.064187	-5.658137	0.0000

R-squared	0.643402	Mean dependent var	-0.895851
Adjusted R-squared	0.642542	S.D. dependent var	2.040936
S.E. of regression	1.220230	Akaike info criterion	3.239156
Sum squared resid	1852.269	Schwarz criterion	3.255596
Log likelihood	-2017.234	Hannan-Quinn criter.	3.245337
F-statistic	748.1747	Durbin-Watson stat	1.917252
Prob(F-statistic)	0.000000		

From the results obtained in Figure 13, we can notice that the systematic risk, ERnas100, is still explaining the most the return on the Amazon Inc. stock. The coefficient β_1 is close to the beta coefficient we got in CAPM and still explains a huge part of the dependent variable.

The coefficients β_2 and β_3 are negatively correlated with the Amazon Inc. stock return However both of them are significant when we look at the p-value because both are less than 0.05 and therefore this shows that the Fama-French explanatory variables do affect the excess returns on the Amazon Inc. stock.

The R-squared and adjusted R-squared for the CAPM model and the Fama-French model are quite close; 0.63 and 0.64. However, they are slightly higher for the Fama-French model which shows that the Fama-French model is somewhat better in explaining the excess returns on Amazon Inc.

Figure 14 Estimation of the Fama French model for Apple Inc.

Dependent Variable: ERAPPLE
Method: Least Squares
Date: 03/18/21 Time: 21:11
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.084802	0.035854	2.365181	0.0182
ERNAS100	1.059320	0.021656	48.91609	0.0000
SMB	-0.101093	0.058663	-1.723278	0.0851
HML	-0.026907	0.053410	-0.503779	0.6145

R-squared	0.671624	Mean dependent var	-0.953391
Adjusted R-squared	0.670832	S.D. dependent var	1.769728
S.E. of regression	1.015349	Akaike info criterion	2.871541
Sum squared resid	1282.480	Schwarz criterion	2.887981
Log likelihood	-1787.842	Hannan-Quinn criter.	2.877722
F-statistic	848.1142	Durbin-Watson stat	1.888255
Prob(F-statistic)	0.000000		

In Figure 14, we can notice that the systematic risk, ERnas100, is still explaining the most the return on the Amazon Inc. stock. The coefficient β_1 is equal to the beta coefficient we got in CAPM and still explains a huge part of the dependent variable.

The coefficients β_2 and β_3 are negatively correlated with the Amazon Inc. stock return and both of them are insignificant when we look at the p-value because both are >0.05 and therefore implies that the Fama-French explanatory variables don't affect the excess returns on the Apple Inc. stock.

The R-squared and adjusted R-squared for the CAPM model and the Fama-French model are equal; 0.67 and 0.67. Thus, this shows that both models can interpret the excess returns of the Apple Inc.

Figure 15 Estimation of the Fama French model for Tesla Inc.

Dependent Variable: ERTESLA
Method: Least Squares
Date: 03/18/21 Time: 21:12
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1248 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.032652	0.090049	0.362601	0.7170
ERNAS100	1.030852	0.054389	18.95319	0.0000
SMB	0.354409	0.147335	2.405462	0.0163
HML	-0.160797	0.134140	-1.198726	0.2309

R-squared	0.247534	Mean dependent var	-0.980905
Adjusted R-squared	0.245719	S.D. dependent var	2.936213
S.E. of regression	2.550081	Akaike info criterion	4.713327
Sum squared resid	8089.625	Schwarz criterion	4.729768
Log likelihood	-2937.116	Hannan-Quinn criter.	4.719508
F-statistic	136.4102	Durbin-Watson stat	2.032637
Prob(F-statistic)	0.000000		

As for the Tesla Inc. regression, it shows in Figure 15 that the risk premium, ERnas100, is still interpreting the most of the excess return on the Tesla Inc. stock. The coefficient β_1 in the CAPM regression is relatively higher than the beta coefficient we got in the Fama-French regression.

The coefficient β_2 is 0.35 which is considered moderate in explaining the excess return. Nevertheless, it is positively correlated with the excess return and is significant. However, β_3 is negatively correlated with the excess return and is insignificant when we look at the p-value because it's <0.05. This implies that the Tesla Inc. stock has size tilt.

The R-squared and adjusted R-squared for the CAPM model and the Fama-French model are equal; 0.24 and 0.24. Thus, we can say that because of the significant size variable used in the Fama-French model, it managed to explain the excess return on Tesla more than CAPM.

D. Estimating the Arbitrage Pricing Theory model

While APT is more flexible than the CAPM, it is more complex. The CAPM only takes into account one factor—market risk—while the APT formula has multiple factors which are considered to be important macroeconomic variables that might help capture the market-wide risks. I chose to use the term structure and the inflation rate as the additional variables for my study. After conducting regressions on the CAPM model and the Fama-French model, I am ready to empirically test the validity of APT by simply using two of the main US macroeconomic variables.

Figure 16 Estimation of the APT model for Amazon Inc.

Dependent Variable: ERAMAZON
Method: Least Squares
Date: 03/20/21 Time: 19:20
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1239 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.269969	0.043633	6.187201	0.0000
ERNAS100	1.192998	0.026520	44.98565	0.0000
DINFLATION	-0.860272	1.154701	-0.745017	0.4564
RTERM	-1.132161	0.875666	-1.292914	0.1963

R-squared	0.631328	Mean dependent var	-0.901463
Adjusted R-squared	0.630433	S.D. dependent var	2.031655
S.E. of regression	1.235085	Akaike info criterion	3.263379
Sum squared resid	1883.911	Schwarz criterion	3.279916
Log likelihood	-2017.664	Hannan-Quinn criter.	3.269599
F-statistic	704.9545	Durbin-Watson stat	1.904451
Prob(F-statistic)	0.000000		

The regression results for the APT on the excess return of Amazon shows that the risk premium, ERnas100, is still interpreting the most of the excess return on the excess return. The coefficient β_1 in the APT regression is slightly higher than the beta coefficient we got in the CAPM regression. The coefficient β_2 and β_3 are both negatively correlated with the excess return on Amazon and are both insignificant since both p-values are >0.05.

Moreover, the R-squared and adjusted R-squared for the CAPM model regression are slightly higher than the APT model regression. Thus, this further implies that the APT explanatory factors are ineffective in explaining the excess return on Amazon.

Figure 17 Estimation of the APT model for Tesla Inc.

Dependent Variable: ERAPPLE
Method: Least Squares
Date: 03/20/21 Time: 19:21
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1239 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.083774	0.035921	2.332163	0.0199
ERNAS100	1.053812	0.021832	48.26866	0.0000
DINFLATION	-0.308543	0.950608	-0.324574	0.7456
RTERM	0.897104	0.720893	1.244435	0.2136

R-squared	0.669737	Mean dependent var	-0.953763
Adjusted R-squared	0.668935	S.D. dependent var	1.767145
S.E. of regression	1.016785	Akaike info criterion	2.874391
Sum squared resid	1276.806	Schwarz criterion	2.890927
Log likelihood	-1776.685	Hannan-Quinn criter.	2.880610
F-statistic	834.8138	Durbin-Watson stat	1.883968
Prob(F-statistic)	0.000000		

Interpreting the regression results of the APT on the excess return of Apple implies that the explanatory variables assiocated with APT are insignificant and have no effect on the excess return of Apple Inc. Furthermore, the R-squared and adjusted R-squared for the CAPM model regression are slightly higher than the APT model regression (0.67 > 0.66).

Figure 18 Estimation of the APT model for Tesla Inc.

Dependent Variable: ERTESLA
Method: Least Squares
Date: 03/20/21 Time: 19:22
Sample (adjusted): 1/05/2015 12/31/2019
Included observations: 1239 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037078	0.089948	0.412211	0.6803
ERNAS100	1.035524	0.054668	18.94189	0.0000
DINFLATION	3.025585	2.380349	1.271068	0.2039
RTERM	0.609996	1.805135	0.337922	0.7355

R-squared	0.243445	Mean dependent var	-0.980988
Adjusted R-squared	0.241607	S.D. dependent var	2.923619
S.E. of regression	2.546056	Akaike info criterion	4.710191
Sum squared resid	8005.766	Schwarz criterion	4.726727
Log likelihood	-2913.964	Hannan-Quinn criter.	4.716411
F-statistic	132.4662	Durbin-Watson stat	2.043057
Prob(F-statistic)	0.000000		

In the regression results on Tesla, we can see that the inflation rate coefficient β_2 is very high but insignificant. The insignificance is applied to the coefficient β_3 as well. However, the market risk coefficient β_1 has a big and significant effect on the excess return of Tesla Inc. As for the R-squared and adjusted R-squared for the CAPM model and the APT model are equal; 0.24 and 0.24.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

To conclude, the aim of this study is to examine the validity of the popular CAPM model for the NYSE:Nasdaq-100 index by regressing it on three strong stocks, Amazon Inc., (AMZN), Apple Inc. (AAPL) and Tesla Inc. (TSLA) and analyzing the outcomes of the beta coefficient associated with market risk. The study used daily stock returns from January 1st 2015 to January 1st 2020. In addition to that, further tests were done on the same stocks using the Fama-French model and the Arbitrage Pricing Theory (APT) model where both of them utilized additional variables that might have a significant effect on the excess return of the respective stocks.

The outcomes of our tests for the Amazon Inc. show that the Fama-French model did the best in explaining its excess return. The reason is that the additional factors, SMB and HML, although had a negative correlation with the excess returns of Amazon Inc., but were significant and had an effect on them. Furthermore, The APT model chosen factors, inflation rate and interest rate term spread, had zero effect on Amazon stock's excess return. By looking at the R^2 = 0.63 which is equal for each model, it hardly serves as a tool to determine which model is better for Amazon.

As for the regression outcomes of the three models tested on the excess returns of Apple Inc. stock, they indicate that the CAPM model is infact was better than Fama-French and APT at interpreting the excess returns as the additional variables associated with each of the latter models showed a negative insignificant correlation with it. And again, the R^2 = 0.67 was equal for all three models and vaguely determined which model is preferable.

Similar to the results of Amazon Inc., the Fama-French model was confirmed to explain the excess returns of the Tesla Inc. stock. The regression result for the Fama-French model detected a positive significant between the size factor (SMB) and the excess returns of Tesla Inc stock. However, no relation is detected for the value factor (HML).

The empirical work of the models suggest that the Fama-French model holds better than the CAPM in interpreting the excess stock returns on the three stocks, Amazon Inc. (AMZN), Apple Inc. (AAPL) and Tesla Inc. (TSLA) from the period January 1st 2015 to January 1st 2020 using the NYSE:Nasdaq-100 index. However, we surely can't fully deny the adequacy of CAPM in explaining the excess returns on other assets at different time periods since the market index used in this test is definitely not the "market portfolio" of what CAPM states. In addition, there were certainly some errors that were accumulated through out the study. And most importantly, the small sample size and the short observation period may have also led to some measurement errors. For future studies, it is certainly recommended for investors and analysts to conduct this test on a bigger sample size for a longer observation period and with extreme caution.

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