



GROUP PROJECT

Calculating return of Automobile and Integrated Energy sectors using CAPM model

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Abstract

This project primarily explains the Capital Asset Pricing Model introduced by Jack Treynor, William F. Sharpe, John Lintner and Jan Mossin independently which was developed based on the limitations of the Markowitz Model Pricing Theory. We predominantly focused on the underlying principles of Capital Asset Pricing Model for mainly 2 sectors, namely, Automobile industry and Integrated Energy sector. We have picked 4 stocks from each sector to enable comparison within the sector and then across the two sectors. We go into depth of calculating Beta (systematic risk) for CAPM model based on the calculated log normal returns, Security Market Line, Jensen's Alpha, Sharpe's ratio, and other descriptive statistics (mean, variance, standard deviation, skewness and kurtosis) using Excel for the above-mentioned calculations and MatLab for plotting. Finally, this project applies these models to analyze the data calculated and draw an accurate analysis of optimal trading strategies for the respective sectors.



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Introduction

The research conducted by our group is focused on the manufacturing sector and the utility sector. We did so by picking 4 stocks from each industry mentioned above and analyzing them using CAPM model and other descriptive statistics. The research primarily has two focus areas, namely, the positive correlation among the two sectors and how the two sectors are integrated.

The reason for us choosing this project is to show how due to amplifying shortage of fuel across the globe has allowed the firms to explore the next best alternative which could be cost-friendly, eco-friendly & non-perishable. A significant amount of innovation has been seen in the automobile sector for the development of electric cars.

As mentioned earlier the amplifying shortage of fuel will force the global economies to move towards a more sustainable supply of resource which is indeed electricity. Therefore, a highly positive correlation can be seen in the utility & automobile sector. A sharp rise in the stock price of power generation firms has already been experienced by the market over the past year and a significant rise could also be experienced soon. The research paper is based on statistical values i.e. mean, variance, standard Deviation, correlation, covariance, Beta, skewness, kurtosis and 30-day moving average. In ratios we calculated the sharp, Treynor and Jensen alpha.

The findings in the research paper provide robust data on the performance of the firms & the industries over a 30-day period. Following the outcomes, a descriptive analysis has also been conducted to provide a significant amount of proof to withstand the objective of the research paper. The outcomes of the research can help the investors in having a short-term analysis of the firms & the industry performance which indeed could help the investors in making a wise decision in accordance with their risk preferences.

The following research paper can also be used in future by having a more in-depth analysis by taking into consideration a wider range of timeline and by using a more descriptive model i.e., multi-factor model which could provide a more concrete analysis & result. The short-term frame moving average is more beneficial to short term traders since it follows the price more closely and therefore produces less lag than the long-term moving average.



Literature Survey

After having done a survey on papers that were similar to the research topic as ours, we came across a case study on CAPM for three stocks, namely, *Kellogg Company*, *KB Financial Group Inc.* and *Kate Spade & Company* (Link of the case study in the citations page). The purpose of this paper was to do empirical research on the capital asset pricing model. The bases of their research were the returns of the afore-mentioned stocks and the S&P500 index. From these findings, they derived that it is not recommended to invest solely based on the Turn-of-month trends that they've plotted. However, their research did not include the individual analysis of the stocks and the index using the CAPM model. It also did not include complex analysis of various measures like Sharpe ratio, Jensen Alpha and SML.

Our project, on the other hand, has 8 stocks: 4 from the automobile industry and 4 from the integrated energy sector. The stocks we've picked are *Ferrari N.V. (RACE)*, *Toyota Motor Corporation (TM)*, *Tata Motors Ltd (TTM)*, *Volkswagen AG (VWAGY)* from the automobile sector and *Enphase Energy, Inc. (ENPH)*, *Vision Energy Corporation (VIHDD)*, *Devon Energy Corporation (DVN)*, *Phillips 66 (PSX)* from the Integrated Energy sector.

The primary reason that drove us to do this is to draw a relative analysis between these 2 sectors and how the stocks are performing within their respective sectors using the CAPM model and other descriptive statistics.

The main contribution to this project is the CAPM model and the optimal trading strategies for the two sectors. The key findings in this project are through MatLab with some calculations on Microsoft Excel. We then analyze and provide our insight into how the stock is performing in its respective sector and across sectors. Finally, we conclude by presenting how CAPM helps us draw the analyses.



Data and Methodology

We have taken 8 stocks, namely, 4 from energy sector (ENPH, VIHDD, DVN, PSX) and 4 from auto mobile sector (RACE, TM, TTM, VWAGY). The study also includes NASDAQ index data as a comparable and a daily risk-free rate (US 3-month treasury bill). The adjusted price of each stock and market is imported from yahoo finance from 10/03/22 to 11/17/22. We calculated the log normal return of each stock on Microsoft Excel using the formula $\ln(\text{close})/(\text{open})$.

Using the calculated log normal returns, we further calculated the descriptive statistical values on Microsoft Excel, i.e., mean, variance, standard deviation, correlation, covariance, Beta, skewness, kurtosis and ratios like the Sharpe ratio, Treynor ratio and Jensen alpha.

using the formulas below.

Hand-written formulae:

- Simple return of single stock: $R = (P_1 + D - P_0) / P_0$
- Portfolio return of 2 securities: $R_p = W_a R_a + W_b R_b$
- Standard Deviation: $\sigma_p^2 = (W_a \sigma_a)^2 + (W_b \sigma_b)^2 + 2 * W_a \sigma_a * W_b \sigma_b * \rho_{ab}$
- $\beta_j = \text{Cov}_{jm} / \text{Var}_m$
- $E(r) = R_f + \beta_j * (R_m - R_f)$
- Sharp Ratio = $(R_p - R_f) / \sigma_p$
- Treynor Ratio = $(R_p - R_f) / \beta_p$
- Jensen alpha = $R_p - E(r)$; Here, $E(r)$ is calculated from CAPM.

Excel Formulae:

- Mean = AVERAGE(range of ln return of stock)
- Variance = VAR(range of ln return of stock)
- Standard Deviation = STDEV(range of ln return of stock)
- Correlation = CORREL(range of ln return of stock)
- Covariance = COVAR(range of ln return of stock)
- Skewness = SKEW(range of ln return of stock)
- Kurtosis = KURT(range of ln return of stock)

The calculations of CAPM and coefficient of determination along with the SML graphs, Serial correlation plotting, log normal return vs moving average graphs are all done on Matlab using the codes mentioned in the pages ahead. The data set we've used for this study is as below. The first one is that of the Integrated Energy Sector and the second one is that of the Automobile Sector.



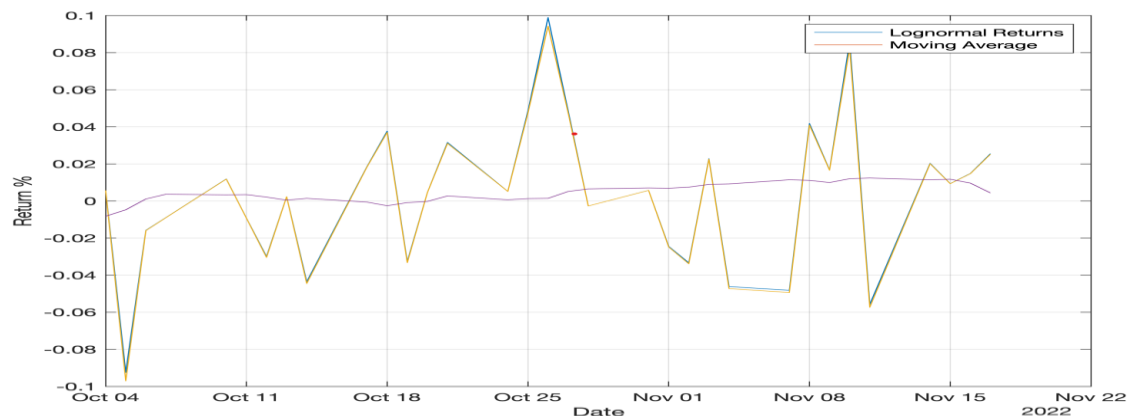
Results and Discussion

1. Log normal return vs Moving Average analysis

1(a). Integrated Energy sector

ENHP

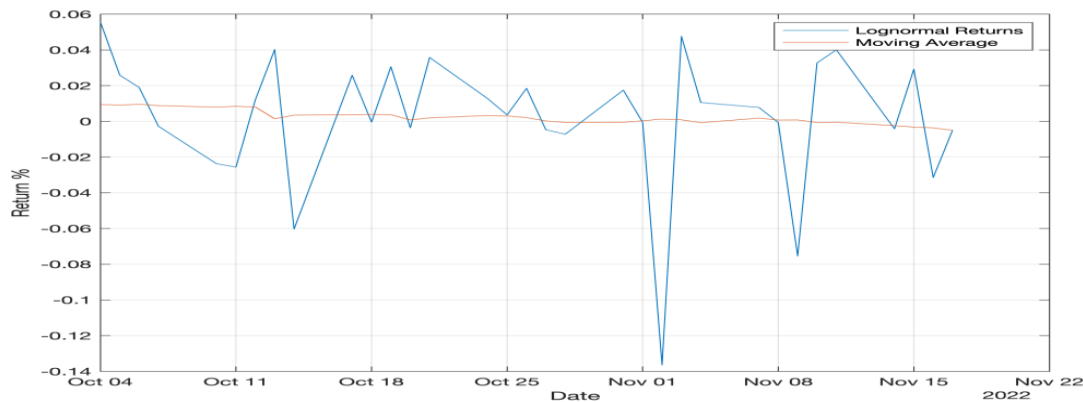
An elevated level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is flat, we can infer that the price is more than the moving average which indicates that the stock may have an uptrend in the near future. This analysis is beneficial for a short-term trader who would invest for less than a year.



DVN

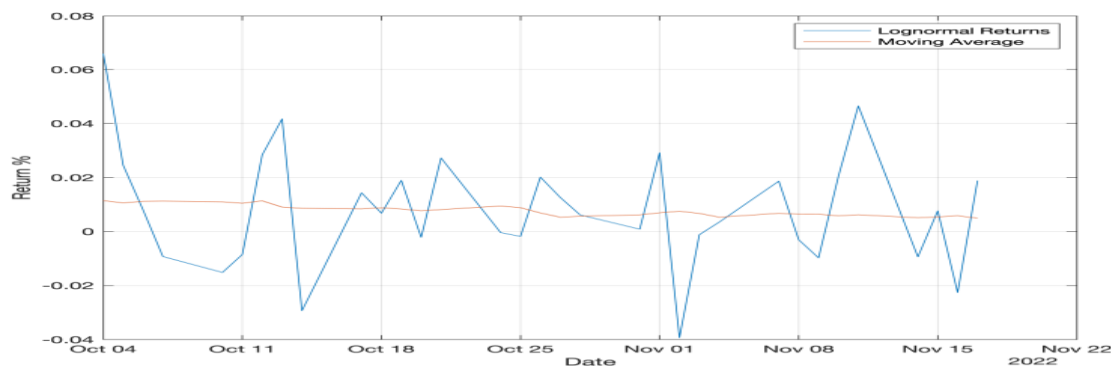
An elevated level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is downward sloping, we can infer that the price is less than the moving average which indicates that the stock may have a down trend in the near future. This analysis is beneficial for a short-term trader who would invest for less than a year.





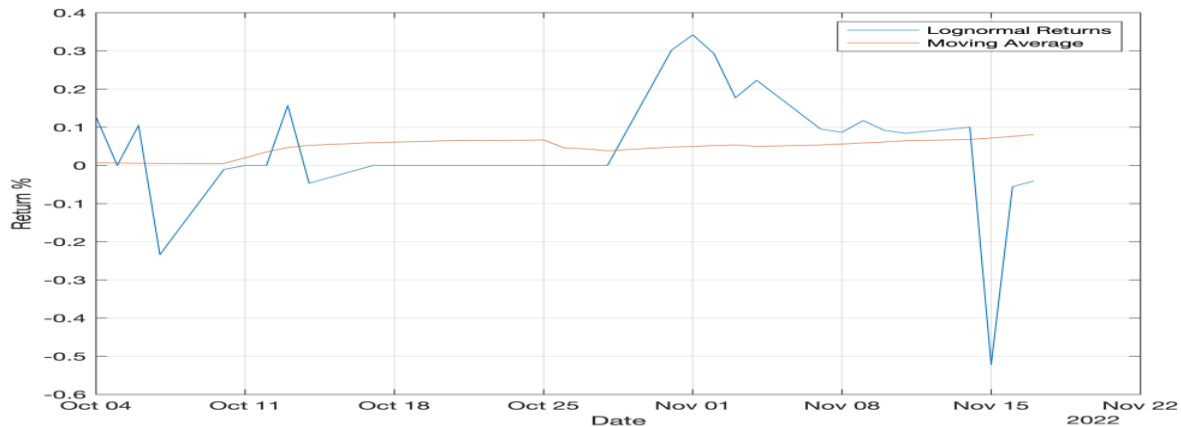
PSX

An optimal level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is slightly downward sloping, we can infer that the price is at par with the moving average which indicates that the stock may have a static movement in the near future. This analysis is beneficial for a short-term trader who would invest for less than a year.



VIHDD

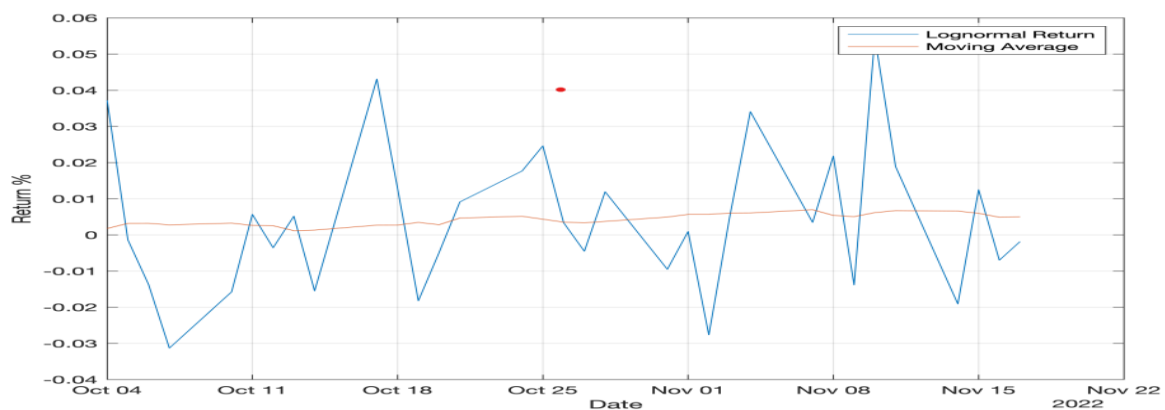
An elevated level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is upward sloping, we can infer that the price is more than the moving average which indicates that the stock may have an uptrend in near future. This analysis is beneficial for a short-term trader who would invest for less than a year.



1(b) Automobile Sector

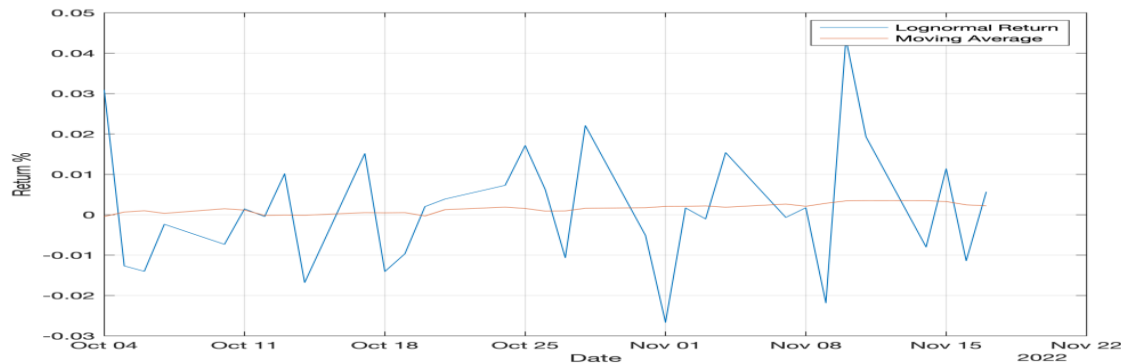
RACE

An elevated level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is flat, we can infer that the price is in par with the moving average, which indicates that the stock may have a static movement in the near future. Ferrari (RACE) builds racing cars which currently operates on premium fuel, a rising shortage of fuel & below development in the universe of electric would impact the sales of RACE which may lead to a static movement in near future & eventually a downward movement may be observed. This analysis is beneficial for a short-term trader who would invest for less than a year.



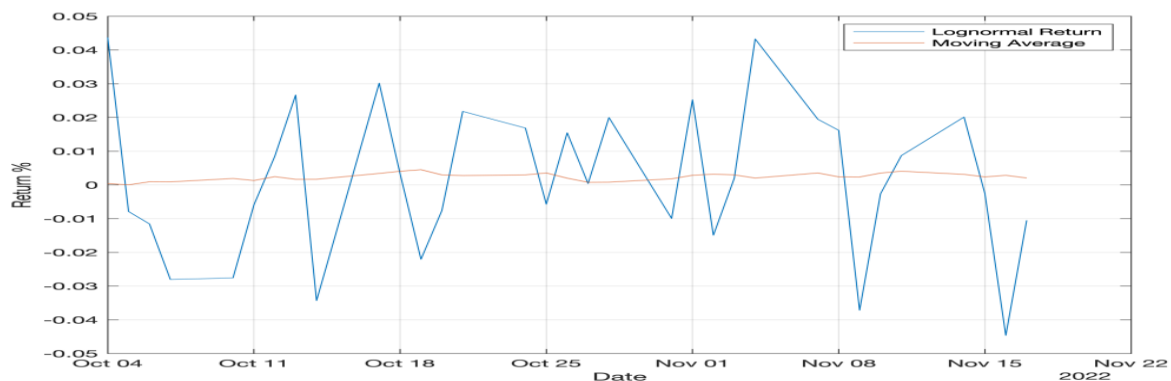
TM

An optimal level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is flat, we can infer that the price is at par with the moving average which indicates that the stock may have a static movement in the near future. This analysis is beneficial for a short-term trader who would invest for less than a year.



TTM

A very conservative level of volatility can be observed in the 30-day moving average with respect to simple returns. Analyzing the exponential returns, where the graph is flat, we can infer that the price is at par with the moving average, but the stock may have an uptrend movement in near future because of an exponential development of technology for electric cars. This analysis is beneficial for a short-term trader who would invest for less than a year.



VWAGY



An upward trend in the 30-day moving average with respect to simple returns can be observed for VWAG. Analyzing the exponential returns, where the graph is upward sloping, we can infer that the price is more than the moving average which indicates that the stock may have an uptrend in near future. VWAG is the biggest automobile manufacturer across the globe. It has had a significant development in technology which could help in performance enhancement of electric cars over the past few years. The positive effects of the innovation can be seen in the stock returns. This analysis is beneficial for a short-term trader who would invest for less than a year.

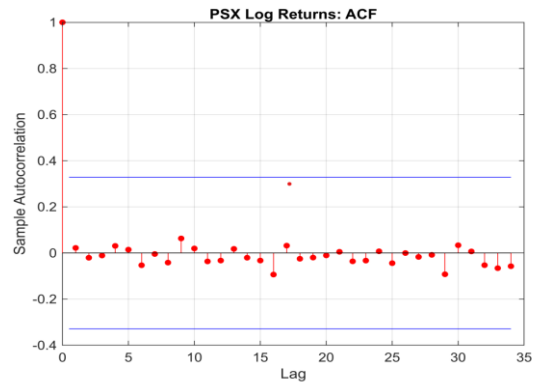
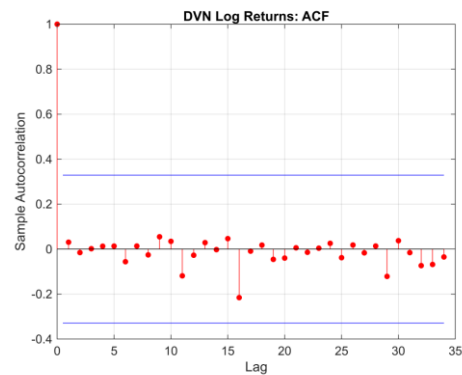
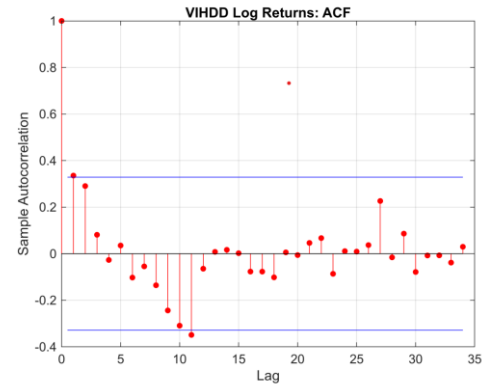
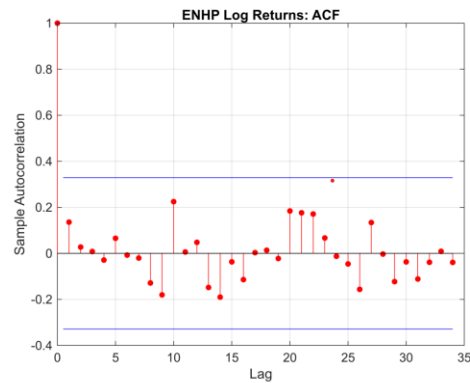


2. Serial Correlation

Serial Correlation is a statistical measure used to describe the correlation between the current value of a variable and a lagged value of the same variable. The study of this is used to predict probable future prices of a stock. In this study, we've used the autocorrelation method which is essentially a measure of the correlation between observations of a time series that are separated by k time units (y_t and y_{t-k}).

2(a) Integrated Energy Sector

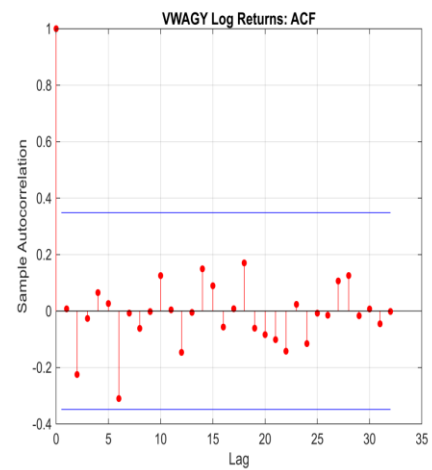
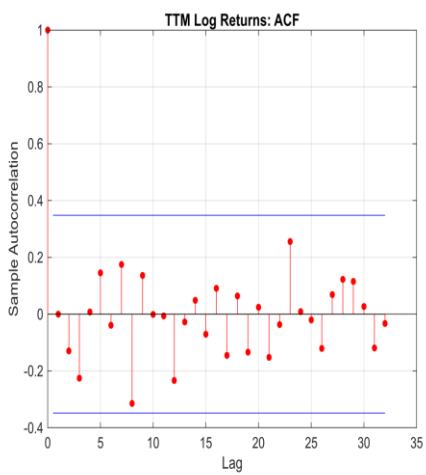
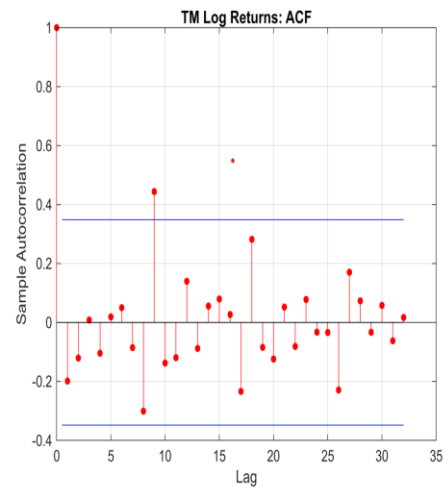
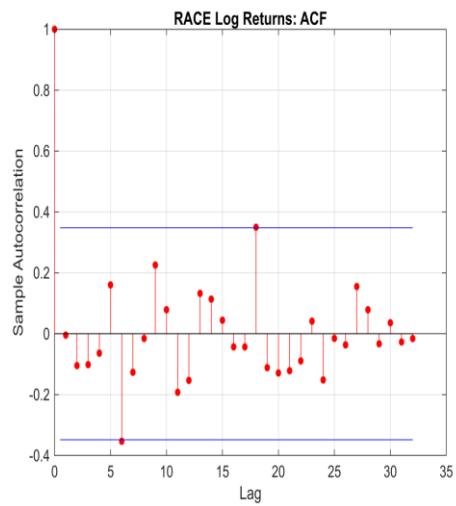
Upon analyzing the plots below, we see that the spikes of ENHP, DVN and PSX at each lag are not extending beyond the significant limits. Hence, this indicates that these values are statistically insignificant and are most likely to be zero. However, the plot of VIHDD has few spikes that are extending beyond the significant limits which indicates that correlation for that lag doesn't equal to zero. The spikes above are closer to 1 whereas the spikes below are closer to -1.



2(b) Automobile Industry

As per the plots below, we notice that all the plots have at least one spike beyond the significant limits all the way up to 1 and few more spikes reaching above or below the significant limit. Comparing these 4 stocks VWAGY and ACF have the least number of spikes extending beyond the significant limits making their values insignificant.





3. Capital Asset Pricing Model

Capital Asset Pricing Model describes the relationship between systematic risk and the expected return of the stock. In our project, we've taken the US 3-month treasury bill rates as our risk-free rate and calculated the Beta, plotted the SML and the co-efficient of determination. The two-dimensional correlation between the beta calculated below and the expected return of the stock is graphically shown through the Security Market Line. The co-efficient of determination measures the goodness of fit of the relationship between the dependent variables and the independent variables in a regression analysis. In this this case, the stocks log normal returns are the dependent variables and the risk-free rate, risk premium are our independent variables. The co-efficient of determination will only lie between 0 and 1. The analysis of the stocks we've picked is as follows.

3(a) Integrated Energy sector

The beta of DVN is 0.9488, ENHP is 0.3922, PSX is 0.5463 and VIHDD is -0.0681. Beta helps us specify the market volatility. In other words, it measures the sensitivity of the stocks to systematic market risk. In this case, we see that VIHDD is the only stock that has a negative Beta which indicates that it is moving in the opposite of the market direction. As for the other stocks, we see that DVN has the highest Beta and hence has the highest risk. Further, looking at the SML of the 4 stocks, we can identify the slope of the market risk premium. Upon analysis, we see that the VIHDD is the only stock with the inverted SML, this is because of the negative Beta and indicates that it has a better return risk return trade off compared to the other stocks. The co-efficient of determination of PSX is the closest to 1 indicating that this model is the best at making future predictions. We also see that the R square of VIHDD is negative. This happens when the returns are doing worse than the mean value of the market return.

3(b) Automobile sector

The Beta of TTM is 0.5468, VWAGY is 0.9231, TM is 0.5094 and RACE is 0.7619. If the Beta of the stock is above 1, the stock is riskier than the market. Comparing the 4 stocks, we can infer that TM has the least risk as opposed to the other stocks whereas VWAGY is the riskiest stock with the highest Beta of 0.9231. As for the SML graph analysis, we see that the VWAGY has the highest risk return trade-off compared to the other stocks we've picked within the automobile sector. Further, looking at the co-efficient of determination we see that RACE has an R squared closest to 1 which indicates that the model is the best at making future predictions as opposed to the other stocks.



Conclusion

The CAPM examines a security's fair value using the tenets of contemporary portfolio theory. It is predicated on unrealistic assumptions about investor behavior, risk and return distributions, and market fundamentals. However, investors who want to make smarter choices about adding securities to a portfolio can benefit from comprehending the fundamental ideas of CAPM and the accompanying efficient frontier.

The analysis performed on the 8 stocks i.e., 4 stocks in integrated energy sector and 4 stocks in the automobile sector is completely independent and should not be used to draw conclusion of the sector. The comparison was drawn amongst the stocks and the results have been discussed with the help of MATLAB. This model can be used to calculate the expected returns with the help of risk-free rate and the systematic risk. However, the link between systemic risk and realized returns is positive, according to empirical research. In addition, risk and return have a linear relationship. Total risk has been determined to be more meaningful and both categories of risk appear to be positively correlated with returns, despite CAPM's attention being focused on market-related risk (systematic risk).

Literature

[https://www.researchgate.net/publication/329072333 Capital Asset Pricing Model CAPM A Case Study](https://www.researchgate.net/publication/329072333_Capital_Asset_Pricing_Model_CAPM_A_Case_Study)

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