Beta Coefficient: *Estimating Non-diversifiable Portfolio Risk*

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Abstract

This note discusses the use of beta coefficient to estimate the non-diversifiable portfolio risk.

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1 Introduction

The Modern Portfolio Theory (MTP) proposed by Markowitz (1952), assumes that investors are risk-averse therefore if they are given a choice between investments with similar returns and different risk profiles, investors will prefer the less risky options. On the other hand, investors may choose a riskier investment if it provides a higher return on investment.

However the exact trade-off between return and risk varies a lot between investors and investments and also changes over time, we can expect that rational investors won't invest in a portfolio if there is an alternative portfolio with the same or lower risk level and a higher return. Therefore high-risk investment will only be attractive to investors if they also offer higher returns in comparison with other lower risk portfolio choices.

A common strategy to reduce portfolio risk is diversification. Portfolio risk is divided in specific risk, associated with individual assets, and systematic risk, which refers to market risk, common to all securities. By holding a combination of assets whose returns are not perfectly positively correlated, it is possible to diminish the exposure to individual asset risk, hence reducing the overall portfolio risk. The systematic risk, on the other hand, cannot be reduced by diversification, thus if a portfolio is more exposed to systematic risk, investors will demand higher returns according to the MTP.

In finance, the beta (β or beta coefficient) of an investment indicates whether the investment is more or less volatile than a benchmark, usually a stock market index is used as a proxy for market behavior. In general, a beta less than one ($\beta>1$) indicates that the investment is less volatile than the market, while a beta more than one ($\beta<1$) indicates that the investment is more volatile than the market. As the market or systematic risk is not reduced by diversification, the value of beta does not measure the risk of an investment held on a stand-alone basis, but the amount of risk the investment adds to an already-diversified portfolio Wikipedia (2016).

Therefore the beta coefficient can be a useful tool to estimate the non-diversifiable risk of individual investments, make decisions about portfolio diversification and evaluate the return on investments.

Beta can be estimated by regression analysis. given the returns of an asset (Ra), returns of the benchmark (Rb) and a time frame, the beta coefficient can be calculated

by the equation below:

$$R_{a,t} = \alpha + \beta R_{b,t} + \varepsilon_t$$

$$R_{a,t} = \frac{AssetPrice_t}{AssetPrice_{t-1}} - 1$$

2 Calculation of beta from Apple's stock: Excel

Using the daily adjusted prices for Apple stocks as the dependent variable and S&P 500 index as independent variable, the value of the coefficient beta was calculated and the results are summarized in Figure 1 and plotted in Figure 2. The data was extracted from the website Yahoo Finance and the time frame utilized was from October 15th, 2014 to October 15th, 2016.

Figure 1: Regression summary of Apple stock's return on S&P 500 returns

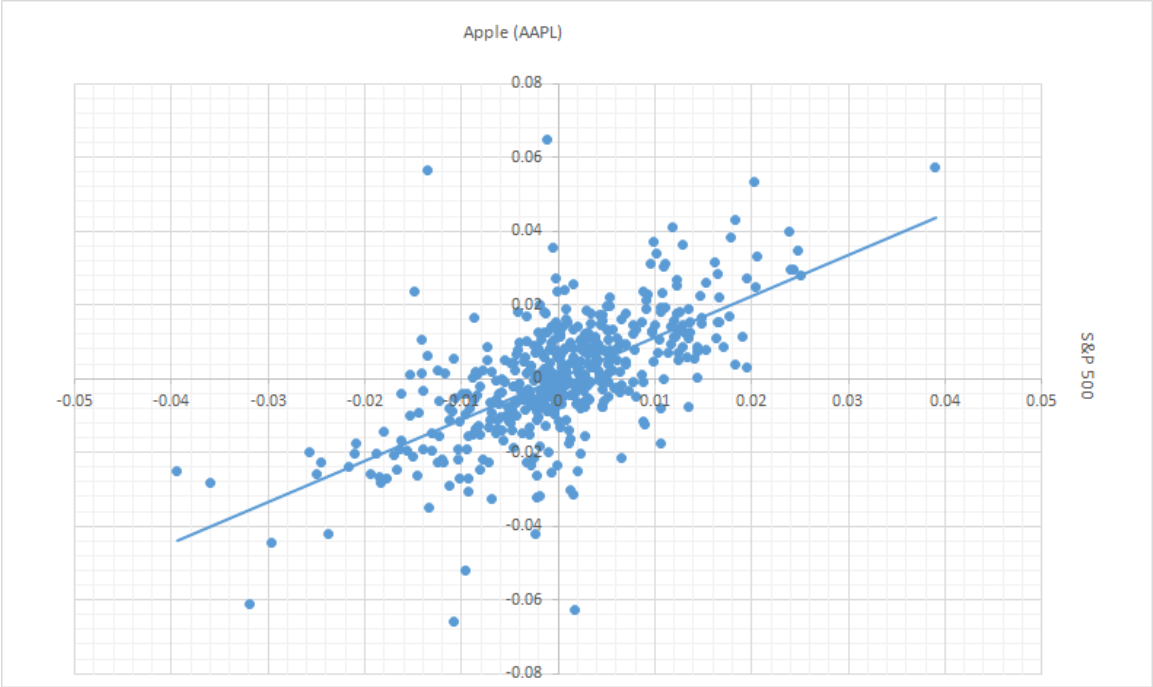
Regression Statistics	
Multiple R	0.640272786
R Square	0.409949241
Adjusted R Square	0.408773841
Standard Error	0.012341969
Observations	504

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.05312676	0.05312676	348.7742633	1.72587E-59
Residual	502	0.076466747	0.000152324		
Total	503	0.129593506			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.000228676	0.000550069	0.415722531	0.6777907	-0.00085205	0.001309398	-0.000852046	0.001309398
Return S&P	1.114762984	0.059691202	18.67549901	1.72587E-59	0.997487629	1.232038339	0.997487629	1.232038339

Figure 2: Apple stock daily returns versus S&P 500 returns



3 Calculation of beta from Apple's stock: Mathematics

Beta coefficient calculation using the software Mathematica presented similar results. The daily Apple stock's prices and S&P 500 index data was automatically provided by the Wolfram Knowledgebase database through the software Mathematica as shown in Figure 3 and 4, the time frame utilized was from October 15th, 2014 to October 15th, 2016.

The algorithm used for the computations in the software Mathematica are described in Algorithm 1. The beta coefficient calculated was $\beta = 1.115468172$ and the alpha coefficient was $\alpha = 0.000305522$.

Figure 3: Apple Stock Prices from Wolfram Knowledgebase database

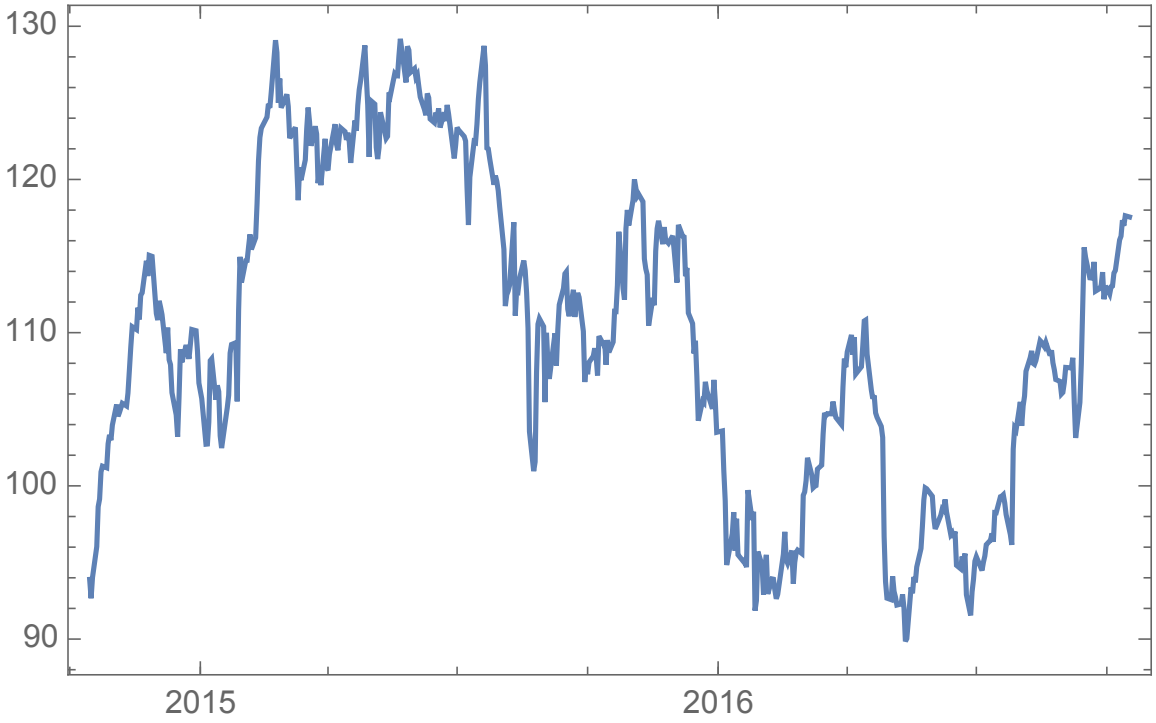
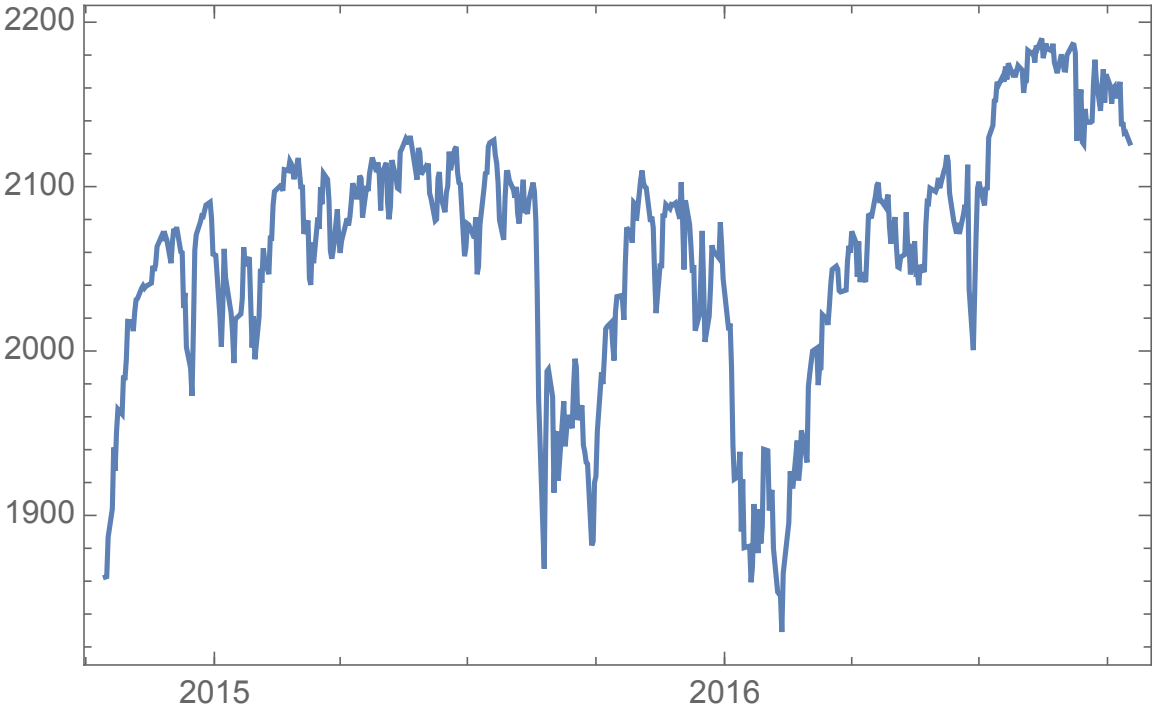


Figure 4: S&P 500 index from Wolfram Knowledgebase



Algorithm 1 Beta and Alpha calculation of Apple stock on the software Mathematica

```
apple = FinancialData["AAPL", "Return", {{2014, 10, 15}, {2016, 10, 15}}];
sp = FinancialData["^GSPC", "Return", {{2014, 10, 15}, {2016, 10, 15}}];
apple1 = Transpose[apple][[2]]; sp1 = Transpose[sp][[2]];
AssetBeta[marketreturns_List, assetreturns_List] :=Coeffi-
cientList[Fit[Transpose[{marketreturns, assetreturns}], {1, x}, x], x][[2]];
AssetAlpha[marketreturns_List, assetreturns_List] :=Coeffi-
cientList[Fit[Transpose[{marketreturns, assetreturns}], {1, x}, x], x][[1]];
beta = AssetBeta[sp1, apple1]
alpha = AssetAlpha[sp1, apple1]
```

Figure 5: Apple stock daily returns versus S&P 500 returns

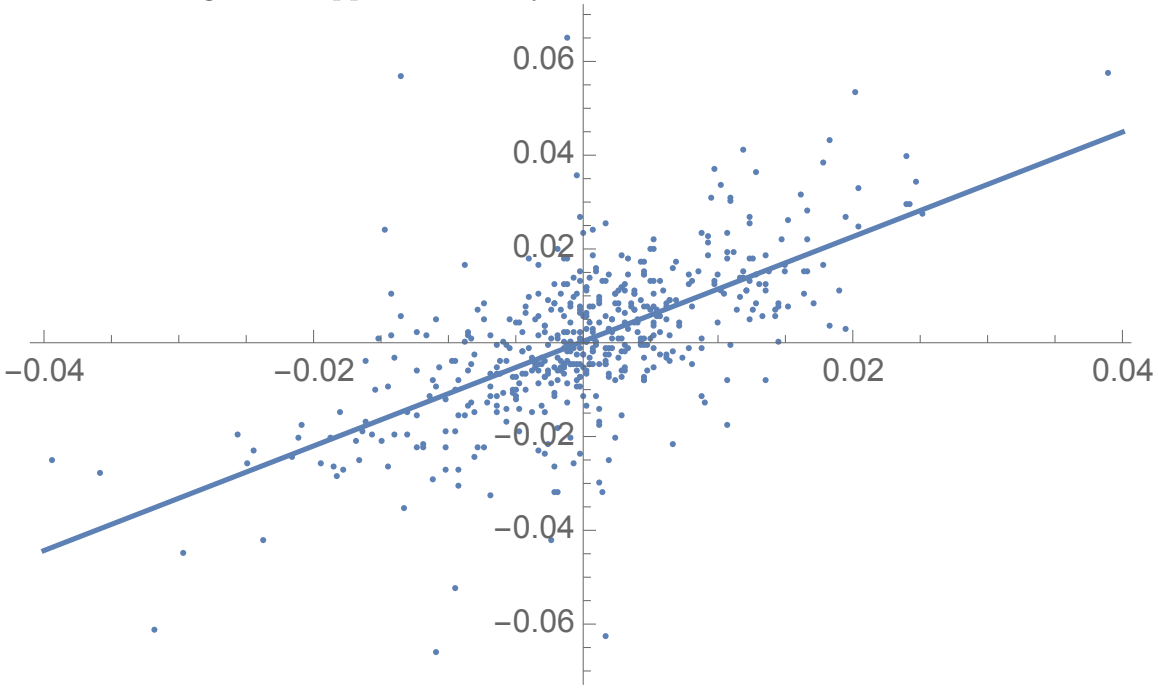


Table 1: Alpha and beta coefficients' comparison

	Alpha	Beta
Yahoo Finance data and Excel	0,000228676	1,114762983
Wolfram Knowledgebase data and Mathematica	0.000305522	1.115468172
Wolfram Alpha	0.0515	1.120

4 Results Comparison

The values for beta and alfa coefficients were obtained in three different ways and displayed in Table 1. The first method was extracting the adjusted stock prices from Yahoo Finance and calculating the coefficients on Excel. The second was using the data from Wolfram Knowledgebase and performing the calculations on Mathematica. The last method was using the calculated information provided by Wolfram Alpha platform.

Although the results were similar, the differences could have been generated by different methods of adjusting the stock prices, or the distinct numeric precision used by the software programs.

References

Markowitz, Harry, "Portfolio selection," *The journal of finance*, 1952, *7* (1), 77–91.

Wikipedia, "Beta (finance) — Wikipedia, The Free Encyclopedia," 2016. [Online; accessed 24-September-2016].