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Investigating Use of Beta Coefficients for Stock Predictions

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Honors Research Paper

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ABSTRACT

By using previous stock market data, investors can get a good sense of how to invest for the future. A common way to determine what stocks are riskier than others is by using the beta coefficient. This paper investigates the relationship between the overall S&P 500 market and certain individual stocks to see if we can use past stock return data to predict the future riskiness of certain stocks. Correlation between the individual stocks and the S&P 500 will allow us to determine the relationship between the two. Finding the beta coefficients for the individual stock market will allow investors to see the sensitivity of a share price to movement in the overall market. When we have a correlation and beta coefficient from the previous year, we will use this information to determine if they are a likely predictor for future prices and their overall trend for the years to come. Knowing the different beta coefficients for multiple stocks will allow investors to diversify their portfolios to allow for maximum profit.

INTRODUCTION

For many years, the stock market has been one of the most influential tools for investors around the globe. Without it, we would virtually not exist as the greatest financial kingpin of the world. It allows for the general public to invest in stocks to perhaps make a quick dollar, for parents to invest in long term stocks to save for their children's college funds or their own retirements, it provides numerous jobs for those who analyze and interact daily with the stock market, and of course it allows for the companies who have stocks for sale to stay in business. These companies would not exist or have become as successful as they have without the money from the stocks they sell.

One of the biggest ways for these companies and investors to determine the future success of these stocks is by looking at their beta coefficients. These beta coefficients are used by comparing the overall market return to the individual stock return of the specific stock. To calculate the beta coefficient, we take the covariance of the market return and the individual stock return and divide it by the variance of the market return. The covariance of the market return and stock returns are showing how one depends on the other.

Of course we know the individual stock return is a part of the market return, so it's not surprising that the covariance will never be zero; therefore, we will always have a covariance and thus a beta coefficient will always exist. Once we divide the covariance by the variance of the market return, it will allow us to see the relationship between the stock return and market return.

$$\beta = \frac{\text{Covariance of Market Return with Stock Return}}{\text{Variance of Market Return}}$$

$$\beta = \begin{matrix}\text{Correlation Coefficient} \\ \text{Between Market and Stock}\end{matrix} \times \frac{\text{Standard Deviation of Stock Returns}}{\text{Standard Deviation of Market Returns}}$$

The beta coefficient can be below one, one, or above one. When the beta coefficient is below one we say it has a lower volatility and when it is above one, we say it has a higher volatility. Volatility is simply the following. It allows us to predict how much a stock price will change in the future compared to the overall stock market. A higher volatility means it is a riskier stock and is more likely to have greater changes, either up or down, in the future. For example, a beta coefficient of 1.2 means that historically, the stock has moved 120% for every 100% that the overall stock market has moved. In another example, if the beta coefficient happens to be 1, this means it will carry the same amount of risk as the overall market when choosing to invest in the particular stock.

When it comes to investing stocks for portfolios, many investors will choose to have a large array of varying beta coefficients. For instance, if one portfolio happened to have all stocks will beta coefficients greater than 1, all of these stocks have a tendency to move at a higher rate with the overall stock market. This could potentially be rewarding, but also traumatic for the portfolio. Think of it as putting all your eggs in one basket. For example, let’s say each beta coefficient for the 5 stocks in our portfolio is 1.3. This means each individual stock will be more volatile than the stock market. Therefore, if the market goes up by 1, we can expect the individual stocks to each increase to 130% of their price from the day before. However, we can see where this can be detrimental. For instance, if the market is having a very bad day and our stocks are roughly 30% more volatile than the market and if there is a decrease in the market, we can expect an even greater decrease in our portfolio. When it comes to deciding how to build a portfolio, investors generally like to have a balanced mix of stocks with different beta coefficients. Having some stocks with betas greater than 1 and some with less than 1 will decrease the chances of large changes in the market greatly affecting the portfolio.

The greatest challenge comes in predicting the future of the beta coefficients. While it is quite easy to calculate beta coefficients based on historical data, it is very difficult to foresee what will happen to the coefficients even one day in advance. In a paper written by Ginny Gegick, she explored the relationship between cointegrated stock pairs and determined if there was persistence in their cointegration relationship. She was able to take a pair of stocks in a given period and determine if they were cointegrated and if the same cointegration would persist in the future. Using this technique, it helps investors to manage their portfolios in the future based on past cointegration relationships. This leads us to using Beta coefficients as another predictor of the stock market to better help investors with their portfolios.

Calculating the Correlation and Beta Coefficients

The data used for these calculations and comparisons are from the S&P 500 Index ranging from January 2010 to December 2013. The stock prices are the historic daily closing prices and are compared from year to year. Looking at four different years (2010, 2011, 2012, and 2013) for two different individual stock prices, the beta coefficients have been calculated according to the formula shown in the previous sections. The Nike stock prices (NKE) and the Best Buy Co. (BBY) daily closing prices are used in comparison to the SPY to calculate the correlation between the market and each individual stock.

Jumping right in to the dirty work, the overall goal of these calculations is to determine if we can use the previous year’s beta coefficient as a general predictor of the next year’s beta coefficient for the Nike stock and the Best buy stock. In order to find the covariance of the market prices and the Nike prices, the COVARIANCE function in excel can perform this task quite easily and efficiently. First, the log return of each daily closing price for the overall market and the Nike prices must be calculated. Looking at the 252 daily closing prices from 2010, we are able to find each daily return by taking the natural log of tomorrow's stock price minus the natural log of today's stock price, or simply taking the natural log of the dividend of tomorrow's price divided by today's price. Once the log return for each day had been calculated, the covariance between the Nike returns and the overall market returns could be found with the covariance function mentioned above. Repeating the same process for years 2011, 2012, and 2013, the covariance could be found for all four years as shown below.

Covariance	2010	2011	2012	2013
SPY and NKE	0.0001191	0.0001979	4.444E-05	4.149E-05
SPY and BBY	0.0001322	0.0001778	6.29E-05	6.738E-05

In order to find the correlation between the SPY and NKE stock returns as well as the SPY and BBY stock returns, the following equation is necessary.

$$\boxed{Correlation = \rho = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y}}$$

where cov (X,Y) = covariance between X and Y

σ_X = standard deviation of X

σ_Y = standard deviation of Y

In our case, the X is the log returns of the market and the Y is the log returns of the Nike stocks for the first case, and in the second case Y is the BBY log returns. Once the standard deviations of both have been found, it is very simple to calculate the correlation between the two for the four separate years. The standard deviations for are listed below:

	Year			
Standard Deviation	2010	2011	2012	2013
SPY	0.0112705	0.0145706	0.0081151	0.0068434
NKE	0.0142347	0.0192671	0.0146668	0.0125826

BBY	0.0208187	0.0236807	0.0311307	0.0275723

Now that we have the standard deviations for each of the stocks in their respective years, they can be used to calculate the correlation between the SPY and NKE log returns, and the SPY and SPY and BBY log returns for each of the four 1-year increments.

	Year			
Correlation	**2010**	**2011**	**2012**	**2013**
SPY and NKE	0.7423012	0.7049301	0.3733864	0.48179
SPY and BBY	0.5634382	0.5152988	0.2489893	0.3571214

Looking at the trends from year to year, we can see each correlation for both stock comparisons are positive for each year. If we are to just look at 2010, we might feel it's reasonable to assume the correlation for 2011 will be around the same value. Since we already know the correlations for 2011, we can see that is exactly the case. The correlations are almost the same for both years. Continuing to use this information to predict the next year, 2012, we can see the correlation for SPY and NKE as well as SPY and BBY experienced sharp decreases in correlations, but they are still positive. In order to determine the volatility of these stocks, we turn to the beta coefficient to further examine the stocks.

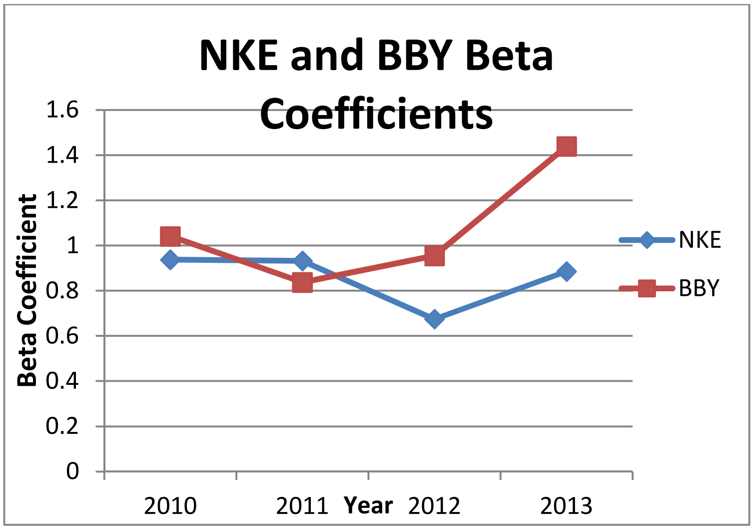
Using the beta formula listed on page 4, we can find the beta coefficients for each stock during their respective years. The results are as follows:

Stock	**Beta for 2010**	**Beta for 2011**	**Beta for 2012**	**Beta for 2013**
NKE	0.937528371	0.932149009	0.67484227	0.885842227
BBY	1.040773038	0.837483521	0.955164875	1.43885665

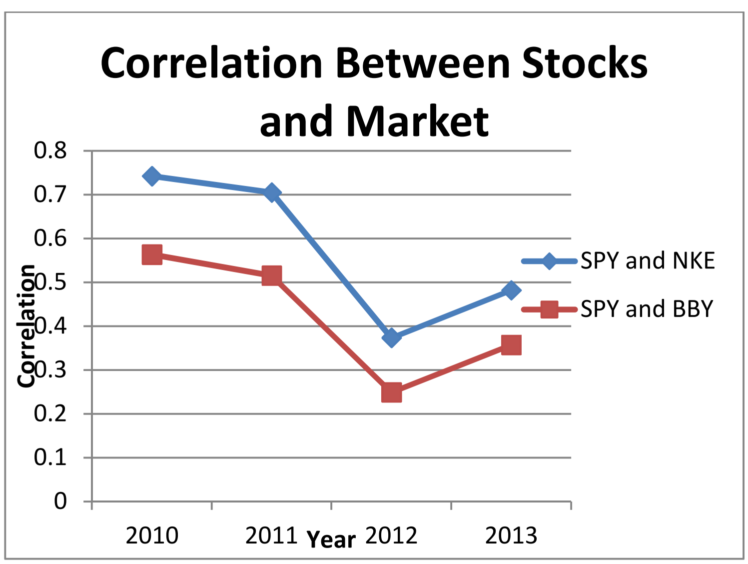
Now that we have found all the calculations necessary, we can use this information to view trends within these stocks compared to the market and determine if knowing the correlation and beta coefficient for a stock from the previous year will help in investing for the future.

Analysis of Correlation and Beta Coefficients

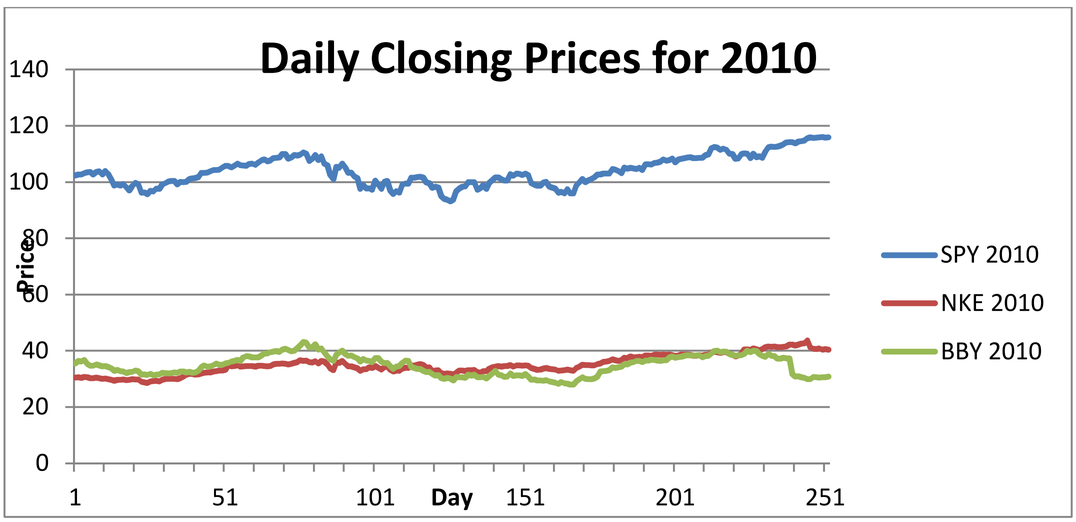
Looking back at the beta coefficients for the Nike and Best Buy stocks, investors can use these to build and diversify their portfolios based on how risky or non-risky they want them to be. Let’s first take a look at the beta coefficients for NKE and BBY stocks.



As mentioned before, having a beta less than 1 signifies the stock is less risky and less volatile compared to the overall market. In 2010, BBY is above 1 while NKE is less than one. Since they are both slightly above and slightly below 1, an investor may look at both of these prices and want to choose both for their portfolio. For the purpose of this paper, let's assume 2010 is the first year for these stocks and we have no previous knowledge of past data. Once the 2010 year has been completed, we may use these betas to predict the beta for the upcoming 2011 year to determine if they are worth investing in or not. Let's also look at the correlation plot.

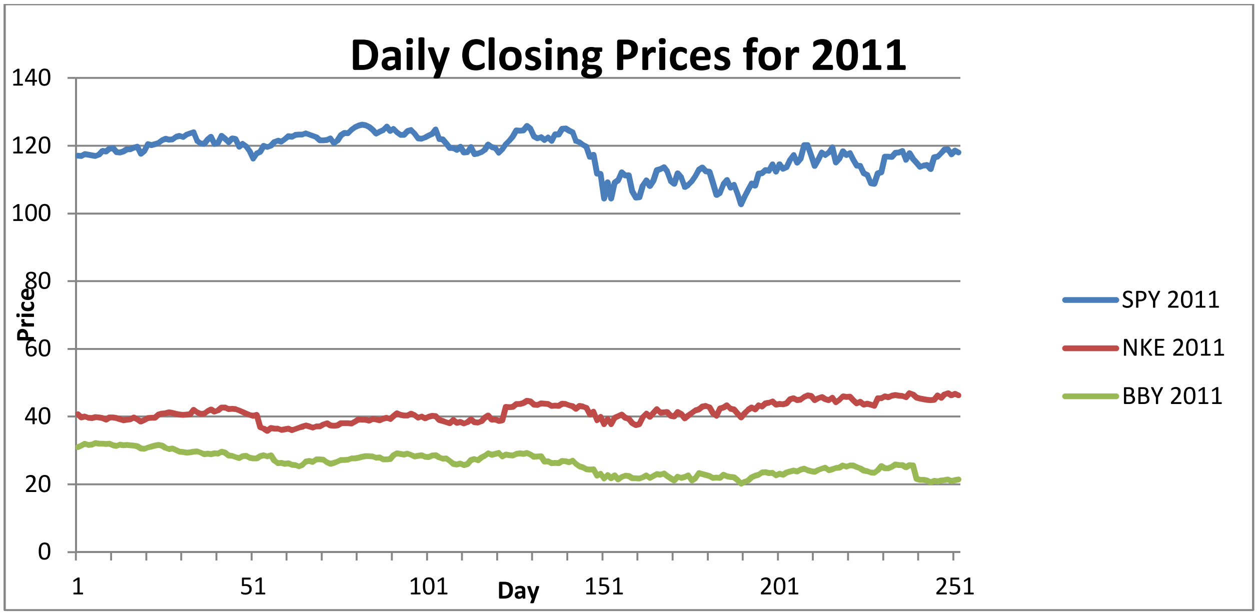


Looking at the graph above, we can see the correlations between SPY and their respective stocks are also closely correlated. This may be helpful when looking at what stocks to invest in as well. We can see the correlation for SPY and NKE for 2010 is 0.742 and SPY and BBY is 0.563. These coefficients are saying they both generally move in the same direction as the overall stock market. Below is the daily closing stock prices for the 3 stocks at hand. As we can see, around day 80 the market began to decrease slightly. Since BBY has a higher beta coefficient than NKE, it makes sense that it is more likely to move at a greater rate than the NKE stock prices. We can view this trend as we notice the BBY prices have more fluctuation than the NKE stock prices.



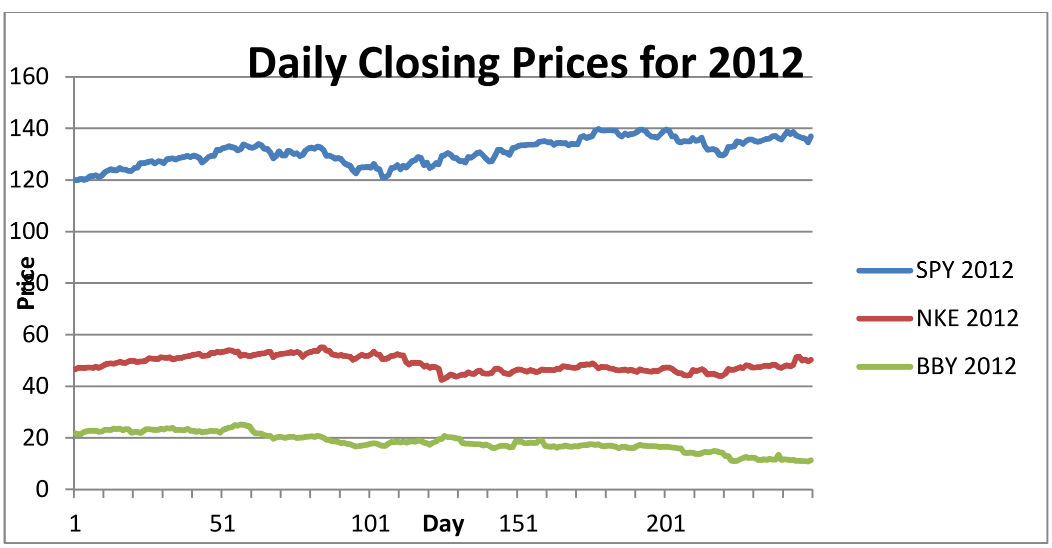
Knowing the beta coefficient of .9375 and the correlation, we can use this data and predict it to be about the same for 2011. Since we have the 2011 data, let's take a look and see how closely the 2011 data is related to the 2010 to see if 2010 is a good predictor for 2011.

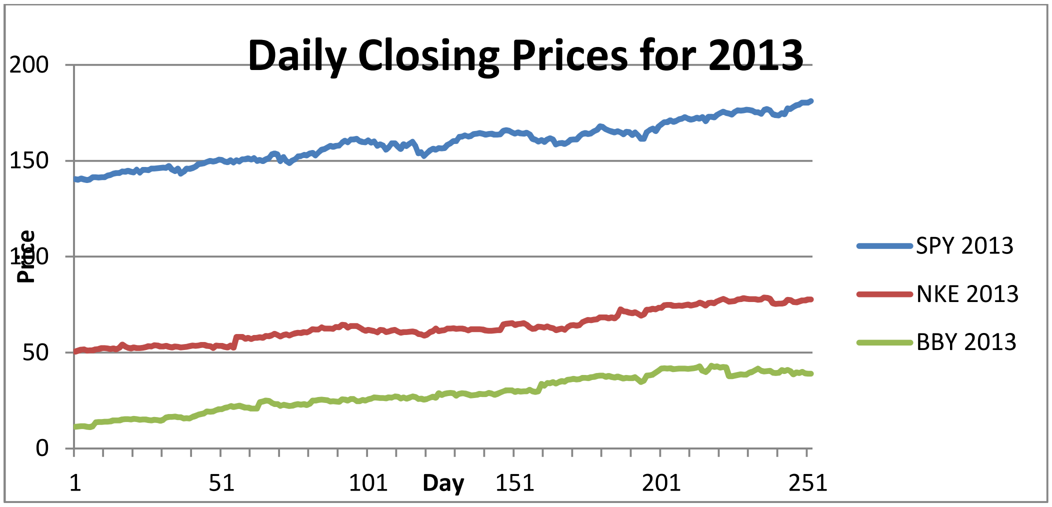
The beta coefficients for both BBY and NKE decreased, meaning they have become less volatile and are less risky investments than the previous year. Since we now have two years of data that are both relatively close to each other, it would be in the best interest to predict the 2012 beta coefficients will stay roughly the same. The correlations for the 2011 log return data both decreased as well. Below is the 2011 daily closing prices for the three stocks.



Now knowing the betas and correlations for the past two years, investors can use this information to predict what the stocks will do in 2012 and even 2013. It's possible to use this data to predict two years in the future but since the stock market is a continually updating database, investors change their portfolios from a day to day basis based on how stocks have done the previous day.

Below are both of the daily closing prices for years 2012 and 2013.





Referring back to the beta coefficients for the two stock prices, there was a big decrease in the

Stock	Beta for 2010	Beta for 2011	Beta for 2012	Beta for 2013
NKE	0.937528371	0.932149009	0.67484227	0.885842227
BBY	1.040773038	0.837483521	0.955164875	1.43885665

beta coefficient for NKE in 2012. This means the stock became increasingly less risky than the year before. Looking at year 2013, we can see the huge increase in the beta for BBY stock. As shown in the graph above, there is a steeper incline in the BBY data than NKE stock prices, suggesting in fact that BBY is more volatile. As the market increases, the BBY stock changes more than the NKE stock which has a lower beta coefficient.

Conclusion

While it is very difficult to accurately predict the future of the stock market, using the beta coefficients can be a great way for investors to diversify their portfolios for future profit. After looking at four years of data, it seems kind of hard to predict how the beta coefficient will move based on previous years. As we saw with the NKE data, It was consistently below one, although had periods of increase and decrease from year to year for 2010-2013. As for the BBY stocks, the beta coefficients were even more spread out. Starting above one and then dipping below one just to return back to a coefficient greater than one shows how versatile the betas can be.

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