



BELL TOWER ASSOCIATES

The Correlation between Individual Equity Performance and Sector
Performance in the Biotechnology Sector of the Stock Market

I. Objective

The objectives of this project were (a) to analyze the extent to which (if any) the returns of stocks in the Nasdaq Biotechnology Index (NBI) are correlated to the return of the index itself, and (b) the extent to which (if any) there is a correlation between the volatility of biotechnology stock returns and the market capitalization or cash holdings of the companies in question.

II. Methodology

a. Data Sources

The current market capitalization, current cash, and individual returns from 2007 to 2013 of each stock in the Nasdaq Biotechnology Index (NBI) were obtained from Bloomberg. The historical prices of the Nasdaq Biotechnology Index (NBI) as a whole and the historical prices of specific studied stocks were obtained from Yahoo Finance.

b. Calculation of Index Returns

The returns for the Nasdaq Biotechnology Index (NBI) as a whole in each year from 2007 to 2013 were calculated via the historical prices of the index on the closing date of each as obtained from Yahoo Finance. The returns were calculated as follows:

$$\text{Return \%} = \frac{\text{Closing Price Year B} - \text{Closing Price Year A}}{\text{Closing Price Year A}} * 100$$

c. Data Processing

- Step 1: The stocks were filtered according to the following criteria: whether they had been part of the Nasdaq Biotechnology Index from 2007 to 2013, thus providing them

with a sample size of six (6) years of returns. Those stocks with a sample size of less than six (6) years of data as part of the index were not analyzed.

- Step 2: The standard deviation of the returns for each stock and for the index as a whole were calculated according to the following formula for the standard deviation of a sample:

$$\sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$$

- Step 3: Correlation tests were run between the standard deviation of the returns for the stocks in the Nasdaq Biotechnology Index (NBI) and (a) the market capitalization of the stocks, and (b) the cash holdings of the stocks. The correlation test was run in Microsoft Excel, which uses the following formula:

$$Correl(X, Y) = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

Where \bar{x} and \bar{y} are the sample means AVERAGE(array1) and AVERAGE(array2).

- Step 4: A third correlation test was run for each stock in the Nasdaq Biotechnology Index (NBI) between the returns of the stocks from 2007 through 2013 and the returns of the index as a whole during that same period. The test was run using the same formula cited in Step 3.

- III.** Step 5: Two more correlation tests were run between the correlation of the stock returns to the index returns and (a) the market capitalization of the stocks and (b) the cash holdings of the stocks. The tests were run using the same formula cited in Step 3.

IV. Findings

a. Standard Deviation

The standard deviation of the returns of each stock in the Nasdaq Biotechnology Index (NBI) from 2007 to 2013 was calculated to measure the volatility of the stocks. The average standard deviation was approximately 78.14 percentage points. The median standard deviation was approx. 56.27 percentage points. These values may be compared to the standard deviation of the index as a whole from 2007-2013, which was approx. 24.58 percentage points. The standard deviation of the average stock was thus approx. 200% higher than the standard deviation of the index as a whole.

b. Standard Deviation and Market Capitalization

The correlation coefficient between the standard deviation of a studied stock's returns and its market capitalization was approx. -0.134, indicating no significant correlation.

c. Standard Deviation and Cash

The correlation coefficient between the standard deviation of a studied stock's returns and its cash holdings was approx. -0.117, indicating no significant correlation.

d. Correlation of Individual Returns to Index Returns

The correlation coefficients between the returns of the individual studied stocks and the returns of the index from 2007-2013 varied widely with a range of 1.521 and a standard deviation of approx. 0.376. Of the sixty-two (62) studied stocks, only eight (8) had correlation coefficients

higher than 0.80, and only two (2) had correlation coefficients higher than 0.90. The average correlation coefficient was 0.496, indicating no statistically significant correlation on average.

e. Relationship between Correlation of Individual Returns to Index Returns and Market Capitalization

The correlation coefficient between the correlations of the returns of the studied stocks to the returns of the index and the market capitalization of the stocks was approx. 0.212. In other words, there was no statistically significant indication that the market capitalization of a stock made its returns more or less likely to be correlated with those of the index from 2007-2013.

a. Relationship between Correlation of Individual Returns to Index Returns and Market Capitalization

The correlation coefficient between the correlations of the returns of the studied stocks to the returns of the index and the cash holdings of the stocks was approx. 0.184. In other words, there was no statistically significant indication that the cash holdings of a stock made its returns more or less likely to be correlated with those of the index from 2007-2013.

V. Conclusions

a. On Volatility and Market Capitalization

In conclusion, there was no statistically significant correlation found between market capitalization and the standard deviation of the returns of the studied stocks. All the studied stocks were generally volatile and had high standard deviation of their returns from 2007-2013.

Furthermore, a biotechnology firm with a larger market cap was no more likely to have stable returns than a small-cap biotechnology firm.

b. On Volatility and Cash

There was also no statically significant correlation found between cash holdings and the standard deviation of the returns of the studied stocks. In other words, the amount of cash held by a biotechnology firm had no discernible effect on the stability of its returns from 2007-2013.

c. On Correlation to the Index.

Only eight (8) stocks out of the sixty-two (62) studied showed high (greater than 0.8) correlation to the returns of the index as a whole. Only two (2) showed a correlation with a coefficient higher than 0.9. This indicates that, in general, the returns of individual biotechnology firms are not correlated with those of the index. Furthermore, neither a high or low market capitalization nor a high or low amount of cash made a stock more or less likely to correlate with the index. Large market cap stocks did not track the index better, nor did small-cap stocks. Neither market capitalization nor cash were indicators of volatility or correlation to the returns of the entire index.

d. Relationship of Returns to Product News: Three Case Studies

Given the conclusion, then, that the biotechnology sector is one in which individual stock performances are not correlated in a statistically significant way to the performance of the sector as a whole, nor one in which the volatility of individual stock returns can be correlated to their size or cash, a research study was run on three of the stocks which had exhibited some of the

most volatile returns during the six-year period examined. These stocks were Dendreon Corporation (DNDN), which experienced a 481 % return in 2009, Arena Pharmaceuticals, Inc. (ARNA), which experienced a 382 % return in 2012, and Vanda Pharmaceuticals, Inc. (VNDA), which experienced a 2,164 % return in 2009.

A study of Dendreon Corporation (DNDN) reveals that much of its massive 2009 return occurred between April 13 and April 14, 2009, when the stock rose in price from \$7.21 per share to \$21.40 per share. This represents a 197 % return, meaning that slightly less than half of Dendreon Corporation's 2009 return of 481% occurred in a single day. Research into the period reveals that on April 14, 2009, Dendreon's drug PROVENGE successfully passed its Phase 3 study. Thus, the stock returns for Dendreon in 2009 were based not on sector performance but on the basis of its drug. The subsequent -78 % return for the stock in 2011 (when the index saw a return of 11%) reflects the poor sales of PROVENGE. Thus, the stock performance, and its volatility, were based on the success or failure of the product in question.

Arena Pharmaceuticals, Inc. (ARNA) appears to have followed the same pattern. Its stock price remained stable in 2012 until May 10-11 of that year, when it rose from \$3.66 per share to \$7.01 per share. This one day thus represents approx. 24 % of Arena Pharmaceutical's entire return for the year 2012. Again, basic research into the period reveals that on May 10, 2012, the company's drug Lorcaserin received a "positive vote from FDA Advisory Committee," according to their own press release for that day. Thus, again, the stock's performance was not reflective of any sector-wide phenomena but the result of approval of its own product.

Finally, the case of Vanda Pharmaceuticals, Inc. (VNDA) suggests a similar pattern. Much of its over 2,000 % return for 2009 occurred in one day, when between May 6 and May 7 of the year the stock price rose from \$1.09 per share to \$9.96 per share. Again, simple research into this date reveals that on May 6, 2009, the company's drug Fanapt was approved by the FDA for the treatment of schizophrenia. Once again, the performance of the stock is heavily aligned to the performance of its products and not to the company's market cap or cash holdings, nor to the performance of the biotechnology index, which returned 15 % in 2009.

e. Final Conclusions

The performance of biotechnology stocks, therefore, is not correlated to market cap, cash holdings, or the performance of the biotechnology index to any statically significant degree. The high standard deviation of their returns reflects the fact that biotech firms rise and fall many times on the basis of performance in drug trials or other test phases of their products. Successful trials result in extreme returns, while failures result in highly negative returns; the propensity of these stocks to remain "steady" rather than fluctuate in price is unrelated to their market cap or to their cash flows. This suggests that a successful biotechnology strategy should not be designed on the basis of one type of biotechnology stock, whether it be small-cap, large-cap, or so forth. Successful returns are driven by successful stock selection and successful targeting of potential or expected returns, and thus research into the firm and, more importantly, into the firm's products and their probability of successful testing, marketing, production, and sales, will provide more meaningful information on potential returns.