Volatility in the NASDAQ 100: An Empirical Analysis

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I. Introduction

Over the last few years, stock market prices have fluctuated at a dangerous rate for many investors and companies. Many have made millions, but just as many have seen their savings dwindle. While most understand that the stock market is more risky than many other investment options, few would have expected this kind of volatility.

These wild price swings have not been limited to unknown penny stocks, making it more noticeable. Stock indices such as the Dow Jones Industrial Average and the NASDAQ Composite are comprised of blue chip, well-established corporations. Normally, people who invest in the stocks of these indices would be considered risk averse. Such investors sacrifice potentially bigger gains in lesser-known companies for the stability blue chip companies provide.

However, many blue chip companies have been just as volatile as a new or an unknown company. Established companies are no longer a safe haven. Volatility is not restricted to particular types of corporations or industries. However, even with this situation, some corporations have experienced much less volatility than others. The question remains as to why. Many have sought to explain this new stock market as a product of increased availability of information or the emergence of technology companies as the focus of the stock market. These may well play a part, but they are very hard to test.

I intend to analyze the reasons behind such uneven changes in the prices of the stocks of different corporations. To do this, I have used some well known statistical methodologies. In this paper, I look at the attributes of the top ten and bottom ten most volatile stocks in the NASDAQ composite and identify whether there exists any

differences among the attributes of these stocks. First, let us look at some existing opinions on the topic of volatility.

II. Survey of Current Literature

With stock market volatility a hot topic, it is not surprising that there are many different theories as to why it exists. I will now briefly discuss some of these ideas. David Dreman, Chairman of Dreman Value Management, has spoken quite a bit on this topic. Dreman says the main cause of volatility is irrational selling by individual investors. As individuals sell at a loss, institutional investors are waiting to snatch up the bargains, causing the markets to go right back up. Dreman points to two key statistics, the number of day traders and portfolio turnover. Dreman said, "That there are six million day traders on NASDAQ leaves the economy very vulnerable." He added, "The turnover on NASDAQ was 100% in 1995, but now it's up to 400%. That means investors are turning over their portfolios every quarter." Dreman believes a company's financial strength, its price in relation to fundamentals, and inflation are things to think about when assessing volatility.

Dreman has a number of supporters for his contention about day traders, even from those with opposite vantage points. Henry Blodget, New Economy analyst for Merrill Lynch, and Jeremy Grantham, Old Economy money manager for Grantham, Mayo, Van Otterloo & Co., both gave their opinions on day-traders impact on volatility. Blodget said, "Day trading has certainly accelerated volatility. It's tremendously short-term investing, the most momentum oriented." Grantham added, "Day trading has obviously exaggerated the problem."

Price in relation to fundamentals is an oft-sited cause of volatility among analysts. Dreman listed it as a cause, and Grantham also sees the ignoring of fundamentals leading to volatility. Grantham said, "Volatility is a symptom that people have no idea of the underlying value – that they have stopped playing the asset game. They're buying because the price is rising." Sam Stovall, Standard & Poor's senior investment strategist says companies with valuations based on the prospect of future earnings are more likely to suffer from volatility. Stovall's claim is supported by my findings as the top six most volatile stocks in my research all had negative earnings. Furthermore, Minneapolis-based Leuthold Research Group reported that 30 percent of the 200 largest NASDAQ companies show losses or have no earnings, and many of the rest are at high price/earnings ratios. This shows that since the fundamentals are not there presently, valuations must be being made on the future, and hence there is volatility. Abby Joseph Cohen, Goldman Sachs investment strategist, takes a different stance on the same topic of fundamentals. Cohen believes the stocks are not overvalued and as a result are near fair value. She said, "There's less of a margin for error. Investors are more easily upset by bad surprises now that stocks are trading closer to their fair value. As a result volatility has stepped up."

Still others claim volatility is simply a sign of impending recession. Economists use volatility as a sign of increasing risk, according to Sy Harding, president of Asset Management Research Corp. Harding points to high volatility leading to market declines of 49 percent in 1938, 45 percent in 1973 and 1974, and 36 percent in 1987. James Paulsen, chief investment officer at Wells Capital Management agrees. "The only other time you have spikes like this is during a recession and crises," he said. Robert S.

Robbins, chief investment officer at Robinson-Humphrey Co., said, "The volatility is best understood as an anxiety over a tug of war between a major positive (strong profits) and a major negative (rising inflation pressures)."

Still others see Internet stocks as a main cause of increased volatility in the NASDAQ. From March 10 to April 14, 2000, the NASDAQ composite plummeted 34%. However, things were even worse for the Goldman Sachs Internet index, which fell 46% over the same period. Then, the NASDAQ went right back up a record 14.2% in two days, only to be beaten by the Internet index which rocketed 16%. This will be supported by my sector analysis. Six of the ten most volatile stocks are Internet stocks.

As we can see, there are a variety of opinions, all of which to varying extents are probably right. My analysis will test some of these popular opinions, primarily the effect fundamentals have on volatility.

III. Empirical Analysis

As the source of my data, I went directly to one of the indices from which one would formerly expect stability. The 100 stocks that make up the NASDAQ Composite were my choice. The NASDAQ 100 contains many of the technology stocks to which people have attributed the cause of stock market volatility. However, the tech-heavy index also has many so-called old economy stocks that serve well as a point of comparison. And even the technology companies are established enough that many have old economy characteristics. Chart A is a table of all the data compiled on the 100 stocks. Chart B shows the 1-year charts for each of the 100 stocks.

From the 100 original stocks, I narrowed the list down to 20 that I would closely analyze. I determined the top ten most volatile stocks and top ten least volatile stocks in

the NASDAQ 100 from the period January 26, 2000 to January 26, 2001. The measure I used for volatility was percentage change from a stock's 52-week high to its 52-week low. I chose this measure because it best reflects the potential loss by investing in volatile stocks.

VOLATILITY CHART

10 Most Volatile

Symbol	Company	% Volatility
CMGI	CMGI	97.6%
INKT	Inktomi	95.5%
RNWK	RealNetworks	94.5%
BVSN	BroadVision	90.8%
ATHM	At Home	90.5%
CNXT	Conexant	90.4%
NOVL	Novell	89.3%
CTXS	Citrix	88.3%
YHOO	Yahoo!	88.2%
PALM	Palm	87.9%

10 Least Volatile

Symbol	Company	% Volatility
PCAR	PACCAR	33.6%
AMGN	Amgen	37.8%
USAI	USA Networks	43.6%
MOLX	Molex	46.3%
LLTC	Linear Tech	46.8%
CMCSK	Comcast	48.2%
CMVT	Comverse Tech	50.3%
TLAB	Tellabs	51.0%
FLEX	Flextronics	52.3%
CHIR	Chiron	53.4%

I chose the ten most and ten least volatile to see if there were structural attributes that made a stock more or less volatile. Having determined the 20 stocks, I then researched common data readily available on each stock. I came up with seven sets of independent variables that may have influences on the price of the stocks. First, I recorded the earnings per share (EPS), revenue, average daily volume (Volume), and average daily volume per shares outstanding (Volume/Shares). I chose these measures because they are amongst the fundamentals people look at (or haven't been looking at) when they buy or sell a stock. I left out some other common measures of a stock's worth, including P/E ratio, yield, and dividend, because they were not material for many of the stocks. In other words, the value was non-existent.

I then determined where the stocks ranked out of the 100 in earnings per share (EPS rank), revenue (Revenue rank), and volume per shares outstanding (Volume/Shares rank) to get the total seven variables. I compiled one non-empirical set of data, the sector each stocks is in. With this data, I conducted the statistical analysis. Chart C is a table of all the values of the independent variables and a list of the sector each stock is in.

I performed different statistical tests to determine whether these independent variables contributed to a stock's volatility. The analysis was descriptive and inferential.

The descriptive data provides a general overview of the data, giving information such as the correlation coefficient, mean, and standard deviation. In the inferential analysis, I conducted different types of tests to identify the contributions of these variables. The simple regression tested each independent variable individually against volatility, while the multiple regression looked at all seven variables together. Forward selection and maximum r-square improvement are stepwise tests that locate the most significant independent variable first and then adds remaining variables until the best equation is created. The Chow test checks whether the most volatile and least volatile stocks have structural differences. The dummy variable tests checked for structural differences in each individual independent variable.

Having explained the background of the experiment, I will now go through the results.

Descriptive Statistical Analysis

The Statistics chart below provides the mean, standard deviation, and correlation coefficient between volatility and each independent variable. While these statistics do

not necessarily tell us any conclusive data, they provide a good idea of where the data may lead us.

STATISTICS CHART

10 Most Volatile

Variable	Mean	St. Dev.	Correlation
EPS	-2.77	6.01	-0.17
EPS rank	74.50	17.63	0.57
Volume	8329168	4481663	-0.17
Volume/Shares	0.03	0.02	0.47
Volume/Shares rank	32.70	24.49	-0.33
Revenue	-999648025	2399995698	-0.12
Revenue rank	72.20	20.74	0.58

10 Least Volatile

Variable	Mean	St. Dev.	Correlation
EPS	1.63	2.02	-0.63
EPS rank	26.40	19.70	0.14
Volume	4621090	3337172	0.18
Volume/Shares	0.01	0.01	0.58
Volume/Shares rank	74.40	22.55	-0.61
Revenue	450501381	393756293	-0.29
Revenue rank	28.20	20.50	0.14

Looking at these statistics, one can see these independent variables are quite different between the two data sets. The mean earnings per share is much higher for the less volatile stocks. On average, the least volatile stocks rank just outside the top quartile of the NASDAQ 100 in this category. Meanwhile, the most volatile barely escaped the ranks of the bottom quartile.

As for average daily volume and volume per shares outstanding, the results flip-flop. Almost twice as many shares of the most volatile NASDAQ stocks are traded daily

as opposed to the least volatile stocks. The least volatile stocks rank just outside the bottom quartile in average volume per shares traded.

As one might expect after seeing the earnings per share results, the least volatile stocks again hold a large advantage. While the most volatile stocks are mired in negative territory, the least volatile companies enjoyed average revenues of over $450 million. Again the two different sets of stocks teeter on opposite ends of the quartile ranking spectrum.

Finally, the correlation coefficients relating the independent variables to volatility is not particularly high for any of them. Therefore, it would not be surprising if some of the variables and volatility did not have linear trends when the simple regression is run. However, correlation data alone is not enough to rule out linear trend so other statistical tests must be conducted.

Simple Regression

The chart below on simple regression gives of the t-test values and associated probability that the independent variable is causing volatility. The data is presented for each of the seven variables and both data sets. The model estimated here is $Y_t=B_0+B_1x_t+e$. Volatility equals Y_t, the independent variables are plugged into x_t and e is the error term.

SIMPLE REGRESSION CHART

10 Most Volatile

Variable	t-Value	Probability	R-squared	F Value
EPS	-0.49	0.638	0.029	0.24
EPS rank	1.97	0.084	0.328	3.90

Volume	-0.48	0.643	0.028	0.23
Volume/Shares	1.50	0.173	0.219	2.24
Volume/Shares rank	-1.00	0.348	0.110	0.99
Revenue	-0.33	0.748	0.014	0.11
Revenue rank	1.99	0.082	0.331	3.96

10 Least Volatile

Variable	t-Value	Probability	R-squared	F Value
EPS	-2.27	0.053	0.393	5.17
EPS rank	0.40	0.702	0.019	0.16
Volume	0.51	0.624	0.032	0.26
Volume/Shares	2.02	0.078	0.337	4.07
Volume/Shares rank	-2.19	0.060	0.375	4.79
Revenue	-0.85	0.420	0.083	0.72
Revenue rank	0.41	0.689	0.021	0.17

The t-tests show us that none of the independent variables cause volatility at a 95 percent confidence interval. This shows us that in the individual data sets, none of these variables is a direct cause of volatility or lack of volatility in a stock price at a five percent level.

At a 90 percent confidence interval, earnings per share rank and revenue rank have a relationship with volatility in the most volatile stocks. However, this is not the case with the least volatile stocks. At a 90 percent confidence interval, earnings per share, average volume per shares outstanding, and volume per shares rank can be said to be a cause of volatility. Therefore, we see that at a 10 percent level some of the independent variables are significant.

Multiple Regression

The next test is a multiple regression analysis. The multiple regression chart below gives of the t-test values and associated probability that the independent variable is

causing volatility. The data is presented for each of the seven variables and the two data sets. All of the independent variable data was combined, and the regression was run for each set. The model estimated here is $Y_t=B_o+B_1x_1+B_2x_2+\ldots+B_7x_7+e$. Once again, volatility equals Y_t, the independent variables are plugged into x and e is the error term.

MULTIPLE REGRESSION CHART

10 Most Volatile

Variable	t-Value	Probability
EPS	-1.09	0.389
EPS rank	0.29	0.797
Volume	-0.74	0.537
Volume/Shares	0.86	0.482
Volume/Shares rank	-0.08	0.942
Revenue	1.10	0.388
Revenue rank	-.031	0.784

R-squared	0.808
F Value	1.20

10 Least Volatile

Variable	t-Value	Probability
EPS	-2.09	0.171
EPS rank	-0.82	0.496
Volume	0.62	0.601
Volume/Shares	1.25	0.337
Volume/Shares rank	1.11	0.384
Revenue	-0.77	0.552
Revenue rank	0.61	0.603

R-squared	0.847
F Value	1.58

In the multiple regression, none of the independent variables cause volatility. In this situation, none of the independent variables was a significant cause even at the 90 percent level.

Forward Selection

Since some of the independent variables are significant in causing volatility as shown in the simple regression, it would still be good to know which variable is has the most effect. Stepwise regression helps us to learn that. The first of our stepwise regression methods conducted was forward selection. Forward selection starts with the best independent variable and then adds variables to the equation until the equation would become worse by adding another. Forward selection produced the following results on the two sets of data. The chart gives the F values and associated probabilities. All seven independent variables were used.

FORWARD SELECTION CHART

10 Most Volatile

Variable	F Value	Probability
1. Revenue rank	3.96	0.082
2. Volume/Shares	4.06	0.084

10 Least Volatile

Variable	F Value	Probability
1. EPS	5.17	0.053
2. Volume/Shares	4.31	0.077

Given the results of the simple and multiple regressions, it is not surprising that the forward selection was unable to produce a result significant at a 95 percent confidence interval. However, three variables came up significant at a 90 percent interval. Volume per shares was most notable as it came up as the second variable added in both data sets. However, the first independent variable differed between the most volatile and least volatile. Revenue rank was the most causal variable in the forward

selection for the most volatile stocks while earnings per share was tops in the least volatile.

Maximum R-Square Improvement

Maximum R-Square Improvement first finds the one-variable equation with the highest r-squared value. It then finds the highest r-squared value for a two-variable equation and continues so on until it gets to, in this case, a seven-variable equation. Below is a chart of the Maximum R-Square Improvement stepwise regression. The chart shows the stepwise results, r-squared values and F values and probabilities

MAXIMUM R-SQUARED IMPROVEMENT

10 Most Volatile

One-Variable	R-Squared	F Value	Probability
Revenue Rank	0.331	3.96	0.0817
Two-Variable	R-Squared	F Value	Probability
EPS rank	0.587	6.23	0.041
Volume/Shares		4.39	0.075
Three-Variable	R-Squared	F Value	Probability
EPS	0.661	6.46	0.044
Volume/Shares		3.35	0.117
Revenue		5.94	0.051
Four-Variable	R-Squared	F Value	Probability
EPS	0.796	10.13	0.025
Volume		3.33	0.128
Volume/Shares		6.46	0.052
Revenue		9.46	0.028

10 Least Volatile

One-Variable	R-Squared	F Value	Probability
EPS	0.393	5.17	0.053
Two-Variable	R-Squared	F Value	Probability
EPS	0.6240	5.34	0.054
Volume/Shares		4.31	0.077
Three-Variable	R-Squared	F Value	Probability
EPS	0.709	7.54	0.034
Volume		1.76	0.233
Volume/Shares		6.44	0.044

The maximum r-squared test gives us another way to rank the variables by significance. The test confirms the results of the forward selection test in the one-variable and two-variable equations. Beyond forward selection, it gives shows us which additional independent variable is most important all the way up to the seven-variable equation. The four-variable equation had the most significant variables for the most volatile stocks. Earnings per share and revenue were significant at a five percent level. Volume per shares was significant at ten percent. Meanwhile, for the least volatile, the two-variable model had the most significant factors. EPS and volume per shares were both significant at ten percent.

Chow Test

Even though we can conclude from these results that some of the independent variables are directly related to volatility in stocks, there are still other things for which we can test. The Chow test and dummy variable test check for structural differences

between the two sets of stocks. A significant F-value in the Chow test would allow us to conclude that the different sets of empirical data are the result of structural differences in the stocks that make up the two data sets.

The Chow test chart below shows the F values. The data is presented for each of the seven variables and the multiple regression. The Chow test is conducted by using sum of squares error information.

CHOW TEST CHART

Variable	F Value
EPS	20.234
EPS rank	6.017
Volume	15.141
Volume/Shares	15.322
Volume/Shares rank	11.818
Revenue	16.195
Revenue rank	7.730
Multiple Regression	18.749

The critical value for the F Statistic $F_{.025}$ is 5.12, and the critical value for the F Statistic $F_{.01}$ is 7.19. Therefore, for a 95 percent confidence interval, all seven independent variable show significant structural differences. Furthermore, all except EPS rank show structural differences at a 98 percent level. The Chow test shows us that there are significant differences in each of the independent variables between the most volatile and least volatile stocks.

Dummy Variable

The chart below for the dummy variable test gives the t-test values and associated probability that the individual independent variables are structurally different between the two data sets. The data is presented for each of the seven variables with all 20 stocks

analyzed at once. The model estimated is $Y_t=B_o+B_1x_1+B_2x_2+\ldots+B_7x_7+d+e$. Y is equal to volatility and x is equal to the independent variables. D is equal to 1 for the most volatile stocks and 0 for the least.

DUMMY VARIABLE CHART

Variable	t-Value	Probability	R-squared	F Value
EPS	0.49	0.6317	0.838	8.87
EPS rank	5.26	0.0002	0.950	32.53
Volume	3.23	0.0073	0.912	17.65
Volume Shares	3.67	0.0032	0.922	20.27
Volume Shares rank	4.97	0.0003	0.946	29.99
Revenue	0.33	0.7478	0.836	8.75
Revenue rank	4.19	0.0013	0.933	23.83

The dummy variable test confirmed most of the results of the Chow test. All of the independent variables came up significant at a 98 percent confidence interval, except for EPS and revenue. However, the F values are significant for those two factors. From this test we see that there are structural differences between the two sets of stocks.

Sector Analysis

Below is a breakdown of the sectors of the 20 stocks analyzed.

SECTOR CHART

10 Most Volatile

Symbol	Company	Sector
CMGI	CMGI	Internet
INKT	Inktomi	Internet Software
RNWK	RealNetworks	Internet Software
BVSN	BroadVision	Internet Software
ATHM	At Home	Internet
CNXT	Conexant	Electronic Components

NOVL	Novell	Computer Networks
CTXS	Citrix	Software
YHOO	Yahoo!	Internet
PALM	Palm	Computers

10 Least Volatile

Symbol	Company	Sector
PCAR	PACCAR	Trucking
AMGN	Amgen	Bio-Med
USAI	USA Networks	Media
MOLX	Molex	Electronic Components
LLTC	Linear Tech	Electronic Components
CMCSK	Comcast	Cable
CMVT	Comverse Tech	Telecommunications Equipment
TLAB	Tellabs	Telecommunications Equipment
FLEX	Flextronics	Miscellaneous Electronics
CHIR	Chiron	Bio-Med

As one can see, there exist some glaring differences between the most and least volatile stocks as far as sectors are concerned. Nine out of ten of the most volatile stocks are mainly focused in the computer industry while computers are not the main focus for any of the least volatile. Although there is no empirical data to analyze sectors, in this case, strong ties to the computer industry seems to lead to high volatility.

Another thing one can take by looking at the sectors is that, with this group, the notion of technology companies being more volatile is shown to be untrue. With the exception of PACCAR from the trucking industry, the other nine stocks in the least volatile category are all technology companies.

Conclusions

The implications of volatility on the economy can be very painful. During the upswings, people become complacent and feel entitled to large returns on stocks. When these gains are just as quickly negated, the people who got in late can be hurt badly. We

see the result of volatility in lay-offs and shut-downs of struggling companies. Knowing where volatility exists can be helpful in off-setting how drastic its effects are.

To summarize the findings, the most important observation is that significant differences exist in the earnings per share, volume traded, and revenues of the most volatile and the least volatile stocks. As a result of these differences, one may be able to predict which stocks may be more volatile or less volatile by looking at the earnings per share, volume traded, and revenue. Someone looking for less risk, and consequently a less volatile blue chip stock should look for a stock with high earnings per share, low trading volume, and high revenues. Someone hoping to get in at the right time with a risky, volatile blue chip should seek a company with negative earnings, high trading volume, and negative revenues. Obviously, there needs to be an outlook for profitability in the near future as well. This contention was supported by the Chow test as well as the dummy variable test.

Also, the empirical analysis showed that some of the independent variables contribute to volatility. This was supported by the simple but not the multiple regression. The stepwise analysis showed earnings per share to being the most causal factor for the least volatile stocks and revenue rank to be best for the most volatile. Volume per shares outstanding showed up as being second most important variable in each data set.

In conclusion, more study may be in order with a bigger or different data set to see if the structural differences are indeed cause of volatility. The mixed results on this are intriguing.

Resources

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