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By

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Abstract

This MQP analyzed the performance of Process Improvement/Supply Chain Management firms in the face of market risk using a regression model to find significance. Research was also conducted on the volatility of Electrical and Energy stocks, the factors involved in their volatility, and the uses of Electrical Engineering in the stock market. The first idea is to see if firms that focus on Process Improvement and Supply Chain efficiency can minimize the normal market volatility of their individual firm. Empirical analysis was conducted that negated this claim. The study also determined that Electrical and Energy firms could not beat normal market volatility. This paper includes an analysis on models used in Electrical Engineering that can predict the price of electricity. This study has provided valuable knowledge that will help the participant in the MQP and other like-minded individuals integrate the two disciplines of interest.
# Table of Contents

ABSTRACT .............................................................................................................................. 2

TABLE OF CONTENTS ........................................................................................................... 3

LIST OF FIGURES .................................................................................................................. 5

LIST OF TABLES ..................................................................................................................... 6

1. INTRODUCTION .................................................................................................................. 7
   1.1 PROCESS, PLAN, GOALS, IMPORTANCE ................................................................. 7
   1.2 SUMMARY OF FINDINGS ........................................................................................... 8

2. BACKGROUND DISCUSSION ............................................................................................... 9
   2.1 THE CBOE VOLATILITY INDEX (VIX) ........................................................................ 9
   2.1.1 Volatility .................................................................................................................. 9
   2.1.2 The VIX Index ......................................................................................................... 10
   2.1.3 Calculating the VIX ............................................................................................... 10
   2.1.4 Interpreting the VIX .............................................................................................. 11
   2.2 PROCESS IMPROVEMENT/LEAN SIX SIGMA ........................................................... 12
   2.2.1 Process Improvement ............................................................................................ 12
   2.2.2 Eliminating Waste with Lean ............................................................................... 13
   2.2.3 Six Sigma Strategies ............................................................................................ 15
   2.3 SUPPLY CHAIN MANAGEMENT-FOUR ELEMENTS .............................................. 16
      2.3.1 Industry Framework ............................................................................................ 16
      2.3.2 Unique Value Proposal ...................................................................................... 16
      2.3.3 Managerial Focus ............................................................................................... 17
   2.4 PROCESS IMPROVEMENT/SUPPLY CHAIN COMPANIES ..................................... 18
      2.4.1 Apple .................................................................................................................. 18
      2.4.2 Amazon ............................................................................................................... 18
      2.4.3 Facebook ............................................................................................................. 18
      2.4.4 Google ............................................................................................................... 19
      2.4.5 IBM .................................................................................................................... 19
      2.4.6 TJX ..................................................................................................................... 19
      2.4.7 Walmart .............................................................................................................. 19
   2.5 ELECTRICAL ENGINEERING AND ENERGY STOCKS ........................................... 20
      2.5.1 Chevron Corp ..................................................................................................... 20
      2.5.2 Conoco Phillips .................................................................................................. 20
      2.5.3 Emcor .................................................................................................................. 20
      2.5.4 Exxon Mobil ....................................................................................................... 20
      2.5.5 Quanta Services .................................................................................................. 21

3. DATA/ANALYSIS .................................................................................................................. 22
   3.1 DATA GATHERING/EMPirical ANALYSIS ................................................................. 22
      3.1.1 Data Gathering...................................................................................................... 22
      3.1.2 Empirical Analysis .............................................................................................. 22
   3.2 REGRESSION ANALYSIS ............................................................................................. 24
      3.2.1 Process Improvement/Supply Chain Companies Stock Regression vs VIX ........ 24
LIST OF FIGURES

Figure 1.1 Summary of Methodology ............................................................................. 8
Figure 2.1 Derivative and Calculation of VIX (CBOE).....................................................10
Figure 2.2 Dow Jones Correlation with the VIX (Index Indicators) ...............................11
Figure 2.3 Process Improvement Implementation Steps .................................................12
Figure 2.4 Diagrams of Six Sigma Strategies ................................................................15
Figure 3.1 Apple Performance vs VIX ...........................................................................25
Figure 3.2 Amazon Performance vs VIX ......................................................................26
Figure 3.3 Facebook Performance vs VIX ....................................................................27
Figure 3.4 Google Performance vs VIX ..........................................................................28
Figure 3.5 IBM Performance vs VIX .............................................................................29
Figure 3.6 TJX Performance vs VIX ...............................................................................30
Figure 3.7 Walmart Performance vs VIX ......................................................................31
Figure 3.8 Chevron Performance vs VIX .......................................................................32
Figure 3.9 Conoco Phillips Performance vs VIX .............................................................33
Figure 3.10 EMCOR Performance vs VIX .................................................................34
Figure 3.11 Exxon Mobil Performance vs VIX ..............................................................35
Figure 3.12 Quanta Services Performance vs VIX .........................................................36
Figure 4.1 Flowchart of Hybrid-Model Steps .................................................................41
Figure 4.2 Hybrid Model Forecasted Results Compared to Actual Price ....................42
LIST OF TABLES
Table 3.1 Apple Regression Analysis.................................................................25
Table 3.2 Amazon Regression Analysis............................................................26
Table 3.3 Facebook Regression Analysis.........................................................27
Table 3.4 Google Regression Analysis..............................................................28
Table 3.5 IBM Regression Analysis................................................................29
Table 3.6 TJX Regression Analysis..................................................................30
Table 3.7 Walmart Regression Analysis............................................................31
Table 3.8 Chevron Regression Analysis.............................................................32
Table 3.9 Conoco Phillips Regression Analysis..................................................33
Table 3.10 EMCOR Phillips Regression Analysis..............................................34
Table 3.11 Exxon Mobil Regression Analysis...................................................35
Table 3.12 Quanta Services Regression Analysis.............................................36
Table 4.1 Hybrid Model Error Compared to Standard Method..........................41
1. Introduction

1.1 Process, Goals, Importance

Major companies have shown that Process Improvement and Supply Chain Management (PI/SCM) save them millions in their spending and cut down on costs. IBM has even created a financial model to show the ROI on process improvement (IBM). These savings lead to my hypothesis as to if PI/SCM could beat the volatility in the market. Therefore, a goal of this MQP is to establish a relationship between PI/SCM and the volatility of the market. To establish this relationship, I researched companies with the best PI/SCM practices. I took these companies and obtained each one’s stock price level over the past 5 years. I needed a standard for volatility to compare these prices to, for this I chose the VIX market indicator. Now I can do regression analysis with each individual firm vs the VIX to see if there is a strong relationship. Next, I can analyze the results of my regression and make a conclusion. Furthermore, in this MQP I investigate how I can integrate my two fields of study, Management Engineering and Electrical Engineering. First, I will establish a relationship between Electrical and Energy stocks with the volatility of the market. I will also find practical uses of concepts from the Electrical Engineering field that help in the Management field. Specifically, hybrid modeling that helps predict the price of electricity. This MQP will give background discussion on the terminology above, investigate the hypothesis, go through the data step by step, explain the results and form conclusions. This MQP will accomplish my goal of investigating the hypothesis but also give me the tools and experience needed to find relationships between important variables in the future. Furthermore, it will help in integrate my two
areas of study, helping me and others bridge the gap between the two field in the professional workforce.

1.2 Summary of Findings

The summary of the Findings is first that there are no Process Improvement/Supply Chain Management companies or Electrical Engineering and Energy stocks that beat the normal volatility of the stock market. Each regression showed a significant correlation between the VIX and the individual company. Figure 1.2 is the steps taken and a summary of the methodology used to make conclusions.

Figure 1.2 Summary of Methodology
2. Background Discussion

This chapter will give background discussion on several important concepts discussed in the project. First it will give an explanation on the VIX. What the VIX is, why it is used, and how it is used. Next the chapter will discuss several key Process Improvement and Supply Chain concepts such as Six Sigma, Unique Value Proposition, and Managerial Focus. It is important to understand these concepts to see how they can make an impact on the bottom line of a company, therefore affecting the stock of the respective company.

2.1 The CBOE Volatility Index (VIX)

2.1.1 Volatility

Volatility in the market measure magnitude of change in price movements that a financial tool (stocks in this report) is experience over a certain period of. This can be both up and down movements. The larger the movement of price, the greater the volatility of that stock. Generally, in stocks the higher the volatility the greater the risk, and on occasion the reward. Some common measures of basic volatility to a stock is a stock’s beta. The beta coefficient approximated the volatility of a stock versus the volatility of a benchmark such as the Dow Jones or S&P 500. If a stock has a beta of 1.3 then it has moved 130% percent for every 100% moved in the benchmark stock. A beta lower than such a .9 indicates a stock as moved 90 percent for every 100 percent in the benchmark. Because larger magnitude moves indicate greater volatility, beta can be used to measure a stock relative volatility (Kepper, 2019).
2.1.2 The VIX

The VIX is the first benchmark index that measured the market’s expectation of future volatility. It was created by the Chicago Board Options Exchange (CBOE). The VIX is composed of price inputs of the S&P 500 index options. Specifically, the purchasing of Calls in the Puts S&P 500. The purchase of Calls mean people are thinking the stock will go up, and the purchase of Puts means people are thinking the stocks will fall. The VIX represents the market’s expectation in 30 days. The VIX has been referred to as the “Fear Index” and has been used by many investors to measure market risk. (Kepper, 2019).

2.1.3 Calculating the VIX

The calculation of the VIX is referenced from the Chicago Board Options Exchange and their equation for the VIX is shown below in Figure 2.1. (CBOE, 2019).

The generalized formula used in the VIX Index calculation\(^1\) is:

\[
\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2
\]

(1)

Where:

- \(\sigma \) VIX/100 = VIX = \(\sigma \times 100\)
- \(T\) Time to expiration
- \(F\) Forward index level derived from index option prices
- \(K_0\) First strike below the forward index level, F
- \(K_i\) Strike price of \(n\) out-of-the-money option; a call if \(K_i < K_0\) and a put if \(K_i > K_0\) both put and call if \(K_i = K_0\). \(\Delta K_i\) Interval between strike prices – half the difference between the strike on either side of \(K_i\):

\[
\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}
\]

- \(R\) Risk-free interest rate to expiration
- \(Q(K_i)\) The midpoint of the bid-ask spread for each option with strike \(K_i\).

![Figure 1.1 Derivative and Calculation of VIX (From CBOE)](image)

The basic notion behind this equation is that CBOE gathers data on the prices of the puts and the prices of the calls in the S&P 500 and measure it against the strike price.
The options (puts and calls) are not bought by anyone yet, the strike price is the price in which the holder of the put or call can purchase their specific option. The bids on the options chances to hit the asking prices before an option expires will give an idea as to the perception of the market. All these factors are used to estimate the expected volatility of the S&P 500 (CBOE, 2019).

2.1.4 Interpreting the VIX

The general interpretation of the VIX is that the higher the VIX the greater the Volatility in the stock market. When the market is falling, fear and uncertainty increase, therefore the VIX will increase. When the market is growing fear and uncertainty decrease, therefore the VIX decreases. Figure 2.2 below compares the VIX to the Dow Jones, another industry benchmark like the S&P 500. The green represents the VIX and the black represents the Dow Jones. One can see that during times of market fall the VIX spiked up and during time of market growth the VIX stayed low and stable (Reiff, 2018).

The VIX has proven to be a strong benchmark for market volatility, that it why it was used as the benchmark for volatility when determining a relationship between PI/SCM stocks and Electrical and Energy Stocks.

Figure 2.2 Dow Jones Correlation with the VIX (Index Indicators)
The next background discussion will involve Process Improvement and Supply Chain Management information and strategies. The goal of providing this background discussion is to show the reader that there is a significant financial benefit to process improvement that would lead someone to believe there could be a possibility of Process Improvement and Supply Chain Management focused companies beating the normal market volatility. By describing the process, the reader can see where the money will be saved, therefore strengthening an PI/SCM companies stock position.

2.2 Process Improvement/ Lean Six Sigma

2.2.1 Process Improvement

Process improvement is identifying, evaluating, and improving process in a company, or creating a new process that will benefit the company. Benefits include saving, time, money, improving product quality, customer satisfaction, customer loyalty, increased productivity, and efficiency. Process improvement has many specific approaches and guidelines. Some benchmarks to process improvement include lean manufacturing and Six Sigma, which will be expanded on further. Process improvement is an evolving process that requires a constant feedback loop for improvement. It is not about using a known solution, rather it is about learning through the process and continually improving. Figure 2.3 from Appian shows the required effort for change. (Appian, 2019).

![Figure 2.3 Process Improvement Implementation (From Appian)](image)
Next, we will discuss the most used process improvement strategies, Lean and Six Sigma. Lean is reducing waste in your firm. Waste can be identified at anything that does not add value or improve the bottom line to your organization. Therefore, Lean has saved companies millions of dollars. The idea is to deliver the same quality of service or products to your consumers with less resources.

Six Sigma is a data-driven problem-solving method. Its goal is to eliminate waste, optimize process, and improve the quality of a product or service. While Lean looks to eliminate processes that are not needed and do not add value, Six Sigma looks to refine processes that are needed and make them as efficient as possible.

2.2.2 Eliminating Waste with Lean

There are 8 main examples of waste: Defects, overproduction, waiting, Non-utilized talent, Transportation, Inventory, Motion, and Extra Processing. These 8 wastes are important to learn as all the companies chosen in the analysis do a great job at eliminating these wastes (PEX, 2017).

Defects: Defects are easiest types of waste to detect. They are products/services that don’t meet industry standard. Defects must be kept to a minimum as they effect customer satisfaction, safety regulation, can lead to fines. It should be the first and most basic priority of a company to consistency produce products without defects (PEX 2017).

Overproduction: Over production is producing more than the customer demands need. Companies will often overproduce anticipated demand that is not there or trying to get deals by ordering in large quantities. This strategy has proven to be risky and can lead to waste. Companies that can accurately gauge their customers demand reduce the
amount of waste from overproduction. Therefore, accurately calculating demand should be a priority (PEX 2017).

**Waiting:** Waiting is the time that is wasted when moving from one process to another. In an ideal company the wait time is limited, and the company is organized in a way to minimize wait time.

Non-utilized talent: Not using your employee’s skills to their full potential has a negative effect on the company. It is important to get constant feedback from employees, especially the ones on the front-line to see what can be done to utilize their skills more efficiently (PEX, 2017).

**Transportation:** Transportation is moving a product to another process or moving to an area to complete a process. Companies should look for ways to complete as many processes at once with a single transportation. An analogy could be companies should look to find a way to carpool products to each process. This can be done by reorganizing workspaces (PEX, 2017).

**Inventory:** Waste in inventory occurs when a product is sitting and waiting to be sold. Inventory waste adds storage cost and is due to poor monitoring of demand, or unreliable suppliers (PEX, 2017).

**Motion:** This waste is a process that takes time and money by the employee, yet it does not add value to the product. For instance, if there are two employees working on something that one employee can do in the same amount of time, then they are motion waste (PEX 2017).
Extra Processing: This time of waste can be from excessive reports, or duplication of data that cost money, and time. Equipment that is expensive that is not needed to complete a simple process, etc. Extra processing is also adding something to your product that does not add value to the customer. It is important to understand the requirement and what is valuable to the customer to avoid this type of waste. (PEX, 2017).

2.2.3 Six Sigma Strategies

There are many popular Six Sigma Strategies and here is a list of twelve better-known strategies. Cellular Manufacturing, Takt Time, Standardized Work, One Piece Flow, Kanban system, Five Whys, SMED, Mistake Proofing, Hijinks, TPM, Five S, and PDCA/PDSA. This report will not go into the specifics or each strategy but rather wants to demonstrate there are many strategies than can adapt to a vast amount of processes and company structures. Below are some diagrams of a few of the strategies, that show some of their components, they are from Process Excellence Network (PEX 2017).
2.3 Supply Chain Management-Three Elements

2.3.1 Industry Framework

This is the interaction of suppliers, customers, economic factor, and technological developments that effect a sector. Below are some main factors that affect the supply chain design with the industry framework.

Demand Variation: The workload of the manufacturer. How much money and resources the manufacturer will need and therefore how expensive the product or service being made in that plant is (Chappelow, 2019).

Market Mediation costs: Altering costs based on excess supply, or lost sales, product defects, lessened demand (Chappelow, 2019).

Product Lifecycle: How long the product will last. The product lifestyle is getting shorter and shorter as companies are continually able to upgrade their products. The new norm is shorter life cycles and higher product development (Chappelow, 2019).

2.3.2 Unique Value Proposal

An organization must understand its position to its competitors to provide unique value to its customers. This sub-topic deals with performance aspects in your company that differentiate from other companies and therefore provide value to the consumer. This could be organically created material, charity help, innovative design, etc. You cannot cut corners on the Unique Value proposal during the supply-chain process, as you want to fulfill the value you have promised the consumers (Kenton, 2018).
2.3.3 Managerial focus

This ties in with the Unique Value Proposal. The managerial focus should be on executing the Unique Value Proposal well, again not cutting corners. This is often where a company will fail as the focus of the managers are not the same focus on the brand being promoted. It is important to be aware the efficiency only solutions may not be what's best for the long-term of the company (Kenton, 2018).

The next part of discussion will briefly give background on the companies that are exemplary in reducing waste and using the strategies listed above, which is the reason they had chosen them in the analysis.
2.4 Process Improvement and Supply Chain Management Companies

2.4.1 Apple
Apple Inc. (AAPL)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD

153.92 +0.62 (+0.40%)

Apple is a multinational company located in Cupertino, California. It was incorporated on January 3rd, 1977. Apple designs, markets, and sells mobile communication devices, and mobile communication software, personal computers, media devices, and digital music players (Reuters, 2019).

Strength: Staying ahead of curve in Product Lifecycle

2.4.2 Amazon
Amazon.com, Inc. (AMZN)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD

1,640.02 +7.85 (+0.48%)

Amazon was incorporated on May 26, 1998. Amazon offers many services and products through their website. Their most profitable operation is providing web services to other companies. The company is venturing into all different industries including selling electronic devices (Reuters, 2019).

Strength: Maximizing use of Industry Framework

2.4.3 Facebook
Facebook, Inc. (FB)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD

144.30 -3.27 (-2.22%)

Facebook was incorporated on July 29, 2004. Facebook focuses on building products, and letting people connect and share through mobile devices and computers. The company is a delivery of news and enables people to learn about the world around them (Reuters, 2019).

Strength: Unique Value Proposal

2.4.4 Google
Alphabet Inc. (GOOGL)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD

1,084.41 +5.78 (+0.54%)

Alphabet was incorporated on July 23, 2015 and it is a parent company to Google. Google provides internet products, such as search, ads, commerce, maps, YouTube, and google cloud and drive (Reuters, 2019).
2.4.5 IBM

IBM was incorporated on June 16, 1911. The company has five major areas: Cognitive solution, Global Business Services, Technology Services and Cloud Platforms, Systems and Global Financing (Reuters, 2019).

Strength: Minimization of Inventory Waste

2.4.6 TJX

TJX specializes in off-price and home fashion retail. The company operates through four companies: Marmass, Homegoods, TJX Canada, and TJX international. The company has over 3800 worldwide (Reuters, 2019).

Strength: Minimization of Inventory Waste

2.4.7 Walmart

Walmart was incorporated on October 31, 1969. Its primary focus is retail wholesale. The company offers lower prices and has a great online presence. The company has approximately 11,600 stores Worldwide under 59 banners (Reuters, 2019).

Strength: Maximizing use of Industry Framework
2.5 Electrical Engineering and Energy Stocks

2.5.1 Chevron Corporation

Chevron Corp was incorporated on January 27, 1926. Chevron's Upstream companies develop and produce crude oil and natural gas. Its downstream companies consist of refining crude oil into petroleum products (Reuters, 2019).

2.5.2 ConocoPhillips

ConocoPhillips was incorporated on November 16, 2001. The company explores for produces, transports, and markets crude oil, bitumen, natural gas, liquefied natural gas and natural gas liquids (Reuters, 2019).

2.5.3 EMCOR

EMCOR was incorporated on March 31, 1987. It is an electrical and mechanical construction firm. It provides building services and industrial services (Reuters, 2019).

2.5.4 Exxon Mobil

Exxon Mobil was incorporated on August 5th, 1882. The company is engaged in the exploration, production, transportation, and sale of crude oil, natural gas, and petroleum. The company is involved in the exploration of green and sustainable energies such as solar, wind, nuclear, and hydro power (Reuters, 2019).
Quanta Services, Inc. (PWR)
NYSE - NYSE Delayed Price. Currency in USD

33.23 -0.18 (-0.54%)

2.5 5 Quanta Services

Quanta Services was incorporated on August 19, 1997. The company is a provider of contracting services and infrastructure solutions. They provide these services to electric power, oil, and gas companies around the United States and Canada (Reuters, 2019).
3. Data/Analysis

This chapter contains the data and regression analysis of all the stock vs. the VIX. It will include an analysis of each company vs. the VIX. This will explain why the data shows that there is a major correlation between the VIX and the stocks.

3.1 Data Gathering/Empirical Analysis

3.1.1 Data Gathering

Data for the Regression Analysis was gathered from Yahoo Financial historical data. Using their resources daily close values for stock were obtained for each stock in the simulation from 10/4/2013 to 10/3/2018. From there the data was extracted into Excel. Using Excel regression analysis, I was able to formulate graphical data as well as variables useful in regression analysis.

3.1.2 Empirical Analysis

This will be a summary of the empirical analysis conducted. The empirical analysis follows the diagram to the right. Studying Management Engineering I saw firsthand how PI/SCM saved money for companies, with this observation I inducted that these companies may beat market volatility with their PI/SCM practices. The diagram below displays a summary of steps taken throughout the process. I observed the practices in PI/SCM companies, deducted that they could beat normal market volatility, tested, and evaluated the results.
I will go through the significant hypothesizes and variables below for the project. Shown below is also the equation used to test my hypothesis through regression and conduct the empirical analysis.

**Returns (Stock) = α + b1 ( Δ VIX)**

Hypothesis: Process Improvement Stocks such as Apple can deviate from normal stock volatility because of their practices.

Null Hypothesis: There is no significant relationship between the VIX volatility indicator and Apple stock prices.

Below I will show an example of regression results for Apple Stock as the dependent variable and VIX as the explanatory. Major statistics to look at for significance are the F statistic and the P Value < .005. I am testing for a 5% Significance level.

3.2 Regression Analysis

3.2.1 Process Improvement/Supply Chain Companies Stock Regression vs VIX

Below are the graphs of the Process Improvement/ Supply Chain Companies closing dates over a time of five years. Some key data points to look at is approximately day 485, and approximately 1101, the dates with the largest VIX spikes. The data shows some companies do show a clear correlation with observations through the graphs but others to not. Also included are the Regression tables from each Regression Analysis completed. The results of each analysis will be explained.
**Apple:** From a Graphical standpoint there is clear correlation between the VIX and Apple Performance. Figure 3.1 Below shows that on day 450 the VIX showed high volatility, this was around the same time the Apple stock showed a decrease in stock price.

The regression analysis in Table 3.1 below shows a high F statistic of 313.317 and an extremely low significance F level. It also shows a low P-value of .000332 which is much less than the signified level tested of .05. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Apple stock. This shows that there is a strong relationship between the variance in VIX and the Variance in Apple stock prices. Apple’s strength in staying ahead of the product lifecycle curve does not avoid normal market volatility.

![Figure 3.1 Apple Performance vs VIX](image)

**Table 3.1 Apple Regression Analysis**
Amazon: The graphical comparison in Figure 3.1 does not show a correlation and as when the VIX spikes the volatility increases, and the stock price of Amazon should decrease. This is not clear in the graphical comparisons but is clear in regression analysis.

![Figure 3.2 Amazon Performance vs VIX](image)

The regression analysis in Table 3.2 below shows an extremely high F statistic of 274.422 and an extremely low significance F level. It also shows a very low P Value which is much less than the significance level tested of .05. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Amazon stock. This shows that there is a strong relationship between the variance in VIX and the Variance in Amazon stock prices. Amazon strength in maximizing industry framework does not avoid normal market volatility.

![Table 3.2 Amazon Regression Analysis](image)
**Facebook:** The graphical comparison in Figure 3.3 of Facebook does not show a clear correlation like Apple. If looked at very closely you can see the correlation between the big VIX spike and the Facebook stock decrease around day 1111.

![Figure 3.3 Facebook Performance vs VIX](image)

The regression analysis in Table 3.3 below shows a high F statistic of 319.36 and an extremely low significance F level. It also shows a very low P Value of .00032 which is much less than the significance level tested of .05. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Facebook stock. This shows that there is a strong relationship between the variance in VIX and the Variance in Facebook stock prices. Facebook’s strength in its Unique Value Proposal does not do enough to beat normal market volatility.

![Table 3.3 Facebook Regression Analysis](image)
**Google:** The Graphical comparison for Google vs. the VIX shows again that on around day 1111 a massive spike in VIX caused a decrease for the Google Stock, and it rose back up after that spike. Figure 3.4 displays this comparison.

![Figure 3.4 Google Performance vs VIX](image)

The regression analysis in Table 3.4 below shows a high F statistic of 461.54 and an extremely low significance F level. It also shows a very low P Value of .00077 which is much less than the significance level tested of .05. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Google stock. This shows that there is a strong relationship between the variance in VIX and the Variance in Google stock prices. Google’s strength it’s Unique Value Proposal does not beat normal market volatility.

![Table 3.4 Google Regression Analysis](image)
**IBM**: The IBM graph V.S the VIX does not show any correlation. It shows that it is important to do regression analysis, as the graphical comparisons does not always show the full picture. Figure 3.5 shows this comparison.

![Figure 3.5 IBM Performance vs VIX](image)

The regression analysis in Table 3.5 below shows a high F statistic of 320.89 and an extremely low significance F level. It also shows a very low P Value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the IBM stock. This shows that there is a strong relationship between the variance in VIX and the Variance in IBM stock prices. IBM’s strength of minimizing its industry waste does not beat normal market volatility.

![Table 3.5 IBM Regression Analysis](image)
**TJX**: The graphical comparison of TJX shown in Figure 3.6 does not show a clear correlation vs. the VIX. The VIX spikes do not show large decreases in TJX stock. Regression Analysis will give a clearer picture.

![Figure 3.6 TJX Performance vs VIX](image)

The regression analysis in Table 3.6 below shows a high F statistic of 233.51 and an extremely low significance F level. It also shows a very low P Value of .014, lower than the .05 significance value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the TJX stock. This shows that there is a strong relationship between the variance in VIX and the Variance in TJX stock prices.

TJX’s strength of minimizing its industry waste as well, does not beat normal market volatility.

![Table 3.6 TJX Regression Analysis](image)
Walmart: The Walmart vs. VIX comparison shows a correlation on the second major spike of the VIX. During this spike Walmart showed a decrease in stock price. This comparison is shown below in Figure 3.7

![Walmart Performance vs VIX](image)

Figure 3.7 Walmart Performance vs VIX

The regression analysis in Table 3.7 below shows a high F statistic of 139.01 and an extremely low significance F level. It also shows a very low P value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Walmart stock. This shows that there is a strong relationship between the variance in VIX and the Variance in Walmart stock prices. Walmart’s strength of maximizing its industry framework is not enough to beat normal market volatility.

![Walmart Regression Analysis](image)

Table 3.7 Walmart Regression Analysis
3.2.2 Electrical And Energy Stock Regression vs VIX

This section will discuss the Electrical and Energy stocks vs. the VIX to see if this field and market can beat normal stock volatility. More indepth discussion on factors that influence the electrical stock market will be discussed in chapter four.

Chevron Corporation:

Figure 3.8 displays the comparison between the VIX and Chevron. There is no clear correlation based on the graphical comparison.

![Figure 3.8 Chevron Performance vs VIX](image)

The regression analysis in Table 3.8 below shows a high F statistic of 355.07 and an extremely low significance F level. It also shows a low P value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Chevron stock. Chevron and VIX are highly correlated.

![Table 3.8 Chevron Regression Analysis](image)
**Conoco Phillips:** Figure 3.9 below shows the graphical comparison between Conoco Phillip and the VIX. There is a strong correlation on stock price for Conoco at the first major VIX spike. The first spike caused a massive decrease in stock price for Conoco Phillips.

![Figure 3.9 Conoco Phillips Performance vs VIX](image)

The regression analysis in Table 3.9 below shows a high F statistic of 228.99 and an extremely low significance F level. It also shows a low P value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Conoco Phillips stock. Conoco Phillips and VIX are highly correlated.

![Table 3.9 Conoco Phillips Regression Analysis](image)
**EMCOR:** The graphical comparison in Figure 3.10 below shows a correlation between the second major spike in the VIX and a minor stock decrease for EMCOR.

![Figure 3.10 EMCOR Performance vs VIX](image)

The regression analysis in Table 3.10 below shows a high F statistic of 366.36 and an extremely low significance F level. It also shows a low P value of .0122. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the EMCOR stock. EMCOR and VIX are highly correlated.

![Table 3.10 EMCOR Phillips Regression Analysis](image)
**Exxon Mobil:** Figure 3.11 shows the graphical comparison of Exxon Mobil and the VIX is shown below. Using the graphical comparison alone, there is a correlation between the second large VIX and Exxon Mobil stock decrease around day 1111.

![Exxon Mobil Corporation Close](image)

![Vix Close](image)

**Figure 3.11 Exxon Mobil Performance vs VIX**

The regression analysis in Table 3.11 below shows a high F statistic of 459.03 and an extremely low significance F level. It also shows a low P value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Exxon Mobil stock. Exxon performance and VIX are highly correlated.

![Table 3.11 Exxon Mobil Regression Analysis](image)
**Quanta Services:** The Graphical comparison of Quanta services and the VIX is shown below in Figure 3.12 Quanta had correlation with both VIX spikes. The first one causing a major loss, and the second one causing a loss and then recovering shortly after.

![Figure 3.12 Quanta Services Performance vs VIX](image)

The regression analysis in Table 3.12 below shows a high F statistic of 264.73 and an extremely low significance F level. It also shows a low P value. Therefore, I can reject the null hypothesis that there is no significant relationship between the VIX and the Exxon Mobil stock. Quanta Service's performance and VIX are highly correlated.

![Table 3.12 Quanta Services Regression Analysis](image)
4. Interdisciplinary Study Discussion

This chapter will be an interdisciplinary discussion bridging the two areas of study for the researcher. The chapter will briefly explain the results of the Electrical engineering and Energy data from chapter three. Next the chapter will discuss the influence of Electrical Engineering in the stock market. Specifically, the use of Hybrid Model’s and Machine Learning Algorithms to make financial gains.

4.1 Volatility in Electrical and Energy Stocks vs. Market Risk

As the data shows in chapter three, there is a direct correlation with every major Energy and Electrical Engineering Stock with the VIX. This means that these stocks are subject to market volatility. It was interesting to analyze if Stock related to my field of concentration would be able to differ from normal volatility. Furthermore, I noticed that the Energy and Electrical Engineering stocks behaved differently over the long term compared to the Process Improvement Companies, despite still being tied to the VIX. Therefore, I was curious to see what other factors affect the volatility of Electrical stocks. This will be discussed below.

4.2 Factors of Volatility in Electrical and Energy Stocks

4.2.1 Weather Changes

Weather changes are a big factor in the short-term volatility of Electrical Engineering and Energy Stocks (EE). Weather changes that are sudden can cause a severe delay in the demand and the supply of various products such as natural gas and other services. This can disrupt companies like Exxon Mobil and Chevron Corp in the short term. Weather also plays a role in the distribution of products and services for EE
companies A delay in distribution results in a delay in revenue which investors know can affect the stocks of a company (EIA, 2017).

4.2.2 Storage Levels

Storage levels are a critical limiter when it comes to demand of a product. Especially in the Electrical Engineering field. Storages of electricity, such as batteries are big and costly. As Storage is needed to keep up with high demand, many investors look at storage supply as an indicator for the way an EE stock will go. For instance, if companies are increasing storage, that is an indicator that the demand is going to be high, and stocks should be bought. Therefore, storage levels of an EE company can affect the volatility of the EE stock. Some companies that are majority affected by storage levels in this project are Exxon Mobil, Chevron, and Conoco Phillips (EIA, 2017).

4.2.3 Market Information:

The lack of market information is a big cause of volatility for EE stocks. Weather Changes and storage levels are unlikely to appear on a financial report for a company. Therefore, many investors act on speculation and other knowledge when buying these stocks. This lack of market information and indicators can lead to volatility in a EE stock, when there should be no volatility (EIA, 2017).

4.3 Electrical Engineering Influence in the Stock Market

This next section will focus how Electrical Engineering can influence the stock market. Through my research I found two studies that showed me a connection between the two. An analysis of the two studies are conducted below.
4.3.1 Hybrid Modeling

“A Hybrid Model for Day-Ahead Price Forecasting” by Lei Wu and Mohammed Shahidehpour is an excellent journal article using Electrical Engineering concepts to predict the daily price of electricity more accurately than previous methods. Below is a summary of my research into their model, and how it can be very useful to EE stock volatility. (Wu & Shahidehpour, 2010).

The price of electricity is a key component to the volatility in Electrical and Energy stocks. With the emergence of solar power, electric cars, and wind turbines the price of electricity will prove to be an even more crucial metric.

As explained earlier electrical companies and electricity itself have different volatility factors than other commodities. Storage is one example of that differentiation, as electricity is very expensive to store. Market information is also lacking; therefore, the volatility of electricity is very high. The price of electricity spikes and previous methods of predicating these prices have been adequate but not exemplary. Therefore, Wu and Shahidehpour decided to create a better Hybrid-Model (Wu & Shahidehpour, 2010).

The previous methods used where fundamental models, mathematical finance models, game theory models, and regression models. The issue with fundamental models is that it required large amount of data, which resulted in more power use, and complex computation. The disadvantage of the mathematical financial model is that it is difficult to incorporate physical factors into the equation. Factors such as weather change, and storage systems are not incorporated into the mathematical model, and therefore can make it inaccurate. The problem with the game-theory model is that assumes that all players are rational. This is not always the case in the Electrical field. It is also a very
time-consuming process to calculate game-theory equations. Although Regression modeling are the most efficient model’s out of the other’s it requires correct and detailed historical data to forecast correctly (Wu & Shahidehpour, 2010).

The solution to the above problems was to create a model with several feedback loops and several models at once each with a different purpose. This would help eliminate the concerns above and increase accuracy in daily forecasting (Wu & Shahidehpour, 2010).

The auto-regressive moving average with exogenous variables model, (ARMAX) catches the linear relationship between price return, and explanatory variables. The ARMAX is used to develop the relationship with price with factors such as weather changes and storage capacity. The ARMAX alone improves on the shortcomings of the mathematical financial model (Wu & Shahidehpour, 2010).

Next the generalized autoregressive conditional heteroscedastic model (GARCH) is used to see the heteroscedastic nature of residuals. In other words, the GARCH is used to test the regression model’s ability to predict the price of electricity across all values of the price. The GARCH will let the Hybrid-Model if it can accurately predict electricity prices along all regions or only a specific set of regions (Wu & Shahidehpour, 2010).

The adaptive-wavelet neural network (AWNN) is used to present nonlinear, nonstationary impact of the load series on electric prices, and the Average mean absolute percentage error (AMAPE) is another feedback used to measure for forecast accuracy. With the three models and the check for forecast accuracy the Hybrid-Model was ready
to go. Figure 4.1 is a flowchart of the procedure and steps taken in the Hybrid-Model (Wu & Shahidehpour, 2010).

![Flowchart of Hybrid-Model Steps](image)

**Figure 4.1 Flowchart of Hybrid-Model Steps**

The paper goes onto conduct a simulation of the Hybrid-Model, by inputting variables and generating an output. From there the results were compared to the real results of the specified month and day. The results were extraordinary. The Hybrid-Model outperformed the forecasting results of traditional methods. Table 4.1 is the error comparison and percent improvements for the Hybrid Model Simulation compared to the standard method used. The Hybrid model had massive percent improvements up to 70.59%. This model is worth using (Wu & Shahidehpour, 2010).

<table>
<thead>
<tr>
<th>Day in 2006</th>
<th>Proposed Method</th>
<th>Results in [31]</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 20th</td>
<td>0.0010</td>
<td>0.0034</td>
<td>70.59%</td>
</tr>
<tr>
<td>Feb. 10th</td>
<td>0.0015</td>
<td>0.0050</td>
<td>70.00%</td>
</tr>
<tr>
<td>Mar. 5th</td>
<td>0.0033</td>
<td>0.0061</td>
<td>45.90%</td>
</tr>
<tr>
<td>Apr. 7th</td>
<td>0.0013</td>
<td>0.0038</td>
<td>65.79%</td>
</tr>
<tr>
<td>May 13th</td>
<td>0.0015</td>
<td>0.0049</td>
<td>69.39%</td>
</tr>
</tbody>
</table>

Table 4.1 Hybrid Model Error Compared to Standard Method
Figure 4.2 shows the forecasted prices in the simulation compared to the actual prices on the specified dates used. The Hybrid-Model can nearly mirror perfectly the changes price, and it can do it hourly, great for day traders that trade in electricity stocks (Wu & Shahidehpour, 2010).

Electricity prices drive the volatility in EE stocks, this model shows large improvement and minimal error in forecasting the daily electricity price. Therefore, this Hybrid-Model showed how different model’s used in Electrical Engineering can prove to be very useful in determining volatility.
5. Major Findings

5.1 VIX vs. Process Improvement/Supply Chain

This report found that the Process Improvement and Supply Chain Companies do not beat the normal stock market volatility. This conclusion comes from the individual analysis of seven Companies known for their PI/SC strategies. Through regression analysis of each company’s stock performance Vs. the VIX there was strong correlation between the VIX and all seven of the companies. The F values of each companies were much higher than the significant F value needed, indicating a very strong correlation. The companies are strongly correlated to the VIX, an indicator of normal stock market volatility. Therefore, Process Improvement and Supply change strategies are not strong enough to overcome normal market volatility.

5.2 VIX vs Electrical Engineering and Energy Stocks

This report found the Electrical Engineering and Energy stocks do not beat the normal stock market volatility. These stocks were particularly interesting as the volatility of these stocks are based unusual factors such as weather changes, and storage capacity. This conclusion is based on the analysis of five major Electrical engineering and Energy Stocks. These stocks were particularly interesting as the volatility of these stocks are based unusual factors such as weather changes, and storage capacity. Despite these unusual factors, the regression analysis of these companies Vs. the VIX showed a strong correlation for each. Therefore, the Electrical Engineering and Energy stocks do not beat normal stock volatility.
5.3 Financial Modeling using Electrical Engineering

Electrical Engineering practices can be used in Management field to discover better procedures. “A Hybrid Model for Day-Ahead Price Forecasting” by Lei Wu and Mohammed Shahidehpou showed that a Hybrid-Model performs better than the status quo models used to predict electricity price. Electricity price is a direct indicator of the volatility in Electrical stocks. Therefore, the Electrical Engineering Hybrid-Model directly impacts the volatility of Electrical and Energy Stocks. With this knowledge in mind there may be several other financial model’s that can be improved upon using Electrical engineering practices.
6. Conclusion

This report proved to be very beneficial to the participant. I achieved the goals developing a hypothesis, testing the hypothesis, analyzing and making conclusions. The conclusions found that no stocks researched could beat the normal stock market volatility. This proves how powerful the stock market is compared to the practices of an individual company. This knowledge will help in my future endeavors when deciding on a stock based on its practices, or its market sector. Next, the project helped me achieve my goal of bridging the gap between my two disciplines of study. It was encouraging to see I could use knowledge from one field to create better processes in the other. This report has helped me understand that I can use both disciplines successfully in my future professional career.
References


