Supply Chain Disasters and Stock Prices

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Abstract

The purpose of this research was to understand the different effects that supply chain disasters can have on the stock price of a company. After extensive research, including analysis of the pre and post returns, betas, standard deviation, Treynor ratios and Sharpe ratios we were able to understand the varying effects that supply chain disasters have on a company, its industry and most importantly, its stakeholders. Supply chain disasters can, over night, reduce years worth of steady increases in stock prices. The result is typically the need to redesign its supply chain processes and recovery initiatives in an attempt to restore market position and become less static and more adaptable. This project demonstrates the importance of considering elements like capacity, process, and efficiency when designing a supply chain.

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Executive Summary

Supply Chain Disruptions are described as significant breakdowns in the production of a product or within the processes that comprise a supply chain. A disruption can take many forms including, but not limited to: machine malfunctions, fires, quality control problems, natural disasters, vendor delays, and unexpected increases in capacity which leads to bottlenecks in the process. A company's reliance on certain resources like oil or information fragmentation can also create significant supply chain risks.

After the recognition of a supply chain disruption, companies must work toward disaster recovery which typically results in a complete redesign of the supply chain process. Companies have always explored ways to reduce risk and be prepared for disasters such as supply chain disruptions, politics, natural disasters, etc. A disaster recovery plan (DRP) guides a company through the next steps after a business disruption.

Supply Chain disruptions have clear negative effects on a company's credibility to deliver a particular product or service. Over the last decade supply chains have become more global which has led to longer and more complex systems. Consultants have speculated that these disasters have become much more frequent and significant, and reduce the share price of a company by an average of seven percent.

We have conceptualized and quantified the risk-return tradeoff of different companies during periods before and after supply chain disasters. We began by researching supply disruptions to gain an understanding of potential root causes and general effects on the

organization. We focused specifically on the effect that these disruptions have on the stakeholders.

We collected and analyzed data about companies during supply disruptions. Supply Chain disruptions are rarely one-day events; the disruptions can take place over the course of several days until a company is able to work towards mitigating the supply chain issues within its processes.

We used varying time intervals when conducting the beta analysis in order to capture a more complete picture of the disruption. We looked to draw inferences between the different funds and understand the degree to which the disruption affected the various companies.

Introduction

1.1 What is a Supply Chain Disruption?

When a disruption occurs, businesses need to have mitigation plans in place to prevent loss of market share to better prepared or less affected competitors. It is increasingly clear that supply chains established during more stable times need to be reshaped for operation in an era of increased volatility.

Disruption can have a major impact on all parties across your supply chain. It can negatively impact the supply of materials from manufacturing plants through to your customers, as well as alter the flow of money. Unfortunately, the cause of the disruption often goes unexposed until the repercussions actually occur. By then it may be too late to account for the changes that should have happened to prevent the disruption. This can lead to major financial problems, such as a devastating loss of revenue (Baxter, 2016).

1.2 What is the impact of a Supply Chain Disruption on an organization?

Managers must be ready to tackle and predict the effect of a supply chain disruption in their day to day operations. This can be done by addressing the following three elements:

1. Unforeseen events: Natural disasters, international conflicts, industrial accidents and any mundane disruption that poses a threat to lean supply chains.

2. Reduced sense-and-response time: Shippers also have to face shorter predictive time horizons. As competition increases, organizations have to deliver goods faster, which means a shorter working time frame.
3. Total visibility: A seamless view of the entire supply chain network drives success, and supply chain managers continue to seek a centralized system of command and control.

Because very little inventory is available to act as a buffer against lost manufacturing time and low productivity, hiccups and failure anywhere in the supply chain could potentially impact the entire value chain. And it's not just direct suppliers that present concern; in fact, greater risk may reside within a supplier's network of suppliers (Logistics Bureau, 2018).

Such impactful disruptions can arise from a number of sources, including:

- Natural catastrophes: The output of magnetic hard drives declined 30% worldwide when Thailand suffered widespread flooding after months of unusually heavy rainfall.
- Human-made disasters: The radiation leak at the Fukushima Daiichi nuclear plant, following an earthquake, contaminated the local food chain and created a global ripple effect of severe price spikes, falling stock prices, and component shortages.
- Supplier delivery delays: Reliance on a single supplier impacted 28,000 employees across six out of Volkswagen's ten factories in Germany when its seat-cover provider did not deliver on time – leading to a €100 million loss in revenue.
- Financial or economic crisis: After Lehman Brothers announced its bankruptcy in 2008, the manufacturing sector suffered a significant drop in customer orders of up to 42%, collapsing entire supply chains as a growing number of providers went out of business.

- Government regulations: An ever-growing set of local, national, and international mandates impact everything from operational processes to product ingredients, especially restrictions on chemicals, hazardous substances, and suppliers financing conflicts and terrorist organizations.

These are just a few of the many incidents that have given chief procurement officers (CPOs) great cause for concern. Even cyber hackers are tricking employees to unintentionally make fraudulent wire transfers, steal or corrupt information, and disrupt operations of multiple businesses.

1.3 Disaster Recovery Plan

Once a company's risk has been assessed, disaster recovery planning can begin. Recovery strategies provide a means to restore IT operations quickly and effectively following a service disruption. Several factors are involved when deciding on a recovery strategy including cost, security, allowable outage time and integration. The disaster recovery planner must choose one that fits the incident, type of system and the company's operational requirements.

The Disaster Recovery Planner characterizes the system requirements, processes and interdependencies. The coordinator then uses that information to determine the requirements and priorities of the plan. Business impact analysis and defining recovery plans are two important job duties of a disaster recovery coordinator (Fallara, 2004).

The business impact analysis is the key step in the disaster recovery planning process. This aspect of the plan is where the results of risk management come into play. As mentioned,

risk management identifies the business processes, threats and vulnerabilities and classifies them by how critical they are to the overall business. With this information, the next step is to determine the impact a particular process has if it is out for a period of time. This is known as the outage time.

There are two ways to measure the impact of an outage. The first measurement is the effect an outage has over time. That is, the maximum amount of time a resource doesn't have to work before it affects the performance of a system. The second measurement is the effect a process being down has on other business resources and processes. By balancing the cost of a system's downtime against the cost of resources required for restoring the system, the disaster recovery planner can identify where the two points meet or the optimum point. The optimum point defines how long the organization can afford to allow a system to be disrupted.

Using the outage impact and optimum point analyses, the planner can prioritize what strategies will be implemented first. For example, if an outage on a component has an optimum point of six hours then the planner would need to implement a strategy that would recover the component before the six hours. However, if a component of the system can allow up to six hours but a critical process has only four hours, then the planner must prioritize and get the critical process up and running first. The longer a company is without critical and vital business functions, the greater the costs of the outage. Also, the less likely it is that a full recovery will ever be achieved. Therefore by carefully prioritizing the strategies, a planner can save time and costs.

1.4 Recovery plans

Besides conducting a business impact analysis, the coordinator must decide what components will be in a disaster recovery plan. These components can include—but are not limited to—backup methods, alternate sites, equipment's replacement, support teams, written policy statements, testing, training and maintenance.

In the event of a disaster, it is important for a company not to lose records and data. To prevent this occurrence, backing up data should be performed on a daily basis. To cover for a possible fire, or any other disaster, it may be a good idea to store backup copies offsite. If so, one must consider geographic location, accessibility, security, environment and cost. If storing backup copies onsite, perhaps a fireproof lock box is in order. Backup policies should also be in place. For example: the location of the backups, rotation of the media.

In case of a major disaster, like a fire, an alternate site able to support the company's system operations should be considered. There are five types of alternate sites: cold sites, warm sites, hot sites, mobile sites and mirrored sites. Cold sites are buildings with just the core requirements of electricity, telecommunications and environmental controls. Warm sites are locales partially equipped with some necessary hardware/software already in place. Hot sites have the hardware, equipment and support personnel available. Mobile sites are transportable units, like trailers, that have the equipment and hardware needed. Mirrored sites are fully ready facilities with realtime information mirroring. There are obvious pros and cons (levels of expense) to each of the alternate sites. If deemed necessary, a planner should choose an alternative site that best suits the company's needs and budget (Ivanov, 2017).

Another aspect that should be considered is equipment replacement. If any hardware and software is destroyed, it may need to be replaced immediately. There are three basic strategies that exist for equipment replacement: vendor agreements, equipment inventory and existing compatible equipment. Vendor agreements should specify how fast a vendor must respond after being notified. Equipment inventory refers to purchasing extra equipment in advance and storing it offsite. Existing compatible equipment is when a business uses equipment already on site to temporarily replace similar equipment that has failed. It is a good idea to create and maintain a detailed list of all equipment as part of the recovery plan.

1.5 Business interruption insurance

Risk management is, just as it says, about managing your risks – it is about being proactive, taking steps to prevent incidents which could result in a loss, having arrangements which will make money available to prevent a financial crisis. Taken as a whole, risk management can be defined as the optimal use of resources to minimize risk. Insurance elements of disaster recovery insurance, on the other hand, comes into the picture once a loss has occurred, and helps you to pay for some of the costs incurred in the loss incident. Insurance on its own does nothing to prevent losses. Rather, it protects you from the financial consequences of loss. The first thing you have to understand is that you cannot get “total protection” (Paradine, 1995).

If disaster strikes, both risk management and insurance have major roles in determining how well you survive the interruption of normal business. Because of the crucial role

information systems can play in keeping a business running, I will not just look at the potential for disaster and business interruption in the information technology area; I will treat the information technology risk situation
as part of the overall business activity.

With an adequate level of business interruption insurance, your revenue can be restored to a level which is sufficient to avert the financial crisis that would otherwise stem from a chance, disastrous event. For every dollar of turnover lost, insurance can compensate for the proportion of that dollar that would normally be allocated to meeting overheads and to producing a net profit.

1.5.1 What you can and cannot insure

To appreciate the full potential of insurance to keep you in business, we need to begin with an understanding of what can and cannot be insured. In terms of the events which may cause you to make an insurance claim, the standard business interruption policy covers events arising from the same kinds of peril that are covered by a standard property-damage policy, and it is usually handled in the insurance market as part of a firm's property damage cover. This means you will be covered for a period of interruption caused by fire, lightning, or the explosion of a boiler. You will also be covered for the indirect effects of a fire, such as smoke damage, and damage from water and other materials used to limit the spread of the fire and ultimately extinguish it (Paradine, 1995).

1.6 Background Discussion

In the following section, we continue to delve into the importance of supply chains in a company's development and profit growth. This includes the various supply chain models that mold how a company functions and its intrinsic interactions between customer management, profit growth, stakeholders and employees.

Furthermore, we explore the distinct interactions and effects of supply chain disruptions. From situations such as supplier and management issues in the Rio 2016 Olympics to General Motors excitement for robotic innovations and lack of proper implementation that led to ineffective management and a visible supply chain disruption (Orton, 2017).

1.7 Gaps in Literature

Recent research underlines the crucial role of disruption events and recovery policies in supply chains. Despite a wealth of literature on supply chain design with disruption considerations, to the best of our knowledge there is no survey on supply chain with disruptions and recovery considerations.

There's a lack of standardized literature and state-of-the-art surveys on proactive Supply chain disruptions (SCD) and Supply chain planning(SCP) with disruption considerations, to the best of our knowledge there is no state-of-the art review on SCD and SCP with disruptions and recovery considerations (Ivanov, 2017).

Consequently, through the development of this project we faced the harsh reality that there no contundent studies overviewing the relationship between supply chain disruptions and

stock price. Nevertheless, we found an interesting business project attempting to structure a model to predict the effect of supply chain disruptions on long-term profitability and stock price (Hendricks, 2005). It covers the predictions of more than 300 publicly traded companies and the effects of supply chain disruptions.

In conclusion, since supply chain performance issues are becoming more relevant in recent years, analysts and investors may be putting more pressure on firms to be more forthcoming about the performance of their supply chains, particularly when it is poor.

1.8 Interdisciplinary and Global Importance of Project

This project's objective is to explore the importance of a supply chain, its recovery plans and disaster management systems as well as business interruption insurance. From those aspects we follow to discuss the relationship between supply chain disruptions and its effects on stock prices, and consequently, on stakeholders.

Furthermore, anyone who has access to this document will be able to easily and quickly realize the importance of being prepared for supply chain disruptions to protect their business, as well as be ready for any kind of disaster (natural disaster, social media related, etc) that may intervene in a company's regular transactions and activities. This also impacts the customer management of a company, as relinquishing normal functions that are scheduled to be made can impact not only short-term business relationships but long-term as well, this including expected cash flow.

We have analyzed a variety of different companies, all of which have varying global impact. This ways in which the companies are global varies as well. Facebook, for example,

creates new opportunities by connecting people and businesses world wide. Nike manufactures in over 40 countries, through 529 factories while innovating to support athletes worldwide. Cisco funds a number of corporate social responsibility programs, partnerships, and business practices. One thing that is consistent across the different companies is the reliance on multidisciplinary teams incorporating, business and technology to improve profits.

In conclusion, anyone will benefit by reading this paper by analyzing the data presented, as well as detailed and informed recommendations to adapt to business interruptions caused by supply chain disruptions and disasters outside of the influence of mankind and supply chain planning.

Background

A supply chain is a network between a company and its suppliers to produce and distribute a specific product, and the supply chain represents the steps it takes to get the product or service to the customer. Business logistics management refers to the production and distribution process within the company, while supply chain management includes suppliers, manufacturers, and retailers that distribute the product to the end customer. Supply chains include every business that comes in contact with a particular product, including companies that assemble and deliver parts to the manufacturer (Culp, 2013).

A typical supply chain begins with the ecological, biological, and political regulation of natural resources, followed by the human extraction of raw material, and includes several production links (e.g., component construction, assembly, and merging) before moving on to several layers of storage facilities of ever-decreasing size and increasingly remote geographical locations, and finally reaching the consumer. Many of the exchanges encountered in the supply chain are therefore between different companies that seek to maximize their revenue within their sphere of interest, but may have little or no knowledge or interest in the remaining players in the supply chain. More recently, the loosely coupled, self-organizing network of businesses that cooperates to provide product and service offerings has been called the extended enterprise.

As part of their efforts to demonstrate ethical practices, many large companies and global brands are integrating codes of conduct and guidelines into their corporate cultures and management systems. Through these, corporations are making demands on their suppliers

(facilities, farms, subcontracted services such as cleaning, canteen, security etc.) and verifying, through social audits, that they are complying with the required standard. A lack of transparency in the supply chain is known as mystification, which bars consumers from the knowledge of where their purchases originated and can enable socially irresponsible practices. Supply Chain Managers are under constant scrutiny to secure the best pricing for their resources, which becomes a difficult task when faced with the inherent lack of transparency. Cost benchmarking is one effective method for identifying competitive pricing within the industry. This gives negotiators a solid basis to form their strategy on and drive overall spend down (Hicks, 2012).

2.1 Supply Chain Models

In industries where the value proposition is oriented to metrics such as high relevance of asset utilization, low cost, and total cost, the end-to-end efficiency is given high priority. Examples of such industries include steel, cement, paper, low-cost fashion, and commodity manufacturing in general (Magaya, 2016). Three supply chain models fall under this category:

The "efficient" supply chain model

This model is best suited to industries that exist in highly competitive markets with several producers, and customers who may not readily appreciate their different value propositions. These are usually commoditized businesses where production is scheduled based on expected sales for the length of the production cycle and competition is almost solely based on price. The steel and cement industries fall under this category.

The key objective of the efficient supply chain model is that managers should focus on maximizing end-to-end efficiency including high rates of asset utilization in a bid to lower costs.

The "fast" supply chain model

This supply chain model is best suited for companies that manufacture trendy products with short life cycles. Consumers are mostly concerned with how fast the manufacturer updates their product portfolios to keep up with fashion trends.

Companies that adopt the fast supply chain model focus on shortening the time from idea to market and maximizing the levels of forecast accuracy so as to reduce market mediation cost.

The "continuous-flow" model

This model is ideal for industries with high demand stability. The manufacturing processes in a continuous-flow model are designed to generate a regular cadence of product and information flow. This supply chain model is suited for mature industries with little variation in the customer demand profile. Competitive positioning for this model involves offering a continuous-replenishment system that ensures high service levels and low inventory levels at customers' facilities.

Supply chains oriented to responsiveness

In industries that are characterized by high demand uncertainty and where market mediation costs is the top priority, supply chain models that are oriented to responsiveness are usually employed. These include:

The "agile" supply chain model

The agile supply chain model is ideal for companies that manufacture products under unique specifications by their customers. This model is mostly used in industries characterized by unpredictable demand. The model uses a make-to-order decoupling point that involves manufacturing an item after receiving customers' purchase orders.

To ensure agility in the supply chain, managers focus on having the ability for excess capacity and designing manufacturing processes that are capable of the smallest possible batches.

The "custom-configured" model

This model is ideal where products with multiple and potentially unlimited product configurations are required. It features a high degree of correlation between asset cost and the total cost. Product configurations is usually accomplished during the assembly process where different product parts are assembled according to a customer's specifications.

The custom-configured model combines the continuous-flow supply chain model and an agile supply chain where the processes before configuration of the product are managed under the continuous-flow model while downstream processes operate as an agile supply chain.

The "flexible" supply chain model

This supply chain model is best suited for industries that are characterized by high demand peaks followed by extended periods of low demand. This model is characterized by high adaptability with capability to reconfigure internal manufacturing processes so as to meet specific customer

needs or solve customer problems. For this supply chain model to be successful, the management should focus on ensuring ample flexibility with emphasis on rapid response capability, having extra capacity of critical resources, possessing adequate technical strengths, and developing a process flow that is quickly reconfigurable (Magaya, 2016.

2.2 Importance of Supply Chain

It is well known that supply chain management is an integral part of most businesses and is essential to company success and customer satisfaction. They can aid to boost and maintain a high level of customer service, reduce operating costs by focusing on incremental improvements if needed, thus, improving the financial position of the company. Ergo, leading to a more streamlined and efficient business process and growth development (Culp, 2013).

For example, profitable revenue growth is a sure sign of business success, and one of the most important factors driving profitable growth is customer service and most importantly, customer satisfaction. Customer satisfaction is highly dependent on the supply chain and to be successful, your business must manage its supply chain with that in mind. That means the customer must be a primary focus when considering supply chain strategy, network design and performance management.

Furthermore, the cost of meeting demand is one of the most telling ways in which the supply chain matters to business success. Supply chain outlay can make up a large proportion of product costs, while excessive inventory in the system can tie up working capital and stifle cash flow. Investigating the costs of serving customers is one way to understand the way supply chain costs

affect business success. The use of a methodology known as “cost to serve analysis” often reveals shocking realities about supply chain costs.

Also, recent times have seen what might almost be described as an explosion in the number of commercial brands suffering tarnished reputations and revenue-loss, as a result of unethical practices among their suppliers. Moreover, corporate responsibility issues like this can impact any business, even if unethical supplier practices are discovered two or three tiers deep in the supply chain. If yours is a small or young enterprise trying to find its feet, public knowledge of association with unethical suppliers might very well lead to financial disaster and business failure, as customers react to what they perceive as your wrongdoings. If your supply chain operates across international borders, out of sight must never be out of mind as far as supplier management is concerned. Any performance management program you implement should therefore focus on the integrity and ethical responsibilities of your suppliers’ sources, as well as on service performance and collaborative initiatives.

2.3 What are the different types of supply chain disasters?

1. Natural Disasters
2. Political related
3. Technological related
4. Shipping related
5. Social media related

2.3.1 Examples

1. Rio 2016 Olympics

Brazil raced to complete its Olympic venues right up to the opening ceremony. One complication was the glacially slow Brazilian customs system. Imports are taxed at a high rate and customs officers take time to process the archaic paperwork. Shipments can be held up by standards and quality regulator Inmetro, by the agricultural department MAPA, which will demand articles of association among other paperwork, by health regulator Anvisa, and by federal or state tax collectors. All supply chains cross borders at some point. Even with the right paperwork, goods can get stuck in customs. Mutual recognition agreements can speed things up, but even the Olympics can be imperilled by a man with a clipboard (Orton, 2017).

2. Nando's

The most important decision for a supply chain manager? Probably the trade-off between buying excess stock to insure against a shortage and running a tight model to keep costs low. Different businesses prioritise differently. The Ritz Hotel running out of champagne is a disaster. A discount supermarket, by contrast, prefers to run out of cabbages by the end of the day than overstock. Nando's ran out of chicken during this New Year's bank holiday. It triggered a furious tweetstorm. The result? Acres of coverage in the newspapers. Nando's countered with smart public relations and boosted its reputation for keeping stocks fresh. And the chicken restaurant saves money in the long run by keeping its supply chain tight at the risk of occasional shortages (Orton, 2017).

3. Venezuela

Prices talk. They send messages across the supply chain, warning of shortages. The most famous lesson of this power is from the 1585 Siege of Antwerp. The Spanish blockaded the city. No goods in or out. So the price of bread soared. The mayor of Antwerp became aggrieved by profiteering. So he capped by the price of bread. This immediately killed smuggling. What's the point of risking death through a blockade if there's no material reward? But no smugglers, no bread. So the city starved. Modern day Venezuela is making the same mistake. The socialist government fixes prices, often below market rates. So supermarket shelves are empty. The animals at Caracas Zoo were recently eaten by members of the starving middle class (Orton, 2017).

4. GM's Robot Mania

General Motors CEO in the 1980s was Roger Smith, of "Roger and Me" fame, the documentary that really launched the career of liberal filmmaker Michael Moore. Smith was fascinated with technology. Among other projects, such as the purchase of IT firm EDS, Smith embarked on a very aggressive effort to implement robots in GM factories.

When Smith was appointed, GM had approximately 300 robots of one kind of another. He soon created a joint venture with Japan's robot designer Fujitsu-Fanuc, and said he planned to deploy 14,000 new robots in GM plants by 1990. Bad move. Costing billions of dollars, the robots never really worked. As one observer wrote, "The robots accidentally painted themselves and dropped windshields on to front seats" (Orton, 2017).

A “show place” factory in Hamtramck, MI turned out to be more like a “basket case.” Introduction of the robots lowered productivity. A nearby Mazda plant produced just as many vehicles, with 1,500 fewer employees. The entire project was later largely scrapped, as GM’s costs rose and market share shrunk. Meanwhile, Toyota delivered low cost, high quality vehicles using comparatively low tech “lean production” techniques. As one GM finance executive later noted, at the time the company could have bought both Toyota and Nissan for the money invested in the failed robot technology, a point especially painful given GM’s troubles and Toyota and Nissan’s success today.

Methodology

In collecting the data, we first determined the different funds we would analyze on the nature of the supply chain disaster. We evaluated the trends of the market over roughly one trading month before and after the identified supply chain disruption. We used the S&P 500 as a proxy for the market in conducting the analysis of firm-specific stock prices in the United States (Kenya, 2018).

It became necessary to examine the return of the particular fund in relation to the market. We analyzed the performance of a given fund over the course of the two months and drew correlations between the different funds based on the varying nature of the supply chain disruptions. Next, we found correlations between the funds and the market. After comparing the funds, we regressed the return of the funds against the return of the market.

During the regression process, we utilized the Market Model (*Figure 1*). To analyze risk in real world situations, the Market Model is taken into consideration; this allows one to look at the beta of a given factor in determining risk. The purpose of this was to analyze the betas to determine how a particular bond moves in relation to the market. The regression analysis is an academically promoted method of quantifying the risk by taking historical returns and taking a moving average to determine the risk-return tradeoff. The model suggests that the return on a particular asset is equal to an intercept plus the estimate of the systematic risk for that asset multiplied by the the return on the market plus the regression error.

Figure 1: Market model

$$R_i = \alpha_i + \beta_i * R_M + \varepsilon_i$$

We also analyzed the variance of returns to determine risk. Variance measures dispersion. High variances suggest more risk. We evaluated Treynor ratios which gave us a better sense of the reward-to-volatility ratio (Kenya, 2018). The Treynor Ratio is equal to the asset return minus the risk free rate divided by the beta (*Figure 2*). Sharpe Ratios were assessed as a way of gauging the risk-adjusted return (Lioudis, 2018). The Sharpe Ratio is the result of the asset return minus the risk-free rate divided by the standard deviation of the asset return (*Figure 3*).

Figure 2: Treynor ratio

$$T = \frac{r_p - r_f}{\beta_p}$$

Figure 3: Sharpe ratio

$$S = \left(\frac{R_p - R_f}{\sigma_p} \right)$$

Data

Firm Specific Stock Prices:

Table 1

Table X: Pre and Post Summary Measures						
Company	Pre-Beta	Post-Beta	△ Beta	Pre-Returns	Post-Returns	Std-Dev
Nike	-0.013420045	0.753140777	0.369860366	0.00799	-1.714	4.05220473
Boeing	0.278991306	0.789071535	0.534031421	0.5074	-0.3358	1.33414141
Cisco	3.05358121	2.831173846	2.942377528	-0.424	-12.003	6.72895218
FedEx	1.099235024	0.650283501	0.874759262	0.064411176	0.07731323	0.84740034
Facebook	0.959213397	1.033616045	0.996414721	0.159316767	-0.379898847	1.61837531
BMW	0.629886091	1.37091796	1.000402026	0.136429337	-0.035247529	1.02280738

Table 2

Table XY: Pre and Post Risk-Return Tradeoff				
Company	Pre-Treynor Ratio	Post-Treynor Ratio	Pre-Sharpe Ratio	Post-Sharpe Ratio
Nike	-0.595378015	-2.275802947	0.001971766	-0.422979616
Boeing	1.818694666	-0.425563444	0.380319506	-0.251697458
Cisco	-0.138853356	-4.239584234	-0.063011296	-1.783784411
FedEx	0.058596364	0.118891575	0.076010326	0.091235779
Facebook	0.166091056	-0.367543488	0.098442411	-0.234740882
BMW	0.216593665	-0.025710896	0.133387127	-0.034461551

Nike:

Nike is a multinational company with over 70,000 employees that manufactures and sells footwear, apparel, equipment, and a number of accessories.

In February 2001, Nike worked to implement a new supply chain management system for the purpose of streamlining its processes. However, the initiative resulted in a more complex system which led to significant supply chain issues for the company. Nike's new planning system

struggled with a number of software problems, lacked integration capabilities, and as a result, Nike was unable to properly train its employees, and has problems forecasting demand and controlling its inventory. Nike reported a $100 million revenue shortfall as it worked to face these challenges. Also, Nike's stock price dropped roughly 20% which would take the company roughly 10 months to fully recover (Koch, 2004).

We focused on evaluating Nike's stock price from January 1st, 2001 to March 5th, 2001. During that time period, the S&P 500 stock price fluctuated (Yahoo Finance, 2018). Through conducting a regression analysis we compared the pre and post disaster betas. A pre beta of -0.013 suggests an inverse relationship between the market and Nike's stock price. A post beta of 0.75 suggests that for every one value that the S&P 500 goes up, the stock price will move in the opposite direction by 0.75. This means that there is significantly higher risk associated with the stock price after the supply chain disaster.

The pre and post returns suggest that, on average, stockholders we're losing $1 more per trading day than before the supply chain disaster. In evaluating the risk-adjusted return through the Sharpe Ratio, we noticed that the Sharpe Ratio jumped from positive to negative which suggests that the excess return for Nike is negative.

Boeing:

Boeing is the largest aerospace company in the world. It "[leads the manufacturing] of commercial jetliners, defense, space and security systems...the company supports airlines and U.S and allied government customers in more than 150 countries."

In 2007, Boeing relied heavily on outsourcing development both locally and internationally for the purpose of lowering its costs and accelerating the design process. The company was actively looking to reduce the process of developing its new Dreamliner 787 aircraft with the goal of reducing the development cost from $10 to $6 billion and reducing the time from six to four years. Because of the company's reliance on outsourcing, it experienced significant problems with its deliveries which resulted in over $2 billion in losses and a three year delay. The company would experience a significant reduction in its stock price which would take over 5 years to recover from (Peterson, 2017).

In evaluation of Boeing's stock price from September 4th, 2007 until November 1st, 2007, we noticed that the both the pre, and post betas are positive which means that the stock price tends to move in the direction of the S&P 500 (Yahoo Finance, 2018); however, the post beta suggests that, as expected, there was more risk associated with the stock price after the supply chain disruption.

In analysis of the pre and post returns, stockholders went from gaining roughy 50 cents per day, to losing 33 cents on average per share. The Sharpe Ratio suggests that, like Nike, the excess return for is negative.

Cisco:

Cisco specializes in internet networking. The company is a service provider for small to medium size businesses. The company invested in half of the Japanese switch market.

In 2001, the United States economy was significantly impacted by the tech bubble, however, Cisco was unable to anticipate and prepare. The company had a poor inventory system and was unable to see the slowing demand for its routers and switches which it was heavily invested in. In May of 2001, Cisco announced a $2.2 billion inventory write down and the company's stock was cut in half as a result (Berinato, 2001).

We evaluated the stock price of Cisco between January 1st, 2000 and February 6th, 2000. Through this analysis we determined that there is significant risk associated with the betas especially in comparison to Nike and Boeing (Yahoo Finance, 2018). For every one value that the stock market went down, Cisco's stock price dropped by 2.83.

Cisco stock holders were losing an average of $12 per share every day following the supply chain disaster in comparison to losing roughly 42 cents per share before the disaster. In evaluating the risk-adjusted return through the Sharpe Ratio, we noticed that both the pre and post Sharpe Ratios are negative; however, the post Sharpe Ratio is significantly more negative.

FedEx:

FedEx Corporation is an American multinational courier delivery services company headquartered in Memphis, Tennessee.

In September 2017, FedEx fell victim to a cyber attack called NotPetya. Operations of FedEx's TNT Express unit were disrupted by the attack and the company previously warned that the financial cost of the incident was likely to be significant. But now, with the publication of its first quarter earnings FedEx has revealed the cost of falling victim to Petya to be an estimated $300 million in lost earnings (McKevitt, 2017).

Combed with the impact of Hurricane Harvey, the cyber attack posed significant operational challenges. While no data breach or data loss occurred as a result of Petya, the company previously warned that it may not be able to recover all of the systems affected by the cyber attack.

Consequently, FedEx's saw a 1% decline in stock price which is the double of what is expected from a cyberattack crime. The costs are still being compiled, but given the extent of lost operations, they will likely surpass the million-dollar mark.

We focused on evaluating FedEx's stock from May 1st, 2017 to November 1st, 2017 (Yahoo Finance, 2018). During that time period, the S&P stock price fluctuated. Through conducting a regression analysis we compared the pre and post disaster betas. We noticed that the both the pre, and post betas are positive which means that the stock price tends to move in the direction of the S&P 500; however, the post beta suggests that, as expected, there was more risk associated with the stock price after the supply chain disruption.

In analysis of the pre and post returns, stockholders went from gaining roughy 42 cents per day, to losing 24 cents on average per share. The Sharpe Ratio suggests that, like Nike, the excess return for is negative.

Facebook:

Facebook, Inc. is an American online social media and social networking service company based in Menlo Park, California.

In March 2017, Facebook admitted it knew, but didn't notify users, that political intelligence firm Cambridge Analytica had obtained data on hundreds of thousands of Facebook users without their consent. It made this disclosure on the eve of investigative articles in the New York Times and The Guardian's The Observer, which detailed a scheme by the Trump campaign-linked firm to tap likes and posts from tens of millions of unwitting users to predict how they would vote (Molina, 2018).

Facebook defended keeping users in the dark by saying it had thought Cambridge had deleted the data — and because it didn't qualify as a data breach, since users had agreed to share their data with the quiz app. That response didn't sit well with lawmakers, regulators and privacy activists. Thus, Facebook's stock dropped in the following two weeks by around 15%.

We focused on evaluating Facebook's stock price from March 1st, 2018 to April 3rd, 2018. During that time period, the S&P 500 stock price fluctuated. Through conducting a regression analysis we compared the pre and post disaster betas. A pre beta of 0.959 and a post beta of 1.033 meaning that there was an increase in risk. Furthermore, there's a significant increase in

variance from 0.8 to 4.8, which also is shown in the Sharpe ratio going from 0.17 to -0.17. In conclusion, the aforementioned disaster caused a significant stock loss and decrease in market strength and user trust.

BMW:

BMW AG is a German multinational company which currently produces luxury automobiles and motorcycles, and also produced aircraft engines until 1945.

In May 29, 2017 BMW AG, the German luxury car maker, halted production of certain models in response to a shortage of parts caused by delivery problems from supplier Bosch GmbH.

The hiccups in the normally smooth operation show how dependent manufacturers are on a global, smoothly running supply chain. Even small disruptions anywhere along the line can cascade into delays in getting the company's big money-making products off the assembly line and into showrooms (Boston, 2017).

In BMW's case, the culprit is a "Lenkergetriebe," or steering gears manufactured by Stuttgart-based auto-parts giant Bosch and used in BMW's 1-Series, 2-Series, 3-Series and 4-Series compact cars.

We focused on evaluating BMW's stock price from May 1st, 2017 to July 1st, 2017. During that time period, the S&P stock price fluctuated. Through conducting a regression analysis we

compared the pre and post disaster betas. We noticed that the both the pre, and post betas are positive which means that the stock price tends to move in the direction of the S&P 500; however, the post beta suggests that, as expected, there was more risk associated with the stock price after the supply chain disruption. Nevertheless, the returns fluctuated from 0.13 to -0.03. Furthermore, both the Treynor ratio and Sharpe ratio had significant diminishments. The pre Treynor ratio is 0.21 and the post Treynor ratio is -0.02; the pre Sharpe ratio is 0.13 and the post Sharpe ratio is 0.03.

Hypothesis Development

In doing this research the main questions we looked to answer include but are not limited to:

-How does a supply chain disruption affect the stock price of a particular firm?

-How does a supply chain disruption affect the country's market?

Findings

In evaluating the stock price for US companies that have experienced supply chain disasters, we noticed a number of trends in the data. Although at varying levels, the beta analysis suggests that there is significantly more risk associated with Nike and Boeing following the supply chain disaster. Cisco, however, had slightly less risk associated with their stock price following the supply chain issues. This data initially seemed misleading, but upon further analysis we discovered that the company was already experiencing a negative average return before the disaster. All three of the companies experienced negative post returns, but Cisco had a more significant decrease in average returns.

In assessing the different betas, it is important to acknowledge that the betas change as time changes, thus it became important for us to choose time intervals that capture the full effect of the supply chain disruptions.

The Treynor Ratio is a metric for determining how much excess return was generated for each unit of risk taken on by a portfolio.

Conclusions and Recommendations

In summary this project was designed to quantify the risk return tradeoff of various companies both before and after a supply chain disaster. Through this process, we were able to understand the many forms that supply chain disruptions can take. All disasters have the impact of tainting a company's credibility in delivering a particular product or service. Trends suggest that as supply chain systems become more complex they will also become more frequent.Through the application of the market model, analysis of the variance, Treynor and Sharpe Ratios we were able to quantify and analyze the impact of a particular disruption focused specifically on the effect that these disruptions have on the stakeholders.

We also, analyzed various mitigation and recovery techniques. We recommend that companies create visibility across the supply chain process and develop data-sharing platforms for risk identification and response.

Furthermore, this analysis has unraveled the uniqueness of supply chain disruption and how they have changed through time. The most relevant papers start in the early 1970s covering early innovations to counter the possibilities of business interruption based on supply chains. And most recently, a 2017 paper underlined the crucial role of disruption events and recovery policies in supply chains. Consequently, teaching us how they have slowly evolved and become deeply more understood.

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