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SUPPLY CHAIN BOTTLENECKS FROM COVID-19: THE BLACK SWAN

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ABSTRACT

The pandemic uprooted the lives of millions of people around the world. To no surprise, companies faced disruptions unimaginable caused by a series of triggered events, particularly in their supply chains. Supply chain bottlenecks were seen as the primary cause of financial impacts, as costs for production increased and demand was unable to be fulfilled. With the reliance on outsourcing labor and raw materials, many industries faced supply chain crises that remained unsolved for months to follow. While supply chain issues have been disturbed before, the pandemic brought on a new set of challenges to overcome, and companies were left to make decisions on how to subsequently adapt their business models. This thesis serves to uncover the truth behind how companies handled supply chain bottlenecks, and what the financial implications were as a result.

As for the research component, the information found in the literature review stems from primarily outside sources and consulting articles. The latter half of the thesis delves into interviews with various employers within leading industries affected by the pandemic, and their understanding of the damage the pandemic left behind on supply chains.

Through interviews and research analysis, it was concluded that companies had no substantial changes in their business models during or post pandemic. Moreover, the overwhelming response was that companies saw supply chain bottlenecks as anomalies, or something that can be overcome. However, those that entered the pandemic with a business model conducive to flexibility saw greater success in controlling supply chain issues than those who did not.

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Chapter 1: Introduction

In March of 2020, the world was shaken when the infamous COVID-19 virus spread across the globe and victimized millions of people. Work-from-home became the new norm. Masks were no longer seen as an anomaly but rather a dire precaution, and government lockdowns forced the world to stop almost all leisure activities. What was once described as a flu-like disease, experts quickly dispelled that claim after realizing the highly contagious manner at which it was spreading. Not only were individual citizens negatively impacted, but also, at the macro level, the pandemic disrupted entire supply chain systems, causing stock market crashes, bottlenecks, and insatiable demand for necessary commodities. It was a catastrophic problem lacking quick solutions, as time quickly ticked away.

According to the Federal Reserve Bank of St. Louis, the sharp increase in demand for home goods exposed vulnerabilities in global supply chains (Santacreu and LaBelle, 2022). The rise of globalization in the past few decades provided companies with the cheap option of outsourcing their production to lower income countries; therefore, the manufacturing of these durable goods relies entirely on global value chain (GVCs) (Santacreu and LaBelle, 2022). This exposed a few major risks when the pandemic hit, such as low vaccination rates, high mortality rates, political unrest, and limited access to healthcare. When these countries' supply chains failed to provide adequate supply, it resulted in global bottlenecks. A bottleneck is defined as delays to providing goods and services due to a point of congestion which can result in increased production time and expenses. The supply chain disruptions directly caused high inflation and unemployment rates which made investors look at the connection between supply chain and financial markets much closer.

In the “post COVID-19 world” economists agree that the pandemic exacerbated economic collapses. However, the area that is left unclear is why was this pandemic the first sign of a correlation between finance and supply chain? Pandemics and other epidemic disease outbreaks have occurred in the past, but attention on supply chain disruptions and financial market failures has only recently been brought together.

This study expands upon the unanswered questions of how certain industries were impacted financially due to supply chain successes or challenges and how this affected the broader financial market system. It will also look at historical supply chain bottleneck issues and the effects on financial markets at that point in time. This research helps further the understanding as to how supply chain and finance are interconnected and what this means for the global economy moving forward. The next sections will explore and analyze how companies are addressing their supply chain disruptions as well as what changes, if any, companies are making to their financial business models.

Research Question and Hypothesis

Research Question: To what extent have the bottleneck issues been fixed, and how have firms adjusted their supply chain systems as a result?

Hypothesis: Firms are still struggling with supply chain bottleneck disruptions and have made little to no changes in their business models to readjust their supply chain process as COVID-19 is seen as an anomaly.

Chapter 2: Literature Review

Studies conducted about supply chain bottlenecks focused primarily on the results of the Covid-19 pandemic. However, research also reveals information about historical supply chain disruptions and what affects those had on financial markets. Broadly, these disruptions negatively impacted financial markets, but the magnitude of damage proved much smaller as they did not shock the global economy in the way COVID-19 did otherwise.

Pre COVID-19 Supply Chain Bottlenecks

The COVID-19 pandemic was not the first disruptor to global supply chains. Previous outbreaks and epidemics triggered bottlenecks that made it costly for companies and consumers. A paper written in 2009 by four scholars analyzed impacts on critical infrastructures and worker absenteeism. They described how the influenza outbreak during the mid 2000s impacted freight transportation immensely since it was the most labor-intensive component; as employees became sick or took care of loved ones, it became hard to fulfill demand (Jones, Nozick, Turnquist, Sawaya, 2009). Interestingly, the paper outlined how numerous experts suggested that another pandemic is bound to arise in the future, and there are several steps companies should take to ensure disruptions are minimized. Clearly, a pandemic did arise decades later which left a catastrophic mark worldwide. Therefore, it poses the question of did multinational corporations (MNCs) enact these preventions? Or did they simply believe the foreshadowed problem was smaller than experts claimed? At a macro level, the pandemic notably made demand fulfillment harder across all financial sectors. On the other hand, individual companies at the micro level were able to thrive in the pressurized environment, implying that the pandemic did not necessarily mean chaos for all corporations but rather it depended on a company's business model. Those who created flexible and creative business models proved to be more successful, like grocery store curbside pickup and take-out food deals to combat dine-in lockdowns. On the other hand, corporations who constructed models conducive to short-term survival rather than long-term resilience experienced major struggles with customer loss. One example is Spotify which relied on free users listening to advertisements for steady revenue. After the pandemic, many companies cut back on advertising expenditures, and Spotify saw large declines in their revenue stream. Yet, they quickly pivoted to a more sustainable business model by expanding their original content in the form of podcasts. They signed exclusive deals with celebrities and podcast hosts, and this shift in strategy proved to be immensely successful, even now (Guillen, 2020).

In 2004, the ports of Los Angeles and Long Beach handled roughly 16 million TEU's (twenty-foot equivalent units) of container traffic which accounts for almost one-half of all US container imports (Jones, Nozick, Turnquist, Sawaya, 2009). Roughly forty percent of these containers were handled by the Union Pacific and Burlington Northern Santa Fe railroads. During the summer of 2004, Union Pacific did not have enough trained labor to handle the container traffic because of a federal labor law that triggered early retirements. Clogging of rail yards and congestion of storage areas were the main sources of delay. By September, truckers were experiencing long wait times to pick up the containers, which resulted in further delays to retailers who then could not fulfill consumer demands (Jones, Nozick, Turnquist, Sawaya, 2009). This example illustrates how labor shortages can trigger massive shipping and transportation delays and how they are interconnected.

Similarly, because of the pandemic, many eligible workers could not work due to sickness or taking care of an infected loved one. Other employees, especially in the airline industry, retired early due to the pandemic because airlines require by federal law for pilots to retire by the age of sixty-five. Those who were close to that age retired early as to not fly during a global pandemic and risk increased exposure.

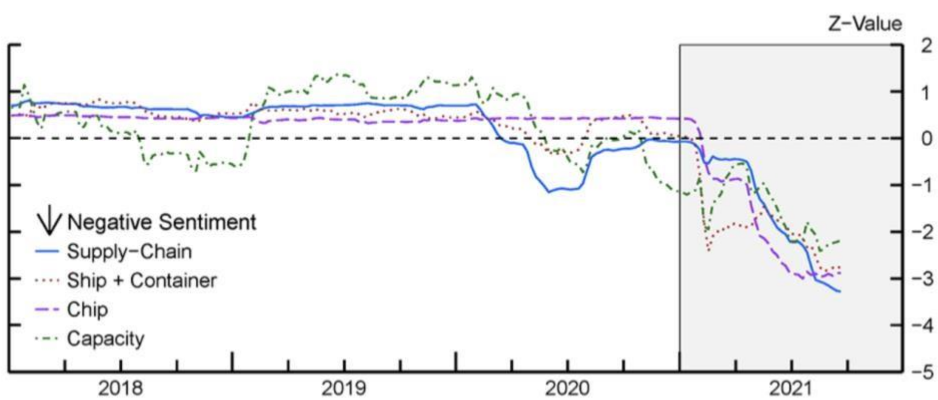
It is difficult to find concrete research that explains why the COVID-19 pandemic created a disruption unlike any other. However, logical reasoning points to the idea that it uprooted people's lives in an entirely different manner, which created a deep seeded fear in companies and consumers on future financial outlooks. Additionally, globalization has expanded tremendously since the early to mid 2000s, and MNCs almost entirely rely on outsourcing production to countries with cheap labor (Shih, 2020). Compared to supply chain bottlenecks before the pandemic, the reliance on low-cost labor-intensive countries has grown stronger, which poses an eminent risk if a global disruption, like coronavirus, occurs.

Coronavirus Supply Chain Bottlenecks and Financial Implications

At the end of 2020, there was a heavy strain on the world's transportation system as demand skyrocketed. During the summer months, supply chain bottlenecks were mostly concentrated in the consumer products sector and automobile industry. Recently, supply chain disruptions have become more spread out across all sectors of the economy. Firms that faced extremely disruptive bottlenecks reported higher prices in their earnings calls relative to firms that did not face turbulent supply chains (Young, Monken, Haberkorn, Van Leemput, 2021). For consumers, this translates into higher prices because there was a lack of supply along with incredibly high demand which led to supply fulfillment issues. Shipments that used to take four days to arrive at their destination prior to the crisis, now required two weeks, almost tripling their fulfillment time.

In a study conducted by the Board of Governors of the Federal Reserve System, they analyzed aggerate firm sentiment indexes of supply chain bottlenecks. They then plotted these time series on a ninety-day moving average, as seen below in Figure 1. Results from this study showed a notable increase in concerns regarding bottlenecks, particularly with regards to shipping services. This directly correlates to tighter capacity constraints which continued to persist in recent months; after the ninety days, concerns significantly worsened three standard deviations below the mean, which indicates that capacity constraints and firm sentiment surrounding supply chain crises are only getting worse (Young, Monken, Haberkorn, Van Leemput, 2021).

Figure 1: Aggregate Negative Sentiment



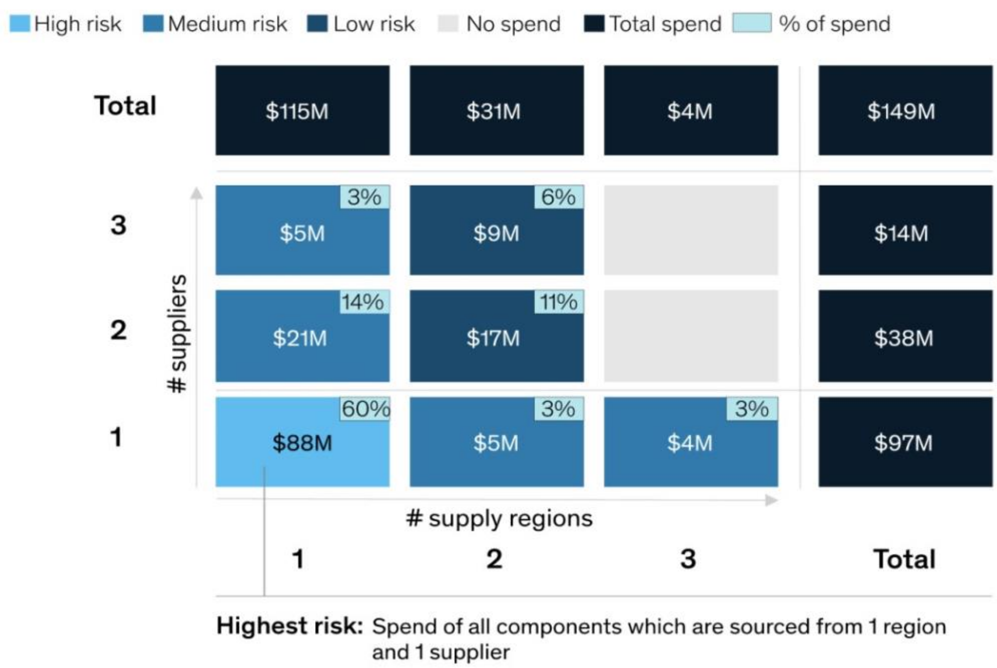
Note: *The Aggregate Negative Sentiment Index is constructed by counting the total number of negative sentiment words found within 10 words of the main search term from quarterly firm earnings call transcripts. This sum is then divided by the total number of words within the transcript and then the 90-day moving average of this ratio is calculated. Data are then aggregated to the weekly level by taking the last moving average value for each week and finally the z-value (z-score) is computed. The z-value is a measurement of the number of standard deviations that sentiment series are away from their mean value. Since the sentiment series have different means, the z-values better reflect relative changes in negative sentiment. The gray shading begins in January 2021. The series end on September 21, 2021.

Source: S&P Global Market Intelligence.

In the past decade, the severity and frequency of supply-chain disruptions are increasing, with the most prominent being the recent pandemic. It is reported that even thirty-day disruptions can bring down corporate EBITDA by three to five percent, so it is crucial for companies to stress test their supply chains. McKinsey defines a comprehensive supply-chain stress test to assess a company's resilience to a disruption using five main factors: industry attractiveness, corporate resilience, supply-chain exposure, operations exposure, and customer exposure (Anstey, Bayazit, Malik, Padhi, Santhanam, Tollens, 2020). In a survey conducted by McKinsey, after COVID-19, ninety-three percent of executives said that they expect to increase their company's resilience by rebalancing their supply chains, which is roughly a twenty-three percent increase in responses from pre-pandemic numbers. Some companies chose to shift component-production locations which reduces not only cost but also logistics and trade risks. With production location sites moved closer to distribution, the logistical risk of transportation has been reduced, as it is now easier to transport the goods to wherever they need to go (Anstey, Bayazit, Malik, Padhi, Santhanam, Tollens, 2020).

The stress test defined above provides insight into specific weaknesses within individual company supply chains and where these companies should implement mitigation solutions. This could include diversifying vertical and horizontal integration to include more local suppliers or digitizing and automizing critical manufacturing to increase production flexibility and efficiency. Some companies choose to rely on one supplier for their manufacturing inputs, rather than outsourcing various suppliers for various components. In Figure 2 below, McKinsey shows how dependency on one supplier creates the most risk for a company, whereas diversification reduces supply chain risk significantly which allows for a company to be better prepared for supply chain disturbances.

Figure 2: Sourcing Spend Based on Number of Sourcing Regions and Suppliers



There is an emerging understanding that supply chain uncertainty and a "bleak outlook" with financial markets are connected. The pandemic gave spotlight to this theory, as beforehand, supply chain and finance were not as clearly linked together, but during COVID-19, analysts understood that the reason markets were down was directly correlated to global supply chain bottlenecks. This is not a new theory as stock markets and company outlook typically falter with uncertainty, but the findings above emphasize the point that MNCs underestimated the damage a disruption to their supply chain can inflict. Post pandemic, supply chain unpredictability has become one of the most pressing issue when making business decisions. However, as mentioned earlier, the solution is the responsibility of companies, rather than the responsibility of regulatory institutions. A company can still succeed with supply chain bottlenecks if organizations can respond to changing demand forecasts. Academic literature on COVID-19 supply chain disruptions examine several industries to better understand how to adjust for future shocks. Three industries in particular, hospitality, consumer product goods, and technology provide the most insight.

Hospitality Industry Impacts from COVID-19

The supply chain disruptions hit the hospitality sector particularly hard because the risks exposed were much greater. The industry relies on human workers who often could not attend work due to illness themselves or having to care for sick loved ones. Additionally, activities like eating out, traveling, and watching movies were all under strict lockdowns, so people were not venturing out of their homes to foster the hospitality industry. Not only did this affect specific companies but also a broader range of business. In Hospitality there are two main sectors under the US BLS: Arts, Entertainment, and Recreations and Accommodation and Food Services. A paper published in the International Journal of Hospitality Management analyzed the Accommodation and Food Services and its resilience to COVID-19 (Aigbedo, 2021). The paper conducted a study that compared unemployment levels in the A&F sector compared to the 2008 financial crisis. What it found was that unemployment exceeded during COVID-19 versus the 2008 crisis, which supports the understanding that financially, the pandemic was the largest disruption in the most recent decade.

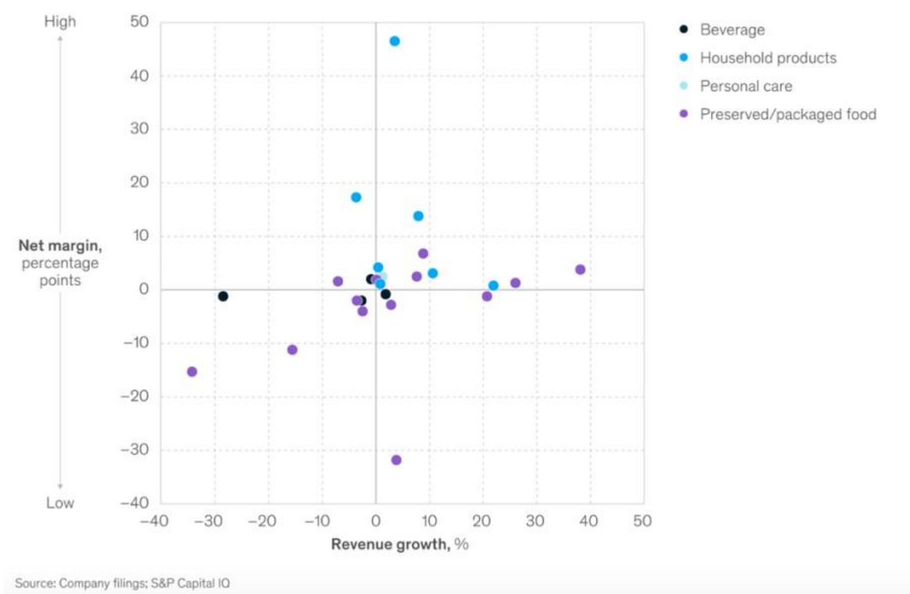
The paper also described how many companies within the Hospitality industry were successful during the pandemic including Popeye, Dominos, Hilton, and Wyndham. This was largely due to quick adaptability including contactless delivery, utilizing outdoor space more, and the “Buy-Now Stay-Later” approach (Aigbedo, 2021). Ultimately, designing a creative business model to adapt to the pandemic directly correlates with success of the business which is defined as positive revenue growth.

Since Feb 2020, US hotels have lost more than $46 billion and 4.8 million hospitality and leisure jobs have been lost. The hospitality and travel industry accounted for about ten percent of the US GDP prior to COVID-19 (Shapoval, Hagglund, Pizam, Abraham, Carlback, Nygren, Smith, 2021). Because it is such a major contributor, how companies show reliance and ability to bounce back from the pandemic directly affects consumers. If a company is not resilient to the unexpected, unemployment rates, prices for food, travel, and lodging increase; in essence, the more expensive it is for the company to produce their good or service, the more expensive it will be for spenders.

Consumer Product Goods Industry Impacts from COVID-19

Due to more people being online as a result from pandemic lockdowns, consumers became avid online shoppers, and a study conducted by Global Web Index saw a 10.5% increase in social media usage in July 2020 compared to July 2019 (Snyder, 2023). With more people online means higher engagement with brand advertising. The pandemic brought in an unprecedented level of brand switching with seventy five percent of consumers trying new shopping patterns and thirty nine percent of those consumers shattered their brand loyalties (McKinsey, 2023). This amount of brand growth, however, exacerbates the bottleneck problem as these companies cannot keep up with their skyrocketing demand and limited supply. An article by McKinsey discusses the effects of the pandemic on the Consumer Product Goods (CPG) industry. McKinsey notes that brand growth was the highest in 2020, but actual demand fulfillment was significantly low due to supply chain restrictions (Alldredge, Henrich, Lal, Verma, 2021). At certain points, elastic goods became inelastic; toilet paper demand spiked eight hundred forty-five percent in 2020 as the pandemic drove people to panic buy common goods (Narishkin, Cameron, Barranco, 2020). Because people were working from home, demand for prepackaged goods was exceedingly high, especially snacks, bath supplies, dish care, plastics, frozen food – see Figure 3. Yet, company performance varied even within the CPG category. Like the Hospitality sector, the pandemic itself disrupted entire systems at a macro level but company performance at the micro level depended on its resilience. Even so, costs of production remain high overall as manufacturing costs are still higher across the board compared to pre-pandemic prices. The analysis further explains that the main revenue challenges post-pandemic for CPG are brand switching, competition from smaller brands that gained popularity during lockdown, greater price transparency, and pressure from big retailers like Walmart (Narishkin, Cameron, Barranco, 2020).

Figure 3: Q2 year-over-year changes, 2019 to 2020



The Technology Industry Impacts from COVID-19

The chip industry has been facing struggles since the rise of the COVID-19 pandemic. The global computer chip industry accounts for roughly $600 billion in output while being extremely concentrated in certain areas (Jakeman, 2022). Predominantly, production occurs on the small island of Taiwan. The growth of the chip industry moved increasingly fast, but as companies pushed for smaller and smaller chips, the laws of physics became a challenge. One of the foundational elements is lithography or using light to print or remove material to shape the chip. By the early 2000s, the chip had become so small that even ultraviolet light was too large of a wavelength for accurate precision. A Dutch company, ASML, specialized in lithography and tried to explore using extreme ultraviolet light (EUV). The process to use this is extremely difficult and incredibly expensive. The lasers used to melt metal require half a million parts and each machine costs US$100 million, which is "the most expensive mass-produced machine tool in history" (Jakeman, 2022). The Taiwan Semiconductor Manufacturing Company (TSMC) accounts for eighty-five percent of global supply of the most advanced chips that are used in smartphones and other powerful devices (Jakeman, 2022).

The leading chip supplier produces for major Chinese companies, as well as Amazon and Apple. The world's reliance is almost entirely on this company; but what does this mean for consumers? A multibillion-dollar corporation like Apple relies entirely on one company in one country for its core technological components, which proved detrimental during the pandemic. When the global disruption occurred (i.e., the pandemic), Apple products became more expensive. Consumers were not able to go to a Best Buy and buy a MacBook immediately, all because of the increasing dependency on global supply chains. Not only did customers feel this effect, but also in 2021, Apple reported a loss of $6 billion in sales due to chip shortages

(Rosenbaum, 2021).

The automobile industry was equally hit hard during the pandemic. In 2021, they lost more than $200 billion in revenue with eleven million fewer cars produced (Walsh, 2022). There are several reasons that contribute to the chip shortage and the pandemic exacerbated it: labor shortfalls, lack of raw materials, trade tensions, and growth of 5G electronics which requires more chips than other generations of devices (Walsh, 2022). Primarily, supply chain issues rested on a foundational constraint: the process of creating crystals for silicon wafers for microchips. These grow at a fixed rate, so it is entirely based on physics with no way to expedite the process. Therefore, companies have been taking steps to reuse and retrofit by trying to bring facilitation plants back to the US and adapting manufacturing processes to take whatever microchips they can get. Nonetheless, cars can be entirely built but be missing one key component that inhibits companies from shipping it off the lot. The cars then sit in long term storage containers as they devalue in worth (Walsh, 2022).

The main key problems that the pandemic created are:

1. Inflexible business models
2. High brand growth that cannot fulfill demand
3. Reliance on one key supplier

Although companies are “trying” to solve the issues, the question arises of whether they actually are. Evidence suggests that companies may be putting up a “façade” that their production lines are changing, when, nothing is concretely changing but lofty goals that prove to be costly and sometimes unreasonable.

Chapter 3: Methodology

The methodology behind this research focuses on interviews with Fortune 500 company executives in the CPG, Tech, and Retail space. As some of the information is confidential, the names of the executives and the companies they work for are kept anonymous. They will be listed as Executive X, Y, and Z at companies X, Y, and Z, respectively. The interviewees were chosen at the direction of the thesis reader, Dr. Robert Novack. Questions related to the interviews can be found in Appendix A. The goal of these interviews was to provide more in-depth knowledge as to how the pandemic shifted the way companies approach their supply chains. Through extensive research, there is limited data showing that companies have restructured their business models to adapt for future supply chain bottlenecks. The questions asked in the interviews act as a guide to uncover the “truth” behind corporation’s models in a post COVID-19 world and compare that to what the media reports.

The case-study style methodology allows for personal insight that raw data analysis cannot provide. While companies may have reported earnings during the pandemic and even post, that does not necessarily equate to a successful supply chain model. By asking leaders within the organization what their thought processes were when discussing production bottlenecks, as well as why their company made certain business decisions provides maximum detail into how companies are changing post COVID, or are they at all? The types of questions asked were tailored to focus on their roles in supply chain, and what they envision for the future. Is the company going to switch models to something more flexible? Are they satisfied with their current plan? What was it truly like dealing with supply chain bottlenecks during the pandemic compared to how it is now? The interviews from the three different industries hope to encompass the reality of the corporate response to the supply chain crisis and forecast what companies envision for the future.

Chapter 4: Analysis

This chapter will focus on the responses of three different supply chain leaders at their respective companies. The three companies selected resided in the retail, consumer product goods, and technology industries. For example, the retail company will be referred to as "Company X" and the corresponding employee will be referred to as "Executive A". See table below for the reference pseudo names. The interviews revealed a sample of insights into the effects that COVID-19 had on supply chains across the globe, and how companies are now self-reflecting on how they can improve their business models to mitigate future risk as much as possible.

Table 1: Interview References

Industry	Company Name	Executive Name
Retail Industry	Company X	Executive A
Consumer Product Goods Industry	Company Y	Executive B
Technology Industry	Company Z	Executive C

Interview: Online and Brick & Mortar Retail

Speaking with a supply chain expert at a company that supplies their products to a popular retail corporation illuminated differences of their manufacturing processes pre and post covid. Company X specializes in products dealing with home improvement, so the biggest change they experienced with consumer spending during the pandemic was the spike in demand for “do it yourself” projects. With lockdowns, families started to tackle home improvements themselves, which required spending money on tools and equipment to execute those projects. Executive A explained how families were given stimulus checks from the government every month for twenty-four months, and an in-depth study showed them that this influx of disposable income went directly into home spending. One of the biggest challenges was the unknowing of how long the spending “spree” would last. Company X faced more demand than imaginable with safety stock levels typically two months of inventory; now, Executive A said the pandemic created a six-month lead time which was extremely hard to manage and predict.

When looking into the future, Executive A claimed that COVID-19 exposed the weaknesses the company had overlooked due to a naturally stable environment. When disruption occurred, all the weaknesses surfaced to the top, and it became imperative to fix them. For instance, the unprecedented demand for PCBA and chips along with lack of supply of raw materials led to shortages in the production of goods and revealed flaws in the manufacturing process. Once the company highlighted the inefficiencies on the production line, they were able to improve their long-term planning with an eighteen-month horizon while acting strategically about their sourcing.

One of the ways Company X addressed them was through increased collaboration efforts amongst all parties involved in the supply chain. While they met once a month already, Executive A explains how they started meeting a few times a week to make sure everyone was on the same page. The goal was to increase intensity and frequency of these meetings, as collaborating on end-to-end supply chains were key ingredients to success. Furthermore, during the discussion regarding the impact globalization has had on their supply chain system, they agreed it proved tremendously difficult to rely on other countries who followed different lockdown protocols, as it was entirely out of their control. However, the overwhelming response was that globalization helps production efficiency and is cost effective which offsets any setbacks the pandemic presented in the long run.

Interview: Consumer Product Goods Industry

The CPG industry boomed during the pandemic, as demand for pantry stocked items exceeded supply. With the newsworthy headlines of consumers overstocking their household with toilet paper, Executive B discussed how their company saw unprecedented demand in items like condiments, ice cream, and cleaning products. As promising as it was to see the company grow at a rapid rate, the biggest challenge encountered revolved around mitigating waste. Certain product lines became more resistant to COVID-19 than others, and those that did not, had to be scaled back in production to avoid significant waste in the supply chain. To do this, Company Y engaged with third party manufacturers to increase capacity and used company facilities that were not at full capacity to make more product. For instance, one of their plants in Asia ran under capacity, therefore the company ramped up production for certain goods in that facility and then shipped it to the United States for distribution. This approach seemed costly at first but supported the company in the months to come, as it became easier to fulfill demand.

When asked about company adaptations to their supply chain post pandemic, Executive B reflected on any changes to their business model. They confirmed that there were no fundamental changes as a result of COVID-19 because the corporation saw the disruption as a one-off incident. The most noticeable change included entering business streams that they were not a part of before. Company B found that some of their raw materials could be useful in creating new product lines, which ultimately proved valuable during the pandemic. This is not to say that the company did not face financial hardships, even with growing businesses. Executive B states that costs increased dramatically during COVID-19 with a need to pay high prices for extra suppliers. Competition for suppliers fueled high costs as many suppliers shut down manufacturing plants for a variety of reasons, so even in countries where production costs are normally low, they demanded premium prices for their services. Additionally, Company B paid more in logistics costs which include ocean freight, air freight, and truck freight. Maintaining social distancing practices were costly with the additions of masks, hand sanitizers, and other protective gear. However, to offset some of these expenses, Company B saw much higher sales in the U.S. for particular product lines; in other words, the overall financial impacts were significant, but the outcome was mixed.

Interview: Technology Industry

While speaking with Executive C at a predominant technology company, they were able to shed light into their experiences as a supply chain leader and dealing with the chip crisis. As almost ninety percent of the technological chips required for tech products are produced in Taiwan, when the pandemic began, the country went into stringent lockdown, and chip production fell flat. This resulted in a global chip shortage; Executive C goes on to explain how it required Company Z to be consistent and sure of what the demand would be for their products, because if they could not acquire the chips they needed, then they had to see how much demand would be unfulfilled and to plan accordingly. Much of the hardship revolved around coming up with creative ways to procure the chips or use other technological chips to produce the same product. Another solution was to find a different supplier not based in Taiwan or bring production in-house. Although finding a solution to the basis of multiple products lines became quite difficult during the pandemic, all technology-based companies experienced the same burden. They physically could not source any more chips than they already had, so bidding higher prices for the product would not have been fruitful either.

In terms of adaption to their supply chain, Executive C outlined one key area that drastically changed the way they carry out business. A portion of the business focuses on auditing facilities and suppliers to ensure they are safe for workers and business can be conducted. The procedure was extremely costly with travel, but when the pandemic hit, the company could no longer travel to the site in person. Company Z designed virtual audits as a solution where a factory worker would take a camera and do the audit while leaders would watch from beyond the screen. They found that this method worked equally as well as in person, and it saved a substantial amount of money. Executive C further explained how they scaled back the amount of in-person audits they do now and will only go in if the facility is quite large to see over a screen. The business model now conducts about seventy five percent of audits virtually and twenty five percent in person, marking a significant change in the way they perform a business operation.

Especially with the technology industry and the over-reliance of one main source for chip production, I asked Executive C whether globalization made the supply chain bottlenecks worse. They replied by saying how yes, outsourcing to other countries to manufacture products or obtain raw materials has caused bottleneck issues, but it has also helped because there are so many more options globally to solve those issues. In other words, globalization offers alternates and new suppliers, whereas keeping suppliers in-house does not allow for flexibility. In agreeance with the rest of the Executives interviewed from the other industries, Executive C saw the pandemic as a blip in the road more than a wakeup call, stating that much of the time, globalization has significantly helped the company versus hurt it.

Chapter 5: Conclusion

It is hard to pinpoint a clear answer as to how companies should address their supply chain bottlenecks for the future. While the financial impact was dire across the board with increased costs, some industries benefitted from the pandemic through new product lines or target markets. If another pandemic were to occur within the next five years, all three employers interviewed said their company would be better, if not equally prepared. There are numerous lessons learned of what works and what did not, which would result in a faster turnaround of what to do in a crisis. When conducting the interviews, it was important to contrast the actuality of what companies are focusing on post-pandemic and what the media is claiming they are doing. Consulting with more companies within each industry could have made the findings stronger and more convincing to the reader. Further opportunities for research on this topic can look at the length of time companies continue to see negative financial impacts post-pandemic to shed light into the inefficiencies of supply chains.

The most interesting observation was how each industry leader did not try to hide the notion that their business models have not explicitly changed because of COVID-19. In many of the articles researched regarding company response to the pandemic, the findings centered around company restructuring to ensure disruption does not sidetrack them again. However, when sitting down with current executives, they openly stated how they simply understood their weaknesses exposed and implemented short-term solutions rather than upheaving an entire operations model. This idea supports the hypothesis that companies are making little changes to their supply chains, despite the financial impacts the pandemic left.

From a globalization perspective, it was clear that the virus derailed corporation operations. Yet, companies still rely on the cheap labor and production costs because it is more beneficial in the long run. While there is no right or wrong answer per say, companies must look at the gross margin of the product sold and its market share to determine what business strategy would work best. Supply chain segmentations run different supply chain networks, so while some lines need one factory, others may need multiple nodes across the globe. The more diversified a supply chain is, the more accurate and visible forecasting demand will be.

Appendix

Sample Interview Guide

The purpose of this research is to identify the implications of the pandemic on global supply chains and their repercussions in the U.S. financial markets.

1. Could you describe your experiences working in supply chain during covid and how you adapted your role to adjust to the pandemic?
2. What were the biggest challenges you encountered when fulfilling demand?
3. Has the company adapted their supply chain post covid or made any business model changes, and if so, how?
4. How do you measure risks in your job?
5. What do you see as the biggest impact financially to the company?
6. Do you think globalization made the pandemic supply chain bottlenecks worse?
7. What do you think would happen if another pandemic were to occur in the next 5 years? Do you think your company would be better prepared for it?

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ACADEMIC VITA

RITIKA NAGPAL

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EDUCATION

The Pennsylvania State University | Schreyer Honors College — **University Park, PA**
Smeal College of Business | Bachelor of Science in Finance — May 2023
Minor in Legal Environment of Business

LEADERSHIP AND INVOLVEMENT

Alpha Kappa Psi Co-Ed Professional Business Fraternity — **University Park, PA**
Vice President of Community and Culture (Jan 2020 – Jan 2021) | Pledge Master (Jan 2022 – Dec 2022) — *Dec 2019 – Present*

- Spearheaded logistics and financial budgeting of weekly bonding in person and virtual events such as brother blind dates, pledge class Olympics, a virtual bakeoff and birthday celebrations which aimed to strengthen unity for the brotherhood of 111 members
- Oversaw the Fraternal Development, Special Events, and Social Chairs to coordinate and plan at least one Covid-19 friendly event per week and organized an induction and initiation ceremony over Zoom between the incoming pledge class and brotherhood
- Supervised a group of 25 underclassmen through an eight-week pledging process which included weekly meetings, community service and brotherhood events to develop fundamental professional skills to be a future business leader

Penn State Dance MaraTHON — **University Park, PA**
Donor Outreach Captain (Sept 2021 – April 2022) | Alternative Fundraising Captain (Present) — *Sept 2021 – Present*

- Assisted in the largest student-run philanthropy committed to provide emotional and financial support for children and families impacted by cancer by heading year-round fundraisers while actively attending weekly educational meetings with 23 other co-captains
- Processed monetary donations by entering checks deemed as problems from donors into their respective THON databases and printed out letters to donors verifying their donation to ensure that all organizations are credited accurately and efficiently
- Initiated a new project that allowed for donors who could not be recognized due to errors with their donation form to still be recognized by creating a resubmission form for donors to fill out and submit with the correct information to be acknowledged in THON 2022
- Tracked all alternative fundraising donations from over 400 organizations on Penn State's campus by verifying org totals through Excel spreadsheets and an internal THON platform to correctly account for money raised during the year

Schreyer Consulting Group — **University Park, PA**
Vice President of Corporate Relations — *Sept 2019 – Sept 2022*

- Developed critical thinking, business acumen, and presentation delivery by conducting numerous case studies with industry experts and pitching solutions to organization's executives while also leading club wide meetings on these topics to younger club members
- Directed and marketed a student-run case competition by creating social media campaigns around campus newsletters to reach a wider audience while also contacting company recruiters from various consulting firms to judge and critique the case presentations

PROFESSIONAL EXPERIENCE

PricewaterhouseCoopers — **Chicago, IL**
Operations Transformation Management Consulting Intern — *Jun 2022 – Aug 2022*

- Engaged with a gas and utilities client to transform their supply chain process from paper to an Oracle based software platform
- Earned a Human-Centered Design Badge through various modules engaging in agile thinking, and data-driven storytelling while also incorporating opportunities on how to apply human-centered perspectives into problem-solving with clients

University Professional and Continuing Education Association (UPCEA) — **University Park, PA**
Research Consulting Intern — *Jan 2021 – May 2021*

- Conducted research analysis for 3 higher education institutions to evaluate the strength of their online assets by using a UPCEA service which identifies and analyzes 12 website and social media specific variables which is used to create a recommendations report
- Proposed over 20 healthcare focused graduate certificate offerings with an estimated $500k of expected annual revenue to a small, private health science focused institution through course inventory analysis, competitive benchmarking, and market research

PPG Primer Internship — **Pittsburgh, PA**
Financial Transformation Intern — *May 2021 – Aug 2021*

- Assessed PPG's financial data of their nine SBU units by creating visual dashboards in Excel and ServiceNow to present to executive business leaders about future process improvement through cost savings and critical thinking analysis
- Collaborated with 77 interns and networked with 20 PPG professionals in leadership workshops to develop future design thinking and critical analytical skills which resulted in creating a custom PPG app that allows consumers to purchase paint virtually and in 3D

SKILLS, HONORS, AND INTERESTS

Skills: Familiarity in C++ and Python, Working knowledge in Microsoft Office (PowerPoint, Excel, Word)
Honors: Sam Wherry Scholarship, Deloitte 2021 National Undergraduate Case Competition Winner, Lean Six Sigma Yellow Belt
Interests: Tennis, *New Girl*, Frank Ocean, The Pittsburgh Steelers, Thai Food, Online retail shopping, Quentin Tarantino, Catan