

The Effects and Aftermath of the Coronavirus Pandemic

Final Project Report - Group 5

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Executive Summary	2
Introduction	2
Objective/Motivation/Problem Statement	2
Identification of Relevant Issues to be Analyzed	2
Agricultural Economics	3
Chemical Engineering	3
Computer Science	3
Petroleum Engineering	3
Analysis	3
Agricultural Economics	3
Chemical Engineering	4
Computer Science	7
Impact of COVID-19 on Students and Instructors	7
The Digital Transformation of the cloud	10
Petroleum Engineering	11
The Fluctuation of Oil Prices	11
Production Rates	13
Employees during the Pandemic	14
Conclusions	15
Agricultural Economics	15
Computer Science	15
Petroleum Engineering	15
Recommendations	16
Agricultural Economics	16
Chemical Engineering	16
Computer Science	16
Petroleum Engineering	16
References	17

Executive Summary

In 2019, a virus that came from China was introduced and rapidly spread throughout the world. This virus became known as COVID-19 or Coronavirus. As much as this virus has affected our everyday lives, it affected workplace life more than anyone could imagine. The workplace has gone through many different things through these last two years. Changes occurred during the lockdown like working remotely, to the “rebuild” phase like hybrid approaches to coming into the office and working remotely or wearing masks in the office. Group 5 represents 4 different disciplines of work that occur in the United States, they are Agricultural Economics, Chemical Engineering, Computer Science, and Petroleum Engineering. Each discipline may have undergone similar or completely different strategies or changes during this stock that COVID-19 created. Our goal is to establish whether each discipline learned from this virus and the advances and changes that were made in case something like this happens again, also if any of these changes were similar or different from one another.

Introduction

The Coronavirus Pandemic has caused a massive economic shock to the US and all countries around the world. Here in the United States it has caused a shock that is roughly three times worse than the 2008 financial crisis. It has completely revolutionized society since its discovery in late 2019. Society has been through a lockdown, a “rebuild” phase, and almost another lockdown. It has shaped human life more than we could’ve ever imagined. For how much it had shaped everyday life, it changed our industry even more. Industry as we know it today is a completely different lifestyle than it was in 2019, from more people wanting to work remotely to people not getting enough opportunities to work overtime. From the manufacturing standpoint, AWC Frac Technology (a oil field manufacturing company Tucker interned for in 2021) has every single worker, ranging from CEO to welder, only making 60% of their salary. Logistics have been heavily impacted by the pandemic, from new rules for companies to comply with and supply shortages putting stress on multiple industries. We plan to find out what ways industry has changed to address rising issues and to keep the workplace procedures safe.

Objective/Motivation/Problem Statement

- Each discipline from Group 5 will research and analyze lessons learned from the Coronavirus Pandemic and advances that were made as a result of this virus.

Identification of Relevant Issues to be Analyzed

Agricultural Economics

- Lower price yield in crops

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- Difficulty finding buyers for crops during the pandemic
- Higher costs for farming necessities

Chemical Engineering

- Supply and demand disruptions and inconsistencies effect on manufacturing
- Logistics disruption exacerbating effect on supply chain
- Workplace worker safety, worker scarcity, and possible solutions

Computer Science

- Impact of COVID-19 on students and instructors
- Digital Transformation of the cloud (i.e. cloud computing)

Petroleum Engineering

- The fluctuation of Oil Prices during 2020
- Production Rates
- Employees during the Pandemic
- Lessons learned in our industry

Analysis

Agricultural Economics

With the pandemic making its way around the world it is affecting our food sources at the farming level which could affect everybody and it has as of now. The COVID-19 outbreak has put a stop to many things we normally did in our daily lives.

Our farmers are being affected left and right and they cannot seem to catch a break. Our producers are experiencing lower yields in their crops which is making it difficult for them to justify producing more when they are making less per bushel per say. Farming is not an easy way to make a living and even harder when you are hardly breaking even, it makes it difficult to make a living out of it. The cost of harvest goods in stores have increased dramatically but that does not benefit the farmer in any way, the extra cost and profit goes to the big name producer that buys from the farmer and distributes to the grocery stores and restaurants. The farmers and producers are experiencing lower yields due to the inability for the food sector to find people to work and be steady workers at that.

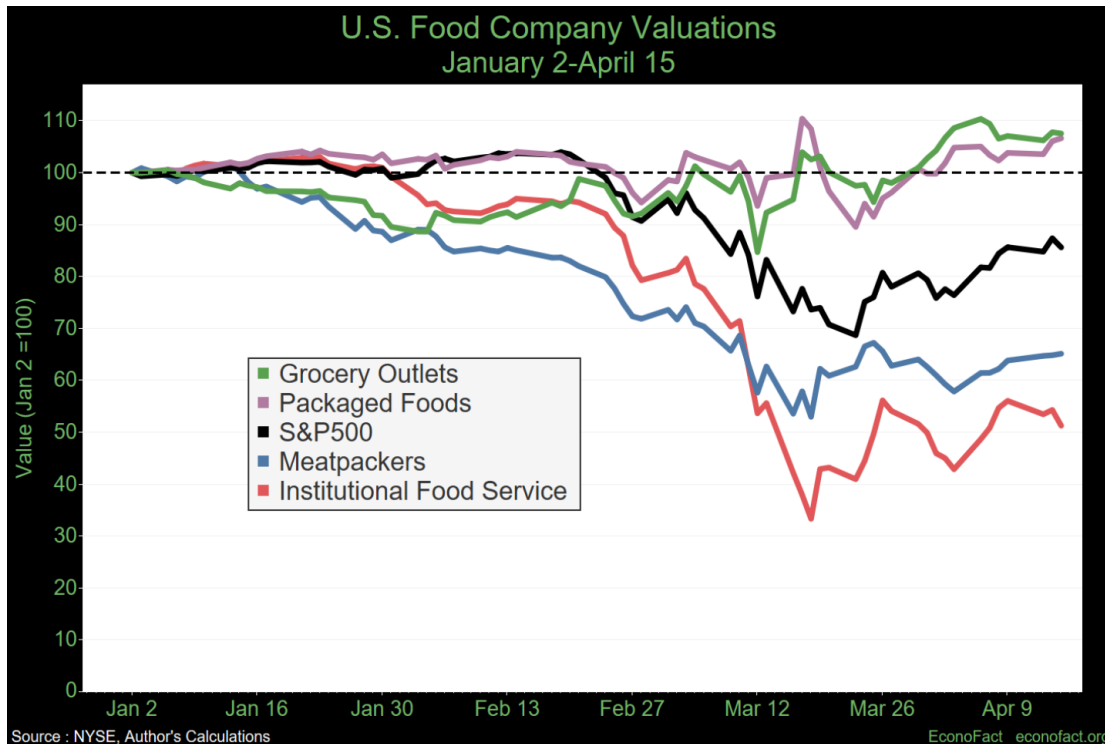


Figure 1 : shift in commodity prices

With the inability for the food sector to find workers they cannot afford to purchase crops and get them prepared and shipped to stores and restaurants, the supply chain is broken in this industry and seems to be getting worse as the pandemic drags on. With the supply chain being broken and it more difficult to get products it has inadvertently raised the price for goods in the farming industry.

The farming industry is not a rich industry, yet it is an expensive industry to be a part of and people work hard for everything that they have and want. The costs of some of the necessary farming supplies and implements have increased in price such a dramatic manner that it is simply too expensive for some farmers to be able to afford and making their lives that much harder. Farmers have certain pieces of equipment that have to be replaced every couple years or even every harvest or planting season. Our producers cannot keep up with prices as high as they are and a change needs to happen or else the COVID pandemic can easily turn into a hunger pandemic.

Chemical Engineering

With the pandemic came lockdowns, consumer panic, and workplace upheaval. Such changes affect the entire supply chain from consumers and retail to manufacturing and raw materials.

Downstream companies experienced a strong shift in consumer behavior, with some types of goods increasing in demand immensely and other goods losing most of their demand. This shift was fast and the manufacturing response was often not fast enough for such changes, resulting in some surplus of low demand items but scarcity of high demand products. After the

recovery period began and governments started easing restrictions consumer behavior changed once again, though more slowly. Companies are still struggling with supply shortages. Manufacturing industries have needed to respond to dramatic changes in demand both decreasing and increasing worldwide within a period of only a couple of years.

On the other side, manufacturing has also run into supply chain issues from upstream in the form of raw materials scarcity, a lack of materials to manufacture products from. This causes suboptimal and inconsistent manufacturing which can cause adverse effects on the economy and societal behavior. Substitution practices and products were exercised in order to dampen the effects of inconsistent supply at both manufacturing and consumer levels. Many companies were unprepared or struggled to find available alternatives or substitutions for critical production steps.

Many prominent issues along the entire supply chain are exacerbated by problems with logistics. Worldwide logistics issues amplify raw materials scarcity, supply shortages, moving product from place to place. What are the causes of these logistics issues? One reason may be the increased health safety restrictions and regulations on international imports that not only vary from country to country but can vary within a country as well. These limitations slow down the movement of goods and may bar some imports. Areas under high containment have even higher delay times. Another reason adding to logistics problems may be the lack of transport availability. Some countries, such as India, have suffered from a shortage of vehicle transportation such that only a fraction of existing commercial vehicles are actively being used (Alok Raj). Storage inventory stockpiling can possibly run into capacity constraints where warehouses and distribution centers are holding inventory in anticipation of demand. Such stockpiling may run into perishability issues or block working capital from functioning efficiently. Finally, the issue of how to deliver products to customers has changed dramatically due to the pandemic. Demand for non-contact delivery and postal or delivery services skyrocketed during the height of the pandemic. However, as society reopens to normal this demand has decreased but will likely continue at a higher rate than before the pandemic. Logistics continues to be a lasting issue in many places worldwide.

Worker participation dropped as a result of many companies focusing on responding to the pandemic crisis by cutting hours and staff while increasing viral safety by instituting masking, social distancing, and other hygiene practices. Process and manufacturing industries are no exception to these changes. Many problems mentioned thus far are caused in part by the lack of workers in industry and logistics, places where remote work is not possible or is inefficient. Worker scarcity is a prominent issue that continues to affect the entire supply chain even after the recovery period began.

Process industries have struggled to keep their workforce safe from the virus while continuing operations efficiently. These industries are slowly increasing their technological integration but still require a sizable skilled labor force able to communicate quickly without impediment. Digitization of these industries often does not reduce the amount of personnel necessary but instead incentivizes integration of human capabilities with technology. It is clear that humans will continue to take a central role because they govern systems and can address a variety of situations with flexible solutions (Giuseppina). The problem that needs to be solved is how to keep the workplace safe and effectively running under pandemic restrictions.

One possible solution could be to increase digitization of process operations allowing for personnel to interact with equipment remotely. The amount of innovation, design, and capital investment to create such a workplace puts this solution requiring long-term planning. For workers in-person there were many preventative and mitigative elements that were adopted in order to create a more safe work environment.

For the purpose of visualizing the layers of protection against COVID-19 and other potential contagions the LOPA method used by process industries can be approximated for epidemiological management as shown in the following figure from (Md Alauddin).

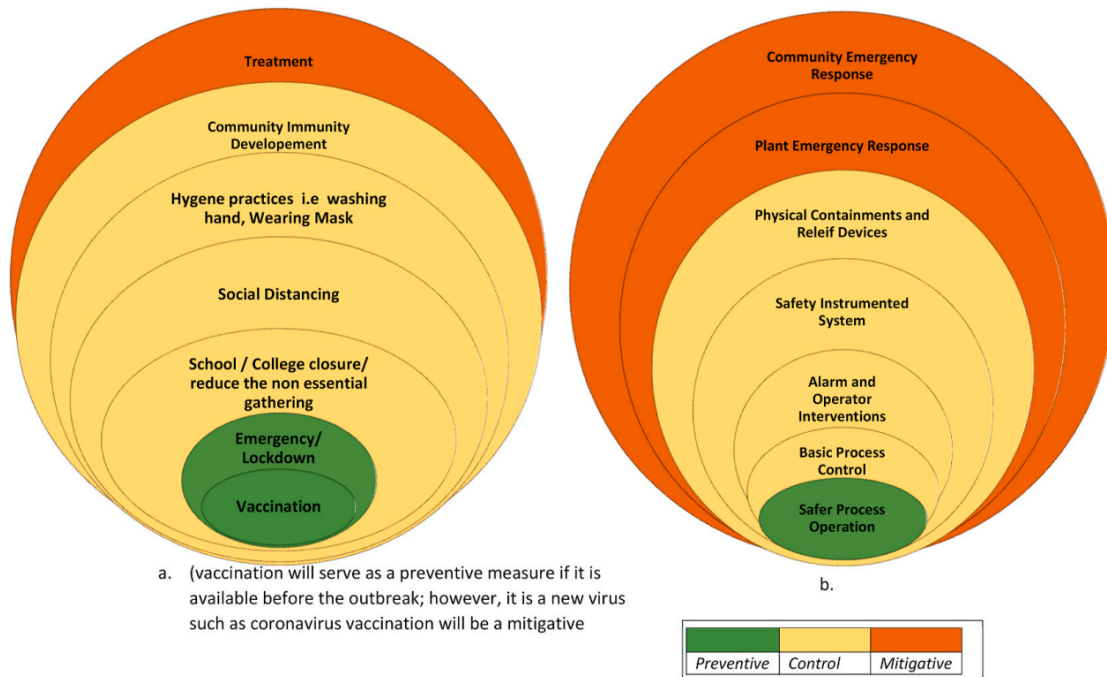


Figure 2: Layer of protection analysis (LOPA) for (a.) Epidemic management (b.) Process safety

The preventative and mitigative elements presented in these visualizations still need to be verified as effective measures, just like process elements must be effective safety barriers. Bow tie analysis can also be used to visualize preventative and mitigative measures that can be applied within an organization or applied to the general community. Following figure developed by (Kayleigh Rayner Brown).

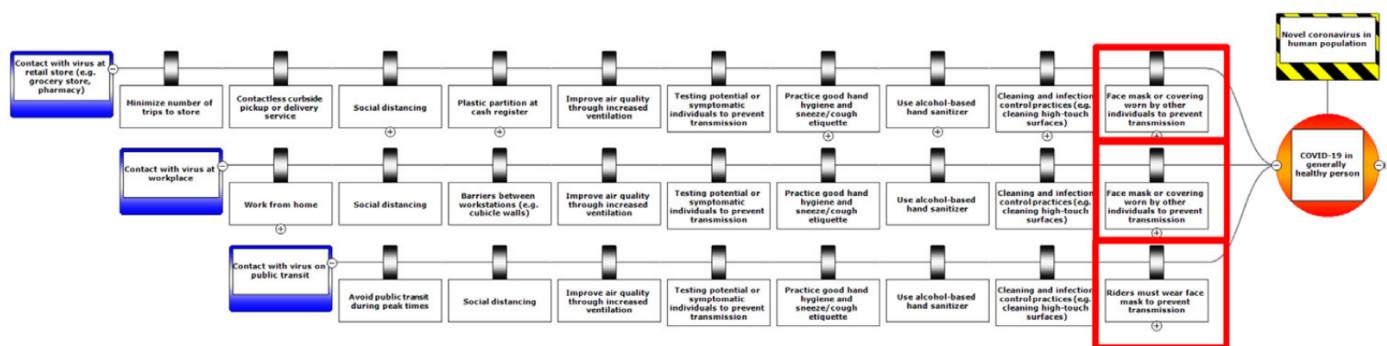


Figure 3: Bow tie preventative measures

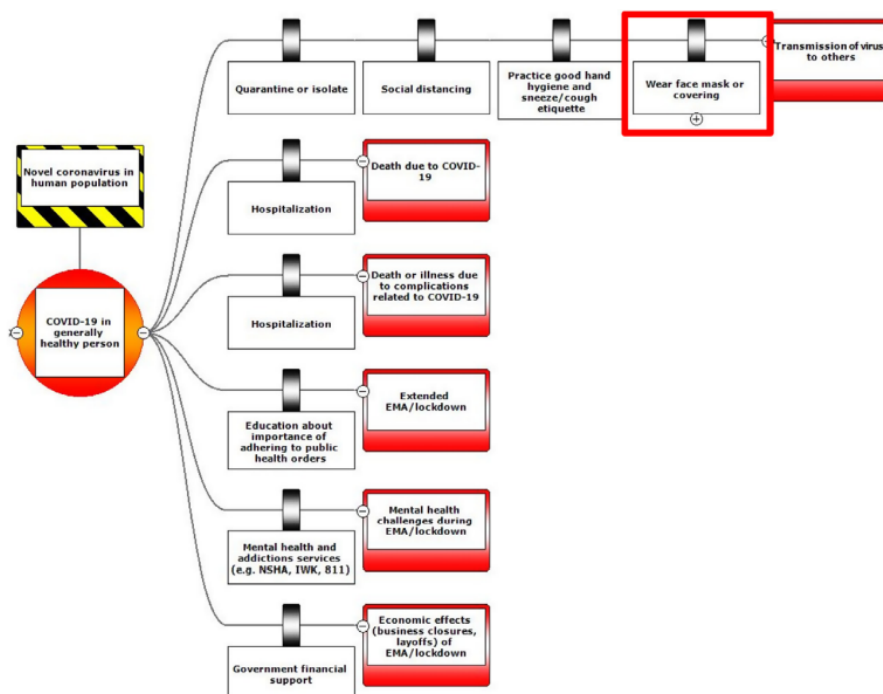


Figure 4: Bow tie mitigative measures

Computer Science

Impact of COVID-19 on Students and Instructors

The pandemic affected students in a variety of ways. Prior to COVID-19 the average student spent most of their education in-person. In-person learning provided students with a multitude of ways to keep track of their responsibilities and due dates. Professors would announce upcoming due dates in class and for many universities attendance was mandatory.

Group 5

With the acquisition of platforms like Zoom and Google Classroom and the state of the world during the pandemic students no longer were required to attend class on virtual video platforms. In fact, many professors opted to provide students with pre recorded lectures and e-book reading assignments. Intrigued by the changes to students lifestyle Iman YeckehZaare from the Symposium on Computer Education conducted a study to analyze students interaction with the e-book that their professors provided. Utilizing multiple regression models, he analyzed how many students were engaging with the e-book and how they were engaging in it. He compared two sequential winter semesters of the course, one prior to the pandemic (Winter 2020) and one during the initial stages of the pandemic (Winter 2021).

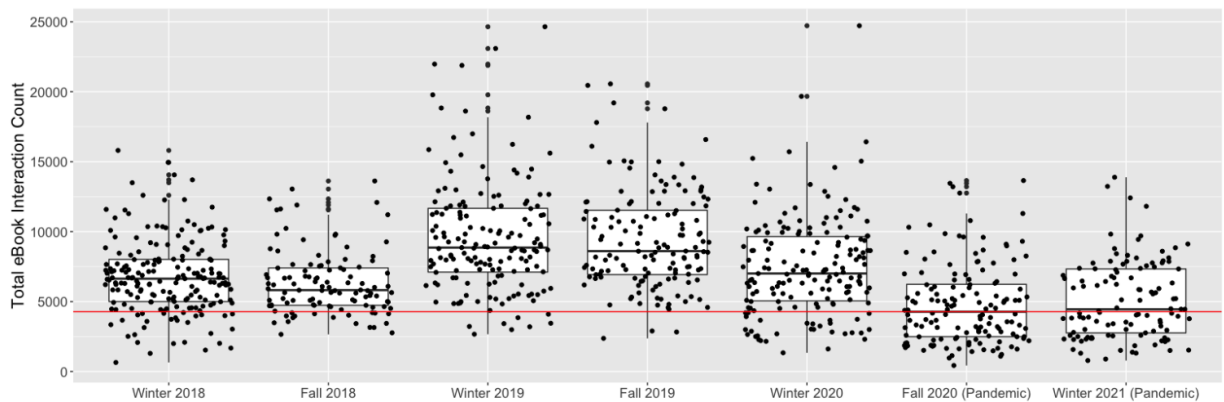


Figure 5: Total eBook interaction count

After accounting for any confounding variables, students had 1,345.87 fewer ebook interactions during the pandemic when compared to the semester prior to the pandemic. This trend is very apparent in figure 5. **Figure 5** shows the total number of student interactions per semester from winter 2018 to winter 2021. The horizontal redline in the figure corresponds to the median total ebook interaction count among students in the fall 2020 semester (during the pandemic). As shown the median usage of the e-book is much higher in the semesters before the pandemic. Not only were fewer students using the e-book, they were also using it for a shorter period of time.

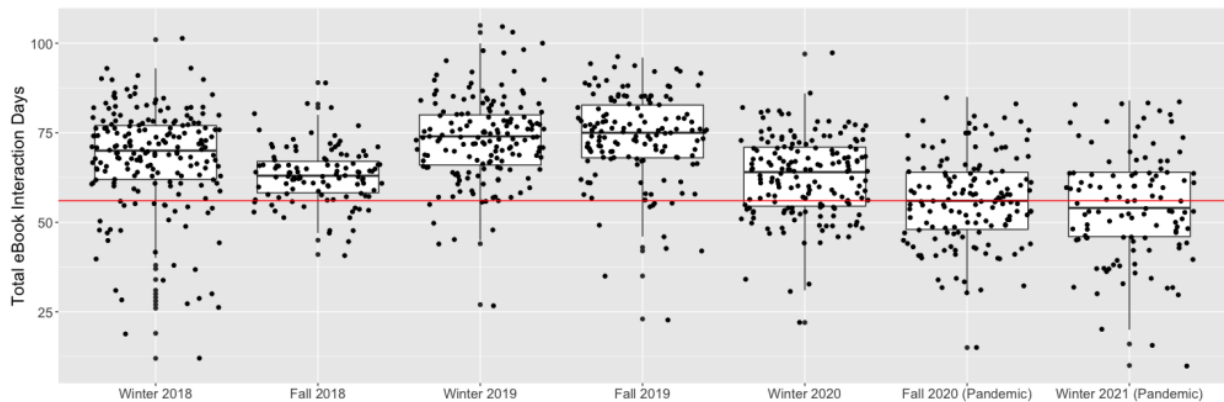


Figure 6: Total eBook interaction days

In fact, the study shows that students had 2.36 fewer study days during the pandemic. The impact on study days is clearly visible in figure 6. **Figure 6** displays the total ebook interaction days per semester from winter 2018 to winter 2021. The horizontal redline in the figure corresponds to the median total ebook interaction days among students in the fall 2020 semester (during the pandemic). Prior to the pandemic, students spent a significantly larger amount of their time on their e-book. Overall, this finding is astonishing because more professors relied on e-textbooks to teach their students due to the fact that paper-pencil assignments were no longer allowed.

As soon as the pandemic started professors and teachers all across the globe had to adapt their curriculums and teaching styles to the new normal. For remote learning to be effective it requires three components : suitable technology, devoted learners, and effective teachers. Governments and instructors all over the world implemented these three components in a variety of different ways. As expected, low-income countries did not rely on technology and remote learning as much as high and medium countries did. Hence, instructors in low-income countries risked their livelihoods in order to teach. In some cases, they even lost their lives. Evidence also shows that students in low income countries experienced less learning due to the new standards. Many families did not send their children to in-person schooling in fear of their health. In some cases, the students could not go to school even if they would have liked to because of school closures. For example, as of June 2021 approximately 40% of the countries in sub-saharan africa did not implement any remote learning strategies despite their being school closure mandates for an entire year. This devastating fact meant that millions of children did not receive education for an entire year.

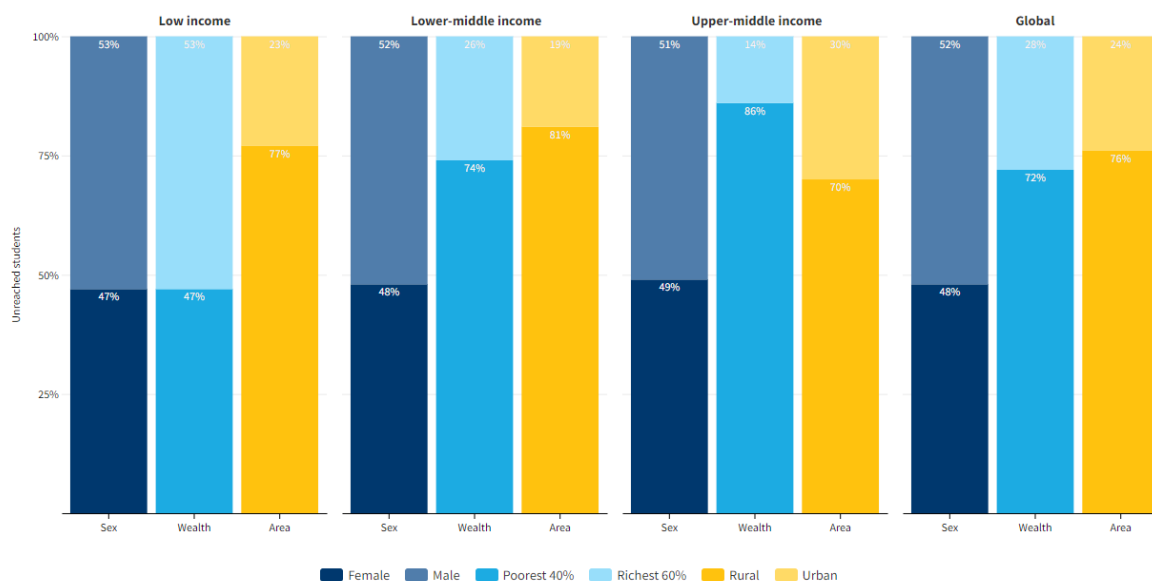


Figure 7: Composition of unreachable students

Figure 7 above shows the percentage of students who cannot be reached, broken out based on their gender, household wealth, and location of residency. For example, globally 72% of

low-income students did not get access to education during the pandemic. Additionally 3 out of 4 students that did not receive remote education during this period came from rural areas around the world. Some countries took advantage of already existing remote learning environments and strategies. The tools and resources they used included paper-based take-home packages to radio, TV, phone, and internet-based solutions. Higher income countries provided students with technology devices to use in order to participate in classes. Not only did the higher income countries aid students but they also provided teachers with remote learning training to onboard them onto the new technologies being implemented to the curriculum.

The Digital Transformation of the cloud

During Covid-19 millions of jobs were saved because of the ability to work from home. Employees were able to work remotely due to the existence of cloud computing. Cloud computing is the practice of utilizing remote servers hosted via the internet to store, process, and manage data. Prior to COVID-19 a lot of companies still utilized local office servers to store data. This made it impossible for employees to work remotely as they needed access to the servers to utilize the data in their project. Hence, in order to stay afloat during covid-19, many businesses relied on the cloud. According to a financial study conducted by Gartner during the pandemic, the global end-user spending on publically available cloud services is forecasted to grow 18.4% in 2021 to total \$304.9 billion. As shown in **Figure 8** companies providing cloud services like Microsoft, Google Cloud, and Amazon Web Services experienced a steady increase in revenue amidst the pandemic. The main reasons for cloud adoption during the pandemic were business resilience, evolution of business operations, remote working, healthcare investments, online education, and environmental sustainability.

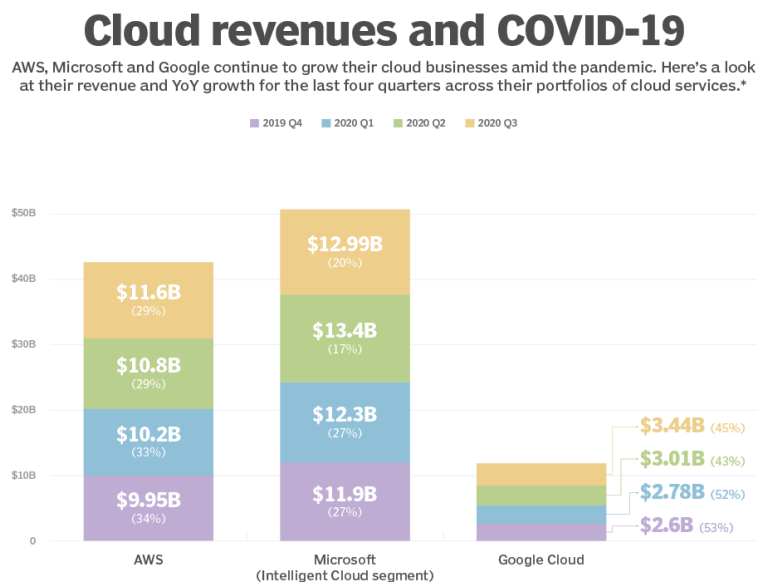


Figure 8: Tech Sector & Cloud Revenues

Petroleum Engineering

The Fluctuation of Oil Prices

The price of oil is dependent on two factors; the supply of oil and the demand for oil. They are perfectly correlated which means that if one is less needed than the other, then it hurts it. This means that if the demand for oil is low but we have a very high supply, then the price of oil will experience a downhill trend. This is exactly why the price of oil changed so much in the last three years. It changed because of the effects of the coronavirus and the price war between Russia and OPEC. These all contributed to the WTI or West Texas Intermediate oil price in April of 2020 to be -37.63 dollars; this was the lowest price ever recorded in history.

The effect of the coronavirus was the first to cause a huge price decrease in 2020. COVID started in 2019 in China and the widespread across the world affected our way of life so much more than people realize. China is the largest oil importer in the world, this means that other countries like the United States sell their own production to them since China does not have any oil production in their country. **Figure 9** shows the yearly imports that are given to China. Because China relies so heavily on Oil Imports, they tend to capitalize on lower oil prices by filling up their reserves before the price goes back up. But these lower prices were for all the wrong reasons; these reasons were for the recent lockdowns that countries have started implementing due to this new virus and the sharp increases in cases and deaths that came with COVID-19. These lockdowns kept people at home, which means the demand for oil drastically decreased, the demand in April 2020 showed that it had dropped by more than 30 million barrels of oil per day. Since there was a really low demand, **Figure 10**, China did not need to fill their reserves because oil was not needed because everyone was staying at home. This is why the lockdown had a huge impact on the price of oil in 2020.

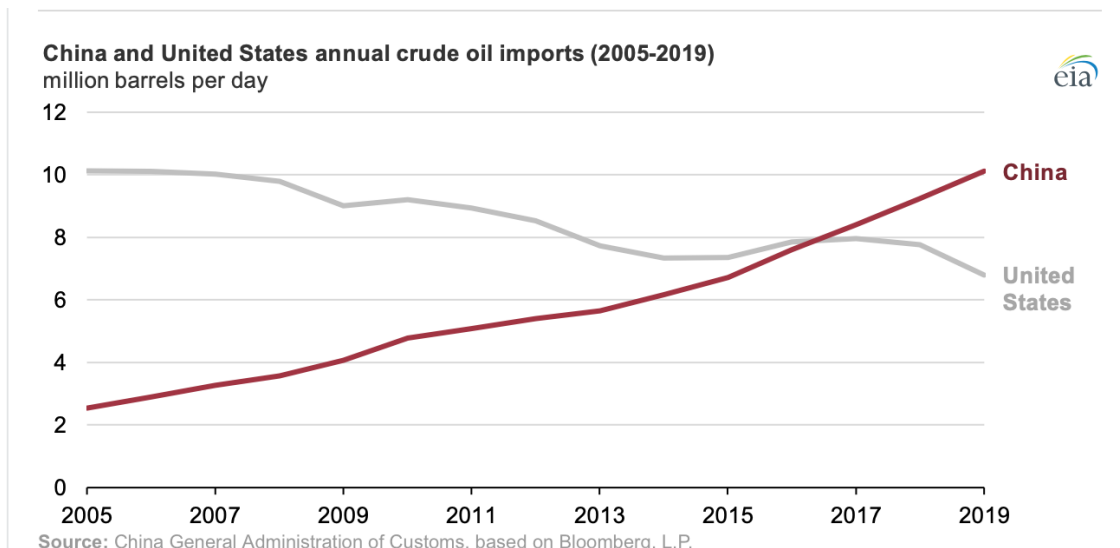


Figure 9: Yearly Imports to China prior to the Pandemic

WORLD OIL DEMAND/SUPPLY BALANCE OUTLOOK (million b/d)

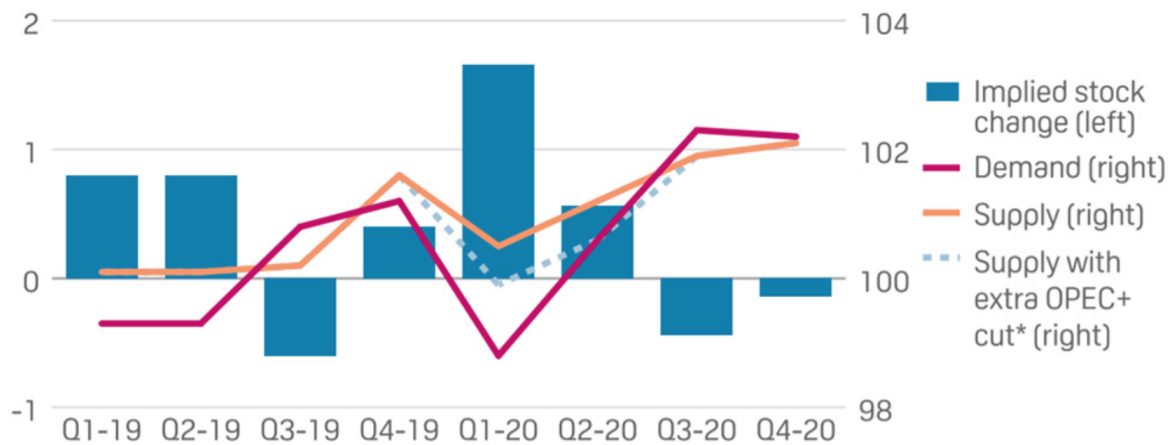


Figure 10: World Supply and Demand in 2019 and 2020

Another reason and possibly the biggest contributor to why the huge drop in the oil price here in the United States was so extreme was the price between Russia and OPEC. OPEC stands for the Organization of the Petroleum Exporting Countries, and it consists of 13 neighboring countries (mostly major oil producing countries) and they have control over the global oil market and international relations. In 2016, OPEC+ was created, and it consisted of a lot more countries to have even more control of the world market of oil. In the midst of the pandemic, OPEC proposed production cuts in order to keep a steady price range of oil over the global market since the demand for it was so low. Russia responded to this by not cutting production and continuing producing as it was before, thus resulting in a huge drop in the global price of oil, **Figure 12**. Saudi Arabia, in response to Russia's resistance, decided to actually increase their production to twelve million barrels a day in April, you can see this in **Figure 11**. Then when selling starting in April for future contracts of oil, global oil price has decreased by 30% in less than 30 seconds. In order to end this, Former President Donald Trump made cuts in production that Russia gradually agreed to by 10 million barrels per day, thus ending the price war. Since the supply was so abundant and the demand so low, millions of workers lost their jobs and many companies declared bankruptcy.

Saudi Arabia's oil production

The kingdom said it would offer discounts on its crude and increase production to over 12 million bpd in April 2020



SOURCE: Refinitiv

NOTE: Dotted lines indicate forecasts and estimates



Figure 11: Saudi Arabia's oil production



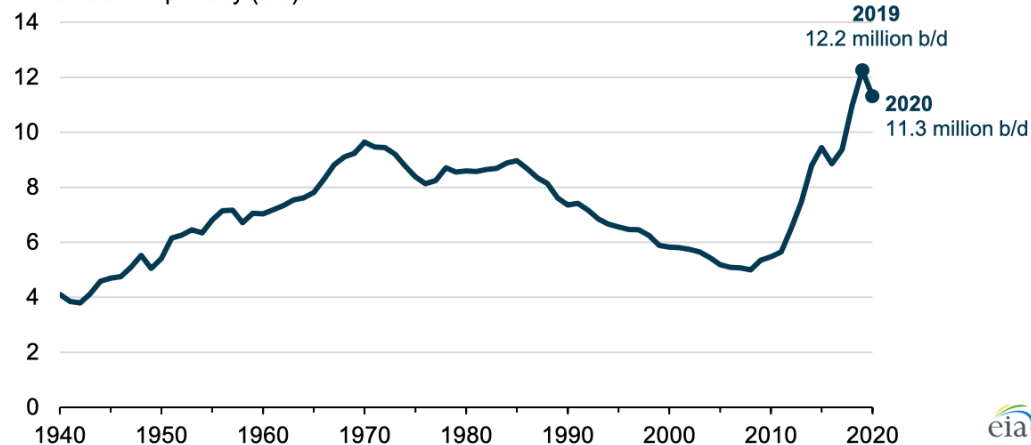
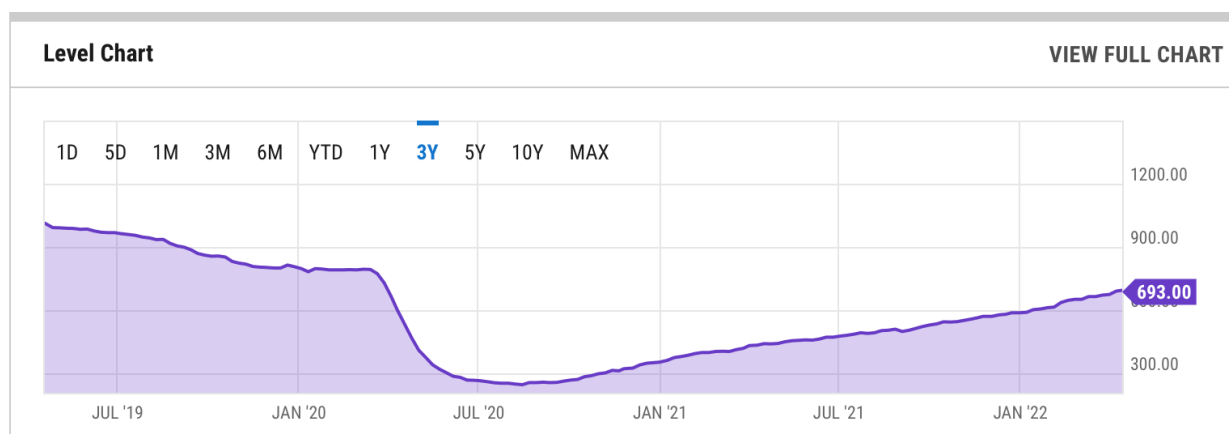
Figure 12: The price of WTI (US) and Brent (Europe) oil in 2020

Production Rates

The United States recorded an all time high in 2019 with an average of 12.2 million barrels of oil produced a day. In 2020, it had dropped 8% to 11.3 million barrels of oil a day, this is the largest decline ever recorded. This can be seen in **Figure 13**, and since the declining prices of oil was happening in 2020, this led to operators shutting down rigs and also limiting the production on the select rigs they keep up. Lastly, fracking was put on hold since the cost was still high in the midst of the low demand of oil. **Figure 14** shows us the sharp decline of rigs in the United States.

U.S. annual crude oil production (1940–2020)

million barrels per day (b/d)

Source: U.S. Energy Information Administration, [Petroleum Supply Monthly](#)**Figure 13: U.S oil production in 2019 and 2020****Figure 14: Rigs in the United States in 2019-2022****Employees during the Pandemic**

The oil and gas industry experienced the highest layoff percentage ever. Over 100,000 employees have lost their jobs due to the huge downturn of the COVID-19 pandemic. Schlumberger, an oil and gas technology service company, in 2020, cut more than 21,000 jobs and lost around one billion dollars in severance benefits. These 21,000 jobs contributed to around a quarter of their workforce. Also, Exxon Mobil cut around 15,000 jobs and that contributed to around 15% of their entire workforce due to the massive rout in demand for oil during the coronavirus pandemic.

Conclusions

Agricultural Economics

The food and agriculture industry has taken some massive blows during this pandemic and something needs to change so that things do not get worse for everybody. Due to the broken supply chain that every industry is experiencing, our farmers that everybody rely on are suffering and may not be able to survive and provide the food that is on your table and that feeds your family. The chain needs to be fixed so that farmers can afford to plant and harvest their crops and then the large producers need to have employees so that they can purchase the crops from the farmers and give them a fair payout on their hard worked on crops. This weakness needs to be taken care of because it could lead to much worse for people and potentially a global hunger issue.

Chemical Engineering

There were weaknesses in the ability of manufacturing companies to respond to dramatic changes in consumer behavior due to lack of preparation for such an event. The recovery period emphasizes this as companies responded better due to preparation for this event. Companies struggled to meet demand due to raw materials shortages and manpower shortages. Logistics suffered delays and lower throughput which amplified problems. New implementations for worker health and safety disrupted or impeded operations. Overall, The pandemic highlighted weaknesses of previous business strategies and provided an opportunity to learn and improve business continuity.

Computer Science

The computer science industry had an influential impact on how employees, students, and teachers around the world adapted to the new normal. Without the technological infrastructure and resources set in place by computer scientists, employees and students around the globe would not be able to work/study from home. Without cloud computing, businesses would not have been able to adapt to the increase in online shopping. As we enter a post covid era, our lifestyle remains shifted with the implementation of new technologies like zoom. These new technologies allow us to be more effective students, teachers, businesses, and employees.

Petroleum Engineering

In the end, 2020 and the pandemic showed a ton of weaknesses in the oil and gas industry and required lots of work and buildup to strengthen the industry in 2021. The biggest thing is spending control. Before the pandemic, companies poured tons of money into fracking and developing new wells and built up lots of debt to do so, this caused a lot of bankruptcies due to the low demand of oil during lockdown. I think another term that entered is sustainability, since this crisis caused a lot of reactive planning, building sustainability in the last two years allows oil and gas companies to build better for the future and are prepared for catastrophes better than before. Lastly, to help shape the future for these companies in technology, with the

changing landscape, it is crucial to rely on technology to mitigate spending control and supply chain risks.

Recommendations

Agricultural Economics

- People need to go back to work
- Farmers need yield to increase

Chemical Engineering

- Expand scenario planning techniques to ensure business continuity during uncertain times
- Improve alternative and substitute supply sources for critical production steps
- Verify effectiveness of listed preventive and mitigative elements for epidemic
- Ensure cooperation, coordination, and communication between all levels of supply chain
- Improve remote workability of process operations and equipment

Computer Science

- conducting more remote teaching professional development and trainings for instructors
- More partnerships between public and private sectors to ensure remote learning is possible
- Adopt suitable technology based on location and income levels
- Increased reliance on cloud computing to ensure supply meets demand in the data-driven world

Petroleum Engineering

- Controlling spend and cost containment
- Focus mergers and acquisitions on cost control
- New technologies for the changing landscape
- Mitigate supply risk

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Group 5

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