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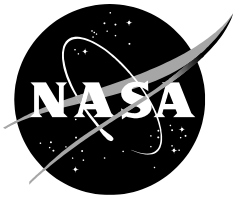

An Analysis of COVID-19's Impact on U.S. Aviation

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Volunteer Internship Program
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August 2020

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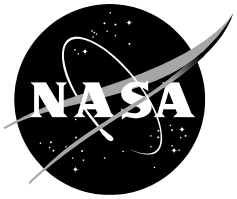

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Abstract

To better understand the effects of COVID-19 and prepare for crises in the future, the changes in the aviation industry during the pandemic were analyzed. Data was gathered on airlines' economic status, passenger travel, air cargo, avionics manufacturing, and the environment. It was found that passenger air travel was severely depressed, dropping 96% in April 2020 compared to April 2019 [1]. Air cargo and manufacturing also felt the effects of the decrease in air traffic. In comparison to the previous year, air cargo capacity in July 2020 was down 28% [2], and manufacturing companies, such as Boeing, have seen more than a 10% decrease in revenue [3]. Many companies have adapted to the pandemic with new protocols and procedures, such as social distancing guidelines and using passenger planes as cargo planes. Based on these actions taken guidelines were created for future crises. The objective is to facilitate a faster recovery and a more prepared airspace system. Lastly, health guidelines and areas of research that are relevant after a global pandemic are outlined.

1 Introduction

The Coronavirus Disease 2019 (COVID-19) took many countries by surprise, unprepared, and hesitant about how to respond to the virus. Because it is transmitted through respiratory droplets released when people talk, sneeze, or cough, the coronavirus has changed the way people interact with each other especially in confined areas [4]. Social distancing protocols were established all over the world to help prevent the spread. This had widespread negative effects on economies and industries around the world, one being the aviation industry. By prompting fear of crowded flights, combined with travel bans and an increased reluctance to spend money, the pandemic has severely slowed air industry activity. As the industry is a complex network, the effects of COVID-19 are felt in every sector. The U.S. has the largest air industry in the world with 44,000 departures from 19,622 different airports managed by 14,695 air traffic controllers every day [5]. In April 2020, total aircraft operations within the U.S. dropped 79% at its worst [6]. COVID-19 has exposed several weaknesses and potential areas of improvement within the industry. To fully understand and fix these weaknesses, preventing future pandemics from affecting the industry to the extent COVID-19 has, extensive research and data analysis is required.

The COVID-19 Pandemic has impacted all aspects of the U.S. aviation industry from economics and passenger flight to cargo transport, manufacturing, and environmental impact. A solid understanding of the state of normalcy among the several sectors and an in-depth analysis of the current impact on those categories are crucial to understanding the full scale of the pandemic's impact. This report introduces the activity in each sector before COVID-19. Then it goes through the effects of COVID-19 on each sector. Finally, the report provides recommendations for future work.

2 Background

Before COVID-19, the U.S. aviation industry was growing. This was apparent as the number of air passengers had been increasing since the 1970s, and reached 925.5 million passengers in 2019 as seen in Figure 1 [7-8].

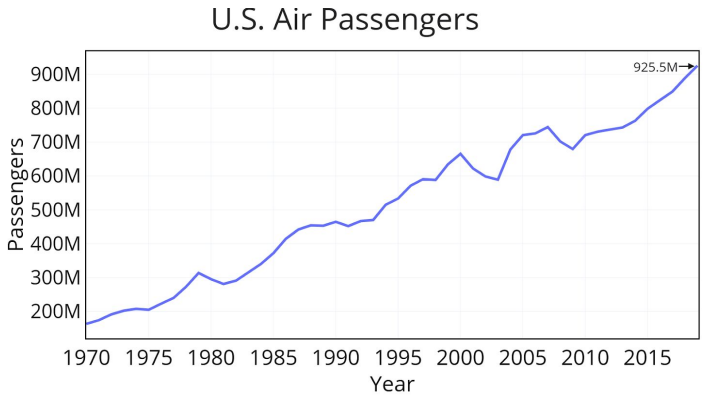

Figure 1: The number of U.S. air passengers reaches 925.5 million in 2019

The air cargo industry was a large part of world trade and the number of goods being transported was continually rising [9]. In addition, the aviation manufacturing industry was growing [10]. The increase in traffic and manufacturing have resulted in an increase in profits for the aviation industry, and the industry's economic growth contributed to that of the nation. The industry's fast growth made it the 7th leading contributor to the U.S. economic growth out of the 63 industries that make up the U.S. economy [11]. Average emissions from the aviation industries have grown with its

expansion as well, and have attracted public attention [12]. The following sections of the report will explain how each section of aviation was faring before the COVID-19 pandemic.

2.1 Passenger

Before the COVID-19 virus, passenger air travel in the United States maintained a busy yet healthy industry. With almost 1 billion annual United States passengers, the industry generated almost $500 billion. Air traffic was incredibly complex with over 5,000 aircraft in the airspace during peak hours [5], yet it still allowed passengers to reach almost anywhere in the United States in a matter of hours, all while being generally safe and reliable. In addition, the domestic U.S. passenger market remains the largest in the world with 590 million passenger journeys in 2018 [13].

However, passenger air travel still was not perfect. Crowded planes and overbooking would contribute to the poor passenger experience. In addition, poor efficiency in airports lead to wait times for flights sometimes exceeding the duration of the flight itself. In summary, passenger air travel was in no way perfect but has been further complicated due to the restrictions and dangers of COVID-19.

2.2 Cargo

As it stands, the global air cargo industry makes up a significant portion of world trade. The global industry transports $6 trillion worth of goods, accounting for 35% of world trade in 2020 by value [14]. The goods which are transported include airmail and freight. Before COVID-19 the global air cargo industry was growing strong with a 9.7% growth in demand for air cargo in 2017, and a 3.4% growth in 2018 [15]. This growth was a result of the improved modernization and safety standards the industry has placed, making air cargo more reliable [15]. An increase in businesses and e-commerce has further pushed the growth of the industry [15]. The US air cargo industry is the most developed air cargo industry in the world [16], meaning it influences the growth of global air cargo heavily. The U.S. air cargo revenue matches up with the global increase in demand, with an increase of 11.8% in 2017, and 5.11% in 2018 [17].

2.3 Manufacturing

Another industry that plays an important role in worldwide aviation is manufacturing, which consists of building, designing, and shipping airplanes, drones, and other air transportation vehicles across the world for use. According to the 2019 end-of-year report conducted by the General Aviation Manufacturers Association (GAMA), aircraft deliveries reached a value of $26.8 billion, which also portrays progress compared to the $24.3 billion worth of deliveries in 2018 [18]. The manufacturing industry continues to grow with a greater demand for more aircraft around the world. From 2014 to 2019, the industry had a growth of 1.7% which was dependent on the downstream demand from airlines. In 2019, the industry had an estimated market size of $712 billion, 20,312 businesses, and more than 4 million workers. With the discovery and modernization of new aircraft vehicles, such as drones and 4-person passenger aircraft, the manufacturing industry was expected to grow tremendously between 2020 through 2025 [19].

2.4 Environment

The environmental impact of aviation has been a source of public attention for many years. Although aviation pollution made up a small 12% [20] of total emissions from the transport sector compared to up to 74% from road transport, the effects of it were still serious. Emissions of an average air transport aircraft with 88 passengers are staggeringly high at the equivalent of 285 grams of carbon dioxide per passenger per kilometer (gCO2/pkm), compared to 55 gCO2/pkm for the average car with 4 passengers [21]. This pollution was also very concentrated around airports. The area that toxic pollutants such as ultrafine particles (made up of particles under 2.5 microns in diameter) are dispersed over these big cities is quite substantial; studies show that the areas of Los Angeles impacted by ultrafine particle pollution from Los Angeles International Airport (LAX) is around 20 square miles, far greater than previously assumed [22]. Health effects of pollutants like this are serious as these small particles are fine enough to be trapped in the lungs, or be absorbed into the bloodstream. An estimated 2,000 deaths a year globally result from airport activity such as take-offs and landings, and a further 8,000 result from

high altitude cruising activity [23]. The FAA and NASA had put effort into this area as well, creating programs to facilitate a reduction in emissions. This included metering systems such as in the Airspace Technology Demonstration 2 (ATD-2) [24], which has saved the equivalent of 15.7 million pounds of CO_2 (which is equivalent to planting 116 thousand trees in urban areas) during the 29 month period from 29 November 2017 to 30 April 2020 [25].

2.5 Economics

The U.S. aviation industry has been vital in the nation's economy. Before COVID-19 it created $1.6 trillion in annual economic activity and supported 5% of the nation's GDP It also provides more than 10 million U.S. jobs, which is more than 7.3% of all U.S. jobs [12] [26]. The growth of the industry has led to it being an important part of the nation's economy. Figure 2 shows that the number of passenger revenue miles, the miles that paying passengers fly, has seen an upward trend since 2010 [27]. The aviation industry in North America has seen an overall increase in net profit from 2011 to 2019, going from $4.2 billion to $17.4 billion. While the net profit did not increase every year, there was never a net loss, as seen in Figure 3 [28-29].

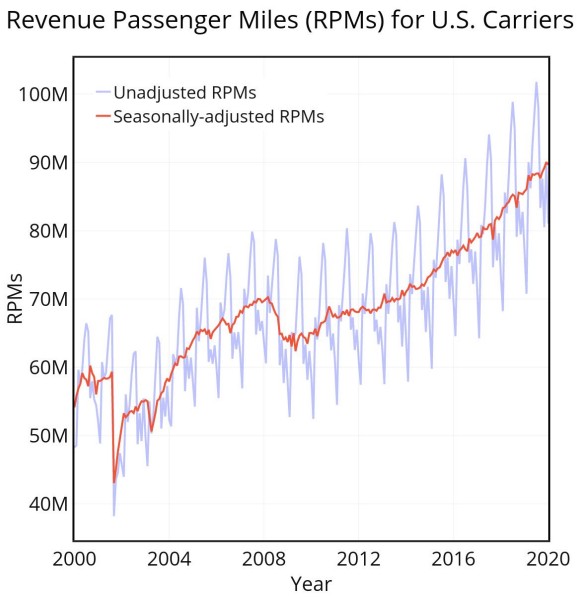

Figure 2: Revenue passenger miles

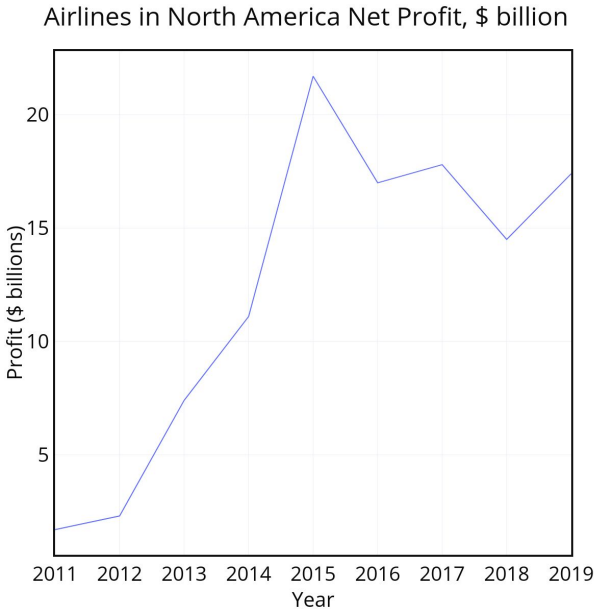

Figure 3: North American airlines annual net profit

3 Impact of COVID-19

The coronavirus pandemic has been one of the most catastrophic events that the air industry has experienced [Appendix A]. In the following subsections, the impact of COVID-19 on different sectors of aviation will be discussed. All of the major U.S. carriers reported net losses in the first quarter of 2020 [30-38]. The air cargo industry has also been affected with a 28% drop in capacity and major cargo companies in the U.S. reporting Year over Year (YOY) losses [2] [39]. And aviation manufacturing companies have lost revenue as demand for aircraft has gone down [3]. However, the impact of air traffic on the environment has been lessened by this pandemic [40]. In the following sections of the report the impact COVID-19 has had on passenger travel, aviation economics, air cargo, avionics manufacturing, and the environment are explained.

3.1 Passenger

The pandemic created a significant decrease in air passengers. Beginning in March 2020, shelter in place orders were issued across the nation. This, combined with the fear of catching COVID-19 caused a significant drop in demand for flights. In a public confidence survey issued by the International Air Travel Association (IATA), 58% of participants said they had been avoiding air travel out of fear of the virus [41] as shown in Figure 4.

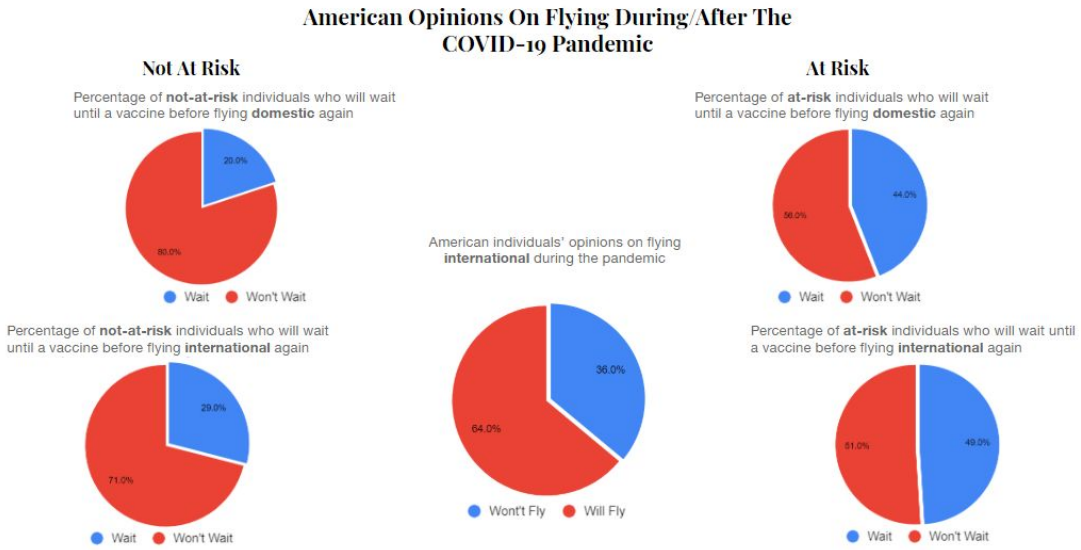

Figure 4: Surveys shows that many Americans will wait before flying

Due to the current pandemic and its high infection capacity, the public currently perceives a crowded airplane cabin as a threat to their health. Airlines have taken steps to counter this perception. Some air carriers have attempted to make passengers feel safer by filling 60% of seats on a flight. However, passenger count is still extremely low, down roughly 80% from 2019 [42]. Figure 5 illustrates this drop in passenger throughput.

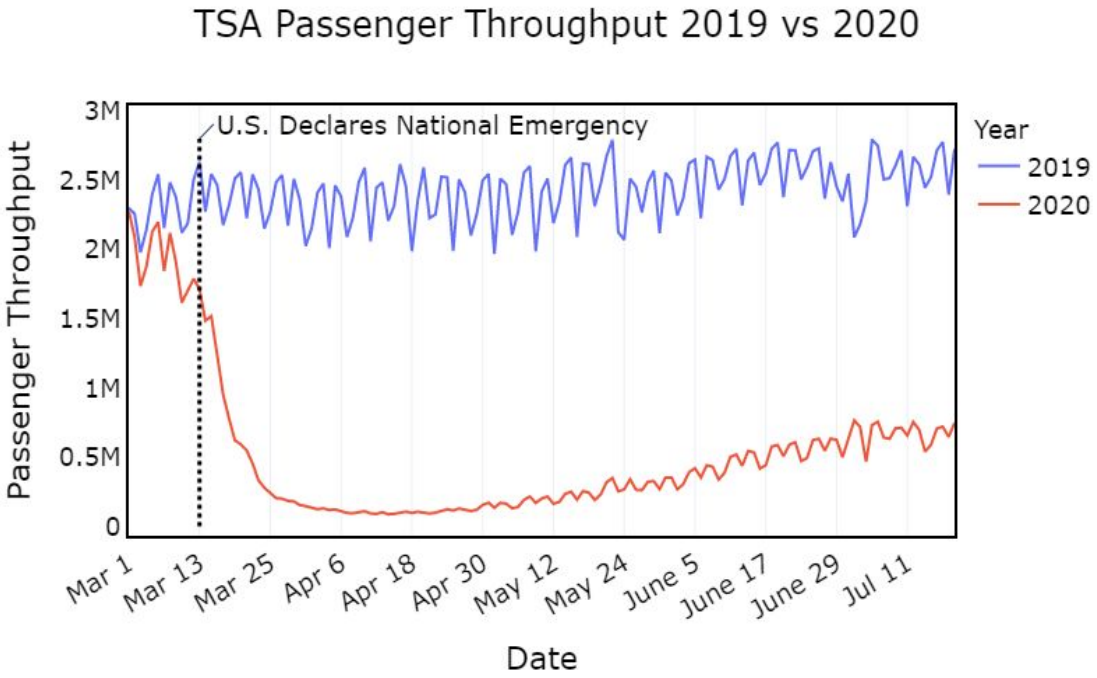

Figure 5: COVID-19 effect on U.S.passenger throughput

3.2 Cargo

Air cargo consists of any package transported by plane, including airmail and air freight. Every year the U.S. manages around 44.3 billion pounds of freight [5]. However, COVID-19 has caused significant drops in capacity, demand, and volume of air cargo as a result of several businesses closing, countries placing trade restrictions and a general decrease in the affinity to spend money, the industry has experienced slowdowns [43]. The air cargo industry hasn't been impacted as hard as passenger air travel, as COVID-19 has increased the

demand for medical supplies, and stay-home orders have increased the demand for e-commerce, yet this increase wasn't enough to offset the total loss in air cargo demand and volume [44] [45].

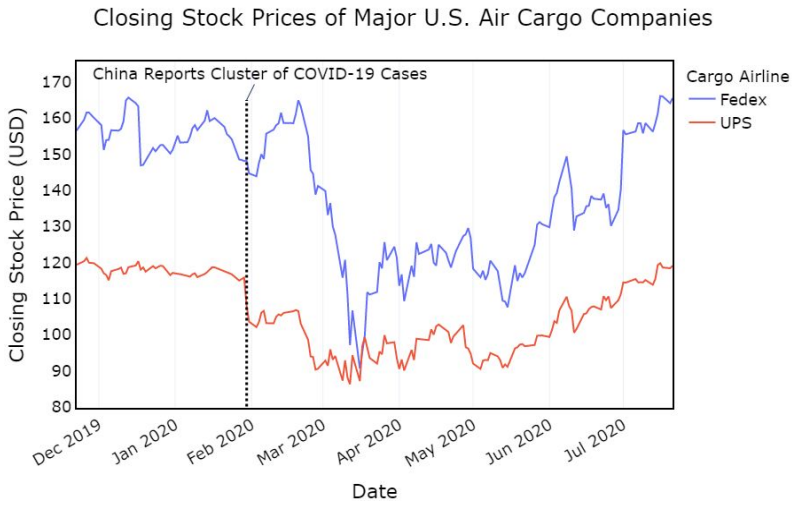

Figure 6: Effect of COVID-19 on closing stock prices of Fedex and UPS

The primary air cargo airlines in the US are FedEx and UPS and thus have been heavily impacted. FedEx's Q3 2020(December-February) net income was down 57.37% YOY and its Q4 2020 (March-May) net income was up 83.05% YOY [46]. UPS's Q1 2020 (January-March) net income was down 13.14% YOY and its Q2(April-June) was up 8.8% YOY[47]. In addition, stock prices for both companies fell significantly after COVID-19 became more widespread (figure 7), because of drops in demand, capacity, and volume of air cargo [48] [49]. It can be noted, however, that both companies are starting to recover growth for both companies YOY in the second quarter of 2020.

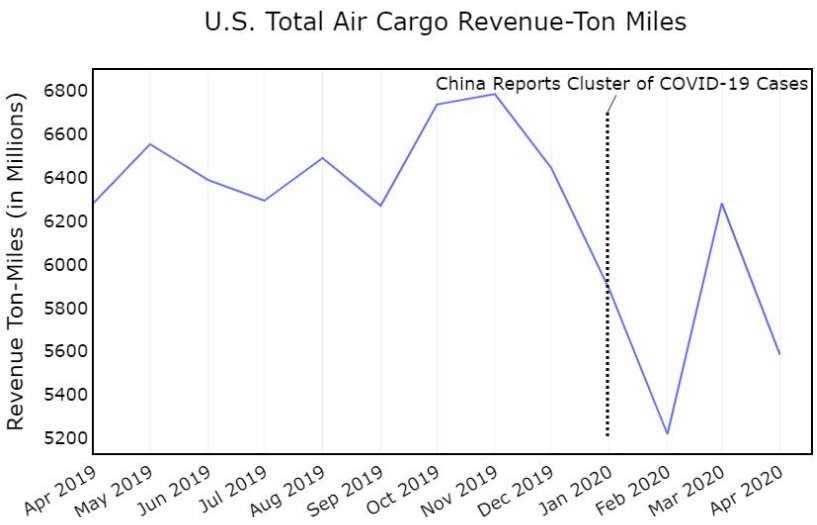

Figure 7: Drop in air cargo revenue as a result of COVID-19

Total U.S. air cargo revenue, in April 2020, dropped 11.12% YOY (figure 7) [17]. This drop in revenue is a result of reduced volume in and out of the country, capacity, and demand. Total air cargo volume in and out of the US was 84.8% in March 2020 YOY [50]. This drop in volume was paired with a drop in demand of 13.2% in May and 8.8% in June YOY for North America, leading the global industry in recovery [51]. Although these stats pertain to global/North America cargo capacity, stats for U.S. cargo are most likely identical because the U.S. industry is one of the leading air cargo industries in the world. The decrease in capacity is more than the decrease in demand, resulting in an unstable relationship that places a strain on air cargo capacity.

Cargo capacity globally in May 2020 was 65.2% staying relatively the same in June at 65.9% YOY, which is a result of grounded passenger planes that usually carry cargo in their bellies [51]. These grounded planes have caused global belly capacity to drop 66.4% in May 2020 YOY [45]. To help battle this loss in capacity, airlines such as American Airlines have tried to compensate for the loss by stripping the seats in passenger planes and using the aircraft to ship cargo [52].

The air cargo industry has not been impacted as severely as passenger travel with capacity down only 34.8%, as opposed to the 60% of the commercial passenger plane industry. When looking at the aerospace industry as a whole air cargo might not seem to play a big role, but the pandemic has moved the spotlight onto the industry as it shows that it is flexible in the face of this pandemic.

3.3 Manufacturing

Aviation manufacturing consists of building, designing, and shipping airplanes, drones, and other air transportation vehicles across the world for use. Due to COVID-19, a majority of air transportation vehicle manufacturers have been met with severe losses which are explored in this section.

Boeing, one of the leading airplane manufacturing companies in the world, has noted a decrease in the company's overall revenue, dropping from $19.98 billion in Q3 2019 to $16.91 billion in Q1 2020. Furthermore, Boeing's commercial airplane deliveries have dropped from 149 deliveries in the first quarter of 2019 to 50 in the first quarter of 2020, a 66% decrease [53]. Commercial airplane revenue has dropped 48% as a result.

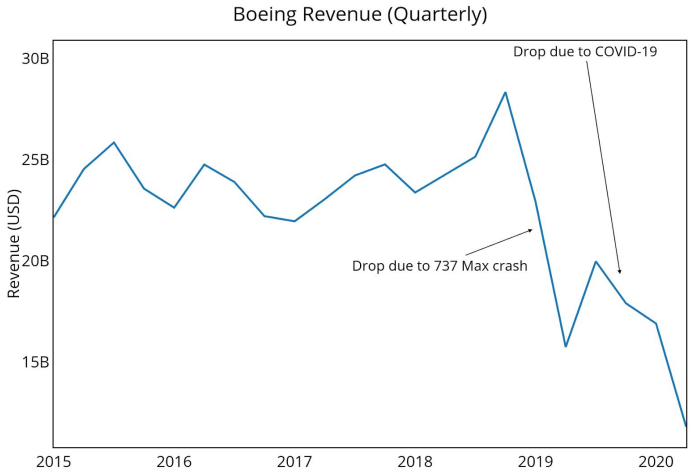

Figure 8: Boeing revenue drops from 2019 Q3 to 2020 Q1

As seen in Figure 5, just when Boeing's quarterly revenues were starting to recover from 737 MAX's troubles, COVID-19 caused Boeing's revenue to plummet once again. As COVID-19 had all of quarter two to wreak economic havoc on aviation manufacturing, Boeing's Q2 2020 performed significantly worse than projections, bringing in $11.8 billion as opposed to the expected $16 billion [54]. Boeing's revenue has hit an all-time low due to the pandemic and while recovery is expected, the industry may continue to struggle if the current conditions persist.

3.4 Economics

The International Air Transport Association (IATA) has estimated that North American airlines will lose $23.1 billion in 2020 [28]. In April 2020, air traffic dropped to having 4% of the number of passengers in 2019 [1], and in April 2020 through March of 2020, countries put up international travel bans, and many states in the U.S. had a shelter in place order in effect [55].

Table 1: Daily cash burn rates for major U.S. airlines

Airline	Cash Burn in April	Cash Burn in June
Delta	$100 million	$27 million
American	$70 million	$40 million
United	$50 million	$40 million
Southwest	$30 million	$16 million
Spirit	$9.5 million	$1.5 million

Airlines lost millions of dollars a day. At its worst, Delta airlines had a daily cash burn of $100 million, and in June, Delta had net losses of about $27 million a day. Other U.S. mainline carriers had daily cash burn rates ranging from $1 million to $70 as seen in Table 1 [32, 33, 37, 56-59]. The U.S. mainline carriers have reported net losses in the first quarter of 2020 [30-38]. For United Airlines and Delta Airlines, it has been the first reported loss in more than 5 years [60]. Even though air traffic is not expected to be as low as it was in April 2020, many industry experts predict a slow recovery.

These losses have resulted in airline corporations being worth less as investors are not receiving the returns they expected. From January 2020 to April 2020 airline stock prices dropped approximately 50%, as seen in Figure 6. The smallest drop was seen with Southwest Airlines whose stock price dropped 42%, and the largest drop was seen with Spirit Airlines whose stock price dropped 72%, both shown in Table 2 [61-69].

Table 2: U.S. airlines closing share price

Airline	1/2/20	4/1/ 20	Percent Drop
American (AAL)	29.09	10.69	63.25%
Alaskan (ALK)	68.17	26.35	61.35%
Allegiant (ALGT)	176.05	71.29	59.51%
Delta (DAL)	59.04	23.87	59.57%
Hawaiian (HA)	29.23	9.84	66.34%
JetBlue (JBLU)	18.89	8.11	57.07%
Southwest (LUV)	54.84	32.04	41.58%
Spirit (SAVE)	40.65	11.32	72.15%
United (UAL)	89.74	25.65	71.42%

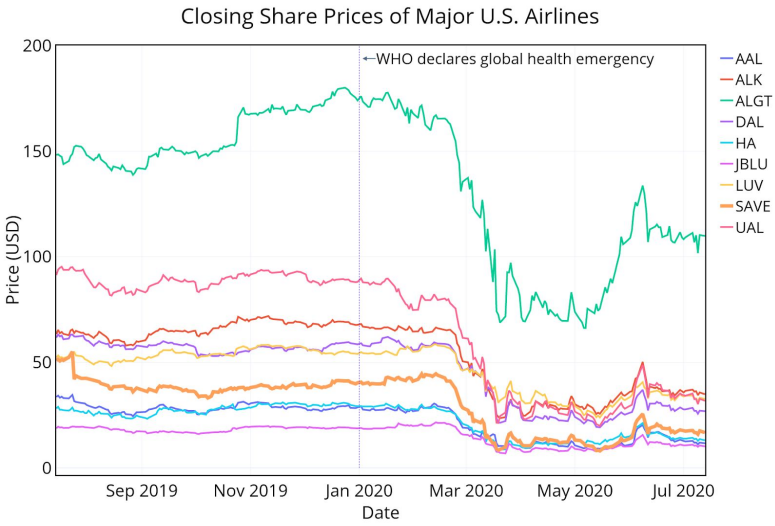

Figure 9: U.S. airlines share prices drop from August 2019 to July 2020

In order to protect American jobs and businesses, Congress passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act on March 27, 2020. The CARES Act provided loan funding: $25 billion for passenger air carriers, repair stations, and ticket agents, $4 billion for cargo carriers, $17 billion for businesses critical to national security, and $454 billion for distressed businesses (other transportation businesses apply). In addition to loans, the CARES Act gave grants to airlines to prevent furloughs and protect jobs. The $32 billion for grants was divided up between the different sectors in the air industry: $25 billion for passenger air carriers, $4 billion for cargo air carriers, and $3 billion to airline contractors (including caterers, baggage handlers, and wheelchair pushers) [70].

Despite federal aid, some airlines did not make it through the pandemic. Miami Air filed for bankruptcy on March 24. RavnAir, Trans States, and Compass all filed for bankruptcy in April. Makani Kai Air merged with Mokulele Airlines to create more stability in the face of the pandemic [71-73]. These airlines that have gone bankrupt or merged are all small low-cost airlines, and they show how the pandemic poses a greater risk to small airlines than large airlines. In comparison to large airlines such as Delta or United, the small airlines don't have sufficient savings to rely upon through the pandemic. Furthermore, big, publicly traded companies are more likely to receive loans as they have powerful lobbyists and more negotiation power.

3.5 Environment

Pollution data during COVID-19 show that the changes in general human-induced pollution varied widely from location to location in America. According to the University of Washington [74], air pollution in states such as California, New York, and Washington saw temporary changes during stay-at-home orders. California and Washington saw a decrease of 0.39 ug/m3 and 0.44 ug/m3 respectively, while New York's was still higher than the University of Washington's calculated expected value. An air quality report from Swiss air purifier manufacturer IQAir shows PM2.5 levels had dropped significantly during a 3-week lockdown in Los Angeles, 31% lower than the same time last year, and down 51% from the average of the previous 4 years [75]. However, this currently available general data may not fully represent the changes in pollution from aviation alone.

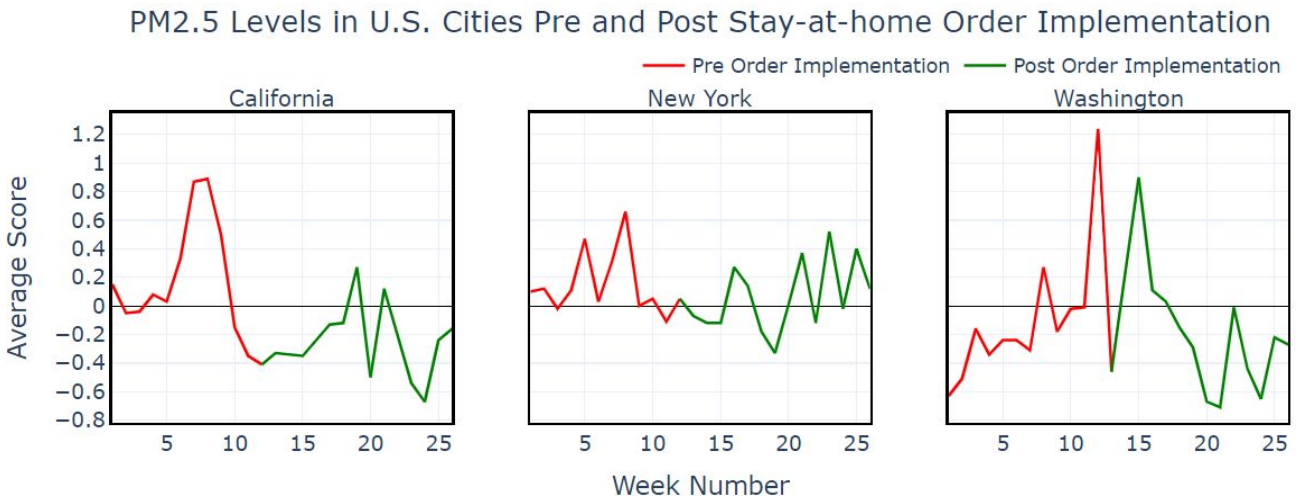

Figure 10: PM2.5 scores in the states of California, New York, and Washington during stay-at-home orders.

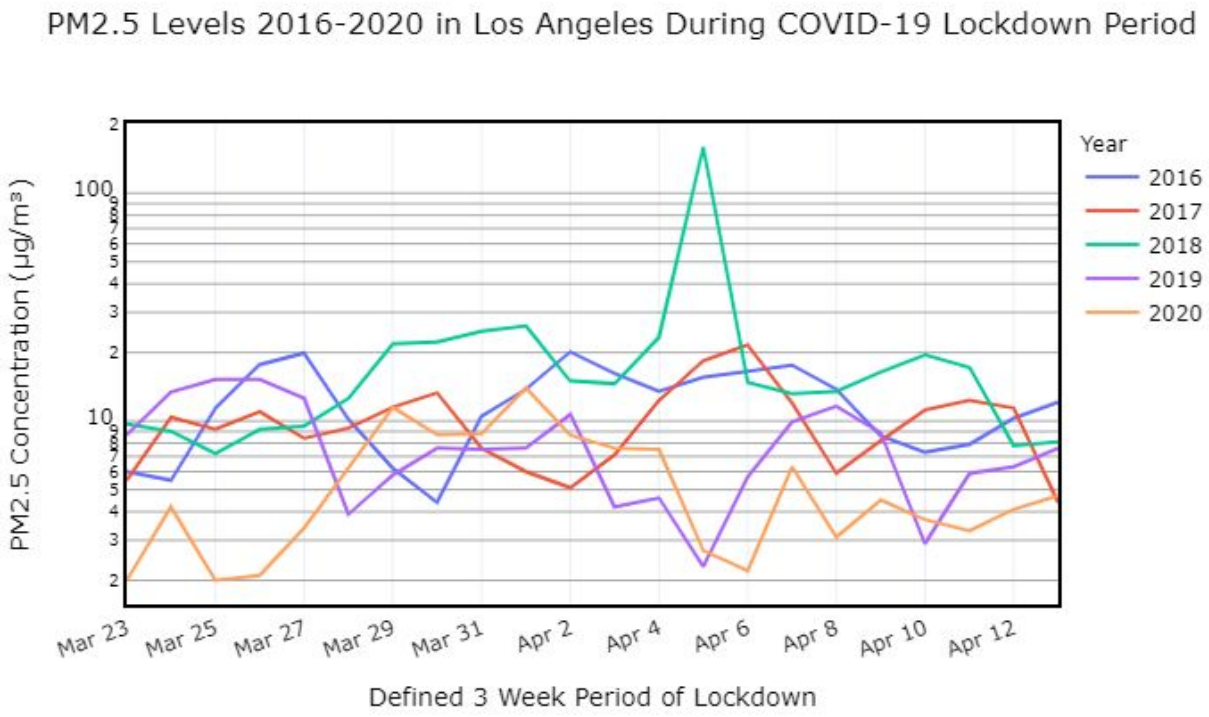

Figure 11: PM2.5 levels in Los Angeles during a 3-week lockdown period from March 23 to April 13, including the last 4 years

Currently, during COVID-19, there are many ongoing aviation-related pollution tests from which data has yet to be released. One project in progress, by Jennifer Kaiser at Georgia Institute of Technology and Elena Lind at Virginia Polytechnic Institute, is set on monitoring the changes of pollution at airports resulting from reduced air traffic [76].

4 Research Recommendations

Urban Air Mobility (UAM) is a prospective airspace system for short-distance air travel in cities. It includes infrastructure that would track the small aircraft that fly within cities [77]. Due to the COVID-19 regulations on

social distancing, Urban Air Mobility (UAM) research on its development should be continued by NASA. Small aircraft that seat 6 or less may appeal to people who are worried about catching the virus. There has been extensive research done on electric vertical take-off and landing vehicles (eVTOLS) [78], and their presence in the airspace may come earlier than expected as COVID-19 has led to passengers being fearful of crowded commercial flights. Research on the public's opinions on UAM, and whether they would use it would also be practical.

Passengers may also start to pay for private chartered flights. Because of this, air traffic controllers may have to be aware of an increase in air traffic. Smaller aircraft with fewer passengers may mean that more planes are flying in the sky. Research that would support this development are projects such as Next Generations Air Transportation System, ATD-2, and testing done in the Air Traffic Control Simulator [79] [24] [80].

In addition, Unmanned Aircraft System Traffic Management (UTM) may be useful during the pandemic [81]. Many people have been staying at home under a shelter in place or for fear of catching the virus. There have been a lot of deliveries, and UTM could help increase shipping efficiency. UTM would limit the contact between workers shipping goods and the customers which could put more people at ease.

To help prevent future pandemics and widespread disease to spread on aircraft, NASA could research different ways that aircraft circulate air. Currently, the air is released from the top of the cabin and directed toward the outer walls in a circular pattern [82]. Research could be done to see if different airflow configurations reduce the risk of transmitting an airborne virus or a virus that spreads through respiratory droplets. One possible configuration would be air that enters from the top of the cabin and leaves at the bottom, minimizing the number of people the air reaches. Furthermore, a breathable aerosol type chemical could be mixed in with the cabin air to kill bacteria and viruses during flight. This new chemical solution would have to be developed and integrated into the current airflow apparatus, allowing constant distribution of the solution. This allows the viruses/bacteria to get killed before it has the chance to infect another person.

To further increase safety and to protect passengers during any future pandemics, a modular divider can be designed to separate passengers preventing the spread of airborne or waterborne viruses and other bacteria between passengers. The divider may be either a simple plexiglass divider or it could be a fully sealed divider with a filter limiting the potential spread to a minimum. NASA would design the divider by working with several aircraft manufacturers to fit the specification of the planes.

There are also health guidelines and possible plans for airlines to protect their customers and their own economic interests [Appendix B].

5 Conclusion and Next Steps

The next step is to monitor the aviation industry's recovery. The total number of operations and passengers should continue to be tracked. This data will show how long the industry takes to recover and will become useful information during future crises. The number of commercial flights compared to the number of private chartered flights should also be recorded. This data would be important if private flights become more popular. The industry has to know what shifts are occurring to effectively plan for them.

The airlines that managed the crisis well can help provide guidelines for the future. There may be certain guidelines, such as requiring masks, that build customer confidence and create a quicker recovery. Another possibility for future research is to study how auxiliary air transport services were affected and how they reacted. The caterers who provide airline food were probably affected, but their services may have allowed them to be flexible and find new sources for profit.

Researchers can also look to other countries to see how aviation fared during the pandemic. Other countries may have aviation industries that recovered quickly, and the U.S. industry would be able to learn from their success. Data on the global aviation industry could be compiled and compared. This way, analyzers can see all of the airlines that went bankrupt and all of the airlines that regained business the fastest.

Appendix A: Comparison With Previous Crises

The effects of COVID-19 have been more significant and are predicted to be longer-lasting than the effects of crises in the past. COVID-19 created the largest percentage drop in revenue passenger kilometers compared to 9/11, the 2003 SARS outbreak, and the 2008 recession [83].

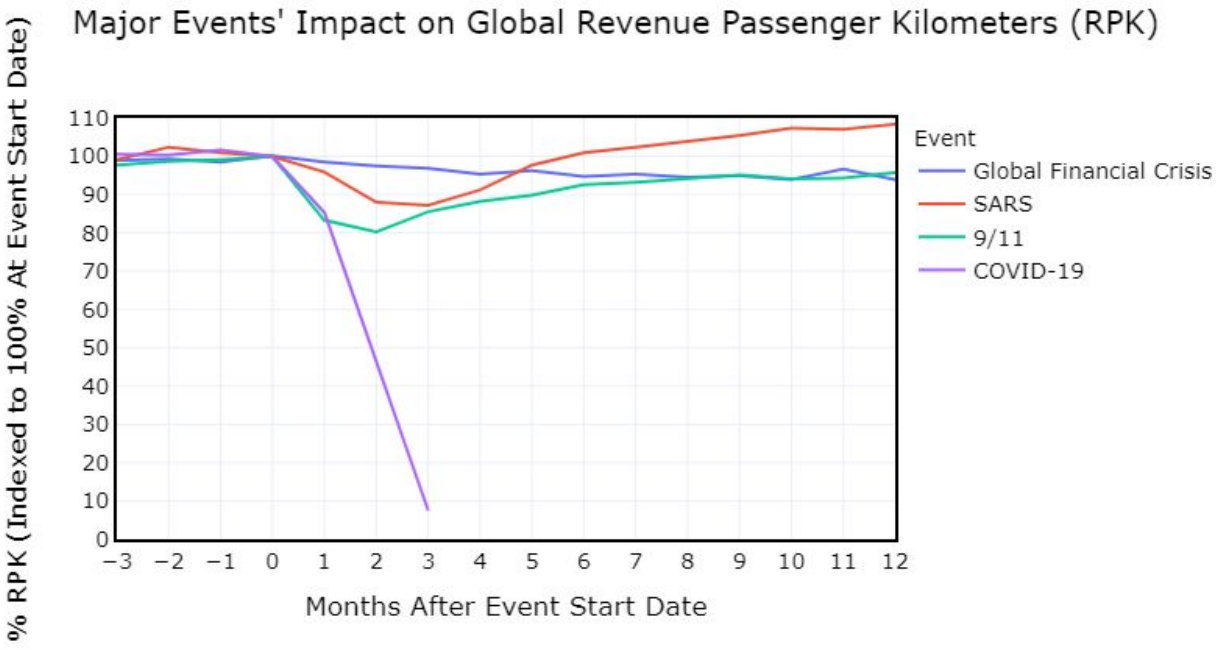

Figure 12: Comparison of different events on aviation

9/11

9/11 created a wave of fear that kept people from flying for many years. A study done by the Bureau of Transportation shows that the number of airline operations dropped from 1.27 million in August 2001 to 981,000 in September 2001 and that it took 4 years for the number of operations to return to what it was in August 2001 [84]. The airline industry's activity after 9/11 can be connected to COVID-19 because both events stirred a sense of fear within the community. Looking at the effects of 9/11, it can be inferred that it will take years for the airline industry to fully gain the trust of its customers, even if a vaccine is found promptly.

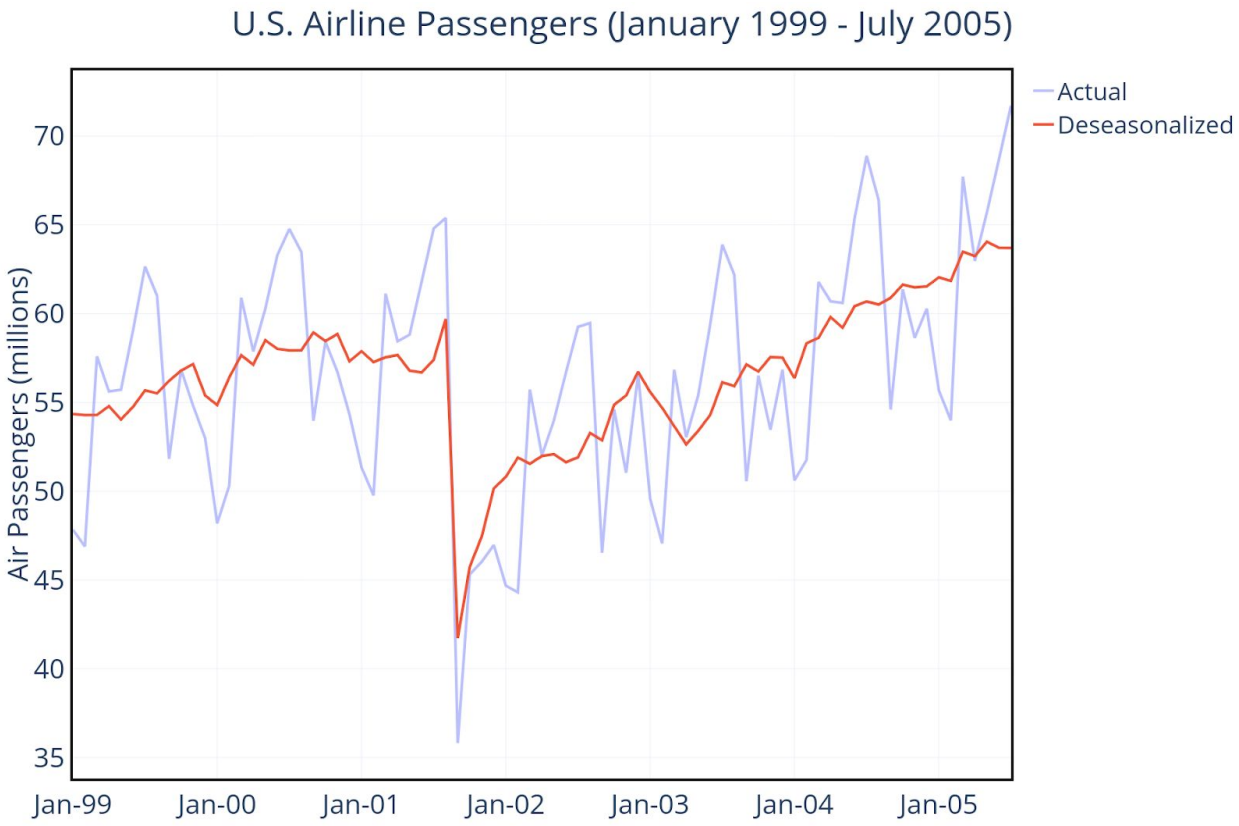

Figure 13: Passenger numbers drop after 9/11

2003 SARS Outbreak

Industry experts have also analyzed the effects of previous pandemics on aviation to gain a better understanding of how the industry can recover from COVID-19. The 2003 SARS outbreak is often looked at, as it is one of the more significant outbreaks in the history of aviation. Furthermore, COVID-19 and SARS are both caused by the coronavirus and are spread through respiratory droplets, leading to people being fearful of taking crowded flights. SARS resulted in the global aviation industry losing more than $7 billion, but the data on revenue passenger kilometers show that the aviation industry recovered from that pandemic in less than a year [85] [83]. While SARS shows that recovery is possible, differences between the 2003 outbreak and the COVID-19 pandemic are considered as well. Although SARS was a global outbreak, most cases were in Asia, and the U.S. only had 8 reported cases [86]. This means that American airlines were not affected as much as Asian airlines. Furthermore, COVID-19 has had a more significant economic impact. Many people have lost jobs or have seen a smaller income which has inhibited their ability to pay for flights and vacations. The effect of COVID-19 will be much more significant, and the IATA has already estimated that North American airlines will lose more than $20 billion [27].

2008 Recession

The 2008 Recession is another example that helps predict the effects of COVID-19 on the aviation industry. The 2008 Recession, also known as the Great Recession, was a time period when deregulation of the financial industry caused a general decline in the global economy. After the 2008 recession, the American economy plummeted and the airline industry became stagnant as a result. Data provided by the Federal Aviation Administration (FAA) shows that the total number of operations declined as 2008 ended and it's recovery came more than 7 years later [87]. The COVID-19 pandemic is expected to create a similar long-lasting decrease in the number of aviation operations because COVID-19's effect on the economy has been comparable to that of the 2008 recession [88].

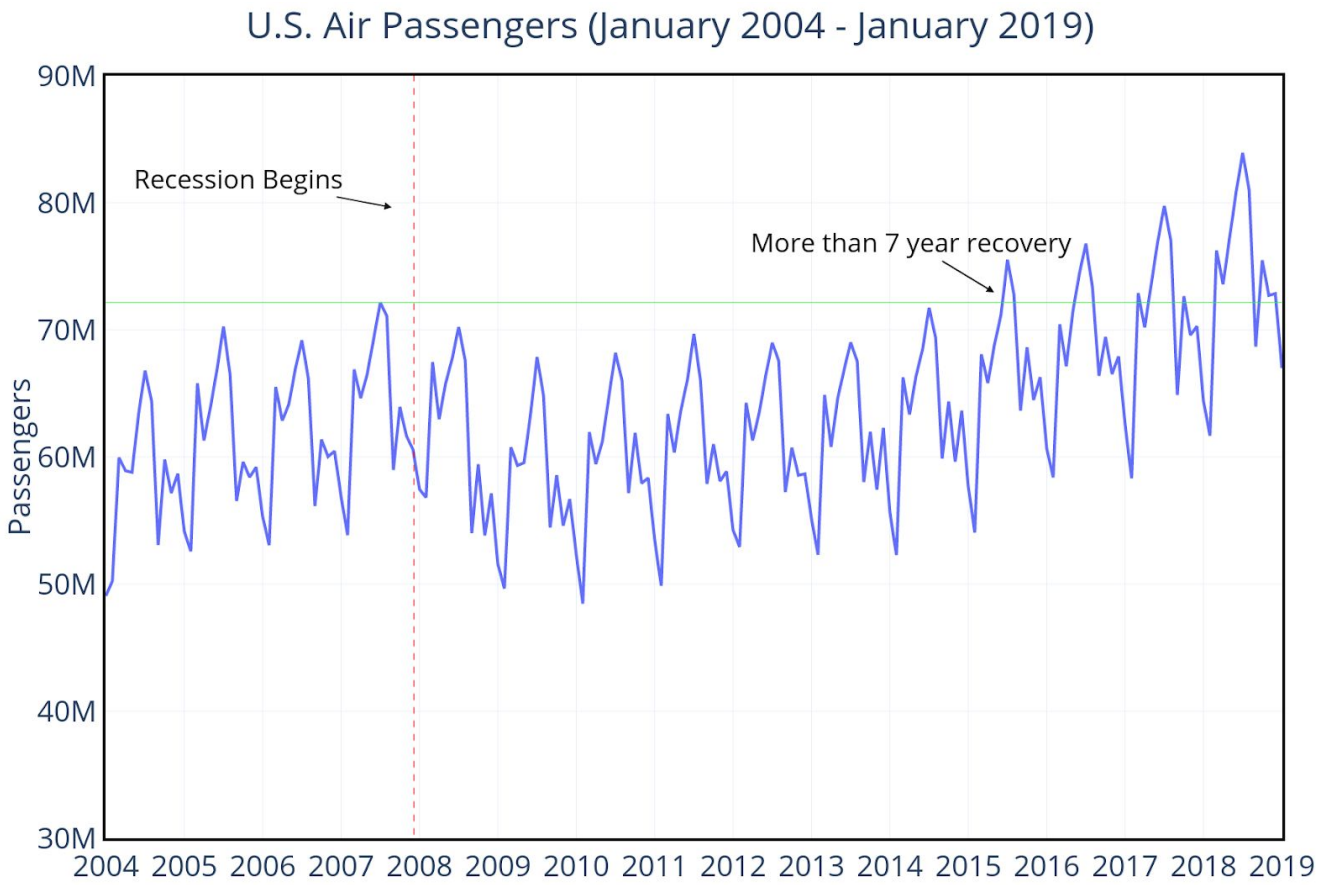

Figure 14: Air passenger numbers are low during the 2008 recession

Appendix B: Airline Recommendations

Airlines should promote safety in airports and aircraft. For example, in the case of a future pandemic, information about where it has originated, how it is spread, and how to prevent the spread of the virus should be prominently displayed as soon as possible. Airlines should also require masks, social distancing, and sanitation once the virus is seen to be a threat. Flexible booking is also an important feature that allows someone who is sick to cancel their flight, and therefore protect others from exposure, without a penalty. Furthermore, because the aviation industry has experienced the effects of COVID-19, they should have protocols in place for biometric testing in the future.

Airlines and manufacturers can also work to optimize seating arrangements during a health crisis. Instead of having all of the aircraft passengers on one level, airlines could try having two levels. This would minimize the amount of people passengers and staff walk by when walking through the aisles. When flights are not full, airlines could also remove seats on flights that don't have assigned seating. This way they would encourage their passengers to partake in social distancing.

While the safety guidelines above help protect passengers and airline workers, they also improve customer confidence. This is an important factor in the aviation industry recovering from COVID-19, and it will be a factor in future crises. The industry should take measures to protect everyone and show their customers that they are protecting. An increase in customer confidence can lead to an increase in bookings.

During future crises involving aviation, air traffic will likely drop no matter what. Safety guidelines and customer assurances will serve to help recovery, but they will not guarantee a profit. One way for airlines in the future to protect their financial interests is to create aircraft that hold passengers but can also be easily changed to

hold cargo. Even though cargo shipping has gone down due to COVID-19, it has not been hit as hard as passenger air carriers. During the COVID-19 pandemic, there have been a couple of passenger airlines, such as American Airlines, that have stripped the seats from several aircraft in order to ship cargo. This is a possible solution in the future as well, and airlines can start making it easy to switch between passengers and cargo now. This would establish flexibility in preparation for future events.

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