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The Effects of the Coronavirus on Transportation

Brittney Crandall
bnc51@zips.uakron.edu

Department of Civil Engineering

Honors Research Project:

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List of Acronyms

Americans with Disabilities Act: ADA

Centers of Disease Control and Prevention: CDC

District Department of Transportation: DDOT

Environmental Protection Agency: EPA

Greenhouse Gas: GHG

Metropolitan Transportation Authority: MTA

Vehicle Miles Traveled: VMT

World Health Organization: WHO

Section 1: Executive Summary

1.1 Goals and Objectives

This year the world has been challenged with the coronavirus pandemic. The first cases began in late 2019 and early 2020 in Wuhan China. Since then, the virus has spread throughout the world. This has led to national shutdowns which have negatively affected many aspects of everyday life. One of the industries that has seen adverse effects from the global pandemic is the transportation industry. The goal of this report is to explore how the transportation industry has been effected by the pandemic and to use this data to predict what the future implications will be.

1.2 Data Collected

All the data in this report has come from either government or university sites. Through calculations, it has been found that vehicle miles traveled has decreased by 14.75% from 2019 to 2020. It has also been estimated that without the pandemic, the total vehicle miles traveled would have been 3,071.72 billion miles. This is a 1.377% increase in vehicle miles traveled from 2019. However, the actual vehicle miles traveled in 2020 was only 2,583 billion miles (Highway Travel - All Systems).

The decrease in transportation has led to revenue loss. It is estimated that there has been a loss of 10.62 billion dollars from gas tax revenue that was lost due to less miles traveled in 2020. Domestic airlines have also lost $27.7 million in the first three quarters of 2020 (Commercial Aviation in 2020).

1.3 Future Implications

It has been predicted that conditions in the transportation industry will improve throughout the year of 2021. This is because the public is beginning to be vaccinated. As the public becomes vaccinated, it becomes safer for things to return to normal. This return to normalcy will allow for a rise in travel. This means fuel prices, public transit ridership, vehicle miles traveled, and domestic airline ridership will all increase throughout the year. Fuel prices and vehicle miles traveled will increase to values greater than they experienced before the pandemic in 2019. However, public transit and domestic airline ridership will not reach the values they did before the pandemic in 2021.

Section 2: Introduction

2.1 Problem Statement

The coronavirus has created countless problems this past year. The long term effects of these problems are unknown. Using research from the current effects from the coronavirus, this report will use data to predict the long term effects of the coronavirus on the transportation industry.

2.2 Coronavirus

The first cases of the coronavirus began in Wuhan China in December of 2019 (WHO Timeline - Covid-19). The coronavirus quickly spread throughout the world. As of March 2021, there have been 113,989,973 confirmed cases of the Coronavirus in 223 countries throughout the world. Of these cases, there have been 2,531,542 deaths (Coronavirus Disease (COVID-19) Pandemic). In March of 2020, the World Health Organization (WHO) made the assessment that the coronavirus could be characterized as a pandemic (WHO Timeline - Covid-19).

The coronavirus is an infectious disease which causes mild to moderate respiratory illnesses in people. However, it is shown to cause more serious side effects to those who are older or have underlying health conditions. The virus primarily spreads through droplets when a person sneezes or coughs. This is why mask wearing and social distancing has been enforced throughout the pandemic (Coronavirus).

To try to stop the spread of the coronavirus, many places went into a lockdown. The lockdowns helped to slow the spread of the virus by limiting contact between people (Coronavirus Disease (COVID-19): Herd Immunity, Lockdowns and COVID-19). This led to mass shutdowns which negatively affected the transportation industry.

2.3 Key Assumptions

There will be a few key assumptions made throughout this report. This is because no one knows the actual long term effects the virus will have. Assumptions will be made to help predict these changes. One assumption made is that the expected increase in vehicle miles traveled from 2019 to 2020 can be calculated by averaging the rate of changes from 1994 to 2019. Another assumption made is to only consider gasoline when calculating the gasoline tax loss and to not look at tax from diesel fuel. Also, when looking at the gas tax loss, the gas tax from the states is an average of all the states' gas tax instead of each individual state's gas tax. The final assumption made is that fuel prices, public transit ridership, vehicle miles traveled, and domestic airline ridership will all increase linearly. This linear increase is

based by averaging or taking the change from past months and assuming each month will increase by the same amount.

2.4 Goals and Objectives

The main goal of this research project is to look at research conducted on the coronavirus and use it to predict the future implications on transportation. If successful, this data can be used to help better prepare for the what the future will look like after the pandemic. In addition, this report will document current data about the coronavirus so if the world is faced with a similar situation in the future they can study this data to better prepare themselves.

Section 3: Response to the Coronavirus

3.1 Lockdown

One of the ways lawmakers attempted to slow the spread of the virus was to enforce lockdowns. These lockdowns looked different depending on the area. For example, in some cities in California, there were stay at home orders which lasted many months (About COVID-19 Restrictions). While in Ohio a stay at home order was put in place for six weeks. This order prohibited anyone from leaving their house unless it was essential. This stopped most travel throughout the state. After this order was lifted, businesses began slowly opening back up (Public Health Orders).

3.2 Restrictions

Once things did open again, there were still restrictions. Everyone must wear a mask and try to social distance. To help enforce these rules many places have instituted strict capacity limits. This restricts the number of people allowed in a store or restaurant. Many places are operating at a much lower capacity than before the pandemic. In addition, there are some businesses that have not reopened. For example, in Ohio, Regal Cinemas have been closed since the initial stay at home order.

In addition, travel restrictions were put in place. One of the restrictions was limiting travel between Mexico, the United States, and Canada. As of March 21, 2020 travel between these countries was limited to only essential travel. This restriction will be in place for a year (Temporary Restriction of Travelers Crossing US-Canada and Mexico Land Borders for Non-Essential Purposes). Similar to this restriction, some states created travel bans to other states during the peak of shutdowns. As of March of 2021, there are no travel restrictions across states. But, if returning to Ohio from a state with a positive testing rate greater than 15%, that person is advised to self-quarantine (COVID-19 Travel Advisory).

3.3 Working from Home

Another thing that has changed since the start of the pandemic is the number of things that have been moved to homes. Many people have switched to working from home and online schooling. This is all in an effort to decrease the contact between people. According to an article published by Stanford University, the percentage of the United States' labor force working from home is 42%. This is more than double the number of people working in person (Wong). This switch to online working was imperative for the lockdowns to occur. If the labor force was not able to work from home, the lockdowns would not have lasted. Another change that was imperative was the switch to online schooling. Almost 93% of households with school age children reported their child participating in a form of distance learning

(McElrath). No matter what action was taken to prevent the spread of the coronavirus, the changes had many effects on everyday life. In particular, these changes dramatically decreased travel throughout the United States.

Section 4: Decrease in Travel

4.1 Data

The stay at home orders had immediate effects on travel. With everyone being ordered to stay home except for essential travel, the vehicles on the road dramatically decreased. This is shown below in Figure 1. This figure was created by the Bureau of Transportation Statistics. The baseline of the graph is set at 1.0. The baseline is what expected travel was for 2020 if there was not a pandemic. If the VMT index is at 1.1, that means that travel is 10% higher than what was expected for 2020; however, if the VMT index is at 0.55 it means that travel is 45% less than what was expected for 2020. By studying Figure 1, the decrease in travel from March until July of 2020 is evident. These months were the height of government mandated lockdowns, so it makes sense that the vehicle miles traveled was so low. In addition, the graph shows how after many of the lockdowns were lifted in April-June travel began to increase. But throughout 2020, the vehicle miles traveled rarely reached what was expected for the year. This could be because of all the regulations still in place, many people still working from home, and because people do not want to leave their house unless necessary to decrease their contact with others.

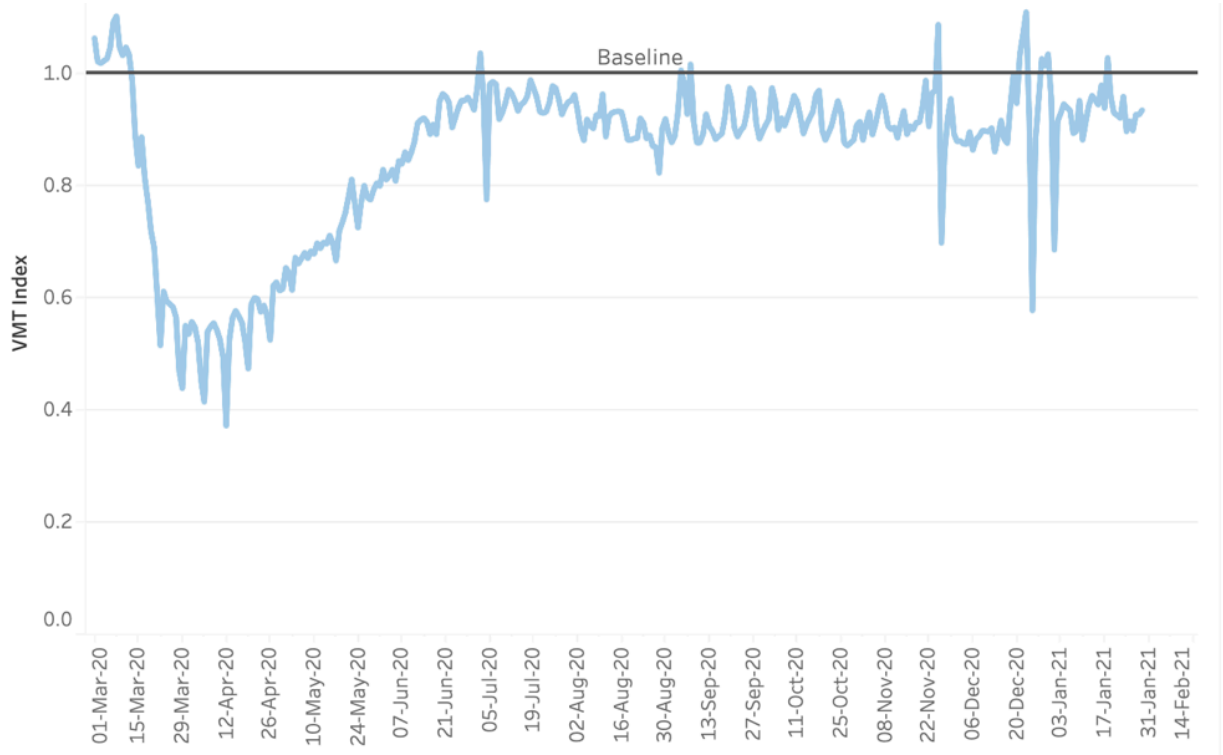

Figure 1: Passenger Vehicle Miles Traveled (VMT) (Daily Vehicle Travel During the COVID-19 Public Health Emergency).

Another figure which shows the travel decrease during the pandemic is shown in Figure 2. This figure was created by New York University. It shows the vehicle traffic on the metropolitan bridges and tunnels in New York City. This figure compares travel in 2020 to travel in the same week during 2019. The figure shows how in the beginning of March, average travel was higher than the same week in 2019. But, by the middle of March there was a slight decrease in travel, and by the end of March there was a dramatic decrease in travel when compared to 2019. New York City is the largest city in the United States, so it normally experiences lots of traffic. This figure shows the substantial impact the coronavirus had on transportation at the height of stay at home orders.

Vehicle Traffic via MTA Bridges and Tunnels (Data source: MTA[6])

% Change in vehicle traffic compared to the same week in 2019

Toll Plaza	3/1-3/8	3/8-3/15	3/15-3/22	3/22-3/29
Robert F. Kennedy Bridge Queens/ Bronx Plaza	-0.1	-15.5	-41.7	-55.2
Robert F. Kennedy Bridge Manhattan Plaza	-2.7	-17.9	-48.5	-63.3
Bronx-Whitestone Bridge	4.1	-12.6	-36.8	-50.2
Henry Hudson Bridge	0.3	-24.9	-56.7	-72.3
Marine Parkway-Gil Hodges Memorial Bridge	8.1	-9.0	-33.9	-49.5
Cross Bay Veterans Memorial Bridge	4.2	-6.9	-29.5	-38.8
Queens Midtown Tunnel	0.1	-20.8	-52.7	-68.0
Hugh L. Carey Tunnel	0.8	-16.7	-47.6	-66.3
Throgs Neck Bridge	-3.6	-15.4	-37.4	-48.2
Verrazano-Narrows Bridge	2.2	-10.2	-32.1	-43.4

Figure 2: Vehicle Travel on the Metropolitan Transportation Authority's (MTA) Bridges and Tunnels in New York City (Gao, Duran and Bian).

4.2 Calculations

The statistics shared in the data section show how overall travel decreased due to the coronavirus. Using data from past years, one can determine the rate of change of vehicle miles that was expected for 2020. The Federal Highway Administration lists the vehicle miles traveled in 1994 to 2019 (Traffic Volume Trends). By determining the average change between each year and averaging these changes, the rate of change expected for 2020 can be determined. The calculation for the expected rate of change of vehicle

miles traveled in 2020 is showed in Table 1. The calculations show that vehicle miles traveled were expected to increase by 1.377% from 2019 to 2020. (Traffic Volume Trends)

Table 1: Calculation for Average Rate of Change of VMT in 2020.

Year	Volume	(in millions of miles)	Difference	(in millions of miles)	Percent Change
1994	2,297,939				
1995	2,386,720		88,781		3.863505515
1996	2,417,911		31,191		1.306856271
1997	2,496,251		78,340		3.239986914
1998	2,570,334		74,083		2.967770469
1999	2,626,392		56,058		2.180961696
2000	2,697,095		70,703		2.692020079
2001	2,754,784		57,689		2.138930961
2002	2,808,501		53,717		1.949953245
2003	2,854,268		45,767		1.629588168
2004	2,904,170		49,902		1.748329169
2005	2,972,672		68,502		2.358746217
2006	2,999,380		26,708		0.898450956
2007	3,012,977		13,597		0.453327021
2008	3,031,224		18,247		0.605613651
2009	2,962,426		-68,798		-2.26964421
2010	2,945,064		-17,362		-0.586073711
2011	2,973,046		27,982		0.950132153
2012	2,958,872		-14,174		-0.476750107
2013	2,968,068		9,196		0.310794113
2014	2,983,420		15,352		0.517238823
2015	3,036,013		52,593		1.762842644
2016	3,107,344		71,331		2.349495868
2017	3,183,253		75,909		2.442890134
2018	3,213,116		29,863		0.938128386
2019	3,228,026		14,910		0.464035534
				Average Percent Change:	1.377485198

In Table 2 the total vehicle miles traveled in each month in 2019 is shown. The total vehicle miles traveled in 2019 is 3,030 billion. Using this information, the travel for 2020 without COVID-19 can be predicted. This is done by increasing the vehicle miles traveled in 2019 by 1.377% which was calculated in Table 1. This shows the expected travel in 2020 is 3,071.72 billion miles. This calculation is shown below. Equation 1 calculates 1.377% of 3,030 billion miles and Equation 2 adds this value to 3,030 billion miles to calculate the total miles that would have been traveled without the pandemic.

Equation 1: $3{,}030 * 1.377\% = 41.7231$

Equation 2: $3{,}030 + 41.7231 = 3{,}071\ billion\ miles$

Table 2: Vehicle Miles Traveled in 2019.

Vehicle Miles Traveled in 2019 (in billions)	
284	
227	
271	
281	
286	
281	
296	
287	
272	
284	
261	
Total:	3,030 billion miles

The vehicle miles actually traveled in 2020 are shown in Table 3. The table shows that the travel in 2020 was 2,583 billion vehicle miles. This value is 488 billion miles less than what would have occurred without the coronavirus. This calculation is completed by subtracting the predicted miles traveled in 2020 without COVID-19 by the actual miles traveled in 2020. This calculation is shown below in Equation 3. While Table 4 compares the actual vehicle miles traveled from 2019 to 2020. It shows that there were 447 billion less miles traveled in 2020 than 2019. It also shows that this was a 14.75% decrease.

Equation 3: $3{,}071\ billion\ miles - 2{,}583\ billion\ miles = 488\ billion\ miles$

Table 3: Vehicle Miles Traveled in 2020.

Vehicle Miles Traveled in 2020 (in billions)
253
232
220
168
213
244
262
252
248
259
232
Total: 2,583 billion miles

Table 4: Comparison in Vehicle Miles Traveled from 2019 to 2020

Comparison Between Vehicle Miles Traveled in 2019 and 2020	
Difference Between 2019 and 2020:	447 billion miles
Percent Change:	14.75%

4.3 Travel Time

With the dramatic decrease in vehicle miles traveled, the time it takes for vehicles to travel have decreased as well (Gao, Duran and Bian). This is because there are less vehicles on the road due to more people staying at home. Vehicles are able to travel faster without as much congestion on the roadways. For example, traffic on MTA bridges and tunnels saw a dramatic decrease as shown in Figure 2. With less traffic, the vehicles that are on the road are able to travel much faster. In addition, there has been a shift to working from home. With this shift, there has been a decline in rush hour traffic. The cars that are still traveling during rush hour are able to reach their destination quicker than before the pandemic.

An example of the decrease in travel time is shown in Figure 3. This figure shows the travel time for vehicles traveling eastbound and westbound on the 495 corridor in New York City. This figure shows how the travel times decrease throughout the month of March. At the beginning of the month the travel times were around 80 to 100 minutes. By the end of the month the travel times dropped to about 30 minutes. This figure gives a direct example of how the coronavirus has decreased travel times.

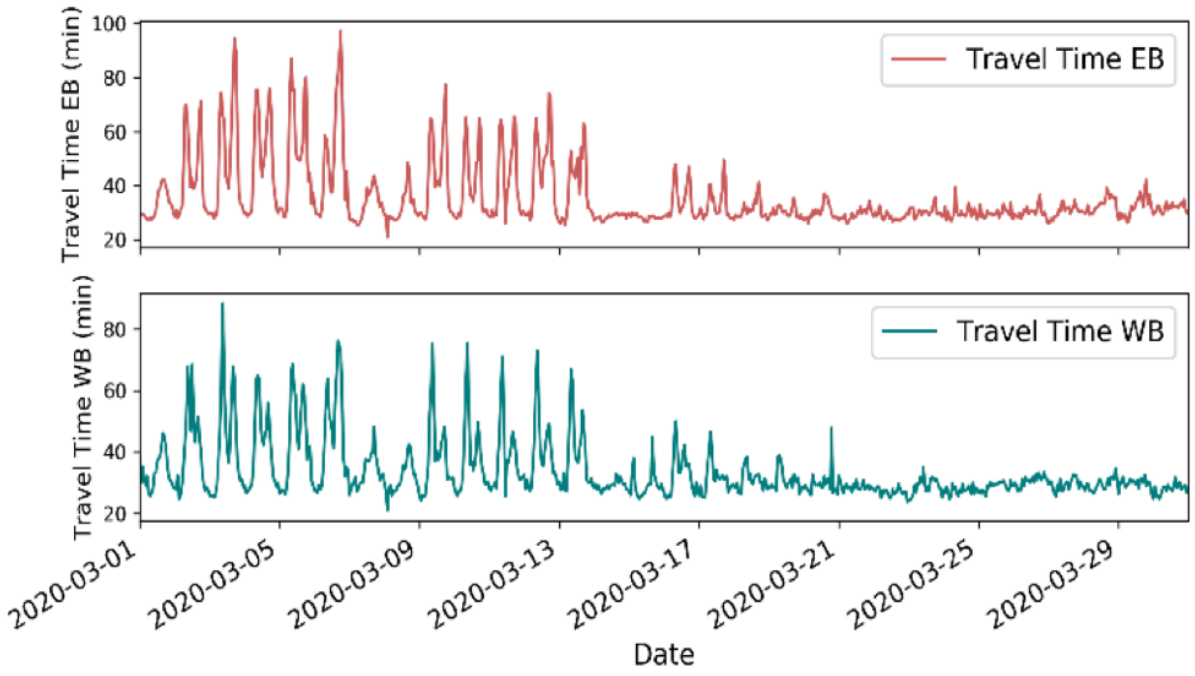

Figure 3: Travel times on the 495 corridor in New York City during March of 2020 (Gao, Duran and Bian).

4.4 Car Accidents

An effect of the decrease in travel due to the coronavirus is the subsequent decrease in car accidents. Based on the New York Police Department's Motor Vehicle Crash Reports shows that car crashes were down in the month of March (Gao, Duran and Bian). The New York Police Department posts traffic data for each month of the year. In March of 2019 at Brooklyn intersections there were 6,529 vehicles involved in collisions. While in March of 2020 there were 4,215 vehicles involved in collisions. This means there was a 35% reduction in the number of car accidents (Traffic Data). Figure 4 shows a visual representation of the crashes in February and March in New York City. The red line depicts crashes in 2019 and the green line shows crashes in 2020. The figure shows how the number of crashes steeply decreased once New York declared a state of emergency. Overall, the decrease in travel has lowered the number of car accidents occurring. (Traffic Volume Trends; Highway Travel - All Systems)

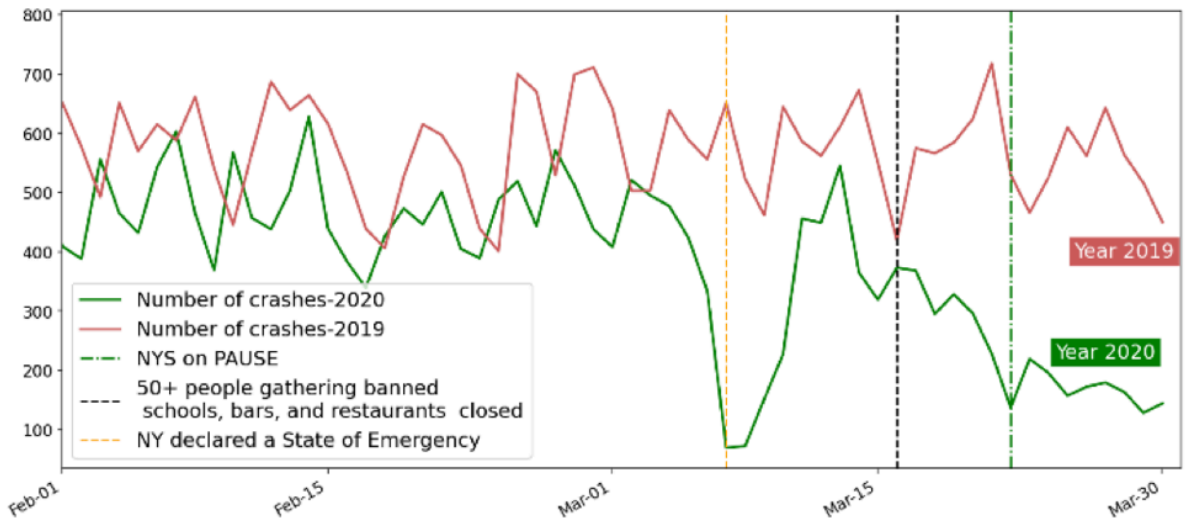

Figure 4: Number of crashes in New York City during February and March of 2019 and 2020 (Gao, Duran and Bian).

4.5 Public Transportation

With the outbreak of the coronavirus, there has been a steep decline in the number of people using public transportation. In particular, New York City has seen a large decrease in public transit users. Figure 5 compares the ridership of subways, buses, and railroads from 2019 to 2020 in New York City. The figure shows that in the end of March, all transit ridership was extremely low when compared to the same day in 2019 (Gao, Duran and Bian). One reason for this is because of the stay at home orders. Less people are leaving their houses, so there are less people on public transportation. Another reason is because it is difficult to stay away from other people while on public transit. One of the ways to stop the spread of the coronavirus is to limit contact with other people, so not riding on public transit helps to limit additional contact.

Transit Ridership

Based on statistics from MTA Annual Disclosure Statement Supplement, March 25th, 2020

% Change in ridership compared to the same date in 2019

	3/12	3/16-3/17	3/20-3/23
NYC Subways	-18.6	-59.9	-86.9
NYCT Bus	-14.4	-48.3	-60.3
MTA Bus	-18.9	-51.3	-62.4
Metro North Railroad (a.m. peak)	-48	-90	-94
Long Island Rail Road (a.m. peak)	-31	-67	-71

Figure 5: Transit Ridership in the MTA during the month of March (Gao, Duran and Bian).

Public transportation also saw drops in ridership in other parts of the country. For example, the number of people riding the public buses in Baltimore fell by more than 50% from February to April of 2020 (How COVID-19 is Affecting Transportation). To try to make up from the lost revenue, some buses are not operating as much as they used to. They have cut their hours down. While in some places, they are offering free passes to essential workers to make sure they can get to and from work (How COVID-19 is Affecting Transportation). Another way buses are trying to promote ridership is by making passengers enter in exit through the rear door. This limits their contact with the driver (How COVID-19 is Affecting Transportation).

To summarize, the coronavirus has caused a decline in the use of public transportation. This is especially true in large cities like New York City. Measures are being taken to promote ridership, but they are still lower than what they were before the pandemic.

4.6 Aviation

Beginning in February of 2020, the rise of the coronavirus triggered a significant drop in the number of flights and passengers. This led to the airline's decline in profit and subsequent layoffs of personnel working in passenger airlines. Figure 6 shows the domestic flights scheduled, canceled, and operated in January 2019 to December 2020. In the figure, there is a steep decline in the number of flights operated

from March 2020 to May 2020. May of 2020 was an all-time low for the number of operating flights. There were only 180,151 flights while there where 680,165 flights in May of 2019 (Commercial Aviation in 2020). After the initial drop, there is a rise in flights from May 2020 to August 2020, but the flights operated are still much lower than they were before the pandemic. In December of 2020, flights operated at 58% less flights than December of 2019 (Commercial Aviation in 2020). Figure 6 also shows the canceled flights in red. The figure shows a large number of flights canceled in March and April. In April, 41% of the scheduled flights were canceled (Commercial Aviation in 2020). The cancelations were due to the uncertainty of what was happening with the coronavirus. In total, the year of 2020 operated 4,721,342 domestic passenger flights while 2019 operated 7,938,055 flights (Commercial Aviation in 2020). This is a 41% drop in the number of domestic passenger flights.

Even though passenger flights dramatically decreased in 2020, air cargo flights increased. From May of 2020 to the end of the year, United States' airlines carried 1.34 million more tons of cargo than in the same period in 2019. This led to a 11% rise in tons of cargo carried. This number includes 6% more international cargo and 13% more domestic cargo (Commercial Aviation in 2020). This data is shown in Figure 7. This figure displays the air cargo carried by United States' airlines in billions of pounds. The blue line shows data from 2020 and the orange line shows data from 2019. The figure shows that starting in May of 2020, the cargo carried is larger in 2020 than 2019. The airlines have lost a lot of profit due to the pandemic, but the increase in cargo offers a ray of hope for the airlines.

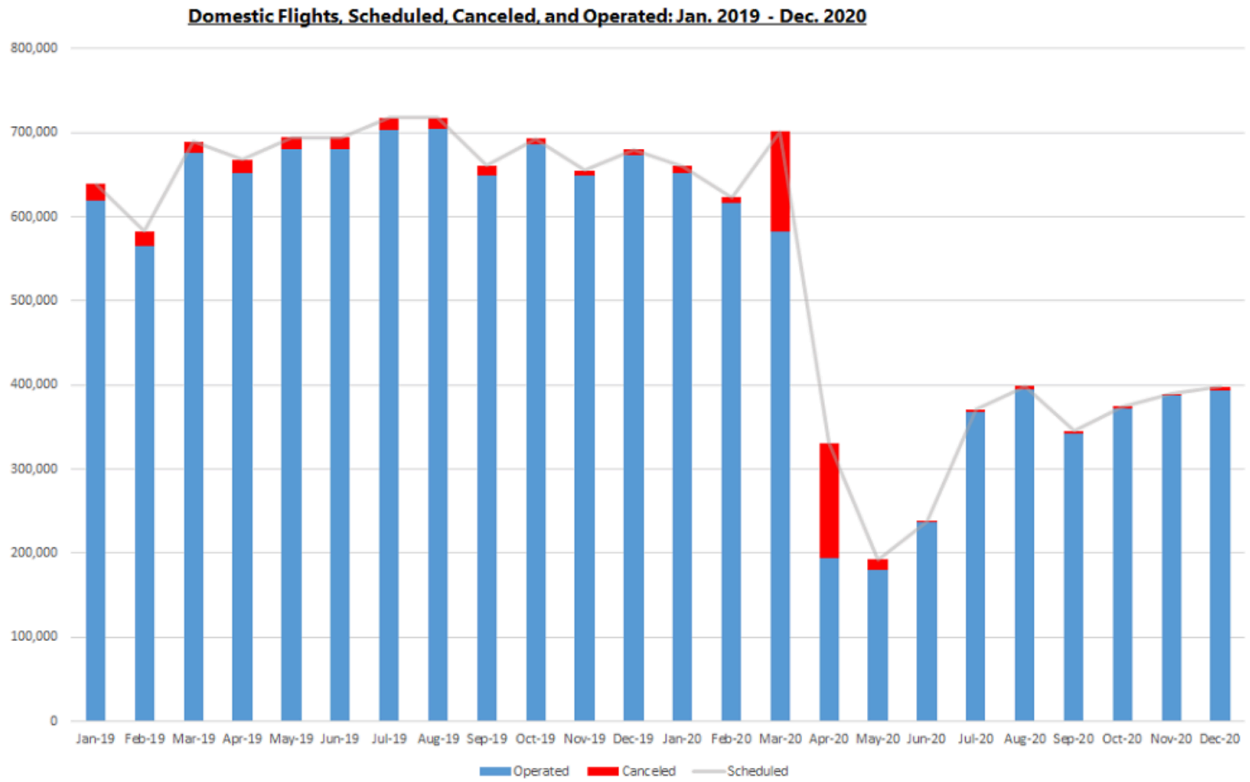

Figure 6: Domestic Flights, Scheduled, Canceled, and Operated: Jan. 2019 – Dec. 2020 (Commercial Aviation in 2020).

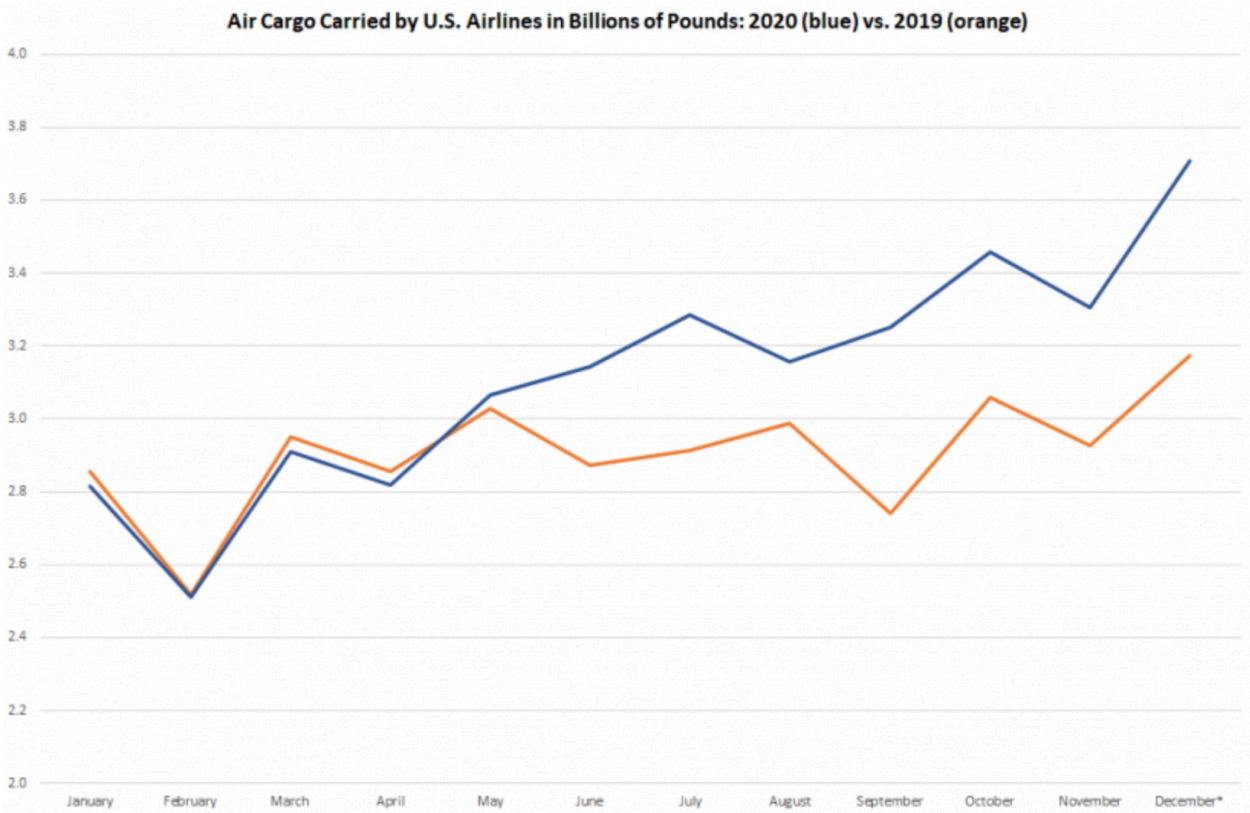

Figure 7: Air Cargo Carried by U.S. Airlines in Billions of Pounds (Commercial Aviation in 2020).

4.7 Carbon Emissions

The large decrease in vehicle travel also led to a decrease in the amount of carbon emitted. According to the Environmental Protection Agency (EPA), the transportation sector is the biggest contributor in carbon emissions. In 2018, 28% of emissions came from transportation (Fast Facts on Transportation Greenhouse Gas Emissions). The different sectors of carbon emissions is shown in Figure 8. When looking at the transportation sector as a whole, the largest section is light-duty vehicles. Light-duty vehicles contribute to 59% of the transportation section (Fast Facts on Transportation Greenhouse Gas Emissions). With the coronavirus, travel has decreased by 14.75% as calculated in the calculations in Section 4 of this report. With the decrease in travel, the amount of greenhouse gases emitted has decreased as well with transportation being the largest contributor to the emissions.

According to research conducted at the University of East Anglia, the University of Exeter, and the Global Carbon Project, carbon emissions have declined by an estimated 2.4 billion tons in 2020 (COVID Lockdown Causes Record Drop in Carbon Emissions for 2020). This is the steepest decline in carbon emissions that the earth has seen in the past century and a 7% drop when compared to emissions in 2019. Stanford University professor Rob Jackson compared the drop in carbon emissions to taking 500 million cars off of the world's roads for the year (COVID Lockdown Causes Record Drop in Carbon Emissions for 2020).

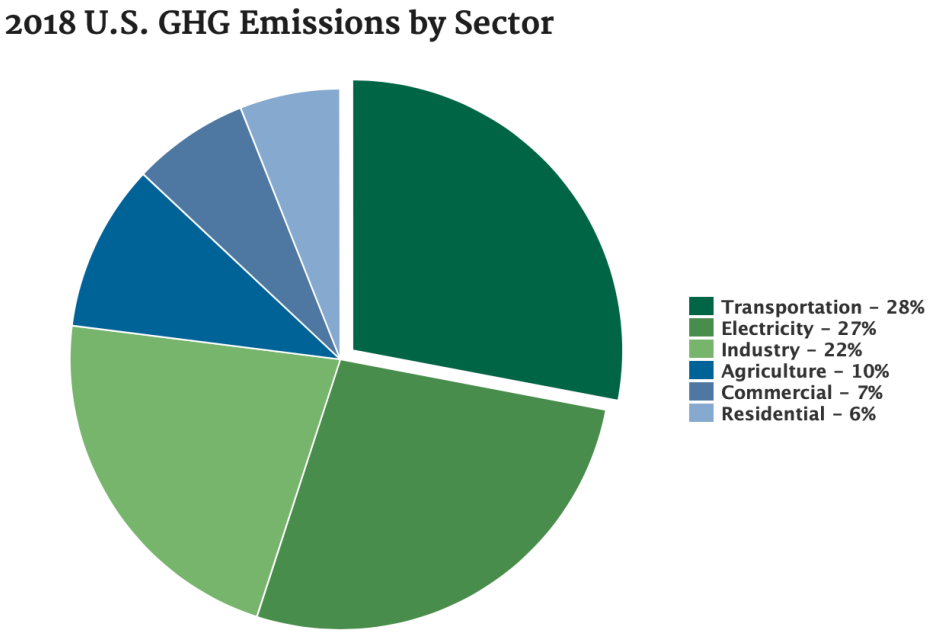

Figure 8: 2018 United States Greenhouse Gas (GHG) Emissions by Sector (Fast Facts on Transportation Greenhouse Gas Emissions).

Section 5: Six Feet Apart

5.1 Public Transportation

One of the main prevention methods the Centers of Disease Control and Prevention (CDC) has enforced is the six feet apart rule. The CDC has been advising everyone to stay six feet apart from people you do not share a residence with. However, the CDC states that it can be difficult to stay six feet apart while traveling on public buses, trains, subways, and airplanes. This is because traveling on these modes of transportation may involve being in crowded terminals and having to stand or sit closer than six feet to others for extended periods of time (Travel During COVID-19). Travelers may not feel safe going on public transportation due to the uncertainty of being able to stay six feet apart from others. This is one of the factors that has led to the decline of public transportation. Measures have been taken to keep those who do use public transportation safe. The CDC recommends that those traveling using public transport should wear a mask. They also recommend to practice social distancing whenever possible (Travel During COVID-19).

5.2 Sidewalks

Staying six feet apart from others has also proven difficult when walking on sidewalks. The basic urban sidewalk sits five feet back from the curb or six feet back if it is at the face of the curb (Walkways, Sidewalks, and Public Spaces). This width does not leave enough room for two people to walk next to each other and keep the recommended six foot distance between them. This is an issue because on sidewalks, there can be pedestrians walking in different directions and their paths will have to cross. The sidewalk is not large enough to maintain the necessary distance between them. One example of the government tackling this problem is in Washington D.C. The District Department of Transportation (DDOT) has been temporarily extending sidewalks in front of essential businesses (Sidewalk Extension Plan to Support Social Distancing Near Essential Businesses). This gives pedestrians enough space to practice social distancing during the pandemic.

Sidewalks are also being used for restaurant outdoor seating. New York City is implementing a concept called street seats. This program allows local restaurants to apply for street seats. Street seats are when restaurants create temporary public seating in the curb lane. These seats can be used for many purposes such as eating, reading, and working. The business selects the design and maintains the street seats. While the New York City Department of Transportation (NYC DOT) provides elements such as signage, wheel stop bars, and striping (Street Seats). An example of a street seat is shown below in Figure 9. The picture shows tables and chairs added to the curb lane. Flower pots are used as a barrier to protect pedestrians

from traffic. This is a regulation when installing street seats. Some sort of planting must be used to block pedestrians from traffic. Another regulation of street seats is that they have to maintain roadway drainage, be ADA compliant, and allow access to underground utilities (Street Seats). The use of street seats are one of the ways the government is trying to help businesses safely reopen during the midst of the coronavirus outbreak.

Figure 9: Picture of Street Seats in New York City (Street Seats).

5.3 Bicycles

Since the coronavirus, there has been a shift to cycling. This is because it is a safe way to travel if commuters do not have a car and do not want to use public transportation. Bicycling allows travelers more opportunity to stay away from others compared to public transportation. In New York City there was a 55% increase in the number of bicycles traveling over the Brooklyn, Manhattan, Williamsburg, and Queensboro bridges when compared to the same week in 2019 (Gao, Duran and Bian). This statistic was taken in the first ten days of March of 2020. After the tenth day, New York City implemented the stay at home order so nonessential workers were forced to stay home. However, it is safe to assume that without the stay at home order bicycling would have continued to increase as a mode of travel. The study also saw an increase in ridership of bicycles near hospitals (Gao, Duran and Bian). This shows there was an

increase in essential workers biking to work. Overall, bicycling has been a good alternative to public transportation in an effort to stay six feet apart from others.

Section 6: Revenue Loss

6.1 Calculations

The coronavirus outbreak has led to large revenue losses throughout the world. One area that has been hit is the revenue lost due to less travel. There is a gas tax on each gallon of gas bought. On each gallon of gasoline there is a federal 18.3 cent fee for excises taxes and 0.1 cent leaking underground storage tank fee. In addition, the average gasoline tax of the states is 30.06 cents. This tax is for things like excise taxes, environmental taxes, and inspection fees. Some of the money obtained from the taxes goes towards maintaining and constructing new roadways (Tax on a Gallon of Gasoline). With less travel, there has been a decrease in the amount of gasoline sold. This results in less money obtained from the gas tax. Overall, it is estimated the government has lost $10.62 billion in gasoline tax that they would have received if the pandemic did not occur. This value was calculated by taking the estimated value of vehicle miles traveled without COVID, which is 3071.72 billion vehicle miles (calculated in section 4.2) and subtracting the actual vehicle miles traveled in 2020 which was 2583 billion vehicle miles (from Table 3). This is shown in Equations 4 and 5. This gives the difference between expected miles traveled and actual miles traveled in 2020. This value is then used to see how many gallons of gas would have been purchased if the pandemic did not occur. The average car gets 22.2 miles per gallon (Average Fuel Efficiency of U.S. Light Duty Vehicles). To figure out how many gallons of gas would have been purchased the 488.72 billion miles is divided by 22.2 miles per gallon. This shows the gallons of gasoline that would have been purchased if the pandemic did not occur is 22,014,554,045 gallons. This calculation is shown in Equations 6 and 7. To find the revenue lost from not getting as much gas tax the gallons of gas is multiplied by the gasoline tax. The total federal and average state tax is 48.46 cents which was calculated in Equations 8 and 9. This gives the total revenue loss from the gasoline tax is $10.62 billion. The calculations for this value are shown below in Equations 10 and 11.

Step one:

Equation 4: $Estimated\ VMT\ for\ 2020 - Actual\ VMT\ for\ 2020 = difference\ in\ VMT$

Equation 5: $3071.72\ billion\ VMT - 2583\ billion\ VMT = 488.72\ billion\ VMT$

Step 2:

Equation 6: $\frac{difference\ in\ VMT}{Average\ miles\ per\ gallon} = Gallons\ of\ gasoline$

Equation 7: $\frac{488.72\ billion\ VMT}{22.2\ miles\ per\ gallon} = 22{,}014{,}554{,}045\ gallons$

Step 3:

Equation 8: $Federal\ Gas\ Tax + State\ Gas\ Tax = Total\ Gasoline\ Tax$

Equation 9: $18.3\ cents/gal + 0.1\ cents/gal + 30.06\ cents/gal = 48.46\ cents\ per\ gallon$

Step 4:

Equation 10: $Gallons\ of\ Gas * Gas\ Tax = Potential\ Revenue\ without\ COVID$

Equation 11: $22{,}014{,}554{,}045\ gallons * 48.46\ cents\ per\ gallon = \$10.62\ billion$

Another area which has seen major economic loss due to the coronavirus is the aviation industry. As stated in Section 4.6, the airlines have seen a 41% drop in the number of domestic flights from 2019 to 2020 (Commercial Aviation in 2020). This has caused passenger airlines to lose a lot of money. Figure 10 depicts the after tax net profit of passenger airlines in the United States. This figure shows that in the first, second, and third quarters the passenger airlines were not making a profit. In quarter one the passenger airlines lost $5.2 billion, in quarter two they lost $11 billion, and in quarter three they lost $11.8 billion. This means all together the airline has lost $27.7 billion in the first three quarters of 2020.

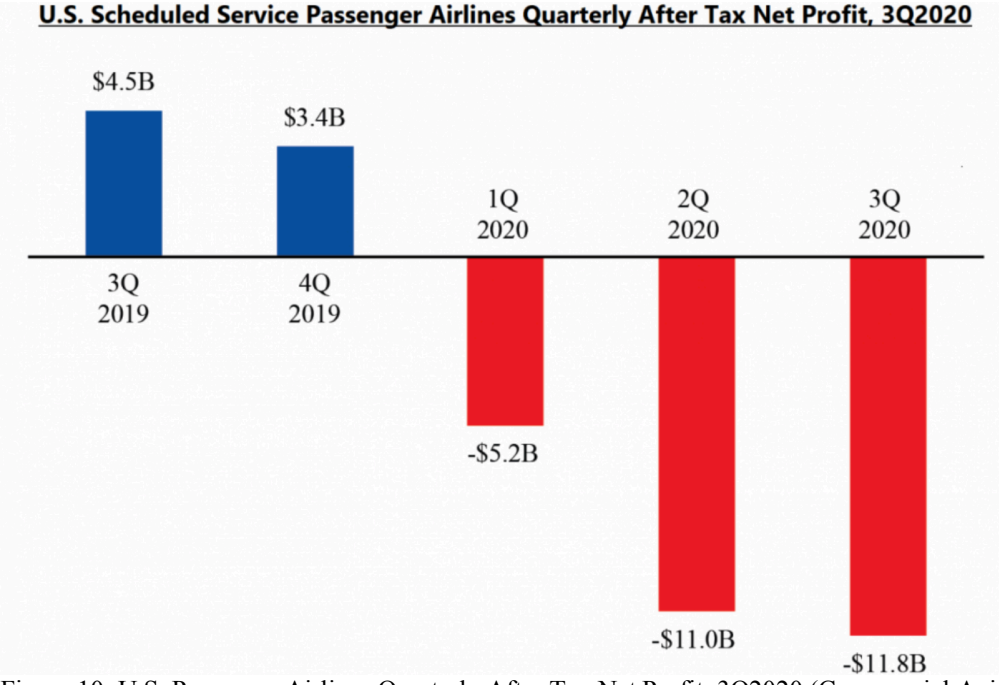

Figure 10: U.S. Passenger Airlines Quarterly After Tax Net Profit, 3Q2020 (Commercial Aviation in 2020).

6.2 Effects

As shown in the calculations above, the government has lost a lot of tax revenue because of the pandemic. Specifically, the loss of gas tax revenue has had negative effects. Some of the money obtained from this tax goes towards funding for highways, local roads, and transit. This can help pay for maintenance and rehabilitation of the roadways (Impact of COVID-19 on State Transportation Revenues). But, with a decrease in revenue from the gas tax there will not be as much money for roadway funding. This means it may take longer to fix roadways, so things like outdated bridges will take more time to get rehabilitated (COVID-19 Pandemic Could Cost California Transportation Billions in Revenue). Another effect is that states may have to initiate reductions to counteract the revenue loss. This could mean stopping new projects from being started. If this happens, it could lead to personnel layoffs in the roadway construction and design fields. It could also mean that roadways that need repaired will not get fixed because there is not enough money in the budget.

The aviation industry has also faced major economic loss from the coronavirus. As shown in the Calculations Section, the passenger airline has lost $27.7 billion in profit in the first three quarters of 2020 (Commercial Aviation in 2020). This loss has led to layoffs of personnel in the passenger airline industry. December of 2020 had the lowest December employment on record. The Bureau of Transportation Statistics has been tracking airline employment in 1990. The number of employees in December of 2020 was even less than December of 2009 when the United States was in a recession (Commercial Aviation in 2020). In addition, November of 2020 was the lowest airline employee count on record. There were only 366,750 full time employees (Commercial Aviation in 2020). Figure 11 depicts the full time employees in passenger airlines in 2019 (shown with an orange line) versus 2020 (shown with a blue line). This figure shows the drop in employees starting in March of 2020 with an all-time low in November of 2020. Overall, the loss in airline profit has led to a decline in passenger airline employment.

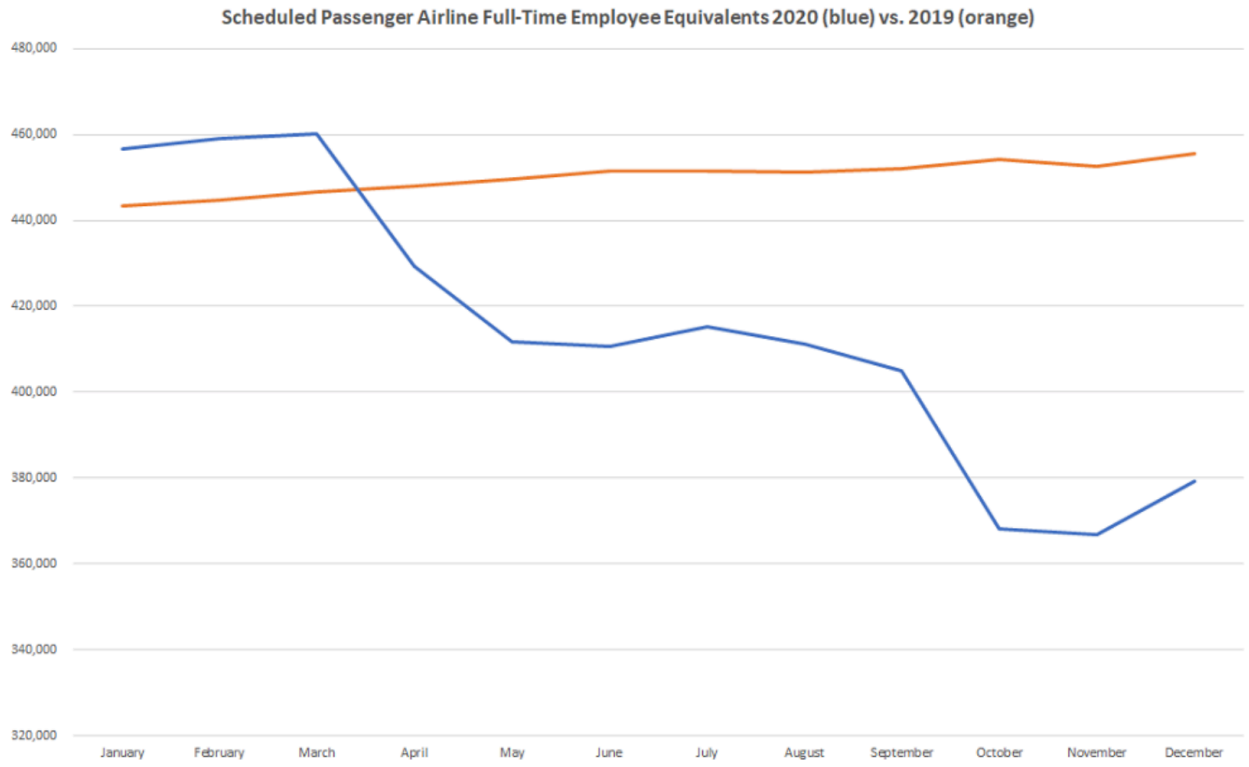

Figure 11: Passenger Airline Full-Time Employees in 2019 (blue) vs. 2020 (orange) (Commercial Aviation in 2020).

Section 7: Long Term Effects

7.1 Fuel Prices

As stated in section 6.1, there has been revenue loss from gas tax. In addition, there has been revenue lost because fuel prices were lower during the pandemic. The lower prices were caused because there was less demand for the fuel so prices went down. During the height of lockdown which was in April of 2020, gasoline prices were at $1.87 per gallon (Fuel Prices - Regular Gasoline). While in April of 2019, gasoline prices were at $2.80 per gallon. This means fuel prices dropped by 33% because of the lockdowns. Figure 12 shown below shows a comparison of fuel prices in 2019 and 2020. The large drop in prices can be seen in the months of April and May of 2020.

Things have slowly started to open up again like restaurants, stores, and activities. As things open there becomes more traveling. This causes the demand for gasoline to go up, which makes the price go up as well. Since the initial crash in April of 2020, fuel prices have been rising. The rising fuel prices can be seen in Figure 12. Using this data, the fuel prices in 2021 can be predicted. It has already been determined that the gasoline prices in January and February of 2021 were $2.33 and $2.50 respectively (Fuel Prices - Regular Gasoline). This was in increase in price of $0.17 per gallon. Assuming that the rest of the months will have the same increase, the fuel prices for the rest of the year can be predicted. This prediction is shown in Figure 12 with a gray dashed line. This figure shows that fuel prices are already higher in 2021 than they were in 2019. They are expected to reach $4.20 in the month of December. This value makes sense because as things continue to open throughout the year people will start to travel more. This will cause fuel prices to rise. Once things are more normal, fuel prices will level out, but until then they will continue to rise throughout the year of 2021.

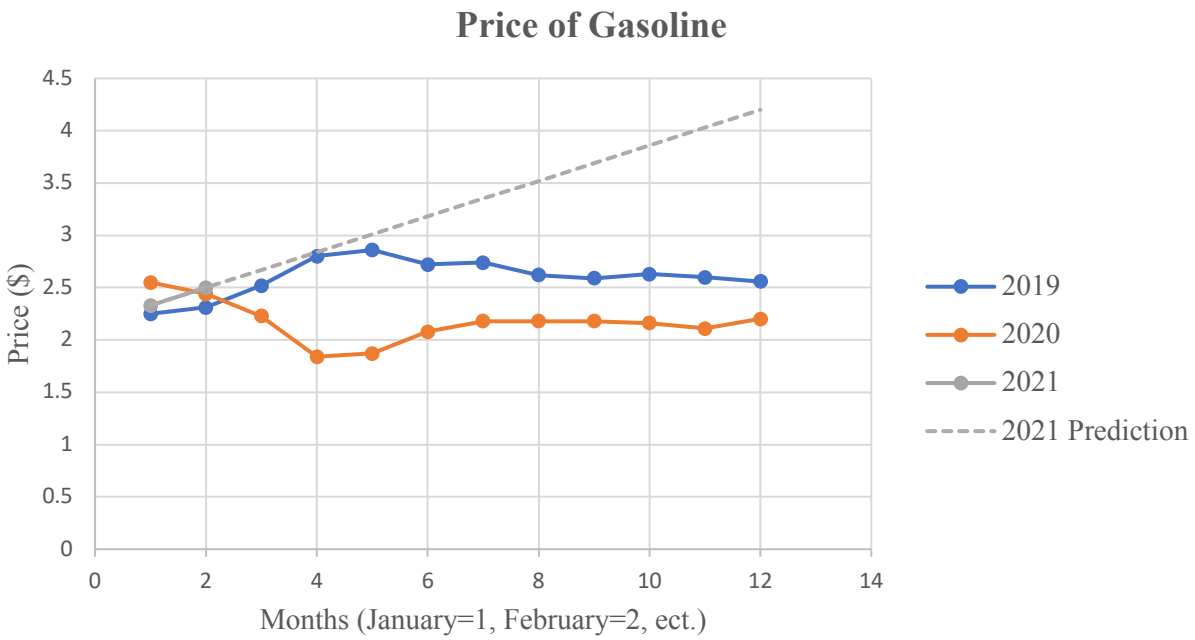

Figure 12: Price of gasoline each month for 2019, 2020, and 2021.

7.2 Public Transportation

After the start of the start of the pandemic, the use of public transportation dramatically decreased. This was discussed in sections 4.5 and 5.1 in the report. Both sections explained the reasoning for this decrease. As the world progressed through the pandemic, transit ridership continued to stay low throughout the year of 2020 and into 2021. In 2019, transit ridership ranged from 350 million passengers to 430 million passengers per month. While in 2020, ridership fell to a low of 110 million passengers in April. Since April of 2020, transit ridership has stayed around 180 million passengers each month (Transit Ridership). This data is shown in Figure 13. Figure 13 shows transit ridership each month in 2019, 2020, and 2021.

Figure 13 also shows the prediction for transit ridership in 2021. The graph shows that in January of 2021, transit ridership was 154 million passengers. But, after that, the rest of 2021 ridership is a prediction. This prediction was made by finding the average change of passengers between the months of April of 2020 and January of 2021. This showed the average change was an increase of 4.89 million passengers each month. It was then assumed that each month in 2021 would increase linearly by this amount. This prediction is shown in Figure 13 with a gray, dashed line.

Based on this prediction, transit ridership will not reach the values it was in 2019. It will be 2.5 years until transit ridership reaches the same ridership it experienced in 2019. In 2019 the lowest amount of

passengers was 352 million, which occurred in December. If transit ridership continues to increase 4.89 million passengers each month, it will reach 352 million riders in June of 2023.

Looking at Figure 13, this prediction also shows that transit ridership in the Summer of 2021 will be slightly more than the Summer of 2020. In June, ridership will be around 18 million more passengers than there were in 2020. Next, in July, there will be 2.3 million more passengers in 2021 than 2020. Finally, in August there will be 3.2 million more riders in 2021 than in 2020. Even though ridership is slowly increasing, it will be a while until it is back to what is was before the pandemic. Vaccinations and herd immunity will help speed up the process, but transit ridership will continue to stay low as long as riders are worried about catching the virus.

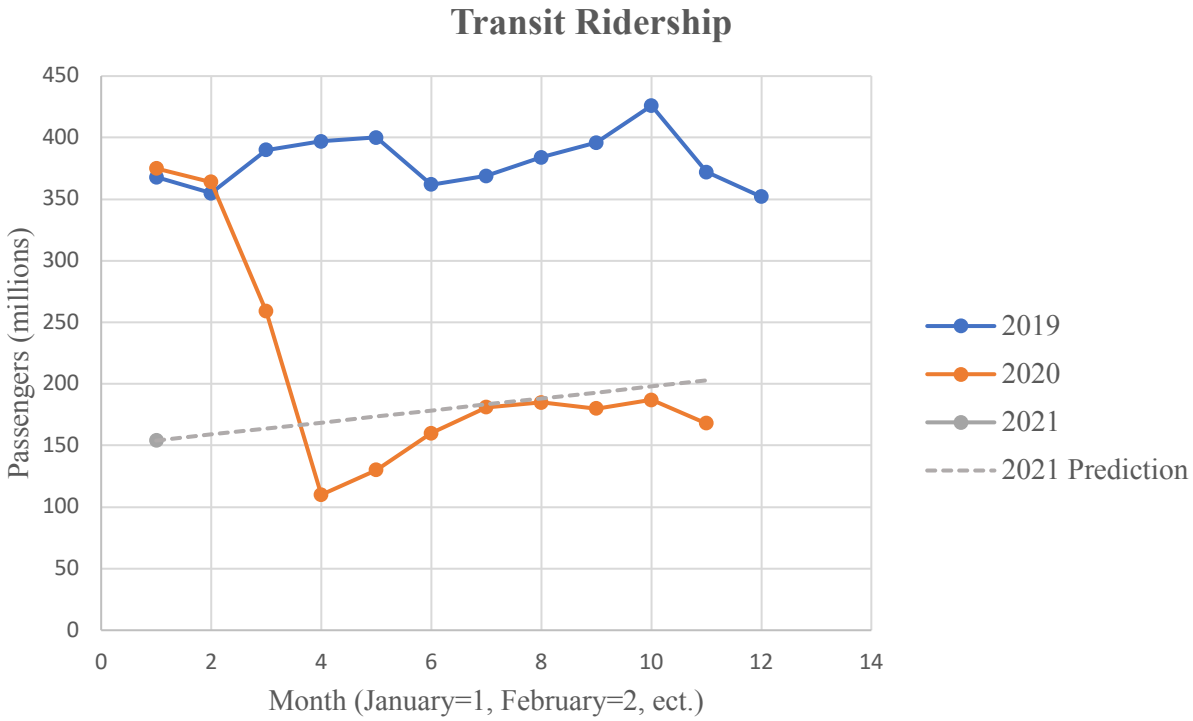

Figure 13: Transit ridership each month in 2019, 2020, and 2021.

7.3 Vehicle Miles Traveled

The coronavirus has caused a decrease in the total vehicle miles traveled (VMT) throughout the United States. This was originally discussed in sections 4.1 and 4.2 in the report. After the start of the pandemic, vehicle miles traveled stayed lower than what they were in 2019. The lowest VMT in 2020 occurred in April. There were only 166 billion vehicle miles traveled in that month. This compares to 277 billion vehicle miles traveled in April of 2019 (Highway Travel). This data is shown below in Figure 14. Vehicle miles traveled in 2019 is shown with a blue line, while VMT in 2020 is shown with a gray line.

Additionally, the value for VMT in January of 2021 is shown in Figure 14 with a gray dot. The value of VMT in January of 2021 is 223 billion vehicle miles traveled. After the initial value of 223 billion VMT, the prediction for the VMT in 2021 is shown with a gray, dashed line. This prediction was made by averaging the change in VMT from April of 2020 to January of 2021. This showed the vehicle miles traveled increased by an average of 6.3 billion miles each month. Assuming that the VMT will increase linearly by 6.3 billion miles each month, the 2021 prediction was formed.

Based on the prediction for the VMT in 2021, the VMT in the summer of 2021 will be higher than the VMT in the summer of 2020. In June, the VMT will be 7.7 billion more miles in 2021 than in 2020. Next in July, the VMT in 2021 will be 1 billion miles more than in 2020. Finally, in August, the VMT will be 14.3 billion miles more in 2021 than 2020. Overall, there will be 23 billion more vehicle miles traveled in the summer of 2021 than in the summer of 2020. This makes sense because circumstances of the pandemic have been improving since the summer of 2020. For example, there have been three different coronavirus vaccines released to the public. They are the Pfizer-BioNTech, Moderna, and the Johnson & Johnson. As of the last week in March of 2021, everyone over the age of 16 is eligible for the vaccine in Ohio. This means by the summer, everyone who wants to be vaccinated should be. This will allow for travel to increase because it will be safe to be around people again and things will be closer to normal.

After the implementation of the vaccines, things will become closer to normal. This is shown in the prediction for the VMT in 2021. In October of 2021, the VMT will reach what it was in 2019 before the pandemic. After October, the VMT in 2021 will be more than what it was in 2019. This is shown in Figure 14. This increase will occur because once travel restrictions are lifted, there will be a boom in travel. This is because people have been stuck at home for over a year, so once it is safe to travel there will be a large increase in the amount of vehicle miles traveled. This increase in travel will be seen at the end of 2021 and into the year of 2022.

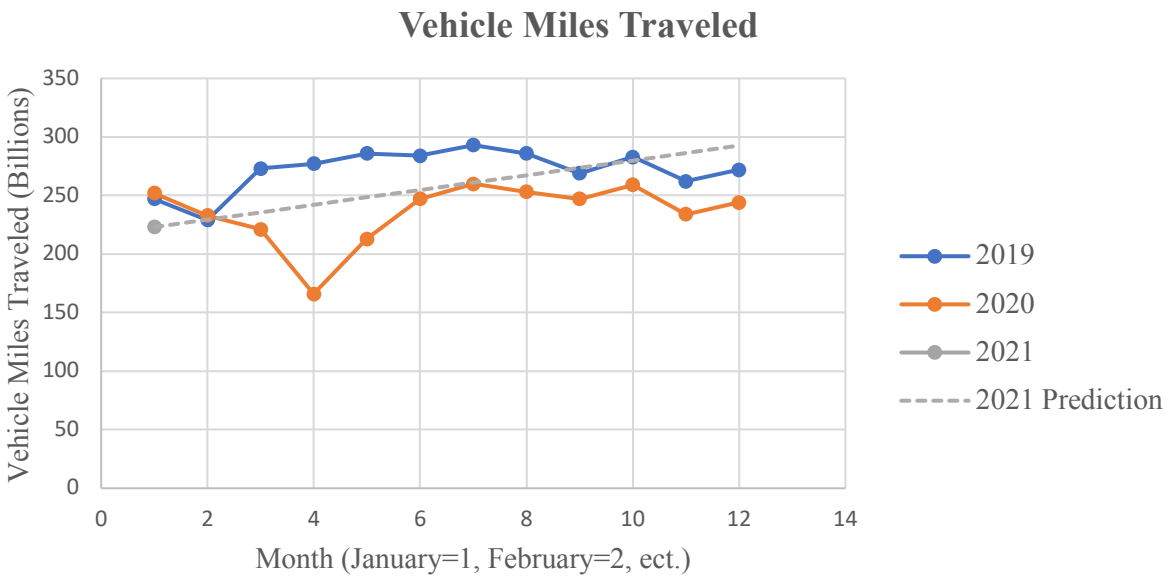

Figure 14: Vehicle miles traveled each month of 2019, 2020, and 2021.

7.4 Domestic Airlines

The spread of the coronavirus has led to a decrease in domestic air travel. This decrease was discussed in sections 4.6 and 6.1. At the height of lockdowns, domestic air travel fell to 2.86 million passengers in April of 2020. This is a 96% decrease from the amount of passengers in April of 2019. After April of 2020, the number of passengers on domestic flights continued to rise, but the numbers are still much lower than what they were before the pandemic. For example, in December of 2019 there were 69.1 million passengers while in December of 2020 there were only 27.9 million passengers (Air Travel-Domestic). These values are shown below in Figure 15. The number of passengers in 2019 is shown with a blue line, while the number of passengers in 2020 is shown with an orange line.

Also shown on Figure 15 is a prediction for the number of domestic airline passengers in 2021. This prediction was formed by calculating the average percent change from April of 2020 to December of 2020. This calculation found that the number of domestic airline passengers increased at an average of 3.13 million passengers each month. The 2021 prediction was made by assuming that each month will increase by this average. This assumption makes sense because the implementation of the vaccines will allow for more travel to occur. The prediction is shown in Figure 15 with a gray, dashed line.

Figure 15 allows one to compare the summer of 2020 to the summer of 2021. It shows that air travel will be significantly more in the summer of 2021 than 2020. Domestic air travel will increase by 209%, 145%, and 135% respectively in June, July, and August of 2021 when compared to the same months in 2020.

Even though the year of 2021 will see an increase in domestic travel, it will still not reach the values it was at before the pandemic. In December of 2021, there will be 3.64 million less passengers than in 2019. If each month continues to increase by 3.13 million passengers, in January of 2022 there will be more passengers than there were in January of 2019 before the pandemic.

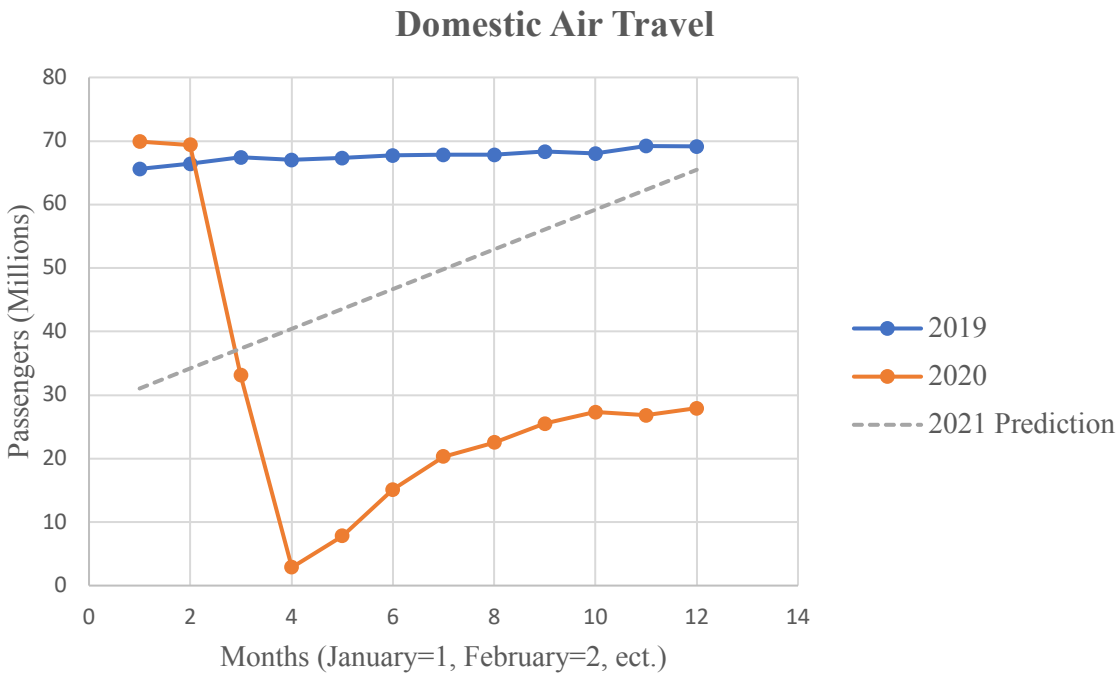

Figure 15: Domestic air travel in 2019, 2020, and 2021.

Section 8: Conclusion

The coronavirus outbreak has changed lives in many ways. It has placed the world in lockdowns which have stopped most travel. It has also instilled a fear in the public. This is the fear of catching the virus and spreading it to others. This worry makes people not want to leave their houses and be closer than six feet to others. All of these things have led to a large decrease in the transportation industry.

The transportation industry has experienced a decrease in travel from the pandemic. The vehicle miles traveled dropped 14.75% from 2019 to 2020. This percentage equates to 447 billion less miles in 2020 than 2019 (Traffic Volume Trends). The decrease in travel has led to shorter travel times. This is because there are less vehicles on the road which makes travel faster. A specific example of this occurred in New York City. In the month of March, vehicles traveling eastbound and westbound on the 495 corridor experienced a 50 minute reduction in travel time (Gao, Duran and Bian). The decrease in travel has also led to a decrease in the number of accidents that are occurring. Less cars are on the road, so there are less chances for accidents. The number of accidents in New York City decreased by 35% in the month of March of 2020 when compared to March of 2019 (Traffic Data). Travel decrease has also been seen in public transportation and aviation. Riders want to be able to safely stay six feet away from others when riding and at terminals, but this can be difficult when crowded. This worry has caused public transportation and aviation to drop in many areas. For example, the number of people riding the public buses in Baltimore fell by more than 50% from February to April of 2020 (How COVID-19 is Affecting Transportation). Also, the total number of domestic flights dropped 41% from 2019 to 2020 (Commercial Aviation in 2020). The final sector effected by travel decrease is carbon emissions. Due to less vehicle miles being traveled, the carbon emission in 2020 decreased. It is estimated that carbon emissions dropped by 2.4 billion tons in 2020 (COVID Lockdown Causes Record Drop in Carbon Emissions for 2020).

The need to stay six feet apart has had impacts on the transportation industry. It has decreased the use of public transportation. It has also introduced a need for larger sidewalks because the average width of a sidewalk does not provide enough room for people to pass each other at six feet apart. Sidewalks are also being used for outdoor seating in some areas. New York City is installing street seats so that seating can be put in the curb lanes of roads (Street Seats). This increases the space available for outdoor seating. The pandemic has increased the use of bicycles. Both for transportation and recreational use. During the middle of March of 2020, bicycle use increased 55% in New York City when compared to the same week in 2019 (Gao, Duran and Bian).

The decrease in travel has led to losses in revenue. Some of this revenue comes from the gas tax. It is estimated that there was $10.62 billion is gas tax revenue loss due to the pandemic. The airline industry also faced revenue losses. In the domestic airline industry, they have lost $27.7 billion in the first three quarters of 2020 (Commercial Aviation in 2020). These losses have led to delays in construction projects and to layoffs in the domestic airline workers.

Using the data collected through the report, predictions for 2021 were made. It was found that fuel prices will rise throughout the year. They have the potential to reach a high of $4.20 per gallon. This is much higher than they were in 2019. While transit ridership will experience a small increase in 2021, but ridership will be well below what it was in 2019. Next, the vehicle miles traveled will experience an increase. In October of 2021, they will be higher than what they were before the pandemic in 2019. Finally, domestic airline ridership will increase, but it will not reach the number of passengers it had before the pandemic until January of 2022.

It is safe to assume all of the areas mentioned above will experience growth because the conditions from the coronavirus are improving. Three different vaccines have been implemented. As more of the public is vaccinated, it is safer for things to return to normal. This will cause rises in the transportation industry. The extent of the long-term effects of the coronavirus are still unknown, but society is slowly returning to a state of normalcy.

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Section 10: Appendix

PowerPoint Slides

Effects of the Coronavirus on Transportation

Brittney Crandall

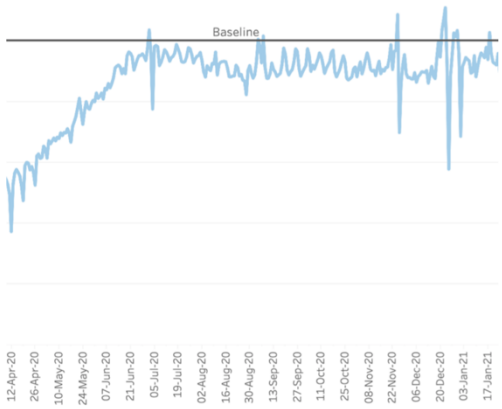
Source: https://abcnews.go.com/Lifestyle/wireStory/city-sleeps-empty-nyc-streets-amid-virus-69739239

Introduction

- The coronavirus pandemic has led to national lockdowns to try and slow the spread of the virus which has decreased travel and negatively effected the transportation industry
- Data has been collected from government and university websites and will be analyzed and used to predict future implications of the pandemic on the transportation industry

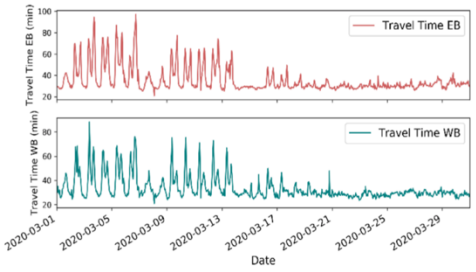
Decrease in Travel

- Travel decreased 14.75% from 2019 to 2020 due to COVID-19
- The graph shows a baseline which was the expected vehicle miles traveled (VMT) for 2020 and the blue line shows the actual VMT in 2020
- There is a large drop in the VMT in March and April of 2020, this was at the height of lockdowns
- Using past data the predicted VMT for 2020 without COVID-19 is 3,071 billion miles
- The actual VMT for 2020 is 2,583 billion miles



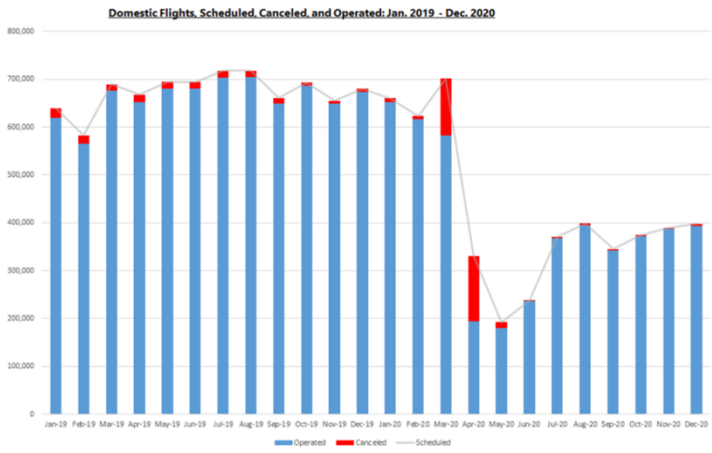
Source :https://www.bts.gov/covid-19/daily-vehicle-travel

Effects of Decreases in Travel



Source: https://c2smart.engineering.nyu.edu/wp-content/uploads/2020/04/C2SMART-COVID-19-Whitepaper_draft_v10_final.pdf

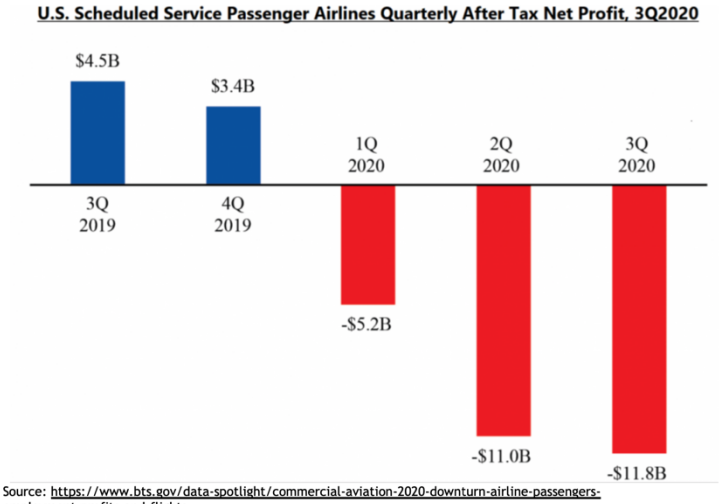
- Travel time decrease
  - Vehicle travel times traveling eastbound and westbound on the 495 corridor in New York City decreased by 50 minutes throughout the month of March
  - The decrease in travel times is shown in the figure on the left
- Decrease in Car Accidents
  - In March of 2019 there were 6,529 vehicles involved in collisions at Brooklyn intersections while there were 4,215 vehicles involved in collisions in March of 2020 at Brooklyn intersections
  - This is a 35% reduction in the number of collisions from March of 2019 to March of 2020



Source: https://www.bts.gov/data-spotlight/commercial-aviation-2020-downturn-airline-passengers-employment-profits-and-flights

Effects of Decreases in Travel Cont.

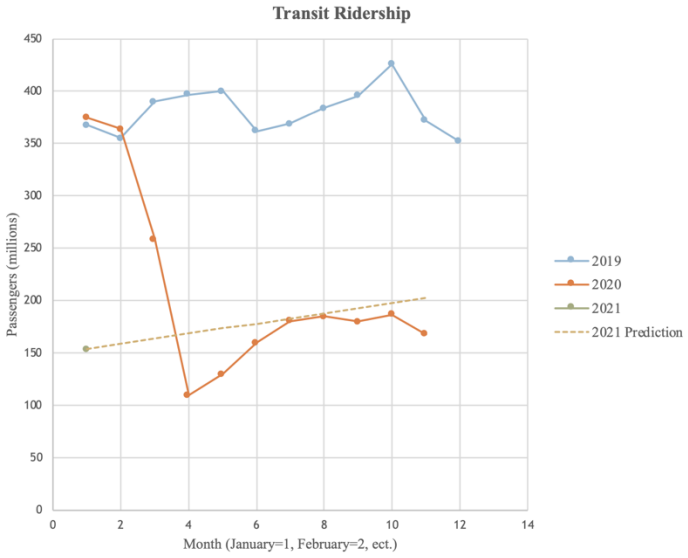
- Public Transportation
  - Ridership for public transportation dramatically decreased
  - The number of people riding buses in Baltimore fell by more than 50% from February to April of 2020
- Aviation
  - 41% decrease in number of domestic flights operated from 2019 to 2020 (flights in 2020 shown in the figure on the left)
  - Increase in air cargo flights
    - 6% more international cargo and 13% more domestic cargo carried in 2020 than 2019
- Carbon Emissions
  - Carbon emissions have decreased by 2.4 billion tons in 2020



Source: https://www.bts.gov/data-spotlight/commercial-aviation-2020-downturn-airline-passengers-employment-profits-and-flights

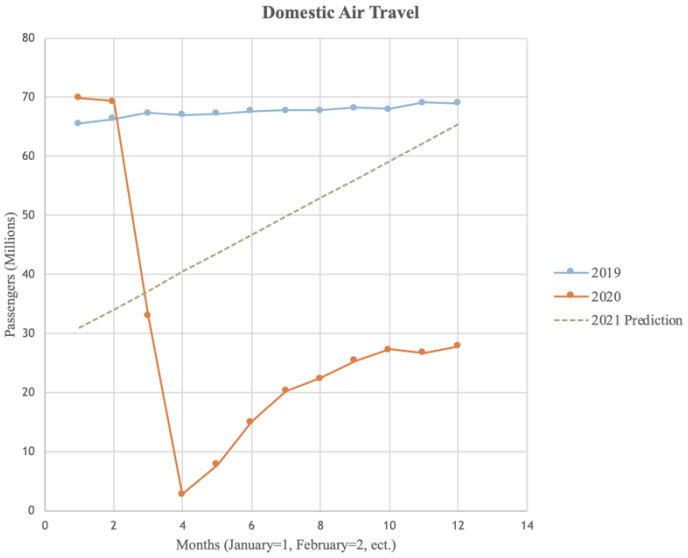
Revenue Loss

- There is an approximate combined federal and state tax of 48.46 cents on each gallon of gas purchased
- Less travel led to less gallons of gas being purchased which caused the government to receive less money in gas taxes
- Without the pandemic the government would have received 10.62 billion dollars from the gas tax
- The airline industry lost 27.7 billion dollars in the first three quarters of 2020
- The airline industry revenue loss is shown in the figure



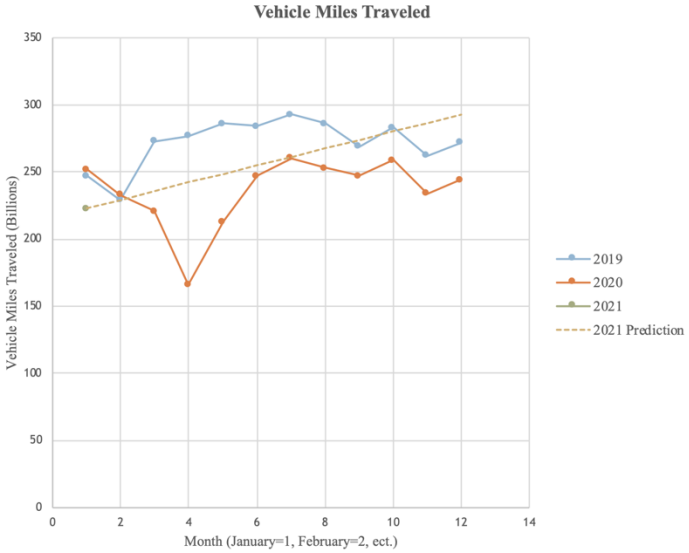
Public Transportation: 2021

- Ridership in January of 2021 was 154 million passengers
- The 2021 prediction was made assuming the rest of 2021 will increase by the average rate of change from April 2020 to January 2021
  - This rate of change is an increase of 4.89 million passengers each month
- Ridership will not reach pre-pandemic 2019 values until June 2023
- Ridership will increase by 23.5 million passengers from summer of 2020 to summer of 2021



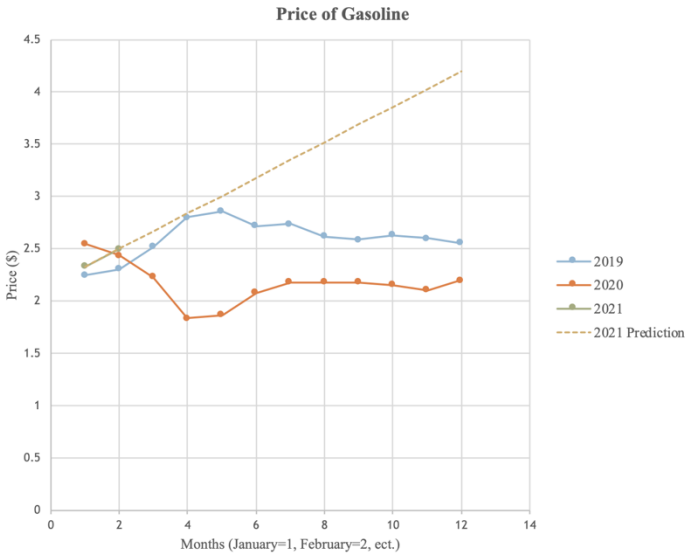
Domestic Airlines: 2021

- There were 27.9 million passengers in December 2020
- The 2021 prediction was made assuming 2021 will increase by the average rate of change from April 2020 to December 2020
  - This rate of change is an increase of 3.13 million passengers each month
- In January of 2022 ridership will be greater than January of 2019 which was before the pandemic
- There will be more passengers in the summer of 2021 than the summer of 2020



Vehicle Miles Traveled: 2021

- VMT in January 2021 was 223 billion miles
- The 2021 prediction was made assuming the rest of 2021 will increase by the average rate of change from April 2020 to January 2021
  - This rate of change is an increase of 6.3 billion vehicle miles traveled each month
- In October of 2021 VMT will reach values greater than before the pandemic in 2019
- Summer of 2021 will have 23 billion more VMT than summer of 2020



Gasoline Prices: 2021

- Prices increased by $0.17 from January to February 2021 assuming the same increase the rest of the year, the 2021 prediction was made
- Prices in January 2021 are higher than prices in January of 2019 before the pandemic
- Prices will be higher in the summer of 2021 than summer of 2020

Source: https://www.mercurynews.com/2020/03/10/before-and-after-coronavirus-traffic-nearly-disappears-for-commuters/

Conclusion

- The coronavirus has caused decreases in travel this has led to decreases in:
  - Travel time
  - Car accidents
  - Public transportation
  - Aviation
  - Carbon emissions
  - revenue
- By June of 2023 the transportation industry will have values greater than 2019, which was before the pandemic