

# **COVID-19's Effects on The Future of Transportation**

This paper discusses quantitative data on the effects of COVID-19 on transportation and the challenges it poses for the future of transportation. The paper is exploratory and intended to spur discussion. It is not purporting to be the policy positions of the administration.

**Office of the Assistant Secretary for Research and Technology**

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With data support from the Bureau of Transportation Statistics

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# COVID-19's Effect on the Future of Transportation

## Introduction

The COVID-19 pandemic has greatly affected the nation's transportation users and providers since February of 2020. Urgent questions arise: how will the pandemic affect the long-term future of transportation in the United States and how will the U.S. Department of Transportation and other public and private concerns craft their policies and investments in response?

Widespread public health effects, economic consequences and government responses to address the outbreak have already changed the population's behavior and the transportation system. Uncertainty remains about how the future course of the disease and the prospects of subsequent waves or new viral pandemics will affect public and private behavior.

In our highly-interconnected world, contagious diseases can spread quickly, and COVID-19 has done just that. Despite decades of global and national mobility that can speed the transmission of pandemics, there is no parallel to COVID-19. But, the population domestically and globally is larger, denser, more urban, older, and more mobile, factors that exacerbate disease transmission. The loss of life and the shut-down of much of the economy have shown people the risks of globalization and interdependency.

A note of hope has been sounded, however. After successful clinical trials, pharmaceutical companies began, in December 2020, to distribute doses of the vaccine. It is hoped that this innovation – developed with unparalleled speed—will end the ongoing disruption and pave the way for the recovery of transportation and the economy. Precautions will be taken to prevent, mitigate, and treat future threats. Many people will now more actively try to minimize the risk of contracting contagious diseases by retaining some behavior modifications.

Transportation, for the most part, is an intermediate function, a means to an end. The rate of economic recovery will substantially affect the demand for all kinds of transportation. The resumption of pre-COVID-19 economic and other activities will depend on the ability to return to normal life and work safely --contingent upon how well medical progress conquers the pandemic and how much the public is willing to assume some health risks. The year since the emergence of COVID-19 has shown significant effects on the transportation sector especially for modes that involve shared travel. In that time, individuals and businesses have adapted behaviors and altered practices to mitigate the effects of the pandemic.

Most importantly, communications as a substitute to travel has been actively deployed in many areas, from telework to e-commerce, telemedicine, web-based meetings in lieu of traditional business communications, distance learning, delivery of restaurant meals and online worship services among others. As these behaviors have become more engrained, analysts are envisioning a different future than what might have been anticipated only a year ago.

Multiple new data products and surveys show new and emerging travel and human behavior patterns and help us understand what travel might be like post-COVID. Changes in economic conditions, business practices and land use and activity pattern trends are all critical data points.

Public and private transportation sectors are seeking to understand future conditions so as to position transportation services to function effectively and efficiently in this new context.

The degree of change compels public leaders and private enterprise to rethink the Federal role in transportation going forward. A sober and serious study will enable Federal, State and local leadership to develop good programs, sound policy guidance and prudent financial priorities.

This paper provides quantitative information about the effect of the crisis on different modes of transportation and discusses currently discernable critical issues. The paper is organized into the following sections: Background, Demand for Transportation, Supply of Transportation, Transportation Moving Forward, Policy Implications, and Conclusion.

## Background

The Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21) reshaped much of how transportation planning was done, after its passage in June 1998. At that point, computerization and the Internet were already growing for both work and home use. September 11, 2001 had not yet occurred, and the iPhone was still seven years away. Maglev and high-speed rail were among the modes being talked about, but the concept of transportation network companies was not in transportation professionals' vocabulary, nor were e-commerce, bikeshare, e-scooters, hyperloop or Tesla. Climate change and resiliency were not yet key considerations in transportation policy and the prospect of a virus radically altering global transportation was not among the events used in scenario planning and other strategic planning methods. Perhaps most importantly, the past decade of technology progress fueled high expectations for automated and connected vehicles. The business models and logistics optimization for such vehicles promised a transformational time for transportation.

In the immediate period, preceding COVID-19, the nation heralded record high employment. Rates of e-commerce, ridesharing, and electric vehicles were rising and driver assistance technologies and automation showed growing potential. With a robust economy, roadway vehicle miles of travel were pacing slightly ahead of overall population growth. Public transportation declines leveled off in 2019 after five years of declining ridership as travel alternatives captured customers. Ridesharing was nearly ubiquitous in urban areas and e-scooter use was surging with each new market opening. Freight activity remained strong across the modes. Amtrak was near breakeven operations. Air travel passenger volumes were at a record.

Except for air travel and despite a very robust economy, the last three years' travel demand growth has been moderate. Table 1 provides key transportation trend data. Technological progress accelerated over the past decade: improving safety; enhancing logistics; easing scheduling and payment functions; and spurring private sector investment in transportation.

**Table 1 - Pre-COVID-19 Travel Trends**

	2010	2016	Change 2016- 2010	Annualized % Change 2016-2010	2019	Change 2019- 2016	Annualized % Change 2019-2016	Source
<b>U.S. Population</b>	309,321,666	322,941,311	4.4%	0.7%	328,239,523	1.6%	0.5%	Census
<b>Total Employment</b>	139,077,167	151,439,083	8.9%	1.4%	157,528,667	4.0%	1.3%	BLS
<b>Real GDP</b>	15,598,753	17,730,509	13.7%	2.2%	19,091,662	7.7%	2.5%	BEA
<b>Gas Price (No. 2 Diesel)</b>	2.992	2.304	-23.0%	-4.3%	3.056	32.6%	9.9%	EIA
<b>Registered Cars and Light Trucks</b>	230,444,440	247,644,981	7.5%	1.2%	253,814,184	2.5%	0.8%	FHWA
<b>Light Vehicle Sales</b>	11,772,526	17,865,773	51.8%	7.2%	17,480,004	-2.2%	-0.7%	FRED
<b>Count of Zero-Vehicle households</b>	10,397,000	10,364,975	-0.3%	-0.1%	10,571,819	2.0%	0.7%	Census
<b>VMT</b>	2,967,266	3,174,408	7.0%	1.1%	3,269,088	3.0%	1.0%	FHWA
<b>VMT Passenger Car (Light Duty Vehicle Short WB)</b>	2,025,745	2,191,764	8.2%	1.3%	2,232,588	1.9%	0.9%	FHWA
<b>VMT Truck (Light Duty Vehicle Long WB)</b>	622,712	657,954	5.7%	0.9%	664,495	1.0%	0.5%	FHWA
<b>VMT Heavy Truck</b>	286,527	287,895	0.5%	0.1%	304,864	5.9%	2.9%	FHWA
<b>Public Transit Ridership (UPT)</b>	9,924,345,155	10,024,337,321	1.0%	0.2%	9,656,090,113	-3.7%	-1.2%	NTD
<b>Amtrak Ridership (FY)</b>	57,149,062	62,264,546	9.0%	1.4%	63,137,328	1.4%	0.5%	Amtrak
<b>Airline Passengers</b>	660,884,123	762,873,095	15.4%	2.4%	853,273,717	11.9%	3.8%	BTS Transtats
<b>Rail Ton-Mile</b>	1,691,004	1,585,440	-6.2%	-1.1%	1,729,638	9.1%	4.4%	Railroad Facts
<b>Domestic Water Ton-miles</b>	502,212	477,861	-4.8%	-0.8%	491,800	2.9%	1.4%	USACE
<b>Total Waterborne Tonnage (short tons)</b>	2,334,547,565	2,292,043,500	-1.8%	-0.3%	2,416,852,000	5.4%	2.7%	USACE
<b>Air Freight Ton-miles</b>	12,025,549,086	13,157,110,679	9.4%	1.5%	15,663,530,781	19.0%	6.0%	BTS Transtats
<b>Air Enplaned Revenue Freight Tons</b>	11,936,668	12,774,959	7.0%	1.1%	14,595,064	14.2%	4.5%	BTS Transtats

COVID-19 occurred at a time when the pace of change in transportation was already greater compared with the prior half century. The influence of COVID-19 accelerated those trends while also creating significant new disruptions. For example, COVID-19, by affecting transportation revenues, exacerbates the perennial challenge of identifying adequate resources to rehabilitate, upgrade and expand transportation infrastructure and operate services. Transportation safety, a top U.S. DOT priority, now entails protecting passengers and the work force from viral exposure and transmission. Transportation safety also entails mitigating high- risk driving behaviors associated with the pandemic, such as speeding and diminished seatbelt use and greater substance abuse.

COVID-19 is not happening in a vacuum. It appeared during a presidential election year, and near the end of a surface transportation authorization cycle. Political polarization is at very high levels. The period of the pandemic also overlapped with nationwide protests and episodic violence. These factors add to the challenges of enabling transportation to recover and helping the economic recovery.

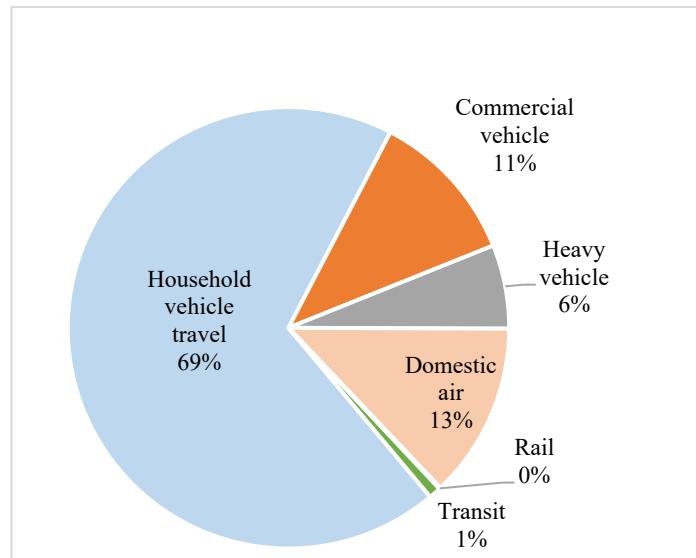
### **Transportation Overview**

How COVID-19 affects transportation is more clearly seen by examining the mobility influences of the various modes. Person miles of travel (PMT) is the best multimodal metric for equating the relative contributions in moving people provided by various modes. As the data in Figure 1 indicate, household-based vehicle travel is the dominant means of travel, constituting 69 percent of all person miles of domestic travel. Commercial vehicles and heavy freight collectively account for the second largest share, an estimated 17 percent of person miles of travel. This category accounts for such a surprisingly large share of person miles of travel because it includes heavy trucks, delivery vehicles, shuttle vehicles, taxis and transportation network companies (TNCs), buses, police, fire and utility vehicles, and business owned vehicles involved in construction, repair and delivery of materials and services. Domestic air travel holds the third largest share, comprising approximately 13 percent of all person miles of travel. Intercity rail and public transit together constitute approximately 1 percent of PMT. These numbers represent national annual totals pre-COVID but conditions vary considerably depending on location and time. These shares would be different if expressed as a percent of trips rather than person miles.

The COVID-19 crisis dramatically reduced the demand for transportation because the government ordered large parts of the economy to shut down and instructed a large part of the population to stay at home. Freight travel escaped the most dramatic consequences as freight remained critical to sustaining the population. Beyond mandatory shutdowns, many sporting, entertainment, business and other functions that involve large groups have remained curtailed and are scheduled to remain so well into 2021. Large swaths of the population have limited their normal activities and movements voluntarily for fear of infection, and will continue to exercise caution for some time.

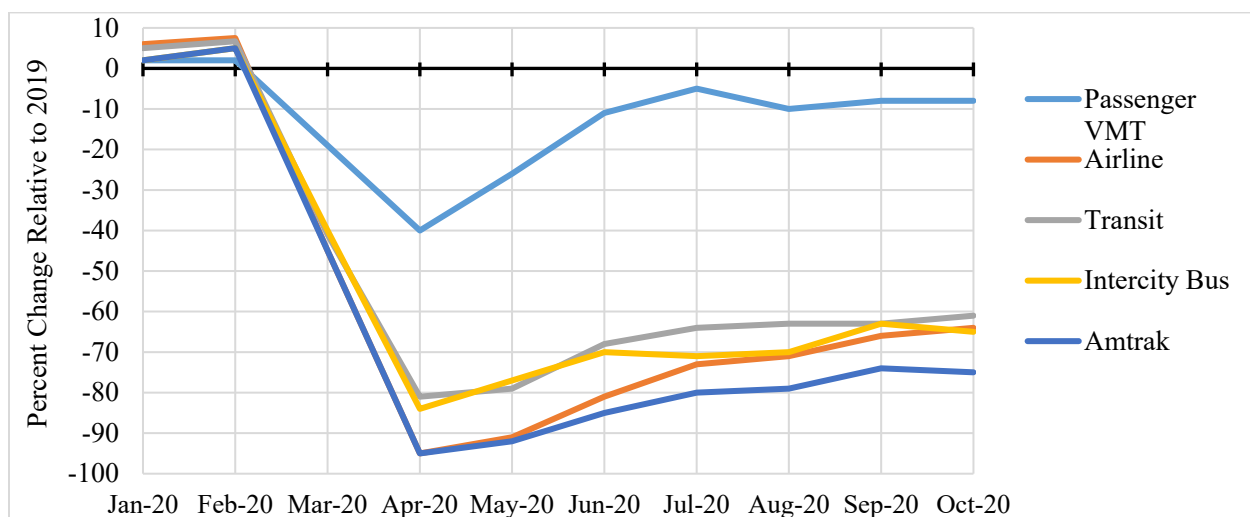
During the worst of the COVID-19 shutdown personal vehicle travel was down approximately 40 percent below pre-COVID-19 (February 2020) levels, but household travel was the least affected of the person travel modes. All personal travel is affected by the shutdowns and closings and by the economic challenges. But, unlike other modes, personal vehicle travel does not suffer from the same fear of exposure risk during travel if one is the sole occupant or traveling with others known not to pose a health risk to the driver. The difference in recent declines in person travel between personal vehicles and other modes reflects the difference caused by shutdowns and economic constraints and the fear of exposure risk during travel. Also, personal vehicles are exempt from reductions in service as, unlike other modes, vehicle owners control the supply. This difference is shown in Figure 2.

**Figure 1 - Annual Person Miles of Travel by Mode**



Source: OST-R analysis of Bureau of Transportation Statistics (BTS) and National Household Travel Survey data.

**Figure 2 - Change in Demand for Personal Travel Versus Group Travel**



Source: Data from various sources compiled by BTS

From 2016 to 2019, the annualized percent change in real Gross Domestic Product (GDP), often considered a surrogate for travel demand, was 2.5 percent, while the increase in Vehicle Miles



Traveled (VMT) was 1 percent. The United States has seen record low numbers of households without vehicles, strong vehicle sales, low fuel prices and auto loan rates, and robust employment. However, vehicle miles of travel on roadways grew quite modestly, only slightly faster than population growth. Analysts note several responsible factors, including an aging population, larger concentrations of population in urban areas where travel levels are lower, shifts of some travel to communications (telework, e-commerce, distance learning, etc.), and shifts of some long-distance travel to air as air travel costs have been relatively affordable.

Major developments had been underway before COVID-19 that were changing travel supply and demand. The Internet gave rise to electronic commerce and rapid growth of companies that use the Internet to provide both new services (Facebook) and conventional services in new ways (Amazon). The Internet enables new forms of communication and telework, which was a growing practice by some employers pre-COVID-19. Urbanization and the aging of the U.S. population had been moderating travel demand growth. Transportation network companies offering app based ride-hailing, bikeshare and e-scooters were also changing travel choices.

## **Demand for Transportation**

The COVID-19 outbreak has profoundly transformed the economy, society, and the transportation sector in the near-term. However, transportation is so fundamental to peoples' economic and social needs that it has been resilient to drastic changes and shown mainly incremental changes over several decades. But, the pandemic has persisted for months and as 2020 came to a close hospitalizations and fatalities in the U.S. continue at rates higher than the spring of 2020. Analysts anticipate that some elements of the short-term responses of individuals and businesses will become permanently changed behaviors.

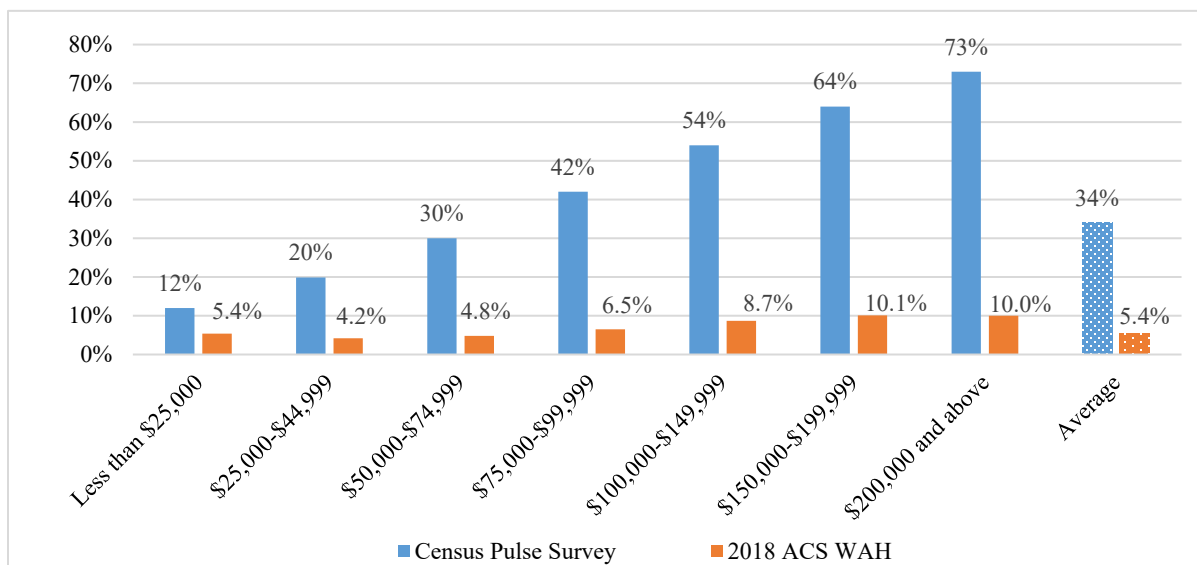
Segments of the population will certainly moderate behaviors because they fear the risk of contracting COVID-19 and/or some mutated strain of the virus. The success of vaccines and therapeutics will certainly lessen such fears but other unknown viral infections may arise. Choices to participate in certain activities and travel changes made during COVID-19 may become more pronounced and create new habits or patterns that travelers continue even when concerns of COVID-19 no longer directly influence their decisions. New habits could include higher auto use as households buy additional vehicles and changes in travel destinations as the pandemic has motivated home, work and other activity location changes for some.

Some of these changes are likely to affect travel long-term. The most apparent of these is the adaption of communications as a substitute for travel. Remote working and shopping are trends that the crisis has dramatically accelerated but it is still speculative to gauge at what level they will settle once the threat of infection recedes. Analysts are speculating whether the 5.7 percent share of individuals who reported in the 2019 American Community Survey as usually working at home the week prior to their survey in 2019 will be exceeded by a few percentage points or as much as 10 to 20 points higher after the health crisis passes.

Figure 3 reports on the Census Pulse Survey carried out in early September 2020, of persons who previously worked at an employment site. The survey revealed a dramatic adaption of working at

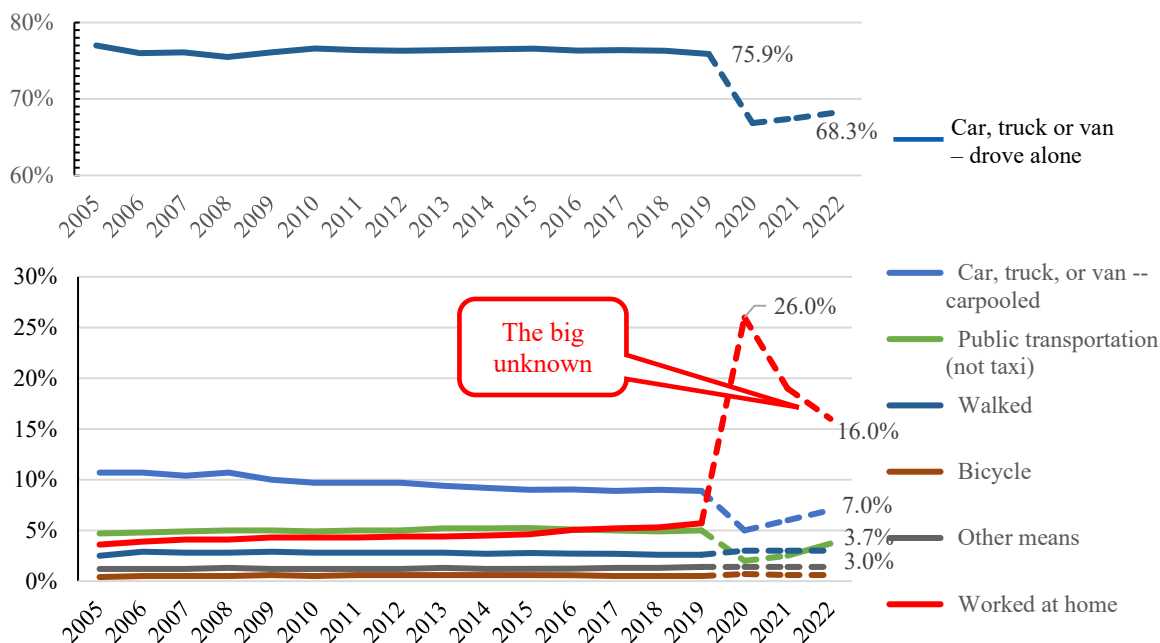
home averaging 34 percent. Even more striking in the survey results was the strong relationship between income and working at home. Higher income household workers are much more likely to be engaged in working at home.

**Figure 3 - 2020 Substituted Work-at-Home for Usual Work Location and 2018 Usual Work-at-Home by Income**



Source: 2020 Census Pulse Survey (Sept 2-14), 2018 Census ACS

**Figure 4 - "Usual" Means of Commuting**

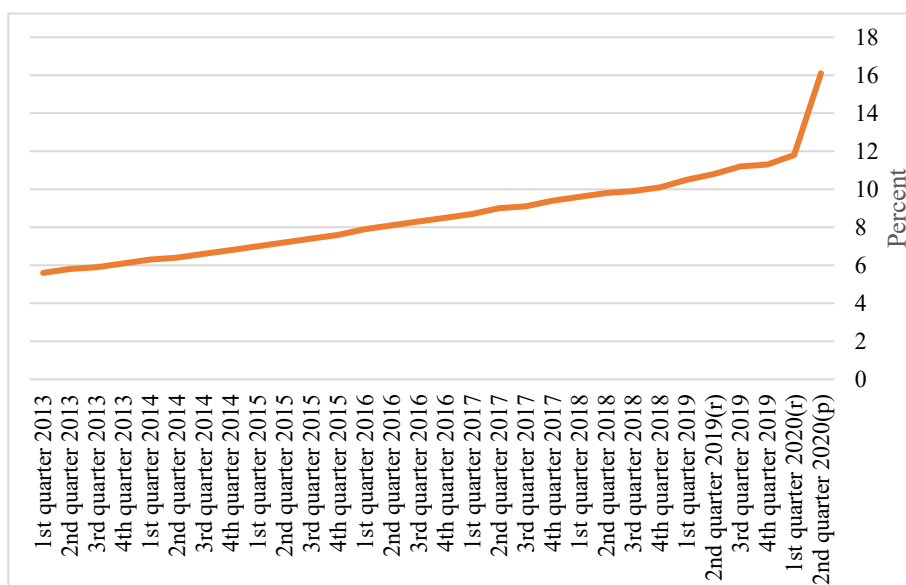


Source: ACS Commute data with post-Covid future scenario

Figure 4 shows the trends by mode of travel for commuting based on the Census American Community Survey. This graphic shows the historic trends as relatively stable. The most notable changes are general declines in carpooling and growth in work at home. Work-at-home had been increasing faster than any other change related to commuting. The data shown for 2020-2022 represent a scenario of what the trends might look like. The 2020 numbers are based on a review of mode use so far in 2020. The most critical question is what will be the post-COVID share of workers who continue to work at home? If this settles into a long-term trend, it will be significant for transportation.

The influence of substituting telecommuting for travel includes retail trip making. Figure 5 shows the share of commerce being carried via the Internet. The second quarter of 2020 showed a steep increase as the share of sales via e-commerce jumped 36% from an 11.8 to a 16.1 share. This metric is based on dollar value and does not address trips or net travel inclusive of delivery.

**Figure 5 - Estimated Quarterly U.S. Retail Sales (Adjusted):  
E-commerce Percent**



Source: 2020 Census Monthly Retail Trade Report.

Numerous other types of activities including distance learning, telemedicine, electronic banking, online worship, and various types of online social interactions have emerged or gained prominence. Equally

important, communications substitution for travel also influences business travel. Conferences, sales calls, client/customer meetings and other interactions are being replaced by remote communications. The extent to which these behaviors persist post-COVID remains to be seen. The pandemic has rapidly enhanced how well individuals and institutions can function differently, learn new software, deploy and understand new communication technologies, work through learning curves and adjust to less travel. Preference surveys of various consumers suggest this new behavior will continue in full measure.

In addition to communication substitution, the pandemic appears to be influencing land use patterns. While the inventory of residential capacity affects these changes,

*According to a recent survey conducted by McKinsey & Co., 75% of American consumers tried a new shopping method due to the coronavirus, and 50% of respondents said they intended to shop via curbside pickup and/or delivery services in the future.*

Harriet Torrey, WSJ, Nov. 15, 2020

evidence is emerging of some pronounced shifts or accelerations in trends. Residential rental and sales data suggest a strong suburbanization trend. Stress on brick and mortar retail, tourism, restaurant and lodging properties portend market changes and speculation abounds regarding the fate of traditional office space needs – both with respect to amount and location. As land use changes, travel patterns – both the amount of travel and its geographic distribution, respond.

Travel demand is tied to the economy. People travel for employment, to socialize and to engage in commerce. The economic consequences of the pandemic on travel are significant. As the direct consequences of COVID and the influence of the COVID inspired economic stimulus plays out, the economy will face challenges related to the disruptions in household, business and government revenue streams and increased federal debt. While the economic recovery time frame and its impact on travel remain uncertain, travel demand may remain dampened for an extended period of time. The great recession only reduced vehicle miles of travel by a few percent yet the peak vehicle miles of travel level reached in 2007 was not exceeded until 2015, eight years later, well into the economic recovery. Given slower population growth and a growing shift toward an information economy, VMT is less directly tied to economic activity levels and may recover more slowly from downturns than it used to.

Domestic travel demand is also influenced by the extent of international visitors. Demand for travel likely will recover more slowly to and from international destinations because of varying travel regulations, extent of infection risks, and therapeutic and vaccine deployment across countries. Nearly half of international travel to and from the United States is by non-U.S. residents and their willingness and ability to travel may not return for some time.

In sum, we may well see an extended period of adjustment and recovery, especially for some segments of the transportation sector. It remains unclear how long the public health crisis will dampen overall transportation demand. Travel demand has been growing slowly, and 2019 is likely to mark the peak year of travel demand for many modes.

In the near term, the challenge for transportation will not be expanding capacity to accommodate growing demand but rather sustaining the infrastructure system and services so they do not diminish mobility and become an impediment to full economic recovery. Maintenance should take priority and funds should not be used to expand capacity unless there is demonstrated demand. Beyond the direct effects on travel demand from the pandemic and the behavior changes induced by or accelerated by the pandemic, secondary effects may include changes by individuals, businesses and governments in values and spending priorities as they adjust to a post COVID-19 world. While difficult to predict and highly speculative, the COVID-19 experience may well influence the ability and/or willingness of transportation consumers and transportation providers, including governments, to commit resources to transportation at the pre-COVID-19 levels. For example, there is active discussion of businesses reducing budgeted business travel and local governments postponing construction projects due to revenue shortfalls.

## Supply of Transportation

The crisis also affects the supply of transportation. In the short run, government mandates such as stay-at-home orders, social distancing, and closure of non-essential businesses caused double-

digit drops in ridership and substantial losses of revenue to transportation providers. Many transportation providers have discontinued or reduced service levels. The post-COVID supply of services will depend on the subsequent levels of demand and on the financial condition of the transportation providers. The severity of accumulated revenue losses and the depletion of cash balances or credit lines may require transportation providers to provide lower service levels and possibly undergo reorganization or changes in ownership. Profit-dependent transportation providers will have to adjust costs, staffing, pricing and supply levels to be sustainable in post-COVID market conditions. Such adjustments have already been evident in airline and intercity bus systems, to give just two examples.

Policymakers will need to examine if an excess supply of or inefficiently operated public transportation services are consuming scarce public funding, causing excessive emissions, using too much energy, or otherwise wasting resources.

All shared modes of travel have confronted increased costs of mitigating infection risks. Sustaining such accommodations in a post-COVID environment (such as enhanced cleaning) may increase the costs of future operations. These costs include investing in additional protections such as ventilation upgrades; vehicle space reconfiguration to enable distancing; shielding; and other infrastructure modifications. Differences in the cost of mitigating infection risk is a new competitive factor among the modes and among individual transportation companies. Cost changes may influence the overall levels of travel and the modes that are chosen. Higher costs for privately-operated modes or publicly-subsidized modes that need to increase traveler prices may incentivize travelers to use personal vehicles. This effect is exacerbated if there are both service reductions and traveler cost increases.

Governments should adapt publicly-subsidized services to post-COVID demand conditions. Airlines, for example, are adapting their capacity, routes and services in response to market changes brought about by COVID and competition from automobiles. All modes should make such accommodations.

The following is a discussion of how individual modes of travel might be affected by post COVID-19 changes.

### **Transportation Moving Forward**

Various analysts are producing estimates of how demand will recover as medical progress diminishes the influence of COVID-19. The effect of the pandemic on travel behavior has been significant, but the rapid development and rollout of vaccines suggests that a return to a post COVID normal can begin as soon as spring or summer 2021. Of course, there are longer term questions about how long protective benefits of the vaccine will last and if large enough percentages of the population will agree to be vaccinated.

The current situation is unprecedented and there is little basis for developing estimates in which one can place significant confidence. However, an understanding of travel behavior and observations of emerging trends can provide insight into post-COVID travel. Over the past several months as more data and perspectives have been assembled, various scenarios have been

updated and revised. Therefore, the characterization of modal recoveries shown in Figure 6 illustrates a recovery premised on medical progress throughout 2021 and recognizes that the timeframe for that recovery could shift.

The next key aspect of the recovery is understanding demand levels when major transportation changes level off and fears of disease transmission subside. What will be the levels of demand that will then persist over time as influenced by traditional economic and demographic factors? The shape of the recovery and the levels of demand in more stable times ahead are critical issues that will influence transportation policy and investment decisions for all public and private entities.

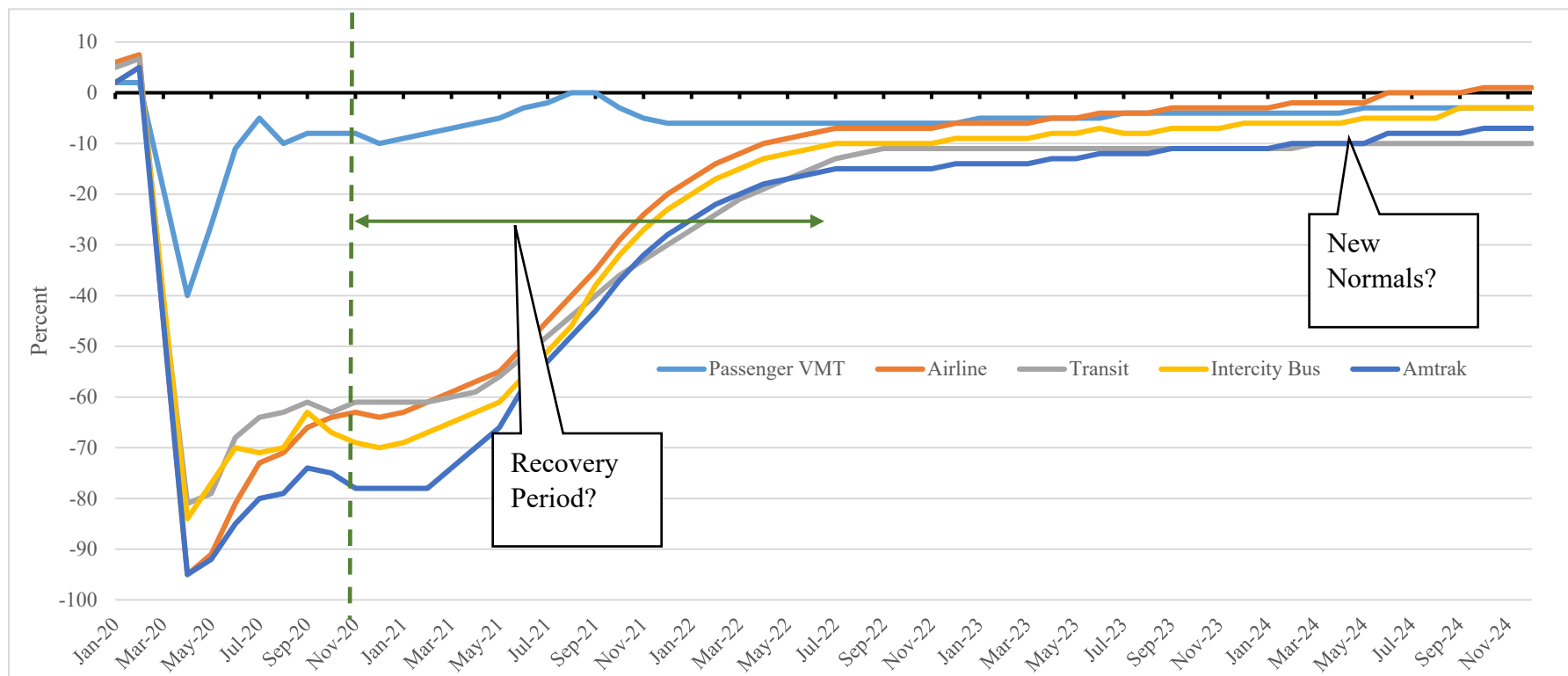
### **Roadways and Personal Vehicles**

As expected, roadway travel has proven to be the most resilient as it is least affected by fear of contagion. It has recovered from a peak decline during the shutdown of over 40 percent for several weeks to being within 10 percent of pre-COVID levels during the fall of 2020. Personal vehicle travel offers travelers the ability to control exposure during travel and also avoids traversing terminals where crowds, lines, and check-in/payment interactions introduce exposure risk. However, future personal VMT levels post-COVID will continue to be shaped by competition from other modes, increased teleworking, and other economic stressors.

### **Geographic changes in travel**

There is growing evidence that COVID-19 has resulted in a geographic redistribution of travel. At the macro level, volumes in rural or non-metropolitan areas have been more resilient relative to urban areas. This is consistent with several phenomena such as shifts from air travel to driving, declines in commuting for knowledge workers' characteristic of urban office employment, and travelers seeking activities in less dense areas more conducive to social distancing. Data from INRIX (a private company providing location-based data and analytics to automakers, cities and road authorities) on personal vehicle travel confirms this observation. As shown in Figure 7, personal VMT in the 98 metropolitan areas which they track are reporting lower levels of recovery compared to the country as a whole. From June 1 through the first week in November, the U.S. is tracking at nearly 92 percent of normal versus 87 percent for metro areas. Federal Highway Administration (FHWA) data confirms that for August 2020, the rural share of all VMT was nearly 32 percent, approximately a one percent higher share than in 2019.

**Figure 6 - Travel Recovery Scenarios, Comparison with 2019**

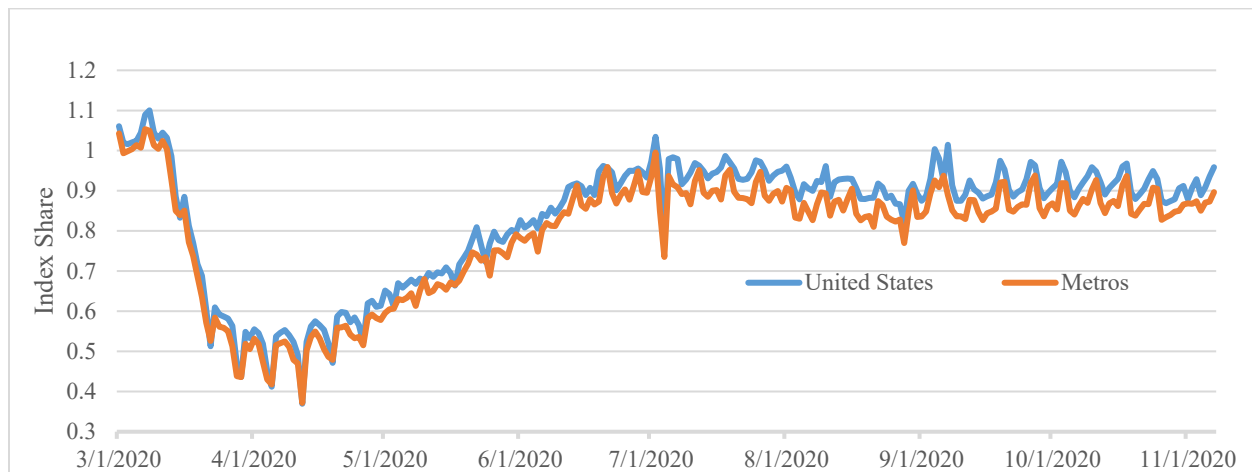


Sources: Data compiled by BTS from modes. INRIX personal vehicle data.

Table 2 - Travel Recovery Scenarios, Comparison with 2019					
	2020	2021	2022	2023	2024
Passenger VMT	-11.8	-4.5	-6.0	-4.5	-3.3
Airline	-58.3	-44.8	-9.3	-3.6	-1.7
Transit	-52.5	-48.3	-16.0	-11.0	-10.2
Intercity Bus	-56.2	-49.8	-12.3	-7.8	-4.7
Amtrak	-64.5	-55.4	-17.3	-12.3	-8.7



**Figure 7 - Personal VMT Trends for U.S. versus Metro Areas**



Source: INRIX Travel Trends Data. <https://iq.inrix.com/>

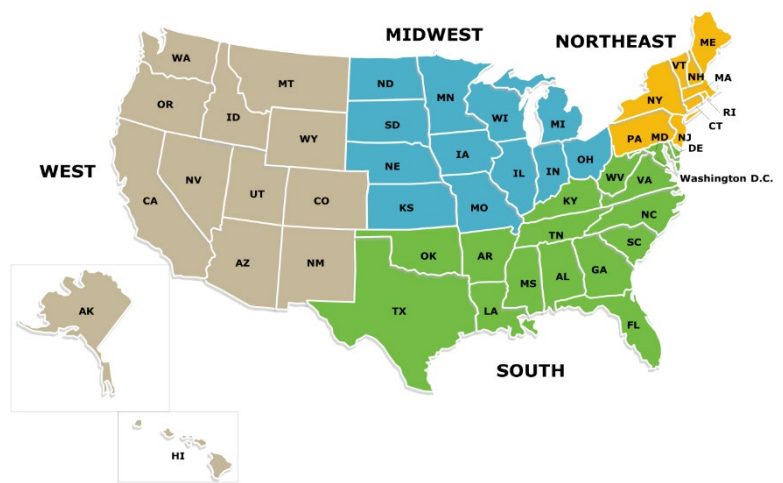
This data, collected by INRIX, reports the relative travel volume levels in 2020 compared to “normal” had the pandemic not occurred. The Metro area data, an unweighted sum of the demand indices for 98 metropolitan areas that are tracked in the database, clearly indicates that metropolitan area traffic volumes lag below the national total by approximately 4.5% since June 1, 2020. A number of factors appear to be contributing to this disparity. The decline in work trip commuting is an important consideration but in addition, social and recreation travel may also be shifting to more dispersed non-urban destinations. Venues such as sports facilities, concerts, movie theaters, music venues, stage theaters and other destinations are not attracting travel and those activities are partially being replaced by non-urban travel to beaches and natural attractions.

## Land use

While land use and the associated activity patterns generally evolve slowly, events such as the COVID pandemic can change or accelerate land use trends. These changes influence travel activity patterns and can change the total demand for surface travel. They can also alter the geographic distribution and the extent of congestion and patterns of transportation services.

Figure 8 portrays the migration patterns in the U.S. in the 2013 through 2018 period. These data confirm the ongoing migration patterns from the Midwest and Northeast to the South and West but emphasize the softening of migration to the West and

**Figure 8 - U.S. Regional Migration Flows**





the strengthening of migration to the South. As people seek generally lower density and lower cost of living locations and as telecommuting frees people from needing to live near their employment, the public health emergency may be causing geographic redistribution.

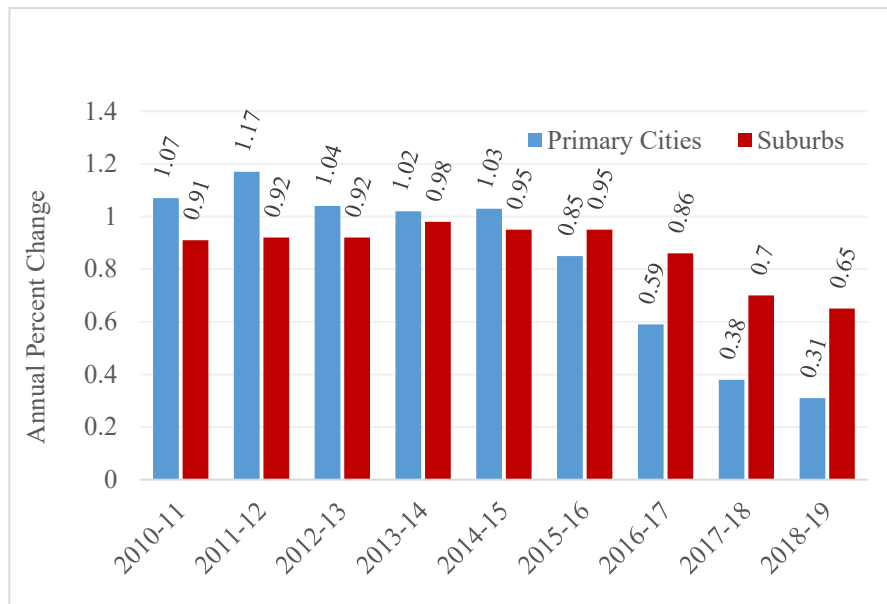
This redistribution of the population creates transportation challenges. These shifts tend to increase demands in growing areas with limited infrastructure while perhaps harming the economic vitality of locations they leave: their contributions to the tolls, fares, and the tax base are diminished, services and infrastructure may be undermined.

**Table 2** - Census American Community Survey 2013-2018 Regional Migration Flows

	In Domestic	Out Domestic	Net Domestic	In from Abroad	Net Regional Totals
Midwest	783,261	934,353	-151,092	304,237	153,145
Northeast	529,112	844,470	-315,358	396,618	81,260
South	1,598,693	1,215,461	383,232	815,151	1,198,383
West	974,183	890,965	83,218	571,725	654,943

Figure 9 shows relative growth rates of urban and suburban geographies since 2010. This figure points out both the decline in growth rate during that period as well as the softening of urban growth at the expense of suburban growth. As in the case of regional migration, the COVID public health crisis appears to be accelerating the relative growth pattern by stimulating population growth in less dense, lower cost suburban geographies.

**Figure 9** - Population Growth Trends, Analysis of Census Estimates

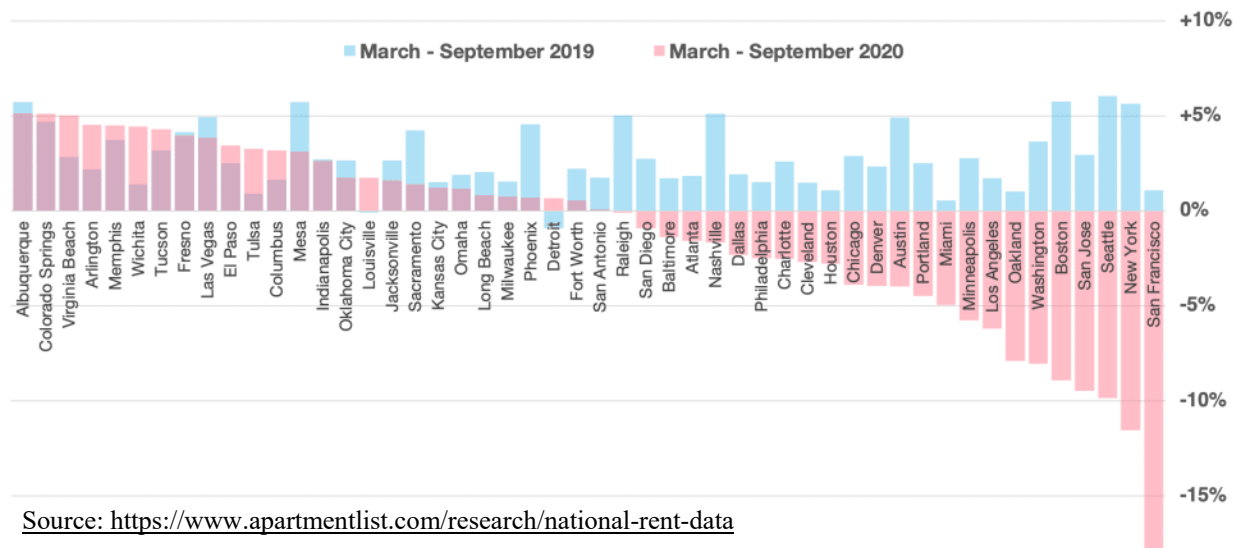


Source: William H. Frey, Analysis of primary cities and suburbs within major metro areas, May 21, 2020

Anecdotal evidence suggests suburban residences have gained favor for having affordable and more accommodating spaces for work at home activities. Record low interest rates and a millennial generation reaching peak home-buying age further this trend. However, the millennial home ownership rate is 43 percent, well below the rates of generation X (67 percent) and the baby boomer and silent generations (77 percent).

Figure 10 reveals how the pandemic has weighed on apartment rental costs. The influences are distinctive by geography and magnitude. Similar trends have been witnessed in Europe. Cities with the most pronounced rent declines are among those that have been associated with high

**Figure 10 - Rent Change from March to September in 2019 & 2020**

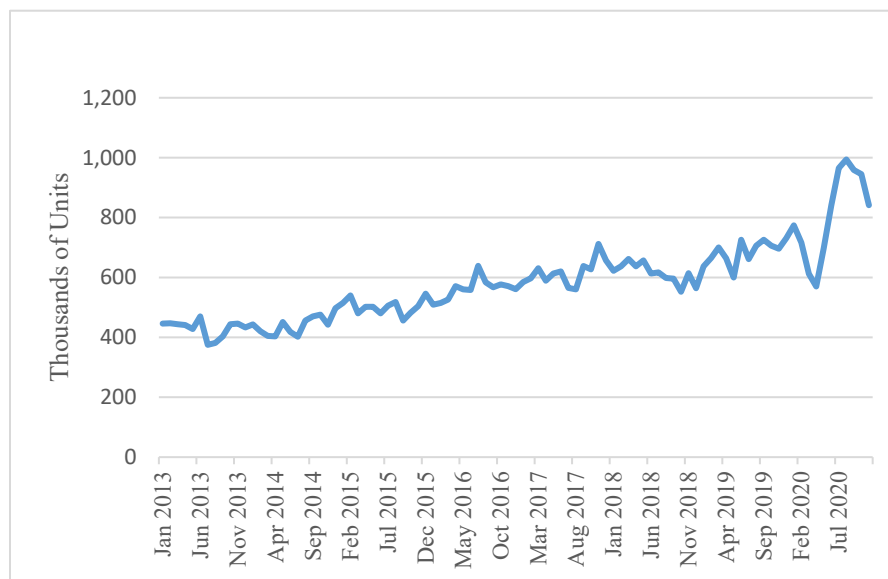


Source: <https://www.apartmentlist.com/research/national-rent-data>

levels of congestion and high levels of public transit and transportation network company vehicle use.

Figure 11 shows the trend in residential sales with a pronounced spike in the summer of 2020. The Wall Street Journal reported record home sales at a 14-year high with inventory levels at record lows.

**Figure 11 - New Residential Sales Seasonally Adjusted Annual Rate**

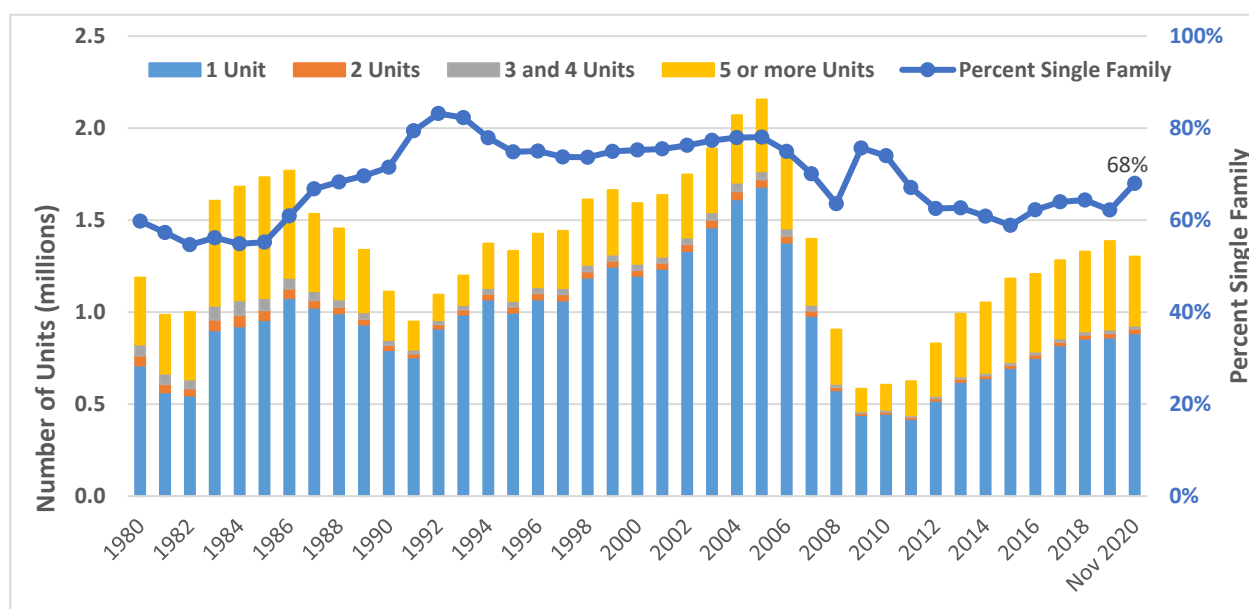


Source: Census New Residential Sales Data,  
[https://www.census.gov/construction/nrs/historical\\_data/index.html](https://www.census.gov/construction/nrs/historical_data/index.html)

Figure 12 shows housing permit activity for the nation as recorded by the Census Bureau. The data shows that new dwelling units are being added at approximately 1 to 1 ½ million units per year. This activity represents a very modest pace in relationship to the approximately 124 million occupied residential units in the United States as reported by the American Community Survey. The existing national housing inventory is approximately 75% single unit dwellings which compares to permit levels for single units running in the 60 percent to 70 percent range. The data for January through November 2020 shows a jump in the single-family share of homes.

This data suggests that residential development trends are a precursor to understanding changes

**Figure 12 - National Inventory New Units, American Housing Survey**



Source: <https://www.census.gov/construction/bps/>, 2020 data through November 2020.

in travel demand and patterns. The pace of residential capacity additions/replacements – new dwelling units in the inventory – is very modest (only slightly more than 1 percent of the total count of occupied units per year) and constrains the pace of changes in short-term settlement patterns.

The COVID-19 health crisis is also creating great changes in commercial real estate. Brick and mortar retail operations are facing economic headwinds. It is expected that bankruptcies and other industry trends will further reduce the space demands for traditional retail space. Other analysts are closely monitoring the office space markets and speculating that there may be a decline in office space demand as businesses reduce space needs to reflect greater work-at-home trends. This phenomenon is particularly true for technology-based industries where the ability to work remotely is greater.

The tourism, lodging and restaurant sectors have been highly affected by the pandemic. Tourism activity is anticipated to resume when the COVID-19 threat passes; however, economic disruptions and behavioral changes will likely affect how tourism activity will look in the near and long-term future. Some catch-up in demand from deferred travel may be anticipated but

there may also be delays associated with slower ramp ups of international tourism and travel. Lodging and restaurant real estate highly dependent on business travel will be affected if communication substitution for business travel continues at high rates post-COVID-19.

Nonresidential real estate is often leased longer term, which mitigates against rapid change. However, bankruptcies and the ability to repurpose some nonresidential real estate can speed up changes in land use and the travel patterns they influence. In general, experts anticipate that the pandemic will reinforce trends toward the de-densification and dispersion of activities. Costs, crime, governance and regulatory environments, and other factors are also influencing real estate trends. These trends merit scrutiny by transportation planners to better understand and prepare for future transportation needs.

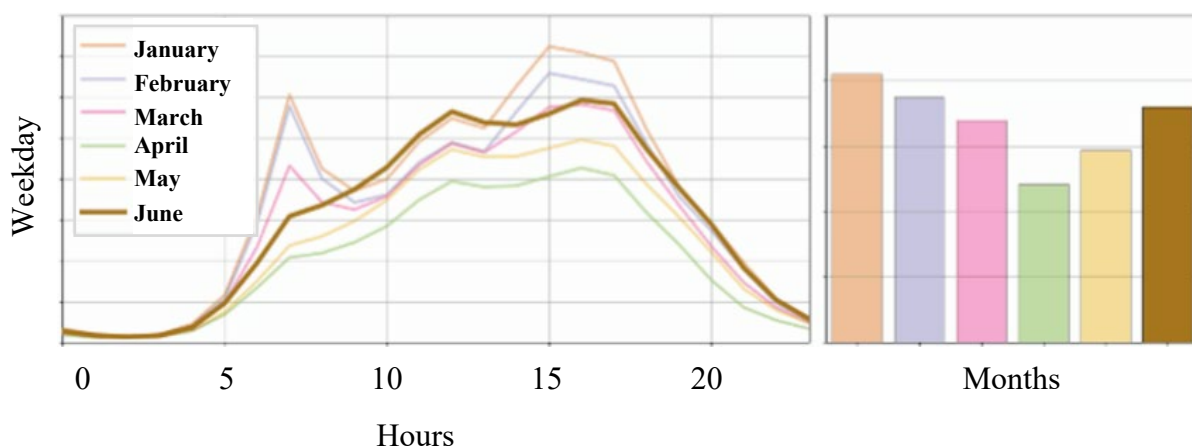
Changes in the geographic pattern of travel have significant implications for transportation planning, investment, and policy initiatives. Changing travel patterns can change the distribution of traffic and congestion and influence the investment priorities for surface modes of travel. It is difficult to quantify the redistribution of travel demand as it can be distinct in individual areas, however, emerging data sources enable an understanding of geographically precise trends.

Time will reveal the extent and persistence of this trend and the nature of changes in travel patterns within metropolitan areas. These changes are likely to affect the extent and location of roadway congestion and to alter investment priorities and transportation needs going forward. These trends may influence travel patterns for public transit users and change critical locations for capacity enhancement, demand mitigation, safety improvements, pedestrian and bicycle accommodations, and other transportation initiatives. Public funding of capacity increases should be closely scrutinized for the value they add.

### Temporal changes in travel

In addition to geographic changes in travel, there are changes in the temporal pattern of travel. As shown in Figure 13, the travel peaking pattern has changed: the morning peak is noticeably reduced and the evening peak is flattened. This change reflects greater flexibilities in activity

**Figure 13 - Temporal Travel Changes, Light Vehicles**



Source: INRIX Trip Data analyzed by the National Renewable Energy Laboratory.

patterns associated with responding to COVID. Particularly, the commuting travel pattern has diminished due to work at home and other travel appears to have shifted away from the morning peak. The extent to which this pattern will persist depends on the extent to which work at home continues post-pandemic. As is the case with geographic redistribution of travel, diminished travel during the peak will change congestion patterns and the nature of traffic flows. These changes may sustain different travel behaviors than pre-COVID. Such changes influence the competitive position of urban travel modes and may have other effects such as influencing safety, energy use, emissions and travel costs in time and money.

The levels of VMT in personal vehicles through the first ten months of 2020 suggest that the 2020 total will be more than 11 percent below 2019 levels, a change that is dramatically greater than any prior annual change. While personal VMT has recovered far more rapidly than has demand for shared mode travel, the magnitude of change is sufficiently large to meaningfully change the performance of the roadway transportation system. Demand levels have backed off to levels similar to nearly 20 years ago.

The importance of changes in personal VMT become most relevant as changes persist after the direct influence of COVID has passed. Residual effects on personal travel may persist due to several factors including:

- ↓ residual diminished activity participation by a small segment of the population that sufficiently fears the prospect of new strains of COVID or other viruses such that they are motivated to change behaviors and reduce exposure,
- ↓ diminished travel resulting from the remaining economic effects from COVID that may result in lower levels of employment commuting and lessen other travel as resources affect consumers' ability to pay for travel and pursue other activities such as shopping, eating out, etc.,
- ↓ diminished travel due to ongoing communications substitution for travel for telework, e-commerce, virtual business meetings and other activity.
- ↑ additional personal vehicle travel by persons who have shifted travel from air, transit or other modes to auto travel,
- ↑ catch up travel from activities forgone during the pandemic such as visiting friends and relatives,
- ↑ changes in travel associated with changes in the land use /activity/travel patterns, and,
- ? possibly other unanticipated factors.

The magnitude of the respective factors listed above will determine post-COVID VMT levels. For perspective, work commuting constitutes nearly 30 percent of household travel and approximately 20 percent of total roadway VMT (inclusive of freight, commercial vehicle and business travel). If telework reduces commuting by 10 percent, this would dampen overall VMT by approximately 2 percent in the absence of offsetting additional travel. While these are modest numbers, recognizing that VMT has been growing at less than 1 percent annually in spite of a

very strong economy, it does support estimates of soft VMT extending well into the future. Communication substitution for other activities such as shopping, personal business, worship, and education, etc. would enhance this softening of demand on total VMT.

With COVID's dramatic disruption of the economy, the multi-trillion dollar economic effects will likely dampen travel demand growth for some period of time. As of this writing, in early 2021, vaccines are in the early stages of distribution, and it appears that vehicle travel demand will be lessened by foregone activities well into 2021. As the population is vaccinated, it may gain confidence in resuming more normal activity patterns. The early months of 2021 are likely to see high single digit declines in VMT for several months making it very unlikely that 2021 could match 2019 VMT levels. It is possible that travel volumes in late 2021 and early 2022 might surpass normal levels if the economy has fully recovered and "catch up" travel for social recreation and vacation travel spur demand temporarily during that time period.

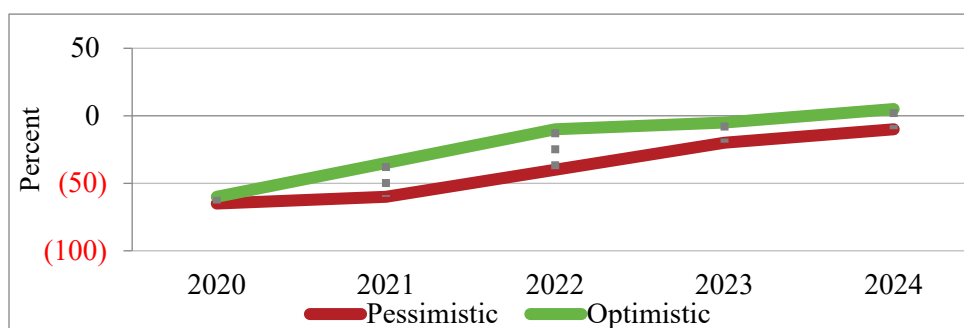
Also noteworthy is the prospect that fear of shared travel, specifically airline travel, will continue beyond the time when people are anxious to resume normal activities and result in continued shifts in demand from air travel to roadway travel for social and recreation purposes. An approximate 6 percent shift of person miles of travel from airline to roadway (at normal long-distance vehicle occupancies) could create an approximate 1 percent increase in roadway VMT.

It is reasonable to assume that VMT reductions due to communication substitution of 2 to 6 percent and perhaps a reduction of 1 to 2 percent due to a less robust economy will result in VMT levels remaining below their prior 2019 peak for several years.

## Airline Travel

Numerous enterprises in the air travel system have been anxiously monitoring air travel and offering scenarios of the pace of recovery of the airline industry. A consensus indicates airline travel will require multiple years of growth to recover to 2019 levels. Longer distance trips have no time-competitive alternatives to airline travel, thus assuring a base level of demand for airline travel after the fear of COVID transmission diminishes. During the health crisis, some shorter distance air travel has shifted to personal vehicles. Recapturing this market will be affected by service availability and pricing. The resumption of business travel and overall economic health of consumers and businesses will also increase future demand.

**Figure 14 - Airline Travel Relative to Pre-COVID levels**



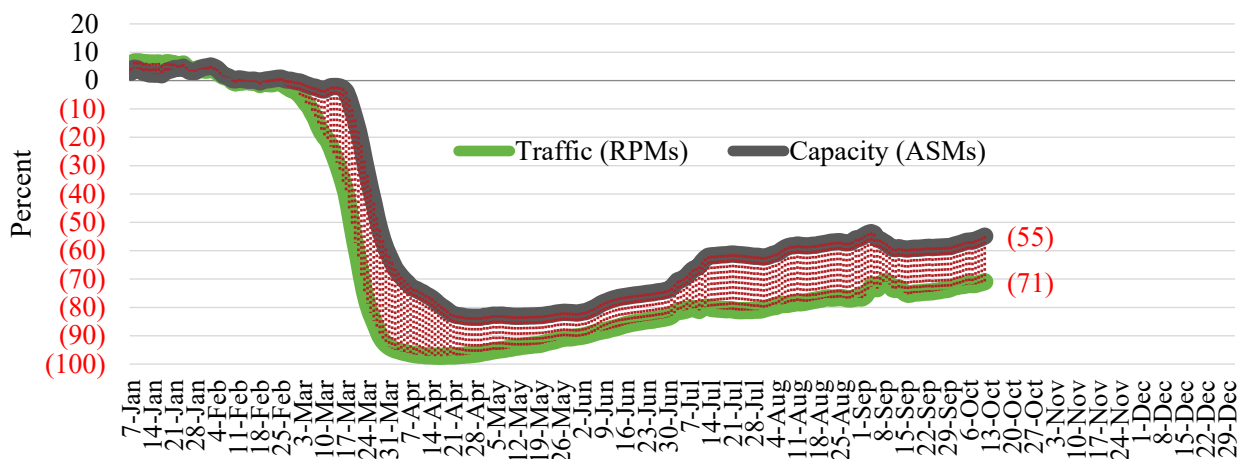
Source: Airlines 4 America

Figure 14 shows scenarios of air travel recovery produced by Airlines 4 America, an airline association. The range of optimism and pessimism in the scenarios reinforces the uncertainty involved in forecasting recovery from an unprecedented occurrence. Additionally, the multi-year recovery trend recognizes that it will take years to return to a more normal state of affairs.

International air travel will be affected by the extent to which other countries are deemed safe destinations or safe origins. To the extent mitigation efforts continue, such as greater social distancing and robust cleaning, it will increase the costs of air travel, which will tend to raise fares and reduce ticket purchases. For shorter distance air trips, higher costs, reduced frequency, lingering exposure fears and potentially slower passenger screening or processing could shift some short-haul demand to roadway travel.

Figure 15 documents the industry response to pandemic conditions as service supply has contracted in response to collapsing demand. However, the more modest decline in service levels has resulted in far lower flight occupancy levels, and increased pressure on revenues already strained by aggressive pricing. Among the more critical issues for the airline recovery is the pace at which business travel resumes.

**Figure 15 - Airline Traffic and Capacity Trend Relative to Pre-COVID**

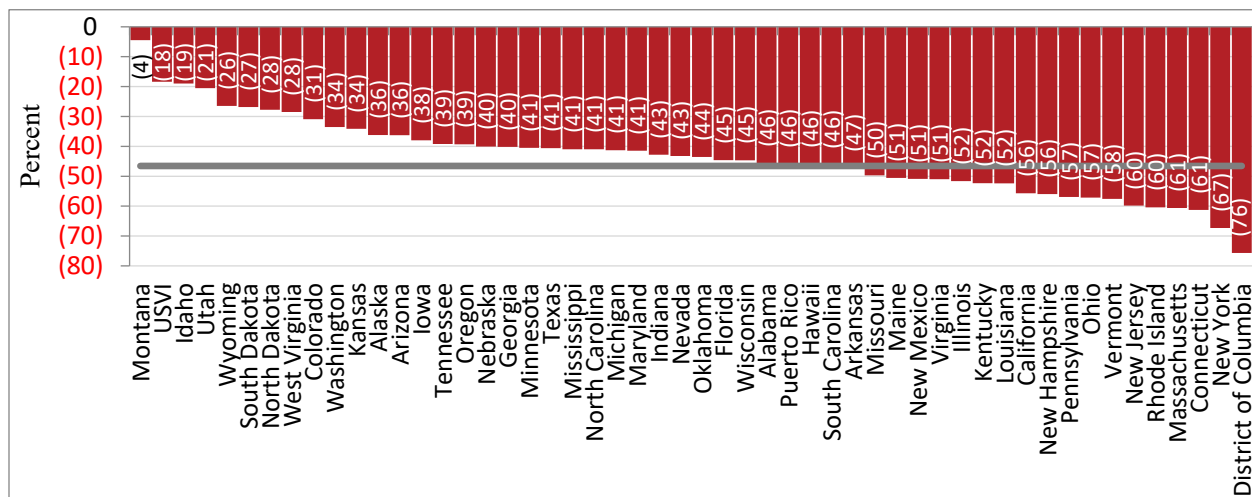


Source: A4A member passenger airlines as report to A4A on a consolidated company basis (including branded code share partners). RPM is Revenue Passenger Miles, ASM is Available Seat Miles

Figure 16 portrays the variation in reduced travel demand across various domestic airports. The measurable disparities in effect indicate different passenger profiles and trip purposes (business, pleasure, government, international, etc.) as well as differences in the prevalence of COVID and the responses of various geographies in terms of canceled activities and discouragements to travel.



**Figure 16 - Airline Traffic Level Variations Across Airports Relative to Pre-COVID**



Source: Via A4A, Diio by Cirium published schedules (Sept. 18, 2020) for all airlines providing scheduled service to all destinations.

The rate at which business and international travelers return and the degree to which they do so will strongly influence the recovery of air travel. Business trips constituted 29 percent of air trips in 2019 according to Airlines 4 America. As business travelers often book with less advance

notice and purchase higher grade tickets, business travel accounts for a larger share of airline revenues and an even larger share of airline profits according to some analysts. Some share of business travel will not return as digital communications have been refined to carry out several business functions. Airlines may have to adjust their capacity and pricing to accommodate this change.

The willingness to travel internationally and the continued travel restrictions imposed by the U.S. and other governments around the world will significantly affect demand for air travel. Nonresidents constituted 44% of international air travel and 3% of domestic air travel in 2018 according to the Bureau of Economic Analysis. Thus, a full recovery of U.S. airline traffic will depend upon the medical and economic recovery in other countries around the world.

***The Covid Pandemic Could Cut Business Travel by 36%—***

***Permanently***

*Between 19% and 36% of all business trips could disappear, given efficiencies developed during the lockdown, our Middle Seat columnist and airline experts estimate.*

Scott McCartney, The Wall Street Journal, December 1, 2020

Current conditions could lead to a push for aviation industry consolidation and restructuring with changes in fares, flight frequency and geographic coverage as airlines struggle to return to a sustainable business model. Ultimately service levels and pricing will need to reflect post-COVID demand levels and a pricing structure that is sustainable and accommodates the incurred debt during the crisis.

Residual effects on airline travel may persist for an extended period of time due to several factors including:



- ↓ residual diminished activity by segments of the population that fear the prospect of new strains of COVID or other viruses and reduce their exposure to group travel as a result. Retired seniors who are frequent travelers but have a higher risk of infection consequences may be slower to return to air travel,
- ↓ diminished travel resulting from the remaining economic strain from COVID that may result in lower levels of discretionary spending on airline travel,
- ↓ diminished business travel due to ongoing communications substitution for travel via business meetings, sales calls and other virtual activity,
- ↓ diminished international travel as health and economic conditions abroad reduce travel to and from the U.S. for an extended period of time,
- ↓ diminished air travel due to pandemic-related changes in air travel availability (flight frequency, directness of connections, available destinations, etc.) and pricing,
- ↓ shifts from air travel to other modes as behaviors adapted during the pandemic become routine,
- ↑ catch up travel from activities foregone during the pandemic such as visiting friends and relatives,
- ? possibly other unanticipated factors.

## **Transit**

As noted in Figure 2, the COVID public health emergency has had serious effects on public transportation. Prior to the public health emergency, transit ridership was approximately 32 million trips on a typical weekday. At its lowest point in April 2020, ridership decreased by approximately 80 percent to 6.1 million trips per weekday. Since then, transit ridership is increasing but is still down by approximately 63 percent. This figure represents current service levels of nearly 12 million trips per weekday. Market share has shifted from mass transit to personal vehicles, walking and biking.

Mass transit has been viewed with greater trepidation than other ways of traveling. Social distancing and disinfecting/sanitizing in transit is difficult and costly as transit is designed to move masses of people in a space efficient manner. To enhance the safety of their employees and passengers, reduce the transmission of COVID-19 within their systems, transit agencies have implemented various approaches to cleaning and disinfecting their equipment, vehicles, and facilities. Many systems are using dedicated cleaning crews to wipe down high-touch surfaces several times daily and to disinfect trains and buses nightly. Some systems are testing increased ventilation and improved air filtration protocols.

Transit systems also have instituted social distancing policies to reduce the number of passengers that are allowed on buses and trains, require face masks and rear door boarding, installed compartment barriers between passengers and bus drivers, and instituted other social distancing practices. However, high customer turnover—an average trip length is about 5 miles—makes it

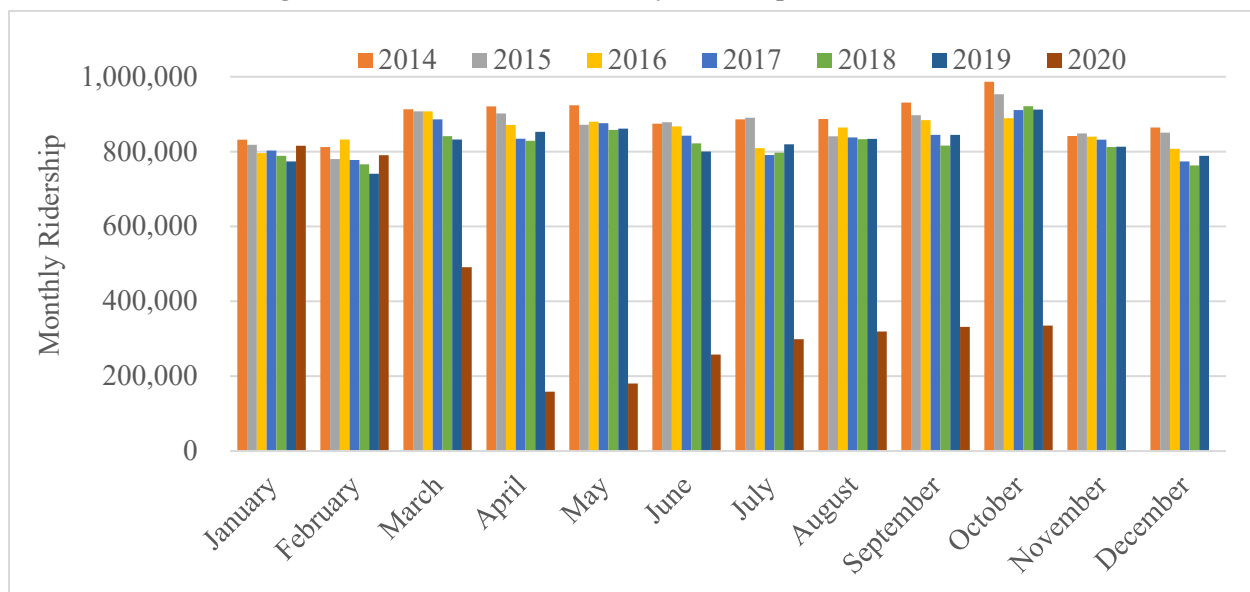
impossible to ensure sanitizing between customers or compliance with social distancing guidelines in vehicles and facilities not designed to accommodate 6-foot person spacing.

Transit ridership had been declining for several years in spite of strong economic growth. Declines finally stabilized in 2019. Growing auto availability; low cost fuel and vehicle financing costs; availability of transportation network companies' services; bike share and scooters; relatively strong growth in southern and western geographies that have less transit-conducive metropolitan areas; and growing telecommuting and e-commerce activities have been challenging public transit before COVID. In addition, the public transit industry is facing future competition from automated vehicles operated by mobility services and the conversion of personal vehicles to hybrid and electric propulsion that will remove the comparative energy efficiency and environmental motivations for transit use.

Closings and shutdowns were a heavy burden on service workers who comprise a significant market segment for urban public transit systems. Information/knowledge workers, another major market segment, occupy a large percentage of space in central business district office buildings – the dominant target market for most public transit systems. This market segment was readily able to shift to telecommuting during the health crisis. These information workers typically can afford to use personal vehicle travel alternatives—desirable alternatives in the diminished urban congestion associated with COVID. Finally, the exposure risk of using public transportation yielded dramatic declines in ridership. This marked decline in demand undermined fare revenues, particularly in larger public transit markets. The economic effects of COVID have also diminished sales tax and other general revenue funding sources that provide most state and local government subsidy support for public transportation.

Figure 17 shows the monthly ridership trends for U.S. transit ridership since 2014. The modest pace of recovery since the shutdowns in early 2020 suggests that ridership numbers will be

**Figure 17 - Public Transit Monthly Ridership Trends since 2014**



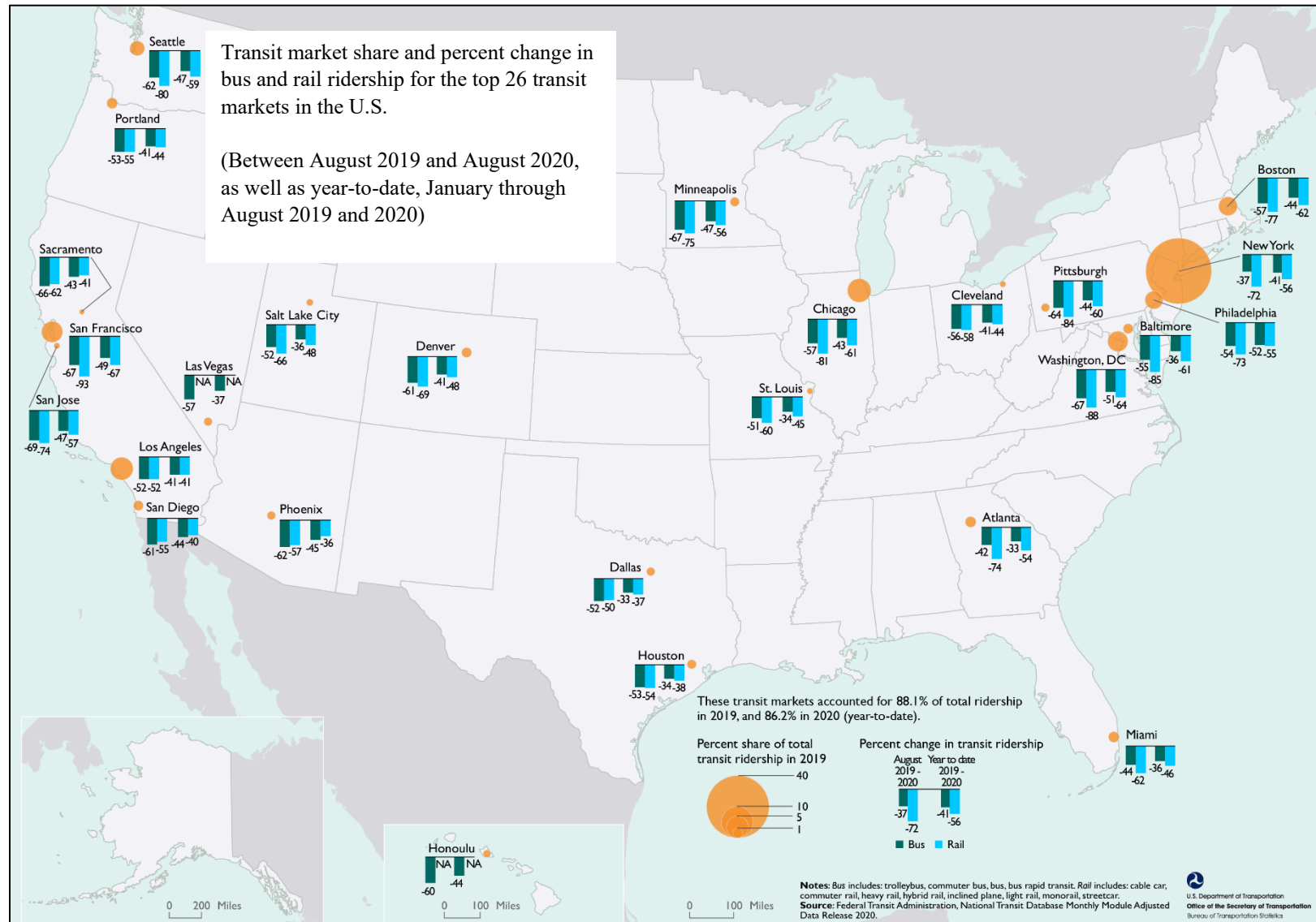
Source: National Transit Data.

strongly affected until COVID risk is minimized and activity levels rebound. Late spring or summer 2021 are best case projections for this scenario.

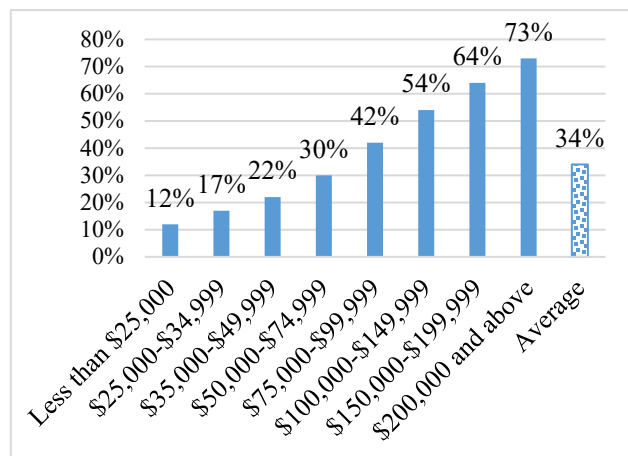
Figure 18 shows the modal and geographic distribution of COVID's effects on public transportation. The 26 metropolitan areas for which data is shown comprise approximately 88 percent of total mass transit ridership in the U.S. As highlighted in Figure 19, it is noteworthy that in August 2020 rail ridership was down 72 percent from prior year counts whereas bus ridership was down 37 percent. This disparity across public transit modes in conjunction with the data in figures 20 and 21 characterizes the challenges for public transportation created by COVID.

Figure 19 reiterates the strong relationship between income and the shift to work at home during the pandemic. Figure 20 shows the relationship between transit sub mode use and income. These two graphics make clear the different effects of COVID across public transit modes. Knowledge workers who are more able to work-at-home are also more inclined to use rail modes. As a group, they typically travel from white-collar urban and suburban locations to central business district or office center employment locales which are frequently serviced by rail modes. Other destinations often served by rail services include airports, convention centers arenas and sports venues. During the pandemic, these locations, often frequented by higher income individuals, have mostly remained far less active.

**Figure 18 - Percent Change in Bus and Rail Ridership and Market Share for Major Metropolitan Areas**

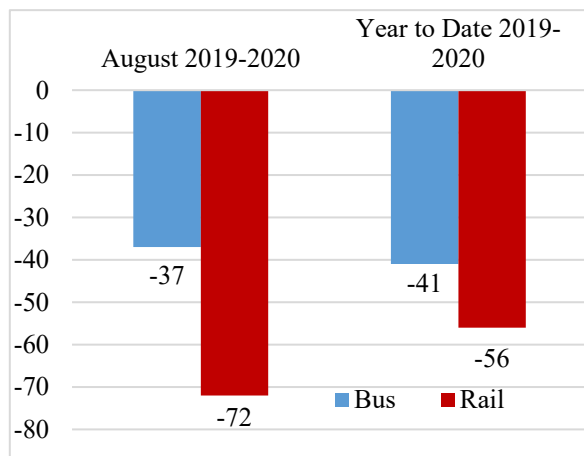


**Figure 19 - Work-at-Home by Income**



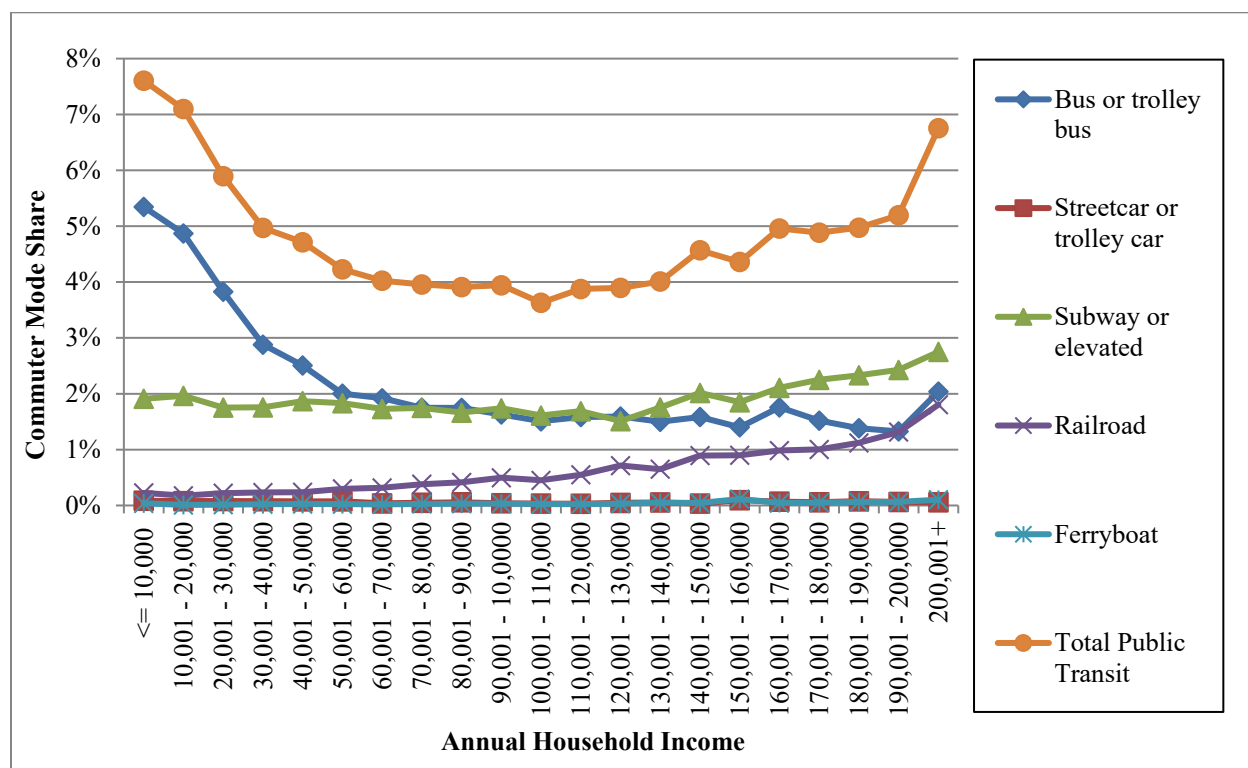
Source: Census, Pulse Survey, September 2 – 14, 2020

**Figure 20 - Transit Ridership Changes in Top 26 Metros (%)**



Source: National Transit Data, analyzed by Bureau of Transportation Statistics

**Figure 21 - Commuting Mode Share by Income and Transit Sub Mode 2017 American Community Survey**



Source: National Transit Data, analyzed by Center for Urban Transportation Research

It is important to note that the data presented on public transit refers to a count of trips. As rail trips are typically longer and often with higher fares, the differential effects if measured in passenger miles or fare revenues would be even more pronounced.

Bus services are more traditionally concentrated in core urban areas and more likely to be used by individuals who are less able to work at home or less likely to have alternative means of travel. This group includes substantial numbers of essential workers and service workers in positions with low to moderate compensation.

Different kinds of service will of course have different kinds of recoveries. It is expensive and inefficient to operate underutilized services. At the same time reductions in service levels undermine the appeal of the respective mode.

Given the disproportionate effects of the public health crisis on service workers and essential workers, it's important to facilitate the mobility of these population segments. It seems insensitive to diminish the quality of services available for low income, minority, or disadvantaged individuals who are dependent on public transportation. Hence a broad consideration of costs, consequences and benefits is essential in order to be prudent stewards of public resources. This should include consideration of the need to support population segments that have disproportionately suffered during the public health crisis.

Market demand is not the only factor influencing public transit service supply. For many public transportation systems CARES Act (Coronavirus Aid, Relief, and Economic Security Act) resources have offset much of the fare revenue loss associated with the public health emergency and in some cases more than offset that loss. However, that same public health emergency has reduced other revenues that support public transportation to varying extents. Sales taxes, tolls, gas tax, or parking revenues, payroll or income taxes, and property taxes have been diminished by different extents depending on location. COVID-related declines in these subsidizing revenues also influence the ability to sustain service levels in the near and long term future.

Residual effects on public transit travel may persist due to several factors including:

- ↓ residual diminished activity by a small segment of the population that sufficiently fears the prospect of new strains of COVID or other viruses such that they change behaviors to reduce exposure,
- ↓ diminished travel resulting from the remaining economic difficulties from COVID that may lower levels of employment commuting and other travel such as trips for shopping, eating out, leisure travel, etc.
- ↓ diminished travel due to ongoing telework, e-commerce, virtual business meetings and other activity shifted to communications instead of travel,
- ↓ diminished travel due to individuals retaining travel behaviors acquired during the public health emergency, for example, retaining an additional vehicle acquired in response to the crisis; carrying out activities at different times or at destinations accessible via other modes including walking, biking, or using ride-shares in lieu of returning to prior transit using behaviors,

- ↓ diminished travel should post-COVID service levels remain or become more modest and less competitive due to diminished demand or resource constraints,
- ↓ diminished travel activity in office job centers - key target destinations for public transportation – as retail, restaurant, and service positions readjust to post-COVID conditions, as service employment in those locations is lessened by greater work-at-home options for workers in office centers and central business districts,
- ↓ diminished travel demand if increased work at home reduces peak period congestion and changes the competitive travel time differences between public transportation and personal vehicle travel options,
- ↑ catch up travel from activities foregone during the pandemic such as visiting friends and relatives, and attending events at convention centers, concerts, sports facilities, etc,
- ↑ potential increase public transportation use if post-COVID unemployment and economic conditions make personal vehicle ownership less attainable or sustainable for more people,
- ? potential changes in demand should policy initiatives such as pricing, preferential treatment of various modes, or other policy initiatives influence the competitiveness of public transportation versus personal vehicle travel,
- ? possibly other unanticipated factors.

### **Amtrak and Motor Coach Intercity Travel**

COVID-19 has also altered demand for surface intercity travel. Shutdowns, activity cancellations, and fear of exposure have combined to dramatically reduce demand. Reductions in supply/availability of service have exacerbated those factors. By virtue of longer trip distances these travel options exacerbate exposure risk as experts have learned more about viral load and the exposure effects to asymptomatic and symptomatic carriers of the virus. These modes have an advantage over urban public transit as they do not depend on crowded or standing room rush hour loads and are more accommodating of social distancing. Scheduled vehicle layovers, and lower passenger turnover also make cleaning between passengers more feasible and potentially more effective.

Intercity bus services do not have the subsidy resources to operate unproductive service for an extended period of time, particularly in the absence of federal financial support from the CARES Act, and the need to quickly adapt service supply to match demand.

Amtrak received additional public support through the CARES Act. Governance processes preclude them from being as responsive to changes in demand as is the private sector. Neither mode is well-suited to scaling cost to match the demand without affecting service quality – specifically trip frequency or network coverage. While Amtrak can shorten train lengths this does not reduce costs proportionally.

Should pandemic concerns or economic consequences moderate demand for publicly subsidized intercity rail services, policy decisions will be required regarding service levels, fare levels, and the warrants for public subsidy levels.

Intercity surface travel trends may show residual demand reductions due to several factors including:

- ↓ residual diminished activity participation by individuals that fear new strains of COVID or other viruses such that they change behaviors and reduce shared vehicle exposure.
- ↓ diminished travel resulting from the economic strain from COVID that may result in lower levels of travel. Lower income travelers, students and retirees are significant market segments for these services and are price sensitive.
- ↓ diminished travel due to ongoing communications substitution for travel.
- ↓ diminished travel should post-COVID if service levels remain more modest due to diminished demand or resource constraints,
- ↑ catch up travel from activities foregone during the pandemic such as visiting friends and relatives, and attending events at convention centers, concerts, sports facilities, etc.,
- ↑ potential increased intercity surface travel if air services are less available or more expensive for some markets,
- ? possibly other unanticipated factors.

### **Rental Cars, Chauffeured Services, Bikes, and Other Private Sector Modes**

Beyond the effects of canceled activities diminishing demand, private sector operated travel modes, such as taxis, transportation network companies, rental cars and bike and scooter rentals face obstacles. These include user concern over residual contagion from riding with other passengers simultaneously, doubts about the degree of vehicle cleanliness, and fears about the health condition of preceding travelers. In addition, part of the demand for these services is based on their role as feeder and distributor services for other intercity travel by air, rail and intercity bus. Thus, their future markets will be influenced by the pace of recovery in these modes.

The private sector nature of these modes means data on the COVID effects are less available and more dependent on secondary data sources. Their lack of a financial relationship with the federal government has resulted in less robust data at the national level on supply and demand for these travel methods. Other observations about the pandemic's effect on these modes are noted below.

#### **Car rental**

Business is reported to be down 50 to 90 percent at airport locations which comprise approximately 50 percent of the market and down 50 to 100 percent in off-airport locations, many of which have been closed. Two of the top rental companies have sought Chapter 11 protection and the industry has furloughed approximately 60,000 persons or 35 percent of its



workforce. Ripple effects will influence new vehicle sales as the rental industry has historically purchased one out of every eight vehicles sold in the U.S. Emerging trends include greater vehicle rentals for family vacations as air travel options have declined in popularity and renters seeking larger and/or more reliable vehicles for long distance trips.

The CARES Act has offered no direct support to the rental car industry; however, airports and other landlords are occasionally granting concessions to help sustain the industry during the pandemic.

### **Transportation Network Companies (TNC)**

At the height of the April 2020 pandemic shutdowns, rideshare companies were reporting decline bookings of 75 to 80 percent compared to a year ago, according to reports from Urbanism Next Center, at the University of Oregon, and the publication Smart Cities Dive. Second quarter Security and Exchange Commission (SEC) financial reports noted Uber gross bookings were down 73 percent from a year ago, while Lyft reported a 70 percent decline. Uber's involvement in meal delivery helped offset passenger trip losses. Shared trip services were discontinued and active safety protocols have been implemented. Both companies have offered free or reduced cost rides to attract travelers. By May 2020, Uber had cut about 27 percent of its workforce while Lyft had announced cutting 17 percent.

### **Bikeshare and E-Scooter**

Before COVID, there were 159 bikeshare systems and 213 e-scooter operations. By August 2020, 65 percent (104) of bikeshare operations remained open while 20 percent (32) were closed permanently and 14 percent (23) were suspended. Thirty-six percent (77) of e-scooter systems remained open while 1 percent (3) were closed permanently and 62 percent (133) were suspended according to data collected by the Bureau of Transportation Statistics. Extremely strong bike sales as noted by inventory shortages suggest individuals are purchasing bicycles to travel for both functional and recreational purposes, however cell phone data tracking bike use has shown mixed results with foregone activities offsetting more recreational use. Personally-owned vehicles (versus using shared vehicles) mitigate any concern that other vehicle users might have contaminated the vehicle.

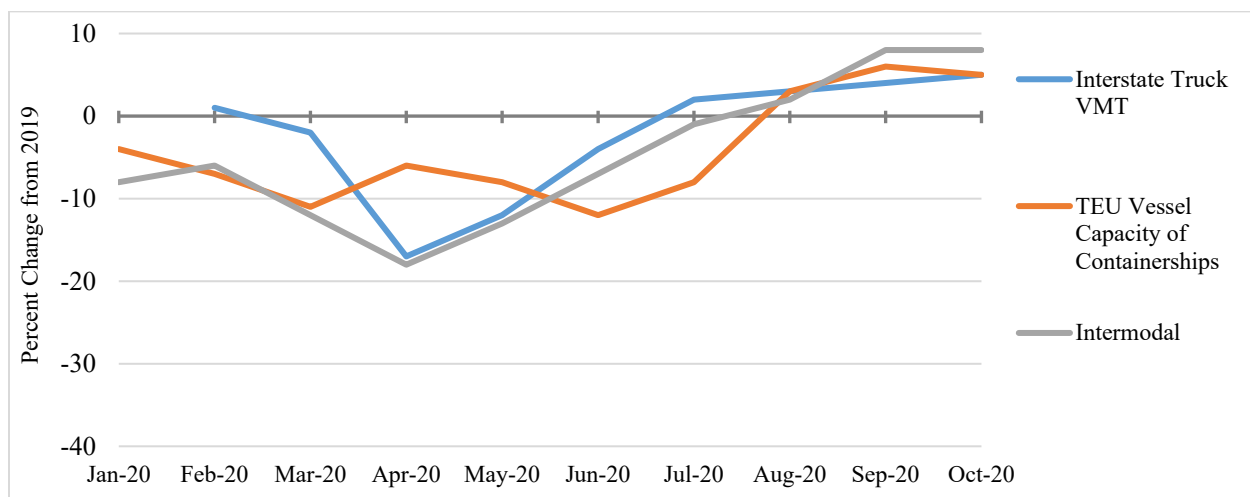
This subset of private sector travel options has incurred additional costs associated with cleaning and other safety protocols. The extent to which these cleaning and safety protocols continue will influence the user cost and/or profitability of these services. The private sector nature of these travel options suggests that service levels and pricing strategies will be responsive to market conditions going forward. As is the case with other modes, numerous factors will influence the future of these travel options: the economic health of customers; the extent of recovery in travel modes that these options often complement; the influence of communications substitution for travel for persons who use these modes; and other factors associated with regulatory, financial, or operational and infrastructure accommodations that may influence the competitiveness of these travel options.

## Freight

The pandemic has not affected the transportation of freight nearly as much as it has affected passenger related transportation. Generally, freight does not increase exposure risk for the workforce while in their vehicles. Closedowns can affect freight patterns and can create workforce risk in interfaces with customers, but these risks are not equivalent to passenger travel risks. In fact, since the height of the pandemic in April, when freight was most affected, freight volumes have generally rebounded to higher levels than before the pandemic as of August 2020. This is true for freight transportation modes by land, water, and rail. Figure 22 shows trends in freight activity as affected by COVID.

Truck Freight (Interstate Truck VMT) - Vehicle miles traveled (VMT) by trucks on all interstate highways started to decline in March, and by April had reached a low, having declined almost 20 percent, compared to the same time a year ago. Since then, truck VMTs have rebounded in the upward direction for six consecutive months. VMTs had recovered above the pre-pandemic levels in July, and as of October, were staying positive above the 5 percent range.

**Figure 22 - Trends in Select Freight Activity**



Source: Data sourced through Bureau of Transportation Statistics

### Maritime Freight (Vessel Capacity of containerships, TEU)

The carrying capacity of containership vessels calling at U.S. ports is a near real-time indicator of maritime freight activities, primarily reflecting the trend in trade volumes. Measured in twenty-foot equivalent units (TEUs), the capacity was down in the 10 percent range (compared to a year ago) for the first several months of the pandemic through July. By August, it had recovered above the pre-pandemic level and has since continued to trend in the positive territory.

### Rail Freight (Intermodal)

Similar to truck freight, the trend in intermodal rail freight reached its low in April but has since rebounded in consecutive months to above pre-pandemic levels and more. As of October, intermodal rail freight was almost 10 percent higher compared to the same time a year ago.

Despite a difficult second quarter (Q2 2020) with significantly lower traffic which required some furloughs and layoffs, the rail freight industry remains confident that the third quarter recovery will continue into the near future. Both operational and financial metrics in the third quarter were showing stabilizing trends and showing signs of steady recovery to above pre-pandemic levels.

Local freight services associated with deliveries, while not shown in the figure, have surged during the pandemic to accommodate the shift to e-commerce. The rate of economic growth will drive freight's levels of demand, although financial stress on shipping companies from the economic shutdown could cause some bankruptcies and pose limited hindrances in the short run.

Longer term, yet-unknown developments from repatriating manufacturing and shifting to e-commerce could change modal freight market shares. If more manufacturing is repatriated from overseas to the U.S. mainland, it could increase freight travel demand. Increased e-commerce could create more demand for delivery services and offset some of the decline in demand for personal travel. If recovery lingers with higher unemployment and lower economic growth, it will reduce demand for consumption and hence freight volumes for personal consumer goods.

Particularly strong housing construction associated with COVID-accelerated population shifts will generate freight demand for construction materials as might stimulus investments in infrastructure. Softness in office construction, brick-and-mortar retail, and perhaps urban rental/condo markets might soften demand for associated building materials.

The pandemic heightened the importance of ensuring robust transportation freight and delivery systems. The COVID public health emergency has underscored how important it is to have the appropriate logistics capabilities to support critical deliveries in spite of extraordinary events. As true as it was for Personal Protective Equipment (PPEs) in the early days of the pandemic, it is especially true for vaccine delivery and distribution.

## **Policy Implications**

The pandemic has created changes in travel demand, in private and commercial behavior, and in government actions. Taken together, these will create policy challenges for the future of transportation. In numerous cases COVID-19 exacerbated current trends and heightened our awareness of existing challenges facing transportation. The balance of this paper discusses several of those policy challenges and offers commentary intended to help frame the discussions as these issues are addressed. The discussion is by no means exhaustive either in topical areas or in the depth of discussion afforded each issue.

While the previous discussion focused on the transportation and travel behavior effects of COVID-19, the public health crisis has also hit the economy with multiple trillions of dollars in lost productivity and incurred debt in both public and private realms. The extent of these consequences, and their short run and long run term will shape the policy agendas in important ways. At a minimum, the COVID-19 pandemic and its economic consequences will influence the priorities that households, businesses and governments exert upon transportation. The economic consequences of the pandemic may have an effect on transportation as great or greater

than COVID-19's direct effect. Several critical policy issues are enumerated and discussed in the balance of this paper including:

- Transportation Planning
- Transportation and Equity
- Future Challenges for Public Transportation
- Transportation Funding and Spending

## **Transportation Planning**

COVID-19 strengthens the arguments for updating transportation planning processes and methods. Virtually every step in the planning process -- the identification of goals to the assessment of needs, collection of data and information, generation of ideas and options, etc.-will benefit from a review that integrates changes resulting from the pandemic and its technological, demographic and economic effects. For example, post-pandemic planning goals may include greater sensitivities to workforce and customer protections and preservation of options or generation of new travel options for those unable to avail themselves of personal vehicles. Examples of new goals could include: maintaining and restoring infrastructure, adapting technologies and services to meet the evolving needs, integrating flexibility and adaptability, enhancing safety, increasing resilience, enhancing accessibility and supporting equity aspirations.

Post-pandemic planning will require extensive data collection to quantify travel behavior and changes in activity that result from the pandemic. There is clear evidence of changes in travel behaviors (trip generation, trip distribution, mode choice and trip path selection) and most probably there will be permanent changes in the characteristics of the travel options (speed, capital cost, operating cost, productivity, environmental consequences, etc.).

The performance and cost characteristics of various transportation investments are changing. If the levels of supply and demand for travel modes change, the fundamental metrics of performance and will also be transformed. If enhanced social distancing, new screening protocols, new operator protections, or other changes in the design and operation of facilities and services come to fruition, it will make it necessary for planners to re-evaluate the cost, productivity and other economic and social effects of respective investments. Cost-benefit calculations will change, as will other performance metrics such as energy efficiency and environmental effects.

The existing goals, databases, travel demand models and other forecasting methods that underlie planning for the roadway and public transportation systems will require review and updating to account for the short- or medium-term declines in use and user-based revenues of the great magnitude caused by the pandemic. The planning process needs to accommodate the fact that the choice of using communications in lieu of travel is far more prevalent and practiced than ever. COVID-19 has accelerated the adoption of behaviors such as working at home, distance learning, telemedicine, on-line worship, first run movies via web streaming, e-commerce, and related substitutions of work, social, and business transactions on line. Understanding these new

behaviors and post-COVID trends is likely to take a few years but in the context of multiple hundreds of millions of dollars for various infrastructure investments, such understanding is critical to prudent decision making.

While the COVID-19 pandemic itself motivates a careful review of transportation planning and decision-making, it also enforces the growing awareness that the pace of change in transportation is accelerating, and technologies are greatly influencing travel behaviors. COVID-19 most certainly compounds the uncertainty facing transportation. While meeting, future needs will continue to be the foundation of planning, accommodating greater demand is less likely to be the dominant premise.

It is similarly apparent that planning contexts vary quite dramatically across the U.S. suggesting different methods and strategies, and perhaps different requirements should be adopted. Approximately one-third to one-half of the counties in the U.S. are shrinking as are some city centers and metro areas. The needs can vary across contexts as can the available resources and the technical and political viability of various strategies. Planning regulations and recommended planning methods will be more effective if modified to accommodate these differences.

Planners and policymakers will have a host of challenging questions and tasks to address as they rethink transportation planning post-COVID. Several of those issues are noted below.

- Planning data needs to be updated to include 2019 base year data and new data that reflects post-COVID conditions and trends and embraces new considerations reflective of post-COVID priorities. COVID-19 reinforces the desire to have data collected more frequently, delivered more expeditiously and provided with more geographic precision/specificity.
- Forecasting models need to be recalibrated to reflect the emerging importance of communication as a substitute for travel and altered travel behaviors residual from the pandemic. Questions include:
  - What will the post-COVID work-at-home share be?
  - How will workplace “lost to telecommuting” trips be distributed geographically and what are the implications (if work-at-home settles at 15 percent nationally, what will that number be for central business district offices jobs)?

“This [post-COVID-19] prospective future no doubt would come as a disappointment to Urban Triumphalists, who insist the value of cities is due to economies of agglomeration resulting from face-to-face interaction. . . . While historically in-person contact has driven economies of agglomeration, and ‘why be in cities but to be near other people,’ the question remains: Must it always be so? Mega-cities were largely non-existent in the pre-Industrial Revolution period when the economies of agglomeration were often outweighed by the diseconomies. Cities will not be abandoned quickly; transitions are long, but we may be nearing ‘peak city.’ This shift undermines all the place-based strategies that economic development organizations have been promoting for decades.”

—David Levinson, “[The New Normal: Mobility and Activity in the ‘After Times’](#),” *Transportist*, Nov. 3, 2020

- How will post-COVID work trip home ends be geographically distributed – will population disperse?
- What will be the urban daily temporal distribution of travel be after COVID-19? Will reduced peak period congestion affect modal competitiveness?
- What will be the urban day-of-week temporal distribution of travel post COVID-19? Will cities build peak infrastructure and services for Tuesday through Thursday, or attempt to apply travel demand management strategies to allow the system to operate more efficiently spread uniformly over five days?
- How will trips previously linked to commuting trips, such as stops at the dry cleaners, be accomplished after the pandemic?
- Will new activities and travel be added to replace the socialization lost if individuals work at home?
- Will the time and money saved by telecommuting be redeployed on other travel?
- Planners have leaned on scenario planning as a tool to accommodate uncertainty. While this is a reasonable strategy, scenario planning is not enough. It is necessary to integrate consideration of flexibility and adaptability of investment and operations into decision-making. It may be meritorious to postpone major irreversible decisions until some uncertainties have passed. For example, radial toll roads or rail transit projects that are highly dependent on work trip commuters for justification might best be postponed until post-COVID commuting patterns reveal themselves.
- Develop methodologies for planning for stable or declining travel. Historically, even areas with declining population and economic activity still had growth in per capita travel and through travel from adjacent geographies sufficient to use infrastructure and services. Future per capita vehicle travel growth is not anticipated to be robust and may even decline and overall population growth is projected to be moderate in the U.S. overall. Thus, some geographies will be challenged to maintain current infrastructure and services in the face of declining demand and weakening economies. Planning practices need to address this challenge.
- Performance metrics for transportation need to be updated post-COVID (capital and operating costs, capacity, productivity, energy/emissions efficiency, etc.) to reflect COVID-19 and equity or other factors that will alter prior relationships. Many existing perceptions as to attributes of various investment and service options are dramatically out of date and reflect historical conditions that no longer prevail. Future service levels need to be scaled to demand to optimize their cost-effectiveness, energy efficiency and emissions profiles. Similarly, if different options integrate technologies at different paces (electrification, automation, etc.) the performance characteristics and consequences can be very different from prior perceptions and forecasts.
- The evolution to far more complex funding strategies with reduced dependence on user fees has increased uncertainty regarding future resource availability. This was compounded by substantial federal general fund allocations to transportation in response to COVID-19. This ad hoc funding of transportation and/or dependence on reoccurring general fund appropriations undermines sound mid- to longer-term transportation planning.

The broad set of issues that should be considered as the country reassesses transportation planning post-COVID means a comprehensive rethinking of transportation planning may be in order. While this change may be incremental and vary across geography, COVID-19 serves as a trigger mechanism for beginning a redesign of transportation planning. This should not imply abandoning the decades of progress that have been made in planning but rather building on that knowledge and adapting transportation planning around the vast array of changes in the past few years and those revealed by COVID-19. If planning is not significantly updated and redesigned it will lose its credibility and relevance to decision making.

## **Transportation and Equity**

COVID-19 has affected different population groups in different ways, and new and existing inequities have been emphasized by social unrest. Lower income household members, often inclusive of disproportional shares of racial and ethnic minorities, are more likely to have been hurt by job layoffs or engaged in high exposure service or production employment not conducive to telework. They are also more likely to live and work in environments that make social distancing challenging, and to depend on shared modes of travel with higher exposure risk. This differential effect of COVID-19 has sensitized the public to disparities in transportation, and has caused some to argue that transportation should not worsen the health and welfare of low-income population segments. These concerns encourage public funds spent on transportation so as to lower costs.

Similarly, the availability of robust transportation options and contingency transportation capabilities for persons with disabilities was reinforced by the COVID pandemic. Part of the equity challenge is ensuring access to transportation for all segments of the population, especially in times of crisis and when travel options, features, and delivery methods are changing.

Not surprisingly, one can find a number of situations when pursuit of equity with respect to one set of individuals can affect the ability to be equitable to others. There are two particular situations exacerbated by COVID-19 that merit attention. Historically, transportation supply and investment have been driven substantially by market demand. Measuring, modeling and forecasting demand have been critical elements of transportation planning and input into decision making. The ability to scale services and infrastructure to demand, and the subsequent effects on the productivity of transportation aid the affordability of mobility in the U.S. and result in the more efficient use of energy and other transportation investments. To the extent that equity considerations diminish the sensitivity to demand in the allocation of resources it could affect the productivity and cost-value of transportation investments.

A second issue meriting consideration relates to how equity considerations can affect the incentives for the private sector to participate in providing transportation. If equity considerations undermine the ability of transportation providers to be competitive and profitable it could ultimately undermine the extent and quality of transportation provided.

Equity between payees and beneficiaries—those who pay for transportation facilities and services versus those who benefit from transportation—is another dimension of equity that some consider important as funding and spending patterns are changing.

Finally, the equity of transportation is influenced by geography, topography and the network nature of the various transportation modes. Differential geographic equity and its potential for differential incidence over population groups is often not within the control of the transportation builders or operators. Not everyone in a region can be equally accessible to the airport or port. Residents near the cores of urban areas have better accessibility via road and transit networks as urban economies have created greater densities near the urban cores. By virtue of geometry, residents near the center are closer to a greater share of activities.

Understanding and analyzing equity considerations will be an important but challenging consideration as decisions on providing transportation in a post-COVID era unfold. If not executed carefully and governed by clear objectives, consideration of equity could become a contentious process that delays and disrupts transportation progress.

### **Future Challenges for Public Transportation**

As noted earlier in this paper, the COVID-19 pandemic exacerbates an already challenging environment for public transportation. Ridership had declined over several years in spite of a robust economy and growing levels of service. Record auto ownership, burgeoning travel choices such as transportation network company services, e-scooters and bikes, growing telecommerce and e-commerce over the last two decades, and changing demographics had been challenging public transportation. The competitive advantages of mass transit's space, energy, and emissions efficiencies were already being downgraded, as personal vehicles have become more efficient and evolve toward electric propulsion. Already a huge share of personal vehicle travel is more energy and emissions efficient than the vast majority of transit services.

With greater energy efficiency and the possible movement to electric vehicles, these comparisons are likely to be even more stark. That future risk to demand is compounded by the possibility that automated vehicle services could render uncompetitive traditional public transit services in all but high-volume corridors. The emergence of COVID-19 and its substantial reduction in public transit ridership results in a perfect storm of challenges for public transportation as we know it today.

Social distancing undermines the fundamental advantage of "mass" transportation, namely the ability to carry large numbers of passengers on larger shared vehicles. Until progress on the medical front enables public transportation safety risk to return to near normal, this competitive disadvantage has pronounced effects for public transportation. A need for sustained social distancing on public transit or a reluctance of travelers to endure prospective risks would likely not work well on heavily used systems.

However, transit's role in providing mobility for those without alternatives, will remain a serious public concern and require strategies for meeting this mobility need. The gravity of this concern will be among the most pressing challenges for transportation policy makers.



As discussed earlier, higher income knowledge workers have been able to substitute work at home for transit commuting or to take advantage of dramatic reductions in urban congestion by commuting via personal vehicles instead of transit services. This change could lead to a more polarized profile of transit users with a potential loss of political support for and willingness to use public transit by potential transit travelers. The economic consequences of COVID-19 have also resulted in reduced services in many markets, further undermining the competitiveness of public transit choices.

Public transportation aims to provide “common carrier” service, i.e., low-priced service to the general population. This mission has led to capital-intensive, long-lived, long lead time projects on the theory that at full capacity the cost per rider will be low. There is a proclivity toward inflexible rail transportation and large buses that cannot adapt to changing market conditions and that are largely empty outside of rush hour. These modes depend on high occupancy rates to produce real benefits. The growing evidence that the public transit ridership levels will not return to pre-COVID levels even after the health risk has passed will make them generally even more uncompetitive and unproductive.

The challenges for public transportation are substantial and easy answers are nowhere to be found. Reactions range from a hope that things will return to normal as the COVID-19 risk diminishes to a hope that we will revive our dense urban environments so they are once again conducive to public transportation. Others have advocated initiatives such as abandoning fixed route services in unsupportive environments; leveraging technology, logistics and the private sector to move toward demand responsive services for persons dependent on public transportation; focusing current assets on the highest volume corridors where transit’s space and resource efficiencies can be attained; and exploring user side subsidy strategies for ensuring adequate mobility to support economic opportunity for those in need.

Transit data show that the effect of the public health emergency is pronounced and unprecedented. There is growing evidence that post-COVID travel behavior will be different in ways that challenge some current public transportation services. The magnitude of the COVID storm means that a swift return to normal is unlikely. Rather, transportation planners need to monitor emerging trends so that future investments in facilities and services can be informed by post-COVID travel behavior.

Goodwill toward public transit and the desire to meet mobility needs and ensure mobility is not an impediment to economic opportunity, should not be squandered on reactionary responses or poor stewardship of public resources. Underutilized public transportation does not save energy, reduce emissions or support the productivity of the economy. Data informed decisions that reflect current and anticipated realities need to be made to best accomplish the meritorious goals of public transportation – this will not necessarily mean restoring transit to its pre-COVID conditions with respect to services, technologies, or governance.

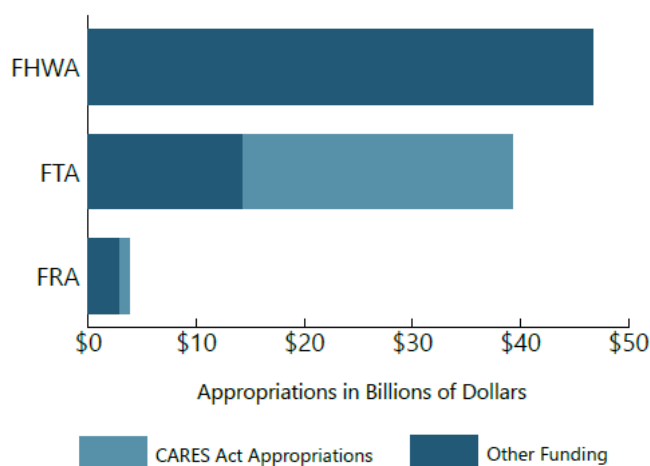
## Transportation Funding and Spending

Transportation funding has changed significantly due to the COVID-19 pandemic. This situation has further complicated securing predictable, policy-driven federal transportation funding. Fare and toll revenues for transportation, fuel taxes and related vehicle use fees, parking and enforcement revenues, and sales, income, and other revenue streams that support governments and contribute to transportation operations and investment have diminished. Already this has resulted in delays and postponements of some investments at the state and local level, and created calls for the federal government to replace lost revenues. Private companies have also cut back. Airlines have postponed fleet replacements, Hertz has declared bankruptcy, Uber has laid off thousands of employees, and numerous other entities are rethinking or rescheduling various initiatives.

The challenge of funding federal investment in transportation have been unresolved for years. The problem has grown worse as the Highway Trust Fund balance has been depleted and required repeated subsidies from general fund revenues. Interested parties sought both higher levels of funding and a dedicated funding sources. The original logic of users paying for transportation infrastructure—the foundation of the original Highway Trust Fund—has been weakened over time as increasing diversions to transportation investments that are not generating trust fund revenues have increased.

As noted in Figure 23, the CARES Act resources from the general fund substantially increased Federal funding for surface transportation, specifically public transportation and to a lesser extent Amtrak. The Consolidated Appropriations Act 2021 provides additional general fund investments in FY21 to provide further relief. Many are advocating for additional investment for economic stimulus. Numerous arguments including economic stimulus, social equity, and accounting for differential externalities have all been used to justify moving away from a user or beneficiary-based funding strategy.

**Figure 23** – U.S. DOT Funding for Surface Transportation Agencies for FY2020, Including CARES Act Appropriations



Source: OIG analysis of DOT data

- Emergency relief funding often deviates from traditional norms with respect to its source and its allocation, but these deviations make it difficult to identify a rational or stable funding and resource distribution mechanism. The CARES Act allocations raise several key questions: The Federal Transit Administration funding supplement was nearly twice the prior annual total federal commitment to public transportation. This more than offsets

fare revenue losses for all public transit systems for well over a year and, thus, these funds offset shortages in local and state funding for at least some systems. If federal resources are used to replace shortages in state and local funding streams for public transportation should a similar treatment be afforded to funding for state and local roadway systems?

- How will entities that received supplemental funding be weaned from extra federal funds to offset any “not-their-fault” shortages in normal revenues? How will policy makers discipline or evaluate the desires to have future man-made or natural disasters of other types result in requests for federal intervention?
- Different entities have different local funding mechanisms to support public transportation affected by COVID-19. Some entities, for example those that are funded with property tax revenues that have not been affected by COVID-19, are receiving a windfall with CARES funds. What is the best way to distribute emergency resources in an equitable fashion?
- Multiple local communities voted for new revenues and debt to fund future public transportation expansion in November 2020 while simultaneously the industry trade group was advocating for an additional \$32 billion in federal funding to avert a funding crisis. How should local and federal roles and responsibilities be reestablished?
- In the CARES Act not all modes were treated similarly. Is it fair to intercity bus to provide Amtrak extra funds, strengthening their competitive position?
- Airlines were provided high risk loans, so should taxi, car rental, intercity bus, e-scooter and other private providers be given the same opportunity?
- Should federal supplemental investment attempt to sustain services at pre-COVID levels when numerous experts anticipate post-COVID demand levels to be more modest for a number of years? At what levels should industries and workforces be sustained?

The multiyear movement toward more non-user-based funding diminishes the share of user-borne costs of publicly provided transportation infrastructure and services and implicitly diminish the competitiveness of private sector services. The financial stress of COVID-19 and the prospect that it will strain markets for several years, risk further diminishing the competitiveness of private travel options. Different degrees of subsidy/investment provided by other than direct beneficiaries can alter the competitiveness of travel options. Intercity bus is more challenged to compete with Amtrak if fares are relied on to pay a smaller share of costs. Transportation Network Company (TNC) services, rental cars, and e-scooters are less competitive if transit services are more highly subsidized.

As attention turns toward reestablishing longer-term funding and spending strategies, decision-makers need to be fully informed as to the consequences of those decisions. They will have to carefully analyze the mobility and financial consequences for modes, market segments, geography, and public and private sector interests. Numerous questions regarding transportation funding at the federal level will benefit from input from transportation professionals with respect to travel behavior, equity, public perceptions, stability, and other attributes. These include:

- To what extent does greater general fund investment (which implicitly makes travel lower cost relative to funding via user-based fees) undermine market based privately provided/operated transportation options or alter the overall level of travel?
- How will congestion dependent options (toll facilities, managed lanes, exclusive right of way transit, etc.) be affected by changed travel behaviors post-COVID?
- Do the lessons learned from COVID-19 and other ongoing changes influence the viability or traits of various revenue sources to support transportation?
- As events have different effects on revenue streams, can the resiliency of the revenue stream be gauged with respect to incidents like COVID-19 and can policies help govern external (federal) involvement in addressing shortfalls should subsequent disruptive events occur?

As the federal government over the past several months has been the default source of resources, and in some cases regulation and deregulation, COVID-19 has altered the allocation of responsibility for oversight and funding of transportation across different levels of government. Having stepped in as the financial resource of last resort, and unconstrained by the financial and legal constraints on deficit funding that state and local governments face, the federal government will find it difficult to withdraw from that role. The transition from being the beneficent distributor of new resources in a crisis to having to reject public and private requests for more federal funding will be difficult and demand clearly defined resource allocation principles. Being responsible stewards of transportation resources will be aided by a culture of responsible spending throughout the levels of government and across all sectors. Such a culture requires a sense of consequences associated with ever more federal debt financing.

## Conclusion

The policy issues discussed in this paper are just a few within the full universe of issues that need attention as the pandemic recedes. COVID-19 will influence efforts in many areas including regulatory priorities, environmental considerations, private sector roles in transportation, innovative uses of transportation infrastructure, safety initiatives and others. The pandemic is a transformational event and it is hoped that a broad review of transportation activities and priorities will strengthen the quality of life and economic conditions of the country. Every mode, every level of government, the public sector, businesses that operate and support the transportation sector, travelers, and institutions should reflect on lessons learned and transportation challenges brought forth by the COVID-19 pandemic.

The U.S. economic and governance systems are remarkably resilient, as we have seen from surmounting natural disasters, economic events and disruptions such as the 9/11 attacks. The COVID-19 crisis presents new challenges but also increases the importance of addressing previous problems. This roster of challenges will require fact-driven, innovative and collaborative efforts. Making well-founded, hard decisions to sustain the fundamental goal of having a world-class transportation system will not be easy. It is hoped that thoughtful discussions provoked by reflection on the impacts of COVID-19 and supported by sound data, will help speed our progress in helping our transportation systems to flourish.