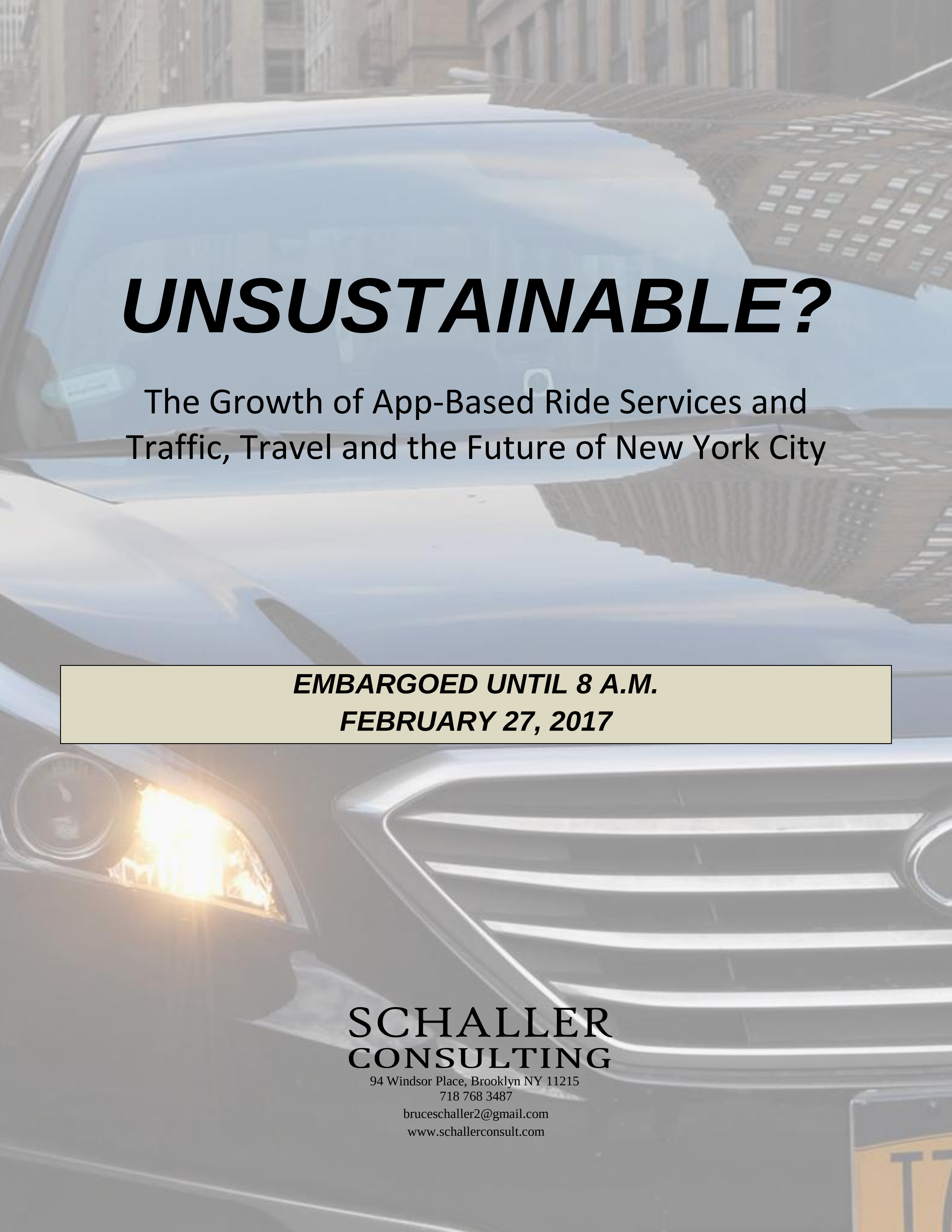

UNSUSTAINABLE?

The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City

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SCHALLER
CONSULTING
94 Windsor Place, Brooklyn NY 11215
718 768 3487
bruceschaller2@gmail.com
www.schallerconsult.com

This report was prepared by Bruce Schaller, Principal of Schaller Consulting. Mr. Schaller has 30 years of experience on urban transportation policy and operations as a consultant and senior local government official. He served as Deputy Commissioner for Traffic and Planning at the New York City Department of Transportation and held managerial responsibilities at the NYC Taxi and Limousine Commission and MTA NYC Transit. He has conducted studies for the U.S. Department of Transportation and for local governments throughout the country on transportation, transit and vehicle-for-hire issues. He is the co-author of a 2015 National Academy of Sciences report on emerging mobility providers, and served as an Advisor for the City of New York's study of for-hire vehicle issues. He has been called "a widely acknowledged expert" on issues related to taxis, Uber and Lyft (*Politico)* and a "nationally recognized expert in the cab business" (*Washington Post).* Mr. Schaller has published extensively in peer-reviewed academic journals including *Transport Policy*, *Transportation* and the *Journal of Public Transportation*.

This report was researched and written by Mr. Schaller for the purpose of furthering public understanding and discussion of the role that app-based ride services and other vehicle-for-hire services can and should play in furthering urban mobility, safety and environmental goals. The author would like to thank staff at the Taxi and Limousine Commission, NYC Department of Transportation and MTA NYC Transit who provided information and insight for the analysis. The analysis and conclusions are the sole responsibility of the author.

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Summary

The rapid growth of app-based ride services such as Uber and Lyft has raised both hopes and fears for their role in American cities. These services are widely embraced as a new transportation option that offers a higher level of availability, reliability and ease-of-use than traditional taxi and transit services. Patrons also avoid the cost and inconvenience of parking one's own vehicle. But the rise of app-based ride services has also raised widespread concerns about their effects on traffic congestion and vehicle emissions and also about their potential to undermine public transit and taxi services that are essential components of urban transportation networks.

The overarching question is how app-based ride services, also called Transportation Network Companies (TNCs), might support or obstruct goals for mobility, safety and environmental sustainability. The dearth of factual information available to date, however, provides little basis to assess the impacts of app-based ride services or decide whether public policy is needed in any of these areas.

This report presents findings from a detailed analysis of the growth of app-based ride services in New York City, their impacts on traffic, travel patterns and vehicle mileage since 2013, and implications for policy makers. The analysis utilizes trip and mileage data that are uniquely available in New York City, providing a detailed and comprehensive look at the expansion of app-based ride services and their impact on critical City goals for mobility, economic growth and environmental sustainability.

Findings from this analysis show that TNCs have become an important and fast-growing part of the city's transportation system. In each of the last two years, they have been the leading source of growth in non-auto (i.e., non-personal car) travel in the city. They have also added significantly to vehicular travel and mileage on city streets. Key findings are:

- TNCs transported 15 million passengers per month in Fall 2016 -- nearly as many trips as served by the city's yellow cab industry -- in 43,000 licensed vehicles.
- TNC ridership tripled between June 2015 (the end of the period examined by the City of New York's For-Hire Vehicle Transportation Study) and the fall of 2016.
- After accounting for declines in yellow cab, black car and car service ridership, TNCs have generated net increases of 31 million trips and 52 million passengers since 2013.
- In 2015 and to an even greater extent in 2016, growth in taxi and for-hire ridership outpaced growth in transit (subway and bus) ridership and is now the leading source of growth in non-auto travel in New York City. This marks a reversal from the transit-oriented growth that lasted from 1990 to 2014.
- TNCs accounted for the addition of 600 million miles of vehicular travel to the city's roadway network over the past three years, after accounting for declines in yellow cab mileage and mileage in personal vehicles. The additional 600 million miles exceeds the total mileage driven by yellow cabs in Manhattan.
- Total mileage of TNCs, yellow cabs, black cars and car services combined increased from 14 percent to 19 percent of total citywide mileage from 2013 to 2016. (The industry mileage includes transportation of passengers, "dead-head" miles between dropping off one passenger and picking up the next passenger, and drivers' personal use of driver-owned vehicles.)
- In Manhattan, western Queens and western Brooklyn, TNCs added an estimated 7 percent to existing miles driven by all vehicles, an increase of the same magnitude as the 2007 congestion pricing proposal would have decreased vehicle miles traveled.
- Since mid-2015 TNCs have offered and heavily promoted "pooled" options such as UberPool and LyftLine. TNC mileage nonetheless continues to grow rapidly because exclusive-ride trips still predominate, and because most TNC customers are coming from transit, walking and biking. Migration from public transit translates to increased mileage even if the trips are shared.
- Growth in trips, passengers and mileage is seen throughout the city as TNCs attracted yellow cab riders, those who would otherwise use the bus, subway or their personal vehicle, and people who would not otherwise have made the trip.
- Trip growth in Manhattan has been concentrated during the morning and evening peak periods, when yellow cab shift changes produced a shortage of cab availability, and late evenings and weekends when passengers may prefer

the comfort and convenience of TNCs over yellow cabs or transit services.

Rapid TNC growth raises important questions about the ability of New York City's transportation system to support the city's economic and population growth. From 1990 to 2014, the subway and bus system absorbed all or nearly all the growth of travel in the city generated by increases in population and economic activity. The city depended on the transit system to absorb the growth in travel since already-congested streets could not accommodate the increased traffic that would occur if growth were channeled to the automobile.

A continuation of TNC-led growth in travel is not a sustainable way to grow the city. Adding TNC mileage to already-congested streets will lead to mounting costs for businesses and consumers from increasing traffic delay and hinder progress toward the City's goals for mobility, economic growth and the environment.

City and transit officials can take a variety of steps to address the rising attractiveness of TNCs while also supporting the mobility benefits that TNCs clearly offer. These include many initiatives already underway to improve the speed, reliability, comfort and ease-of-use of bus and subway service and the comfort and safety of cyclists and pedestrians. Examples include count-down clocks, dedicated bus and bike lanes and train signaling systems that enable more through-put of subway cars. But more needs to be and can be done. Additional steps can include adapting traffic signal timing to make bus and bike speeds competitive with auto speeds, and reducing bus delay with off-board fare collection on busy routes when the MetroCard fare payment system is replaced.

Continued TNC growth, particularly as that growth becomes increasingly fueled by low fares, also raises the need to return to the subject of road pricing. The City has historically used pricing of taxicab fares and parking to discourage auto use in Manhattan. As they steadily cut fares, TNCs are erasing these longstanding financial disincentives for traveling by motor vehicle in Manhattan. If TNC growth continues at the current pace (and there is no sign of it leveling off), the necessity of some type of road pricing will become more and more evident. Technological innovations have created new options for design and implementation of a road pricing system that targets the most inefficient use of scarce road space during the times and on the streets where additional vehicles contribute the most to traffic delays. There are thus practical opportunities for officials to design, test and gain public acceptance of a road pricing scheme carefully targeted to reducing unnecessary traffic congestion.

Although this report is specific to New York City, the findings have important implications for other major American cities. The findings show that as TNCs grow, they are becoming central to changes in how people travel within dense urban areas, with potentially far-reaching implications. How they affect traffic and transit is shaped by the availability and attractiveness of existing transit, taxi and other for-hire services, which vary by city, location and time of day. Even where TNC trips replace personal auto trips, TNC growth can generate additional mileage on city streets because of dead-heading to pick-up locations and drivers' personal use of the vehicle. There is thus a strong need for a public policy response to the growth of TNCs. Developing a policy response should utilize trip data from TNCs, taxis and other for-hire services, as is currently possible in New York. Street management, transit services and road pricing should all be examined in formulating a policy response.

Introduction

App-based ride services like Uber and Lyft have grown rapidly in New York City, as across the country, since they began offering on-demand rides just a few years ago. The number of licensed vehicles affiliated with these app-based services, which are also called Transportation Network Companies (TNCs), more than doubled in each of the past four years in New York City, a pattern seen in other major cities from Boston to Los Angeles.[1]

The popularity and growth of TNCs is driven by their ready availability, speed of travel, comfort and convenience, particularly for social and recreational trips or traveling to or from an airport. Customers say that taking a TNC saves time and reduces stress while offering affordable fares. They use TNCs when they are in a rush, when it can be hard to get a cab, when public transit is not available or parking is difficult, as well as to avoid driving after drinking.[2]

TNC usage is becoming increasingly widespread. A recent on-line survey found that 38 percent of smartphone users in the United States have taken a TNC at least once, about half of whom use a TNC at least once a month.[3]

Customer satisfaction appears to be high; an independent survey found that 78 percent of Uber users say they are extremely or very satisfied with the service while only 3 percent are slightly or not satisfied at all.[4] While taxi and sedan services have long provided the same basic service -- a ride from point A to point B -- the ease, comfort and transparency of using Uber and other TNCs has felt like a revolution in transportation for many of their customers.

Not only their customers, but also urban officials have high expectations for the role that TNCs can play in supporting key city goals for mobility, economic growth and the environmental. Embracing and working with app-based mobility services is expected to enable cities of all sizes "to provide a wide range of mobility options than can utilize road space more efficiently and mitigate congestion."[5] In New York, "shared-use mobility" is a key element in plans to reduce greenhouse gas emissions, expand opportunities for walking and biking and facilitate faster bus service.[6]

TNCs clearly intend to help achieve these goals. An Uber spokesperson said that by "getting more butts into the backseats of fewer cars," his company and other TNCs help not only their customers get around, but improve traffic and reduce emissions overall. When Uber first announced flat fares for pooled rides in Manhattan, it said that its "goal is simple: take 1 million cars off the road in New York City and help eliminate our city's congestion problem for good."[7] Lyft says that customers sharing rides "are helping to reduce the carbon footprint left by our country's dominant mode of transportation – driving alone."[8]

Yet even as city officials and TNCs themselves view app-based ride services as part of the solution to crowded roadways, there are increasing concerns over TNC impacts on traffic congestion, transit services and vehicle emission levels. These concerns came to prominence in New York City in June 2015, when New York City Mayor Bill de Blasio proposed a moratorium on TNC growth to give the City time to assess the causes of rapidly increasing congestion in Manhattan. Although Uber and Lyft were able to block a moratorium, the City proceeded with its planned study and released a report in January 2016.

Surprising many people, the City's For-Hire Vehicle Transportation Study (FHV study) concluded that TNCs were "a contributor to overall congestion, but did not drive the recent increase in congestion in the CBD."[9] The analysis showed that worsening congestion was driven primarily by increased freight movement, construction activity, pedestrian volumes and record levels of tourism, all of which put growing demands on the streets' limited capacity.

The New York City report also noted that TNC growth "could drive modest growth in congestion in the future" if it drew customers from public transportation. Partly due to this possibility, concerns over TNC impacts in large cities have intensified over the last year. An association of city transportation officials released a policy statement in June 2016 that, while recognizing the mobility benefits brought by TNCs, also stated that "the growth of ride-hailing services has had and may have negative impacts on city transportation and the environment."[10] The statement cited congestion, emissions and access for people with disabilities and disadvantaged persons as key concerns. In December 2016, the City of San Francisco appealed to the state agency that regulates TNCs in California to conduct an environmental impact study of TNCs, writing that, "Much of the increase San Francisco has experienced in vehicular traffic can be attributed to the huge increase in the number of [TNC] vehicles operating on city streets."[11]

Recent national trends have given further reason for concern about traffic, transit and environmental trends. After nine years of contraction, per capita vehicle miles traveled in the United States increased between the spring of 2014 and end of 2016.[12] Meanwhile, U.S. transit ridership reversed course in the opposite direction, declining between the first half of 2014 and first half of 2016.[13]

Underlying both the concerns of urban officials and these broad national trends are basic questions about how TNC growth affects use of city streets and transit systems. Is TNC growth making more efficient use of scarce street space by putting more passengers in each vehicle? Or does it add to traffic by diverting people from high-capacity services such as rail and bus? The answers to these core questions largely determine whether TNCs are helping cities meet their goals for sustainable growth, or hindering or even obstructing cities from reaching these goals.

So far, the answer has not been clear. A 2015 National Academy of Sciences report stated that how TNCs and other new mobility services such as car share and bike share "affect travel behavior and demand, the use of all other modes ... [and] private vehicle ownership ... remains to be seen".[14] The announcement of a study by the Natural Resources Defense Council and the University of California at Berkeley gained much attention over a year ago because it plans to address climate and environmental impacts in five major urban areas, including New York, Los Angeles and San Francisco.[15]

This report examines the core issues of TNC impacts on travel choices, vehicular use and traffic congestion in New York City over the last several years. The analysis utilizes datasets on fleet size, trips and mileage that are uniquely available in New York City. The report provides the first detailed, comprehensive and data-driven look at the expansion of TNC operations in a major American city. Findings are based on direct measurement of trip volumes and vehicle mileage (from in-vehicle systems and odometer readings taken at required vehicle inspections, respectively), thus providing comprehensive and accurate data. The analysis covers the entire universe of taxi, TNC and other for-hire vehicles, thus taking into account declines in trips and mileage among taxi and car services to calculate the overall growth of taxi/for-hire services including TNCs.

The report uses these data to document trends in trips, passengers and mileage from 2013 to 2016, the impacts of TNCs on transit ridership, and overall growth in travel and impacts on traffic congestion and vehicle emissions. The report also discusses public policies that could help mitigate traffic, transit and environmental impacts of TNCs while also preserving their valuable enhancements to the city's transportation network. The report concludes with implications that other major cities can draw from the findings for New York.

TNCs and autonomous vehicles

The arrival of autonomous vehicles in coming years is expected to bring myriad benefits to cities. These range from reduced traffic injuries and fatalities to reducing the use of single-occupant vehicles.

The findings in this report are directly relevant to a central vision of how autonomous vehicles should be deployed in dense urban settings -- namely, in fleets of shared autonomous vehicles that would provide on-demand transportation, much like TNCs today but without drivers. By eliminating the need to pay drivers and or to park in dense city centers, shared autonomous vehicles (SAV) are envisioned to have a broad set of benefits to traffic and the environment. A widely-cited simulation model using trip patterns in Lisbon, Portugal found that if deployed in concert with existing rail service, SAVs could eliminate congestion completely, reduce emissions by one-third and reduce the space required for public parking by 95 percent.[16] Freed-up parking spaces could provide land for new housing and commercial buildings, increasing urban densities and furthering sustainability goals. An SAV fleet could also be electrically powered, further reducing greenhouse gas and other vehicle emissions.

Leavening this optimistic vision are a number of concerns. Combining low fares and fast trip-making, shared autonomous vehicles could attract transit users, negating the congestion benefits.[17] The transition period is also likely to be perilous. Initial implementation of SAV service could easily increase vehicle mileage since there are fewer opportunities to fill vehicles with riders until SAVs becomes a predominant way of traveling. Travel simulations show a 5 to 11 percent increase in vehicle mileage in the early stages of deployment.[18] Add in a substantial shift from public transit, and increases in vehicle mileage could be much higher.[19]

The arrival of fleets of shared autonomous vehicles may seem like a far-off possibility as no one knows how soon autonomous vehicle technology may arrive at this scale.[20] However, the same impacts -- good or bad -- can arrive well before autonomous vehicle technology is sufficiently mature to operate in dense urban environments. The modeling shows that changes in travel and vehicle mileage are generated primarily from the combination of demand-responsive service and shared use of the vehicles, with automated operations being of secondary importance.[21] In other words, the SAV future can arrive with continued growth of TNCs driven by actual people. That future may thus be evident today, as documented in this report.

1. Methodology

This report utilizes a series of datasets that are uniquely available for TNCs, taxicabs and other for-hire vehicles in New York City. The availability of these data make possible the most in-depth examination of the growth of TNCs in any American city. This section describes the source data and how they are used in this report.

Data Sources

1. Electronic trip logs. The most widely known data are trip logs for taxicabs and TNCs. These data have been widely used by the press and researchers interested in taxi trip patterns in New York. The trip logs include date, time and origin location of each trip. Taxicab logs also include destination location, distance, duration and fare. Yellow cab data are available since 2009; trip logs for TNCs are available starting in January 2015.[22]

In addition to this ongoing reporting of taxi and TNC trips, the Taxi and Limousine Commission (TLC) has made publicly available a file of Uber trips from selected months in 2014 and 2015. This file was provided by Uber for the City's FHV study in 2015. Unlike the ongoing data releases for TNCs, these data include trip destination, duration and distance.

2. Weekly FHV trip volumes. In addition to trip logs, TLC makes available weekly summaries of the number of trips and the number of vehicles dispatched by for-hire vehicle (FHV) bases, including TNCs.[23] Data for TNCs are available starting in 2015. Other FHV bases have ramped up data reporting over the past two years; most black car and car service bases are now reporting data.

3. Monthly taxi trip volumes. Monthly trips, fare revenue and other indicators are available for yellow and green cabs, posted in spreadsheets on TLC's website.[24]

4. Current licensees. Complementary to the trip files are lists of licensed taxicabs, FHV vehicles and FHV bases. The licensing files provide a snapshot in time of all licensed vehicles and bases. Current licensees are available on the City's Open Data website.[25] Licensing information for earlier years was obtained using the internet archive "wayback machine".[26]

5. Vehicle Mileage. TLC inspects each licensed taxicab and FHV vehicle periodically, ranging from every four months for yellow cabs to every two years for most FHVs. Vehicles are inspected at TLC's inspection facility in Queens. Odometer readings from these inspections were obtained through a Freedom of Information request.

Electronic trip log data are used for detailed analysis of trip patterns by geographic area and time of day. Due to the voluminous nature of the trip data, the report utilizes data from three selected months: June 2013, June 2015 and June 2016. The same month is used each year to avoid introducing seasonal effects on the analysis of trip patterns. These particular months were selected because:

- June is a reasonably typical travel month, with moderate weather and no holidays.
- The last taxi fare increase was in September 2012. Using data for June 2013 means that trends in taxi trip patterns are not affected by changes to the taxi fare.
- The City's FHV study relied on data through June 2015. Analysis for this report can thus look both at the timeframe studied in the City's report (pre-June 2015), and what has happened since then.
- June 2016 was the latest month for which trip log data was available at the time of analysis, enabling the analysis to report the most up-to-date available data.

For each of these June months, monthly totals are for 28 days in each month (June 2 to June 29) so that there are consistently 20 weekdays and 8 weekend days in each reported month.

In addition to these trip and odometer data, the report relies on publicly available data on travel in New York City. Each data source is cited in the tables and figures where it is used. The main sources are:

- Subway and bus ridership, provided by MTA New York City Transit.
- Bike ridership, provided by New York City Department of Transportation through 2015 and estimated for 2016.
- Ferry ridership, reported in the Mayor's Management Report.
- Personal travel by all modes, based on a household travel survey conducted for the New York Metropolitan Transportation Council (NYMTC) in 2010-11.

Metrics and Analysis Method

These source data are combined in various ways to produce results for the following metrics. This section defines each metric and the source data used for it.

Trips means trips with one or more fare-paying passengers traveling as a group. Thus, two people traveling together from point A to point B constitutes one trip. For "pooled" TNC rides using UberPool, LyftLine and Via, each traveling party is counted separately. Thus, when one person goes from point A to point B, and the driver stops and picks up two passengers along the way who travel from point C to point D, this is counted as two trips (one from A to B, the second from C to D). Sources: Electronic trip data, weekly FHV trip volumes, and monthly taxi trip volumes.

Although the data TLC receives counts pooled trips, they are not identified per se in the files TLC currently receives. There are press reports that about one-quarter or more of customers in New York benefit from pooled fares. However, customers selecting pooled options are not always matched with other riders so the actual number of shared trips is lower.[27] Under a recently adopted TLC rule, TNCs will be required to indicate which trips are pooled.

Passengers and Ridership refer to the total number of fare-paying passengers. Each passenger is counted separately even when traveling together.

Passenger volumes are based on the number of trips multiplied by the yellow cab average of 1.66 passengers per trip. The 1.66 figure is used for TNCs as well as yellow cabs as TNC trip data do not show the number of passengers. It might be expected that TNCs have more passengers per trip given their somewhat different trip profile (more evening trips, greater distances). However, the yellow cab data show minimal variation in per-trip passengers by time of day, and to the degree that TNC traveling parties may generally have more passengers, passengers using pooled services may be more likely to be traveling solo.

Mileage refers to miles traveled by licensed taxis and for-hire vehicles. Unless otherwise noted, mileage includes miles traveled with passenger(s) as well as mileage between trips (e.g., cruising, repositioning into more active zones, and driving to a passenger pick-up location). In addition, drivers who own the vehicle typically use it for personal travel as well as while working for-hire. Mileage includes this personal use of the vehicle as well. Source: Odometer data for average mileage per vehicle, combined with vehicle counts from licensee files.

Industry sectors

These metrics are analyzed for total volumes (trips, passengers and mileage), changes over the last three years, and net change for the taxi/for-hire industry as a whole. The net change is important to gauge the impact of TNC growth in the context of offsetting declines in yellow cab and sometimes FHV trips and mileage.

New York City's taxi/for-hire industry has a number of different sectors. The basic distinction is between the well-known yellow cabs which are authorized to pick up street hails throughout the city, and "for-hire vehicles" (FHVs), a separate licensing category. FHVs are generally only authorized to pick up pre-arranged requests for service, whether by telephone or app. (The exception is green cabs; see below.) TNCs are licensed as FHVs and subject to the same regulatory structure as the traditional FHV sectors, generally known as black cars, car services and luxury limousines.

This report uses the following terms to refer to the various industry sectors:

- *Yellow cabs* are licensed vehicles authorized to pick up street hails throughout the city. The number of yellow cabs, which has been regulated since the 1930s, is currently 13,587.
- *Transportation Network Companies* (TNC) are app-based ride services, sometimes also called rideshare services. Five TNC companies are currently operating in New York City: Uber, Lyft, Via, Gett and Juno. "TNC" and "app-based ride services" are used interchangeably in this report.
- *Green cabs*, a category first licensed in 2013, are authorized to pick up street hails in upper Manhattan, the Bronx, Brooklyn, Queens and Staten Island. They are authorized to drop off passengers throughout the city. They are affiliated with car service bases and also serve trips dispatched by these bases. Their operations are included with car services in this analysis.
- *Black cars* and *car services* are comprised of bases, vehicles and drivers authorized to serve pre-arranged rides. Except for green cabs, they are not authorized to pick up street hails. Vehicles are required to be affiliated with a base. Some black car and car service drivers also carry smartphones and respond to TNC trip requests, somewhat blurring the line between TNCs and this group.

  Black cars historically served a corporate clientele using voucher payments while car services were historically neighborhood based, serving the general public and accepting cash and sometimes credit card payment. These lines have also blurred somewhat in recent years but the distinction has been maintained in city regulations.

- Luxury limousines provide a higher class of service; they operate on a "garage to garage" basis and charge a flat rate based on time or mileage. Unlike the other industry sectors, luxury limousines do not operate on-demand. They are not included in the analysis in this report.

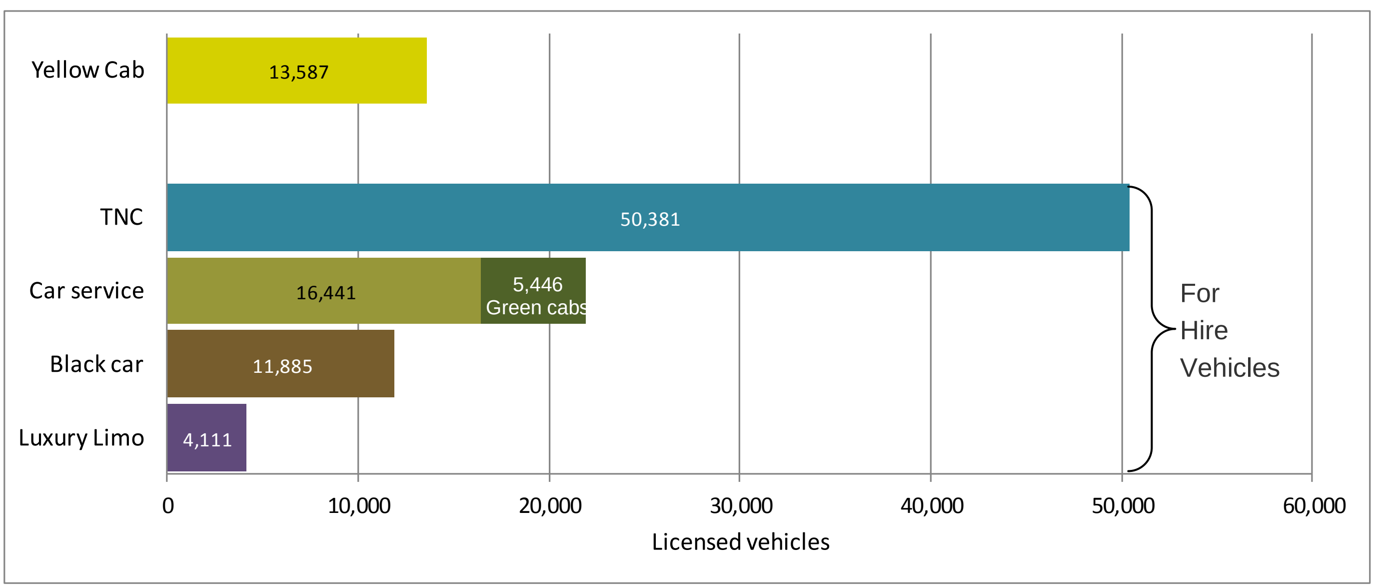
About 10 percent of trip requests to TNCs are actually serviced by black car and car service drivers. As noted above, these drivers respond to dispatched requests for trips from both TNC companies and their own black car or car service base. Annual figures for trips and passengers presented in this report assign these trips to the black car/car service category since the vehicles and drivers serving them fall into that category.

Figure 1 shows the number of vehicles in each sector as of February 2017.

The report also uses the following terms to refer more generally to the industry:

- *Taxi/for-hire industry* encompasses all of the above sectors: yellow cab, green cab, TNCs, black cars and car services.
- *Taxi/TNC* refers only to yellow cabs and TNCs.

Figure 1. Industry sectors, February 2017



Source: TLC licensing files.

2. Findings

This section presents citywide TNC trip and passenger volumes and vehicle mileage, growth rates and geographic distribution. Also presented are trends in trips, passengers and mileage for the overall taxi/for-hire sector, taking into account taxi and (where data are available) car service and black car trends. Results are presented first on a citywide basis, and then with detail by geographic areas and time of day.

Citywide Results

1. TNC ridership doubled annually over the last three years to 133 million passengers in 2016, and is now approaching yellow cab ridership levels.

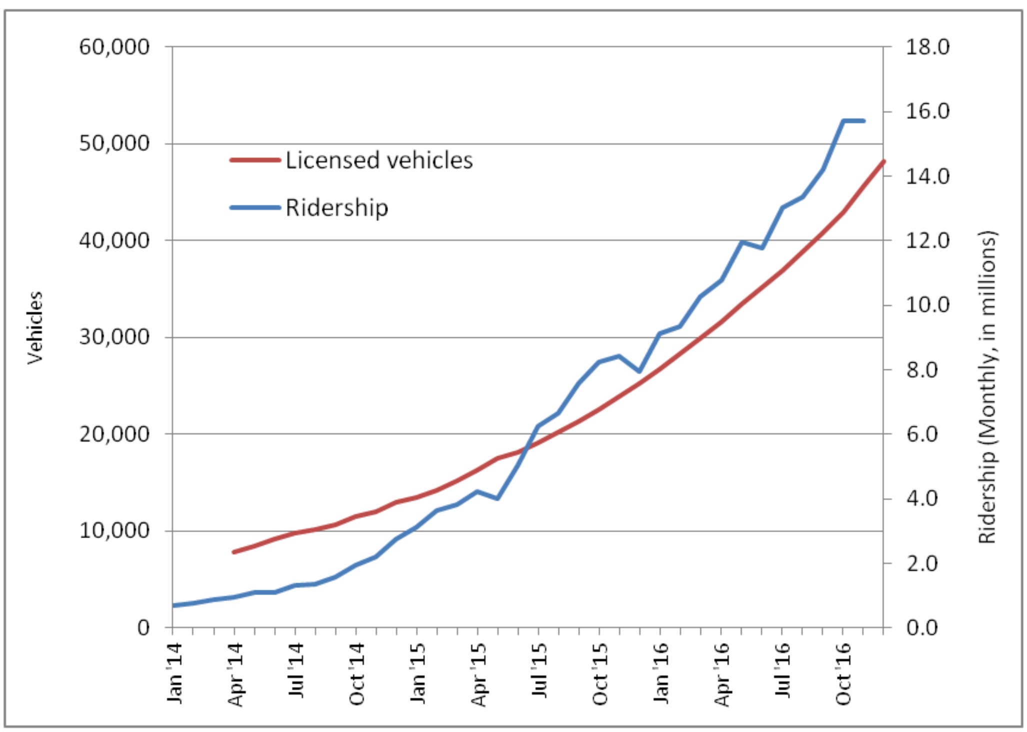
The five app-based ride services licensed to operate in New York City, Uber, Lyft, Via, Gett and Juno, provided 80 million trips and transported 133 million passengers in New York City in 2016. As of Fall 2016, TNCs transported 87 percent as many passengers as yellow cabs. As another comparison, daily TNC ridership was equivalent to the combined number of subway riders entering Times Square-42 St, Grand Central-42 Street, Herald Square-34 St and Union Sq-14 St stations, the four busiest station complexes in the city, in Fall 2016.

TNC ridership grew rapidly in the last several years, doubling each year from 2014 to 2016. Fall 2016 ridership averaging 15 million passengers per month was more than triple ridership levels in Spring 2015, the period studied in the City FHV report. (See Figure 2.) At the end of 2016, there were over 48,000 vehicles affiliated with TNC bases, up from 18,000 in June 2015.

Since mid-2016, TNCs have added an average of 7 million passengers per month compared with the same month in 2015. (Yellow cab ridership has been declining by 2 million passengers per month compared to the same months in 2015.)

Uber is the largest TNC operating in New York City, with a 72 percent share of all TNC trips in Fall 2016. Lyft is the second-largest TNC with 12 percent of the market, followed by Via, Juno and Gett.[28] The smaller companies have grown more rapidly than Uber, however, causing Uber's share of all TNC trips to drop from 91 percent in Spring 2015 to 72 percent in Fall 2016. (See Table 1.)

Figure 2. TNC licensed vehicles and monthly ridership, 2014 to 2016



Sources: Ridership is from TLC trip files and assumes 1.66 passengers per trip. Licensed vehicles is from TLC base and vehicle licensing files for mid-2014, mid-2015, mid-2016 and Dec. 2016, and interpolated for other months.

2. Taking into account declines in ridership among yellow cabs, black cars and car services, passenger volumes for the taxi/for-hire industry as a whole increased by 52 million passengers since 2013.

From 2013 to 2016, yellow cab ridership fell by 70 million. Ridership of black cars and car services declined by about 9 million, based on trends in vehicle mileage for these sectors. These declines partially offset the increase of 131 million passengers served by app-based ride services from 2013 to 2016.

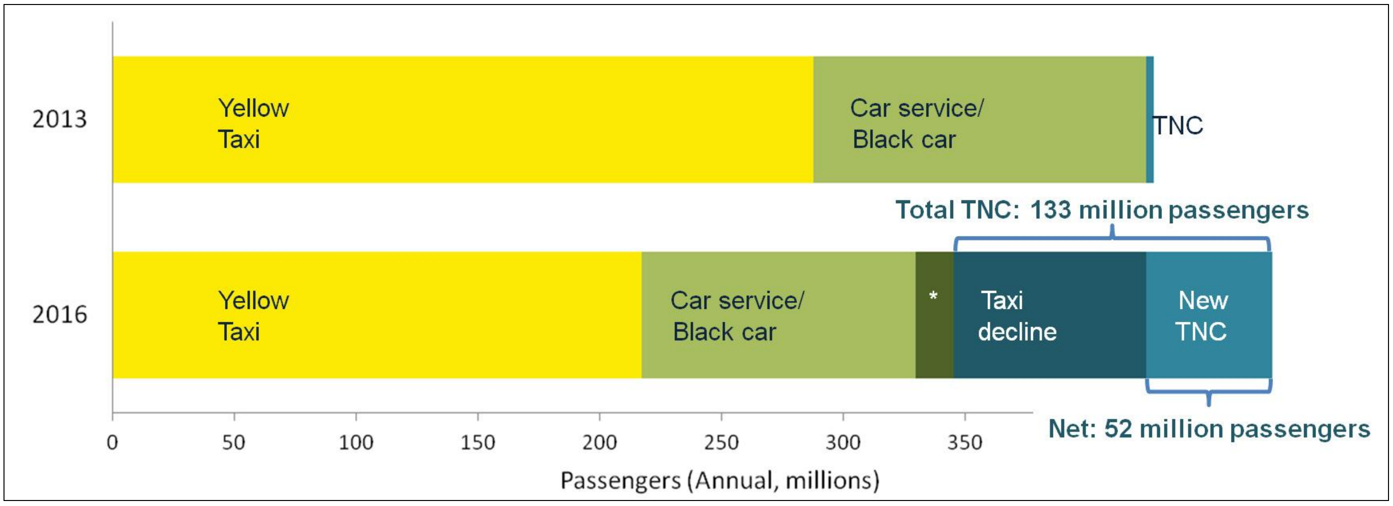
Looking broadly at the taxi/for-hire industry as a whole, overall ridership increased 52 million passengers from 2013 to 2016, as shown in Figure 3. (The number of trips increased by 31 million.)

Table 1. TNC and taxi market shares

	Spring 2015	Fall 2015	Fall 2016
Uber	91%	86%	72%
Lyft	4%	9%	12%
Via	5%	5%	7%
Juno	0%	0%	7%
Gett	0%	0%	2%
Total	100%	100%	100%
Monthly trips (millions)			
TNCs	2.56	4.83	9.06
Yellow cabs	12.85	11.61	10.36
Monthly passengers			
TNCs	4.26	8.01	15.04
Yellow cabs	21.33	19.28	17.19
TNC as pct of yellow cab passengers	20%	42%	87%

Spring=April to June; Fall=September to November.
Source: TLC trip files. Monthly passengers assumes 1.66 passengers per trip (see text).

Figure 3. Passengers, 2013 and 2016



* Trip requests made through TNC apps and dispatched to drivers affiliated with black car and car service bases.

Source: TLC trip files.

3. TNC vehicles drove a total of 1.19 billion miles in 2016. Taking into account declines in mileage for taxis, black cars and car services, and less use of personal vehicles by some TNC drivers and passengers, TNC growth increased driving in the city by 600 million miles from 2013 to 2016.

TNC vehicles drove an average of 34,000 miles per vehicle in 2016. Multiplied across all licensed TNC vehicles, TNC vehicles drove a total of 1.19 billion miles in 2016. This figure is about the same as for black cars and car services combined (1.21 billion miles) and substantially higher than total mileage driven by yellow cabs (770 million miles).

From 2013 to 2016, mileage for yellow cabs declined by 186 million miles and mileage for black car/car services fell by 51 million miles. Combined with an increase of 1.14 million miles for TNCs, mileage for the overall taxi/for-hire industry increased by 901 million miles to 3.17 billion miles in 2016. This figure comprises 19 percent of the total of 17.1 billion miles that are driven annually on city streets in 2016, up from 14 percent in 2013.[29]

A portion of this increase represents shifts from personal vehicles, not "new" mileage on city streets. The shift from personal vehicles occurred among both among passengers and drivers:

- Some TNC trips replace trips for which passengers had used their personal auto. This shift is estimated to be 56 million miles, based on rates of auto usage in New York relative to use of transit and other modes.
- In addition, some drivers have shifted from using their personal vehicles to using their TNC vehicle for personal travel (e.g., driving to the grocery store, transporting family members). This personal mileage is estimated to be 245 million miles based on rates of car ownership for the age group and occupations that drivers tend to be drawn from. (See Appendix B for the methodology for both estimates.)

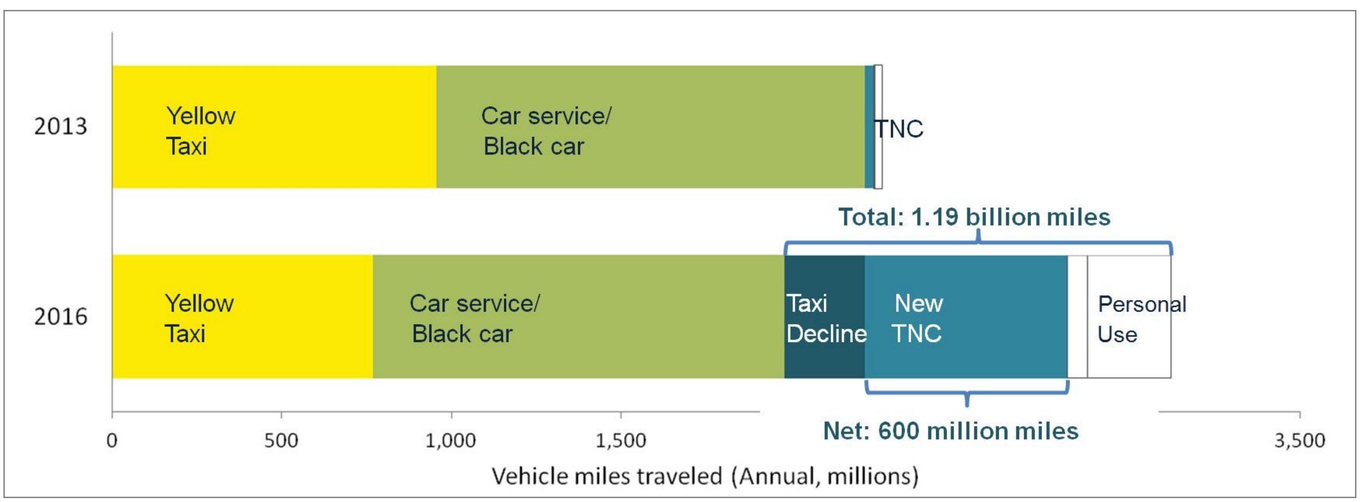
As shown in Figure 4, after taking account of declines in yellow cab, black car and car service activity and shifts from personal vehicles, TNCs generated an additional 600 million vehicle miles from 2013 to 2016. This TNC-generated growth in driving in the city is greater than total mileage of yellow cabs in Manhattan, and constitutes 3.5 percent of vehicle mileage for all vehicles citywide.

4. Mileage increases have occurred even with TNCs offering shared ride (or "pooled") options that were designed to reduce overall vehicle mileage.

Some have hoped that increases in traffic and emissions would abate as more and more TNC users opt for shared ride options such as UberPool, LyftLine and Via. These options became available (and have been heavily promoted) in New York City since mid-2015.

Trip data that TLC currently receives from TNCs do not indicate how many rides are shared under these "pooling" options. Trip counts do, however, reflect whatever amount of sharing is taking place since each traveling group is counted separately. (See methodology section.) Results in this report thus show that current volumes of pooled rides combined with exclusive-ride trips are producing large overall increases in mileage -- not reducing congestion or carbon emissions.

Figure 4. Annual vehicle mileage, 2013 and 2016



Source: TLC odometer and trip files.

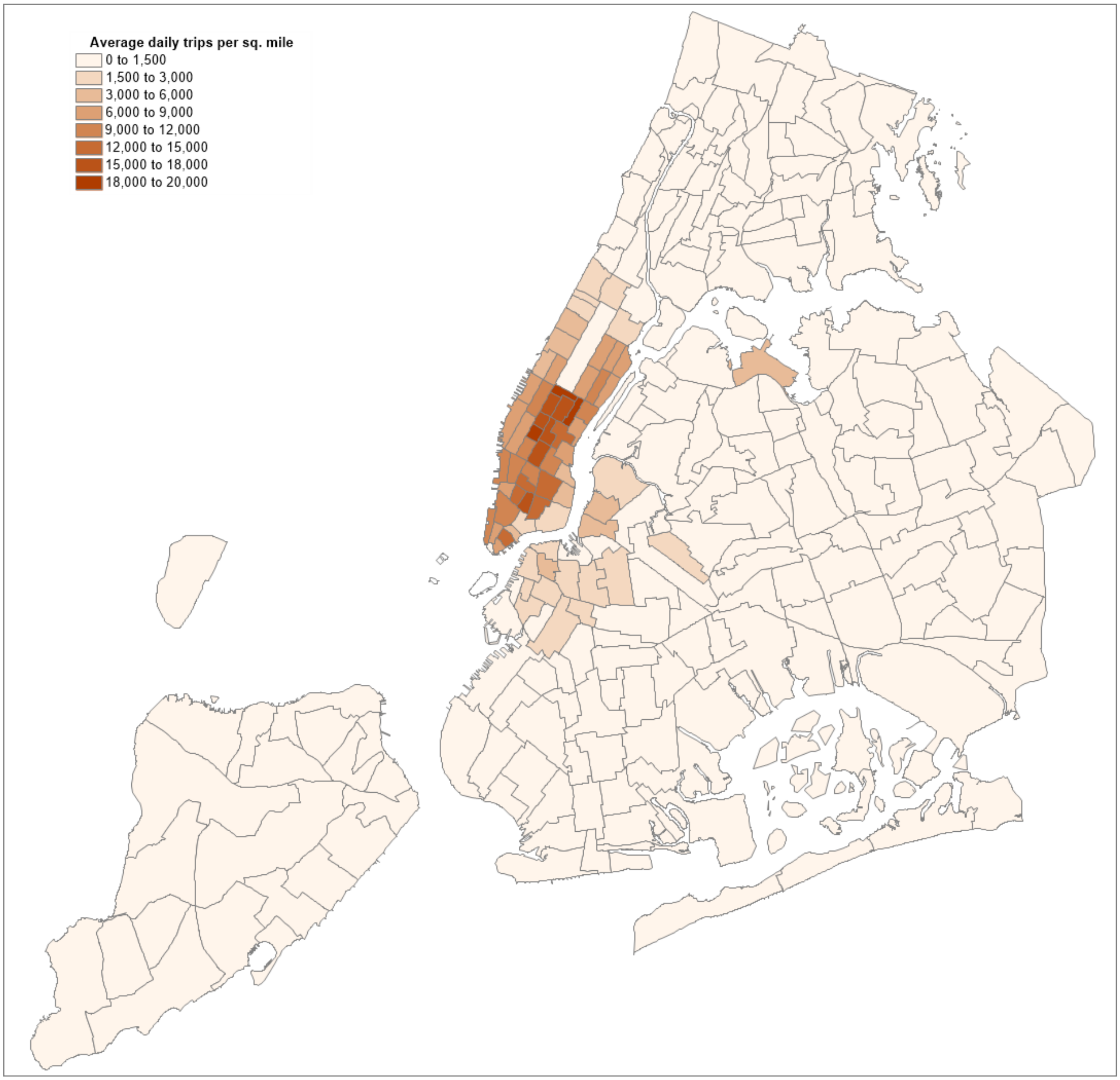
It is by no means certain that use of pooled options will grow significantly given the hassles involved for both riders and drivers, as a number of commentators have noted.[30] More shared rides will not necessarily lead to reduced mileage in any event. As long as TNC riders are coming predominantly from transit, walking and biking, TNC growth translates to increased mileage. Moreover, mileage reductions from pooling among TNC passengers who switch from personal autos may be offset by the "dead-head" miles driven between passenger trips.

Geographic Distribution of TNC Trips

1. TNC trips are most concentrated in the Manhattan core, but serve far more outerborough passengers than do yellow cabs.

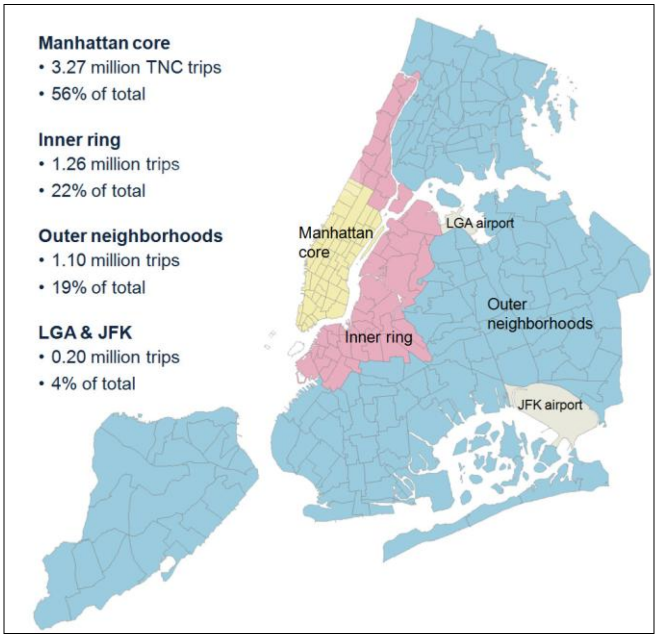
As with yellow cab trips, TNC trips are most intensively concentrated in Midtown Manhattan, South Midtown and nearby neighborhoods, and the Upper East and Upper West Sides. (See Figure 5.) The concentration in the central parts of Manhattan are driven by the high density of business, tourism and leisure activity in these neighborhoods as well as the expense and inconvenience of driving and parking in Manhattan.

Figure 5. TNC trip origins, June 2016



Source: TLC trip files. Data are calculated per square mile to show trip density.

Figure 6. TNC trips by geographic area, June 2016



Source: TLC trip files. Data are for Uber, Lyft and Via. (Geographic distribution is not available for Juno and Gett trips in June 2016.)

Although the greatest concentration of TNC trips is in Manhattan, TNCs also serve a substantial number of customers outside the Manhattan core. In June 2016, 56 percent of trips originated in the Manhattan core and 44 percent originated in the Bronx, Brooklyn, Queens, Staten Island or northern Manhattan (north of East 96 Street and West 110 Street). (See Figure 6.)

TNC trips outside the Manhattan core are almost evenly split between neighborhoods close to Manhattan (e.g., northern Manhattan and western Queens and Brooklyn) and the rest of the city.

2. Most of the growth in taxi/TNC trips since 2013 was outside the Manhattan core.

While the majority of TNC trips originate in Manhattan, the growth of combined taxi/TNC trip-making was concentrated in the rest of the city due to declines in yellow cab ridership. The increases in Manhattan in the past year, however, were quite substantial.

Table 2 shows the growth in combined taxi/TNC trips from June 2013 to June 2016. Of the 2.94 million additional taxi/TNC trips taken in June 2016 compared with June 2013, there were an addition of:

- 670,000 in the Manhattan core (south of East 96 Street and West 110 Street)
- 970,000 in inner ring neighborhoods (northern Manhattan and western Queens and Brooklyn)
- 1,100,000 in the rest of Queens and Brooklyn and The Bronx and Staten Island (the "outer ring")
- 200,000 from LaGuardia and Kennedy airports.

Table 2. Combined taxi/TNC trips, 2013 to 2016

	2013	2015	2016
Manhattan	11,785,652	11,784,731	12,455,200
Inner ring	799,626	993,504	1,773,011
Outer ring	59,935	314,823	1,156,221
Airports	524,784	641,260	725,765
Total	**13,169,997**	**13,734,318**	**16,110,197**
	Change from previous period		
	2013-15	2015-16	2013-16
Manhattan	(921)	670,469	669,548
Inner ring	193,878	779,507	973,385
Outer ring	254,888	841,398	1,096,286
Airports	116,476	84,505	200,981
Total	**564,321**	**2,375,879**	**2,940,200**

Source: TLC trip files. Data are for June of each year, for Uber in 2013, Uber and Lyft in 2015 and Uber, Lyft and Via in 2016 based on data availability.

Manhattan is for the area south of West 110 Street and East 96 Street. Inner ring includes northern Manhattan and western Queens and Brooklyn as shown in Figure 6.

Growth of Taxi/TNC Trips in the Manhattan Core

As both the most congested part of New York and the home to the city's business, media and entertainment industries, it is important to understand how TNC growth has affected trip-making and vehicle mileage in the Manhattan core. This section presents results for combined taxi/TNC trips in the Manhattan core to give an overview of the changes in for-hire travel. (Black car and car service trips are not included due to lack of data. There appear to be small declines in ridership in these sectors that may somewhat offset increases in taxi/TNC ridership in Manhattan, but exact figures are not available.)

1. The rate of growth in overall taxi/TNC trips accelerated in 2016.

As documented in the City's FHV study, weekday, daytime growth of TNCs was largely offset by declines in yellow cab ridership up until mid-2015. Since then, however, combined taxi/TNC trips have grown very substantially. As shown in Table 2 (previous page), taxi/TNC ridership increased by 670,000 in the Manhattan core between June 2015 and June 2016, compared with essentially no change over the previous two years.

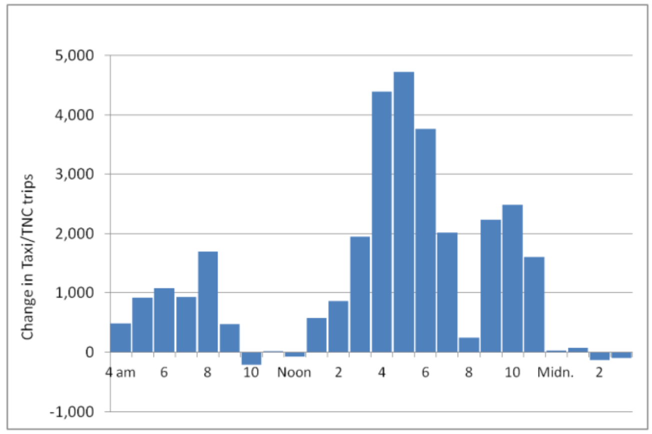
2. The fastest growth in taxi/TNC trips occurred during the morning and afternoon taxi shift changes and in the evening.

For decades, there has been a crunch in yellow cab availability in the late afternoon when fleet drivers return to their garages for shift change and many non-fleet drivers hand off the vehicle from the day driver to the night driver. Given the difficulty cab customers could have in finding a taxi during shift changes, it is no surprise that TNCs have filled in this gap.

Figure 7 shows that the largest increase in combined taxi/TNC trips in Manhattan from 2013 to 2016 occurred during the afternoon shift change. An additional peak is seen in the early morning and evening as well, particularly from 9 p.m. to midnight. This reflects the popularity of TNCs as a quick and reliable way to get to and from evening social and entertainment activities.

Notably, there is virtually no change in combined taxi/TNC trips in the late morning and midday. Growth in TNCs at these times in Manhattan was entirely offset by declining taxi ridership. This is not surprising given that yellow cabs were generally readily available in 2013 and daytime trips tend to be relatively short and for commuting and business purposes.

Figure 7. Change in taxi/TNC trips by time of day, weekdays in the Manhattan core from 2013 to 2016



Source: TLC trip files. Data are for average weekday change in combined yellow cab and TNC trips, June 2013 to June 2016. Includes trips originating south of West 110 Street and East 96 Street in Manhattan.

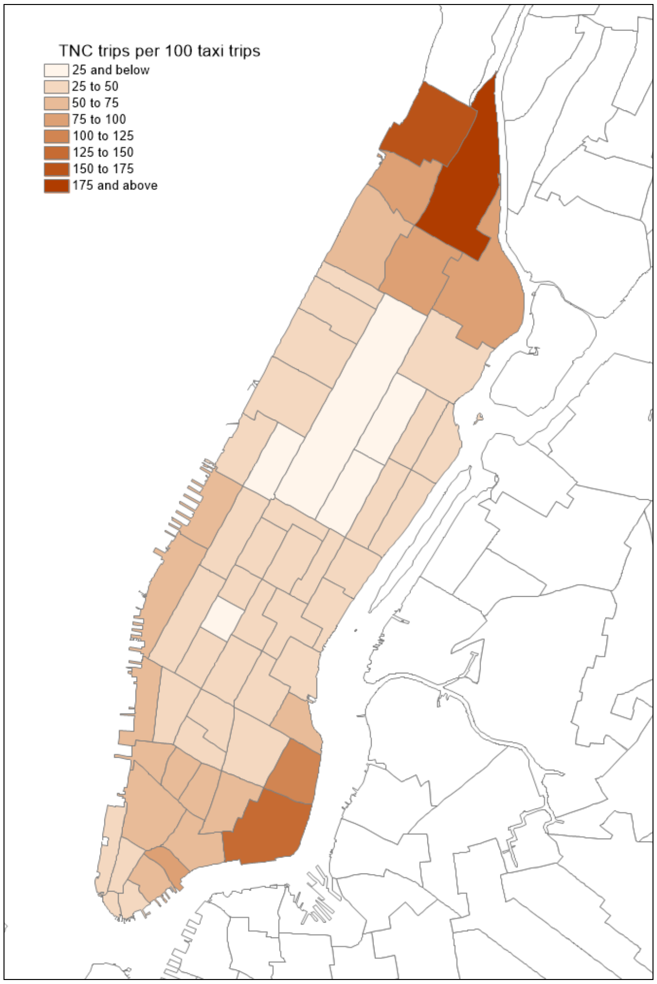
Combined taxi/TNC trip volumes increased more quickly during the day on weekends than on Monday through Friday. The weekend increase was 19,000 trips per day compared with 11,000 on weekdays (8 a.m. to 6 p.m.). Evening and overnight growth showed little variation through the week, with an 11,000 trip per day increase on Thursday through Saturday and 10,000 trip per day increase on Sunday through Wednesday (6 p.m. to 8 a.m.).

3. TNCs have helped to expand service availability in peripheral areas of Manhattan.

While TNC trips are far more numerous in Midtown and down the center of the island, they appear to also have filled gaps in yellow cab availability in primarily residential neighborhoods near the edge of the island. Figure 8 shows the number of TNC trips for every 100 yellow cab trips in June 2016. On the far Lower East Side and west of 10th Avenue, there were over 100 TNC trip originations for every 100 yellow cab pick-ups, compared with 25 to 35 TNC trips per 100 yellow cab trips in Midtown and the Upper East and West Sides.

The more dispersed geographic distribution of TNC trips reflects the advantage of pre-arrangement (via smartphone app) versus street hail in these neighborhoods. In dense Manhattan neighborhoods where yellow cabs are readily available, there is little time savings and may be little advantage in convenience from using the TNC app as compared to walking to the curb and hailing a cab. Where yellow cabs are less plentiful, however, using the app may be a quicker and more assured way of obtaining a ride.

Figure 8. TNC trips per 100 yellow cab trips, by origin



Source: TLC trip files for June 2016

4. TNC trips skew longer compared with yellow cab trips, suggesting a more complex pattern of modal shifts lies behind increases in TNC ridership and decreases in yellow cab ridership.

The simultaneous gains in TNC ridership and losses in yellow cab ridership suggest that travelers are simply shifting from cabs to TNCs. But it is also notable that TNC trips are on average longer than yellow cab trips (5.4 miles versus 3.0 miles, respectively), so that passengers shifts are likely not that simple.

Table 3 compares trip distances for yellow cabs and TNCs in 2016 with distances in 2013 (when there were few TNC trips). The number of very short trips (under 1 mile) was virtually unchanged. The number of 1 to 3 mile trips increased slightly, while there were much larger increases in trips of 3 to 5 miles and especially trips over 5 miles. Overall growth is concentrated among trips of longer distances, likely in part reflecting shifts from the subway which tends to serve these longer types of trips.

Table 3. Taxi/TNC trip distances, Manhattan origins, 2013 and 2016

Distance	Taxi/TNC avg weekday	Change, 2013-16	TNC pct. of taxi/TNC trips, 2016
<0.5 miles	20,990	-7%	10%
0.5-1 mile	105,968	-1%	14%
1-3 miles	325,900	3%	26%
3-5 miles	93,724	12%	37%
5-10 miles	62,359	40%	44%
>10 miles	31,992	112%	59%
Total	640,933	9%	28%

Source: TLC trip files. Data are for combined yellow cab and TNC trips in June 2013 and June 2016 for trips originating south of West 110 Street and East 96 Street in Manhattan, weekdays only.

Yellow cab distances are from June 2013 and June 2016 trip data. TNC trip distances are based on data available for 2015 Uber trips and then applied to June 2016 TNC trip volumes.

Summary of Findings

Results presented above show the increases in trips, passengers and mileage generated by the growth of Uber, Lyft and other app-based ride services since 2013. The major results from this analysis are:

- TNCs provided 80 million trips in 2016, transporting 133 million passengers.
- TNC vehicles traveled a total of 1.19 billion miles in 2016.
- After accounting for declines in yellow cab, black car and car service ridership, TNCs have generated net increases of 31 million trips and 52 million passengers over the past three years.
- TNCs also accounted for the addition of 600 million miles of vehicular travel over the past three years, after accounting for declines in yellow cab, black car and car service mileage and shifts from personal vehicles.
- Growth in trips, passengers and mileage is seen throughout the city. The majority of net growth occurred in northern Manhattan and the boroughs outside Manhattan. But there was also significant growth in the Manhattan core, all of it since mid-2015.
- Trip growth in Manhattan, after subtracting shifts between industry sectors, has been concentrated during the morning and evening peak periods, late evenings, and weekends.

The next section assesses what these results mean for the city's transportation system, economy and environmental sustainability.

These findings and the City FHV study

While TNCs were immediately popular with the traveling public, concerns arose about their impact on traffic congestion as their growth accelerated in the spring of 2015. Data compiled from GPS-based systems installed in yellow cabs showed that Manhattan traffic speeds dropped sharply in the spring of 2015, at the same time that Uber greatly accelerated its growth. Connecting the dots, in June 2015 the de Blasio Administration proposed to sharply limit the growth of TNCs (as well as black cars and car services) to give it time to study TNC impacts on traffic in the Manhattan Central Business District (60th Street to the Battery).

Uber and Lyft opposed the moratorium as stifling competition, preventing them from keeping up with growing demand for rides and limiting job opportunities for drivers. After an intensive political debate in which Uber spent over $5 million in television advertising assailing the Administration's proposal, the Administration shelved the moratorium and reached agreement with Uber to provide trip data for a study. The City FHV report, released in January 2016, found that worsening congestion was driven primarily by increased freight movement, construction activity, pedestrian volumes and record levels of tourism, all of which put growing demands on the streets' limited capacity.

These findings are consistent with data compiled for this report. There was no increase in combined taxi/TNC trips during the business day from June 2013 to June 2015 -- the same period as analyzed by the City. As discussed in the text of this report, combined taxi/TNC trips increased rapidly since June 2015. The findings of this study thus reflect accelerating growth of TNCs. In addition, this report examines weekends, evenings and outside the Manhattan CBD which the City study did not.

3. Travel, Traffic, Safety and Environmental Impacts

The growth in TNC trips and mileage has significant and potentially profound implications for New York City's ability to achieve its goals for sustainable population and economic growth. The most readily quantifiable impacts are the shift from transit-led to TNC-led growth in travel over the past several years. Other potentially significant impacts, needing further study to assess and quantify, are in traffic congestion, traffic safety and vehicle emissions, including impacts on greenhouse gas emissions.

1. Growth of Travel: From Transit to TNC

After the city's subway and bus system fell into disrepair during the fiscal crises of the 1970s, New York State and City leaders recognized that a well-functioning transit system was essential to the city's economic recovery and long-term prospects. Large-scale investment in the city's aging subway system, an historic drop in crime rates, demographic shifts toward immigration, and fare incentives that were introduced with the MetroCard fare system in the late 1990s, led to rapid increases in subway and, at times, bus ridership as well.

As transit ridership increased, auto ownership and use stabilized, first in Manhattan and then throughout the city. The result was an historic shift in travel from auto-oriented growth, which characterized the post-World War II era, to transit-oriented growth. Starting in the 1990s, the bus and subway system absorbed most of the growth in travel in New York City which was generated by growth in population and economic activity.[31] By the mid-2000s, transit was accounting for not just most but all of the growth in travel citywide.[32]

As the city reached all-time highs in employment and population, city officials increasingly recognized the importance of continuing to absorb increases in travel through the transit system and by walking and cycling, which also make efficient use of limited street space. The City's long-term sustainability plan, PlaNYC, released a decade ago, and updated transportation and greenhouse gas reduction plans released under the de Blasio Administration embrace prioritization of transit, walking and biking.

TNCs could support the City's goals if they shifted people from personal cars and exclusive-ride taxis to shared rides in TNC vehicles. Conversely, TNCs might add to overall auto use if shared trip-making is the exception rather than the norm and to the extent that TNC passengers have migrated from high-capacity modes like bus, subway, walking and biking.

Figures 9 to 12 show changes over the last four years in ridership for the taxi/for-hire industry as a whole and for subway, bus, bike and ferry. Private auto use is not included in these charts due to lack of data. Indications are, however, that private auto use was relatively unchanged over this period.[33]

As shown in Figures 9 and 10, growth in travel continued to be transit-focused in 2013 and 2014, with two-thirds or more of the increase in non-auto trip-making (i.e., not using a personal vehicle) in the city being served by transit. In addition, there was significant growth in cycling in 2013 and 2014. Citibike,

Figure 9. Changes in ridership by mode, 2012 to 2013

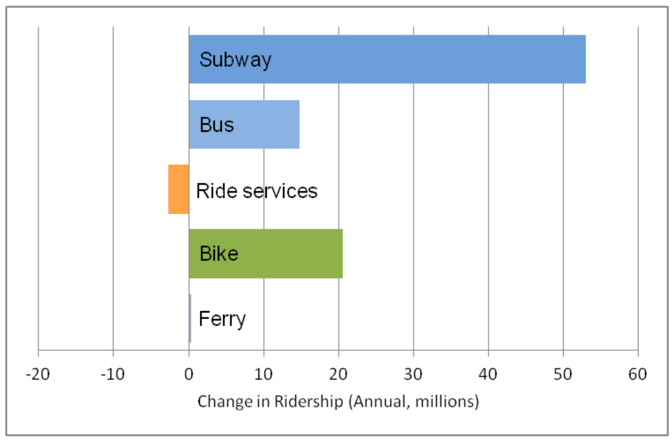
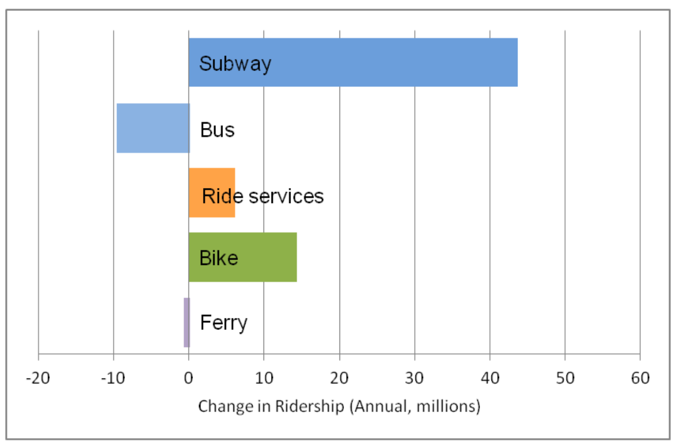


Figure 10. Changes in ridership by mode, 2013 to 2014



the city's bike share system, started operations in May 2013 and contributed to increases in biking. But most of the growth in cycling came on privately owned bikes, spurred by the city's ongoing expansion of its network of bike paths and lanes.

Taxi/for-hire ridership declined slightly in 2013 as a result of a taxi fare increase that took effect in September 2012. Taxi/for-hire ridership expanded slightly in 2014 as a result of Uber's initial growth. However, the increase comprised a small portion of overall growth in travel in the city.

In 2015, however, as Uber and Lyft grew rapidly, taxi/for-hire ridership increased by 17 million passengers. Subway and bike ridership each increased by 11 million trips. Bus ridership declined for the second year in a row. Taxi/for-hire service thus became the leading source of growth in non-auto travel in 2015. (See Figure 11.)

Figure 11. Changes in ridership by mode, 2014 to 2015

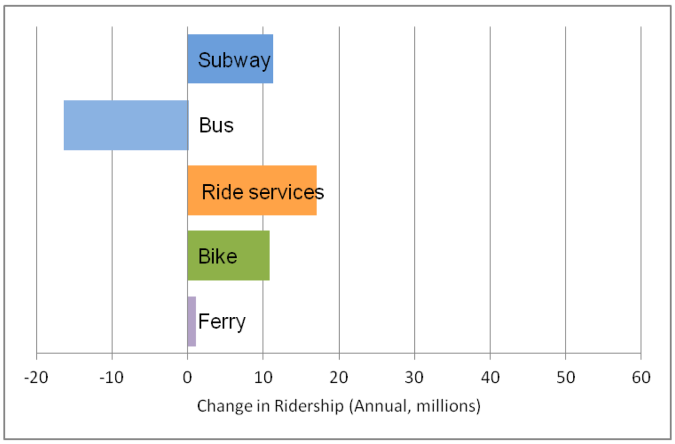
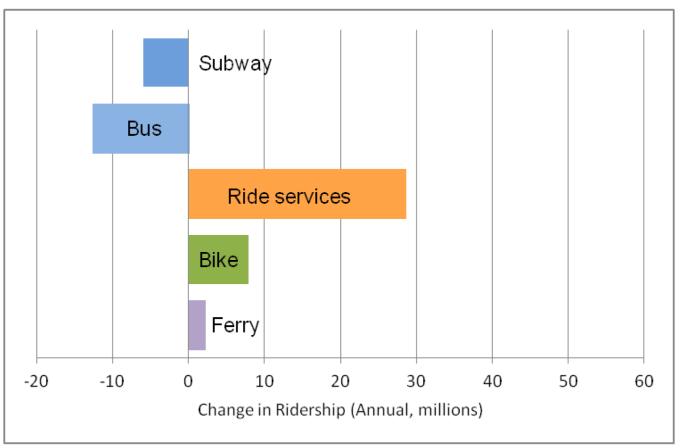


Figure 12. Changes in ridership by mode, 2015 to 2016



Sources: Subway and bus ridership from MTA New York City Transit.

Ride services include yellow and green cabs and for-hire vehicles inclusive of TNCs. Data from TLC trip files. Data for 2016 are actual counts through November and projected for December.

Bike ridership through 2015 is from NYCDOT, "Cycling in the City," January 2017. Datum for 2016 is estimated based on NYCDOT bike counts.

Ferry ridership is from City of New York, "Mayor's Management Report," Sept. 2016. Ferry ridership is for fiscal years ; others are for calendar years.

This trend intensified in 2016, with taxi/for-hire ridership increasing by 29 million passengers while bike and ferry ridership also grew. (Ferry ridership growth was due about equally to growth in private ferries and the Staten Island ferry.) Subway ridership declined for the first time in years and bus ridership dropped for the third consecutive year. (See Figure 12.)

This reversal from transit-led to TNC-led growth in travel in New York City will have profound implications for the city's transportation network if current trends continue. TNC-led growth in travel would affect diverse areas from the functioning of the city's streets for movement of freight, buses and other motor vehicles to traffic safety and greenhouse gas emissions.

2. Traffic Delay in Congested Neighborhoods

Traffic congestion creates significant and widespread costs for both motorists and people who never get into a motor vehicle. Traffic congestion increases the cost of freight movement, goods delivery and provision of on-site services ranging from construction of new commercial buildings to home repairs. These costs are passed on to consumers whether or not they personally have an automobile. In addition, traffic congestion delays buses, taxis and other for-hire vehicles, driving up travel time and costs and introducing uncertainty and unreliability about how long it will take to get from A to B. Traffic volumes also affect the comfort and safety of cyclists and of pedestrians crossing the street. Opportunities for expanding bus and bike lanes and using streets for public space purposes are constrained by the level of traffic volume.

Traffic congestion is thus an important concern for both personal mobility and the city's economy. Concerns about traffic congestion have grown in recent years as people experience increasing congestion in Manhattan and elsewhere in the city. The data bear out these concerns. Since 2013, as the city's economy and population increased, daytime speeds in the Manhattan Central Business District (from 60 Street to the Battery) declined by 11 percent.[34]

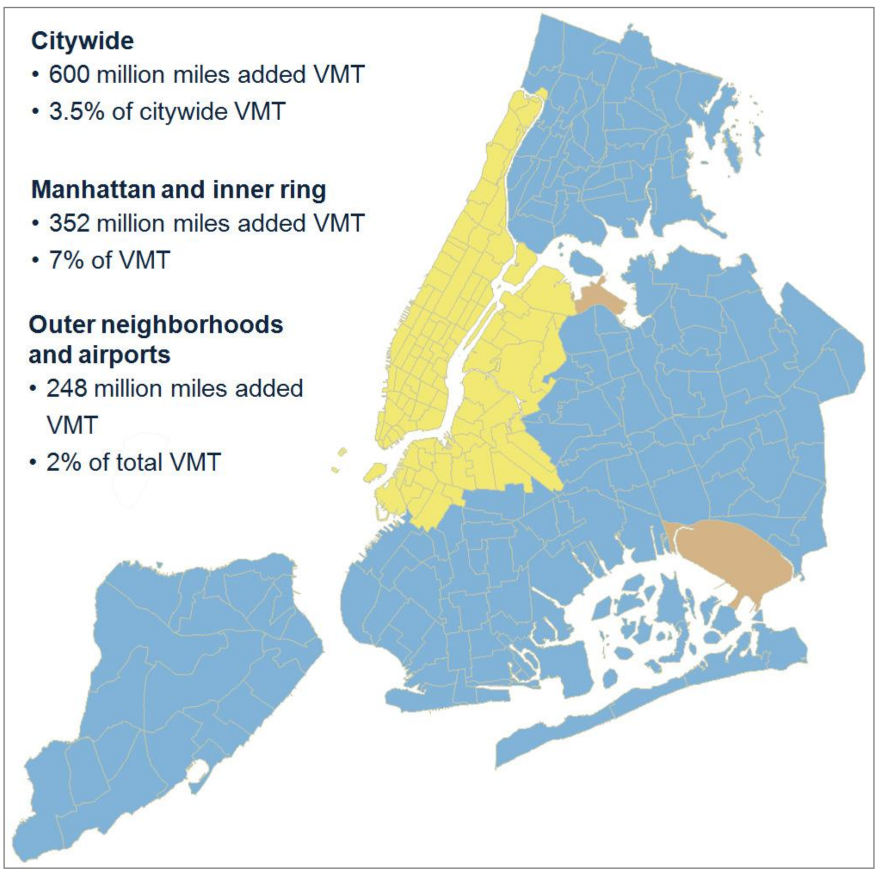
Figure 13 shows estimates of TNC mileage for two broad areas of the city -- Manhattan and western Brooklyn and Queens, which experience relatively high levels of traffic congestion -- and the rest of the city. Of the 600 million additional miles generated by TNC growth from 2013 to 2016, approximately 352 million miles were added to streets in Manhattan and the inner ring area (shown in yellow in Figure 13) -- which constitutes 7 percent of total miles traveled by all vehicles in this area.

A 7 percent increase in vehicle miles can lead to quite substantial worsening of traffic congestion. The 2008 report of the New York State Congestion Mitigation Commission found that congestion pricing would have reduced VMT by 6 percent in the Manhattan CBD and improved average speeds by 7 percent. The amount of stop-and-go traffic would have declined far more quickly, with a 20 to 30 percent decrease in the amount of time motorists spend in stop-and-go traffic conditions.[35] The same dynamic would be expected in the opposite direction -- a single-digit increase in traffic volumes would translate to much larger increases in severe traffic congestion experienced by motor vehicles.

TNC trip growth has added a significant number of trips in certain already-congested neighborhoods where additional vehicles are likely to affect traffic speeds and the amount of stop-and-go traffic. These include Midtown South, SoHo/Little Italy, the Upper East and Upper West sides, and Downtown Brooklyn, where traffic conditions can as much as double the time required to travel a few miles (compared with travel times in early-morning free flow traffic conditions). Figure 14 highlights these areas, as well as less-congested neighborhoods that are further from the congested central areas.

Data showing TNC trip destinations that will become available once a recently adopted TLC rule takes effect, will help to resolve the degree to which TNC trip growth is contributing to growing congestion in Manhattan. Available data are somewhat ambiguous, as the trip growth takes place in both highly-congested and less-congested areas of the city, and it is not clear what parts of the street network these trips utilize. As more data become available, it will be important to continue to assess TNC impacts on traffic and mobility. This assessment should take account how the continued growth in TNC mileage affects both overall traffic volumes and blockages stemming from vehicles stopping to load and unload passengers, waiting for the next trip, etc.

Figure 13. TNC mileage by geographic area, 2016



Source: TLC odometer and trip files.

Figure 14. Increases in combined taxi/TNC trips, 2013 to 2016, average per day, selected neighborhoods

Source: TLC trip data for June 2013 and June 2016.

3. Traffic Safety and Greenhouse Gas Reductions

Two other key City goals may also be affected by TNC growth. Impacts cannot currently be quantified in these areas, but the potential impacts deserve further examination.

Traffic safety. One of the de Blasio Administration's first acts in 2014 was to adopt a Vision Zero plan, setting a goal of completely eliminating traffic fatalities. Fatalities had been declining for over a decade, from 394 in 2001 to 278 in 2012. Traffic fatalities have continued this trend, falling to 229 in 2016.

The growth of TNCs could either help or hinder progress toward Vision Zero goals. On the positive side, some studies have credited TNCs reducing DUI-caused traffic fatalities as they can provide a readily-available ride home. Several other studies, however, found no correlation.[36] Additional studies need to be conducted to evaluate whether TNCs reduce DUI-related injuries and fatalities in New York City.

On the other hand, the growth in mileage inevitably leads to additional motor vehicle crashes involving serious injury and fatalities. However, previous studies have found that the crash rate for yellow taxicabs is lower than for than personally owned autos,[37] and the same is possibly true for TNCs. Thus, the impact of TNCs on crashes and traffic fatalities needs to take into account crash rates for TNC vehicles, and potentially offsetting effects from reduced DUI fatalities and crashes in other personal vehicles.

Greenhouse Gas Reductions. Last fall, the City released its official "80 by 50" plan to reduce greenhouse gas emissions by 80 percent by the year 2050. This is an ambitious goal that has been championed by elected officials not only in New York but in other major cities and states. Much progress can be made toward this goal through technology advancements such as more stringent fuel efficiency standards and wider use of battery technology. Reaching the goal for an 80 percent reduction of GHG, however, will require changes in how people travel, including substantial reductions in motor vehicle use in the City.

Toward this end, the City's plan envisions increases in shared-use mobility (including shared TNC trips) paired with very large reductions in personal auto use. The findings of this report indicate that TNC mileage is growing, but without offsetting reduction in private auto use. Thus, the continued growth of TNCs, based on current trends, appears likely to stand as an obstacle to reaching the 80x50 goals.

4. Policy Responses

Policy Priorities for New York City

Uber, Lyft, Via, Juno and Gett, the TNCs currently operating in New York City, have brought new transportation options welcomed by many New Yorkers. The rapid growth of these services shows how much New Yorkers value speed, reliability and comfort in making travel choices. TNCs, similar to bikes which have joined them atop the rankings for ridership growth, offer these attributes in an on-demand, door-to-door service.

While a valuable addition to transportation options in New York City, the growth of TNCs is unfortunately also working counter to important public policy goals centered on sustainable, high-efficiency modes such as transit, walking and biking. The task for public policy is to support the mobility benefits that TNCs clearly offer, on the one hand, while seeking to manage and mitigate impacts on traffic conditions, the capacity of city streets to support a growing workforce and population, and goals for environmental sustainability.

The very attributes that have made TNCs so popular also point toward ways to manage the streets and improve transit services. TNCs have methodically sought to remove uncertainty, anxiety and stress throughout the travel experience. The smartphone app, for example, greatly reduces the uncertainty and anxiety that travelers experienced trying to flag down a yellow cab on a busy day or waiting for a driver after calling on the phone. Through the use of GPS navigation, TNCs reduce the uncertainty about whether drivers will take the fastest or shortest route. By having credit card information stored in customer accounts, TNCs have eliminated the hassle of fare payment at the end of the ride.

Uncertainty, stress and anxiety are intangible elements of the travel experience. But in "voting with their feet," customers demonstrate the importance of squeezing the stress and uncertainty out of the travel experience. Public officials should focus funding and project selection on addressing the myriad elements of the end-to-end travel experience. Doing so will be a far more beneficial use of scarce public funds than focusing on one expensive element -- be it a custom-designed vehicle such as the city's Taxi of Tomorrow or a magnificent station portal such as the new Oculus structure at the World Trade Center's PATH station -- however imaginative and highly visible those projects may seem.

Street and transit management

Public agencies including the MTA and NYCDOT have built into their programs measures focused on improving travel time, reliability, comfort, transparency and ease of use. For example:

- Countdown clocks in subway stations create transparency in how long customers will wait for different lines arriving at that station, as does the BusTime smartphone app for bus riders.
- Bus lanes and off-board fare collection on high ridership bus routes are designed to make bus service faster and more reliable.
- Computerized train control systems (first installed on the "L" line) makes possible greater throughput of trains and thus more frequent service and less-crowded trains.
- Adjusting traffic signal timing in response to real-time traffic conditions in Midtown Manhattan increases the reliability and predictability of travel times.

The need to continue, expand and strengthen these types of initiatives is made urgent by the rise of TNCs. TNCs have created something not seen in modern times -- competition from a nimble and aggressively customer-focused private sector competitor with deep wells of capital for expansion and marketing. If managers of the transit system and street network do not respond quickly and effectively, TNCs will continue to attract rapidly increasing numbers of customers to their services, with increasing impacts on traffic congestion, transit ridership and potentially traffic safety and the environment.

Thus, it is imperative that the City and MTA pursue additional opportunities to reduce delay, speed service and increase comfort. Traffic signal timing is one such opportunity. NYCDOT has implemented transit signal priority to speed buses on two-way streets but not on one-way avenues, due to the need to maintain a consistent traffic signal progression. Cities such as San Francisco have experimented with changing the timing of the signal progression, however, to match the signal timing to maximize the speed of buses rather than optimizing general traffic flow or matching the speed limit.[38] The "offset" in the progression -- which is the time between the signal turning red at one intersection and turning red at the next intersection -- could be adjusted to maximize the chance for buses to progress from one bus stop to the next stop without encountering a red light. This strategy is most suited to high-volume bus routes that also have off-board fare collection (minimizing variability in dwell times at bus stops). Signals timed for buses would help put buses (and bikes, which often travel at similar speeds) on a more equal footing with TNC passengers and other motor vehicle occupants. This approach is recommended in the *Transit Street Design Guide* published by the National Association of City Transportation Officials (NACTO),[39] in which NYCDOT is a founding member. The traffic engineering for this change would need to ensure that overall traffic volumes would still be accommodated.

Another opportunity concerns off-board fare collection. The MTA is in the process of procuring and testing a next-generation fare collection system that will allow bus and train customers to pay fares by tapping a contactless bank card, smartphone or any mobile device or MTA-issued smart card against an electronic reader. The new system will replace magnetic swipe farecards (MetroCards) used since the 1990s.

The new system provides the opportunity to introduce off-board fare collection across all of the MTA's high-ridership routes where boarding times significantly delay buses. There are technical issues that will need to resolved to ensure that on-board fare inspectors have an up-to-date list of who has paid the fare (including those using third-party cards and smartphones). But the benefits are numerous: faster bus speeds that save customers time, reduce operating costs and fare evasion,[40] and increase reliability in bus service. As the joint NYCDOT/MTA Select Bus Service has demonstrated, travel time savings translate directly into substantial ridership increases.[41]

Road pricing

The second reason for urgency is that TNCs are fundamentally undoing the traditional cost incentives to use public transit.

Historically, the City has used pricing of taxicab fares and parking to discourage auto use in Manhattan. The average taxicab fare was for decades about 4.5 times the subway fare, making cabs a premium service and encouraging use of transit.[42] The City also discouraged driving into Manhattan by limiting the supply of off-street parking and allocating virtually all on-street curb space in Midtown Manhattan to truck loading zones and bus and bike lanes.[43] A moratorium on construction of new off-street facilities, which dates back to the early 1980s, resulted in Manhattan having the nation's highest off-street parking rates, providing a strong financial disincentive to drive into Manhattan, particularly during the business day.

As they steadily cut fares, TNCs are beginning to erase these longstanding financial disincentives for traveling by motor vehicle in Manhattan. TNC fare offerings such as $5 flat rates for shared trips during rush hour in Manhattan put TNC fares at less than twice the transit fare, dramatically weakening the disincentive to travel by auto. Their attractive pricing will be a boon to patrons only until traffic congestion becomes insufferable -- for them and also for freight carriers, bus riders, cyclists and the city's economy.

Whether these fares are sustainable or even yield a profit is unclear.[44] But for the foreseeable future, TNC fares will cover no more than the costs borne directly by drivers and TNC companies (e.g., drivers' time, costs of vehicles, auto insurance and dispatch systems). TNC fares do not reflect the costs to the public in congestion delay and emissions. These costs should be added to TNC operational costs in order to incentivize efficient use of scarce street space.

Road pricing is not a politically easy topic, as vividly illustrated by the intense controversy that surrounded Mayor Bloomberg's ultimately unsuccessful 2007 proposal for a cordon-based charge to enter the Manhattan CBD. But if TNC growth continues at current rates, fueled by low fares, the necessity of some type of road pricing will become more and more evident.

Road pricing that aims to address TNC impacts on traffic will need to take a different approach than the cordon-based scheme proposed in 2007, which only charged motorists entering the Manhattan CBD. Over one-half of TNC mileage in the CBD involves trips that both begin and end between 60th Street and the Battery, and thus would not be subject to a cordon-based charge. In addition, much of the increase in mileage occurs in the evenings and weekends, periods during which there is still substantial delay due to traffic congestion but would not have been subject to congestion pricing fees.

A system of congestion-focused road pricing should be scaled to the times and locations that congestion is most intense and thus the mostly costly to the public. Road use fees should be higher during the business day and in Manhattan. Fees should be proportionate to the actual contribution to congestion and thus should be pegged to actual use of the road -- based on mileage driven -- rather than a one-time fee that is the same for all vehicles whether they are driving around all day or for just a few minutes.

Road use fees should also focus on making the most efficient use of road space. A sedan with only a single passenger is the least space-efficient means of transport and should pay the most. Lesser charges should apply when available seats are filled, and for larger and more space-efficient vehicles.

In 2007, a system such as this would have seemed technologically far-fetched and overly complex. However, TNCs and taxis are now equipped to track their locations. A charge based on efficient use of space could piggyback on this existing in-vehicle technology. The system would need to be enhanced for security and privacy purposes and include a count of passenger seat occupancy. Development of this system could be modeled on Singapore's next-generation Electronic Road Pricing (ERP) system that use satellite-based location technology, replacing overhead gantries currently used in Singapore (and are similar to high-speed toll collection in the United States). Singapore's Land Transport Authority awarded a contract in 2016 to develop the new system.[45]

It should be noted that a congestion-focused pricing system would be complementary to the "Move NY Fair Plan" which has been proposed by Sam Schwartz.[46] Move NY would rationalize bridge tolls in New York City, institute mileage and time-based congestion fees within the Manhattan core for taxis, TNCs and other for-hire vehicles, and raise money for public transit.

Implications for other cities

While the findings of this report are specific to New York City, they also have important implications for other large, dense cities that have experienced rapid growth in TNC usage.

TNCs are becoming central to changes in how people travel within cities that have a mix of transit, auto and other modes, with potentially far-reaching implications.

In their early days, TNCs captured press attention and the public imagination but had little actual impact on overall urban travel. Initial trip volumes were too small to be more than rounding error, particularly relative to the large volume of travel by personal auto and by transit in cities with large rail and bus systems.

Results of this study show that rapid growth over just a few years can make TNCs an important part of the overall transportation network. As they continue their rapid growth, their importance will continue to increase. This will have potentially far-reaching implications for overloading streets with traffic and impeding urban transportation systems' ability to support economic and population growth and achieve environmental sustainability goals.

The results for New York City illustrate the complex dynamics involving TNC ridership growth, shrinkage of competing taxi and other for-hire services and factors of geography and time of day. In some places and times, such as Midtown Manhattan during midday hours, TNCs may directly displace taxi trips, with minimal impacts outside the taxi industry. At other times and places ranging from the traditional taxi shift change in the late afternoon to service in outlying neighborhoods, TNC growth adds substantially to overall taxi/TNC trip volumes and mileage. The impacts of TNC growth are also affected by the availability and attractiveness of transit service, and the likelihood that TNC riders are shifting from transit, walking or biking versus private autos. These various dynamics deserve close attention in assessing the overall impacts of TNCs in the larger transportation network.

Even where TNC trips replace personal auto trips, TNC growth can generate additional mileage on city streets.

Much of the public discussion of TNC growth assumes that shifting of travel from private autos to TNCs is beneficial to traffic and the environment. The results of this analysis points out that the picture is much more complex than that discussion assumes. TNC vehicles are driven a substantial number of miles without a passenger. Of the overall 600 million mile increase in miles traveled since 2013 in New York, revenue mileage accounted for only about one-third (39 percent) of the increase. Other significant factors are miles driven during the working day without a passenger (e.g., dead-head miles to the pickup point for a trip and to reposition the vehicle to a busy area) (49 percent) and for personal use (estimated at 12 percent).

Shared trip-making through options such as UberPool, LiftLine and Via will not necessarily mitigate mileage increases. It may be difficult to shift many trips to pooled arrangements. Passengers have to agree to be matched, computer algorithms need to find another passenger to add to the trip, mileage reductions from matching may be offset by the extra mileage to each passengers' pickup and drop-off locations, and drivers may avoid the hassles of serving these trips. Moreover, migration of passengers from transit, walking and biking to TNC trips inevitably increases vehicle mileage, regardless of whether the ride is shared. These dynamics are clear in the rapid growth of TNC mileage in New York City even though TNCs have offered pooled options since mid-2015.

Need for public policy response.

TNCs have been allowed to grow rapidly with very little intervention from regulation or street management. As traffic, transit and environmental impacts become clearer, there will be an increasingly intense need for a public policy response. The goals of the policy response should be to support the mobility benefits that TNCs clearly offer, on the one hand, while seeking to manage and mitigate impacts on traffic conditions, the capacity of city streets to support a growing workforce and population, and goals for environmental sustainability.

Developing a policy response should utilize trip data from TNCs, taxis and other for-hire services.

New York City's experience shows the importance of trip and mileage data to understand the complex dynamics involved with assessing TNC growth and developing a public policy response. New York's experience also shows that TNC concerns about data confidentiality need to be taken seriously, but also that large amounts of detailed anonymized data can be made public with no evident harm to user privacy or company interests.

Part of the reason that New York City is the national leader in collecting TNC trip data is that it had pre-existing requirements and processes for yellow and green cab trip data. The Taxi and Limousine Commission began collecting very detailed trip data for yellow cabs in 2007 in a program that also involved installation of credit card payment terminals and conversion from paper to electronic trip sheets. TLC developed the capacity and expertise to process and analyze the resulting mountain of data -- over 13 million trip records per month. Equally important, TLC made the data available to the public, and it can now be downloaded from the TLC's website.

TLC then expanded its data collection requirements to TNCs and other for-hire ride services. It applied its systems and expertise to these data, and used the precedent with yellow cabs to make clear that the City was not singling out any one industry segment in its data requirements.

Other cities and states have lagged behind these efforts. There was an agreement in January 2015 for Uber to share aggregated trip data with the City of Boston, but the plan was apparently flawed and there has been little use made of these data.[47] Portland, Oregon currently obtains Uber and Lyft trip data (although the data are not made public) but is having difficulty obtaining comparable data from taxi companies that have less advanced technology.[48] The California Public Utilities Commission requires TNCs to submit trip data, but keeps the data confidential and has released very limited and occasional reports.

Uber recently announced that it would make data available for selected cities showing average travel times from one point to another. These data do not address the issues assessed in this report, however, and Uber has continued to resist New York City's quest for trip destination information.[49]

Street management, transit services and road pricing should all be examined in formulating a policy response.

In tailoring a policy response to a particular city, policy makers have a broad range of tools to consider. These include allocating street space and time (via traffic signals) to speed high-efficiency transit services, focusing transit service improvements on sources of uncertainty and delay in the customer experience, and levying charges so that fares include costs borne by other travelers, e.g., congestion delay. As they develop individual responses, there will be opportunities for cities to compare experiences and learn from each other. The process of developing policy responses will likely benefit from the same type of step-by-step testing and subsequent adjustment of different approaches that TNCs have used in rolling out their services.

5. Conclusion

The tripling of TNC ridership over the last 18 months has resolved the central question about whether app-based ride services need to be a central focus of transportation policy in New York City. TNC growth has added nearly 50,000 vehicles and over half a billion miles of driving to the city's streets in just three years. Much of this growth occurred in Midtown Manhattan and other already-congested areas of the city. Managing the impact of this growth on traffic congestion, vehicle emissions and traffic safety is thus a critical public policy challenge.

In addition, TNCs have become the leading source of growth in non-(personal) auto travel in the city, displacing the transit-oriented growth of the 1990s through 2014. This shift is simply not a sustainable way to serve the growing transportation needs generated by the city's expanding population and economic activity. The central task for public policy is to shift growth back to sustainable, high-capacity modes, ranging from bus to subway to biking, while at the same time maintaining the mobility improvements that TNCs offer.

Within a newly competitive environment, transit must compete with deep-pocketed, nimble and intensively customer-focused private sector transportation providers. Policy makers need to respond with an equal focus on what makes TNCs attractive -- the end-to-end travel experience with an emphasis on fast, reliable, comfortable and easy-to-use service.

Policy makers also need to address the pricing disparities that are becoming increasingly apparent between TNCs and other modes. TNC fares cover, at best, the direct costs of providing TNC rides (vehicle, auto insurance, dispatch system, driver income, etc.). TNC fares do not reflect the costs to the public in increased traffic delay, emissions and potentially safety. These costs are very real, driving up costs of bus operations, freight movement, goods delivery and provision of on-site services. As TNCs move to further reduce fares, the imbalances in traveler incentives will grow steeper, and impacts on traffic, emissions and travel will intensify. Pricing the use of scarce roadway space is essential to correct this imbalance, making inevitable a return to this politically fraught policy area. Technological developments since the congestion pricing proposal of 2007, however, have created opportunities for systems targeted at inefficient use of roadway space, and potentially helping to overcome political barriers.

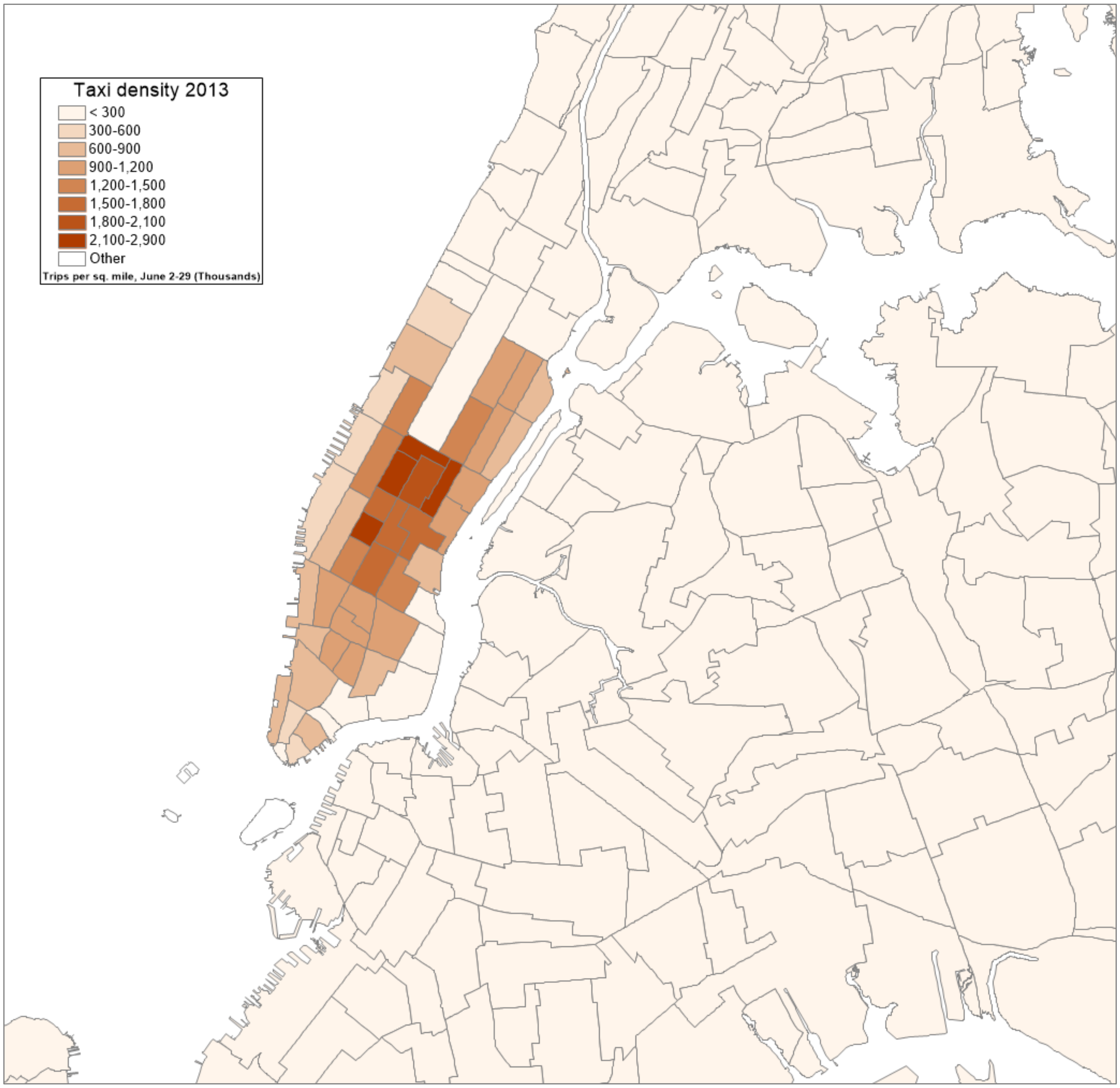
While this report can serve to update and deepen public understanding of how TNCs are affecting travel and traffic in New York City, additional research is also needed to diagnose how TNC, population and economic growth and overall travel volumes are affecting traffic congestion, vehicle emissions and traffic safety. The TLC's recent adoption of a rule mandating that TNCs and other for-hire bases disclose trip destination as well as origin data is a step in this direction. These data need to be mapped to the street network, and data needs to be collected on overall traffic volumes.

TNCs as a mode also need to be incorporated into regional transportation models, which currently undercount taxi and for-hire trips and take no account of TNC growth at all. This is another important step in adapting planning and policy making to TNCs' newly critical place in the transportation network.

The rapid growth of TNCs thus offer reason for both hope and fear for their role in New York and other large, dense cities. The central reason for hope is not just that TNCs bring a welcome new option for how to get around town. It is also that they brightly illuminate what the public wants from transportation services, and provide a seemingly irrefutable argument behind the need to meet the public's demand for fast, reliable, comfortable and affordable transportation service.

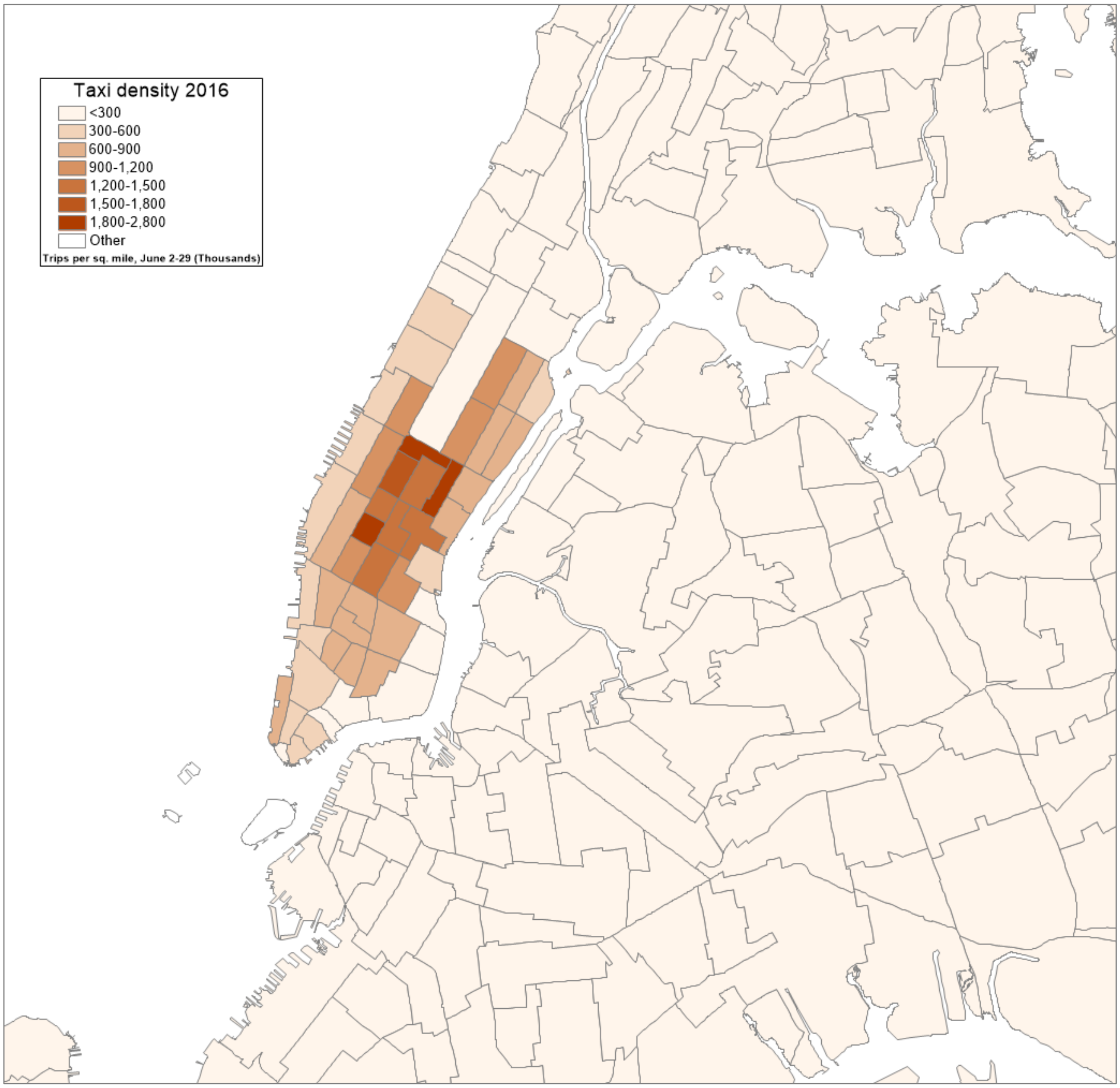
Appendix A. Supplemental Figures and Tables

Figure A-1. Yellow Cab Trip Density, June 2013



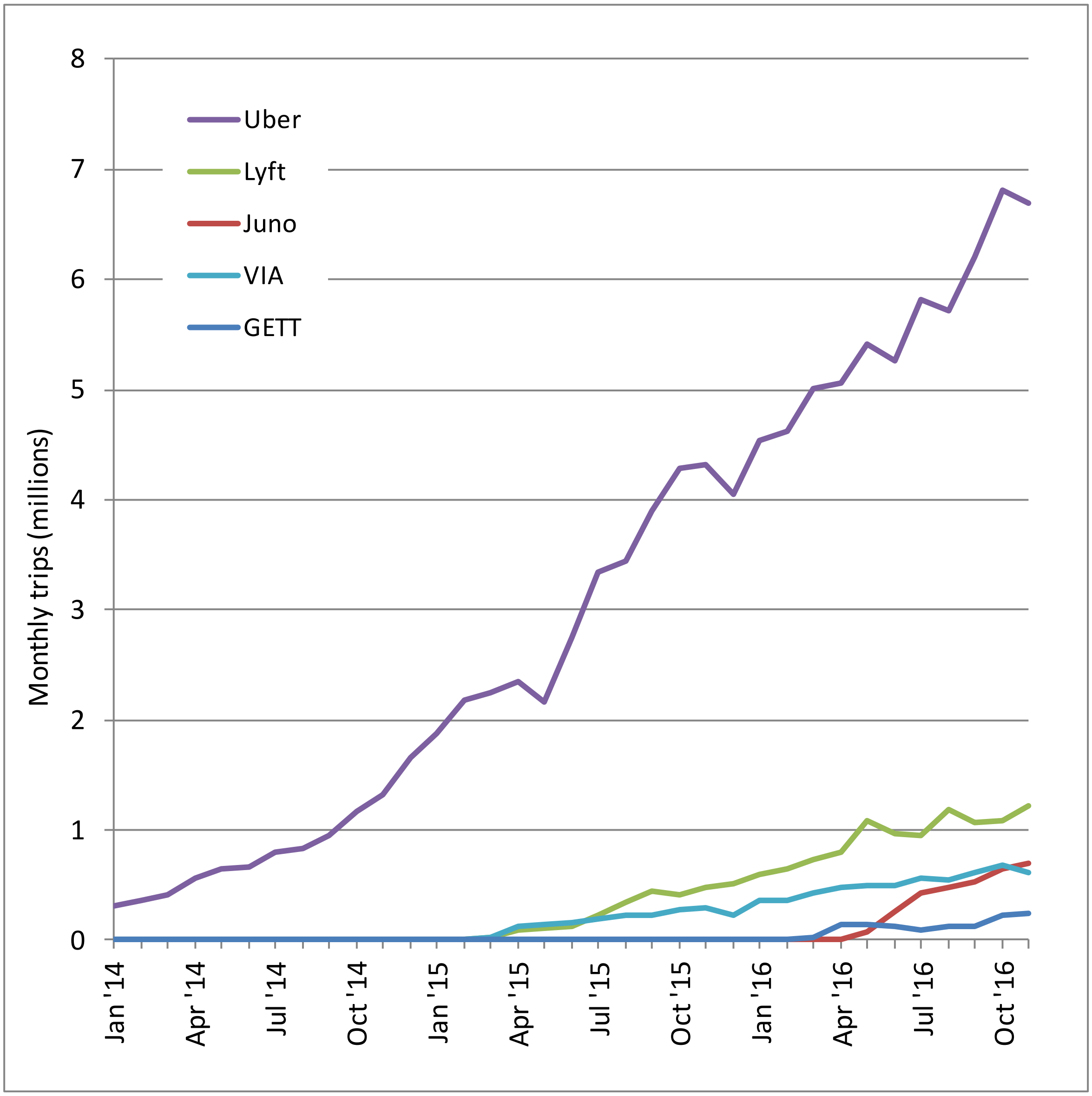
Source: TLC electronic trip logs.

Figure A-2. Yellow Cab Trip Density, June 2016



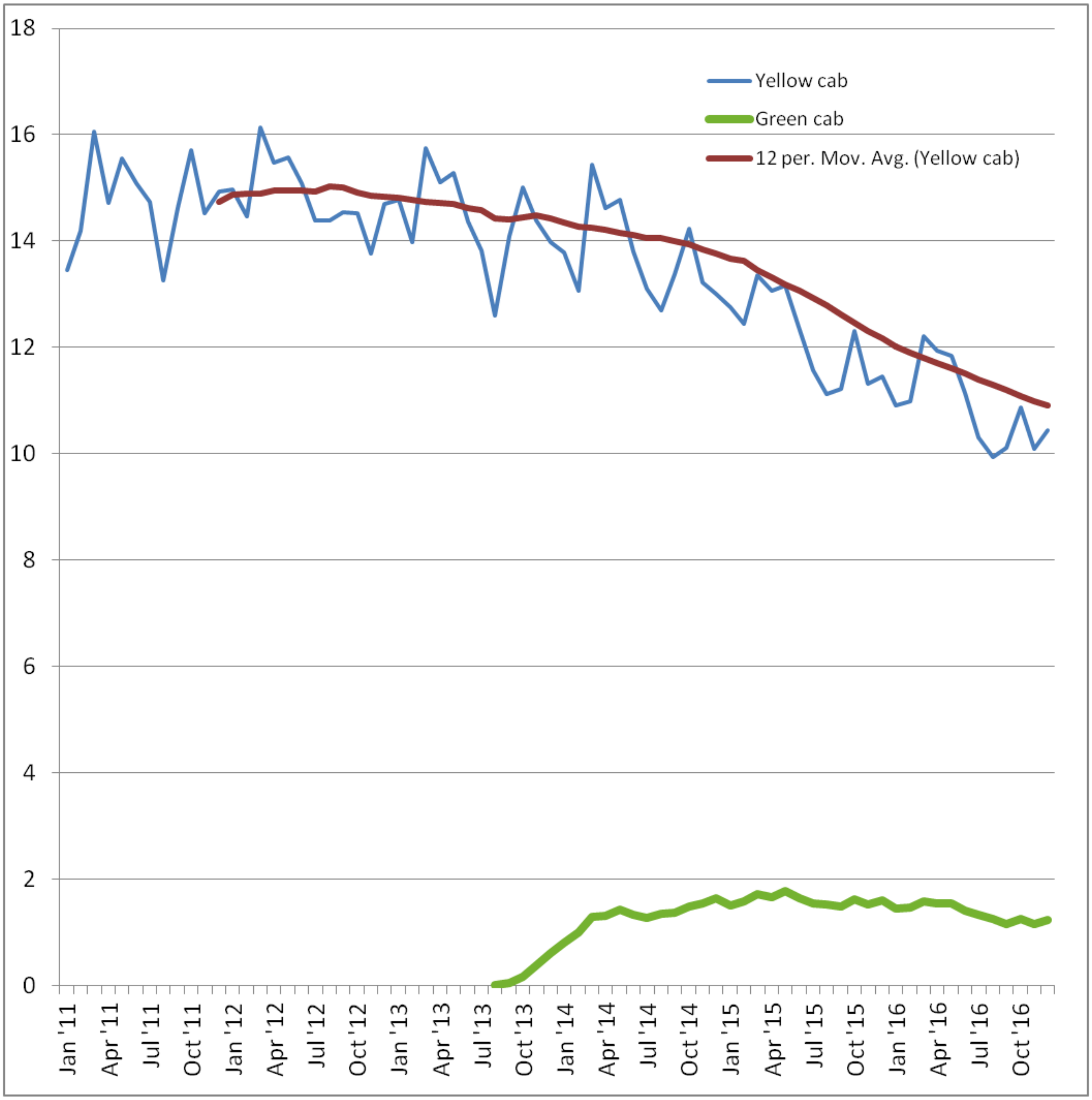
Source: TLC electronic trip logs.

Figure A-3. TNC monthly trips, by company (total dispatched), 2014-16.



Source: TLC weekly FHV trip volumes

Figure A-3. Yellow and Green Cab monthly trips, 2011-2016



Source: TLC spreadsheet files

Appendix B. Personal Use of Vehicles by Drivers and Passengers

The derivation of annual TNC mileage includes adjustments to account for mileage previously driven in personal vehicles of drivers and passengers. Mileage that is shifted from personal vehicles to TNC vehicles is not "new" mileage on city streets, but a function of people using TNC vehicles instead of their own personal vehicle. This Appendix describes the methodology used in making this adjustment, first for shifts involving drivers and then shifts involving passengers.

a) Drivers' personal use of the vehicle

Just as with many yellow cab, car service and black car drivers who own the vehicle they use in for-hire operations, TNC drivers use their vehicle as a personal vehicle for shopping, taking kids to school, etc. When TNC drivers start driving for a TNC, many of them undoubtedly shift their personal travel from a personal vehicle to the TNC vehicle.

The estimate of this displacement is based on a regional travel survey conducted by the New York Metropolitan Transportation Council (NYMTC) in 2010-11.[50] Survey results were extracted for New York City residents, age 25 to 62, who have a drivers license and work in a range of jobs that mirror the blue collar and service jobs that taxi and for-hire drivers typically had before becoming a driver. The travel survey data show that 77 percent of this group have a vehicle available to their household. The analysis assumes therefore that 77 percent of the personal use of the TNC vehicle is a carryover from a non-TNC vehicle.

This assumption is conservative since it is also evident in the regional household data that adding a vehicle to a household with several drivers tends to increase household mileage.

b) Passengers' reduced use of their personal vehicles.

Some TNC passengers would have driven their personal vehicle had they not taken a TNC while others would have used transit, walked or biked. Is was thus necessary to estimate the modal split (auto versus non-auto) for TNC users coming from auto, transit, walking and biking. (Note that shifts from yellow cabs are subtracted separately from shifts from private auto based on the decline in yellow cab usage.)

Insight for estimating the shift from private auto can be gained from intercept surveys conducted in San Francisco and in the Denver area that show a close relationship between shifting behavior and existing modal shares:

- A San Francisco survey of TNC users in the North Beach, Marina and Mission districts found that only 7 percent would have used a personal or rental car had Uber, Lyft or Sidecar (the three TNCs then operating in San Francisco) not been available, while 43 percent would have used transit or walked or biked.[51]
- A survey of Uber riders in the Denver area found that 31 percent of passengers would have used a personal vehicle or rental car if Uber or Lyft were not available, while 28 percent would have used transit or carpooled as a passenger. (In both cities, the remaining customers would have used taxis, other TNCs or not made the trip.)[52]

Thus, in highly transit-oriented areas like the San Francisco neighborhoods where interviewing took place, TNC trips are about six times more likely to displace transit, walking and biking trips than personal auto trips. In Denver, which has a higher non-auto mode share, TNC trips are about equally likely to displace personal auto trips as transit/walking/biking trips.

Based on these results, it seems reasonable to assume that the auto-to-TNC shift in New York City would broadly reflect current levels of auto use. Current mode shares are available from the NYMTC regional travel survey. Mode shares from this survey are analyzed separately for Manhattan, the inner ring and outer ring neighborhoods of the city to take into account geographic variations. In addition, very short trips (mostly walking) are given less weight in the calculation so that trip distances in the calculation match the distances used for TNC trips.

Based on this methodology, it is estimated that:

- 9 percent of TNC trips originating in Manhattan south of East 96 Street and West 110 Street would have used a personal auto had TNCs not been available;
- 21 percent of TNC trips in the inner ring would have used auto; and

- 48 percent of TNC trips in the outer ring would have used auto.

Applying these percentages to increases in taxi/TNC trips yields an estimate of just under 1 million trips shifting from personal auto to TNCs between June 2013 and June 2015. This is 34 percent of the 2.94 million net new trips from TNC growth.

It might be argued that reductions in personal auto use will go beyond the direct effects of shifting individual trips from auto to TNC. Research on car share users has found this type of effect, with overall driving going down as car share users shift trips from personal auto to transit as well as to car share, generally after reducing the number of vehicles owned by the household. Recent surveys of TNC users do not find a similar pattern among TNC users, however. A survey of residents in five large cities including New York, Chicago, Boston and Washington DC, found that rates of auto usage are similar for TNC users and those not using TNCs. There were small but not statistically different rates of driving for work trips while auto usage for personal trips was essentially the same for the two groups. The same research found, consistent with previous research, lower rates of personal auto use among car share participants.[53]

A subsequent survey by the same researchers, conducted in seven large U.S. cities including New York, found that the large majority of TNC users (62 percent) "indicated that there was no change in their personal driving habits". Among those who said they did reduce miles driven in their personal auto, TNC mileage appears to roughly offset the reduction in personal auto use.[54]

Similarly, a national survey conducted by the Pew Research Center found that frequent TNC users also drive a car, take a taxi and use transit daily or weekly (63 percent, 55 percent and 56 percent respectively).[55]

* * *

Additional detail on the San Francisco and Denver surveys follows.

San Francisco: The survey was conducted by researchers at the University of California at Berkeley in 2014. Interviewers intercepted TNC users in the North Beach, Marina and Mission districts. Results from 302 in-person intercept surveys found that:

- 7 percent of TNC users would have used a personal vehicle if Uber, Lyft or Sidecar were not available.
- 33 percent would have used transit
- 10 percent would have walked or biked
- 11 percent would have used a different ride service
- 39 percent would have used a taxi
- An additional 8 percent would not have made the trip.

Denver: This survey was conducted by a Ph.D. student at the University of Colorado who drove for Uber for the purpose of his Ph.D. thesis. Interviews with 311 passengers in Denver, Boulder and elsewhere in the metro area showed:

- 31 percent of passengers would have used a personal vehicle or rental car if Uber was not available;
- 28 percent would have used transit or carpooled as a passenger;
- 19 percent would have taken a taxi or other TNC;
- 12 percent would have walked or biked; and
- 12 percent would not have made the trip.

These results indicate that in areas where the auto is the predominant mode of travel, somewhat more TNC users would have traveled by personal auto (31 percent) than by transit, walking and biking (28 percent).

Endnotes

[1] Indicative of overall TNC growth, growth in the number of Uber drivers is similar for New York City, San Francisco, Chicago and Washington DC. Los Angeles shows more rapid growth and Boston and Atlanta somewhat slower growth than New York. Jonathan Hall and Alan Krueger, "An Analysis of the Labor Market for Uber's Driver-Partners in the United States," National Bureau of Economic Research, Working Paper 22843, November 2016.

[2] See City of New York, "For-Hire Vehicle Transportation Study," Office of the Mayor, January 2016; Rohit Kulkarni, "Uber and Ride-Sharing: The $650 Billion Question," Sharespost Research Report, January 2017; Aaron Smith, *Shared, Collaborative and On Demand: The New Digital Economy*, Pew Research Center, May 19, 2016; and Regina Clewlow and Gouri Shankar Mishra, "Shared Mobility: Current Adoption, Use, and Potential Impacts on Travel Behavior," paper presented at the Annual Meetings of the Transportation Research Board, Washington DC, January 2017.

[3] Kulkarni, "Uber and Ride-Sharing: The $650 Billion Question."

[4] Kulkarni, "Uber and Ride-Sharing: The $650 Billion Question."

[5] Nicole DuPuis, Cooper Martin and Brooks Rainwater, *City of the Future: Technology and Mobility*, National League of Cities, 2015

[6] New York City Department of Transportation, *Strategic Plan 2016*, September 2016; Office of the Mayor, *New York City's Roadmap to 80X50*, September 2016.

[7] Uber Newsroom: https://newsroom.uber.com/us-new-york/taking-1-million-cars-off-the-road-in-new-york-city

[8] Kate Galbraith, "Are Uber and Lyft helping or hurting the environment?" *The Guardian*, January 21, 2016;

[9] Office of the Mayor, "For-Hire Vehicle Transportation Study," City of New York, January 2016.

[10] National Association of City Transportation Officials, "Ride-Hailing Services: Opportunities and Challenges for Cities," June 2016.

[11] Edward D. Reiskin, "Comments of San Francisco Municipal Transportation Agency on Proposed Decision For Phase III.A: Definition of Personal Vehicle," Submitted to the California Public Utilities Commission, December 5, 2016.

[12] Doug Short, "Vehicle Miles Traveled: Another Look at Our Evolving Behavior," Advisor Perspectives, January 17, 2017.

[13] American Public Transportation Association, " APTA-Ridership-by-Mode-and-Quarter-1990-Present" MS Excel spreadsheet, available at http://www.apta.com/resources/statistics/Pages/ridershipreport.aspx

[14] Transportation Research Board, *Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*, TRB Special Report 319, December 2015.

[15] Laura Bliss, "NRDC, UC Berkeley Will Analyze Uber's Environmental Impact," *Newsweek*, November 17, 2015.

[16] International Transport Forum, *Shared Mobility: Innovation for Livable Cities,* Corporate Partnership Board Report, 2015.

[17] International Transport Forum, *Shared Mobility: Innovation for Livable Cities.*

[18] Daniel Fagnant and Kara Kockleman, "The travel and environmental implications of shared autonomous vehicles, using agent-based model scenarios," *Transportation Research Part C*, 40 (2014), pp. 1-13; Daniel Fagnant and Kara Kockleman, " Dynamic Ride-Sharing and Optimal Fleet Sizing for a System of Shared Autonomous Vehicles," Proceedings of the 94th Annual Meeting of the Transportation Research Board, Washington, DC, January 2015; International Transport Forum, *Shared Mobility: Innovation for Livable Cities.*

[19] International Transport Forum, *Shared Mobility: Innovation for Livable Cities.*

[20] Christopher Mims, "Self-Driving Hype Doesn't Reflect Reality," *Wall Street Journal*, Sept. 25, 2016.

[21] International Transport Forum, *Shared Mobility: Innovation for Livable Cities.*

[22] See NYC Taxi and Limousine Commission website for downloadable files for both taxis and FHVs: www.nyc.gov/html/tlc/html/about/trip_record_data.shtml

[23] See links from www.nyc.gov/html/tlc/html/about/statistics.shtml. (The report on the City's Open Data website is called "FHV Base Aggregate Report".)

[24] See www.nyc.gov/html/tlc/html/about/statistics.shtml

[25] See www.nyc.gov/html/tlc/html/industry/current_licensees.shtml

[26] https://archive.org/web

[27] Barb Darrow, "Uber and Lyft Carpooling Services Could Replace 75% of Vehicles," *Fortune*, Jan 3, 2017.

[28] It should be noted that while companies like Uber and Lyft first focused on exclusive-ride point-to-point ride services and then offered shared trip options, Via from its beginning operated shared service and required passengers to walk to a nearby corner. Distinctions between the services offered are blurring as the companies expand the range of services they offer. Uber, for example, requires passengers to walk to a nearby corner for some shared trips.

[29] The 17.1 billion mile figure is based on New York Metropolitan Transportation Council Best Practice Model showing the amount of motor vehicle travel in New York City.

[30] On-line commentators have described why services such as UberPool and LyftLine may not be appealing to drivers or customers. "The uncertainty POOL and Line give passengers is worse for drivers; impatient and clueless passengers are likely to take their bad experiences out on drivers by giving them low ratings, which negatively impact how many rides drivers are able to ultimately get." Jason Koebler, "Why Everyone Hates UberPOOL," *Motherboard*, May 23, 2016. "Driver-support websites like UberPeople.net and various Facebook groups have lit up with complaints from drivers that UberPool is not worth the extra hassle and stress." Steven Hill, "Uber is a nightmare: They're selling a big lie — and the New York Times keeps buying it," *Salon*, April 9, 2016.

[31] Schaller Consulting, "Mode Shift in the 1990s," August 2001.

[32] New York City Department of Transportation, "Sustainable Streets Index 2008," Spring 2008.

[33] NYCDOT traffic counts collected on bridges and at borough boundaries were flat from 2011 to 2015.

[34] Mayor's Management Report, City of New York, September 2016. Figures are for fiscal year 2013 and 2016.

[35] New York State Traffic Congestion Mitigation Commission, " Report to the Traffic Congestion Mitigation Commission & Recommended Implementation Plan," January 31, 2008. New York City Transit and NYC Department of Transportation, "Woodhaven / Cross Bay Boulevards Q52/53 Select Bus Service Frequently Asked Questions (FAQs)," December 2015. San Francisco Municipal Transportation Agency, "All-Door Boarding Evaluation Final Report," December 2014.

[36] Although a joint study by Mothers Against Drunk Driving and Uber found that DUI arrests and accidents fell significantly in areas where TNC services were available, other studies have not found a relationship between introduction of TNC services and indications of DUI. See Fredrick Kunkle, "Is Uber reducing drunk driving? New study says no," *Washington Post*, July 27, 2016; and Tess Townsend, "Uber Says It Reduces Drunk Driving. Does It Really?" Inc.com, May 26, 2016.

[37] Schaller Consulting, "Taxicab and Livery Crashes in New York City 20014," April 2006.

[38] Christopher Pangilinan and Kristen Carnarius, "Traffic Signal Timing for Optimal Transit Progression in Downtown San Francisco," San Francisco Municipal Transportation Agency, 2014.

[39] National Association of City Transportation Officials, *Transit Street Design Guide*, April 2016.

[40] Select Bus Service routes have seen a 48-80 percent reduction in fare evasion. In San Francisco, citywide implementation of proof-of-payment for Muni buses and streetcars led to a drop in the fare evasion rate from 9.5% to 7.9% over five years.

[41] New York City Department of Transportation Reports show travel time savings of consistently 20 percent from Select Bus Service implementations and ridership increases of typically 10 percent. See NYCDOT, "Select Bus Service," 2013; NYCDOT, "Bx41 on Webster Avenue Progress Report," August 2014; and NYCDOT, "B44 SBS on Nostrand Avenue Progress Report," June 2016.

[42] Schaller Consulting, *Taxicab Fact Book*, March 2006.

[43] See Department of City Planning, "Manhattan Core Public Parking Study," December 2011. As a result of the city's parking regulations, the supply of off-street parking in the Manhattan CBD declined by about one-fifth from 1978 to 2010, primarily due to the redevelopment of surface lots and garages and restrictions on construction of new off-street parking facilities.

[44] Bloomberg News reported that Uber lost money on its United States operations in the second and third quarter of 2016. Whether the New York City operations of Uber or other companies is profitable is not known. See Eric Newcomer, "Uber's Loss Exceeds $800 Million in Third Quarter on $1.7 Billion in Net Revenue," Bloomberg Technology, December 19, 2016.

[45] Singapore Land Transport Authority, "Tender Awarded to Develop Next-Generation Electronic Road Pricing System," news release, February 25, 2016.

[46] See http://iheartmoveny.org

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