Providing a 5-Minute Pickup Priority for Ridehail Users Agreeing to Pool: Potential Impacts on Curtailing Bus Delays and Enhancing Equity

U.S. Department of Transportation
Federal Highway Administration

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.
FHWA-HOP-23-013

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Providing a 5-Minute Pickup Priority for Ridehail Users Agreeing to Pool: Potential Impacts on Curtailing Bus Delay and Enhancing Equity

5. Report Date
February 2023

6. Performing Organization Code

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8. Performing Organization Report No.

9. Performing Organization Name and Address
FHWA
1200 New Jersey Ave., SE
Washington, DC 20590

Supported by:
ICF
9300 Lee Highway
Fairfax, VA 22031
&
EBP (formerly EDR Group)
155 Federal Street, Suite 600
Boston, MA 02110

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DTFH61-16-D-00052/Task 10

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Highway Administration
1200 New Jersey Ave., SE
Washington, DC 20590

13. Type of Report and Period Covered
Technical Report, 2021–2022

14. Sponsoring Agency Code
HOTM

15. Supplementary Notes
Allen Greenberg, TOCOR, Harry Crump, COR

16. Abstract
The purpose of this study is to explore the potential to significantly enhance equity and reduce congestion experienced by city bus riders due to transportation network company (TNC) operations (most especially within corridors with significant bus service) through select TNC or government policy measures. The study analyzes data from a survey conducted by a large TNC, coupled with appended demographic and trip data, to ascertain the impacts of changing private party and shared party TNC pricing and trip times to encourage TNC customers to choose a shared instead of a ride-alone trip. Compressing the difference in duration between shared and drive-alone trips (including wait time for initial pick up) by 5 minutes is shown to roughly double the proportion of TNC trips that customers choose to share.

17. Key Words
Shared Rides, TNCs, Ridehailing, Ridesplitting

18. Distribution Statement

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
36

22. Price
N/A

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LIST OF ABBREVIATIONS AND ACRONYMS

FHWA	Federal Highway Administration
NREL	National Renewable Energy Laboratory
SDI	Socially Disadvantaged Index
SF-CHAMP	San Francisco Chained Activity Modeling Process
TNC	transportation network company
VMT	vehicle miles traveled

EXECUTIVE SUMMARY

This study explores the potential to significantly enhance equity and reduce congestion experienced by bus riders due to transportation network company (TNC) operations through select TNC or government policy measures. The study, in furtherance of two Biden Administration executive orders[1] and related U.S. Department of Transportation priorities, examines the equity and congestion implications of ridehailing practices and consumer choices. It uses:

- Previously obtained TNC usage and trip-level survey data from 15 U.S. cities
- An analytic tool for scenario assessments developed by the Federal Highway Administration (FHWA) using such data
- Other research examining choices and impacts of private party and shared TNC travel

Major findings (that led to the subsequent selection of the featured scenario) include the following:

- In Chicago, the U.S. city with the most complete publicly available TNC trip data, shared data that showed TNC trips serve the whole city fairly evenly, including lower-income areas with limited transit service, while private party TNC trips mostly overlap with high-service bus corridors; similar findings might be expected for other cities.

- Low-income TNC travelers are much more likely to choose sharing (39 percent) prior to any policy intervention, and high-income TNC travelers are less likely (24 percent) than average (30 percent) to also do so.

- TNCs cause measurable increases in city traffic—including, for example, causing 51 percent of the vehicle-hours delay increase between 2010 and 2016 in San Francisco (Roy et al. 2020)—with private party TNCs causing significant delay in high-service bus corridors in particular (Diao, Kong, and Zhao 2021).

- The decision to share a ridehail trip is more sensitive to changes in time than to changes in price. Thus, to achieve specific sharing targets to reduce TNC-caused congestion, a significantly larger (by a factor of three) increased price differential between private party and shared rides would be required than a relative reduction in travel delay for shared TNC trips (enabled by prioritizing shared ride pickup requests causing more customers to choose this option and thus also facilitating improved routing efficiency).

- In the travel corridors where transit services provide the best accessibility, and most especially for trips that both start and end in such corridors, the impacts of deploying time-savings strategies for shared TNC travelers over private party TNC travelers are

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[1] The reference here is to Executive Order 13985 on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government and Executive Order 14008 on Tackling the Climate Crisis at Home and Abroad.

more pronounced. Pricing strategies are particularly ineffective at coaxing TNC users to share in such corridors.

- Using strategies designed to impact relative travel time instead of price also conveys the equity benefit of less impact to the travel choices of low-income TNC users than to others.

- Encouraging TNC customers to choose a shared product, and thereby servicing total TNC ride requests in a market using fewer vehicles, would be most beneficial to low-income travelers who are more likely than others to take the bus and choose shared TNCs to begin with.

- Offering relative time savings for high-occupancy-vehicle (HOV) travelers, which sometimes necessitates delay for other motor-vehicle travelers, is a tried-and-true public policy approach that has previously been operationalized by converting general-purpose travel lanes to bus-only use, implementing transit signal priority, and providing HOV ramp meter bypass lanes.

Informed by the above findings, the study then pivots to analyzing one policy scenario, and variants of such a scenario, then assessing implementation possibilities and longer-term considerations. Highlights related to the scenario and analysis are as follows:

- Compressing the trip time differential between private party and shared TNC products by only 5 minutes leads to predicted ridesplitting shares hovering very close to 50 percent of all TNC rides (equaling Lyft's previously stated outcome objective), with shares falling within 45 to 55 percent for 8 of the 15 city-regions, being higher in 4 cities and lower in 3 (ranging from 37 to 70 percent), and having a median value of 52 percent.

- Some of the five-minute relative reduction in total trip time for shared travel would likely be achieved by delaying driver matching for private party ridehailers, but the number of travelers benefited by a faster trip (bus and ridesplitting passengers) dwarfs delayed private party ridehailers, with the median city ratio of 5.9 to 1; if benefited travelers saved 1 minute or less per trip in 11 of the 15 studied markets, a net population time savings would result from delaying private party ridehailers, with low-income travelers benefiting the most.

- A test of an alternative variant of the policy scenario was performed using the FHWA tool to calculate what would be necessary to double the portion of TNC trips that are shared; it could be achieved by reducing the time differential between private party and shared TNC trips by 1.8 to 9.9 minutes depending upon the market, including by between 4.0 and 6.0 minutes in six cities, with less change required in four cities and more in five cities, and with the median city required time compression of 4.9 minutes.

- A test of a second, more ambitious variant was performed to do what is necessary to halve the portion of TNC trips that are private; this could be achieved by decreasing the time differential between private party and shared TNC trips by 4.4 to 8.9 minutes, depending upon the city, where 4 cities required a decrease of between 4.0 and 6.0

minutes and the other 11 of between 6.0 and 8.9 minutes, and with the median city required time compression of 7.5 minutes.

- Any of the policies modeled could be operationalized through independent choices of TNCs, potentially facilitated with government partnerships, or through city ordinances requiring TNCs to share relevant before and after data (stripped of personally identifiable information) and demonstrating policy compliance.

- While travel changes occurred as COVID began and are being seen again as society attempts to return to something closer to its pre-pandemic state, the results from this study remain largely relevant into the near- and medium-term future, when shared ridehailing options are again made much more broadly available.

CHAPTER 1. UNDERSTANDING RIDEHAIL SHARING INITIAL PREFERENCES AND OPPORTUNITIES TO MODIFY SUCH PREFERENCES

Transportation network companies (TNCs) offer two types of service: private party and shared ridehailing (the latter also called "ridesplitting").[2] Policymakers may have an interest in encouraging shared over private ridehailing to promote more efficient use of the transportation network and to deploy policies that enhance equity on the way to achieving a more efficient use of the transportation network. The Federal Highway Administration (FHWA) has pursued this research in furtherance of two Biden Administration executive orders: Executive Order 13985 on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government and Executive Order 14008 on Tackling the Climate Crisis at Home and Abroad, the latter of which includes as a major part, "taking a government-wide approach to the climate crisis."

The FHWA's recently completed ridehailing behavior related research, Analysis of Travel Choices and Scenarios for Sharing Rides, from which this research is derived and expands upon, and it describes the effect of price and time on riders' choices between private party and shared ridehailing, including differences among income groups and in corridors with significant bus service versus elsewhere. (FHWA 2021) As part of this study, FHWA had developed a price-time elasticity model and related interactive tool by analyzing 2018 revealed preferences for private party and shared ridehailing trips in 15 U.S. cities and through a survey of 4,365 anonymized TNC users that included stated preference questions focused on various alternative options for their most recent observed trip choice (with different prices and trip times). Appended user data was linked to the survey responses, such as data relating to demographics, land use characteristics of trip origins and destinations, and historical usage patterns.[3]

As a starting point, FHWA's research looked at choices made between private party and shared ridehailing, absent any interventions. Of particular interest as relating to equity in Table 1 is the disproportionately high sharing rate of households with annual incomes under $50,000 (39.0 percent), especially compared to households earning over $100,000 per year (24.4 percent).

Also of interest from an equity standpoint, and a subject of additional discussion in chapter 3, is sharing behavior among TNC users in corridors with significant bus ridership, labeled as "Most

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[2] Both Uber and Lyft temporarily suspended their shared ride product offerings during the pandemic to allow for some social distancing within vehicles, but Lyft has resumed the service in some markets and a broader gradual resumption is likely. (Pandey 2021)

[3] Readers interested in additional details regarding surveying methodology (including participant recruitment, demographic distribution, response rates, survey weighing, etc.) and the development and potential uses of the discreet choice model beyond what is discussed here are encouraged to examine the final report on the larger study, where such information is provided. That report also contains a literature review that, among other things, discusses the limited published research on TNC customer product choices and how and why the dataset that FHWA was able to use was unique and useful.

Competitive Transit" in Table 1, a term defined in the note immediately below it. Urban bus riders, who are predominantly of low income, are the most efficient users of the transportation network and suffer delays caused in part by unfettered private party ridehailing, most used by higher-income travelers. As discussed in detail later in this document, TNC users choosing private party instead of shared rides—an especially predominant choice for travelers in the most competitive transit corridors—leads to more cars blocking buses and measurable increases in congestion.

Table 1. Initial rate of opting in to shared rides for selected market segments.

Market Segment	Initial Sharing Rate
Annual Income Under $50,000	39.0%
Annual Income Over $100,000	24.4%
Most Competitive Transit* (Trip Origin Only)	30.8%
Most Competitive Transit* (Trip Destination Only)	28.7%
To/From Airport	23.5%
All Trips	29.9%

Source: Federal Highway Administration.

* Defined according to the U.S. Environmental Protection Agency's Smart Location Database's regional centrality index by the 10% of a region's zones where, within 45 minutes of travel, transit provides the best accessibility to the rest of the region's population relative to cars.

The research then pivoted to attempt to explain how to increase the proportion of TNC trips that are shared, focusing on the impacts of potential changes in price and delay. Overall, the research—testing "stretch" but feasible changes in public ridehail offerings—found, as shown in Table 2, that an increase in the relative price difference between private party and shared ridehailing of $1 per mile increases an individual's probability of sharing by 8.6 percentage points, while a decrease in the relative travel time difference of 1 minute per mile (potentially achieved by altering the wait times of private party and shared TNC offerings) increases the probability of sharing by a much larger, 33.3 percentage points.

Looking at this issue a bit differently, to achieve an increase in the probability of sharing for general trips by 10 percentage points (from roughly 30 percent of trips to roughly 40 percent), it would require either an increase in the price difference between private party and shared trips of $1.16 per mile or a decrease in the travel time difference of 18 seconds per mile, as shown in table 2. With an average initial trip price of $3.30 per mile, this $1.16 per mile relative price increase is 35.1 percent of the original price. By comparison, with an average starting trip speed of 23.8 mph (or 151 seconds per mile), an 18 seconds per mile reduction in delay represents a comparatively much lower, 11.9 percent reduction in relative travel time for shared rides, or a change in delay of only one-third in magnitude of that which would be required using a change in price. Put in yet another way, if the same result is realized by compressing the time difference between shared and private party TNCs by 18 seconds per mile as increasing the relative saving by $1.16 per mile, this would equate to a value of time (at least in terms of yielding this particular result) of a very high $232 per hour.

Table 2. Illustration of effect of price and time differences on overall level of sharing.

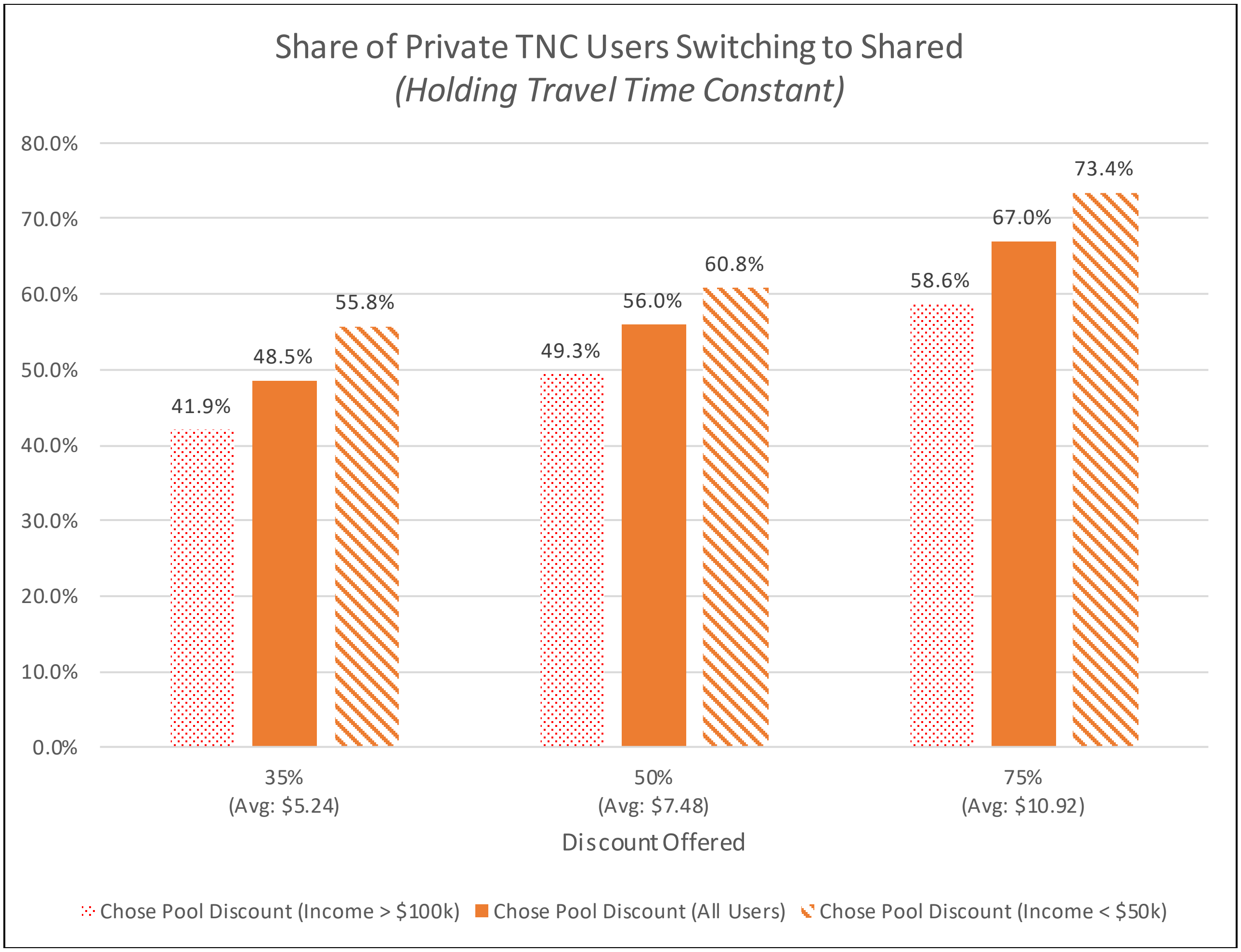
Factor	Price	Time
Unit of change	Dollar/mile	Minute/mile
Unit effect on sharing	8.6%	33.3%
Initial level of sharing	30%	30%
Desired level of sharing	+10% (to 40%)	+10% (to 40%)
Required change to increase sharing by 10 percentage points	$1.16/mile	18 s/mile
Initial price and travel speed	$3.30/mile	151 s/mile (23.8 mph)
Percent change to price and travel speed to increase sharing by 10 percentage points	35.10%	11.90%

Source: Federal Highway Administration.

Market segmentation analysis, including by income group, revealed certain user and trip types where price- and time-based incentives have a relatively greater or lesser effect on the choice between private and shared TNC rides.

The discrete choice model created for FHWA's research evaluated, in one of its iterations, how shared ridehailing rates would change in scenarios where respondents in general, and also from the lowest and highest income groups, experienced different price and travel time options for shared trips relative to private trips in terms of the dollars/cents per mile relative cost differences or minutes/seconds per mile relative time differences.

Based upon the model's descriptive analysis, and starting with a focus on price, Figure 1 shows the share (overall and by income group) of private party TNC users switching to shared TNC trips at each of the three levels of price differences offered in the study. These three alternatives represent shared trips with travel times identical to the observed private trip. Figure 1 shows, as would be expected, that holding travel time constant while varying price, higher discounts for shared rides correspond to greater willingness to share, indicating some amount of price sensitivity. This relationship presents a roughly linear pattern: increasing the price differential from 35 to 50 percent (an average $2.24 additional discount) increases the user's willingness to share by 7.5 percent, while increasing the price differential from 50 to 75 percent (an average $3.44 additional discount) increases the user's willingness to share by 11.0 percent. The increase in sharing per dollar of price differential between these tiers is quite similar: 3.3 and 3.2 percentage points per dollar.



Source: Federal Highway Administration.

Figure 1. Graph. Portion of private party transportation network company users that switched to shared travel in response to discounts.

Note: Users in dataset that switched from private to shared travel at three levels of price differences offered are shown (with average price differential noted in parentheses). These three alternatives represented shared trips with travel times identical to the observed private party trip.

Figure 1 also shows that 33 percent of users overall (including 41 percent in households earning over $100,000 per year and 27 percent in households earning less than $50,000 per year) rejected a shared trip that cost 75 percent less than the observed private trip, even when the presented travel time is identical, demonstrating that unwillingness to share is related not only to price and time (assuming, in the case of the latter, equal trust in the trip times presented for private party and shared TNC product offerings).

Table 3 provides further evidence that lower-income TNC customers are more likely than others to accept financial incentives for sharing. It presents coefficients and exponentiated coefficients from the discrete choice model for several market segments. The first exponentiated coefficient shown in the table, for example, indicates that the model predicts users with household incomes under $50,000 are 49.7 percent more likely than users in general to select a shared ride "all else equal" (and the initial sharing rate confirms that lower-income users did indeed select a shared ride more frequently in the observed data). The opposite was true for high-income riders (exceeding $100,000 in income per year), who, according to the model, were only 67 percent as likely as general users to share, again "all else equal." Other segments relevant to equity concerns are included in the table as well.

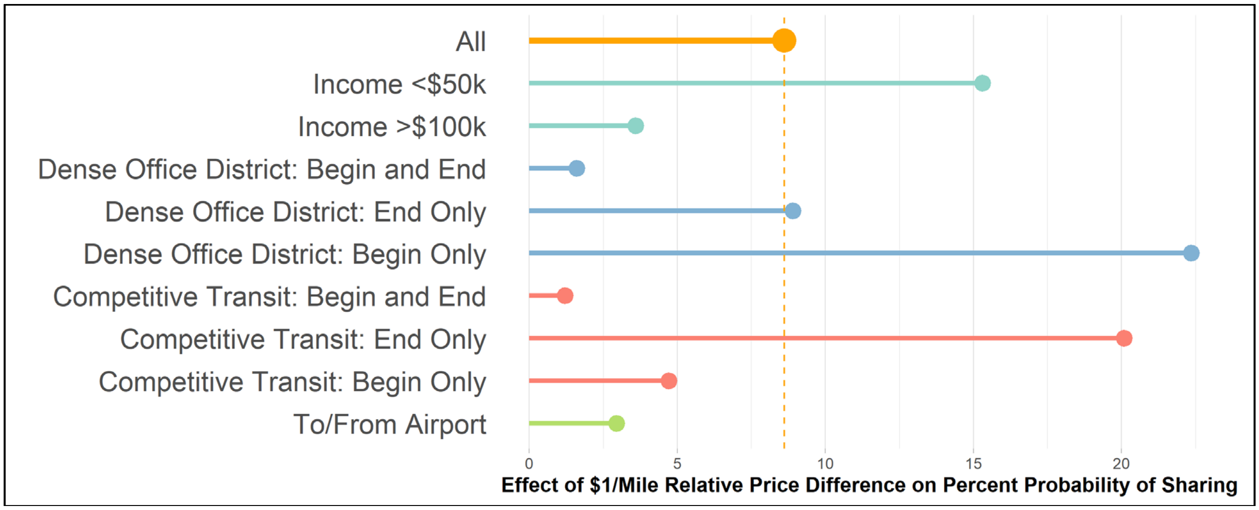
Table 3. Selected exponentiated coefficients of model.

	Variable	Exponentiated Coefficient
Market Segment	Annual Income: Under $50,000	1.497
	Annual Income: Over $100,000	0.667
	Dense Office District (Begin Only)	1.111
	Dense Office District (End Only)	0.953
	Most Competitive Transit (Trip Origin Only)	0.859
	Most Competitive Transit (Trip End Only)	Not Significant
	To/From Airport	0.949
Price and Time	Shared Cost Savings ($/mile)	1.086
	Shared Time Penalty (min/mile)	0.666
Control Variables	Age: Under 25 Years Old	1.470
	Age: Over 65 Years Old	0.759
	Household Owns Car	1.031
	Employer Paid for Trip	0.464

Source: Federal Highway Administration.

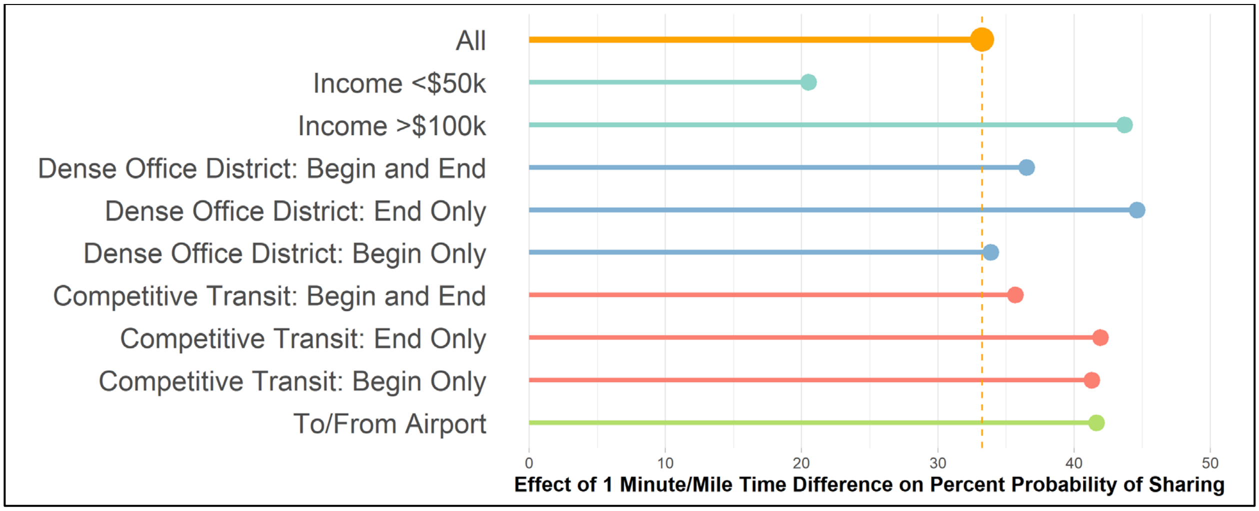
In Table 1, the initial sharing rate for households with incomes under $50,000 per year (at 39.0 percent) was shown to be higher than for wealthier households. Similarly, in the discrete choice model, households with incomes under $50,000 per year exhibit a higher propensity for sharing. These findings align with both past research and economic theory, which show lower-income travelers exhibiting higher price sensitivity and thus choosing lower-cost options more often when they are made available.

Applying the market segmentations from Table 3 to the discrete choice model, Figure 2 presents the effective sensitivities to an example price difference, and Figure 3 presents the effective sensitivities to an example time difference. The segments presented are not exclusive of one another, so that a trip could, for example, be made by a rider with annual income below $50,000, starting in a dense office district and ending in a transit competitive area. The two triplets of location segments related to density and transit competitiveness are exclusive within their characteristics (as shown by use of three bars of the same color in each of the two tables).



Source: Federal Highway Administration.

Figure 2. Graph. Effect of $1 per mile relative price difference on a user's percent probability of sharing rides.



Source: Federal Highway Administration.

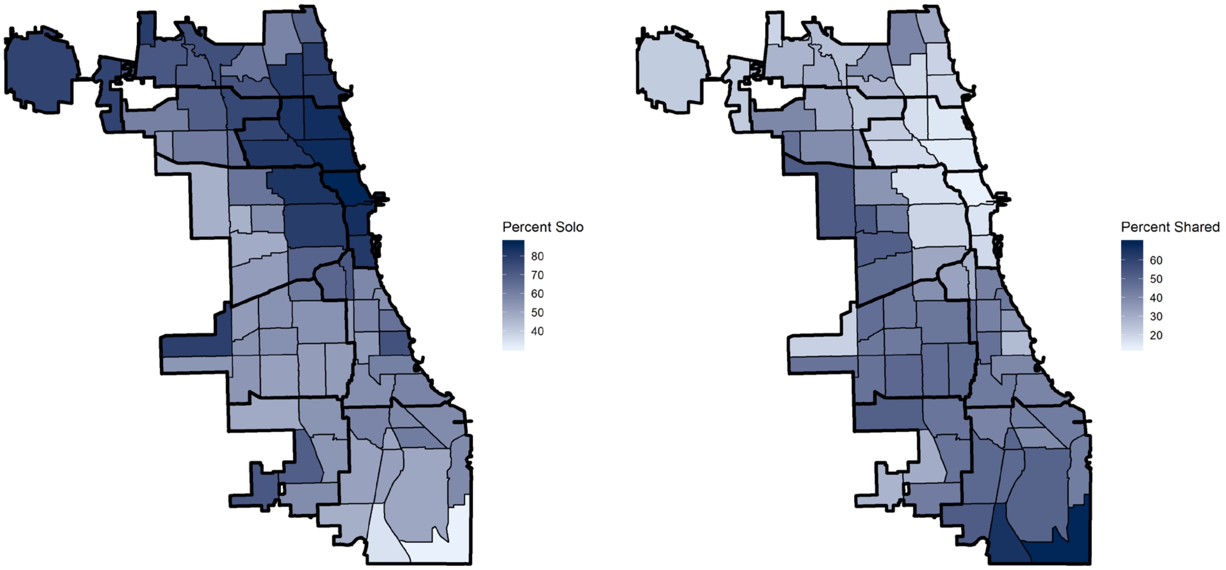
Figure 3. Graph. Effect of 1 minute per mile reduction in relative travel time difference on the percent probability of sharing.

As Figure 2 shows, the effect of increasing price differences is greater for riders with household income under $50,000 per year. Conversely, the effect of greater price differences is much less for riders with annual household income over $100,000.

As Figure 3 shows, the effect of a shrinking time differential between private party and shared TNC trips for low-income riders versus high-income riders is in the opposite direction as the effect of an increased price differential—namely, lower income correlates with less (additional) movement toward shared TNC rides as the time gap between private party and shared TNC trips shrinks. For example, and as noted above, a decrease in the relative travel time difference of 1 minute per mile increases the probability of sharing by 33 percentage points for the overall population of TNC users, but by a much lower, 20 percentage points for TNC users with household annual incomes below $50,000. Nevertheless, any time-savings benefit that can be conveyed to shared ridehailing over private party ridehailing would disproportionately benefit low-income ridehailing customers, who, in all circumstances, skew more toward sharing while ridehailing than others (even with added time-savings incentives).

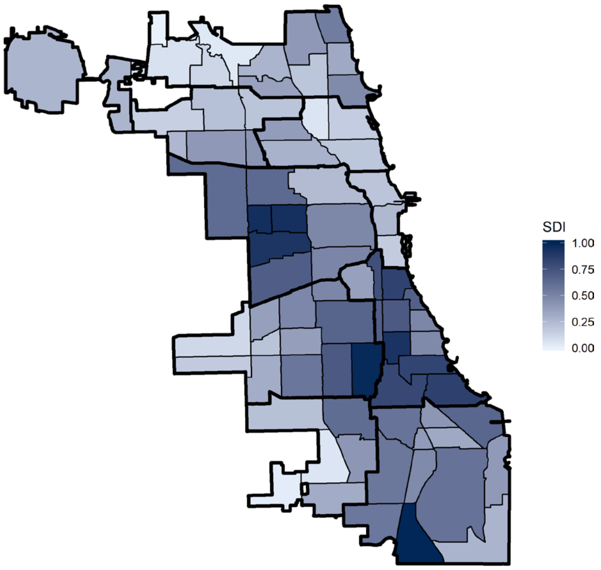
A study conducted by the National Renewal Energy Laboratory (NREL) used a large dataset from Chicago and found results similar to FHWA. In April 2019, the City of Chicago released anonymized trip, vehicle, and driver data associated with citywide TNC operations. The NREL research analyzed data on almost 39 million trips taken between November 2018 and April 2019—specifically, start and end time stamps; trip fare, duration, and distance; pickup/dropoff census tract; trips pooled (number of trips pooled or shared from the time the first passenger was picked up until the car was empty again); and shared-trip authorizations (whether the customer agreed to a shared trip with another customer regardless of whether they were actually matched). This data was supplemented by average income data by census tract (to match trip locations). Among those trips for which customers chose the sharing option is an average match rate of 71.8 percent (18.5 percent of total trips end up being pooled). The trips showed a significant inverse relationship between willingness to share and income by census tract (with a correlation of -.714). The median cost of a shared ride was 66 percent of a private ride. As with the FHWA study, the NREL study found a greater price sensitivity in low-income areas than elsewhere. (Hou et al. 2021)

In another study also using Chicago ridehailing data but over a longer period of time (and, specifically, over 127 million ride records between November 2018 and December 2019), Soria and Stathopoulos (2021) reported that 25.5 percent of trips were authorized to be shared. Only 66.9 percent of the trips authorized to be shared actually were shared, or about 17 percent of all TNC trips in total. These researchers provided the maps below, which show that the prevalences of private and shared TNC rides vary significantly by the financial attributes of an area within the city. Figure 4A and Figure 4B show the portion of trips that are private and shared, respectively, with the darker colors representing higher percentages. These two figures are mirror images of each other; Figure 4A shows dark colors, and hence a high concentration of ridehailing that is private, in the northeast portion of the city and lighter colors elsewhere, while Figure 4B shows the reverse. The research also mapped a Socially Disadvantaged Index, or SDI, based largely on area income and wealth (including poverty levels, unemployment, household and vehicle ownership, etc.), which is shown in Figure 4C. Here, darker colors represent higher proportions of the population that are disadvantaged. Looking at both Figure 4B and Figure 4C and, specifically, the close alignment of the darker colors which are concentrated in the southern and far western portions of the city, it is clear that shared ridehailing is especially prevalent in communities with high SDI scores; these authors found the relationship to be statistically significant. The authors concluded that higher-income areas of Chicago tended to have better transit access, more ridehailing pickups, and less pooling than elsewhere in the city. (Soria and Stathopoulos 2021)



A. Subfigure showing the percent of TNC trips in Chicago that were private party.

B. Subfigure showing the percent of TNC trips in Chicago that were shared.



C. Socially Disadvantaged Index rating.

Source: Soria and Stathopoulos 2021.

Figure 4. Maps. Compound figure showing, for different areas of Chicago, the percent of TNC trips taken privately or that were shared and the Socially Disadvantaged Index rating.

CHAPTER 2. PRIVATE PARTY TNCS AND CONGESTION CAUSATION

Research by FHWA shows that nationally, and even in most regions, the share of total vehicle movements that can be attributed to ridehailing is relatively small (FHWA 2021). But other research, focused especially on the (prepandemic) growth of congestion in large metropolitan areas and in dense cities in particular, tells a different story.

A research article in *Nature Sustainability* reported on a set of fixed-effect panel models that were estimated using metropolitan statistical area level data. It found that TNCs entering a market led to increased road congestion in terms of both intensity (by 0.9 percent) and duration (by 4.5 percent) and to a decline in transit ridership (by 8.9 percent). (Diao, Kong, and Zhao 2021)

In metropolitan areas, the high concentration of TNC activity within the centers of cities suggests an even greater impact there. One city that has been especially impacted by TNC and congestion growth is San Francisco. San Francisco has a suite of advanced tools to assess and project travel, including its detailed activity-based model, SF-CHAMP (San Francisco Chained Activity Modeling Process).

One research study using SF-CHAMP incrementally deconstructed the primary contributors to increased congestion in San Francisco between 2010 and 2016, looking specifically at road and transit network changes, population growth, employment growth, TNC volumes, and the effects of TNC pickups and dropoffs. The study conducted a series of controlled travel demand model runs, supplemented with observed TNC data collected from the application programming interfaces of Uber and Lyft. The results show that road and transit network changes over this period have only a small effect on congestion. Socioeconomic factors contribute about a quarter of the congestion increase, while TNCs are the biggest contributor, accounting for about half of the increase in vehicle-hours of delay and worsening travel-time reliability. Considering TNC volumes and TNC pickups and dropoffs together, TNCs were found to be associated with 47 percent of the vehicle-miles-traveled (VMT) increase, 51 percent of the vehicle-hours-traveled increase, 55 percent of the speed decrease, 51 percent of vehicle-hours delay increase, and 41 percent of the increase in PTI80.[4] (Roy et al. 2020)

While FHWA's and NREL's studies have focused on the question of what it takes to turn private party TNC trips into shared TNC trips, other research suggests that it would not be a panacea to curtail TNC-caused increases in congestion. According to one researcher, Bruce Schaller, addressing a target that Lyft had set for itself in June 2018 for the end of 2020 for 50 percent of its rides to be shared, TNCs as a whole (combining consideration of both shared and private party trips) would still add 2.2 new miles of travel for every mile forgone in personal automobiles. (Lyft 2018, Schaller 2018)

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[4] PTI80 is a measure of travel-time reliability, defined as the ratio of the 80th percentile travel time to the free-flow travel time. It indicates how much extra time a traveler must plan on to arrive on time 80% of the time (Roy et al. 2020).

Schaller examined data related to Uber and Lyft from 2014 to 2020 to, among other things, assess the real-world effectiveness of simply having ridesplitting options in reducing TNC-caused VMT in four cities with significant ridehailing activity, plus in suburban areas of California. By considering rates of sharing within TNCs, modal shifts, and deadhead miles during this time period, Schaller found that TNCs, as a whole, led to VMT increases of 97 percent in Chicago, 114 percent in New York City, 118 percent in San Francisco, 157 percent in Boston, and 118 percent in California suburbs. (Schaller 2021)

Schaller then examined the question of whether, past experience notwithstanding, it might be feasible for ridehailing not to increase overall mileage, again taking account of the most likely travel choices if a TNC vehicle had not been taken. In addition to significantly increasing the percentage of TNC trips coming from private automobile travel and reducing deadheading, his scenario required 86 percent of trips to be pooled (74 percent of them with three passengers), which he concluded was inconceivable given the dual challenge of having to match routes and trip times for shared trips. (Schaller 2021)

Other research has focused on comparing the relative externalities of private party and shared TNC travel against a range of alternatives, including owned-automotive travel and transit travel. Externalities tend to track closely with VMT, with criteria air pollution emissions being one important point of divergence,[5] although the impacts of other externalities, such as congestion, that do track with VMT were found to dwarf this. Overall, TNCs have been found to increase externality costs between \$0.32 and \$0.37 per trip, on average, but impacts vary significantly depending upon the travel mode that would have otherwise been used and also if the TNC trip is private party or shared. When shared TNC trips displace transit, walking, or bicycling, the related increase in externality costs has been modeled to average about \$0.85 per trip versus a reduction of externality costs of \$0.60 per shared TNC trip if replacing personally owned auto travel. (Ward, Michalek, and Samaras 2021)

Ridesplitting services may offer a possible compromise that still allows for most of the advantages TNCs offer to their passengers while to some degree curtailing externalities. In particular, if low-income users are paying for ridehailing in any form, it would seem that, in most cases, it must be because other available transportation is not meeting their needs. Changes in TNC offerings over time suggest continued service evolution and also that policymakers may be able to influence this. Regarding ridesplitting, some modeling research points to potential good news that as pooling becomes more prevalent, it also allows more-efficient routing with less delay—a virtuous cycle. (Shaheen et al. 2021)

While TNC passengers are often of higher incomes than other travelers, that is not the case universally, and so newly burdening TNC travelers could, absent careful consideration, have some negative equity implications. General population surveys in California's four largest

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[5] TNC vehicles yield fewer criteria pollution emissions than when people drive their own cars, because the TNC vehicles tend to be newer and need not be "cold started" for every trip. Even when accounting for deadhead miles that are required when TNC drivers travel between trip ends, TNC travel does lead to reductions in criteria air pollution emissions while increasing other externality costs associated with added VMT.

metropolitan areas were collected in autumn 2018 (Shaheen et al. 2021). Data from heavy TNC users who are young show skewed distribution between two distinct categories: higher-income Whites and lower-income African Americans. Consistent with FHWA's findings, the California data also show that lower-income TNC users choose a shared TNC option more than other TNC users. Thus, if trying to design policies to curtail TNC vehicle travel while minimizing harm to low-income TNC customers, the focus should be on discouraging trips that are not shared.

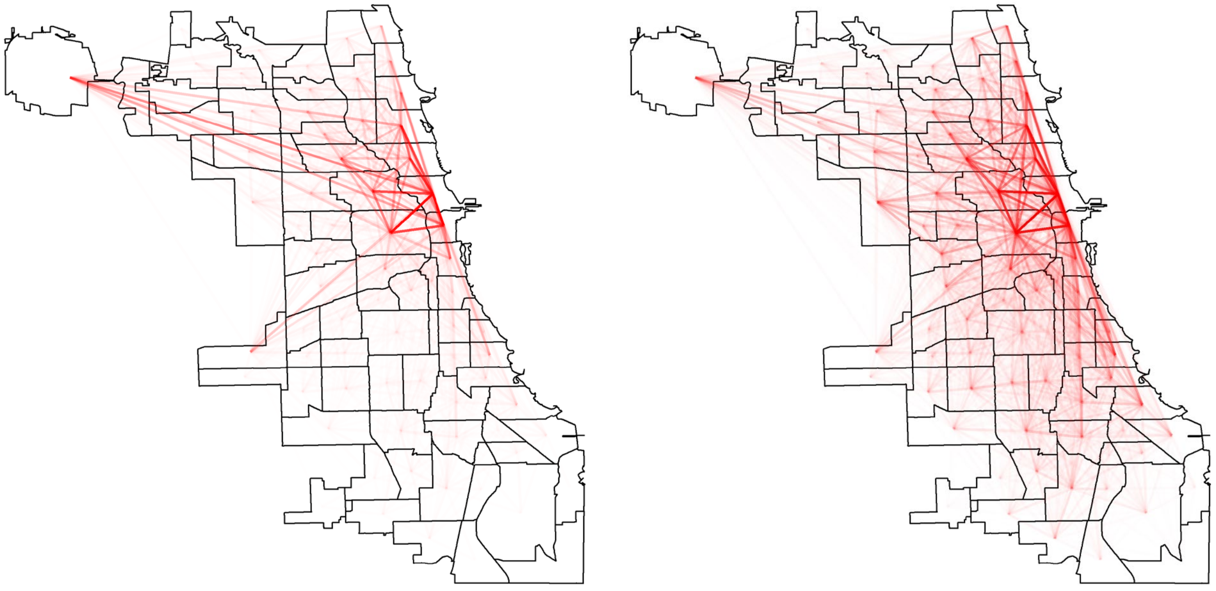
Appendix A (Considering Transportation Network Company Shared Product Design Changes and their Implications) discusses how the survey data that FHWA evaluated can inform efforts to improve shared TNC products and thus increase their use among TNC customers. Appendix B (Would Enhancing Ridesplitting Disproportionately Take Trips From Transit?) describes the debate over whether shared TNC services are pulling more transit passengers than private party TNC services are and concludes that there isn't evidence to support this theory. On the flip side, some may have concerns that making private party TNC travel less appealing than before may lead to more driving of personal vehicles. Given, however, that the constraints that the people who were taking TNCs instead of their own cars would still be present (e.g., destination parking limitations, desire for one-way travel, not wanting to drink and drive, etc.), significant increased personal vehicle use is unlikely. Further, even if some increase in personal driving were to occur, it would probably lead to less VMT overall due to the replacement of TNC trips and deadheading VMT.

CHAPTER 3. KEEPING BUSES MOVING WHERE TNCS OPERATE

Of particular importance to the issue of equity is the degree to which traffic, including from ridehailing use, delays bus travel, since the average household income of bus riders is substantially lower than for users of other travel modes and, as discussed in the following section, since cities have a lot more bus riders than private party ridehailers. This is an especially significant issue in the most competitive transit corridors and so the impacts of incentives and disincentives on TNC product choice, whether presented in the form of time or money, are worthy of close examination in such corridors.

Research shows that ridehailing use in Chicago has a strong positive correlation with transit availability. More bus stops were associated with higher TNC usage (Ghaffar, Mitra, and Hyland 2020). Ridehailing trips, especially those that were not shared, were found to be focused on corridors with significant bus ridership (Soria and Stathopoulos 2021).

Soria and Stathopoulos (2021) also show (in Figure 5A and Figure 5B) how much larger and more diverse the geographical intensity of ridesplitting is versus that of private ridehailing. As can be seen, ridesplitting (shown in Figure 5B) is providing service for a geographically diverse trip set as the color and line density is similar across the city (although a bit more intense in the eastern portion of the city where ridehailing activity in general is more common), whereas private ridehailing (shown in Figure 5A) seems concentrated in a few, likely congested, corridors with significant bus travel (demonstrated by the darker red lines concentrated in the northeastern portion of the city). This suggests that ridesplitting may be much more publicly beneficial than private ridehailing in terms of who and where they serve and their relative impacts on transit delay.



A. Subfigure showing private ridehailing trip intensity in the Chicago area.

B. Subfigure showing shared ridehailing trip intensity in the Chicago area.

Source: Soria and Stathopoulos 2021.

Figure 5. Maps. Compound figure showing (A) private and (B) shared ridehailing trip intensity in the Chicago area.

Using data gathered as part of the FHWA ridehailing study, Table 3 in the previous section shows that for TNC trips starting in the most competitive transit corridors (defined as the 10 percent of a region's zones where, within 45 minutes of travel, transit provides the best accessibility to the rest of the region's population relative to cars), travelers are less likely than elsewhere to choose ridesplitting to begin with, which explains, in part, the challenges that cities are facing in getting car traffic out of the way of buses. The previous FHWA study, as illustrated in Figure 2 above, also found that TNC trips that both begin and end—and also that just begin—in the most competitive transit districts were less responsive to pricing than trips elsewhere in causing a shift to ridesplitting. This finding did not hold for trips that just end in the most competitive transit districts. (FHWA 2021)

By contrast and as shown in Figure 3 above, trips in the most competitive transit districts—whether starting, ending, or both in such districts—were more responsive than trips elsewhere to move toward ridesplitting in response to policies that shift TNC passenger delay from shared to private party passengers (through pickup prioritization causing more customers to choose sharing and thus also facilitating improved routing efficiency for shared TNCs). (FHWA 2021)

All these key findings would be consistent with the theory that TNC use in areas with good bus service is driven largely by the desire to save time but at the expense of delaying other travelers—especially those taking the bus.

Riders who share more often also tend to use transit more. Over half of the riders who frequently share also use transit more than three times a week. For riders who rarely share, over 50 percent of them responded that they use transit zero times per week. (FHWA 2021)

In summary:

- TNC trips beginning in the most competitive transit zones have proportionately more private party ridehailing and less shared ridehailing than elsewhere.

- The greater impact realized everywhere of relative changes in TNC delay versus price on TNC product choice is greater still for trips both beginning and ending, or just beginning (but not just ending), in areas with the most competitive transit.

- Low-income travelers and frequent transit users are much more likely to share than others and are also more likely to be passengers on buses delayed by car travel, including by private party ridehailers.

Thus, it is clear that focusing on decreasing the relative time penalty for selecting a shared TNC option over a private party TNC option would be an especially effective policy choice to increase sharing in the most competitive transit corridors and would do so in an equity-enhancing manner by having wealthier travelers adjust more than lower-income ones. Delaying private party TNC matching in favor of ridesplitters is a means to establish priorities for limited urban street space similar to that of physical bus lanes. Offering relative time savings for high-occupancy-vehicle (HOV) travelers, which sometimes necessitates delay for other motor-vehicle travelers, is a tried-and-true public policy approach that has previously been operationalized by converting general-purpose travel lanes to bus-only use, implementing transit signal priority, and providing HOV ramp meter bypass lanes.

Thus, in the next section, the impacts of a policy scenario compressing the trip time difference between shared and private party TNC travel is quantified, as are the comparative numbers of travelers benefited and inconvenienced as a result.

CHAPTER 4. RESULTS FROM TESTING IMPACTS OF COMPRESSING PRIVATE PARTY AND SHARED TNC TRIP TIME DIFFERENTIALS

The 2017 National Household Travel Survey provided travel mode and related data (including ridehailing data) by city-region across the country (based on the Office of Management and Budget's Core-based Statistical Areas). When examining the impacts of various policies targeted specifically to ridehailing, this current research presents results at the city-region level so as to be able to show relative usage numbers for different travel modes (especially bus transit) where the data are also at the city-region level. Policymakers, though, might choose to design policies for different (likely smaller) geographies. Possibilities for pursuing more geographically targeted policies and projecting their impacts are discussed later in this section.

An interactive tool developed as part of FHWA's recent research on price/time elasticity enables testing of many potential policy scenarios on TNC sharing.[6] This research reports on one test scenario of a policy (plus a couple of variants of the policy) that would be minimally disruptive yet is modeled to be very effective at shifting private party TNC trips to shared trips—namely, compressing the trip time differential between these two TNC product types by 5 minutes. The test is applied to each of the 15 city-regions where the TNC data were gathered, as shown in Figure 6 below.

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[6] Analysis of Travel Choices and Scenarios for Sharing Rides tool code can be found at https://github.com/scottrmiddleton/FHWA-Relative-Mode-Share-Impacts-under-Different-Shared-Rides-Scenarios.

Source: Federal Highway Administration.

Figure 6. Map. U.S. map showing city-regions where TNC data were collected.

Table 4 below shows both initial conditions (for TNC usage and bus transit usage) and scenario test results (for TNC usage only) for each city-region. A comparison of TNC (private party and shared, displayed in separate columns) and bus transit mode shares is displayed, and the scale of benefits (to bus and shared TNC passengers) and burdens (to private party TNC passengers) of the tested policy is presented.

Table 4. Impacts of changing time differentials on TNC sharing.

	Mode Shares by City/Metropolitan Region					Policy Tests on TNC Mode Shares by City						
City	TNC Mode Share—Private in Baseline	TNC Mode Share—Shared in Baseline	TNC Percentage—Shared in Baseline	Road Transit Mode Share (less Rail)	Ratio of TNC Shared + Road Transit to TNC Private	New TNC Shared Percentage with a 5-Minute Trip-Time Differential Reduction	Ratio of Percentage Shared After a 5-Minute Time Differential Reduction to Beforehand	Break-even Savings (in minutes) for Transit Users/Ridesplitters with a 5-Minute Policy	Time Differential Reduction (in minutes) to Double TNC Sharing	Time Differential Reduction (in minutes) to Halve Private TNCs	Break-even Savings (in minutes) for Transit Users/Ridesplitters to Double Ridesplitting*	Break-even Savings (in minutes) for Transit Users/Ridesplitters to Halve Private TNCs*
Atlanta	0.53%	0.14%	21.0%	1.5%	3.1	49%	2.35	1.6	3.9	7.2	1.2	2.3
Austin	0.21%	0.07%	25.7%	1.6%	7.9	51%	1.98	0.6	4.9	7.1	0.6	0.9
Boston	0.47%	0.25%	34.4%	3.3%	7.5	69%	2.02	0.7	4.9	4.7	0.7	0.6
Chicago	0.66%	0.34%	33.8%	4.5%	7.3	52%	1.54	0.7	8.7	8.7	1.2	1.2
Denver	0.21%	0.07%	24.9%	1.7%	8.7	50%	2.00	0.6	4.9	7.6	0.6	0.9
Las Vegas	0.06%	0.02%	25.8%	3.1%	55.2	48%	1.86	0.1	6.3	8.7	0.1	0.2
Los Angeles	0.54%	0.23%	30.3%	2.6%	5.3	70%	2.32	0.9	3.8	4.4	0.7	0.8
Miami	0.73%	0.21%	22.4%	1.6%	2.4	44%	1.96	2.1	5.4	8.9	2.2	3.7
Nashville	0.10%	0.02%	18.2%	0.1%	1.1	41%	2.27	4.5	3.9	8.8	3.4	7.8
New York	1.22%	0.68%	35.6%	4.4%	4.1	52%	1.47	1.2	9.9	8.9	2.4	2.2
Philadelphia	0.41%	0.14%	25.3%	2.6%	6.5	55%	2.19	0.8	4.0	5.9	0.6	0.9
Portland	0.46%	0.05%	9.3%	2.7%	5.9	37%	3.99	0.8	1.8	8.0	0.3	1.3
San Francisco	1.03%	0.58%	36.1%	4.8%	5.3	63%	1.74	0.9	6.7	5.8	1.3	1.1
Seattle	0.53%	0.23%	30.0%	6.1%	11.9	53%	1.78	0.4	6.4	7.5	0.5	0.6
Washington, D.C.	1.00%	0.42%	29.4%	4.4%	4.8	58%	1.96	1.0	5.3	6.2	1.1	1.3

Source: Federal Highway Administration.

*If these users saved more than this amount of time, it would exceed the total time lost to private ridehailers.

Among the columns in Table 4 are “TNC Percentage—Shared in Baseline,” “New TNC Shared Percentage with a 5-Minute Trip-Time Differential Reduction,” “Ratio of Percentage Shared After a 5-Minute Time Differential Reduction to Beforehand,” and “Break-even Savings (in minutes) for Transit Users/Ridesplitters with a 5-Minute Policy.” For “New TNC Shared Percentage with a 5-Minute Trip-Time Differential Reduction,” the predicted ridesplitting shares hover very close to 50 percent Specifically, for 8 of the 15 city-regions, shares fall within 45 to 55 percent, with results higher in four cities and lower in three (range from 37 to 70 percent) and with a median value of 52 percent. The column “Ratio of Percentage Shared After a 5-Minute Time Differential Reduction to Beforehand” shows an approximate doubling or more of ridesplitting in most markets as a result of this policy. If, as shown in the “Break-even Savings (in minutes) for Transit Users/Ridesplitters with 5-Minute Policy” column, such travelers gain 1 minute or less of savings in 11 of the 15 city-regions and less than 2 minutes per trip in an additional two of the markets, a net population time savings would result from delaying private party ridehailers.

Next, two policy variants are considered, focused on what it would take to achieve a policy outcome. The column “Time Differential Reduction (in minutes) to Double TNC Sharing” shows city-region results spanning from 1.8 to 9.9 minutes. Here results are between 4.0 and 6.0 minutes in six cities, with four cities showing lower results and five cities showing higher results. The median city value is 4.9 minutes.

In the “Time Differential Reduction (in minutes) to Halve Private TNCs” column, results trend a bit higher, ranging from 4.4 to 8.9 minutes (with 4 cities showing between 4.0 and 6.0 minutes and the other 11 showing between 6.0 and 8.9). The median city value is 7.5 minutes. In “Ratio of TNC Shared + Road Transit to TNC Private,” results varied substantially from a low of 1.1 (in Nashville) to a high of 55.2 (in Las Vegas) to 1, with a median ratio of 5.9. Finally, in the last two columns, “Break-even Savings (in minutes) for Transit Users/Ridesplitters to Double Ridesplitting” and “Break-even Savings (in minutes) for Transit Users/Ridesplitters to Halve Private TNC,” time savings for bus and ridesplitting passengers of less than a minute was often all that was needed (i.e., in 8 of the 15 cities in the first of the columns and 7 of the 15 cities in the second of the columns), for an overall population time savings if the outcome-based policies were to be implemented (assuming that the compression in time differentials occurs solely by delaying of private party ridehailers is a worst case, as a combination of speeding ridesplitting and slowing private party ridehailing would be more likely). As significant as these benefits are to bus travel, other transportation services also would likely benefit, although this research does not quantify the extent.

The proportional impacts would be even greater if policies were scoped and deployed more narrowly. As noted above, cities might deploy one of the ridehailing policies that was modeled only for trips starting and/or ending in their jurisdictions. They might further choose to narrow the applicability of a policy to cover only pickups and dropoffs in corridors with high levels of bus service. A policy applied to a narrower geography would be relatively more effective—at least within the directly impacted area. The FHWA interactive tool and the data supporting it divide the amount of time (for compressing trip-time differentials) by the number of miles for a trip prior to its application. As TNC trips within the best transit corridors are shorter than other TNC trips (with an average of 3.2 miles compared with 5.6 miles overall), the per-mile time compression (which is the input for the tool) from a 5-minute trip compression is substantially greater in such corridors than for average trips, and thus the impacts in terms of converting private party TNC trips to ridesplitting trips would also be much greater.

A narrower geographical scoping of policies than presented here does not readily lend itself to the bus mode comparisons that have been offered, because, as noted earlier, the data on bus travel is only at the regional level. Cities could take approaches that are in concert with FHWA's interactive tool to look only at trips in the most transit-competitive areas (where transit provides the best access, relative to cars, to the rest of the region's population). To compare ridehailing usage to bus usage in a narrower than regional geography, some commercial products with this capability are available, although not tested as part of this research. Emerging products relying on passive data sources may provide estimates of both the number of ridehailing passengers and number of public transit passengers on specific roadways in a region. Such street-level data would better allow agencies to understand the key question of how ridehailing may be interacting with the performance of transit routes along with the number of affected users of the respective modes.

CHAPTER 5. IMPLEMENTATION CONSIDERATIONS

This research has sought to demonstrate, using an interactive tool developed by the FHWA, strategies that would be minimally disruptive of travel while significantly increasing the portion of TNC rides that are shared. Decisions made by TNCs themselves could create outcomes similar to those modeled. Especially because of recent driver shortages, which have been well documented, TNCs making such decisions is certainly a possibility (Hu, McGeehan, and Piccoli 2021). Alternatively, or perhaps in addition to actions taken by TNCs, city and regional governments could deploy policies that lead to these outcomes.

There is always a risk of customers trying to "game" new travel rules by, for example, requesting in advance private party TNC services and thus potentially avoiding a wait when not desired. Of course, those able to plan and predict their travel needs with a good deal of precision may also have the scheduling control, flexibility, and willingness to take shared TNCs—especially if such services improve.

The precise design of an implementing policy may entail some challenges and tradeoffs. An understanding of baseline application programming interface presentations to users for private party and shared TNC trips may be required to determine if a policy mechanism like compressing the time differential of private party and shared TNC trips by 5 minutes is actually deployed as it is supposed to be. An implementing agency would need the relevant initial and subsequent data (stripped of personally identifiable information) on the choice sets that the TNCs are presenting to customers in their apps. The data would need to be aggregated to show the differences between the average travel times displayed/offered for private party versus shared travel for the same trips. TNCs would need to adjust their offerings such that the average time differential between the product choices is cut by 5 minutes from their original offerings. The reduction in the time differential could be accomplished by a combination of delaying pickups for customers who continue to choose the private party ridehail product, speeding up pickups for customers choosing a shared product, and routing shared TNCs more efficiently (which, with more people choosing a shared product, should be possible due to more overlapping shared-service requests). Such a policy could complement other bus priority policies such as bus-only lanes and signal priority.

An alternative to specifying a deployment mechanism is instead focusing on an outcome (e.g., that ridesplitting must double as a share of TNC travel or that ridesplitting must represent half the active TNC trips in a market at any particular time) and leaving it to the TNCs to decide how to achieve it. The resulting choice of the TNC might, though, lead to greater disruption in the travel decisions of low-income people than those of other customers, which could raise equity concerns (e.g., if using a pricing instead of a delay reallocation mechanism).

Researchers and community activists have at times supported diverting truck traffic out of low-income areas near major ports and warehouses due to the disproportionate concentration of air pollution in such areas.[7] Policymakers could do something similar to what has been proposed for urban truck traffic: route diversion where needed to achieve a public policy objective (e.g., for private party ridehailing, disallowing routing on popular bus roads because bus passengers trend toward lower income). The case for this strategy is further bolstered by research in Phoenix, where low-income communities were found to experience a significant ridehailing cut-through traffic burden, coupled with very few trips ending within and thus benefiting those same communities. (Gehrke and Huff 2022)

Curtailing bus delay is an important goal. Encouraging TNC passengers to select a shared product option to limit the number of TNC vehicles may be a tool to help achieve this goal.

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[7] See, for example, the December 2020 final report *Geofencing as a Strategy to Lower Emissions in Disadvantaged Communities,* prepared for the California Air Resources Board, available at https://ww2.arb.ca.gov/sites/default/files/2021-01/17RD009_0.pdf.

APPENDIX A: CONSIDERING TRANSPORTATION NETWORK COMPANY SHARED PRODUCT DESIGN CHANGES AND THEIR IMPLICATIONS

To maximize sharing and increase transportation system efficiency, transportation network companies (TNCs) may want to consider providing a greater diversity of product offerings to increase the probability of people of different income groups selecting a ridesplitting option. The Federal Highway Administration (FHWA) conducted a separate analysis surrounding users' preferences when choosing one shared TNC option over other shared TNC options (FHWA 2021). Results yielded significant heterogeneity in cost and time savings tradeoffs among users—meaning, substantial differences in user preferences. This suggests that, by offering customers more than one shared product option with time delay and varying price points and by providing these in combination with vehicle routing decisions designed to accommodate differing user preferences, TNCs could increase the proportion of shared trips.

Looking only at those whose most recent TNC trip was shared, only 18.9 percent show a value of time ceiling for sharing of $14.24 per hour, increasing to 70.1 percent when the ceiling value rises to $139.19. Accounting for personal priorities and life circumstances, a time-sensitive wealthier person might accept a pooled ride if the person were not very (or at all) delayed, while a price-sensitive poorer person might be more motivated by cost savings. To put the two together in the same vehicle might entail providing the wealthier customer a more direct trip (e.g., by being picked up second and dropped off first) than the less wealthy "pooling partner," who would pay a lower price in exchange for accepting their own less direct routing. The total ridesplitting trip might be a bit longer than if the pickups and dropoffs were ordered differently, but since in this example the wealthier potential pooling partner would reject a shared option if the ordering were different, a slightly less efficient ridesplitting routing would be preferable to the alternative of two separate private party ridehailing trips.

To further encourage ridesplitting, it is important to provide such TNC passengers a more reliable travel-time estimate with some guarantee of accuracy (e.g., a partial or full fare refund if the performance promise on a trip was not met). A survey including approximately 1,600 people in Singapore reported that respondents experienced significantly better adherence to promised trip times for private party trips (62.6 percent) versus for shared trips (49.5 percent). Then, when they were queried about willingness to pool, their several attitudes significantly impacted this, including reported trust in arrival time estimates shown prior to booking, previous experiences with on-time performance in ridehailing, and views on the importance of time attributes. The researchers concluded that increasing trust in pooled ridehailing reliability may be a key component of increasing adoption in the future. (Bailey, Noursalehi, and Zhao 2021)

To build user trust, TNC operators could consider not diverting the driver of a passenger who chose the shared option to get another passenger when it would result in failure to deliver to the first passenger what was promised. An even more innovative strategy when a pooling possibility emerges that would jeopardize the trip-time promise made to a passenger already in tow would be to allow the passenger rather than the driver to decide whether to accept a pairing in exchange for an additional discount or future credit. If the passenger is not following the trip on the application, the driver could communicate the offer to the passenger and then follow the passenger's wishes as to whether to accept it.

APPENDIX B: WOULD ENHANCING RIDESPLITTING DISPROPORTIONATELY TAKE TRIPS FROM TRANSIT?

One potential concern with making shared transportation network company (TNC) travel too attractive is the possibility of drawing significant numbers of passengers from buses, thereby hindering overall transportation system efficiency. The compression of time differentials between private party and shared TNC options could lead to some service changes that, at the margins, make ridesplitting relatively more attractive than bus travel compared with prior to the service changes (i.e., if some of the time differential compression is achieved by speeding ridesplitting trips rather than slowing private party TNC trips). As detailed in the body of this research, while the Federal Highway Administration (FHWA) model shows the efficiency-enhancing results of the time differential compression on TNC passenger product choice, the data that informed the model do not allow an assessment of the degree to which TNC service changes impact consumer decisions to select TNC travel at all.

The *relative* changes in price and time that are designed to influence TNC customer selection between private party and shared TNC products are not likely to substantially impact *overall* average prices and trip times of TNC travel (i.e., the relative increases and decreases are likely to average out to about zero across all TNC trips). Thus, it would be reasonable to assume, absent other evidence, that overall TNC usage would not change substantially as a result of modeled policies (although the number of TNC vehicles would be expected to decline, since increased ridesplitting would allow fewer vehicles to serve an equivalent number of customers).

Researcher Bruce Schaller, though, argues that private party ridehailing is one type of product (i.e., taxilike), and ridesplitting is entirely a different type of product (i.e., transitlike), suggesting that policies impacting the two types of projects should be analyzed separately. Of particular concern to Schaller is the possibility that too much support for ridesplitting might draw users from bus travel (Schaller 2021). Unfortunately, studies of TNC user travels and, specifically, the mode that would have been taken if ridehailing were not available have usually not differentiated users based on their preferences related to TNC trip sharing.

In the dataset that FHWA analyzed from a large survey conducted by a TNC, the bulk of TNC passengers seemed to be making trip-by-trip decisions between private party and shared ridehailing products. While there are some (33 percent)—among whose last TNC trip was a private party ride—who did not choose a shared option even with (at least as presented to them) no time penalty and a 75 percent price savings, the data did not show very many ridesplitters who did not at least occasionally choose a private party ride (e.g., and as noted in Appendix A, only 18.9 percent of those whose last trip was ridesplitting continued to choose a shared instead of a private party TNC option when a savings of only $14.24 per hour of extra trip time was offered for ridesplitting). (FHWA 2021)

In one study where data showed transit accessibility impacting TNC usage, the impact was found to be very similar on the two types of TNC services. The study, discussed earlier, used Chicago ridehailing data from 127 million ride records collected between November 2018 and December 2019. Among its findings was that increasing transit station access time—meaning, reduced access—corresponded to less ridehailing. Importantly, impacts were indistinguishable between private party and shared TNC trips, with a 1 percent increase in transit access time corresponding to a 1.24 percent reduction in private party TNC trips and a 1.16 percent reduction in ridesplitting trips. Clearly, at least in this case, the two types of TNC trips are not fundamentally different from one another in terms of their relationship to transit. (Soria and Stathopoulos 2021)

Also related to transit and ridehailing—and in furtherance of attempting to discern if there are separate ridehailing markets that impact transit and personal automobile use—an Inter-American Development Bank–sponsored study in Latin America helps shed some light on this. TNC customers who were and were not also regular transit users were found to be indistinguishable in terms of frequency of TNC use and the impacts of price changes on service demand (Oviedo, Scholl, and Sabogal-Cardona 2022). This supports the overall notion that ridehail customers with different transit use patterns are more alike than different, with those who are also regular transit riders no more price sensitive in the decision to ridehail in the first place than other ridehail customers.

In many cases, TNC trips do draw from transit, but data are not available to address whether private party and shared ridehailing draw differently. Bruce Schaller's reporting on city-specific survey results related to the last TNC trip (of whatever type) a user made noted that 50 percent of New York City customers and 59 percent of Boston customers responded that they would have used a clean alternative like transit had ridehailing not been available (Schaller 2021). In other research, it was found that TNC entry into a region reduced public transit ridership by 8.9 percent in the first year, with an increasing effect over the 3 years following entry, stabilizing at about 16 percent thereafter. Entry of a second TNC into a region corresponded to an additional 2.1 percent decline in transit use. The study did not report separately on impacts in cities with TNC service where ridesplitting options were and were not available. (Diao, Kong, and Zhao 2021)

As previously noted, the TNC user survey about which the FHWA study reported found regular transit users more likely than others to choose a shared product. This data does not, however, show the degree to which, absent the availability of shared TNC products, regular transit users and nonregular transit users would have either used transit or a private party TNC option. Regular transit users have shown themselves to be comfortable with transit and thus are likely to have found something unsatisfactory about the transit alternatives available for the trip(s) they have taken via TNC (or they would have stuck to transit), so, in many cases, they may have taken a private party TNC if a shared product had not been available to them. As highlighted in the previous section, the policies explored in this research were designed explicitly to minimize bus delay in corridors where such travel is significant, and so, it seems unlikely that many previous bus travelers would abandon the bus for ridesplitting after the bus has become at least somewhat faster (even as ridesplit trips would also have become faster).

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February 2023

FHWA-HOP-23-013