Shared Mobility and the Transformation of Public Transit

DETAILS

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CONTRIBUTORS

Sharon Feigon and Colin Murphy; Transit Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP RESEARCH REPORT 188

Shared Mobility and the Transformation of Public Transit

Sharon Feigon
Colin Murphy
SHARED-USE MOBILITY CENTER
Chicago, IL

Subject Areas
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TRANSPORTATION RESEARCH BOARD

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, adapt appropriate new technologies from other industries, and introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000,* also recognized the need for local, problem-solving research. TCRP, modeled after the successful National Cooperative Highway Research Program (NCHRP), undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes various transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

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TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

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Dianne S. Schwager, *Senior Program Officer*
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Sharon Lamberton, *Editor*

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Field of Special Projects

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This report was primarily written by Colin Murphy under the direction of the Principal Investigator, Sharon Feigon, and was edited by Tim Frisbie, all of the Shared-Use Mobility Center (SUMC). SUMC is grateful to TransitCenter for a research grant that supported the extensive interview portion of this project. The interviews and transit capacity and travel time analysis were performed in partnership with Sam Schwartz Engineering, overseen by Joe Iacobucci. Additional research, analysis, and editorial input were provided by Albert Benedict, William Kaplowitz, and Jacques Kibambe Ngoie of SUMC, and Ben Norquist and Vig Krishnamurthy of Sam Schwartz Engineering.

FOREWORD

By Dianne S. Schwager
Staff Officer
Transportation Research Board

TCRP Research Report 188: Shared Mobility and the Transformation of Public Transit examines the relationship of public transportation (including paratransit and demand-responsive services) to shared modes, including bikesharing, carsharing, microtransit, and ridesourcing services provided by companies such as Uber and Lyft. This report was designed to assist transit agencies to examine issues and explore opportunities and challenges as they relate to technology-enabled mobility services, including suggesting ways that transit can learn from, build upon, and interface with these new modes.

The study draws on several sources of information:

- In-depth interviews with transportation officials;
- A survey of shared mobility users;
- Analysis of transit and ridesourcing capacity, demand, and comparative travel times;
- An assessment of practices and regulations relating to paratransit provision; and
- A compilation of current business models and public-private partnerships that build on new technologies from the emerging shared mobility sector.

The surveys and interviews were conducted in seven cities: Austin, Boston, Chicago, Los Angeles, San Francisco, Seattle, and Washington, DC.

The report presents five key findings:

1. Among survey respondents, greater use of shared modes is associated with greater likelihood to use transit frequently, own fewer cars, and have reduced transportation spending;
2. Shared modes largely complement public transit, enhancing urban mobility;
3. Because shared modes are expected to continue growing in significance, public entities should identify opportunities to engage with them to ensure that benefits are widely and equitably shared;
4. The public sector and private mobility operators are eager to collaborate to improve paratransit using emerging approaches and technology; and
5. A number of business models are emerging that include new forms of public-private partnership for provision of mobility and related information services.

This report concludes by presenting actions that public entities—transit agencies, transportation departments, and other local and regional agencies—can take to promote useful cooperation between public and private mobility providers. It also suggests regulatory enhancements, institutional realignments, and forms of public-private engagement that would allow innovation to flourish while still providing mobility as safely, broadly, and equitably as possible.

CONTENTS

SUMMARY

Shared Mobility and the Transformation of Public Transit

Technology is transforming transportation. The ability to conveniently request, track, and pay for trips via mobile devices is changing the way people get around and interact with cities. This report examines the relationship of public transportation, including paratransit and demand-responsive services, to shared modes, including bikesharing, carsharing, microtransit, and ridesourcing services provided by companies such as Uber and Lyft. The research included participation by seven cities: Austin, TX; Boston, MA; Chicago, IL; Los Angeles and San Francisco, CA; Seattle, WA; and Washington, DC.

Some transportation observers have predicted that, by creating a robust network of mobility options, these new modes will help reduce car ownership and increase use of public transit, which will continue to function as the backbone of an integrated, multimodal transportation system.

The objective of TCRP Project J-11, Task 21 was to examine these issues and explore opportunities and challenges for public transportation as they relate to technology-enabled mobility services, including suggesting ways that transit professionals can learn from, build upon, and interface with these new modes.

To accomplish this task, the study draws on several sources of information, including:

- In-depth interviews with transportation officials;
- A survey of shared mobility users;
- Analysis of transit and ridesourcing capacity, demand, and comparative travel times;
- An assessment of practices and regulations relating to paratransit provision; and
- A compilation of current business models and public-private partnerships that build on new technologies from the emerging shared mobility sector.

Together, these elements provide a snapshot of a rapidly widening mobility ecosystem at an early moment in its evolution, and form the basis for a number of recommendations for balancing the benefits of innovation with public agencies' responsibility to the common good.

Key Findings

- **Among survey respondents, greater use of shared modes is associated with greater likelihood to use transit frequently, own fewer cars, and have reduced transportation spending.** Supersharers (people who routinely use several shared modes, such as bikesharing, carsharing, and ridesourcing) report the greatest transportation savings and own half as many cars as people who use transit alone.

- **Shared modes largely complement public transit, enhancing urban mobility.** On some routes and at certain times of day, however, shared modes may compete with transit. Ridesourcing services are most frequently used for social trips between 10:00 p.m. and 4:00 a.m., times when transit runs infrequently or is unavailable. Bikesharing plays a peak-hour role in augmenting transit systems, while carsharing is mostly used off peak. The car-based shared modes likely substitute more for taxi or automobile trips than for transit trips. Transit is most competitive when it travels in its own right of way and provides frequent service.
- **Because shared modes are expected to continue growing in significance, public entities are encouraged to identify opportunities to engage with them to ensure that benefits are widely and equitably shared.** Transit agencies can improve urban mobility for the entire spectrum of users through collaboration and public-private partnerships, including greater integration of service, information, and payment methods.
- **Public-sector agencies and private mobility operators are eager to collaborate to improve paratransit using emerging approaches and technology.** Although regulatory and institutional hurdles complicate partnerships in this area, technology and business models from the shared mobility industry can help lower costs, increase service availability, and improve rider experience.
- **Emerging business models include new forms of public-private partnership for provision of mobility and related information services.** Public entities, including transit agencies and local transportation departments, already are engaging with private operators and using new technologies from the shared mobility world. Public agencies can look to many examples for insight. Key areas of collaboration include cross-modal trip planning, reservations, and payment application (app) integration; microtransit/dynamic demand response; private access to public rights-of-way; and service links and hand-offs.

Conclusions

TCRP Research Report 188 concludes by presenting actions that transit agencies, transportation departments, and other local and regional agencies can take to promote useful cooperation between public and private mobility providers. It also suggests regulatory enhancements, institutional realignments, and forms of public-private engagement that would allow innovation to flourish while providing mobility as safely, broadly, and equitably as possible.

CHAPTER 1

Introduction

This study focuses on the intersection of public transit and shared mobility in seven U.S. metropolitan regions of varying character whose transit systems represent a range of sizes and maturities. Some regions include lower density, younger cities that have experienced high levels of urban growth in recent decades but have little tradition of public transit use and are primarily dependent on individual autos. At the other end of the spectrum are regions that include older cities with very dense cores and mature, robust, and widely used public transit systems. Basic characteristics of the regions and their transportation systems are listed in Table 1. Appendix A lists the positions of the public-sector and private-sector individuals who were interviewed in the seven regions.

Definitions

Because shared-use mobility is a relatively new field, the terms for various business models and technologies are still in flux. This study uses terms that might not yet be in common use or widely agreed upon. Table 2 summarizes the definitions used in this report, which generally conform to the definitions set out in *TRB Special Report 319* (2016) and Shaheen et al. (2015).

Research Overview

This study draws on several sources of information, including the following:

- Interviews with more than 75 public-sector transportation officials and private operator representatives from approximately 30 agencies and private companies (listed in Appendix A);
- A survey of more than 4,500 shared mobility users (detailed below and in Appendices B and C);
- Analysis of transit and ridesourcing comparative travel times (detailed in Appendix D) and capacity and demand (detailed in Appendices E and F);
- An assessment of practices and regulations relating to paratransit provision; and
- A compilation of current business models and public-private partnerships that build on new technologies from the emerging shared mobility sector.

Together, these elements provide a snapshot of a rapidly widening mobility ecosystem at an early moment in its evolution, and form the basis for a number of recommendations for balancing the benefits of innovation with public agencies' responsibility to the common good.

Survey Methodology

The user survey was distributed through both private shared-mobility operators and transit agencies in September and October 2015.

Table 1. Summary of study cities' mobility characteristics.

Region	Metro Area Pop. (millions)	Core City Pop. (millions)	Urbanized Area (sq. mi.)	Metro Area Solo Auto Commute %; Avg. Household Vehicle Count	Carshare Operators; Vehicle Count; Total Cars per 10K Core Pop.	Bikeshare Operators; Bike and Station Count; Total Bikes per 10K Core Pop.	Ridesourcing and Microtransit Providers; Launch Year	Transit Systems: Total Annual Unlinked Trips (millions); Annual Trips per Capita (p.c.)
Austin-Round Rock, TX	1.78	0.91	523	81.4%; 1.77	**Car2Go** (one-way), **Zipcar** (traditional); 381 cars; 4.2/10K	**Austin BCycle**; 375 bikes, 46 stations; 4.1/10K	**Lyft, Uber**; 2014	**Capital Metropolitan Transit Authority (CapMetro)**; 36.4; 26.7 p.c.
Boston-Cambridge-Newton, MA-NH	4.60	0.66	1873	72.0%; 1.58	**Enterprise, Zipcar** (traditional); 1265 cars; 19.46/10K	**Hubway**; 1300 bikes, 139 stations; 19.8/10K	**Lyft, Uber**; 2012 **Bridj** (microtransit); 2014	**Mass. Bay Transportation Authority (MBTA)**; 395.3; 94.5 p.c.
Chicago-Naperville-Elgin, IL-IN-WI	9.49	2.72	2443	74.1%; 1.62	**Enterprise, Zipcar** (traditional); 790 cars; 2.9/10K **Getaround** (p2p*) 120 cars; 0.4/10K	**Divvy**; 4760 bikes, 476 stations; 17.5/10K	**Lyft, Uber**; 2013 **Via** (microtransit); 2015	**Chicago Transit Authority (CTA)**; 529.2; 61.5 p.c. **NE Ill. Regional Commuter Railroad (Metra)**; 73.6; 8.6 p.c. **Pace Suburban Bus;** 35.9; 4.2 p.c. Total: 638.7; 74.2 p.c.
Los Angeles-Long Beach-Anaheim, CA	12.95	3.92	1736	77.7%; 1.80	**Zipcar** (traditional and one-way); 241 cars; 0.6/10K	Planned, spring 2016	**Lyft, Uber**; 2013	**LA County Metropolitan Transportation Authority (Metro)**; 476.3; 39.2 p.c.
San Francisco-Oakland-Hayward, CA	4.40	0.85	524	65.1%; 1.69	**City CarShare, Enterprise, Scoot, Zipcar** (traditional); 1315 cars; 15.5/10K **Getaround** (p2p); 1230 cars; 14.4/10K	**Bay Area Bikeshare**; 700 bikes, 70 stations; 8.2/10K	**Lyft, Uber**; 2011 **Chariot** (microtransit); 2014	**San Francisco Municipal Railway (Muni)**; 223.9; 68.2 p.c. **Bay Area Rapid Transit District (BART)**; 126.5; 38.6 p.c. Total: 350.4; 106.8
Seattle-Tacoma-Bellevue, WA	3.50	0.67	1010	73.9%; 1.83	**Zipcar** (traditional), **Car2Go** (one-way); 905 cars; 13.5/10K	**Pronto**; 500 bikes, 51 stations; 7.5/10K	**Lyft, Uber**; 2013	**King County Metro Transit**; 123.2; 40.3 p.c.
Washington-Arlington-Alexandria, DC-VA-MD-WV	5.76	0.66	1322	69.3%; 1.76	**Car2Go** (one-way), **Enterprise, Zipcar** (traditional); 1680 cars; 25.5/10K **Getaround** (p2p); 105 cars; 1.48/10K	**Capital Bikeshare**; 1538 bikes, 204 stations; 23.3/10K	**Lyft, Uber**; 2011 **Bridj, Split** (microtransit); 2015	**Washington Metropolitan Area Transit Authority (WMATA)**; 413.6; 90.2

*p2p = peer-to-peer.

Sources: U.S. Census Bureau American Community Survey 2014, 5-year estimates (metro and city population, commute mode, household vehicles, occupied housing units); National Transit Database 2013 profiles (transit system data, service area population; trips per capita uses each transit agency's service area population); SUMC Shared Mobility Database (shared mobility operators and vehicle counts as of December 2015).

Table 2. Definitions.

Term	Meaning	Other Names/Treatments
Bikesharing	Short-term bike rental, usually for individual periods of an hour or less over the course of a *membership.* (Periods can range from a single ride, to several days, to an annual membership.) Information technology (IT)-enabled public bikesharing provides real-time information about the location and demand for bikes at docking stations throughout a community.	Bike sharing
Carsharing	A service that provides members with access to an automobile for intervals of less than a day. Major carsharing business models include *traditional* or *round-trip*, which requires users to borrow and return vehicles at the same location; *one-way or free-floating,* which allows users to pick up a vehicle at one location and drop it off at another; and *peer-to-peer (p2p),* which allows car owners to earn money at times when they are not using their vehicles by making them available for rental to other carshare members.	Car sharing
Microtransit	IT-enabled private multi-passenger transportation services, such as Bridj, Chariot, Split, and Via, that serve passengers using dynamically generated routes, and may expect passengers to make their way to and from common pick-up or drop-off points. Vehicles can range from large SUVs to vans to shuttle buses. Because they provide transit-like service but on a smaller, more flexible scale, these new services have been referred to as “microtransit.”	Dynamic shuttles, private flexible transit
Private shuttles	Traditional private shuttle services include corporate, regional, and local shuttles that make limited stops, often only picking up specified riders.	Employer shuttles, tech buses
Ridesharing	At its core, ridesharing involves adding passengers to a private trip in which driver and passengers share a destination. Such an arrangement provides additional transportation options for riders while allowing drivers to fill otherwise empty seats in their vehicles. Traditional forms of ridesharing include carpooling and vanpooling. This term is sometimes used to refer to *ridesourcing* (see below) but unless otherwise noted that is not the meaning employed in this report.	Carpooling, vanpooling, slugging
Ridesourcing	Ridesourcing providers such as Uber and Lyft—codified in California law as Transportation Network Companies (TNCs)—use online platforms to connect passengers with drivers and automate reservations, payments, and customer feedback. Riders can choose from a variety of service classes, including drivers who use personal (non-commercial) vehicles; traditional taxicabs dispatched via the providers’ applications (apps); and premium services with professional livery drivers and vehicles. Ridesourcing has become one of the most ubiquitous forms of shared mobility.	Transportation network company (TNC); ridesharing; ride-hailing; e-hailing
Ride-splitting	Dedicated operators, as well as several ridesourcing providers, have launched IT-mediated products that allow customers requesting a ride for one or two passengers to be paired in real time with others traveling along a similar route.	Dynamic carpooling
Shared-use mobility (SUM), shared modes, SUM operators	In general, shared-use mobility comprises intra-urban transportation services in which vehicles are accessed by multiple users for a variety of trip purposes. This umbrella term includes the forms listed above along with traditional public transit, taxis, and other vehicles for hire.	Shared mobility

The survey sample frame included adult residents of the study regions who have used one or more shared-use modes, including transit. The researchers requested distribution of the survey by transit agencies and shared mobility operators in all of the seven study markets, and also in New York City. The recruitment method was through invitations emailed and distributed via social media by cooperating agencies and operators, inviting customers to complete a web-based survey instrument. A link was directly emailed by distribution partners to more than 75,000 email recipients in addition to a large number of newsletter and social media followers. This email received 4,551 at-least partial responses. Provider-specific links, called *collectors*, allowed tracking of response sources and permitted deactivation of particular channels at the end of a 2-week open period. The overall count represents a net response rate of 6.0% for the sources the researchers were able to track.

Sampling Considerations

In each market, the researchers were limited to working with convenience samples—those individuals able to be reached via the partners who agreed to distribute the survey, all of whom were people who had previously supplied their email addresses to the agencies or operators. Given this constraint, it is advisable to be cautious about using the survey sample to make inferences about the wider population of shared mobility and transit users and certainly to the general population. The survey was administered using an online format and email links. This implies a basic level of technological facility on the part of respondents, and also a willingness to participate in research about transportation. Also, the survey took place in several of the largest, densest, and most expensive cities in the country. These cities were chosen for this study specifically because of their known high levels of shared mobility usage. Thus, the sample is likely over-representative of higher income, more highly educated individuals compared to the general U.S. public.

We should also make note of the small sample sizes in some markets relative to others, particularly in Boston and San Francisco. In addition, we might expect some bias related to the mode of the distribution channels for the various surveys. In Los Angeles and San Francisco, the survey was distributed almost exclusively via the transit agencies; in Boston, Chicago, and New York, the survey was distributed solely via bikeshare operators; and in Austin and Seattle, the primary channel was a carsharing operator. One subpopulation this distribution method might miss would be people who use ridesourcing exclusively among shared modes, including transit. The research team did not have a way of estimating the size of this population because so little systematic knowledge currently exists about levels of ridesourcing usage in urban areas and among the traveling population overall. Ongoing research—from other behavioral surveys, public and private operator data, personal travel inventories, and other data sources—is needed to continue building the understanding of the use and effects of ridesourcing and other shared modes.

The survey is described in greater detail in Appendix B, and the survey instrument is presented in Appendix C.

CHAPTER 2

Findings

Transportation and Lifestyle Choices Associated with Shared Mode and Transit Use

Among survey respondents, greater use of shared modes is associated with greater likelihood to use transit frequently, own fewer cars, and have reduced transportation spending. *Supersharers* (people who routinely use several shared modes, such as bikesharing, carsharing, and ridesourcing) report the greatest transportation savings and own half as many cars as people who use transit alone.

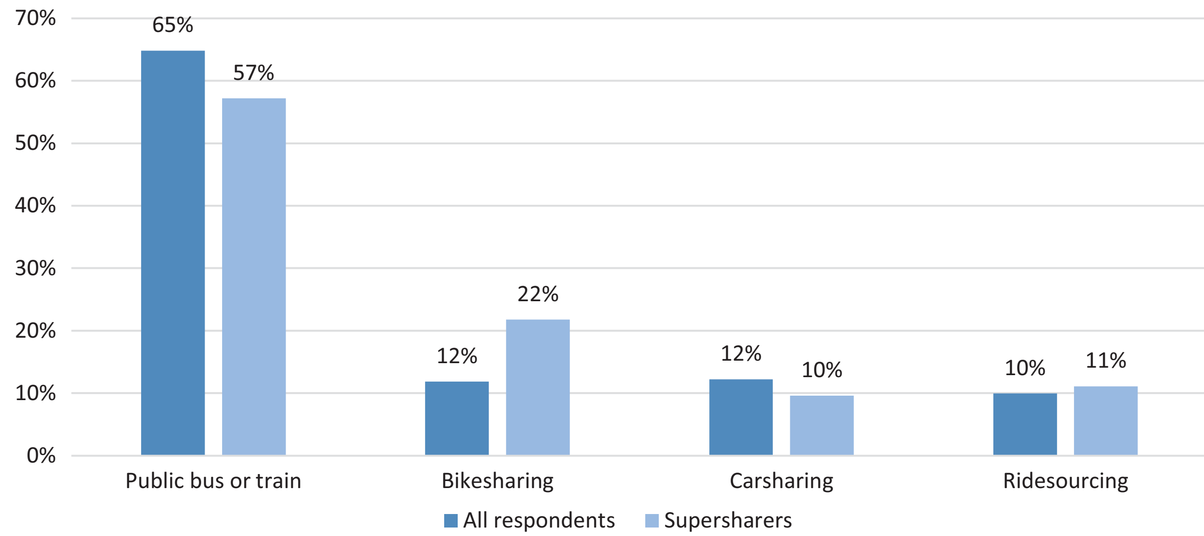
An online survey of more than 4,500 mobility consumers in the study cities explored travel behaviors and attitudes with a particular focus on the interaction of transit and new shared modes and associated effects on automobile ownership and use. The survey methodology is discussed in Chapter 1 and in Appendix B, and the complete survey instrument is presented in Appendix C.

It is important to note that the survey relied on convenience samples of transit and shared mobility users in several large cities, and is not necessarily representative of these populations overall, nor should it be interpreted as establishing causality in the behavior described by respondents. Although this study finds evidence that shared modes appear to discourage automobile ownership and complement transit use overall, and in general focuses on the larger scale lifestyle changes made possible by new mobility options, the evidence also points to possible competitive impacts on transit operations in some specific situations. Additional and ongoing research is needed to more fully understand the net impacts and to track their changing nature over time and in other settings. Urban transportation is evolving rapidly, and even during the brief course of this research new transportation products came to market that may have impacts that were not studied in this work.

Responses to the survey suggest that rail and bus transit were the most frequently used shared modes, followed by bikesharing, carsharing, and ridesourcing (Figure 1). Some 10% of respondents could be classified as supersharers, having reported using at least three non-transit shared modes (bikesharing, carsharing, and ridesourcing) across some combination of trip purposes (commutes, errands, or recreation) within the last 3 months. The supersharers represent the group of people who take broadest advantage of the range of mobility options available to them. These results were notable. As a group, supersharers are likely to be early adopters, and although the survey respondents were concentrated in urban areas, their behavior can give some insights into how travel choices among the broader population may change as the mobility menu gets larger in more and more cities.

Rail and bus transit were the most frequently used shared modes, followed by bikesharing, carsharing, and ridesourcing.

Approximately 57% of supersharers said public bus or train was the single shared mode they use most often, followed by bikesharing, ridesourcing, and carsharing (Figure 1). Asked about

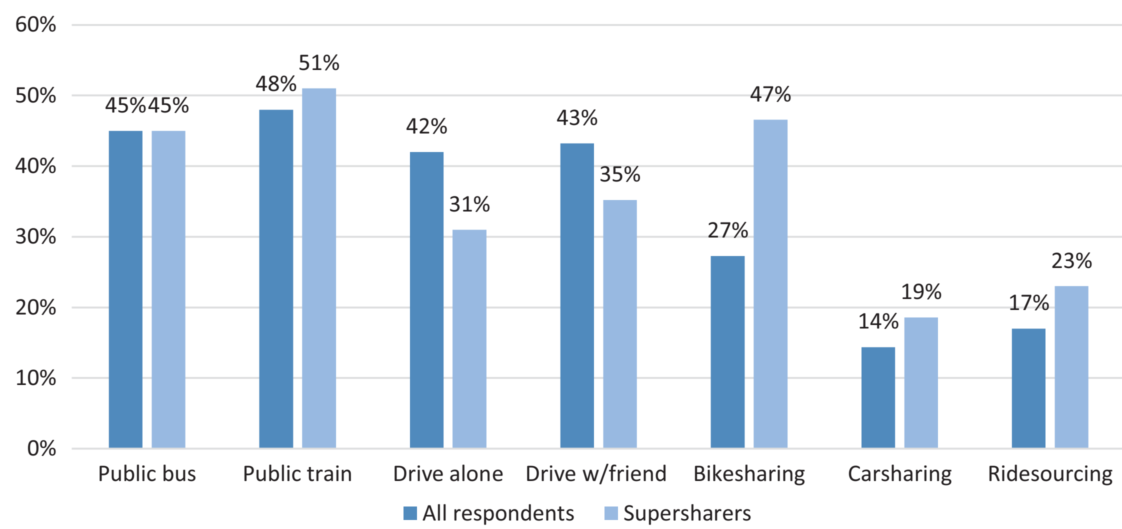


Source: Cross-tabulated responses to survey questions 4 and 9 (see Appendix C).

Figure 1. Single shared mode used most often—supersharers versus all respondents.

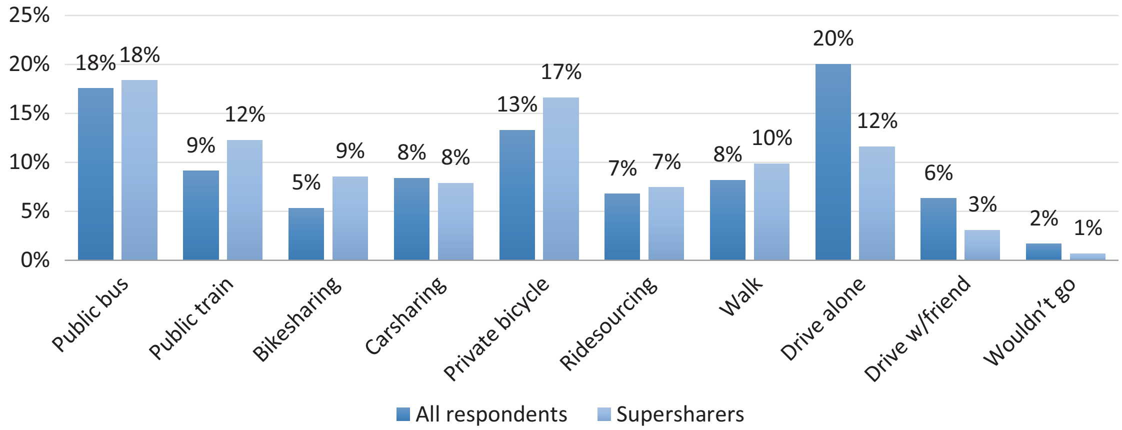
the entire range of mobility options rather than a single top mode, supersharers said they used transit and all of the other shared-use modes with frequency equal to or greater than the general respondents (Figure 2), and reported driving alone or with friends about 10% less than the overall group.

Asked how they would travel if their favored mode was not available, 30% of super-sharers would choose another form of transit (18% bus, 12% train), about one quarter would use one of the other shared-use modes, and another quarter would ride their own bike or walk the whole way, for a 78% total of modes other than personal automobiles (Figure 3). Note: Throughout these figures, data labels are rounded for convenience. Where data labels are equal, variations in column height reflect differences at the decimal level.



Source: Cross-tabulated responses to survey questions 7 and 9 (see Appendix C).

Figure 2. Frequent use (once or more per week) by mode—supersharers versus all respondents.



Source: Cross-tabulated responses to survey questions 5 and 9 (see Appendix C).

Figure 3. Alternative if top mode not available—supersharers versus all respondents.

The picture of how people mix and match various mobility options can be further developed by looking at *all* of the modes respondents reported having used in the last 3 months (Figure 4). (Given that the question on which Figure 4 is based allows for choosing multiple modes for a given trip purpose, the figures represent the proportion of respondents who had used that mode for that purpose, and do not add to 100% across modes.)

Transit forms the backbone of all respondents' mobility picture, but respondents who reported the heaviest use of shared modes also reported heavier use of transit. For every trip type, a 5% to 10% greater proportion of supersharers reports using transit compared with the overall group.

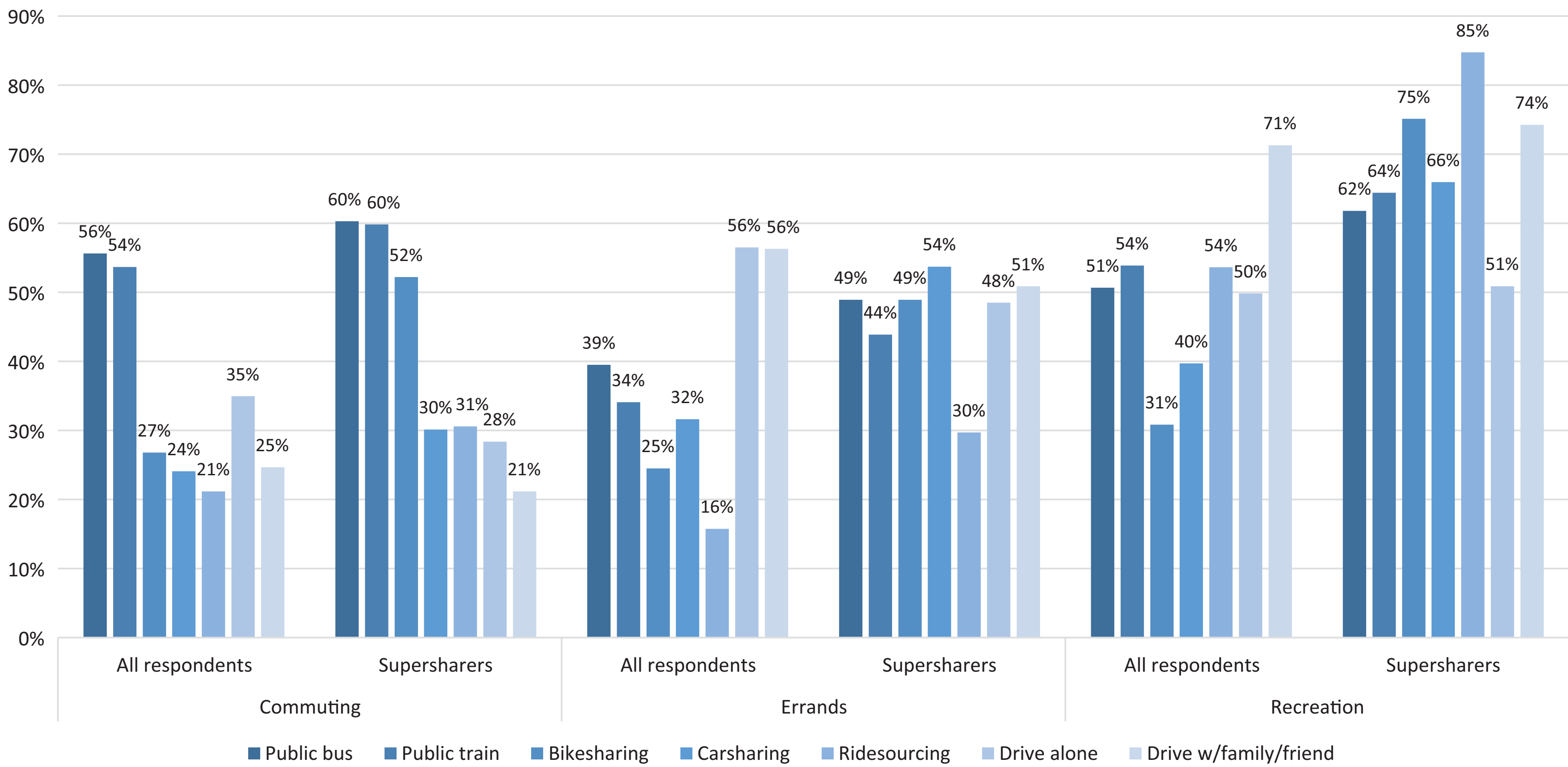
- **Commute trips.** For their commutes, both groups most frequently cited transit modes; but more than half of supersharers also said they had used bikesharing.
- **Errands.** For running errands, the overall group tends to turn to personal vehicles, distantly followed by transit and shared modes. Supersharers are most likely to use carsharing. Ridesourcing was the least-used mode for errands in both groups.
- **Recreational trips.** For recreational trips, supersharers report use of *every* mode (including driving) in proportions greater than the overall group. Especially notable are the very high proportions of supersharers who reported making recreational trips using ridesourcing, bikesharing, or carsharing—percentages that far outweighed those of the overall group (by more than double in the case of bikesharing). The wider variety of modes used for recreation versus commuting likely reflects the greater variety of destinations for social events, at times and places where transit coverage is not necessarily reliable.

Broadly speaking, these responses suggest that the supersharers take advantage of the whole menu of mobility choices, readily switching to the mode that makes the most sense for a given trip and purpose.

People who use transit and shared modes reported lower car ownership and less driving, as well as increased physical activity and decreased transportation spending.

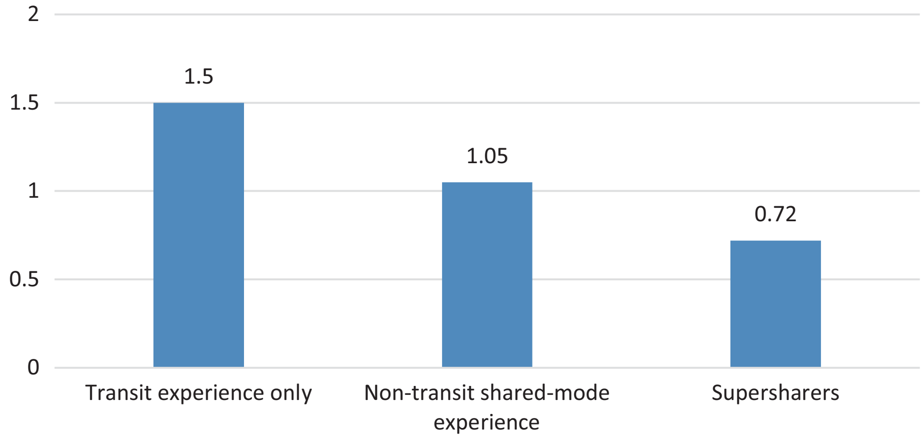
People who use transit and shared modes reported lower car ownership and less driving, as well as increased physical activity and decreased transportation spending. People who take greater advantage of shared modes report lower household vehicle ownership and decreased spending on transportation.

Compared with people who haven't used any shared modes beyond transit, respondents who are experienced with new forms of shared mobility report owning nearly half a car less—1.5 versus 1.05 vehicles per household (Figure 5). Vehicle ownership is even lower among supersharers, who report 0.72 cars per household. By comparison, the average ownership rate across the seven study regions is 1.72 vehicles per household. It's not possible to discern cause and effect



Source: Responses to survey question 9 (see Appendix C).

Figure 4. Mode use in last 3 months, by trip purpose—supersharers versus all respondents.

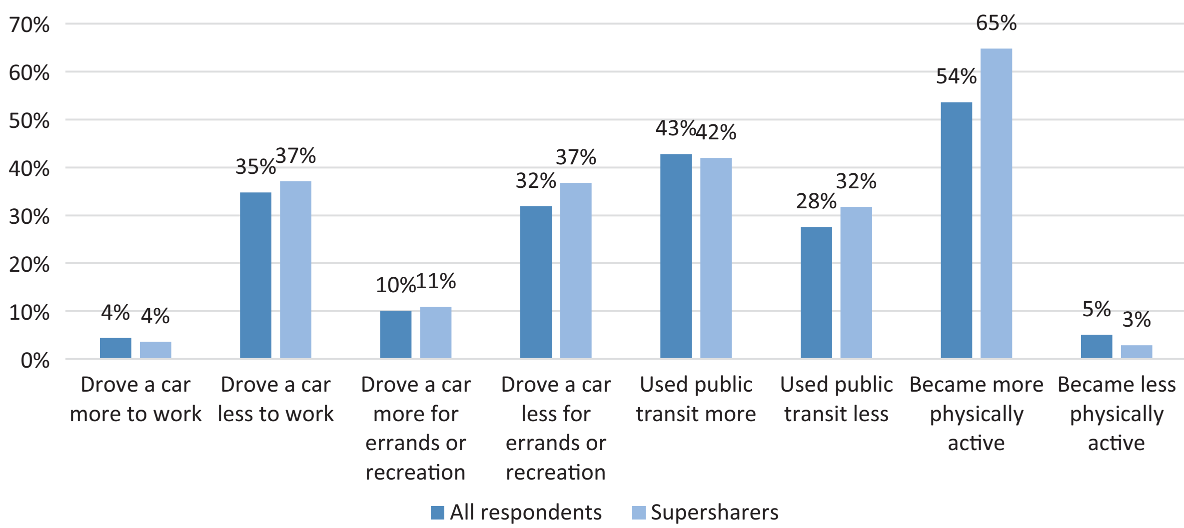


Source: Cross-tabulated responses to survey questions 19, 1, and 9 (see Appendix C).

Figure 5. Household vehicle ownership, by shared-mode experience.

in these responses; however, if these ownership differences are indeed attributable to the early-adopting supersharers' selecting from a larger menu of mobility options, these findings suggest a promising path to vehicle ownership reductions and associated benefits from reduced solo car travel if these lifestyle choices become more broadly dispersed. Increasing the breadth of shared mobility options and broadening access for more neighborhoods and communities could help cities meet goals to reduce single occupancy driving.

Across both groups (supersharers and general respondents), lifestyle changes since beginning to use shared modes are notable, with a net movement away from trips by personal automobile and toward greater use of transit. These responses represent qualitative results—the survey did not gather information on the magnitude of behavior or lifestyle changes for individual users. Considering the net difference between users who reported less driving and those who reported more, 31% of general shared mobility users and 33% of supersharers reported driving a car to work less often; 22% and 26%, respectively, drove less for errands and recreation; and 43% and 42% said they used public transit more, versus 28% and 32% who said they used transit less (Figure 6). Breaking the groups out individually, 35% of general shared mobility users reported



Source: Cross-tabulated responses to survey questions 10 and 9 (see Appendix C).

Figure 6. Lifestyle changes since starting to use shared modes—supersharers versus all respondents.

driving to work less often versus 4% who reported driving more; 37% of supersharers drove a car to work less often, versus 4% who said they drove more. For errands and recreation, 32% of the wider group and 37% of supersharers, respectively, drove less for errands and recreation, versus 10% and 11% who drove more; 43% and 42% said they used public transit more, versus 28% and 32% who said they used transit less.

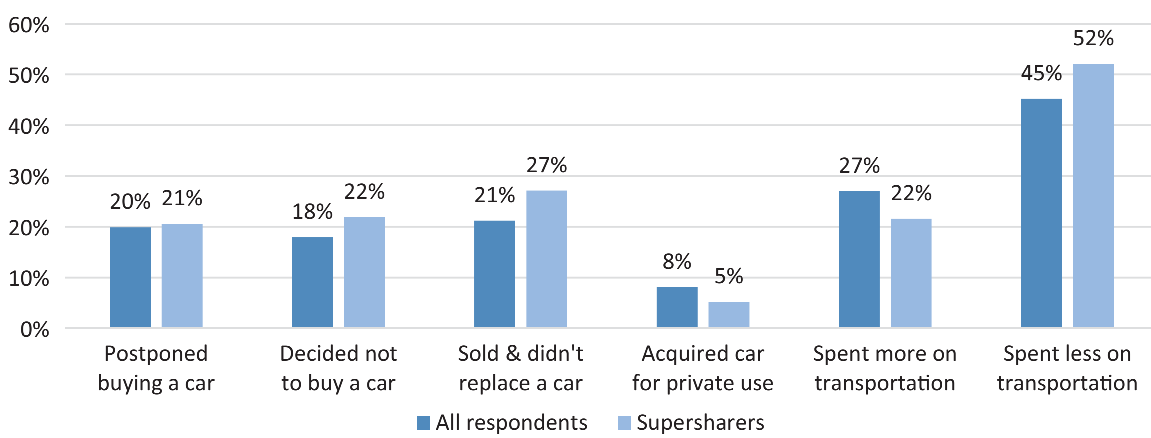
More than half of all respondents and nearly two-thirds of supersharers reported being more physically active since they began using shared modes.

More than half of all respondents and nearly two-thirds of supersharers reported being more physically active since they began using shared modes. Small numbers of respondents in both groups said that they drove more since beginning to use shared modes (about 4% for commuting and 10% for errands). Without knowing more about the individual situations, it's unclear what the reasons are for such a change, or what the magnitude of the change is. Because errands are the trip type with greater increased driving, it is possible this reflects users who begin turning to carsharing to access destinations they were previously unable to reach or for which they previously used a non-auto mode. Also, some percentage of people will simply move to a location, take a job, or enter a phase of life that requires more driving, despite their desires or previous behavior.

When asked about changes to their household and finances since starting to use shared modes, respondents across the board reported shedding vehicles and reducing expenses, though supersharers reported greater benefits (Figure 7). Among supersharers, 21% reported having postponed buying a car, 22% had decided not to buy one, and 27% had sold a car without replacing it, while 5% had bought a car. In the overall group, 20% reported postponing a car purchase; 18% reported having decided not to purchase a car, 21% reported having sold a car without replacing it, and 8% reported having acquired a vehicle for personal use. Moreover, among supersharers, 52% reported spending less on transportation, while 22% reported spending more—yielding a net of 30% of supersharers who reported spending less. By comparison, among all respondents, 45% reported spending less on transportation, while 27% reported spending more—yielding a net of 18% who reported spending less.

Shared Mode and Transit Usage Patterns

Shared modes largely complement public transit, enhancing urban mobility. However, they may compete with transit on some routes and at certain times of day. Ridesourcing services are most frequently used for social trips between 10:00 p.m. and 4:00 a.m., times when transit runs infrequently or is unavailable. Bikesharing plays a peak hour role in augmenting transit systems, while carsharing is mostly used off peak. The car-based shared modes likely substitute more for taxi or automobile trips than for transit trips. Transit is most competitive when it travels in its own right of way and provides frequent service.



Source: Cross-tabulated responses to survey questions 11 and 9 (see Appendix C).

Figure 7. Household and financial changes since starting to use shared modes—supersharers versus all respondents.

The interviews, survey, and data analysis conducted for this study together suggest that public transit and shared modes complement one another by serving different trip types and making car-free or car-light lifestyles feasible for more people. Different shared modes seem to fill specific niches in the mobility ecosystem, with ridesourcing used most frequently for social trips, late at night, and when alcohol is a factor; carsharing used for errands and off-peak trips to areas without good transit access; and bikesharing used for last-mile connections and acting as a pressure valve for crowded transit systems during peak hours.

In interviews, transit system officials tended to view new forms of shared mobility as largely complementary to their core mission, though they are carefully watching for signs of whether new, tech-enabled modes will change how riders use transit. Many parties pointed to the complexity surrounding access to a constrained public way (particularly parking spots and curb access) as an area that will increasingly require negotiation and policy attention as shared modes grow.

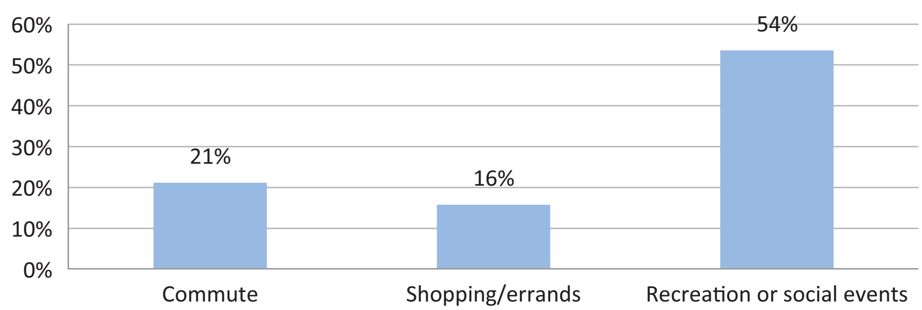
Representatives of cities with robust public transit systems interviewed for the study had the least concern about the impact of new modes on their transit services, and were often already engaged in established relationships with bikesharing and carsharing operators. Transit agencies with more dispersed ridership, fewer fixed guideway routes, or a higher proportion of paratransit rides or other expensive operations tended to be the most interested in possibilities for new complementary mobility options and service models. However, some transit agencies expressed concerns regarding the potential impact of ridesourcing on their existing service, and several local regulators addressed tactics by ridesourcing operators—such as commencing operations in a jurisdiction before regulatory authorization was obtained—that they believed made collaboration more politically complicated.

Ridesourcing is most commonly used for recreation and social trips, late at night, and often when alcohol is involved. Survey responses suggested that ridesourcing is a common part of the mobility menu for many people. However, it is used far more for socializing than for other kinds of trips. More than half of respondents (54%) indicated that they had used ridesourcing for a recreational or social trip within the last 3 months (Figure 8). Only 21% of respondents said they had used it to commute, and 16% reported using it for shopping or errands. For recreational and social trips, ridesourcing was the single top shared-use mode.

Ridesourcing is most commonly used for recreation and social trips, late at night, and often when alcohol is involved.

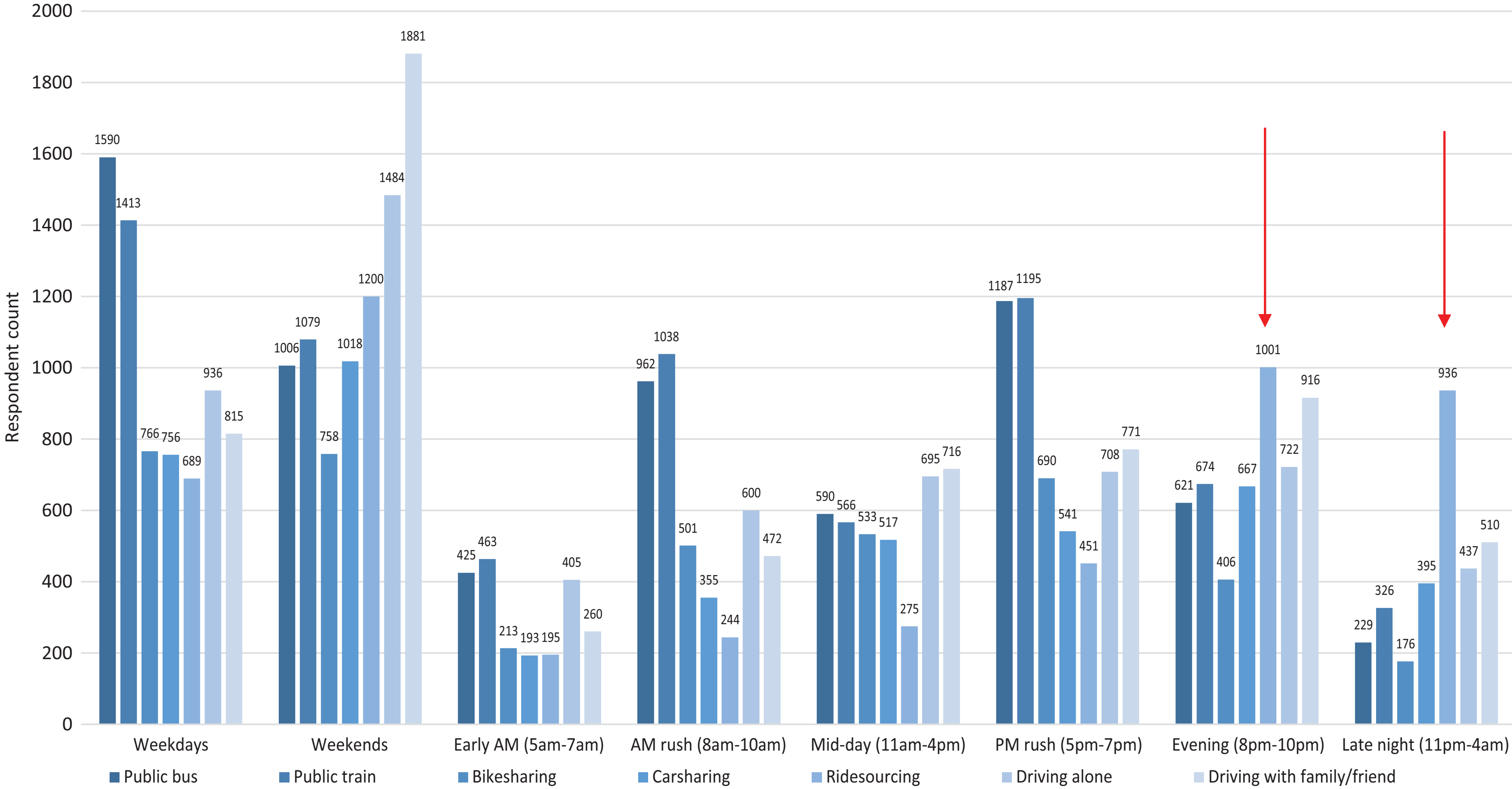
Asked about the hours of the day and times of week that they most commonly use various modes, survey respondents cited ridesourcing as the least frequent choice during the morning rush, evening rush, and mid-day, as well as weekdays overall (Figure 9). During the evening and late at night, however, ridesourcing was by far the top choice.

The survey findings are bolstered by an analysis of ridesourcing wait time and demand (as reflected in the average surge multiplier applied to base fares) throughout the week and around the clock (Figure 10). In every study city, a clear peak in reported ridesourcing demand is visible at some point between 10:00 p.m. and 4:00 a.m. on weekends, and in the majority of cities this is the time of



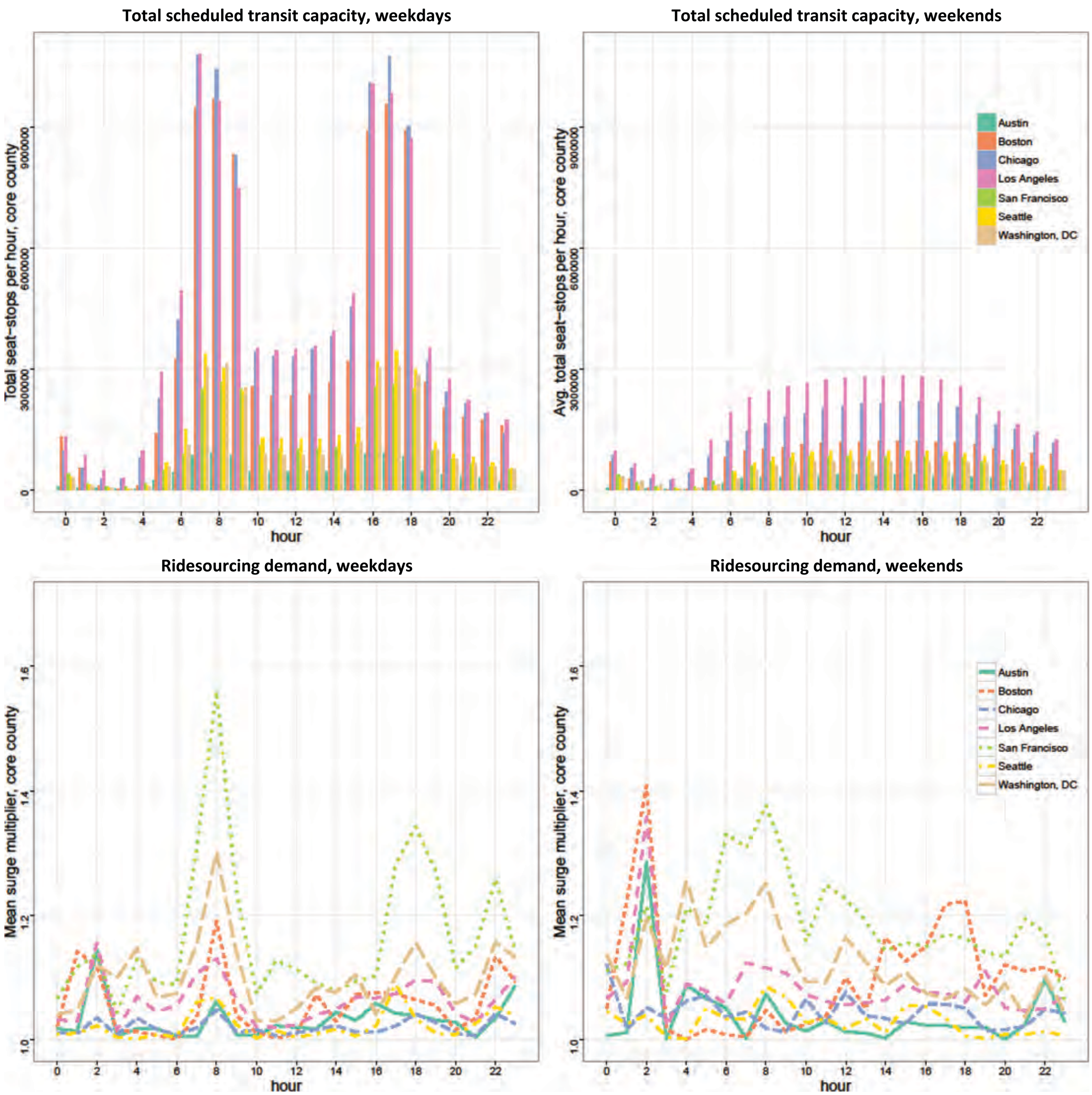
Source: Responses to survey question 9 (see Appendix C).

Figure 8. Recent use of ridesourcing, by trip purpose.



Source: Responses to survey question 14 (see Appendix C).

Figure 9. Mode preference by time of day and week.



The *x*-axis in each chart corresponds to the hours in a 24-hour day (all times local). The *y*-axis corresponds to the relevant metrics aggregated across each study region.

Sources: Transit data—agency GTFS feeds; ridesourcing data—Uber API.

Figure 10. Scheduled transit capacity* (top) *and typical ridesourcing demand* (bottom) *by hour, for weekdays and weekends.

greatest demand overall. It is also the time of the day and week when scheduled transit capacity is at its lowest point and average headways are longest. (See Appendix E for more detail on this analysis.)

These findings are further supported by data released by the New York City Taxi and Limousine Commission, which conducted its own summary counts of ridesourcing service levels for several time periods. Data from the New York study was reviewed by the research team for TCRP Project J-11, Task 21. The New York study is limited to Brooklyn because Manhattan's transportation picture is unique in North America in so many respects. In that study, these actual passenger counts follow the same patterns, with the highest use of ridesourcing taking place late at night during the weekends, with a smaller peak during the weekday morning rush.

Later in this section, an analysis of the travel time by transit and ridesourcing systematically explores the trade-offs that underlie the late-night preference for these services.

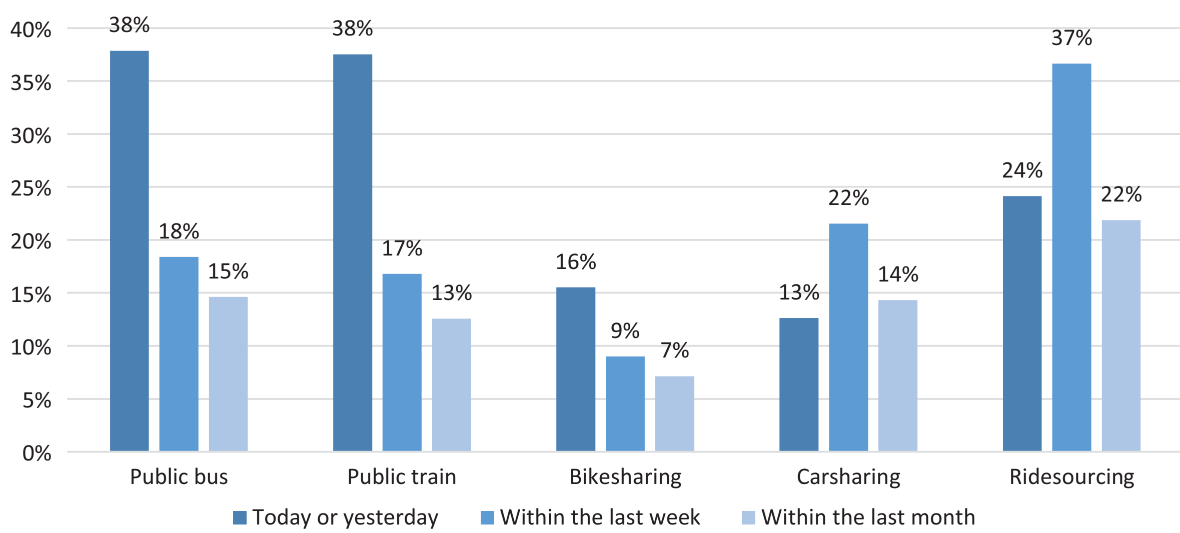
People turn to ridesourcing when they're drinking. The survey for TCRP Project J-11, Task 21 contained no questions specifically about alcohol use, but it did inquire into factors influencing transportation choices and allowed for open-ended answers. Unprompted, more than 100 respondents volunteered that alcohol consumption was a major consideration in their mode choice for recreational trips, and several named ridesourcing (or a specific ridesourcing provider) as their preferred choice in that case. It is likely that if alcohol use had been among the explicit answer choices, the number would have been higher.

Relatively few people use ridesourcing to commute—and those who do, do so occasionally.

Relatively few people use ridesourcing to commute—and those who do, do so occasionally. Some people use ridesourcing to get to and from work at least some of the time. Figure 10 shows clear demand peaks during weekday rush hours, which bears this out. However, ridesourcing did not appear to be a major part of the mobility picture for the majority of commuters who responded to the survey.

Among the 21% of respondents who reported using ridesourcing to commute, 38% said that their most recent ride on a bus or a train was today or yesterday, whereas about one-quarter of the group (or about 5% of total respondents) said that they had last used ridesourcing today or yesterday (Figure 11).

For trips within the last week, the transit proportion declined to 18%, whereas ridesourcing increased to 37% (Figure 11). Together, these changes suggest that people use ridesourcing



Source: Cross-tabulated responses to survey questions 3 and 9 (see Appendix C).

Figure 11. Most recent use of each mode—respondents reporting recent ridesourcing commute.

situationally—and generally not daily—as a mode that fills in gaps or works under specific circumstances rather than as the core mode of their commute. This pattern is similarly reflected in the frequency of use: even among respondents who reported ridesourcing as their top shared mode, only 7% said they use ridesourcing daily, whereas 42% reported using it 1–3 times per month. (See Appendix B, Table B-2 for a full breakout of frequency by mode.)

Lifestyle Clusters

Among shared modes, bikesharing appears to have a role more like transit, whereas carsharing and ridesourcing are used similarly to personal automobiles. In listing alternatives if their preferred shared mode was not available, respondents seem to cluster into two groups: those with "active" transit-centered lifestyles and those with auto-centered lifestyles that feature lower initial levels of transit use (Figure 12).

Bikesharing seems to be very much a part of the active transit-centered lifestyle cluster, with 50% of this group reporting that they would ride a bus or train if bikesharing were not available, and another 39% saying they would walk or ride their own bike; only 7% reported that they would drive or use ridesourcing. This result underscores bikesharing's role as an extension of the transit system—though it could also be seen as evidence of bikesharing diverting some trips from transit, a phenomenon that has been evaluated in several cities by Martin and Shaheen (2014).

The responses from carsharing and ridesourcing users suggest that this group is more auto-centered, with about a third of those modes' top users reporting they would drive alone or with a friend if their preferred mode was not available. Pointing to the level of crossover between modes, 15% of carsharers would use ridesourcing, and 24% of ridesourcers would use carsharing. Both carsharers and ridesourcers are lighter transit users: 23% of carsharers and 15% of ridesourcers would ride a bus or train instead. Some 8% of ridesourcing users say they'd use another mode entirely, and all but one of the open-ended responses to this question mentioned using taxicabs.

These findings suggest two things:

1. Unlike bikesharing, ridesourcing and carsharing are largely not chosen as substitutes for transit trips, but rather as substitutes for private auto trips or taxi rides; and
2. People who prefer carsharing and ridesourcing are probably more likely to have access to a car, and these shared modes give them a way to leave that car at home more often.

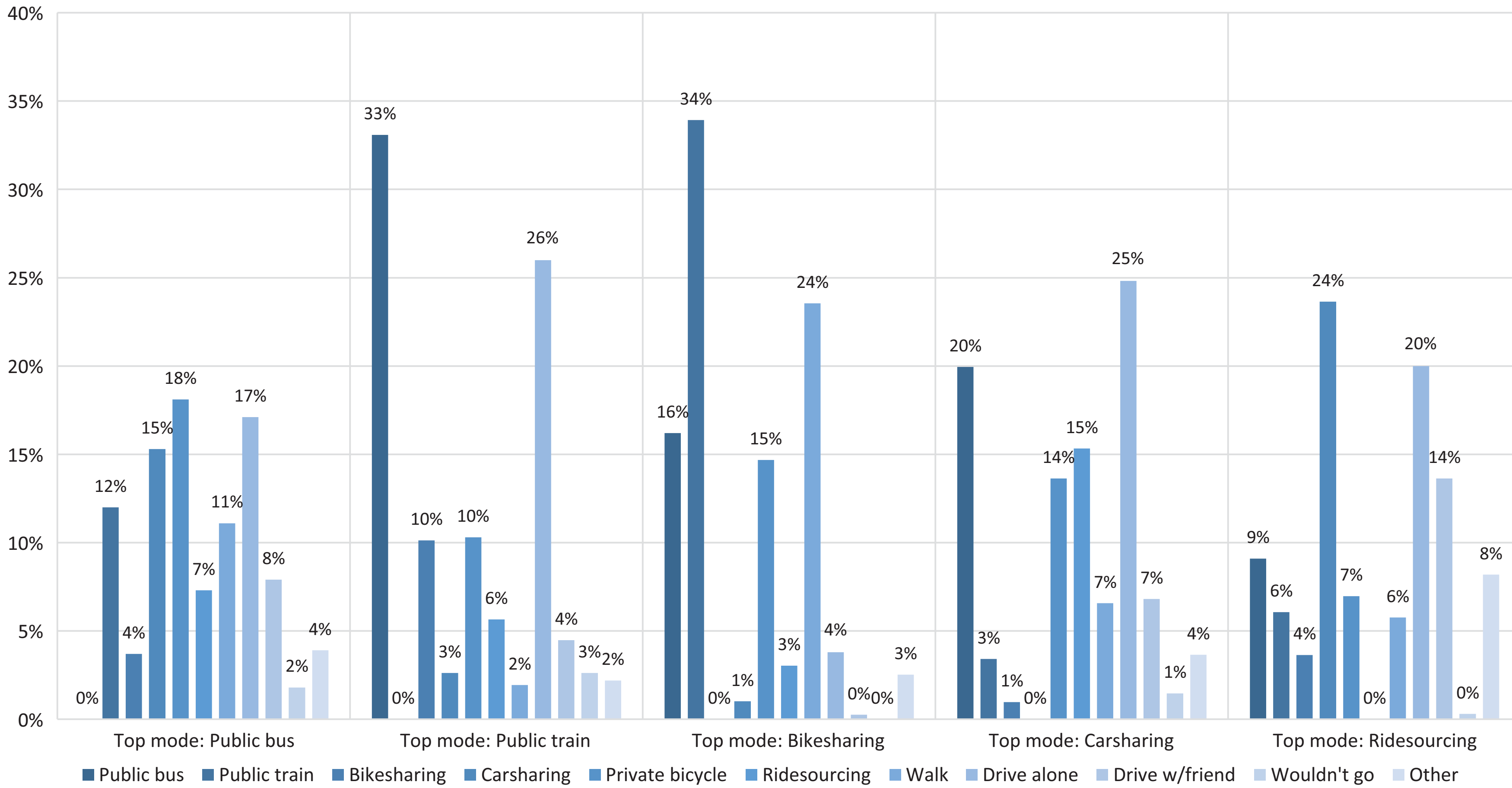
Studies by Cervero et al. (2007), Lane (2005), Martin et al. (2010), and others have established that carsharing users are likely to shed personal vehicles, and the results of the TCRP Project J-11 research point to the possibility of a similar effect for ridesourcing. More research is needed to understand the net effects of these substitutions.

The table of frequency of use by mode (Table B-2, Appendix B) strengthens the associations observed between these lifestyle clusters. Respondents who named carsharing and ridesourcing as top modes reported frequent driving, both alone and with friends or family, at almost twice the rate of those who named bikesharing, bus, or train as their top mode.

Top carsharers and ridesourcers also named bikesharing as their least frequently used mode, with nearly 80% and 70%, respectively, saying they use it less than once a year, or never.

Ridesourcing and Transit: Travel Time Trade-offs

Transit is more competitive when it travels in a dedicated right of way or is otherwise not subject to traffic congestion.



Source: Cross-tabulated responses to survey questions 5 and 4 (see Appendix C).

Figure 12. Alternative for most frequent shared-mode trip if that service was not available—by top shared mode.

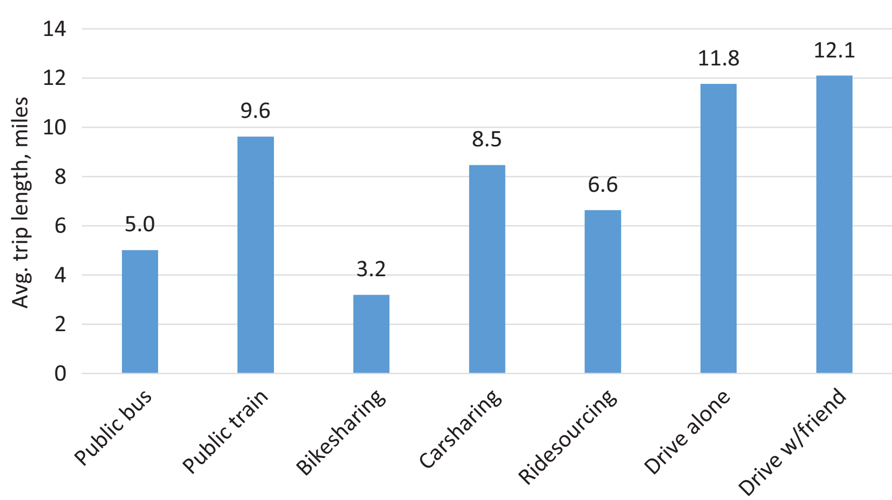
Trip length and speed may be a key concern in decisions about which mode to use, with faster modes increasingly preferable as trips get longer. Although the survey did not ask specifically about the distance of particular trip types, it did ask about typical trip lengths by mode. Among respondents who named ridesourcing as their top mode and who had a ridesourcing commute, 58% reported their most frequent ridesourcing trip was under 5 miles. By contrast, 65% of respondents who named public train as their top mode reported their most frequent train ride was over 5 miles.

Trip length and speed may be a key concern in decisions about which mode to use.

Asked about the length of their most frequent one-way trips using various modes, respondents reported taking the longest trips when driving, averaging about 12 miles both alone or with a friend (Figure 13). For the next-longest trips, the mode most frequently reported was public train, at 9.6 miles. Carsharing and ridesourcing were used for somewhat shorter trips (8.5 and 6.6 miles, respectively), but still for longer trips than the typical bus ride of approximately 5 miles. Bikesharing was used for the shortest trips, at just over 3 miles.

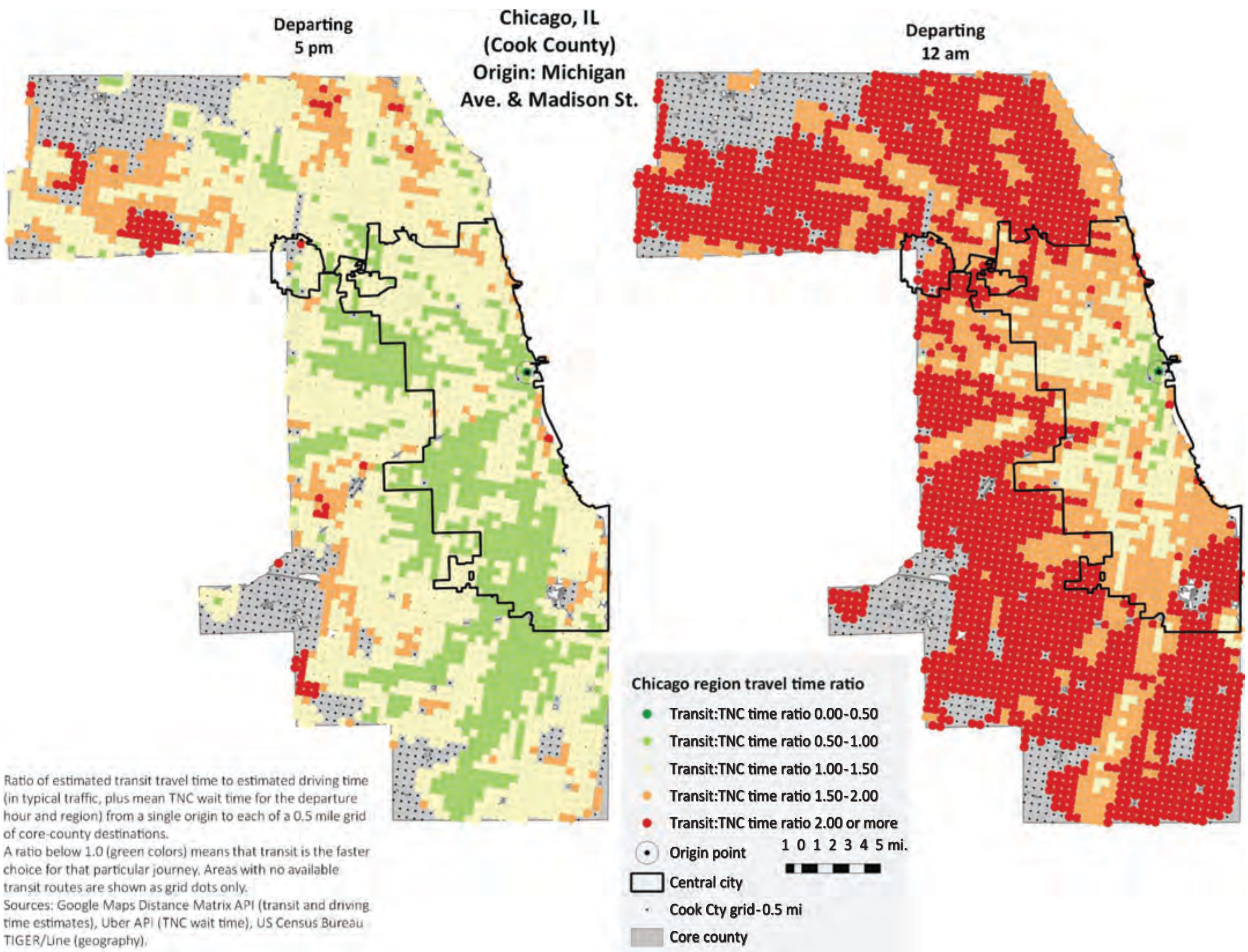
To create a broad picture of the time trade-offs for various trips, and to reveal areas where transit has a particular advantage or disadvantage, the researchers systematically queried a Google-based trip-planning tool to produce a grid of the comparative travel times for transit and for ridesourcing at points across the whole of each study region. Times were calculated for trips from a single origin point located in the highest employment census block group in the region's core county to every other point in the region, along a half-mile grid. Figures 14 and 15 show the ratios between travel times by scheduled transit and travel times by ridesourcing for Chicago, IL, and Austin, TX, including typical wait times and traffic for both modes.

As noted, the comparative travel time analyses for transit and for ridesourcing were performed with all trips originating in the census block group with each region's highest job count. A more comprehensive analysis would create comparisons for a number of origin points—including residential areas, nightlife districts, and large commercial nodes—beyond the business district that is generally the focus of regional transit. This wider analysis was beyond the scope of the present study because of the time required to compile queries and generate the maps; however, the analytical approach shown in this report is readily adaptable to such comparisons. Additional research is being conducted under TCRP Project J-11, Task 25, which will include further analysis along these lines.



Source: Responses to survey question 8 (see Appendix C).

Figure 13. Average trip length, by mode.

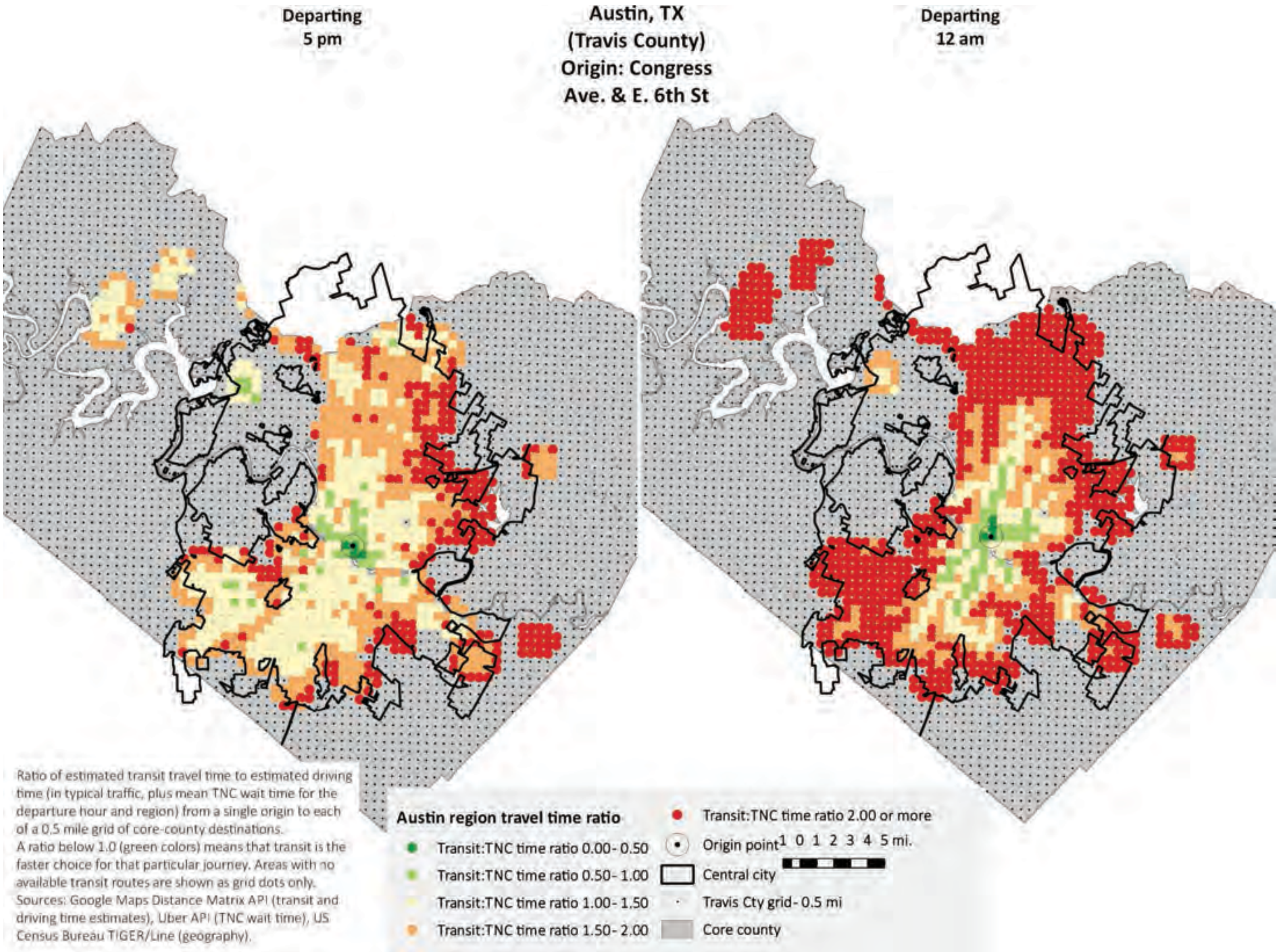


Sources: Google Maps Distance Matrix API (transit and driving time estimates), Uber API (TNC wait time), U.S. Census Bureau TIGER/Line (geography).

Figure 14. Chicago, IL, region travel time ratios.

A comparison of the travel times for the same trip using transit or ridesourcing underscores the rational basis for the usage patterns suggested by the survey and demand analysis. For many trips, transit is a much faster choice at rush hour, especially along fixed-guideway corridors. Alternatively, the trips may be close enough in duration that the significant difference in cost would make a ridesourcing trip prohibitively expensive for daily rides, though using ridesourcing might make sense situationally. But when traffic congestion is less of a factor, and transit headways are much longer, transit's time advantage is much more contained. In addition, some areas or corridors might have unusually long transit times because of the need for multiple transfers even when traveling a relatively short distance. These areas might be places where specific transit improvements, such as new express service or the implementation of bus rapid transit, could have a disproportionate impact for riders.

Figure 14 shows travel time ratios for 5:00 p.m. and midnight in the Chicago study region. The ratios depict estimated transit travel time to estimated driving time (in typical traffic, plus mean TNC wait time for the departure hour and region) from a single origin to each of a 0.5 mile grid of core-county destinations. A ratio below 1.0 (shown in the figure using green points) means that transit is the faster choice for that particular journey; ratios between 1.0 and 1.5 (shown



Sources: Google Maps Distance Matrix API (transit and driving time estimates), Uber API (TNC wait time), U.S. Census Bureau TIGER/Line (geography).

Figure 15. Austin, TX, travel time ratios.

using yellow points) are essentially a wash in terms of time, where it seems likely that cost would play a greater role in the choice; and ratios above 1.5 (shown as orange and red points) mean that ridesourcing is clearly the faster choice. No ratio is calculated for destination points for which no scheduled transit route is available from the origin. (Areas with no available scheduled transit routes appear in the figure as black points on gray.) For example, a peak-hour trip that takes 20 minutes by transit and 40 minutes by ridesourcing would have a ratio of 0.5 (20 / 40 = 0.5). A trip that takes 40 minutes on transit and 20 minutes by ridesourcing would have a ratio of 2.0 (40 / 20 = 2.0). Appendix D of this report provides details on the methodology of this approach and maps of all seven regions.

In Chicago, the region's strong transit service (much of which travels in dedicated rights-of-way) combines with significant traffic congestion to create a map showing large swathes where transit has the advantage or is roughly equivalent to ridesourcing for peak-hour trips from the central business district (Figure 14, left map). Especially along CTA and Metra lines, transit's time advantage can stretch far beyond the city limits in specific corridors. Conversely, several suburban Cook County areas that lie between the region's radial transit lines show a time advantage for ridesourcing, even with typical peak-hour congestion taken into account. However, these points are so far removed from the downtown origin that most people making that trip regularly would far more likely be driving themselves. In these areas, last-mile shared mobility efforts might be fruitful. Many outlying areas (20 miles or farther from the Loop business district) simply have no coverage by scheduled transit, and are so far from regional transit lines that driving is currently the most logical choice for trips downtown.

At midnight, however, the picture shifts considerably (Figure 14, right map). At this time only a limited area close to downtown remains more quickly served by transit. In much more of the city, along with the entirety of suburban Cook County, the time advantage of ridesourcing is considerable. For late-shift workers or people returning from a night out, the choice would likely come down to the ability to access or afford the ridesourcing trip. As the demand and survey data show, this is a time when many people decide to pull out their mobile phones.

The picture is different in regions that have grown around the private automobile and have made less investment in transit that can move past traffic. Figure 15 shows travel time ratios for 5:00 p.m. and 12:00 a.m. (midnight) in the Austin, TX, study region. Again, the ratios depict estimated transit travel time to estimated driving time in typical traffic and using the same distances. As in Figure 14, a ratio below 1.0 (shown in green) means that transit is the faster choice for that particular journey.

In Austin, dedicated-guideway transit is a small portion of the transit system and buses are in mixed traffic and congestion for much of the day. Here, transit is the faster way out of the central business district for fewer destinations. Moreover, for much of the core city and the greater part of the region, no transit routes are available from downtown. Congestion's role in limiting transit accessibility in Austin is underscored by the expansion of transit's time advantage at midnight on a few central-city corridors (Figure 15, right map). This expansion points to the potential for added transit in a dedicated right-of-way to improve the mode's competitiveness, especially in the congested corridors that are covering more of the region. Overall, however, for the vast majority of Austin destinations, ridesourcing is currently the faster of the two modes for travelers departing from downtown, regardless of the time of day.

Equity in an Expanding Mobility Marketplace

Because shared modes are expected to continue growing in significance, public entities are encouraged to identify opportunities to engage with them to ensure that benefits are widely and equitably shared. Transit agencies can improve urban mobility for the entire spectrum of users through collaboration and public-private partnerships, including greater integration of service, information, and payment methods.

Everyone can benefit from a transportation system that provides more mobility options through seamless transfers, integrated fare payment methods, and improved information. However, such a system is only possible if public-sector entities make a concerted effort to ensure that collaboration with private mobility providers results in services that work for people of all ages, incomes, and mobility needs.

Potential for Partnerships and Collaboration to Expand Mobility Access

Many public-sector representatives interviewed for this study (see Appendix A) said they look forward to increased collaboration with the private sector as the shared mobility industry continues to grow and evolve. For instance:

- Several transportation agencies already partner with new shared mobility providers. The earliest collaborations were with vanpooling, carsharing, and bikesharing providers, but

partnerships increasingly include ridesourcing companies and experiments with microtransit and other forms of dynamic demand response.
- Regulation of ridesourcing providers remains a contentious process. At the same time, transit agencies recognize ridesourcing as part of the new urban fabric and an opportunity to extend and expand the use of transit, such as through increased first- and/or last-mile connections.
- Transit agencies are happy to let private providers lead in developing customer-facing technologies, and are widely committed to providing the open data that helps make this possible.

Public-private partnerships increasingly include ridesourcing companies and experiments with microtransit and other forms of dynamic demand response.

Most partnerships between ridesourcing providers and transit agencies are still in the very early stages, however, so at this point little empirical record exists on which to assess their impact or value. Some existing forms of partnership and collaboration are outlined in the section on business models at the end of this chapter.

In reconciling collaborative opportunities with their mandates to serve the public interest, transit agencies and other public entities can recognize their roles as conveners and gatekeepers to the public way. The same institutional heft that makes transit agencies attractive partners for the private sector also allows them to set the terms of agreement to ensure all users have equitable access to information resources, streamlined payment options, and improved, integrated mobility services.

Keeping Service Innovations Fair and Accessible

Because it is a precondition to using many shared mobility services, access to information technology, and smartphones in particular, has been pointed to as a barrier to widespread adoption of new shared modes, especially among people with lower incomes, elderly people, and those who are less comfortable using new technology.

The survey found some differences among the particular tools preferred by various groups of respondents for accessing information about transit and other mobility options. Responses also indicated that transit information technologies are widely used across income and experience levels. (Because the survey was administered online, these results reflect a bias toward users who have some level of familiarity with the Internet.)

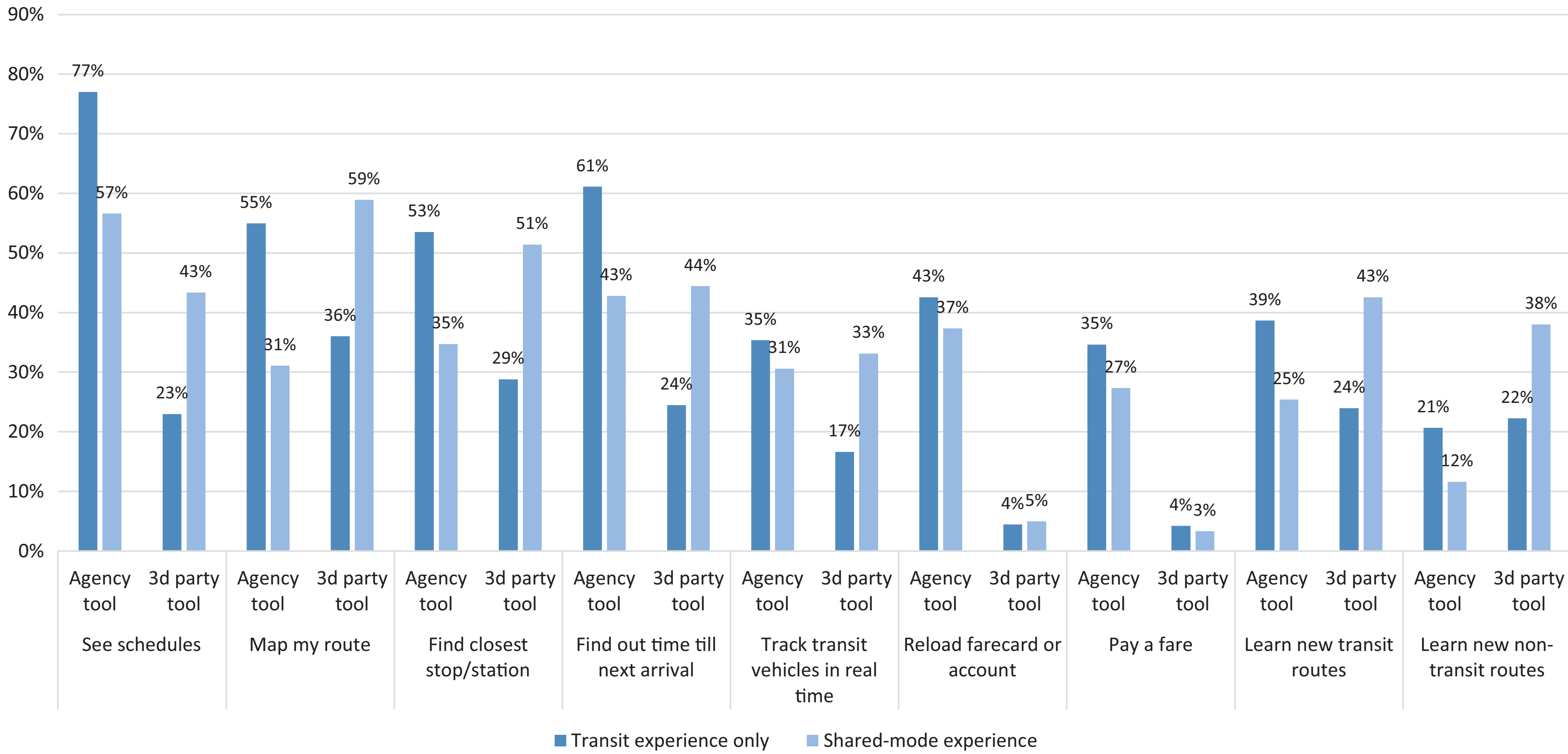
A comparison of respondents with only transit experience to those who have used new shared modes shows that both groups are broadly similar in their familiarity with transit-related information technologies (Figure 16). The most notable difference is in the provider of the tools—the transit-only group was much more likely to use transit agency-provided applications (apps) or websites, as opposed to the third-party tools preferred by respondents who have used other shared modes.

Looking at differences across income levels, the survey found little difference in overall access (Figure 17). Levels of experience were nearly level (at about 70%) across income groups when it came to using transit agency-provided apps or websites to view schedules, whereas use of third-party tools increased with income.

Even among respondents in the lowest income group, about 50% reported having used third-party informational apps, compared with about 70% among the income groups with the highest usage. The difference in adoption rates of transit agency-provided tools versus third-party tools points to the ongoing value of transit agency investment in customer-facing technologies, especially for users who might not have the most current mobile devices.

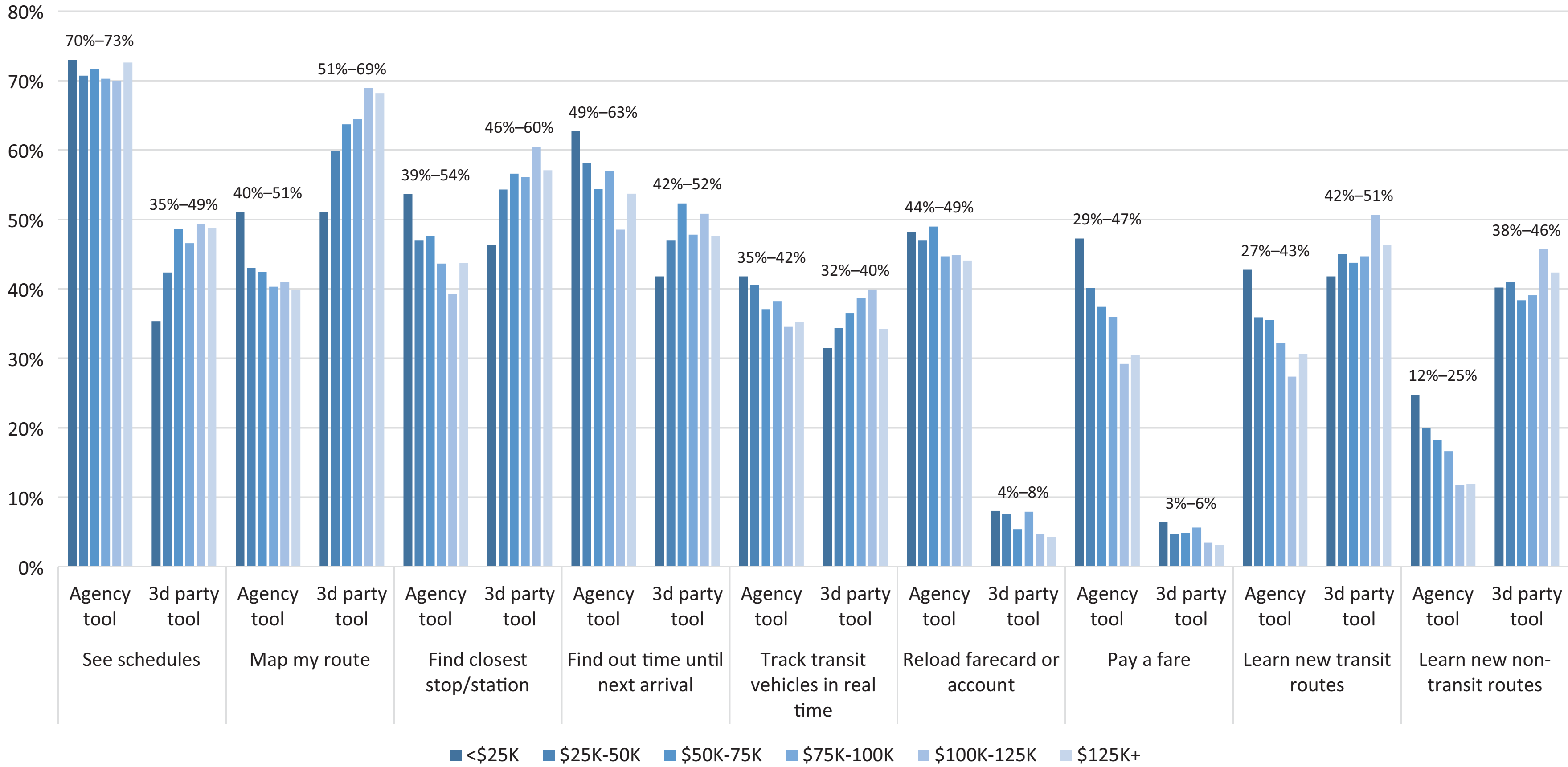
The difference in adoption rates of transit agency-provided tools versus third-party tools points to the ongoing value of transit agency investment in customer-facing technologies, especially for users who might not have the most current mobile devices.

Given that many shared-use services involve using a proprietary mobile app, it follows that use of third-party tools would grow with shared-mode usage in general. Taken together,



Source: Cross-tabulated responses to survey questions 15 and 1 (see Appendix C).

Figure 16. Experience with transit apps and information services, by shared mode experience.



Source: Cross-tabulated responses to survey questions 15 and 22 (see Appendix C). Data labels show ranges of responses.

Figure 17. Experience with transit applications and information services, by income level.

Increasing access to shared-use mobility (SUM) has the potential to improve the transportation picture for people with the fewest options.

these findings suggest that increasing access to shared-use mobility (SUM) has the potential to improve the transportation picture for people with the fewest options—improving connections to transit and access to the region as a whole. Lack of information remains a significant barrier, but lack of access to technology is decreasing over time.

Equity Implications and Other Complexities of Fare and Service Integration

Across the country, transit agencies are working to migrate to new electronic fare payment systems. The integration of fare payment and service information is central to innovations in public transit, the emerging mobility models, and the trend toward mobile app-based payment in general. Even if these innovations involve no changes to the actual fare structure, many transit agencies will need to assess the impact of these changes on minority and low-income customers as part of their obligations under Title VI of the Civil Rights Act of 1964.

Based on lessons from the Title VI equity analyses performed during recent fare media transitions by the Chicago Transit Authority and Portland's TriMet, transit agencies will need to maintain the ability for unbanked customers to purchase fares using cash or other means that do not require a bank account or credit card (Chicago Transit Authority 2013; TriMet 2016). Moreover, transit agencies will need to assess whether proposed changes unduly burden disadvantaged communities in several other dimensions, including:

- New non-fare fee structures;
- Fare loading levels;
- Changes to the mix of retail outlets for fares and fare media, including purchases by mail;
- Access for persons with limited English proficiency; and
- Registration requirements.

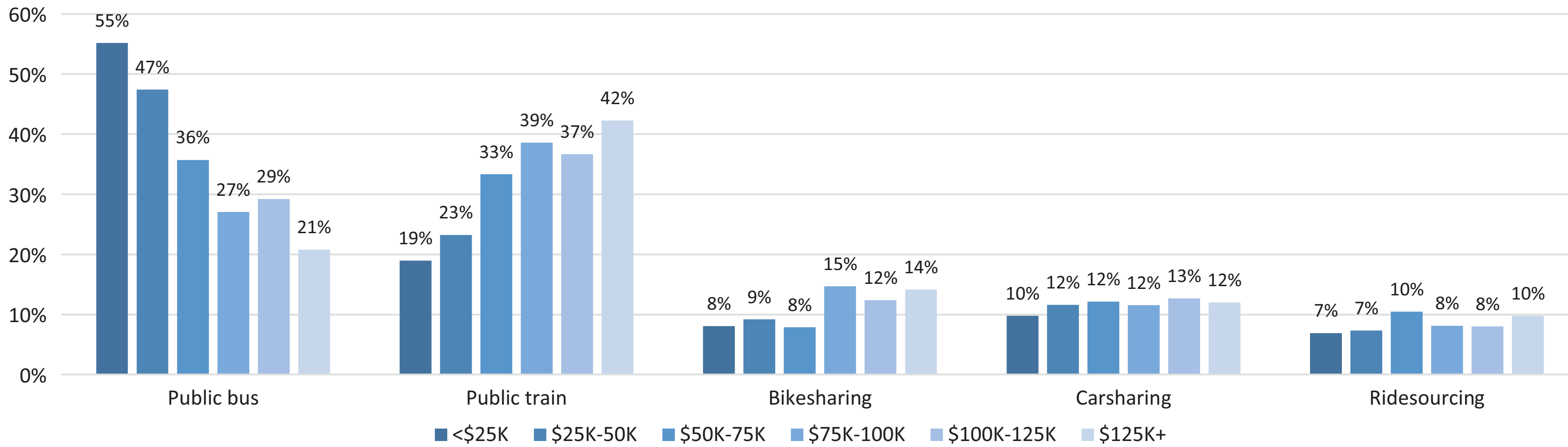
Because they have fewer Title VI reporting requirements, demand-responsive services have more flexibility to change and experiment with new fare structures. As a result, this is an area where many innovations are likely to be initially located. The flipside of this flexibility is that reservations and fare payment for demand-responsive service that is adjacent to a fixed-route transit system (such as a microtransit or ridesourcing provider feeding a larger fixed-route system) might have to remain on a separate payment and reservation platform pending the main transit system's Title VI-compliant adoption of fare changes. So, while this flexibility can help encourage innovative models for fare payment, customer interaction, or actual delivery of mobility services in the demand-responsive services, full fare integration will always be subject to Title VI obligations when it is rolled out to the entire fixed-route system.

Unrelated to Title VI but still central to the discussion of fare integration is the issue of federal transit benefit programs under which pre-tax money can be used for payment of transit fares and certain other forms of commuter transportation. Under present Internal Revenue Service rules, pre-tax dollars cannot be used for carsharing, taxis, ridesourcing, or bikesharing. Thus, any cross-modal fare integration requires the ability (a) to discriminate between modes' benefit eligibility and (b) to pull from separate payment purses accordingly.

Differing Use Patterns Across Incomes

Public transit is the mode of choice for every income level.

Public transit is the mode of choice for every income level. Although the survey revealed differences in how households access the transportation system depending on their income, all households reported one thing in common: Transit was by far the top shared-use mode at every income level (Figure 18). The lowest income riders are most likely to take the bus, whereas riders are increasingly likely to use the train as income level rises. In part, this mode choice may



Source: Cross-tabulated responses to survey questions 4 and 22 (see Appendix C).

Figure 18. Top shared-use mode, by income level.

reflect differences in the geographic availability of bus and train services, especially in the regions studied. Among non-transit shared modes, carsharing is evenly popular across income levels, whereas bikesharing becomes more popular at higher household income levels.

Similar patterns emerge when looking at frequent use (at least weekly) across all modes, split by income level (Figure 19). Bus ridership falls by half as income increases, whereas solo driving roughly doubles between the lowest and highest income levels. Carsharing is used more frequently at the lower end of the income scale, whereas the opposite is true of bikesharing.

Lower income households have much to gain from wider availability of shared-use modes and from carsharing in particular.

Lower income households have much to gain from wider availability of shared-use modes and from carsharing in particular. Shared-use modes expand options for lower income households. As noted before, the option to drive rises with income. Moreover, at three times the rate of every other cohort, the lowest income group reported that if their top mode was not available, they simply wouldn't go (Figure 20).

Among non-transit shared modes, carsharing was reported as the top alternative mode for low- to moderate-income respondents, with its use decreasing at higher incomes. These data underscore the role that carsharing can play in helping people access destinations more easily reachable by car while avoiding the costs of full-time car ownership.

Public-Private Collaborations to Improve Paratransit

Technology and business models from the shared mobility industry have the potential to lower costs, increase service availability, and improve rider experience.

Public-sector agencies and private mobility operators are eager to collaborate to improve paratransit using emerging approaches and technology. Although regulatory and institutional hurdles complicate partnerships in this area, technology and business models from the shared mobility industry can help lower costs, increase service availability, and improve rider experience.

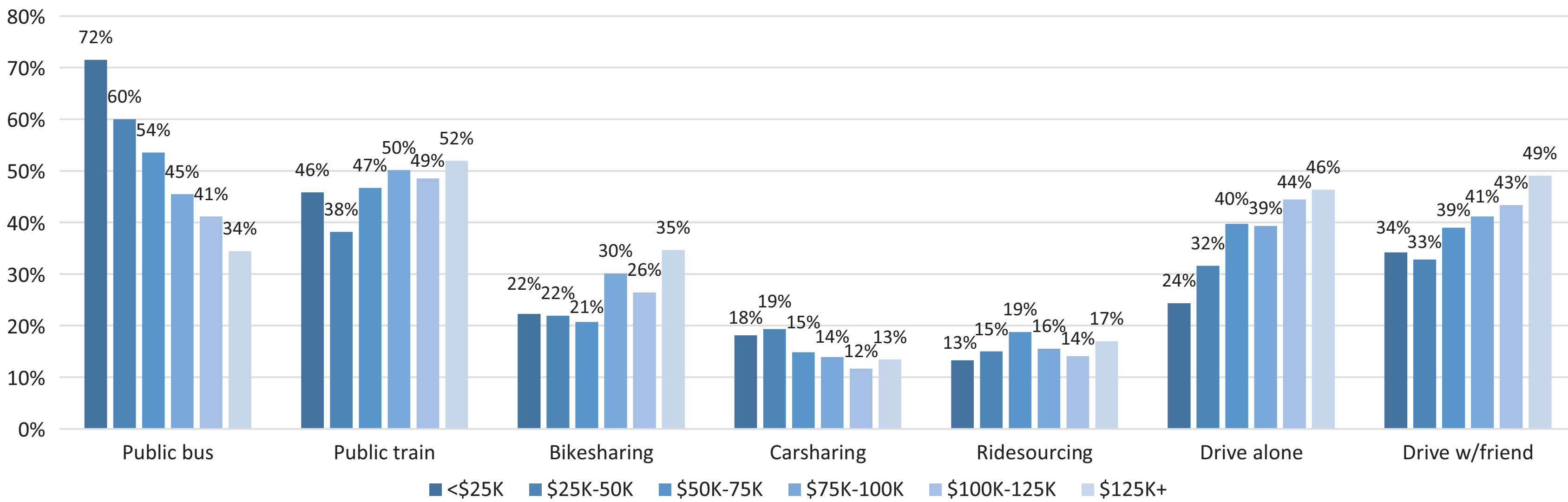
Paratransit and other community transportation services (which often take the form of subsidized door-to-door trips in wheelchair-accessible shuttles and taxis) play a vital role in serving older adults and persons whose disabilities prevent them from readily accessing traditional public transit. These services are highly regulated and expensive to operate, and both demand and costs are rising steeply. A recent FTA study found that between 1999 and 2012, the annual number of ADA paratransit trips increased from 68 million to 106 million, while the average cost increased from $14 to $33 per trip—a cost increase of 138%, compared with an increase in the unit cost of fixed-route bus service of 82% over the same period (FTA 2014).

Representatives from transit agencies and private operators who were interviewed for this study expressed a strong interest in finding ways to harness emerging shared-use business models and technologies to increase mobility, lower costs, and improve the rider experience associated with paratransit and related services. (Agencies interviewed are listed in Appendix A.) Slowing the growth of costs could have a major impact on transit agencies' operational spending.

Several transit agency representatives noted the lack of clear federal guidance addressing some of the emerging partnership models, particularly about the degree to which public agencies' regulatory obligations extend to private partners. Future research could explore areas where clearer federal guidance is needed.

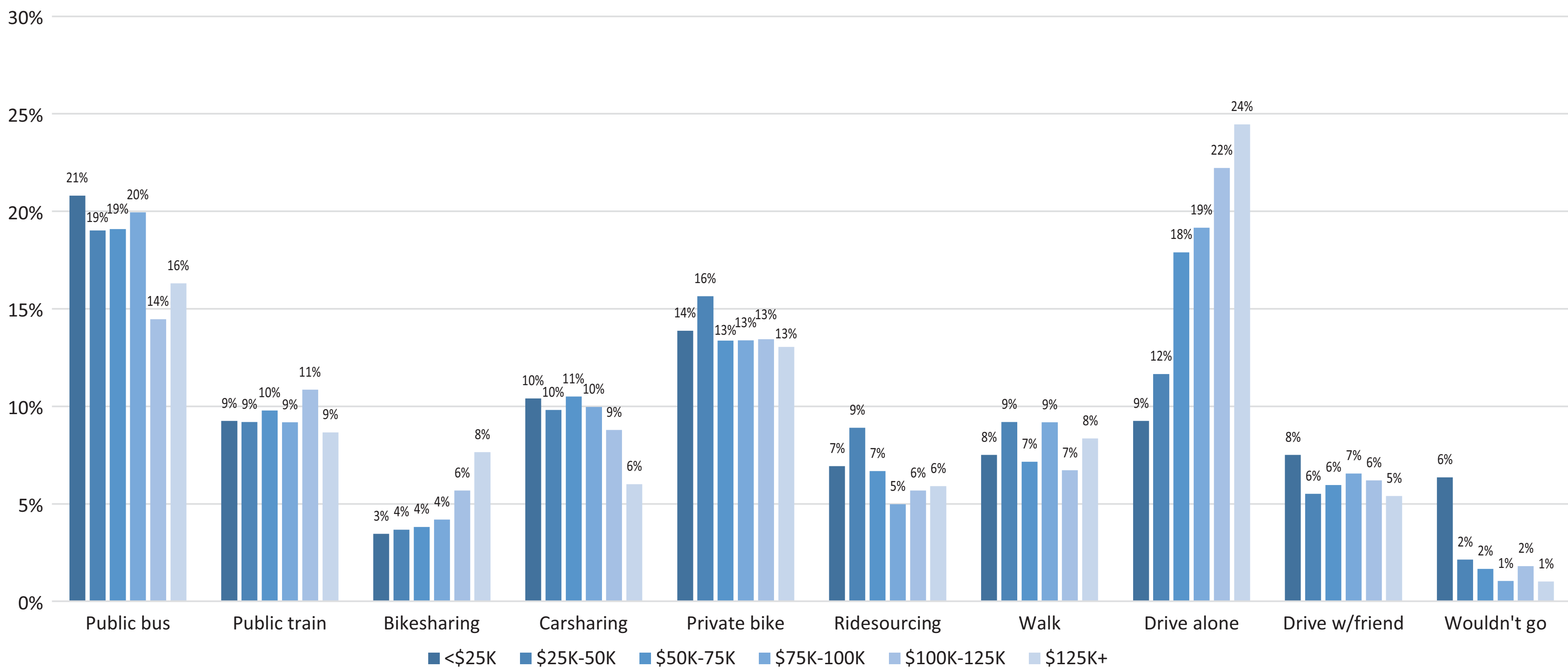
The technologies and business models of the new shared-use modes will likely find applicability to paratransit in two main ways. First, individual technologies developed for new shared mobility services can be folded into existing paratransit operations as part of the ongoing technical evolution of the sector. Some applicable methods and technologies include:

- Interactive reservation, confirmation, schedule adjustment, and cancellation systems;
- Dynamic dispatch and routing of vehicles;



Source: Cross-tabulated responses to survey questions 7 and 22 (see Appendix C).

Figure 19. Frequent use (once a week or more), by income level.



Source: Cross-tabulated responses to survey questions 5 and 22 (see Appendix C).

Figure 20. Alternative if top shared mode not available, by income level.

- Route combination for riders with similar origins/destinations;
- Mobile app-based payment integrated into reservation systems;
- Ability to track vehicle arrival and share trip details, location, and estimated arrival time with caregivers or other third parties; and
- Real-time customer feedback.

The second, and perhaps more revolutionary, application would be the direct provision of transportation services to persons with disabilities by ridesourcing or microtransit operators. Engaging such services might seem like an extension of traditional taxi subsidies or dial-a-ride forms of demand-responsive transportation, but fundamental differences in the underlying business models of traditional and shared-mode transportation options make it a more complicated step. At the same time, such an arrangement offers the possibility for greater change if the business questions can be resolved.

Complexities of Direct Paratransit Provision by Ridesourcing Companies

Much of the complexity regarding current ridesourcing business models as they relate to public transportation springs from the nature of drivers' relationships with the ridesourcing companies (i.e., whether the drivers are employees or independent contractors). This question is currently being litigated in several jurisdictions. As long as drivers are considered independent contractors who can be provided with incentives but cannot be subject to employment conditions, several hurdles make it difficult for ridesourcing companies to begin providing contracted paratransit services using federal monies. Those hurdles include:

- **FTA-required drug and alcohol testing.** Such testing applies to any party contracted to provide transportation services for a public transit agency (Nelson\Nygaard Consulting Associates et al. 2007). Testing is required for operators, dispatchers, and maintenance personnel for transit agencies or contractors receiving funding under Sections 5307, 5309, and 5311, the major public transportation funding programs, including taxi companies in a contractor (rather than vendor/voucher) relationship (49 CFR Part 655 final rule effective June 25, 2013). Section 5310 organizations (which provide services specifically for the elderly and people with disabilities) are exempt from the testing requirements only if they do not provide any services for an agency funded under the other programs.
- **Liability and occupational safety relating to transfers and loading/unloading of non-ambulatory riders.** Potential exists for injury to both drivers and passengers if drivers are not properly trained to help people with impaired mobility to load, unload, and secure their wheelchairs.
- **Provision of door-to-door (versus curb-to-curb) service, which is determined by individual agency policy.** Even if the general practice is to provide only curb-to-curb service, however, a driver must "provide assistance to those passengers who need assistance beyond the curb in order to use the service unless such assistance would result in a fundamental alteration or direct threat" (FTA 2015). Although providers may ask passengers to request assistance in advance, the driver must provide such assistance as would actually allow the passenger to use the transportation to get from the origin to destination, even if the policy is curb-to-curb service and if the passenger fails to request assistance. Any private contractor being used to provide paratransit service would need to follow these rules.
- **Requirements for accepting accessible rides and for accommodating wheelchairs or service animals.** Ridesourcing companies have had inconsistent results in this area, although it is of increasing interest to some companies.

- **Heightened vehicle safety and inspection requirements and insurance costs associated with ADA provision and the transportation of fragile individuals.** These requirements and costs go beyond the already-identified questions about the applicability of non-commercial insurance in a ridesourcing provision.

Even if the employment question is resolved, other considerations remain if ridesourcing or microtransit companies move into direct paratransit provision. Such considerations include the following:

- **Fleet-level accessibility requirements.** Unlike fixed-route transit fleets, which must be 100% accessible, demand-responsive transit service can be delivered with a fleet that offers a mix of accessibility levels, as long as the level of access provided to riders with disabilities is equivalent to the level of service it provides to riders without disabilities (49 CFR 37.77[b]). FTA guidance states that a mix that includes inaccessible vehicles may be used for provision of complementary paratransit "as long as accessible vehicles are dispatched to riders who need them"(FTA 2015).
- **Fleet ownership prohibitions.** In some jurisdictions, questions of fleet-level accessibility may be moot—most notably, throughout the state of California, where TNCs are by definition prohibited from owning vehicles or fleets used in their operations (California Public Utility Commission, Rulemaking 12-12-011, 2013). In these situations, accessible vehicles would have to be provided by drivers under incentives from the companies (leased vehicles are permissible under the rules), or through partnerships with other providers who can own accessible fleets.
- **Buy America provisions.** Most federally funded rolling stock procurements above $100,000 are subject to the requirement that vehicles and components be substantially manufactured and assembled in the United States. Some flexibility exists in the application of these requirements and waivers are available, but the auditing requirements can add significantly to the unit cost of the kinds of smaller vehicles used for paratransit or other demand-responsive services (Macek et al. 2007).

The clearest and quickest way to address the first set of hurdles is for existing paratransit providers to consider licensing portions of these new ridesourcing technologies and deploying them within existing structures. Pilot initiatives along these lines could begin immediately. In the longer term, public agencies may work toward reforming or creating new classes of regulation for emerging business models in order to encourage greater innovation from the private sector to help improve paratransit provision.

Building on the Innovations of Shared-Use Modes for Paratransit

A close reading of the regulations and a review of the policies and practices of paratransit systems across the country suggests a number of applications for emerging shared-use models and associated technologies in serving ADA rides. Public transit agencies can build on the innovations of shared-use modes that include:

- **Bringing reservation systems into the 21st century.** The paratransit sector is ripe for change in the area of reservations. In 2014, FTA found that less than 15% of paratransit systems used voice-interactive or web-based applications for reservations, with electronic fare collection similarly slow to be taken up (FTA 2014). Telephone reservations will always need to remain available for reasons of accessibility, but considerable staff costs could be saved by the wider use of electronic customer interfaces. Several transit agencies, including Capital Metro in Austin, have opened mobile app- or web-based reservation systems for customers who can use those options, while preserving their live telephone reservation systems.
- **Using concierge services.** In several cities, shared mobility providers are piloting services that act as a human front-end to an electronic service interface for customers who want to

access these services but either don't have a smartphone or can't use the default interface. Because it ultimately delivers the request to a ridesourcing provider, this arrangement is at present outside the realm of paratransit; however, paratransit providers that move to dynamic reservation systems could use this option. Together with automated scheduling and rapid improvements in routing software (which are being quickly taken up by paratransit agencies), concierge services could reduce reservation staff requirements.

- **Providing same-day paratransit rides.** Paratransit provision is governed by rules requiring advance reservations, with reservations accepted up to 1 day in advance of the requested ride. These requirements result in a customer experience marked by inflexibility and foreclose the possibility of spontaneous choices. However, FTA guidelines and rules do not prohibit paratransit providers from offering a same-day "premium" service. Because a premium service is not governed by the usual rules regarding complementary paratransit (which include restrictions on service areas, fares, and permissibility of limiting riders based on purpose), a premium service can offer greater scheduling flexibility. Offering a premium service does not remove the paratransit provider's obligation to make available regular ADA paratransit service that complies with regulatory requirements. Several paratransit agencies already provide premium services to ADA-eligible passengers.
- **Making greater use of feeder paratransit.** Feeder paratransit service offers rides to and from transit, rather than door-to-door service. At present this service is used fairly infrequently, likely because of the expense to transit agencies and the additional trip time caused by transfers. More efficient linkages arising from the opportunities and innovations available with shared modes could make feeder paratransit a more practical format and enable riders to make more efficient use of existing transit infrastructure.

Private-Sector Providers Can Improve ADA Services

New technology-enabled services for passengers with disabilities are not yet being widely provided in the context of paratransit, but such services could offer many paratransit customers greater flexibility and better customer service. Private mobility providers can further enhance their ability to serve passengers with diverse needs by taking steps such as:

- **Expanding niche services.** Service models are beginning to emerge that recognize the diverse needs of passengers with disabilities, and the higher standards required of the drivers who work with them. Services like SilverRide (which focuses on older adults who either prefer not to drive or can no longer drive) hire and train drivers to accommodate the specific needs of their customers. For example, drivers receive training in first aid, safe lifting and transfers, and improved communication. Companies like HopSkipDrive and Kango (which offer families ridesourcing for their children) also provide extra training, background checks, and even outside certification of drivers. These companies show how the shared mobility industry is creating new models to accommodate the specific needs and vulnerabilities of various populations. Although these niche services could potentially be bolstered by federal guidance, the role of such services in relation to formal paratransit that makes use of federal funds is still evolving.
- **Providing incentives to drivers for taking accessible rides and using accessible vehicles.** Many of the most innovative features of new shared-use modes, and ridesourcing in particular, are based on the idea of using incentives to produce desired outcomes. To better serve riders with disabilities, companies could provide a way to request drivers willing to accommodate specific needs, and offer incentives for drivers to provide the needed services. Such a system could work best if there are clear state or local regulations that encourage companies to provide universally accessible service, particularly in situations where they receive public monies—which could prompt operators to absorb or underwrite the additional expense to drivers of leasing/purchasing and maintaining accessible vehicles.

- **Making accessible interfaces standard.** Riders might not necessarily want to use paratransit, but in many places it is the only option available to people who can't drive themselves. By making accessible interfaces available (i.e., interfaces that can easily be used with a screen-reader and don't require dropping a pin or dragging a map), shared mobility providers could make their services useful for a wider range of customers.

Emerging Mobility Business Models and Partnerships

Emerging business models include new forms of public-private partnership for provision of mobility and related information services. Public entities, including transit agencies and local transportation departments, are already engaging with private operators and using new technologies from the shared mobility world. This section describes several efforts that can provide examples for agencies interested in beginning to collaborate or incorporate new approaches into their operations.

Cross-Modal Trip Planning, Reservation, and Payment App Integration

Several public entities have taken the lead in establishing partnerships to integrate existing transportation services with private mobility providers.

Cross-modal trip-planning, reservation, and payment application integration can include integration of fare media, trip-planning technology, and physical integration of modes. Such public-private partnerships are important because they can help increase ease of use and transfers between disparate modes. Several public entities have taken the lead in establishing partnerships to integrate existing transportation services with private mobility providers.

- **Buffalo Niagara Medical Campus GO BNMC Program, Buffalo, NY.** Especially notable because the effort is led by a regional institution and large employer rather than a transportation agency, the GO BNMC initiative connects campus employees to alternative transportation options, linking access to carsharing, bikesharing, shuttles, secure bicycle and car parking, and other transportation services through campus IDs that act as contactless smart cards. The campus has received some funding from the New York State Energy Research and Development Authority to launch a second pilot focused on the creation of an integrated mobility hub at which employees and residents can access and make connections between an array of transportation services at a single location (Marlette 2015; BNMC, Inc. 2013).
- **Go LA multimodal trip planning mobile app.** The City of Los Angeles partnered with Xerox to launch the Go LA wayfinding app in January 2016. The app aggregates every available mode of transportation—including transit, carsharing, ridesourcing, private bike, and eventually bikesharing—for a given route and calculates the time, cost, and carbon footprint for each option. As the system learns about its users' individual travel preferences, it will eventually recommend and highlight personalized commuting options. Future updates to Go LA will also include a single payment system that lets users pay for multiple transportation options through the application (Korosek 2016).
- **TriMet-GlobeSherpa Partnership, Portland, OR.** Portland's TriMet transit system announced in March 2016 that riders will soon be able to hail a Lyft ride or reserve a car2go vehicle using its new mobile ticketing application, developed by payment solutions provider GlobeSherpa (now moovel North America). The multimodal integration will be powered by RideTap, a software tool that lets apps integrate with shared use systems and other transportation options (Njus 2016).
- **Twin Cities HOURCAR/Metro Transit multimodal integration.** In 2015, the Twin Cities carsharing company HOURCAR upgraded its vehicle technology to recognize the chips in Metro Transit Go-to cards. This technology allows members to swipe a registered transit pass to lock and unlock the doors of any HOURCAR vehicle (HOURCAR 2016).

- **Ventra Mobile App, Chicago, IL.** Transit users across the Chicago area can access and pay for rides with the region's three transit agencies—the Chicago Transit Authority (CTA), Metra, and Pace—from their smartphones using the Ventra mobile app (Metra 2014). Riders on Metra can use their phones to display their train passes.

Microtransit/Dynamic Demand-Response

These models extend the reach of fixed-route transit into lower density areas with dispersed ridership, provide service in core areas outside of peak travel times, or augment fixed-route transit in corridors that are operating at or beyond capacity. Using dynamically dispatched multi-passenger vehicles such as vans, shuttles, or buses, the services optimize routes and stops by balancing multiple customer requests on the fly. Rather than providing door-to-door service, these models may use a service zone with origin and destination points determined to serve the mix of customer requests at a given moment. The services listed in this section generally connect to fixed-route public transit services at one end of the trip. Some of these services are public-private partnerships and others are operated directly by the transit agencies using emerging reservation and routing technologies.

- **Denver Regional Transportation District (RTD) Call-n-Ride Program.** Denver RTD's Call-n-Ride program provides dynamic shuttle service within 20 service zones in lower density areas of the metro area and focuses on connecting riders with bus routes, rail stations, and Park-n-Ride sites. The system builds routes from phone- or web-based reservations that can be made 2 hours to 2 weeks in advance, and the cost to riders is the same as a local fare elsewhere in the RTD system. Some Call-n-Ride service areas also offer flex-route service during morning and evening rush hours, which provides reservation-free rides from designated stops within the service area (RTD-Denver 2016).
- **Kansas City Area Transportation Authority (KCATA)/Bridj pilot program.** In March 2016, Kansas City's transit agency launched a 1-year pilot program that uses the transit agency's drivers and KCATA-branded vehicles to operate a microtransit system built on the Bridj technology platform. The pilot is based in two zones around downtown Kansas City, MO, and the University of Kansas Medical Center district (KU Med Center) just across the state line in Kansas City, KS. The latter zone is a large suburban campus that is poorly served by public transit and experiences high peak-hour congestion. During weekday rush hours, riders can use the Bridj mobile app to request rides within and between the two zones for a $1.50 fare (the same as a KCATA bus ride but paid through the Bridj app), and the platform matches groups of riders and dynamically generates routes based on common origins and destinations (KCATA 2016; Hawkins 2016).
- **Milton, Ontario, GO Connect pilot program.** Piloted between May 2015 and April 2016 in suburban Toronto, this demand-response pilot addressed passenger connectivity challenges between the regional commuter rail system (GO Trains) and a smaller suburban system through an application-based system. The service operated during the weekday morning and evening peak periods, connecting customers to and from their preferred GO Trains. Shuttles operate on optimized routes, based on reservation requests through the RideCo software platform, which dynamically adjusts routes and pick-up/drop-off locations to maximize operational efficiency and minimize real-time travel delays (Town of Milton News 2015).
- **Santa Clara Valley Transportation Authority (VTA) FLEX pilot.** In January 2016, the VTA launched an on-demand, dynamic transit program that provides connection service between regular transit stops and high density employment centers and retail centers within a 3.25-square-mile section of Santa Clara County. After customers request and pay for rides via a smartphone application, the system creates optimal shuttle routes among a network of stops (VTA 2016).
- **West Salem Connector.** Salem-Keizer (Oregon) Transit's Cherriot bus system began piloting a zone-based dynamic shuttle system in June 2015. The service provides dynamically

routed trips among a network of 26 set stops in the suburban area of West Salem, OR, with the aim of connecting dispersed riders to the transit agency's scheduled routes (Salem-Keiser Transit 2015). The system, based on the DemandTrans reservation/scheduling platform, takes web and phone reservations between 30 minutes and 2 weeks before a given ride to generate routes and stops, and uses the same fare system as the transit agency's regular service. Using the transit agency's vehicles and drivers, the system is being tested as a replacement for several low-ridership routes, with the transit agency instead focusing on providing greater frequency along key corridors, with the new service acting as a feeder based on actual demand (Southward 2016).

Private Access to Public Rights-of-Way

Use of the public right-of-way by private operators—for parking, passenger loading/unloading, deliveries, or travel in limited-access zones such as dedicated transit lanes—can lead to conflict, especially in busy areas with many competing demands for curb access or parking. However, it can also lead to opportunity. Some cities have taken a proactive approach to managing private use of street parking spots, transit stops, and other common areas, and used these new pilots and ordinances to generate revenue, encourage compliance, and ensure that mobility companies help to serve the public interest. Several jurisdictions have tied these policies to broader objectives, such as ensuring equity in the geographic distribution of services and addressing climate goals.

- **DC Carshare Street Space Ordinance.** Beginning in 2011, the District of Columbia Department of Transportation (DDOT) established a program to allow one-way carsharing members to park shared vehicles in residential permit parking zones throughout the city. The ordinance requires carsharing providers to maintain an area of operation that includes the entire District of Columbia and to keep at least one percent of its fleet available in each ward of the city at all times. Additionally, DDOT's ordinance requires that a set number of carsharing vehicles be located in low-income neighborhoods as identified by DDOT, even if such locations are not desired or requested by the company (DDOT 2016).
- **San Francisco Municipal Transportation Agency (SFMTA) Commuter Shuttle Pilot.** The SFMTA launched an 18-month Commuter Shuttle Pilot Program in August 2014, with the goal of minimizing the negative impacts of the region's many private commuter shuttles while offering a framework to manage their operation. Central to the pilot was the creation of a limited network of shared Muni and commuter shuttle stops throughout the city. To use the network, shuttle service providers had to apply for a permit and pay a fee of $3.67 per stop-event (as of Fiscal Year 2016). Meanwhile, the program was enforced by the SFMTA to ensure that shuttle operators followed all rules and regulations outlined in the pilot (SFMTA 2016).
- **Seattle Carsharing Ordinance.** Flowing in part from local climate action goals, this 2015 ordinance realigns curb-access priorities while significantly raising the cap on "free-floating" (one-way) carsharing in the city, allowing carsharing companies to eventually operate a total of 3,000 one-way vehicles and tying this total to full coverage of the city. At the same time, the law seeks to replace revenue lost to carsharing's use of metered parking spaces by both one-way and round-trip vehicles. The ordinance sets annual permit fees for free-floating vehicles ($1,730 per vehicle, which includes access to both metered and residential permit spaces, with annual adjustment for actual use of metered spaces) and for dedicated on-street spaces for round-trip carsharing ($3,000 per metered space and $300 per non-metered space). The program initially caps each one-way operator at 500 vehicles, with a requirement that each establish within 2 years a service area covering the entire city, at which time they may operate up to 750 vehicles (Seattle Municipal Ordinance 124689, 2015).

Service Links and Hand-offs

Several transit agencies have begun working directly with ridesourcing companies and other private providers to link their services or to promote hand-offs through targeted marketing agreements. These arrangements—which include first- and last-mile partnerships, linked mobile apps, and guaranteed ride home programs—can help facilitate the creation of a robust, interconnected network of mobility options that supports car-free and car-light living.

Arrangements such as first- and last-mile partnerships, linked mobile apps, and guaranteed ride home programs can help facilitate the creation of a robust, interconnected network of mobility options that supports car-free and car-light living.

- **Dallas Area Rapid Transit/TNC Partnerships.** In April 2015, DART announced a partnership with Uber that would allow transit riders to connect with Uber through DART's GoPass? mobile ticketing application. DART customers are able to "walk through" the agency's application to access Uber's app. To encourage people to try the new combination, Uber offered a free first ride (up to $20) to new customers. In October 2015, DART announced a similar partnership with Lyft (DART 2015a; DART 2015b).
- **King County Metro and Redmond Real-Time Rideshare and Emergency Ride Home Programs (Seattle and Redmond, WA).** King County Metro and the City of Redmond have partnered with iCarpool, a mobile ridesharing app, to facilitate carpooling among local commuters. Drivers and riders are able to share the cost of the trip via an automated in-app payment system. Drivers post their trip on the application up to an hour before leaving, and riders searching for a trip along the same route or to the same destination will be matched with the driver. Through the service's Emergency Ride Home program, carpool users who can't get a ride home through the iCarpool application are also eligible to receive up to eight free rides with Uber or Lyft per year. The system is designed to allow users to take part in the program with the confidence that they'll be able to get home if an unusual situation were to arise, such as a child care emergency or an unplanned late night at work (City of Redmond 2016).
- **Metropolitan Atlanta Rapid Transit Authority/Uber Partnership.** In July 2015, MARTA launched a Last Mile Campaign in partnership with Uber. Through the partnership, users who are new to Uber can sign up with a promotional code for a first free trip, up to a $20 value (Uber 2015; Irvin 2015).
- **Pinellas Suncoast Transit Authority-Taxi/TNC Partnership.** Through the Direct Connect program announced in February 2016, the PSTA will pay half the cost of an Uber or local taxi ride (up to $3) to or from transit to help provide first- and last-mile connections in the region. Designed to facilitate use of local bus service, the program allows riders to use Uber (in Pinellas Park, FL) or United Taxi (in Pinellas Park and East Lake, FL) to travel within a specific geographic zone to or from a series of designated stops. From there, riders can connect with the regular PSTA public transit bus system. On the return trip, transit riders can use Uber or United Taxi to travel from the designated stop back home or to work (PSTA 2016).

CHAPTER 3

Conclusions: Suggested Opportunities

This research points to actions that public transit agencies and other public-sector entities can take to build on the mobility innovations of technology-enabled shared-use modes. It identifies opportunities for cooperation and suggests regulatory enhancements, institutional realignments, and forms of public-private engagement that would allow innovation to flourish while providing mobility as safely, broadly, and equitably as possible. The conclusions presented in this chapter highlight the following opportunities identified by the research:

- Change performance metrics to make efficient mobility the goal;
- Extend fare integration and mobile payment beyond smoothing farebox interactions to goals such as subsidy administration, mode-shift, and gathering ridership data;
- Keep information open and widely available for the broadest benefit;
- Lay the groundwork for strong public-private partnerships and targeted investments in the mobility system, including public transit and shared modes;
- Maintain accessibility and equity as central mandates for urban and regional mobility, especially with an evolving mix of public and private participants; and
- Transform public transportation agencies into mobility agencies.

Change Performance Metrics

- **Take a big picture approach to make efficient mobility the goal.** Current metrics that focus solely on operational measures such as route ridership, unlinked trips, passenger revenue-miles, or road capacity and congestion are not sufficient for gauging performance in the expanding mobility ecosystem.
- **Improve metrics to take into account the entire mobility picture.** This broader view would include increases in linked multimodal trips and reductions in solo car trips, vehicle miles traveled, and transportation-related climate impacts.

Extend Fare Integration and Mobile Payment

- **Integrate fare payment systems to simplify the subsidy of linked rides.** An example of such integration is the Pinellas Suncoast Transit Agency's pilot to partially subsidize transit-linked ridesourcing trips, or King County Metro Transit's emergency ride home program. In-app payments could draw from a pool of voucher money established through an agreement between the company and the transit agency that is reconciled on the back end.
- **Make use of new technologies' rich data-gathering capabilities.** As part of fare integration, transit agencies can partner with aggregators and other mobility providers to more accurately measure transit usage and cross-mode linked trips, since both are measures of trips that aren't

taking place in personal autos. Increases in linked trips, both within and across modes, could be a performance goal.

- **Use Title VI equity analyses relating to fare medium changes to understand how to broadly distribute the benefits of integrated payment and information.**

Make Information Widely Available

- **Build in accessibility from the ground up whenever information or payment solutions are pursued.** Accessibility can be part of every payment or information system RFP.
- **Continue to develop common standards for payment, storage of customer information, and privacy.** Ideally, public authorities should actually own and maintain cross-modal data in an integrated system.
- **Ensure data reciprocity from the private sector, which benefits greatly from open public data.** A "walled garden" model will not work for ridesourcing companies and other private operators if they expect to take part in a wider mobility ecosystem. Public transit operators, planners, and researchers need these data to understand how people are moving and where intervention may be needed.
- **Support the development and adoption of shared mobility information standards.** The general bikeshare feed specification is already available, but something similar is needed for carshare, ridesourcing, microtransit, and other new modes.
- **Use open data and APIs, continue improvement of feeds, and encourage private sector innovation.** Making contracting more flexible for transit agencies will help ensure they are not locked into a single vendor's proprietary software and hardware.

Cultivate Public-Private Partnerships and Targeted Investment

- **Explore opportunities and challenges for public transportation as they relate to technology-enabled mobility services.** As part of this effort, suggest ways that transit can learn from, build upon, and interface with these new modes.
- **Hold information-sharing sessions to introduce regional stakeholders to one another and to private industry representatives.** Especially when previously unknown business models are entering a region for the first time, much of the groundwork has to do with establishing relationships and trust among players and making sure everyone's goals are on the table.
- **Link objectives to local conditions.** Seek to understand the true state of the shared mobility landscape before making permanent policy adjustments or entering into long-term agreements.
- **Map local mobility assets, deficits, and other local needs.** Make sure that new or updated services, policies, and investments are directed to where they will have the greatest impact.
- **Support the establishment of an information clearinghouse.** Such a clearinghouse could effectively capture, digest, and disseminate practices regarding public-private partnerships for provision of mobility and related information services, and could also continue to identify areas of need for future research.
- **Use requests for information to gauge private operators' capacities and needs before issuing requests for qualifications or proposals.** Obtaining accurate information early in the process of pursuing public-private ventures will ensure that each party knows what the other needs, can supply, and is prepared to do.

Maintain Accessibility and Equity as Priorities

- **Address inequities in access to information.** Because information is the currency of the new mobility system, the capacity to readily use tools for information, schedules, booking, and payment must be ensured for those who face barriers related to cost, technology, technical knowledge, or disability.
- **Consider unbanked individuals.** People without bank accounts need accommodations related to cost and payment options, especially as fare media and payments increasingly migrate to mobile platforms. In Chicago, Philadelphia, and several other cities, mobility and transit pass programs targeted to lower income residents have successfully used retail outlets to maintain the ability to use cash. These programs have found that lower payment increments and more short-term options can improve access and more widely spread the benefits of transportation investments.
- **Evaluate the use of new modes to increase transit access in outlying communities.** Microtransit and one-way carsharing can increase transit access, and agencies can conduct targeted outreach to educate residents about first- and last-mile solutions. The suburbanization of poverty has resulted in longer commutes, poorer job access, and greater reliance on car ownership for many of the people who can least afford the associated costs.

Emphasize Mobility

- **Address mobility beyond direct provision of transportation services.** By spreading awareness and training people how to use the full menu of mobility options to reduce the need for personal vehicles, transportation agencies can further enhance mobility management.
- **Align goals across agencies.** Coordinate transit and transportation operations—along with planning and regulation of bikesharing, carsharing, ridesourcing, shuttles, parking, and curb access—and attempt to align work across all of these regulatory areas with overarching mobility goals. The San Francisco Municipal Transportation Agency and several agencies in Seattle are transforming themselves into mobility managers, with responsibilities that go beyond a public utility model of transit provision or a streets department.
- **Create a network of mobility managers at different levels (e.g., regions, municipalities, transit agencies, and large employers).** This network can communicate and coordinate mobility needs across departmental, jurisdictional, and public/private lines.
- **Create cross-agency working groups to regularly bring together multiple entities to develop policies that promote shared goals.** Bringing together transit agencies, DOTs, streets departments, business affairs divisions, consumer watchdogs, land-use divisions, planners, and public safety agencies can help these agencies avoid working at cross-purposes in pursuit of similar goals.

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APPENDIX A

Public Agency and Private Operator Interviewees

Table A-1. Public agency interviews.

Market	Agency	Position
Austin, TX	Capital Metro	Director, Long Range Planning Service Analysis Manager Director of Service Planning Transportation Planner
Austin, TX	Austin Transportation Department	Assistant Director of System Development and Regulation Active Transportation Division Manager
Austin, TX	Capital Area Metropolitan Transportation Organization	Senior Planner (2 individuals) Commute Solutions Coordinator Planner
Boston, MA	City of Cambridge	Director of Traffic, Parking, and Transportation Transportation Planner, Traffic, Parking, and Transportation Parking and Transportation Demand Management Planning Officer
Boston, MA	Massachusetts Department of Transportation	Project Director, MassRIDES Manager of Long Range Planning Transit and Capital Analyst Transportation Planner Transportation Program Planner Manager of Paratransit Programs Office of Transportation Planning
Boston, MA	City of Boston	Commissioner, Boston Transportation Department Director, Parking Clerk Co-Chair, Mayor's Office of New Urban Mechanics Director of Enforcement, Boston Transportation Department

(*Continued on next page*)

Table A-1 (Continued).

Market	Agency	Position
Boston, MA	Massachusetts Bay Transportation Authority	Manager of Service Planning Assistant General Manager, Operations Strategy and Support
Chicago, IL	Chicago Metropolitan Agency for Planning	Principal Planner, Policy and Programming (2 individuals)
Chicago, IL	Chicago Transit Authority	Vice President, Scheduling and Service Planning Senior Manager, Service Planning
Chicago, IL	Regional Transportation Authority	Executive Director
Chicago, IL	Metra	Department Head, Long Range Planning Director of Marketing Market Development staff member
Chicago, IL	Chicago Department of Transportation	Deputy Commissioner, CDOT Assistant Commissioner, CDOT
Chicago, IL	Pace Suburban Bus	Deputy Executive Director, Strategic Services Planning Services Department Manager
Los Angeles, CA	City of Santa Monica	Manager, Strategic & Transportation Planning
Los Angeles, CA	Southern California Association of Governments	Senior Regional Planner
Los Angeles, CA	City of Pasadena	Transportation Deputy to City Councilmember
Los Angeles, CA	Los Angeles Metropolitan Transportation Authority	Sustainability Policy Manager Executive Officer, Transit Corridors, Active Transportation & Sustainability Deputy Executive Officer of Countywide Planning and Development
San Francisco, CA	San Francisco Municipal Transportation Agency	Senior Transportation Planner Transportation Planner Executive Director Deputy Director for Planning

Table A-1 (Continued).

Market	Agency	Position
San Francisco, CA	Bay Area Rapid Transit	Customer Access & Accessibility Department Manager Access Coordinator
Seattle, WA	King County Metro	Supervisor, Transit Market Development Transportation Planner Transportation Planner Transportation Planner
Seattle, WA	City of Seattle—Department of Transportation	Senior Transportation Planner Director of Active Transportation Executive Director, Puget Sound Bike Share Mobility Programs Manager
Seattle, WA	City of Seattle—Dept. of Finance & Administrative Services	Director of Regulatory Compliance & Consumer Protection Strategic Advisor, Regulatory Compliance & Consumer Protection
Seattle, WA	King County—Records & Licensing Services Division	Deputy Director Finance Administrator
Seattle, WA	Puget Sound Regional Council	Senior Planner
Washington, DC	Washington Metropolitan Area Transit Authority	Managing Director of Planning Director of Strategic Planning Manager, Access Planning & Policy Analysis
Washington, DC	District Department of Transportation	Associate Director, Policy, Planning and Sustainability
U.S.	Federal Transit Administration	ITS Program Manager Director, Office of Mobility Innovation Director, Office of Transit Programs Associate Administrator, Office of Research, Demonstration, and Innovation

Table A-2. Shared-use mobility operator interviews.

Operator	Position
Lyft	Director of Transportation Policy
Bridj	Chief Data Scientist
Zipcar	Director, Corporate Communications & Public Policy
Ridescout	Co-Founder/CEO Enterprise Solutions Communications Director
Bikeshare of Austin	Executive Director

APPENDIX B

Survey Methodology and Additional Data

The user survey was distributed through both private shared-mobility operators and transit agencies in September and October 2015.

The survey sample frame included adult residents of the study regions who have used one or more shared-use modes, including transit. The researchers requested distribution by transit agencies and shared mobility operators in all of the seven study markets, and also in New York City. The recruitment method was through invitations emailed and distributed via social media by cooperating agencies and operators, inviting customers to complete a web-based survey instrument. A link was directly emailed by distribution partners to more than 75,000 email recipients in addition to a large number of newsletter and social media followers, and received 4,551 at least partial responses. Provider-specific links, called collectors, allowed tracking of response sources and permitted deactivation of particular channels at the end of a two-week open period. The overall count represents a net response rate of 6.0% for the sources the researchers were able to track. Distribution partners in each market are listed in the table below.

Table B-1. Survey distribution partners, dates, and response counts.

Market	Agency or operator	Field dates	Total responses
Austin	Car2go	9/17/15–10/1/15	539
Boston	Motivate/Hubway	10/8/15–10/22/15	69
Chicago	Motivate/Divvy	9/24/15–10/8/15	424
Los Angeles	LA Metro	10/6/15–10/20/15	653
New York City	Motivate/CitiBike	9/23/15–10/7/16	508
San Francisco Bay Area	BART	9/18/15–10/8/15 (staggered samples)	179
San Francisco Bay Area	Motivate/Bay Area Bikeshare	9/16/15–9/30/15	5
Seattle	Car2go	9/17/15–10/1/15	992
Seattle	Motivate/Pronto Cycle Share	9/15/15–9/29/15	30
Washington, DC	WMATA	9/16/15–9/30/15	830
Washington, DC	Motivate/Capital Bikeshare	9/17/15–10/1/15	74
Washington, DC	Car2Go	9/17/15–10/1/15	248
Total			**4551**

The survey contained an initial screening question about overall experience with new shared-use modes, asked whether respondents had "ever used a shared form of transportation like bike-sharing, car-sharing, or a ride-sharing service like Uber or Lyft." Respondents who answered "No" went immediately to a portion of the survey that only asked about transit technology, followed by collection of demographic information, including home zip code (mapped in Figure B-1 for all respondents). The geographic distribution of home zips generally matches the distribution locations.

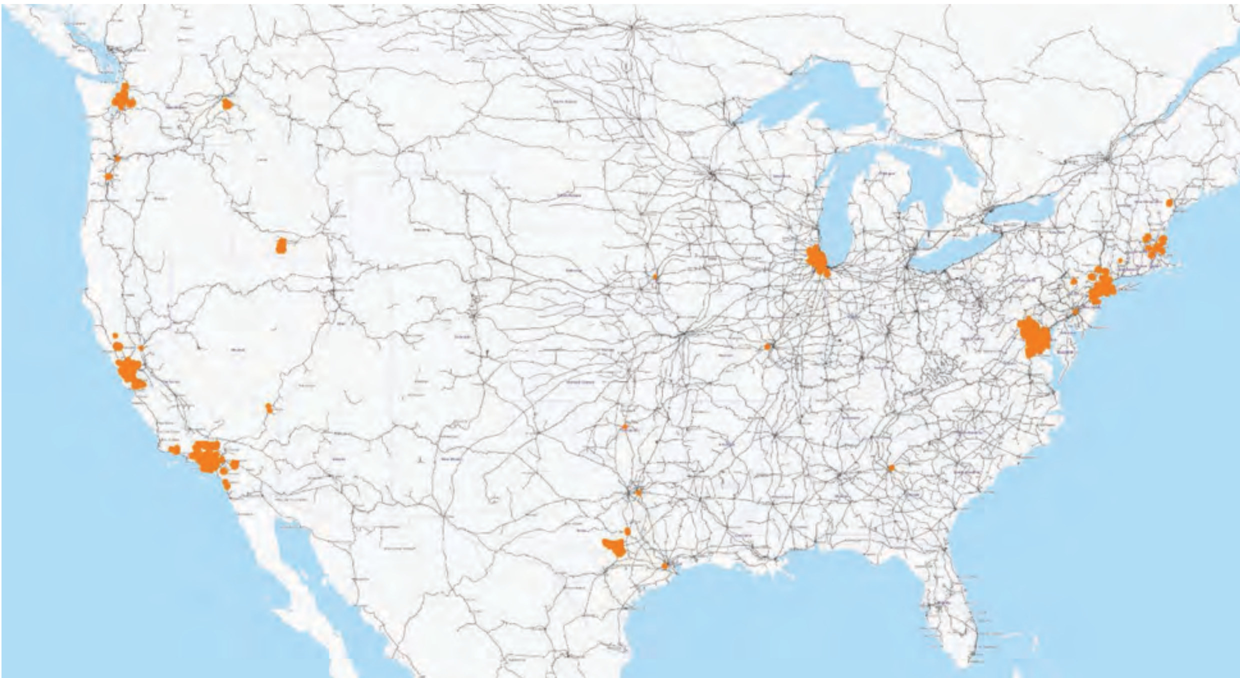

Figure B-1. Reported home zip codes of survey respondents.

Sampling considerations

Because the researchers were limited to working with convenience samples in each market—those individuals able to be reached via the partners who agreed to distribute the survey, all of whom were people who had previously supplied their email addresses to the agencies or operators—we must be cautious about inferring to the wider population of shared mobility and transit users and certainly to the general population. The survey was administered via an online form, and links to this form were distributed by email. This implies a basic level of technological facility, and also a willingness to participate in research about transportation. Also, the survey took place in several of the largest, densest, and most expensive cities in the country, which were chosen for this study specifically because of their known high levels of shared mobility usage. Thus the sample is likely over-representative of higher-income, more highly educated individuals compared to the general U.S. public.

We should also make note of the small sample sizes in some markets relative to others: we received only 69 responses via the Boston channel, and fewer than 200 in San Francisco. In addition, we might expect some bias related to the mode of the distribution channels for the various surveys. In Los Angeles and San Francisco, the survey was distributed almost exclusively via the transit agencies; in Boston, Chicago, and New York, the survey was distributed solely via bikeshare operators; and in Austin and Seattle the primary channel was a carsharing operator. One subpopulation this distribution method might miss would be people who use ridesourcing exclusively among shared modes, including transit. Unfortunately the researchers don't have a way of estimating the size of this population because so little systematic knowledge currently exists about levels of ridesourcing usage in urban areas and among the traveling population overall. Ongoing research—from other behavioral surveys, public and private operator data, personal travel inventories, and other data sources—is needed to continue building the understanding of the use and effects of ridesourcing and other shared modes. Overall, the familiarity with and level of information about shared-use modes in the general population is likely to differ somewhat from what we found from our respondents. However, since the subject of this report is the interaction of shared-use modes and new mobility technologies with transit, the researchers believe it made sense to focus this initial descriptive effort as we did.

Response rate

The survey was distributed through both private shared-use operators and transit agencies starting in mid-September 2015. The survey link was directly emailed to more than 75,000 email recipients plus a large number of newsletter and social media followers, and received 4551 at least partial responses, of which 3548 reached the end of the survey. The number of responses to individual questions varied, with some respondents skipping individual questions while answering others later in the survey.

The overall count represents a net response rate of 6.0% for the sources we were able to track. Response rates from the collectors of individual agencies and operators ranged from less than 2% to more than 15%. Response rate was calculated as the proportion of responses to successful (non-bounce) email deliveries. Since we don't have access to the web social media metrics of the distributing organizations, we did not attempt to calculate response rate for those mediums.

The circulated version of the survey instrument is attached in Appendix C.

Additional data

Table B-2, Figure B-2, and Table B-3 in this section present additional data that informed the main findings.

Table B-2. Frequency of use of all modes, by top mode.

Frequency of use of all modes, by top shared-use mode					
Frequency by mode	Top Mode				
	Bikesharing	Carsharing	Ridesourcing	Public bus	Public train
Public bus					
Daily/almost daily	3%	3%	3%	63%	14%
1-3 times a week	18%	14%	10%	23%	21%
1-3 times a month	39%	25%	23%	11%	28%
A few times a year	31%	34%	35%	3%	23%
<1/yr	9%	24%	30%	0%	14%
Public train					
Daily/almost daily	11%	2%	4%	11%	77%
1-3 times a week	33%	3%	6%	13%	18%
1-3 times a month	39%	13%	18%	21%	7%
A few times a year	16%	41%	33%	34%	1%
<1/yr	2%	38%	38%	16%	0%
Bikesharing					
Daily/almost daily	70%	1%	2%	2%	12%
1-3 times a week	24%	2%	6%	6%	20%
1-3 times a month	8%	5%	8%	6%	15%
A few times a year	1%	10%	13%	9%	8%
<1/yr	0%	78%	69%	68%	43%

Cell shading reflects the relative magnitude of percentages, from lowest (red) to highest (green). Data reflect cross-tabulated responses to survey questions 7 and 4 (see Appendix C). (*Continued on next page*)

Table B-2. (Continued).

Frequency of use of all modes, by top shared-use mode					
Frequency by mode	Top Mode				
	Bikesharing	Carsharing	Ridesourcing	Public bus	Public train
Carsharing					
Daily/almost daily	1%	8%	0%	1%	0%
1-3 times a week	5%	31%	12%	16%	6%
1-3 times a month	14%	40%	33%	39%	15%
A few times a year	23%	20%	29%	20%	21%
<1/yr	53%	2%	23%	18%	55%
Ridesourcing					
Daily/almost daily	1%	1%	7%	0%	1%
1-3 times a week	10%	14%	40%	12%	13%
1-3 times a month	27%	29%	42%	31%	29%
A few times a year	21%	22%	8%	20%	23%
<1/yr	37%	30%	2%	30%	32%
Driving alone					
Daily/almost daily	9%	41%	49%	11%	13%
1-3 times a week	16%	24%	23%	23%	24%
1-3 times a month	21%	11%	9%	17%	17%
A few times a year	19%	7%	6%	12%	20%
<1/yr	33%	16%	13%	30%	26%
Driving with family/friend					
Daily/almost daily	5%	19%	25%	7%	6%
1-3 times a week	20%	41%	40%	37%	28%
1-3 times a month	32%	19%	23%	28%	28%
A few times a year	30%	11%	9%	15%	25%
<1/yr	11%	9%	3%	9%	12%

Cell shading reflects the relative magnitude of percentages, from lowest (red) to highest (green). Data reflect cross-tabulated responses to survey questions 7 and 4 (see Appendix C).

In addition to asking for home zip code, the survey asked respondents in which metro area they generally used their top shared-use mode—this distinction was intended to elicit information about where the shared-mode use actually took place, even if these services were not available near respondents' homes (for example, people who use the public train and bikesharing when they're in Washington, DC, even though their hometown only has bus service).

As would be expected, all but a few respondents told us that they most commonly use shared-use modes in one of the eight metro areas where the survey was fielded (the seven study cities plus New York City). We received fewer than 100 responses to this question for either Boston or San Francisco, reinforcing the caution we must take with what we infer from our results about those areas due to their small sample size.

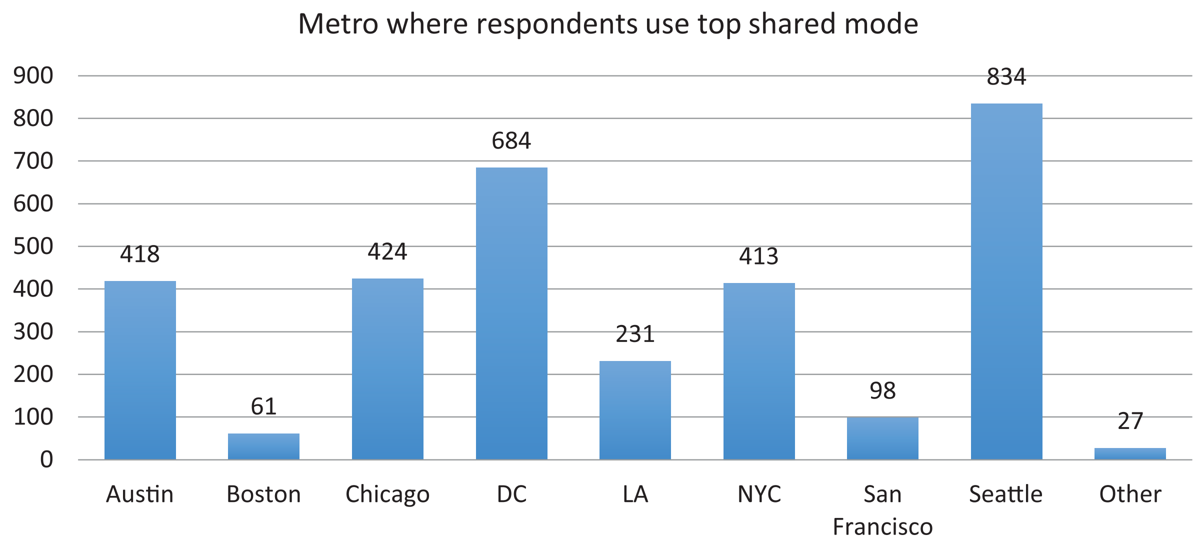

Figure B-2. Metro area where respondents use top shared mode.

Trains are prevalent as the top mode in every city with established heavy rail (Boston, Chicago, DC, NYC, and San Francisco), and Los Angeles has a significant train share even at a relatively early point in its rail system's build-out. Austin is notable as the only metro where the top mode is not a bus or train. It has the largest shares by far of respondents who choose carsharing or ridesourcing as top modes, reflecting a transportation infrastructure based on solo driving that is only starting to be retrofitted with more fixed-guideway transit and emerging shared modes.

Table B-3. Top shared mode by respondent metro area.

In what metro area do you most often make trips by your top shared mode? (mode as percentage of respondents choosing each metro)								
Mode	Metro							
	Austin	Boston	Chicago	DC	LA	NYC	SF	Seattle
Bikesharing	2%	38%	31%	5%	0%	39%	0%	2%
Carsharing	36%	2%	0%	4%	3%	1%	0%	23%
Ridesourcing	30%	3%	7%	5%	11%	1%	9%	10%
Public bus	30%	7%	13%	14%	59%	3%	17%	61%
Public train	2%	51%	49%	72%	28%	57%	73%	5%

Cell shading reflects the relative magnitude of percentages, from lowest (orange) to highest (blue).

APPENDIX C

Survey Instrument

Learning more about the relationship between public transit and other forms of transportation

About this Survey
This survey is about important transportation issues, including how, when, and why people use different ways of getting around
It should take 10-15 minutes to complete.

Your participation is voluntary, and all responses are optional. We collect no personally identifiable information as part of this survey. We know your time is valuable, and very much appreciate your taking the trouble to fill this survey out all the way to the end. With so many transportation choices available, your responses will help researchers fill in the picture about the choices people make in how to travel around their city.

We realize that people make many different kinds of trips using all kinds of transportation, and that these change depending on many different circumstances--so it might be hard to say what's "typical." As you fill out this survey, just try to think about the journeys you make most often.

If you decide you need to change or review something, you can back up at any time without losing your answers.

When you're ready to get started, please click "Next," below.

Your experience with different forms of transportation

1. Have you ever used a shared form of transportation like bike-sharing, car-sharing, or a ride-sharing service like Uber or Lyft?

- Yes
- No

Definitions
Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.
Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.
Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Your experience with shared-use transportation

2. **When was the FIRST time you used each form of transportation?**

	Last 3 months	3-6 months ago	7-12 months ago	1-5 years ago	More than 5 years ago	N/A
Public bus	○	○	○	○	○	○
Public train	○	○	○	○	○	○
Bike-sharing	○	○	○	○	○	○
Car-sharing	○	○	○	○	○	○
Ride-sharing	○	○	○	○	○	○

3. **When was the LAST time you used each form of transportation?***(Please choose the most recent period when you used each type.)*

	Today or yesterday	Within the last week	Within the last month	Within the last 3 months	Within the last year	1-5 years ago	Never, or more than 5 years ago
Public bus	○	○	○	○	○	○	○
Public train	○	○	○	○	○	○	○
Bike-sharing	○	○	○	○	○	○	○
Car-sharing	○	○	○	○	○	○	○
Ride-sharing	○	○	○	○	○	○	○

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Your experience with shared-use transportation (cont.)

* 4. **Which shared-use service do you use MOST OFTEN?** *(If you typically use more than one service per trip, choose the one you spend the most time on.)*

- Public bus
- Public train
- Bike-sharing
- Car-sharing
- Ride-sharing
- Other shared-use service (please specify)

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Your experience with shared-use transportation (cont.)

5. **Thinking about the service you selected in the prior question, how would you make your most frequent trip if that service was not available?**

- Public bus
- Public train
- Bike-sharing
- Car-sharing
- Private bicycle
- Ride-sharing
- Walk the whole way
- Drive alone
- Drive with family/friend
- I wouldn't take this trip
- Other (please specify)

6. **In what metro area do you most often make trips by [Q4]?**

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Driving alone: you driving by yourself in a car owned by your household.

Driving with family/friend: a ride with a friend or family member, regardless of who is driving.

Your experience with shared-use transportation (cont.)

7. **How often do you travel in each of these ways?**

	Daily or almost daily	1-3 times a week	1-3 times a month	A few times a year	Less than once a year, or never
Public bus	○	○	○	○	○
Public train	○	○	○	○	○
Bike-sharing	○	○	○	○	○
Car-sharing	○	○	○	○	○
Ride-sharing	○	○	○	○	○
Driving alone	○	○	○	○	○
Driving with family/friend	○	○	○	○	○

If you usually use another form of transport, please list it here, along with how often you use it:

8. **If you use them, about how long is your most frequent one-way trip on each form of transportation?**

	Under a mile	1-5 miles	6-10 miles	11-20 miles	More than 20 miles	N/A
Public bus	○	○	○	○	○	○
Public train	○	○	○	○	○	○
Bike-sharing	○	○	○	○	○	○
Car-sharing	○	○	○	○	○	○
Ride-sharing	○	○	○	○	○	○
Driving alone	○	○	○	○	○	○
Driving with family/friend	○	○	○	○	○	○

If you usually use another form of transport, please list it here, along with the distance you usually travel on it:

__Definitions__

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Driving alone: you driving by yourself in a car owned by your household.

Driving with family/friend: a ride with a friend or family member, regardless of who is driving.

Comparing different forms of transportation (cont.)

9. **In the past 3 months, which of the following forms of transportation have you used for each type of trip?** *(Please select all that apply, and leave blank any you don't use.)*

	Getting to or from work/school	Shopping or running errands	Recreation or social events
Public bus	☐	☐	☐
Public train	☐	☐	☐
Bike-sharing	☐	☐	☐
Car-sharing	☐	☐	☐
Ride-sharing	☐	☐	☐
Driving alone	☐	☐	☐
Driving with family/friend	☐	☐	☐

If you usually use another form of transport, please list it here, along with the trip types you use it for:

____

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Driving alone: you driving by yourself in a car owned by your household.

Driving with family/friend: a ride with a friend or family member, regardless of who is driving.

Changes since you've started using shared forms of transportation

10. **Have you made or noticed any of these changes in your transportation habits since you started using shared forms of transportation?** *(Check all that apply.)*

- ☐ Drove a car more to work
- ☐ Drove a car less to work
- ☐ Drove a car more for errands or recreation
- ☐ Drove a car less for errands or recreation
- ☐ Used public transit more
- ☐ Used public transit less
- ☐ Became more physically active
- ☐ Became less physically active
- ☐ Other (please specify):

____

11. **Have you or your household made any of these financial changes since you started using shared forms of transportation?** *(Check all that apply.)*

- [ ] Postponed purchasing a car
- [ ] Decided not to purchase a car
- [ ] Sold a car and didn't replace it
- [ ] Purchased/leased a car to work as a ride-sharing driver
- [ ] Other (please specify):
- [ ] Purchased/leased a car to use for peer-to-peer car-sharing
- [ ] Purchased/leased a car only for private use
- [ ] Spent more on transportation
- [ ] Spent less on transportation

When and why you choose different forms of transportation

12. **How would you typically travel to or from your home in these different times and conditions?** *(If you'd combine forms of transport, choose the one you would spend the most time on.)*

	Public bus	Public train	Bike-sharing	Car-sharing	Ride-sharing	Driving alone	Driving with family/friend	Other
When the weather is bad	○	○	○	○	○	○	○	○
If I'm running late	○	○	○	○	○	○	○	○
If I have to be somewhere by a certain time (airport, job interview)	○	○	○	○	○	○	○	○
If I'm concerned about my safety	○	○	○	○	○	○	○	○
When traffic is bad	○	○	○	○	○	○	○	○
When I'm carrying a lot of stuff	○	○	○	○	○	○	○	○
When money is tight	○	○	○	○	○	○	○	○
When I lack access to a reliable vehicle	○	○	○	○	○	○	○	○

If you marked "other," please explain:

13. **For each type of trip, what makes the single greatest impact on your choice of how to travel?**

	Convenience	Cost	Reliability	Weather	Length of trip	How much I'm carrying	Ability to use phone or tablet	Environmental concerns	Traffic	Other
Going to work/school	○	○	○	○	○	○	○	○	○	○
Shopping, appointments, or running errands	○	○	○	○	○	○	○	○	○	○
Recreation or social events	○	○	○	○	○	○	○	○	○	○

If you marked "other," please explain:

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

Public train: light rail, subways and elevated trains, and commuter trains.

Bike-sharing: bicycles available for short-term use, such as Divvy, Social Bicycles, Capital Bikeshare, Hubway, or B-Cycle.

Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Driving alone: you driving by yourself in a car owned by your household.

Driving with family/friend: a ride with a friend or family member, regardless of who is driving.

When you use different forms of transportation

14. **At what hours of the day and week do you generally use each form of transportation?** *(Check as many as apply.)*

	Weekdays	Weekends	Early AM (5am-7am)	AM rush (8am-10am)	Mid-day (11am-4pm)	PM rush (5pm-7pm)	Evening (8pm-10pm)	Late night (11pm-4am)	N/A
Public bus	☐	☐	☐	☐	☐	☐	☐	☐	☐
Public train	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bike-sharing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Car-sharing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ride-sharing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Driving alone	☐	☐	☐	☐	☐	☐	☐	☐	☐
Driving with family/friend	☐	☐	☐	☐	☐	☐	☐	☐	☐

Definitions

Public bus: buses, streetcars, or trolleys that move in other traffic and make many stops, as well as express buses, bus rapid transit and streetcars that may run express or in their own lane for part of their journey. Also includes ADA paratransit and dial-a-ride.

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Car-sharing: cars available by the hour, including services like Zipcar or Enterprise, one-way services like car2go, and peer-to-peer services like Getaround or RelayRides. Does not include cars rented for a day or more.

Ride-sharing: on-demand, app-based systems for finding and paying for rides through a private operator, such as Lyft, Uber, or Sidecar. Also known as ridesourcing.

Driving alone: you driving by yourself in a car owned by your household.

Driving with family/friend: a ride with a friend or family member, regardless of who is driving.

Public transit and new transportation technology

15. **Many websites or apps show information about public transit schedules and operations. Which of the following activities have you performed for trips in the metro area where you live?** *("Third-party" means tools from somebody other than a transit agency, including websites and apps like Google Maps, MapQuest, RideScout, TransitApp or Moovit.)*

	Transit agency app or website	Third-party app or website
See schedules	☐	☐
Map my route	☐	☐
Find the closest bus stop/train station	☐	☐
Find out how long until the next bus/train is arriving	☐	☐
See where transit vehicles are in real time	☐	☐
Reload a farecard or fare account	☐	☐
Pay a fare on a bus or train	☐	☐
Learn previously unknown transit options for getting to a destination	☐	☐
Learn previously unknown non-transit options for getting to a destination	☐	☐

About you and your household

This is the last page of the survey. Your answers to these demographic questions will help us put the rest of your responses in better context, but all of these questions are optional.

16. In what ZIP code is your home located? (enter 5-digit ZIP code; for example, 00544 or 94305)

[ ]

17. What is your gender?

[ ]

18. Including yourself, how many people in each age range currently live in your household?

	0	1	2	3	4 or more
Under 18 years	○	○	○	○	○
18-25	○	○	○	○	○
26-44	○	○	○	○	○
45-64	○	○	○	○	○
65+	○	○	○	○	○

19. How many cars does your household own or lease?

- ○ None
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

20. How many bicycles does your household own?

- ○ None
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

21. What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

22. What was your total household income last year?

- $0 to $24,999
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $124,999
- $125,000 or more

Thank you

You're done!

The Shared-Use Mobility Center thanks you for taking the time to fill out this survey. The results of this research will become available over the next few months. Here are several ways to keep up with our work in the meantime:

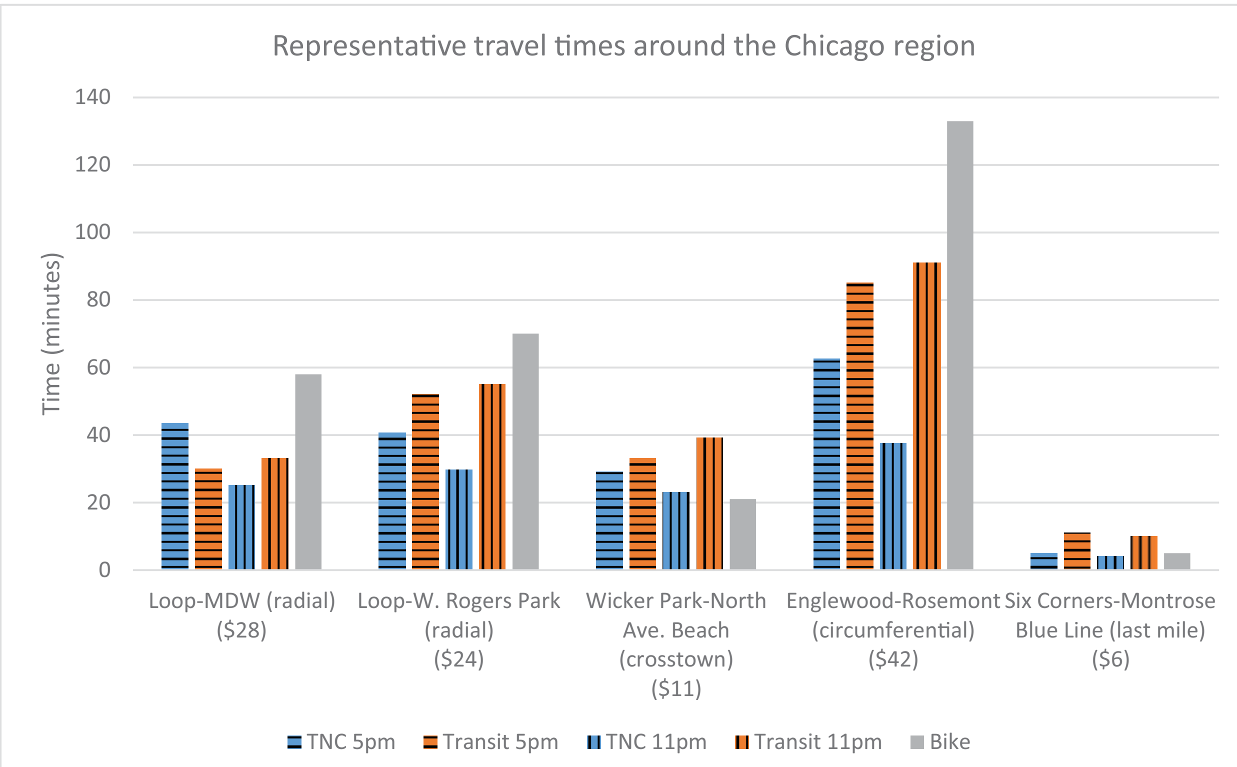
- Visit the Shared-Use Mobility Center's website
- Follow us on social media: Twitter | Facebook | Flickr
- Sign up for our monthly newsletter

APPENDIX D

Ridesourcing and Transit Travel Time Comparison

While demand and capacity tell one story, another method of analysis that might better reflect the customer experience with ridesourcing versus transit is to compare the time and cost of traveling similar routes at different times of day. An exploratory analysis of this kind for the Chicago region compared representative travel times for various trip types, including routes along the radial spokes of the train and highway systems, crosstown surface trips in congested corridors, circumferential trips along the suburban periphery, and short first/last mile trips from transit terminals.

The initial methodology was to simply collect the estimated driving and transit travel times for several routes and several departure times from the Google Maps trip planning tool, along with an estimated cost for that trip from the Uber application protocol interface (API), using the UberX class of service (Figure D-1). To the driving time we added the average wait time for a pickup in Chicago, using the estimated wait time data collected during the earlier scrape of the Uber API. Results of this exploratory analysis are show below.



Dollar amounts in parentheses show estimated trip cost using UberX service, from Uber API.
Data sources: Google Maps (travel times), Uber API (estimated wait times and trip costs).

Figure D-1. Representative travel times around the Chicago region, by scheduled transit and ridesourcing, at 5:00 p.m. and 11:00 p.m.

The initial analysis suggested that at peak hours, fixed-guideway trips are generally the fastest and least expensive in the corridors where they are available. At other times of day, the marginal difference in duration between train and ridesourcing trips would make it difficult for many riders to justify the much higher cost of ridesourcing based on time alone. For other trips, especially crosstown or circumferential ones involving multiple bus routes, the time advantage of ridesourcing was larger, and was amplified outside of peak hours when drive times are lower and transit times are longer. The cost portion of this analysis was based on "traditional," single-rider ridesourcing. In cities where ride-splitting versions of the service is available, ridesourcing may become more economical, and could in some places be competitive to transit in both time and cost to riders. These routes, in particular, represent the places where transit agencies might find opportunities to shed low-ridership bus routes in favor of dynamic demand-responsive service or partnerships with shared mobility providers.

For a broader analysis using the same general approach, we used another Google tool, the Distance Matrix API, which allows large-scale automated queries of their directions system, returning a matrix of optimal travel times for different modes from a common origin but with multiple end points. Driving times are based on historical traffic conditions for a given day and hour, and transit directions are based on scheduled service, in each case producing an optimal route that attempts to minimize travel time.

For all of the study regions, we determined an origin address within the highest-employment census block group in each region. We programmatically queried the system for travel times by car and by transit from the single origin to destination points on a half-mile grid over the core county of each study region, for both 5pm and midnight. Given the two modes' travel times to each point, we calculated a "travel time ratio," which is the ratio of transit travel time to a derived "TNC travel time," using the driving time figure plus average regional wait time for that hour, as obtained earlier from the Uber API (see Appendix E). Plotted on a map, these points give a quick overview of the tradeoffs between different modes at a regional level, as well as showing where transit is simply not an option for a given route. Though these maps show travel between the central business district and the rest of the region, the same approach applied to a number of different origins could reveal much about the mobility picture of a given region.

The maps on the following pages (Figures D-2 through D-8) show the ratio of estimated transit travel time to estimated driving time (in typical traffic, plus mean TNC wait time for the departure hour and region) from a single origin to each of a 0.5 mile grid of core-county destinations. Ratios lower than 1.0 (green colors) mean that transit is faster for a given trip (the darker the green, the greater transit's time advantage), and ratios higher than 1.0 (yellow to red colors) mean that ridesourcing is faster.

Points shown as only a black dot represent areas for which no ratio could be calculated because either a) no transit route exists between the origin and destination; or b) they represent points with no public roads, such as airports, gated subdivisions or undeveloped areas.

While the specific findings emerging from this analytical approach vary from city to city, a few patterns emerge:

- Peak hour traffic congestion tips the scales in favor of transit that travels in its own right of way--on tracks above or below traffic, or in dedicated lanes.
- Long transit headways at night, along with easier travel on largely congestion-free streets, mean that TNCs are the faster mode for many destinations; but cost remains a key determinant of whether this is actually a viable choice for frequent trips.

- In a few places (central Austin and Seattle, for instance), certain trips are faster on transit late at night than at rush hour--reflecting how congestion blocks the effectiveness of transit running in mixed traffic.

Also note that the maps do not account for the differing cost of rides on transit versus TNCs. As distances increase--and costs with them--it is likely that for most users, the appeal of even a relatively faster TNC ride would drop significantly beyond a certain cost threshold. For occasional trips this might not be a central consideration, but for more frequent trips these costs would be unsustainable. For many trips in these areas, the personal automobile is likely to remain as the mode that maximizes utility for the individual traveler, until some combination arises of a) wider coverage of more frequent transit or b) much lower cost TNC services, such as shared ride services.

Figures D-2 through D-8 combine data from Google Maps Distance Matrix API (transit and driving time estimates), Uber API (TNC wait time), and US Census Bureau TIGER/Line (geography).

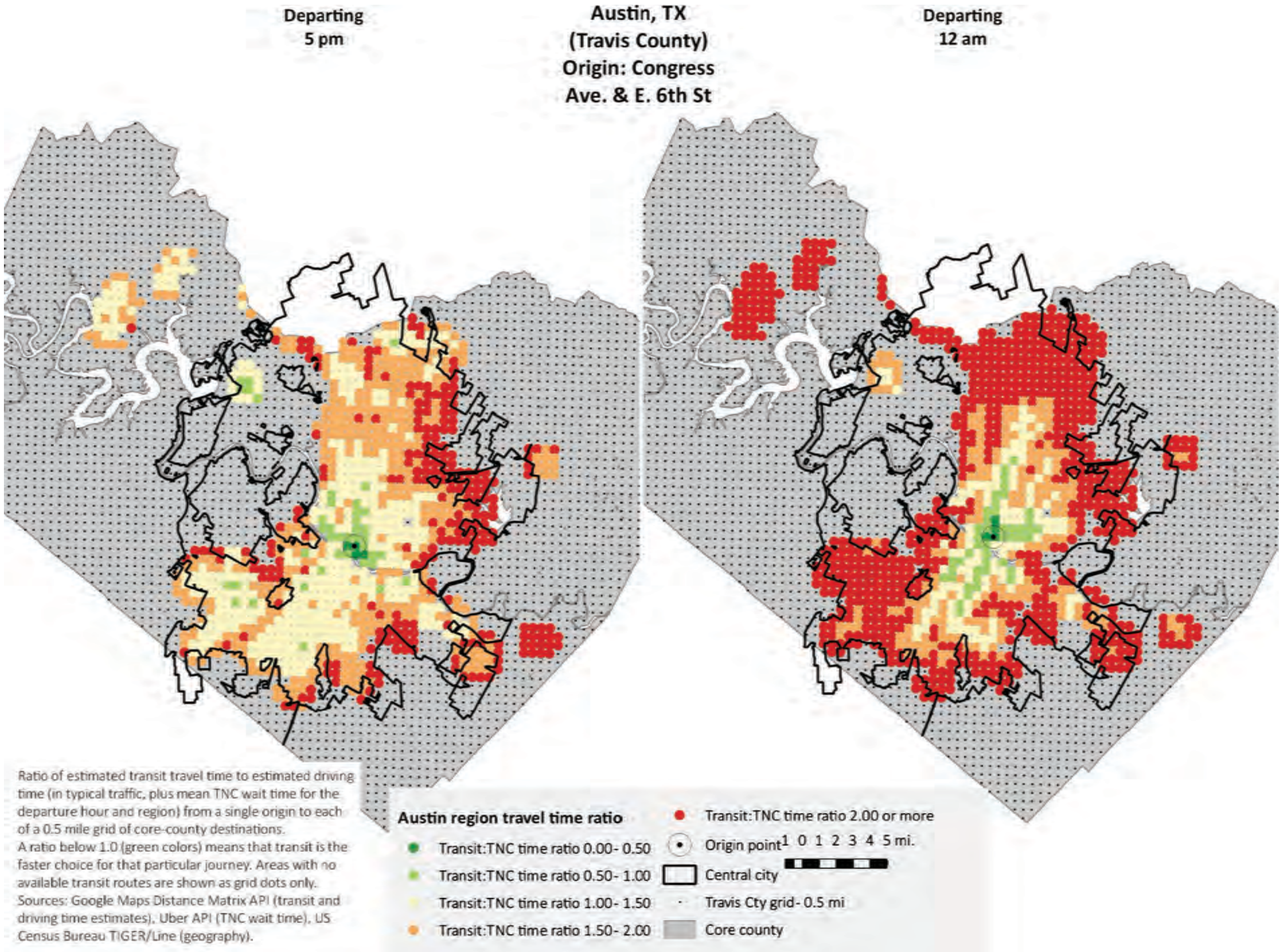


Figure D-2. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Austin, TX.

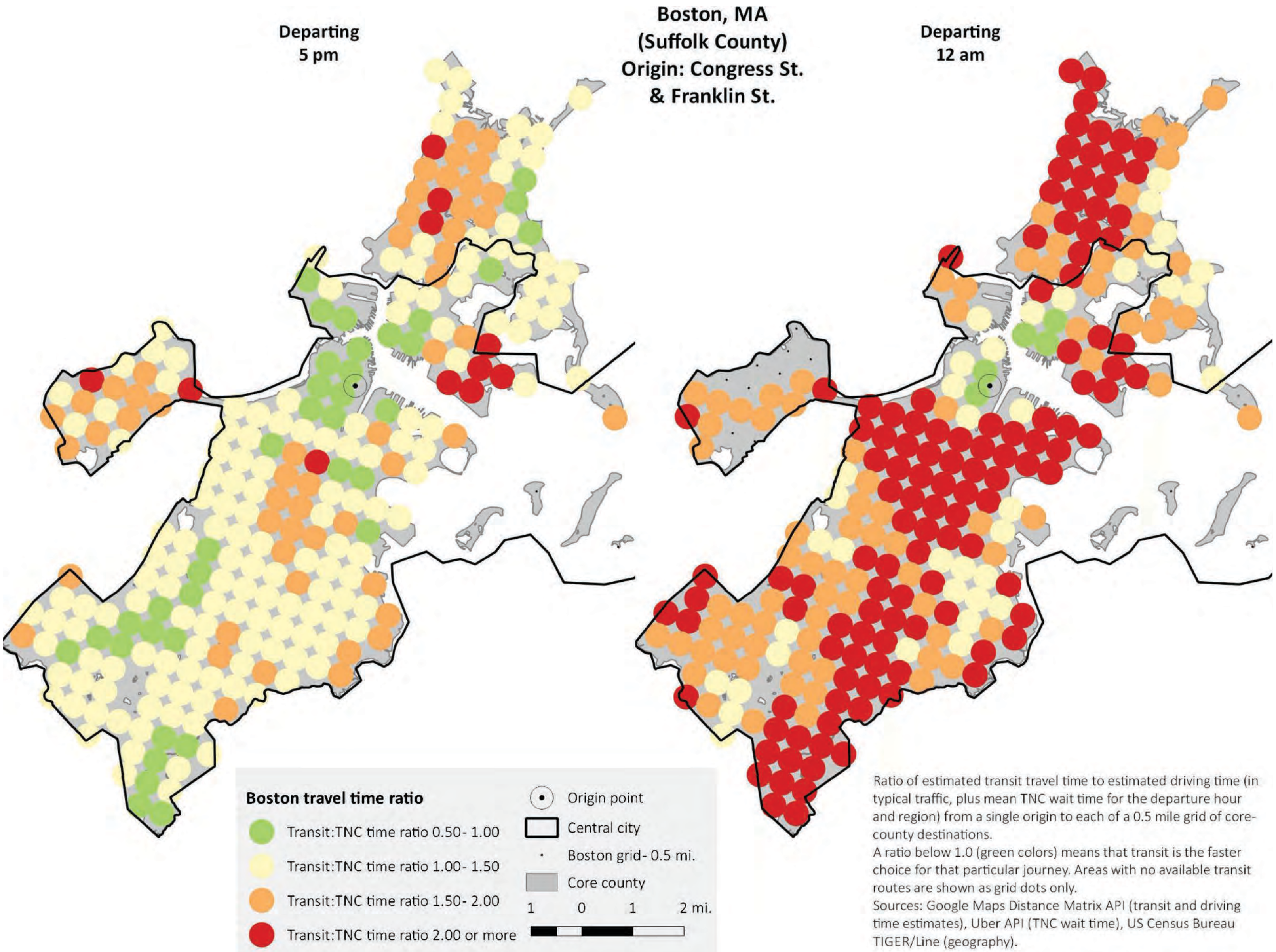


Figure D-3. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Boston, MA.

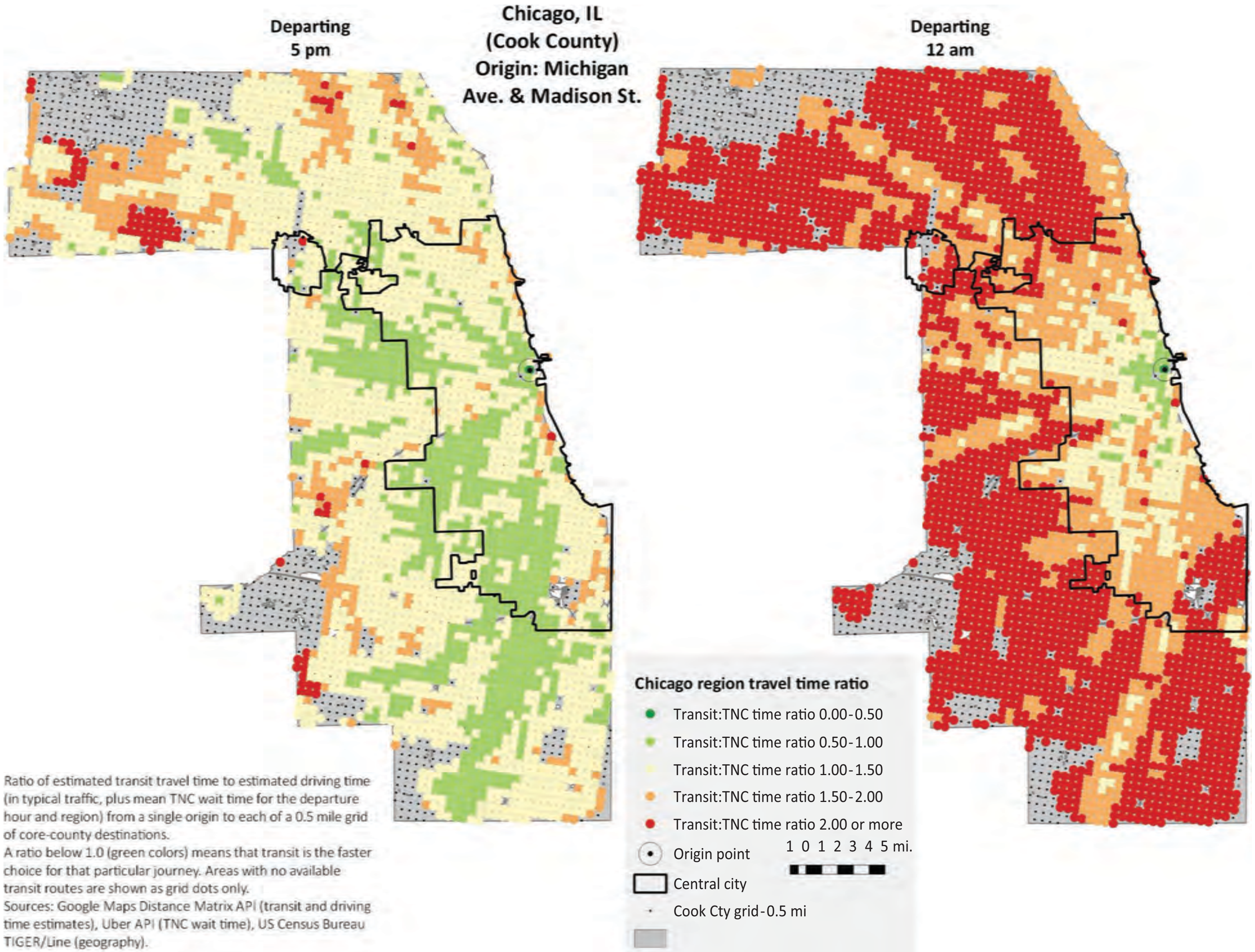


Figure D-4. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Chicago, IL.

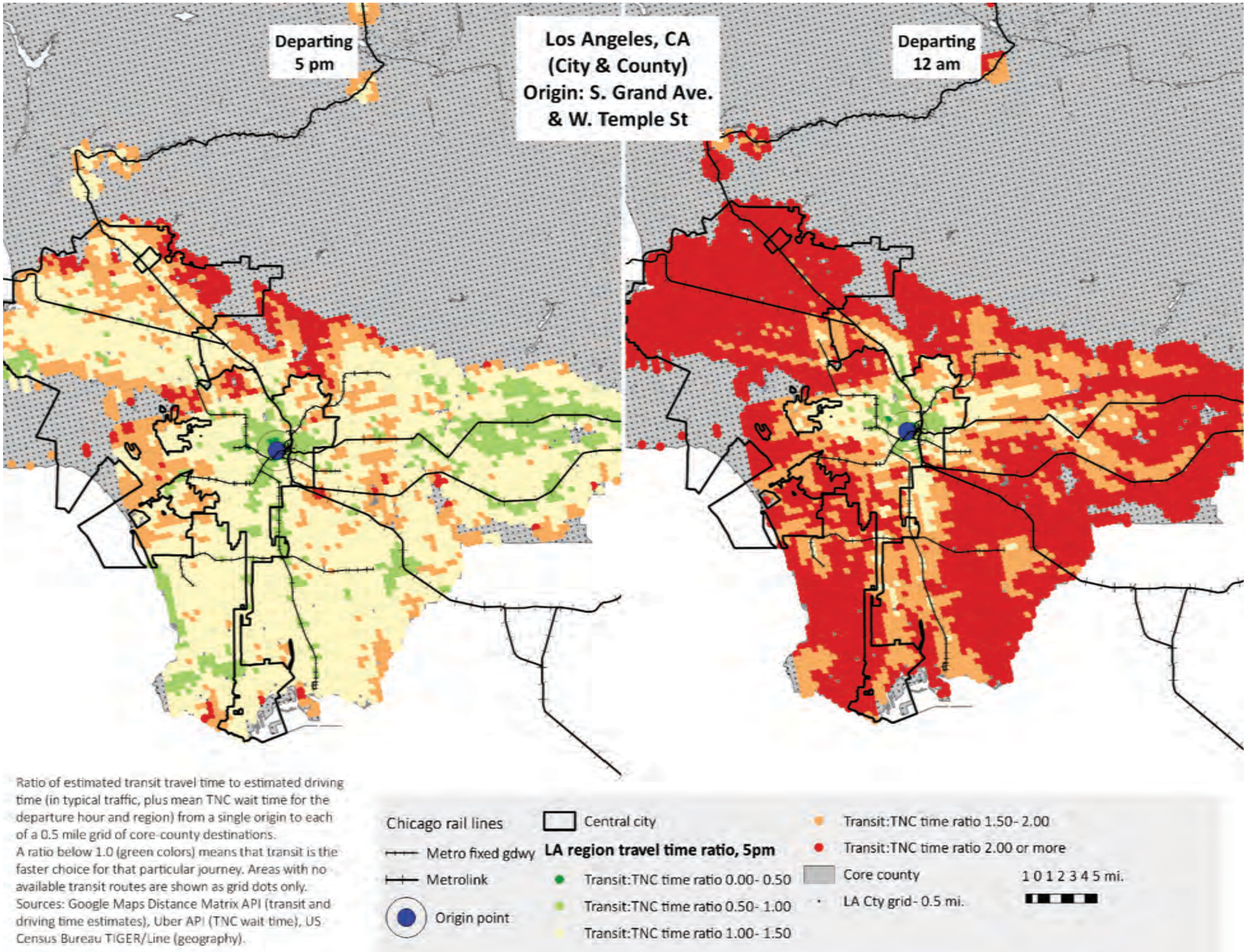


Figure D-5. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Los Angeles, CA.

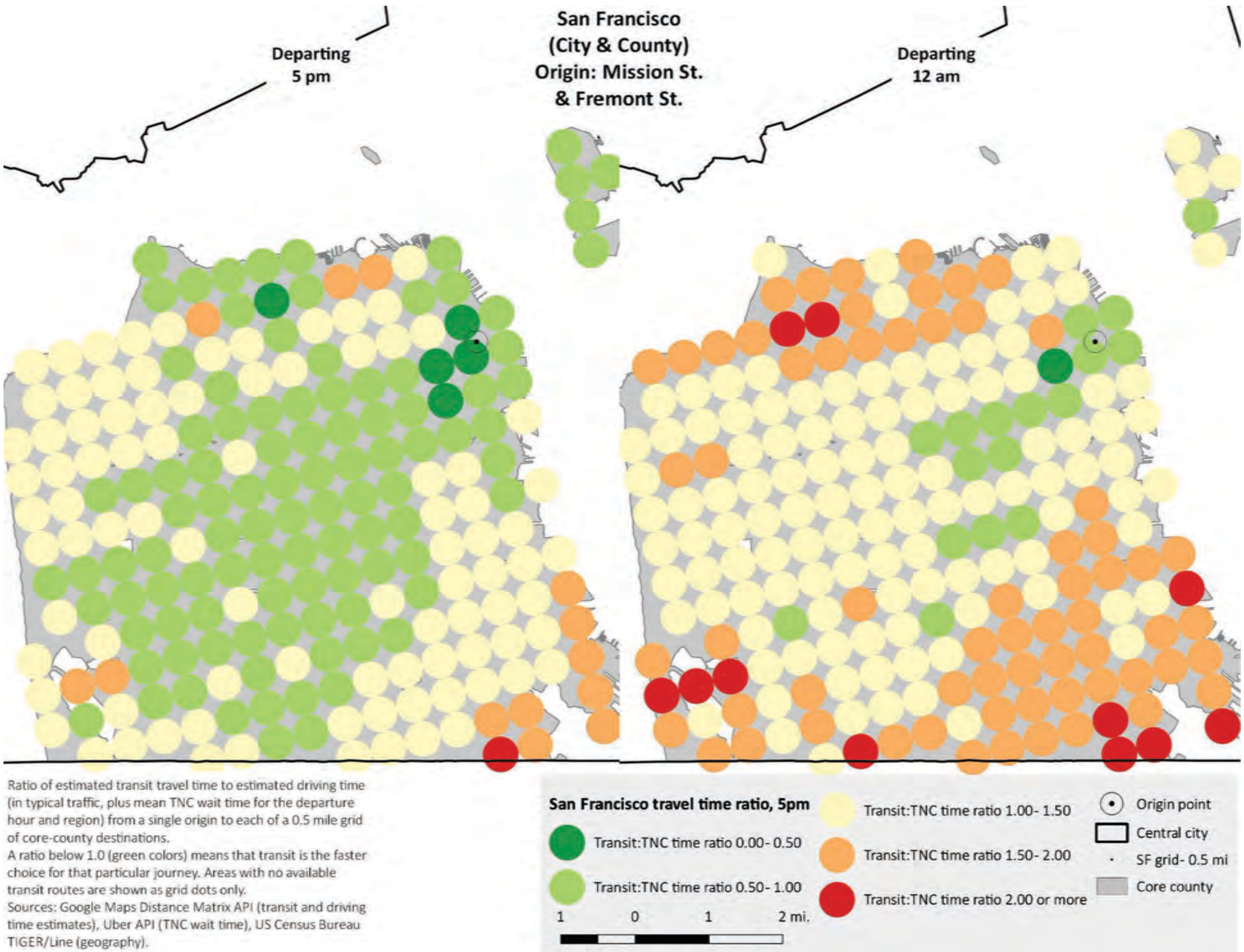


Figure D-6. Transit-TNC travel time ratio, 5:00 p.m. and midnight, San Francisco, CA.

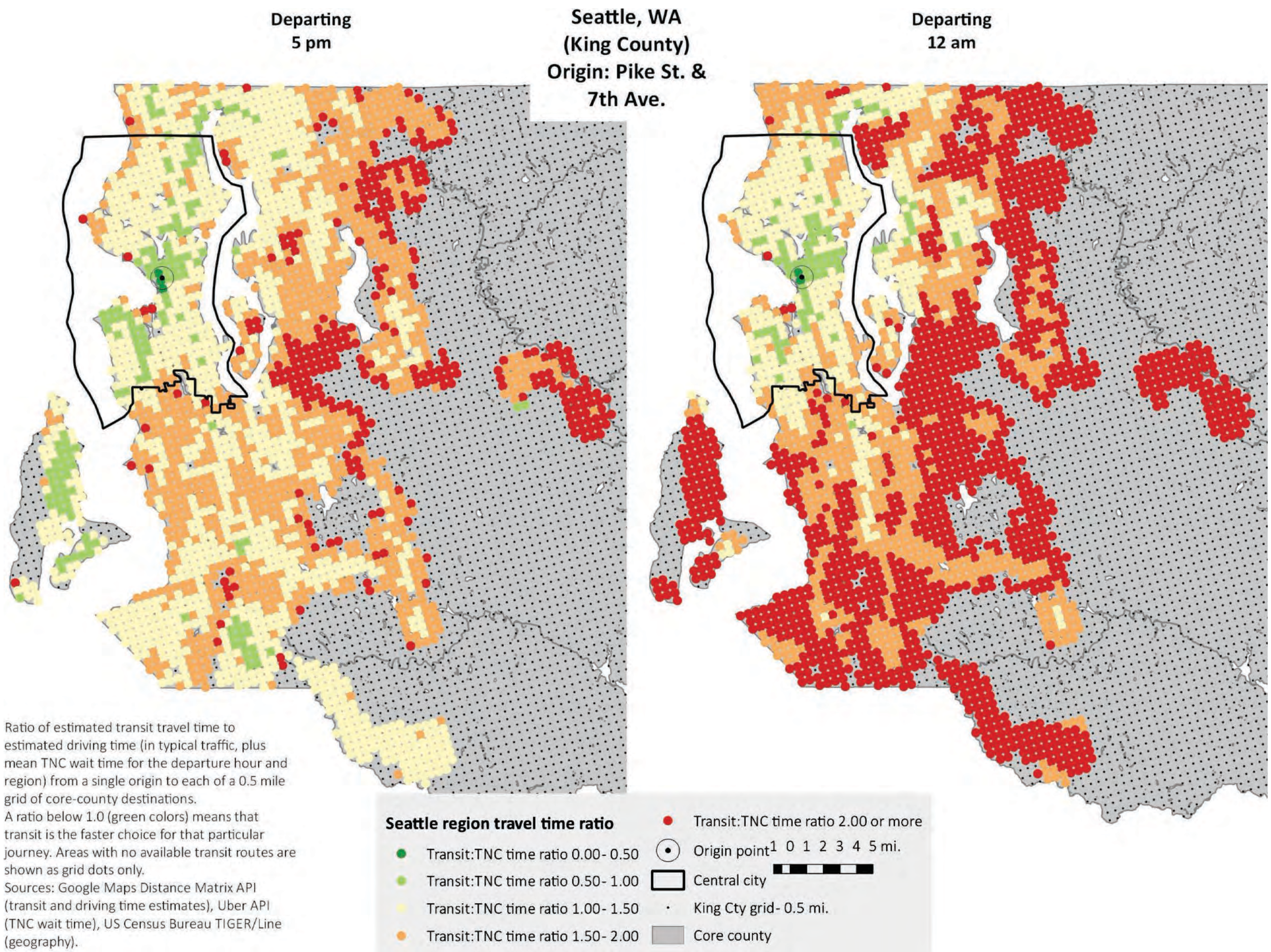


Figure D-7. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Seattle, WA.

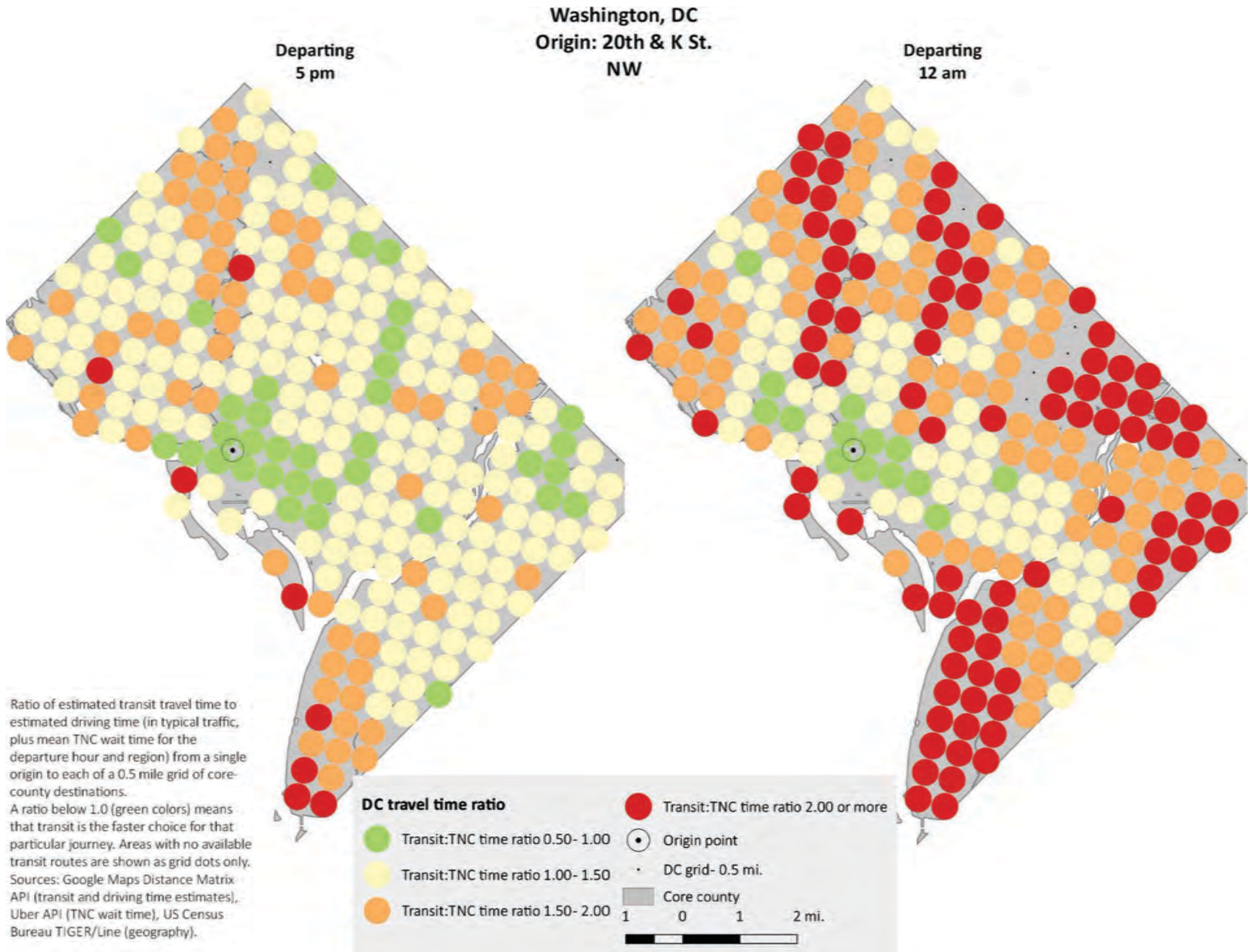


Figure D-8. Transit-TNC travel time ratio, 5:00 p.m. and midnight, Washington, DC.

APPENDIX E

Ridesourcing Demand and Transit Capacity Calculation

Overview of data collection from Uber API

For proprietary reasons, ridesourcing companies are extremely protective of their actual trip data, and the researchers were unable to secure an anonymized or aggregated set of trip data for this phase of the study from either of the two largest ridesourcing companies, Uber or Lyft. However, Uber does provide a way to request information about their services via their application protocol interface (API), a portal where two computers can pass specific information back and forth in a structured way. In the case of the Uber API, a client computer can ask the API for a cost and time estimate for a ride between a specific origin and destination at that moment in time. Queries from the Uber smartphone app use the API to get information, request rides, and interact with their account; Uber also provides documentation of and limited access to the API to third-party software developers.

Uber granted the researchers access to their API for a limited number of requests per hour (1000 each of time and price). All of the queries we made were to a purely informational portion of the API, which did not generate actual ride requests or spoof calls for service. By systematically querying the API throughout the day and week, feeding it origin/destination pairs from specific points providing coverage of our study cities, we gradually assembled a picture of how ridesourcing availability and demand varies across time and geography.

The response from the Uber API contains several potentially interesting data points, among which the most useful for purposes of inferring supply and demand are an estimated time in minutes before an Uber car could reach the origin point, and a price estimate, which includes a component called the surge multiplier, a factor applied to the base price of a ride at times when demand for rides is high in a specific area. Because surge multipliers are limited in time and in geography, and because they vary along a scale from 1 to more than 6 (which means a rider would pay 6 times the base price), they can tell us something about the relative level of demand at a given point and time.

For each study city, we chose to limit the geographical extent of our queries to Census tracts constituting the core county of each metro area. With tract counts ranging from 180 (DC) to more than 2300 (Los Angeles) we would be unable to query the full extent of our regions at the tract level every hour. Instead we chose to employ a weighted random sampling method for an initial four-week round of data collection, and for a second four-week round narrowed the view to four core counties that were able to be fully covered every hour (Austin, San Francisco, Seattle, and, Washington, DC).

To collect the data, we built a set of scripts in the R and Python computer languages that did the following:

1. For each metro geography, we built files with tract-level counts of a variety of Census variables, by which we weight the random tract selection for the next step.
2. Each hour, query the Uber API for estimated wait time and price for each of 1000 theoretical trips in the study cities, and store the responses for later analysis.

Combined, the two rounds of collection produced some 1.07 million usable observations for the study regions.

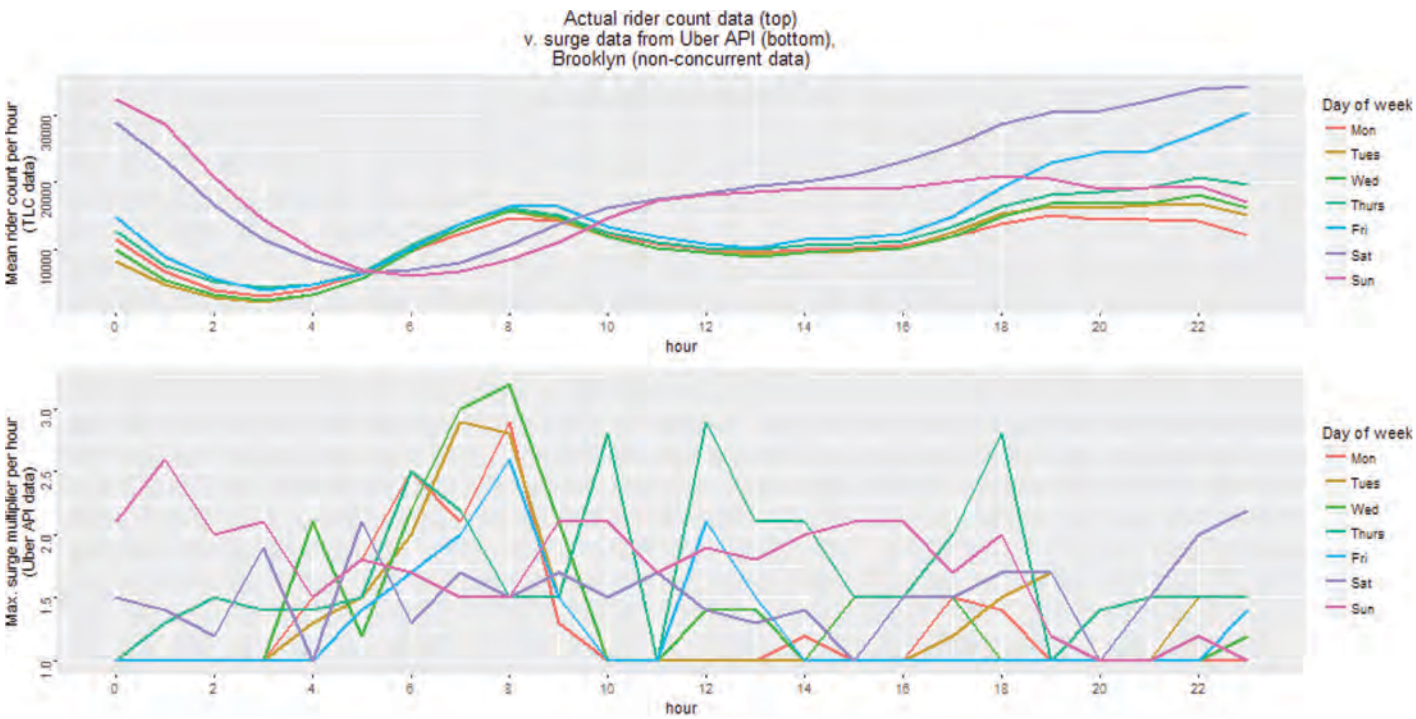
Scheduled transit capacity from GTFS

To determine how Uber rides corresponded with transit trips, the researchers compared the Uber data with agencies' General Transit Feed Specification (GTFS) service information. For the transit capacity side of the comparison, we started from the assumption that the transit agencies schedule service in accordance with customer demand, and used the GTFS schedule data to build estimates of service capacity at the zip code level across the day and week. The researchers were assisted in assembling the transit capacity analysis by our partners at Sam Schwartz Engineering, who gathered all relevant transit agencies' GTFS feeds and programmatically transformed it to hourly counts of trips, vehicles and vehicle types, and maximum wait times for each stop in the system (limited, like the ridesourcing data, to the core county of each region). Using standard load factors and agency-specific vehicle sizes to estimate capacity at each stop, we arrived at a measure of seat-stops per hour for each stop; schedule information allowed us to calculate typical headways at each stop. We then assigned each stop to its containing zip code and generated aggregate measures of seat stops per hour and average headways at the zip code tabulation area (ZCTA) level. Because of differences in how individual agencies convert their operation schedules into GTFS (WMATA's feed in particular has a number of unusual features), cross-agency comparisons based on this data should be approached with caution, especially for more sensitive statistical analyses. However, in aggregated form, the data do serve to usefully illustrate the fluctuation in scheduled service levels across the day and week.

Summary maps of the transit and ridesourcing data are in Appendix F.

Validity of surge pricing as a demand indicator

Though Uber readily acknowledges that surge pricing is their system's way of signaling high demand to both drivers and customers, we validated our interpretation of this indicator by comparing our own additional scrape of these data for Brooklyn, New York, to trip data released by the New York City Taxi and Limousine Commission (TLC). While the samples were not concurrent (the TLC data covered the period January-June 2015, while the API data was collected between October and December 2015), they do show contours in their hourly and daily fluctuations that resemble both one another and the surge pricing patterns in the seven study cities, with the highest use at weekend late nights and moderate rush hour peaks on weekdays (the two sources are shown in Figure E-1). While the surge data showed less range than in other cities and fit was far from perfect, statistical modeling showed that the surge multiplier, day of week, and hour of the day were fairly strong predictors the actual rider count. The surge multiplier tended to overestimate the weekday demand, while moderating the weekend nights somewhat, but the overall pattern remained. Possible explanations for these differences are differing seasonality of the data, actual changes in trip patterns, or that the surge multiplier is a better predictor of demand in a particular location than for a large area.



Note: Data not concurrent; TLC data covers January–June 2015, while API data was collected October–December 2015.

Figure E-1. TNC rider count data from New York City TLC trip reporting **(top)** ***vs. surge multiplier data from Uber API*** **(bottom),** ***for locations covering Brooklyn.***

APPENDIX F

Maps of Ridesourcing and Transit Demand and Capacity

The maps in this section (Figures F-1 through F-21) depict estimates of scheduled public transit capacity and wait time alongside indicators of ridesourcing demand and capacity derived from queries of the Uber API, with data aggregated to the zip code (ZCTA) level. The methodology is described in Appendix E.

For each of the seven study cites, maps are shown for the weekday morning peak (7-10am), afternoon peak (4-7pm), and weekend late night periods (10pm-3am). Each figure displays the following data at the ZCTA level for each time period:

Scheduled transit (left-hand maps)

- Seat-stops per hour (number of stop locations * number of stop events * vehicle capacity), represented by the depth of the red color gradient
- Average wait time in minutes (headway), represented by the direction of crosshatching

Ridesourcing (right-hand maps)

- Average wait time in minutes, shown by the depth of the green color gradient
- Maximum surge multiplier, represented by the direction of crosshatching

Data sources: Transit agency GTFS feeds (transit data), Uber API (ridesourcing data), U.S. Census TIGER/Line (geography).

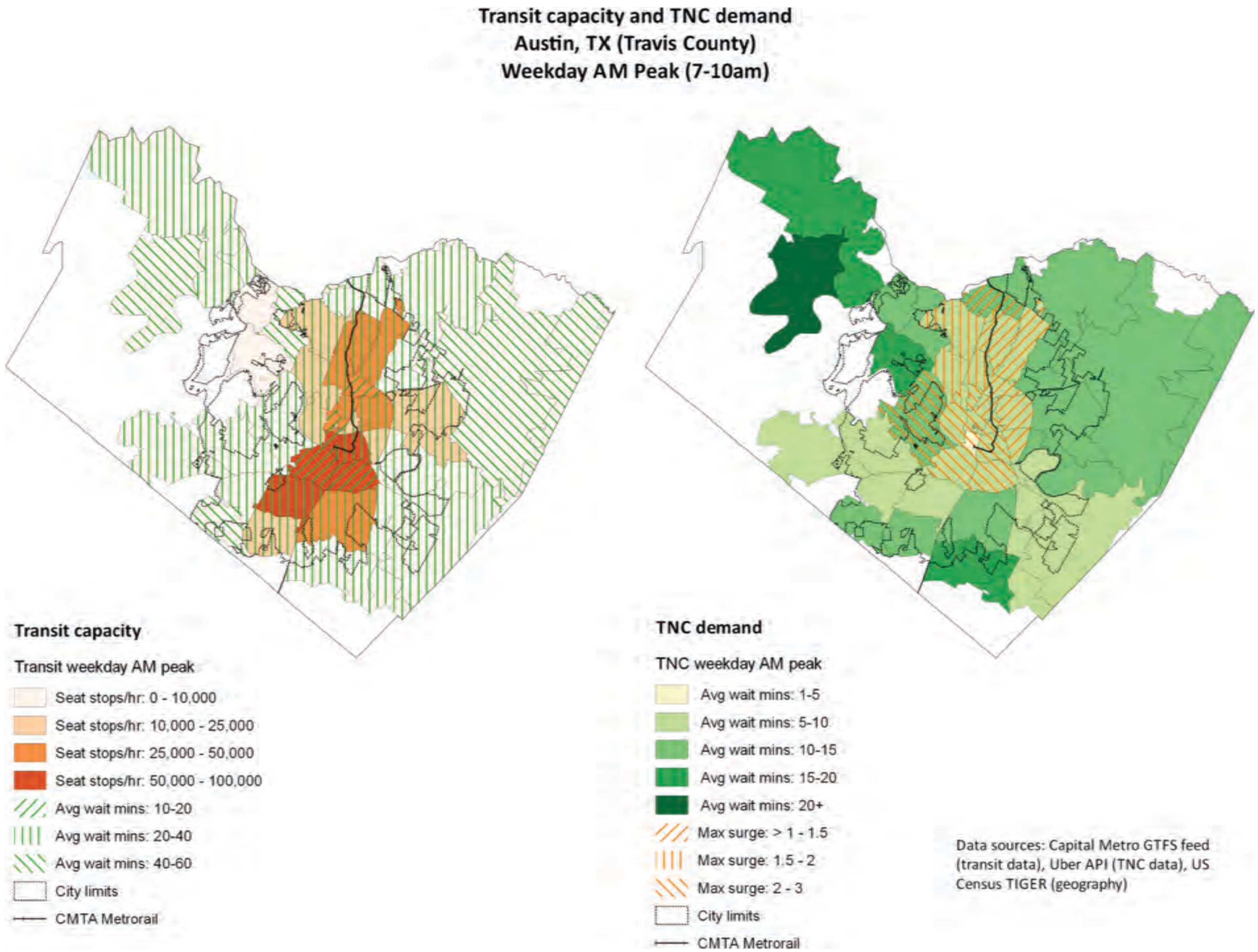


Figure F-1. Transit capacity and TNC demand, Weekday AM peak, Austin, TX.

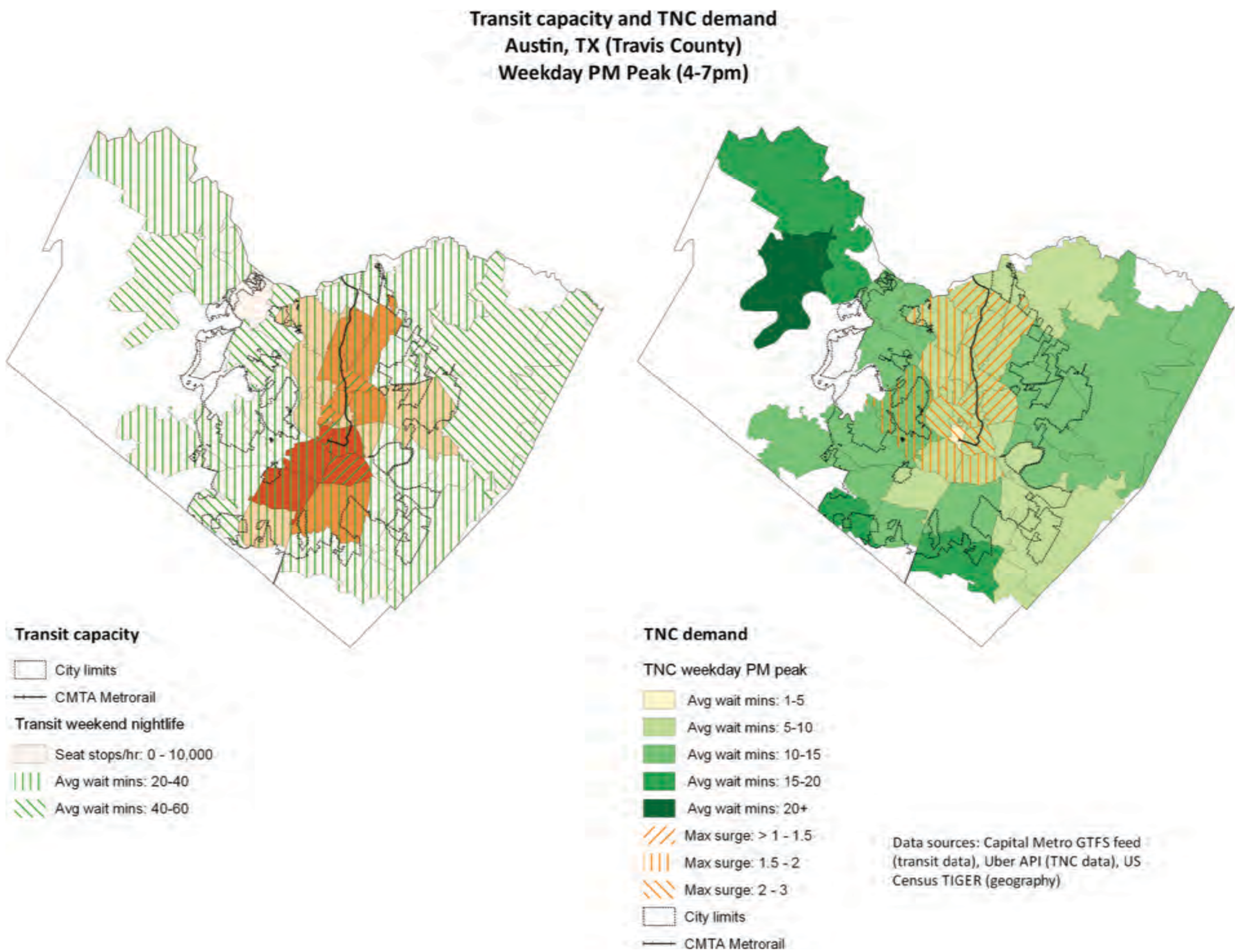


Figure F-2. Transit capacity and TNC demand, Weekday PM peak, Austin, TX.

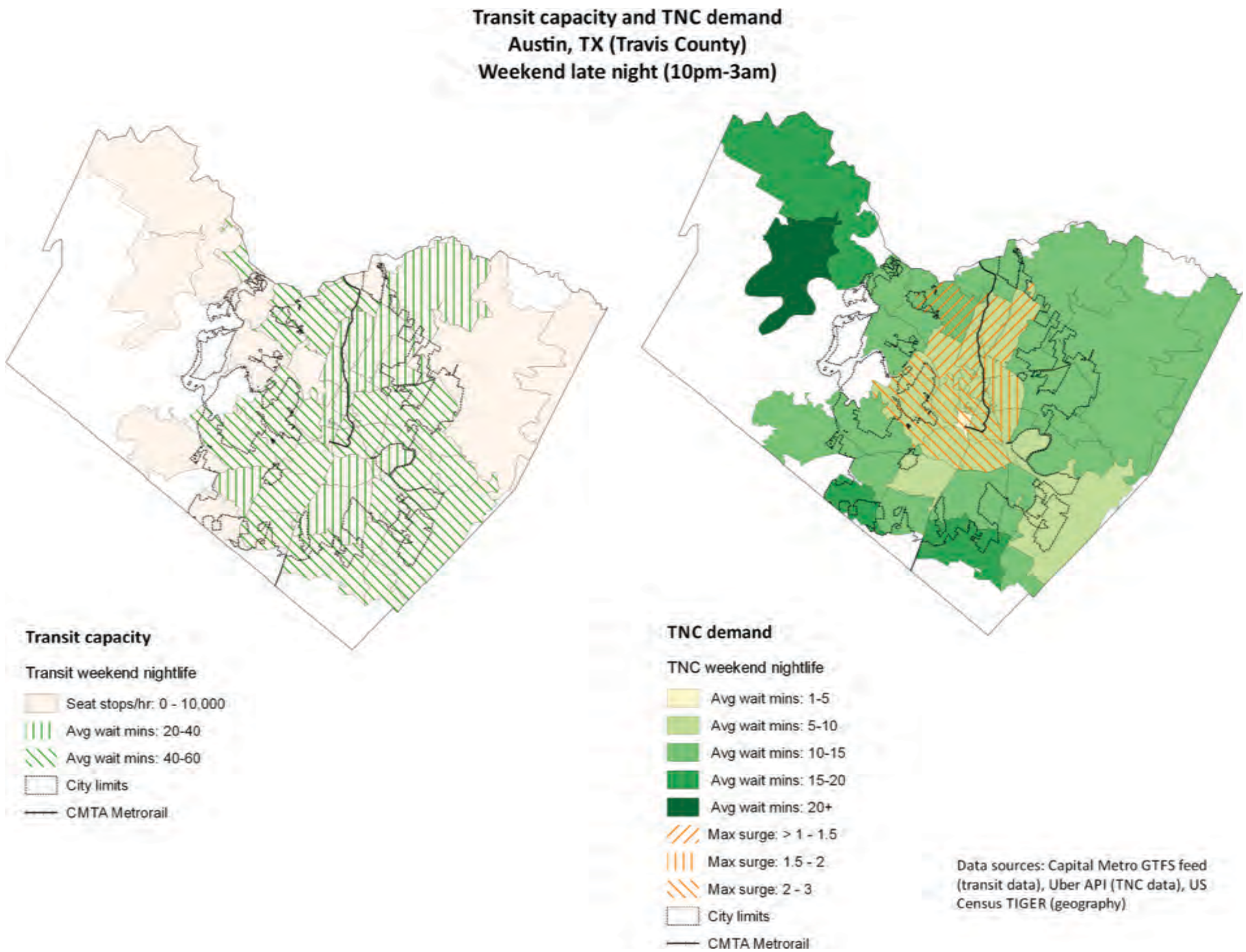


Figure F-3. Transit capacity and TNC demand, Weekend late night, Austin, TX.

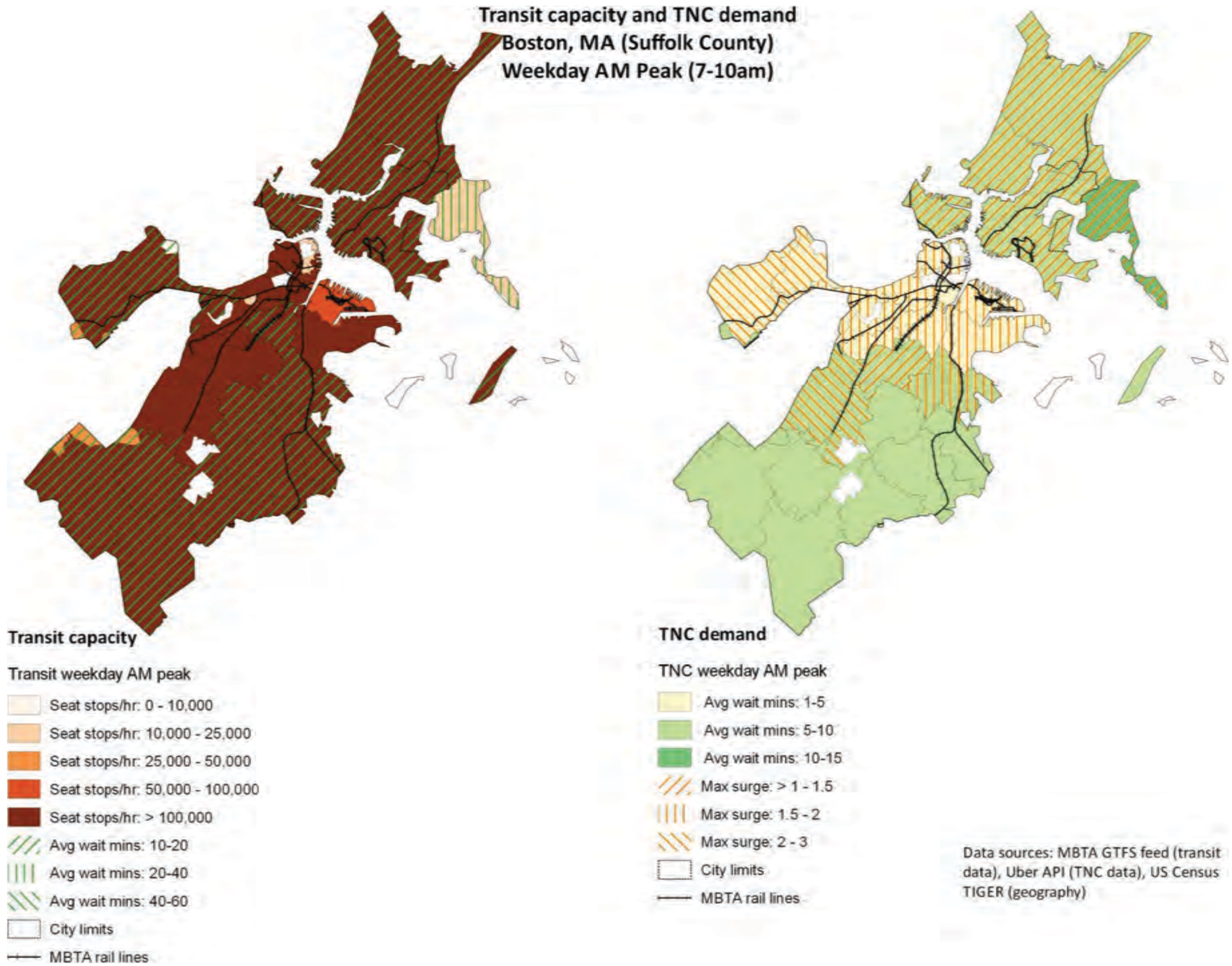


Figure F-4. Transit capacity and TNC demand, Weekday AM peak, Boston, MA.

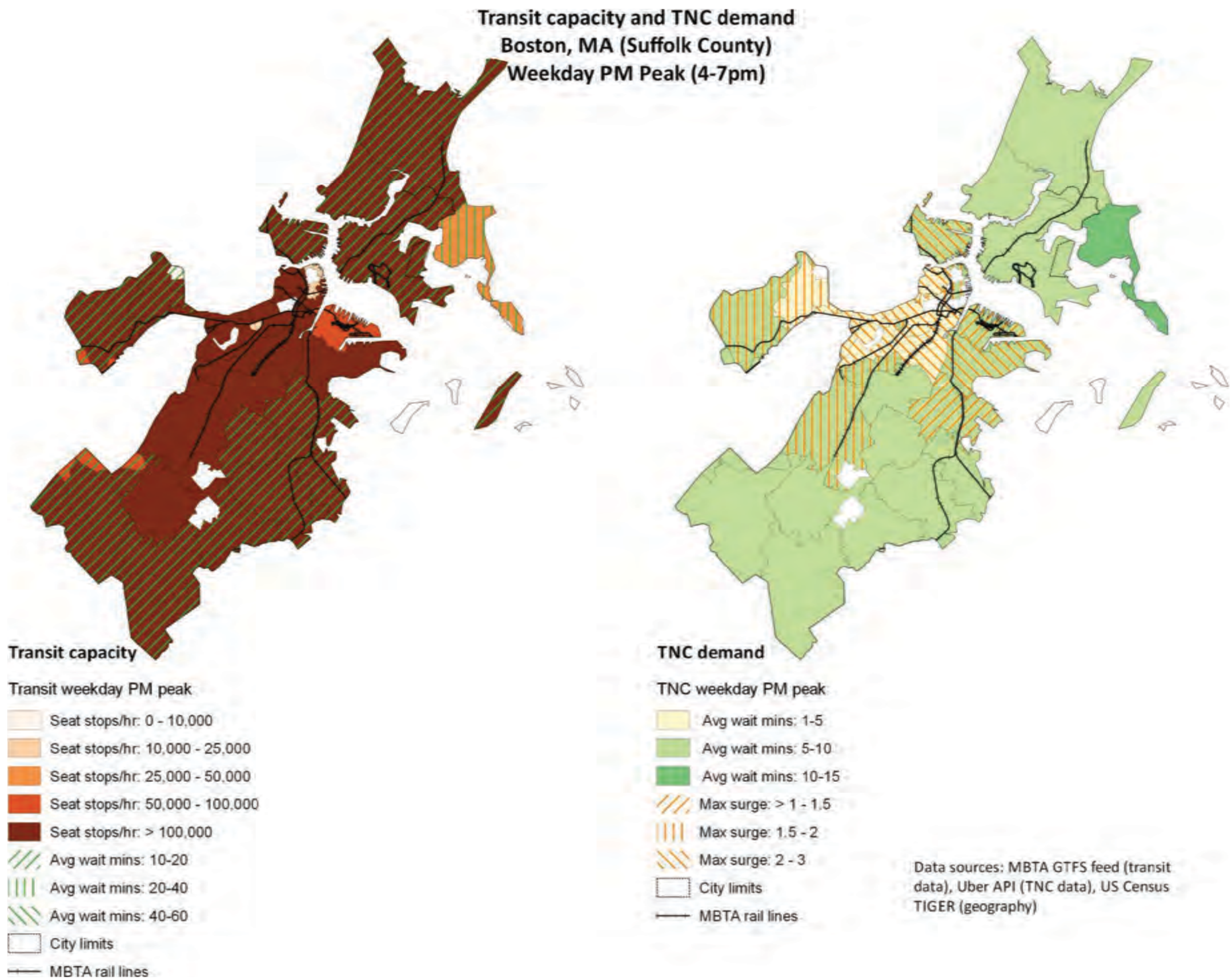
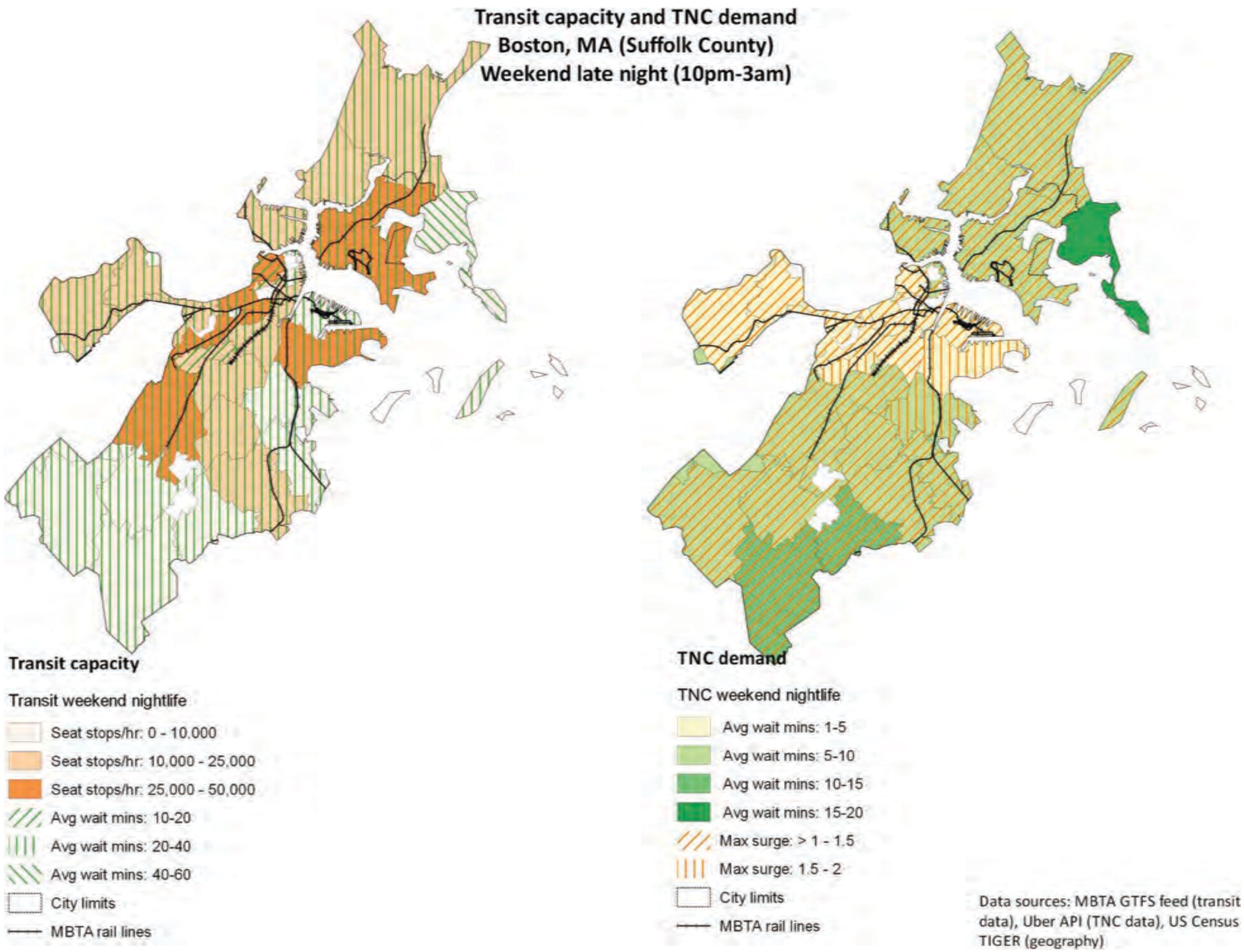


Figure F-5. Transit capacity and TNC demand, Weekday PM peak, Boston, MA.



Boston transit data do not reflect March 2016 cuts to late-night MBTA service.

Figure F-6. Transit capacity and TNC demand, Weekend late night, Boston, MA.

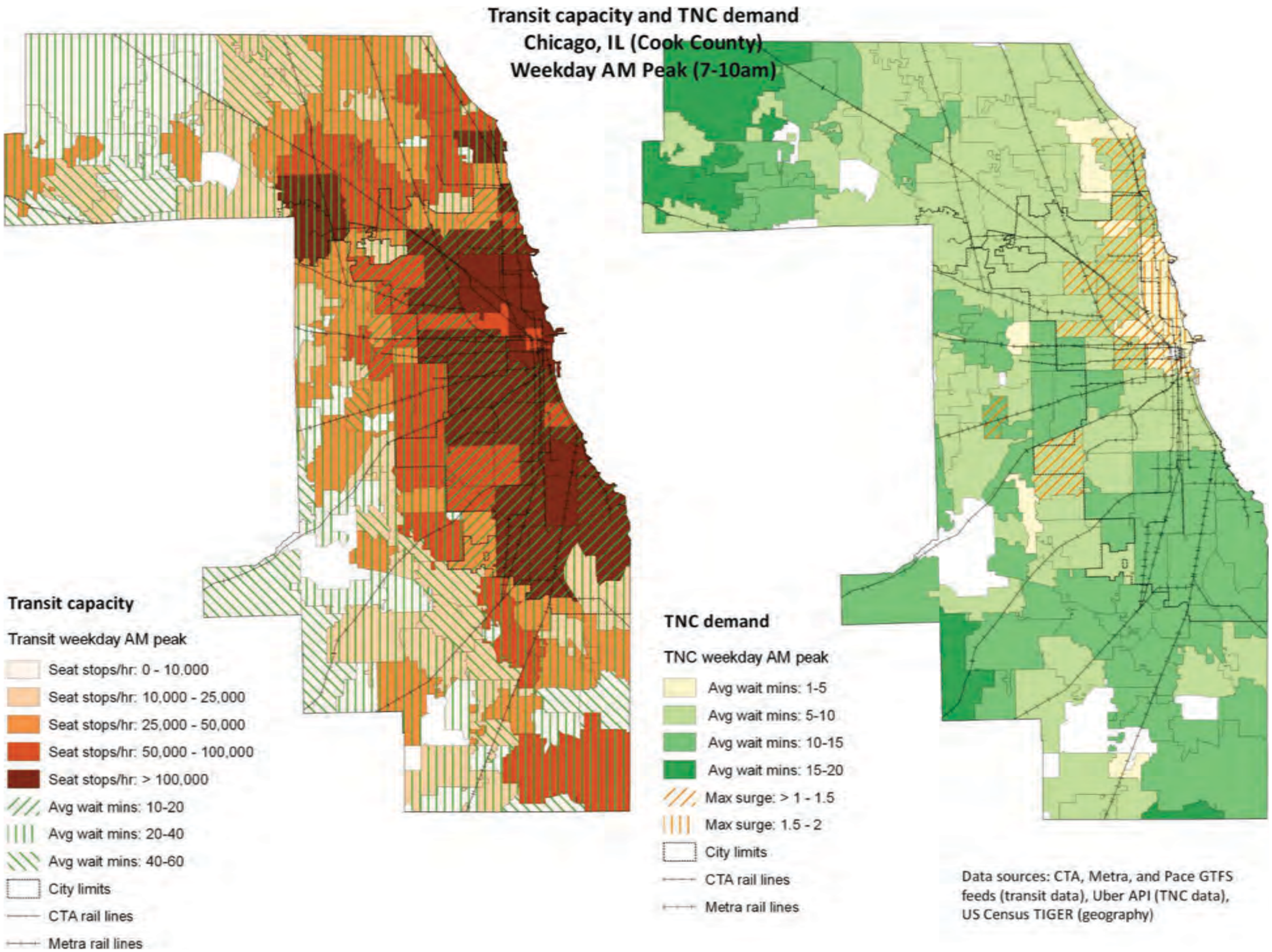


Figure F-7. Transit capacity and TNC demand, Weekday AM peak, Chicago, IL.

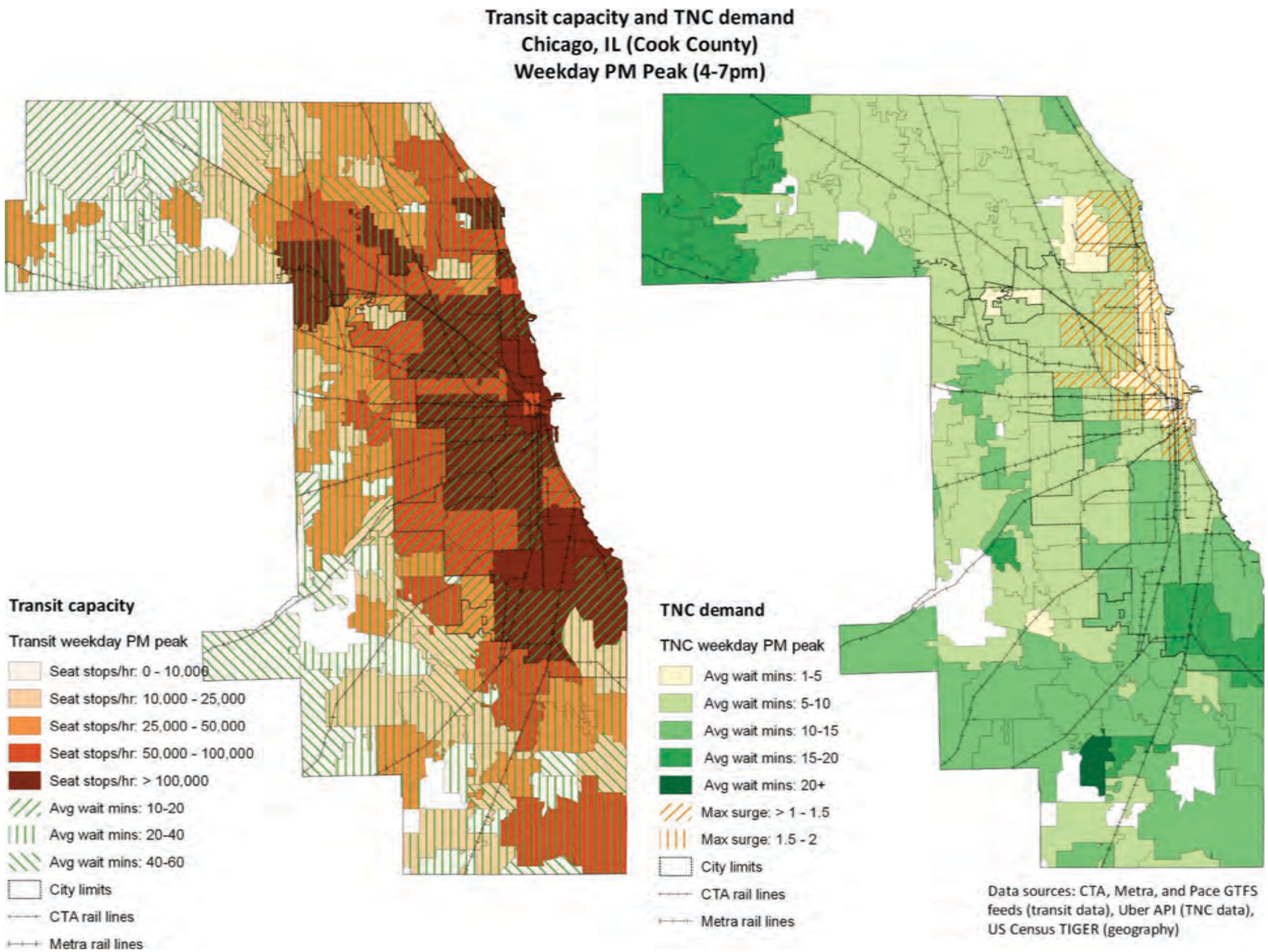


Figure F-8. Transit capacity and TNC demand, Weekday PM peak, Chicago, IL.

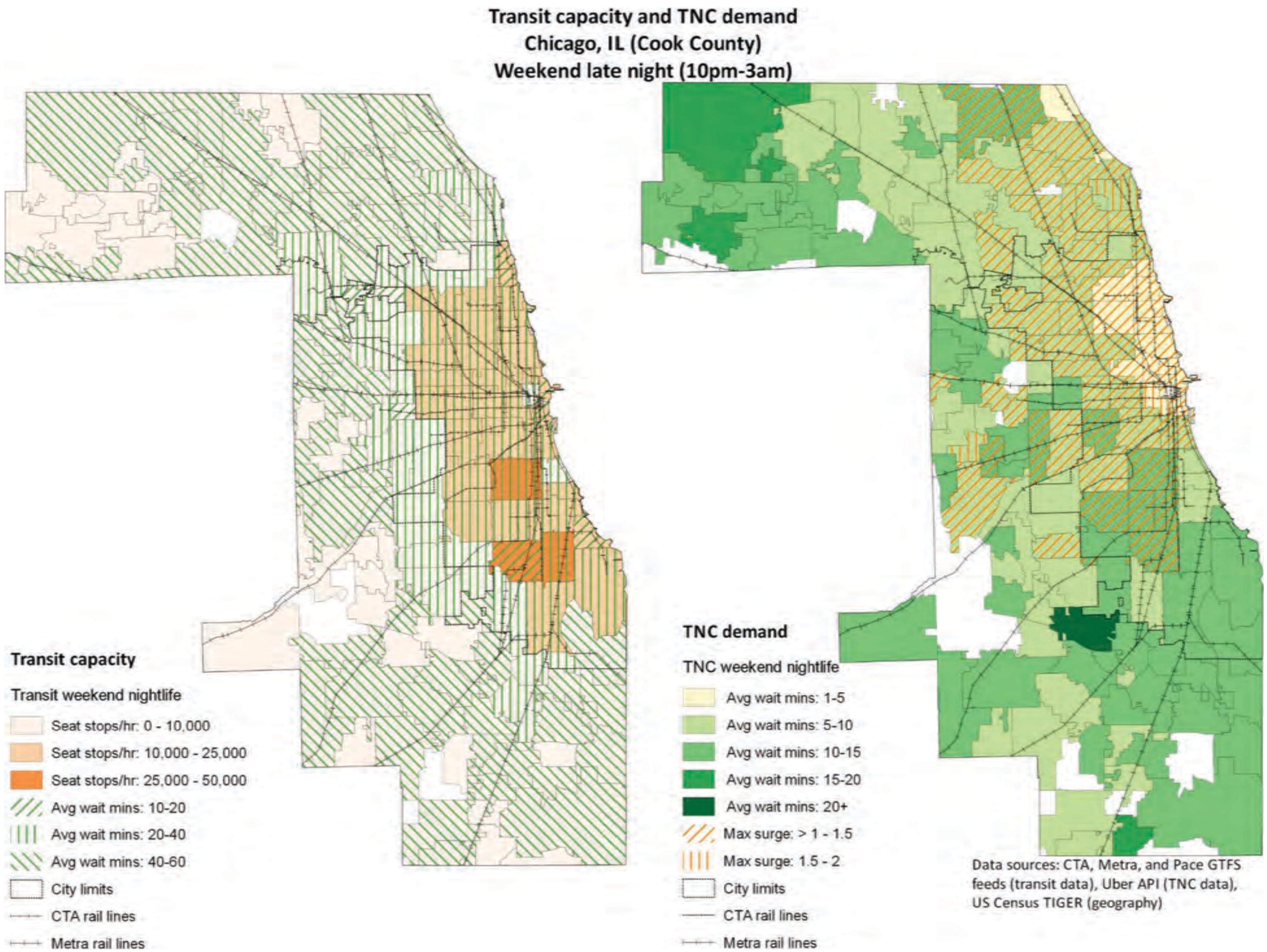


Figure F-9. Transit capacity and TNC demand, Weekend late night, Chicago, IL.

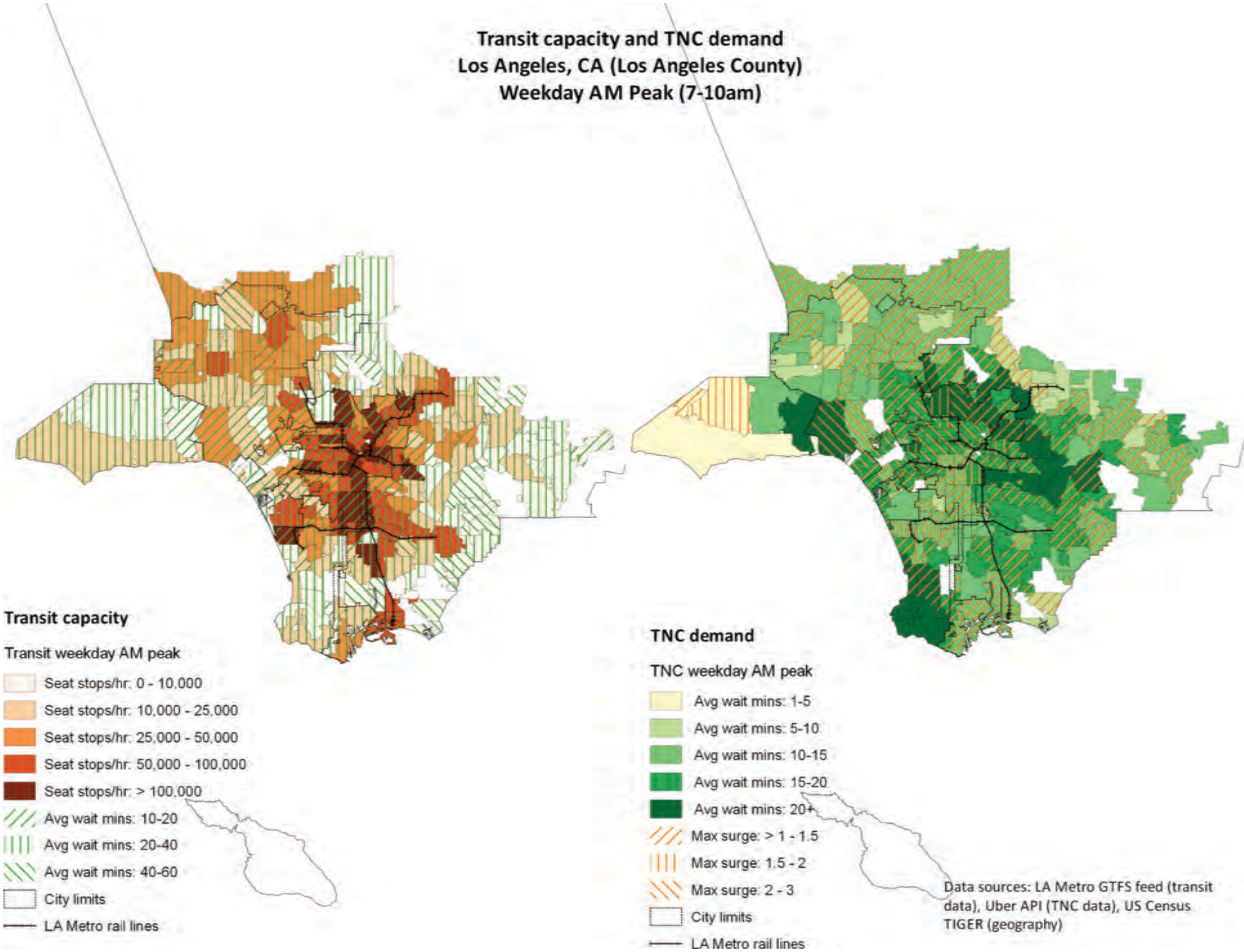


Figure F-10. Transit capacity and TNC demand, Weekday AM peak, Los Angeles, CA.

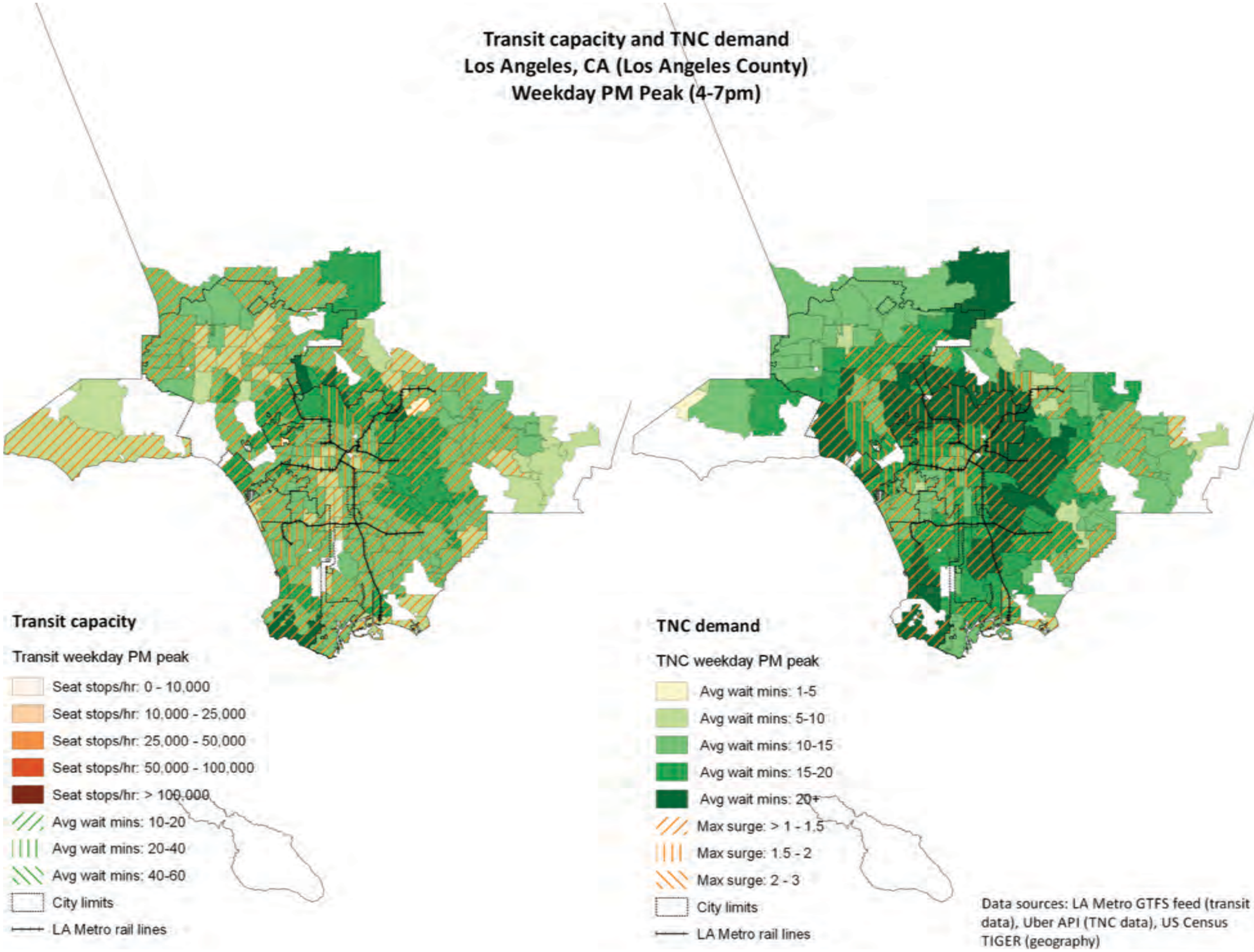


Figure F-11. Transit capacity and TNC demand, Weekday PM peak, Los Angeles, CA.

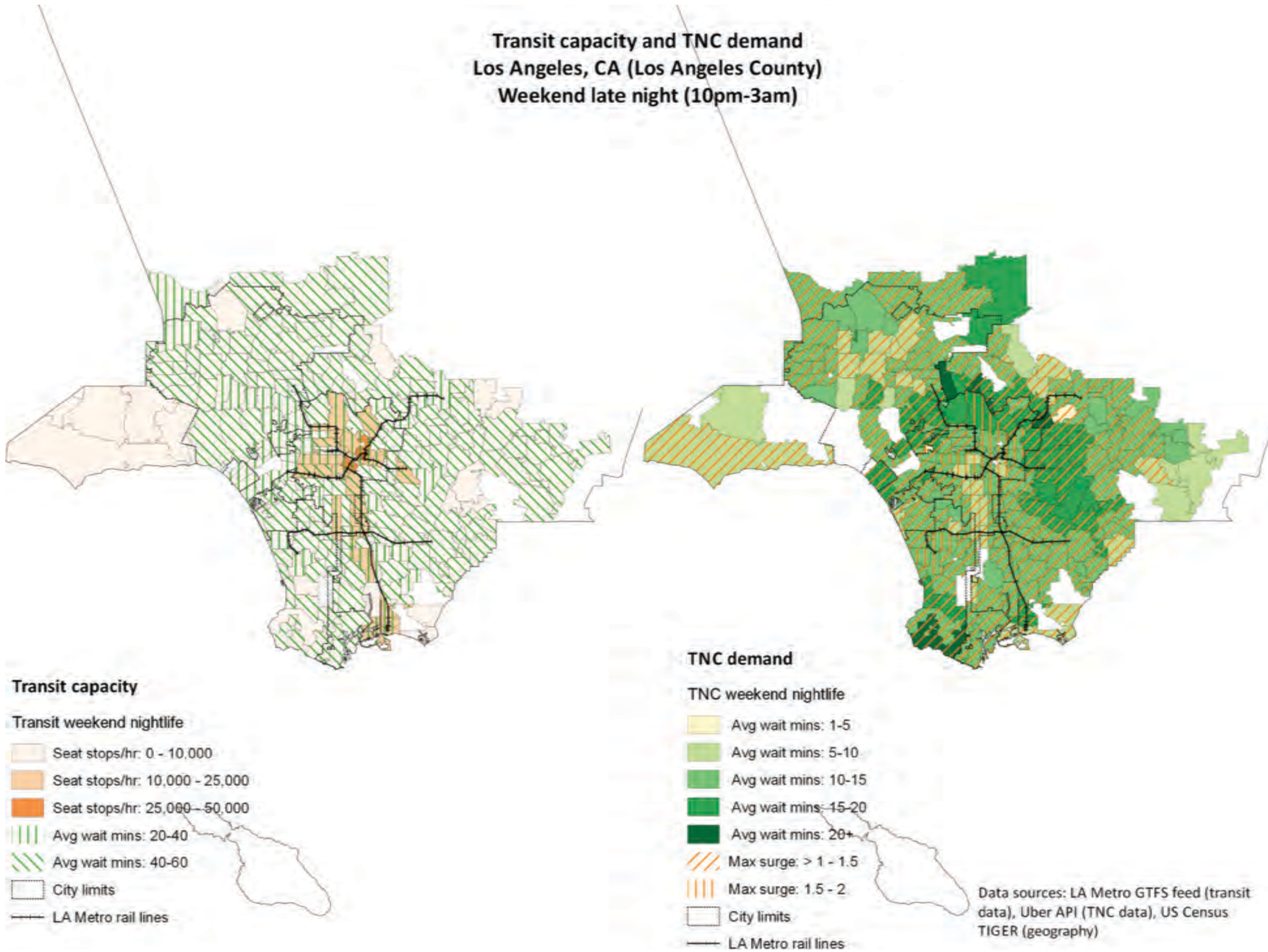


Figure F-12. Transit capacity and TNC demand, Weekend late night, Los Angeles, CA.

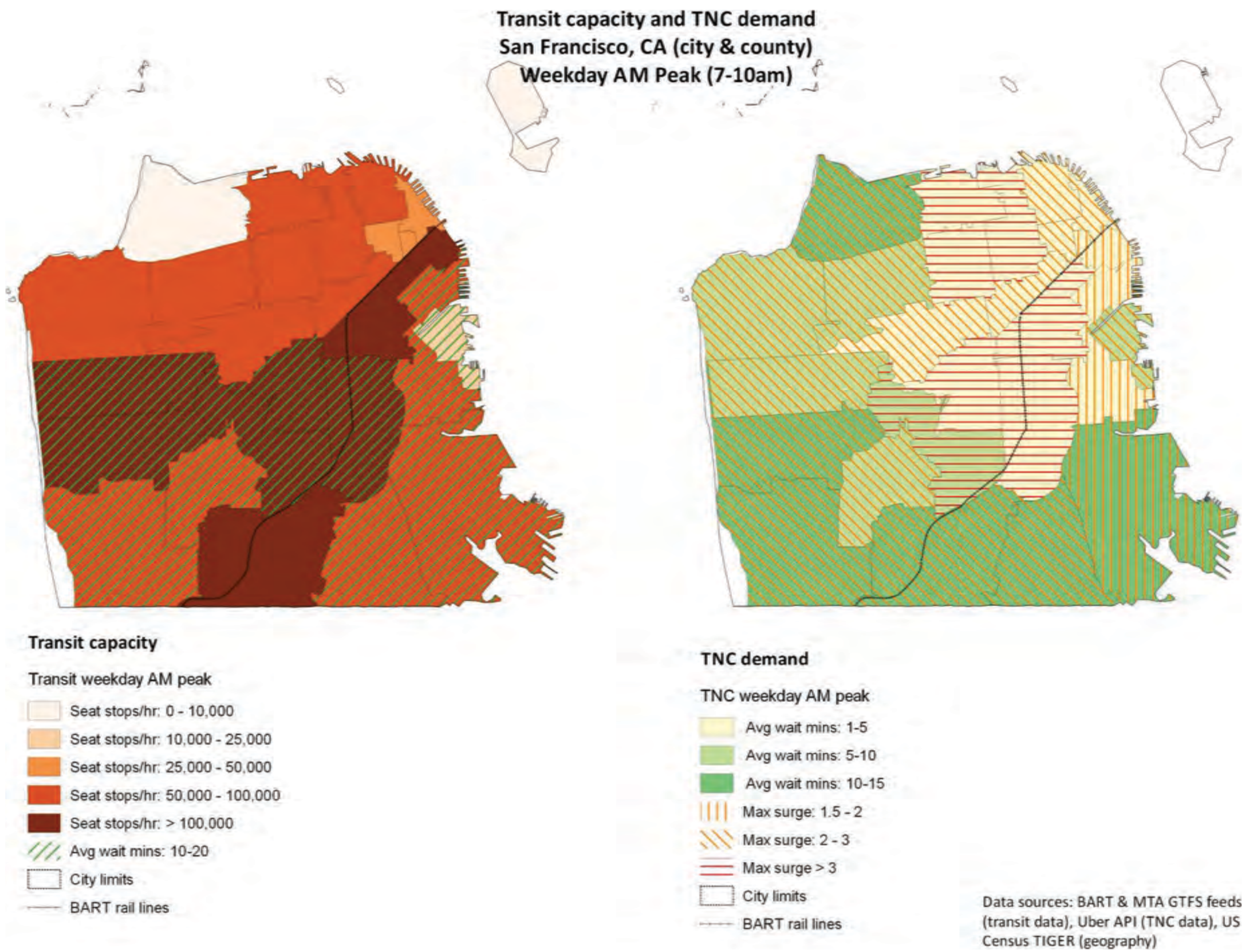


Figure F-13. Transit capacity and TNC demand, Weekday AM peak, San Francisco, CA.

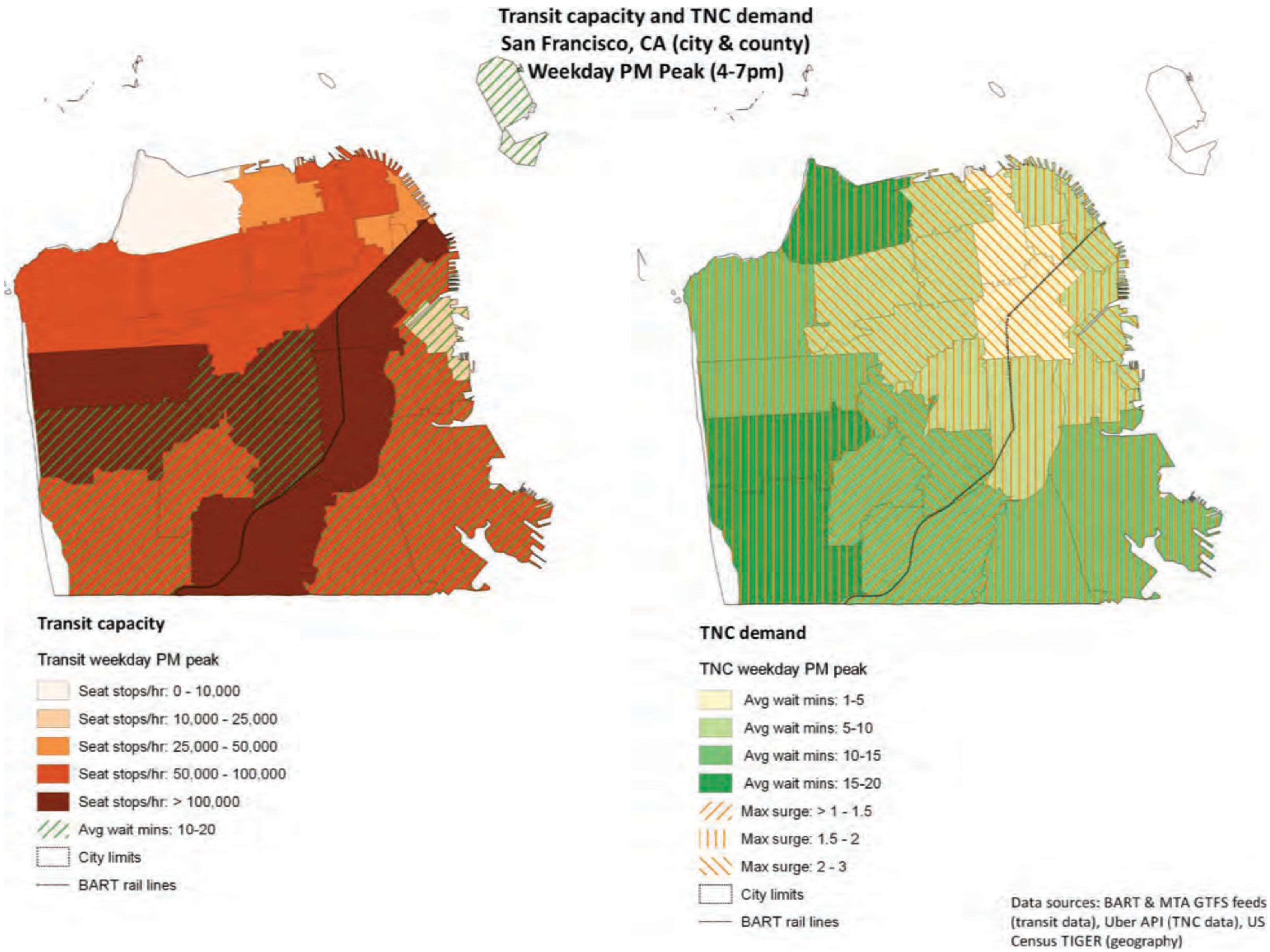


Figure F-14. Transit capacity and TNC demand, Weekday PM peak, San Francisco, CA.

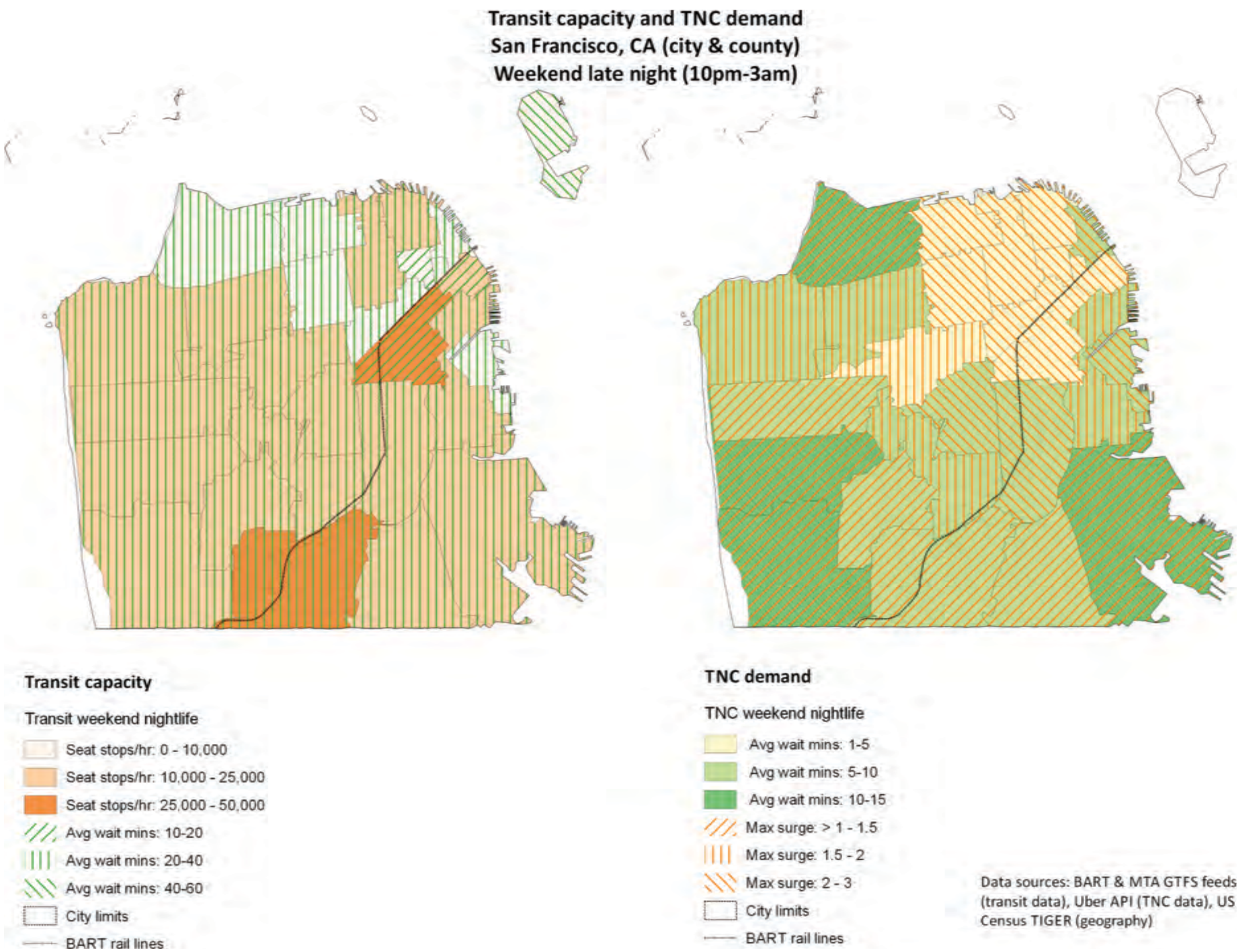


Figure F-15. Transit capacity and TNC demand, Weekend late night, San Francisco, CA.

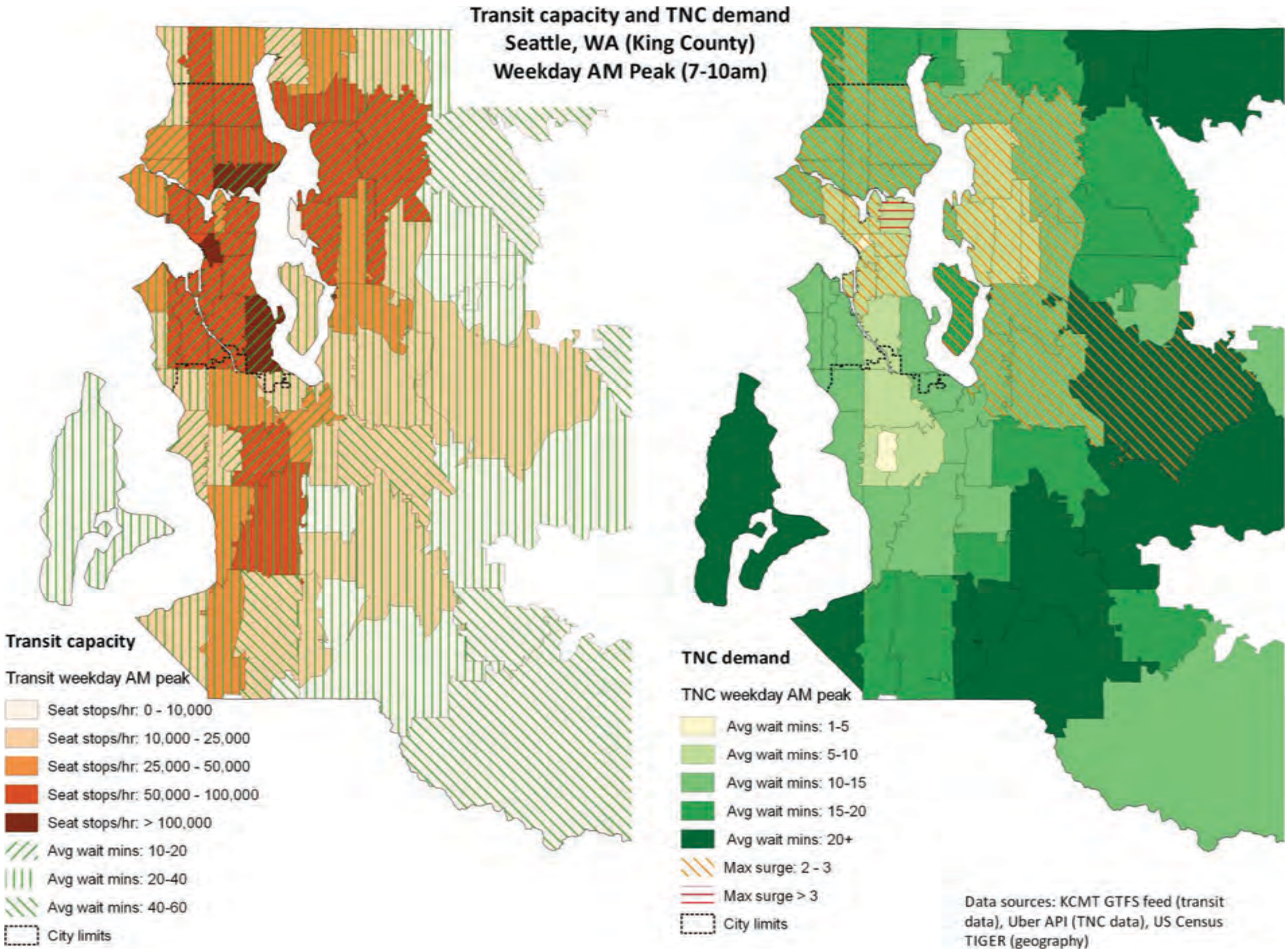


Figure F-16. Transit capacity and TNC demand, Weekday AM peak, Seattle, WA.

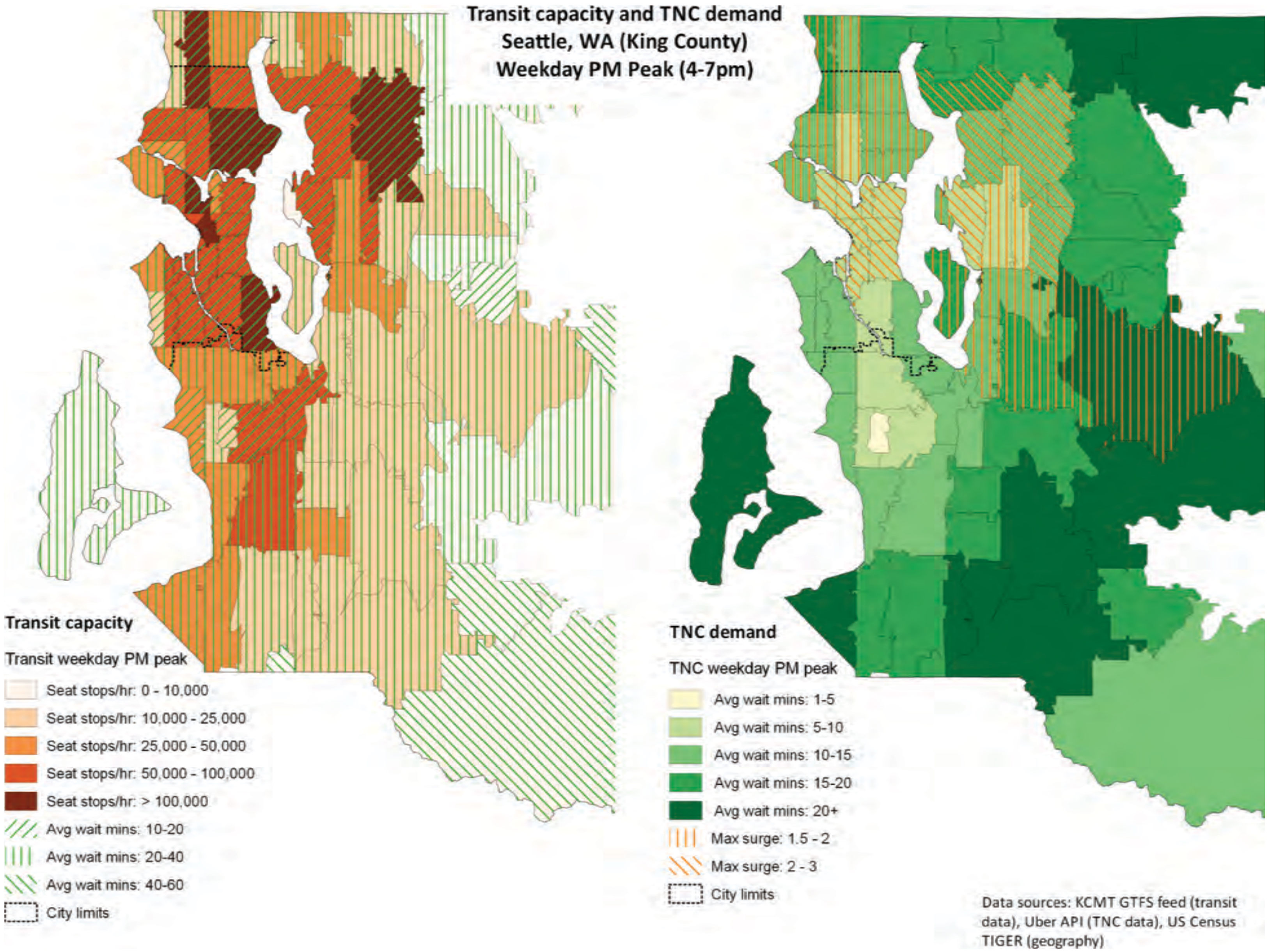


Figure F-17. Transit capacity and TNC demand, Weekday PM peak, Seattle, WA.

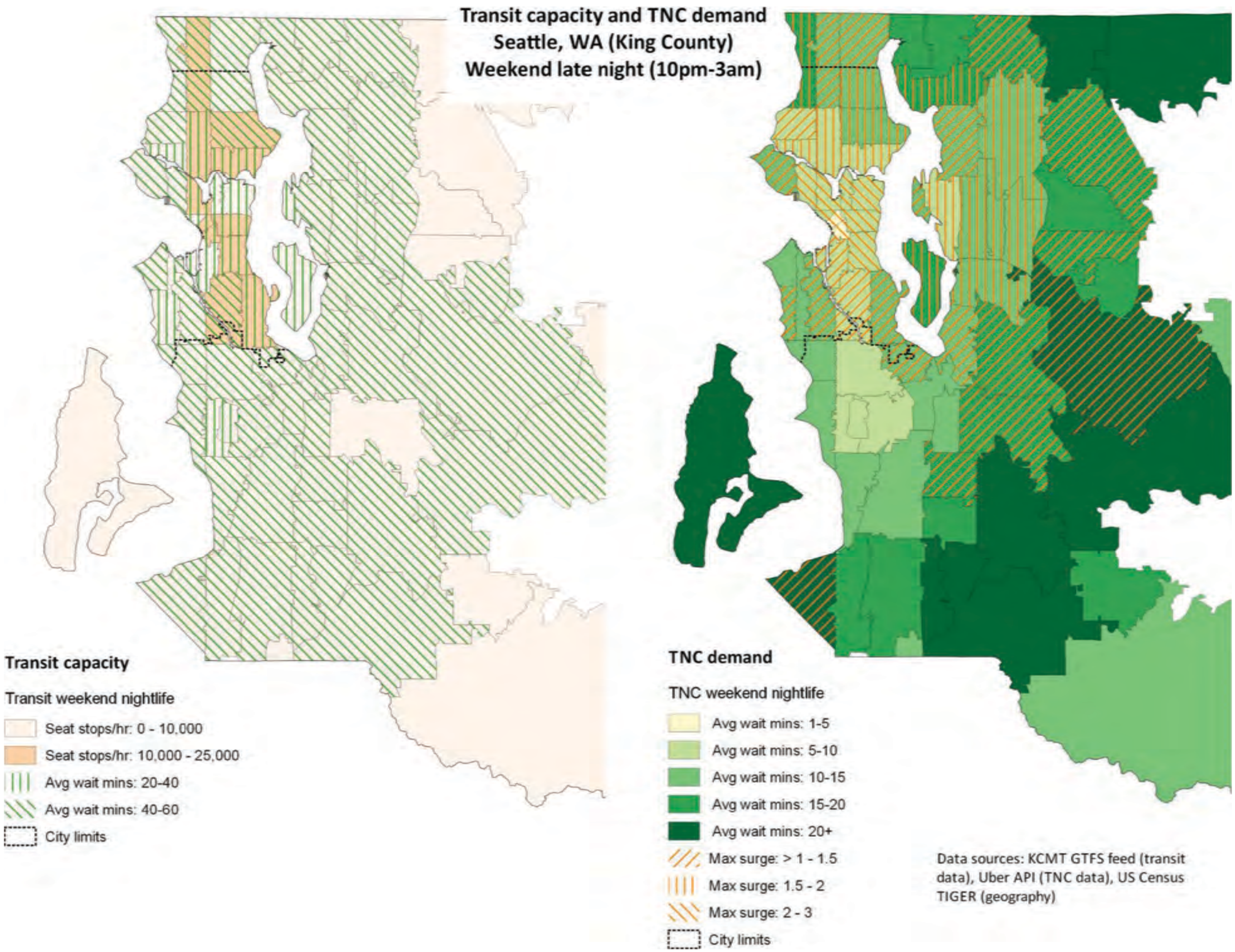


Figure F-18. Transit capacity and TNC demand, Weekend late night, Seattle, WA.

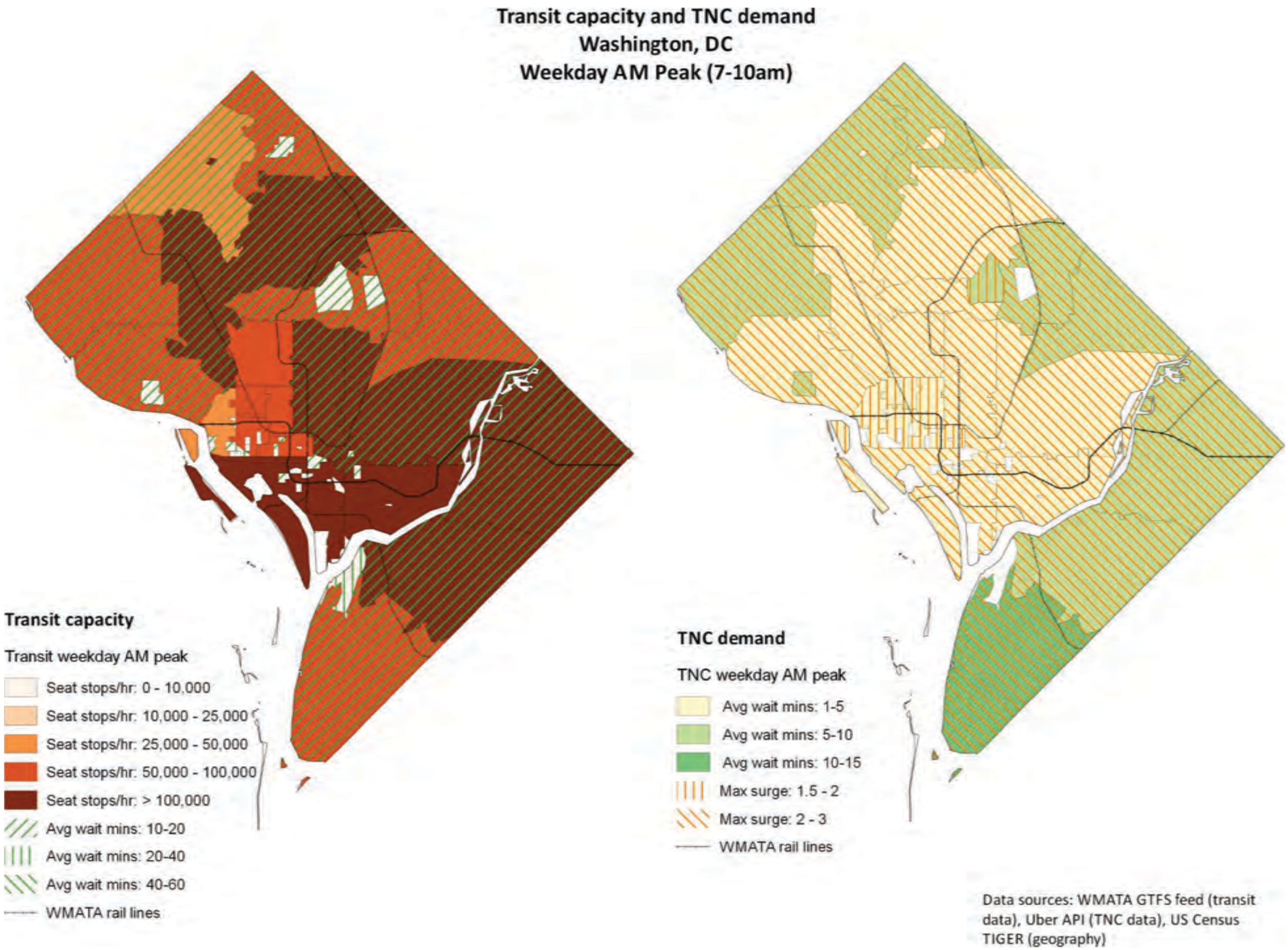


Figure F-19. Transit capacity and TNC demand, Weekday AM peak, Washington, DC.

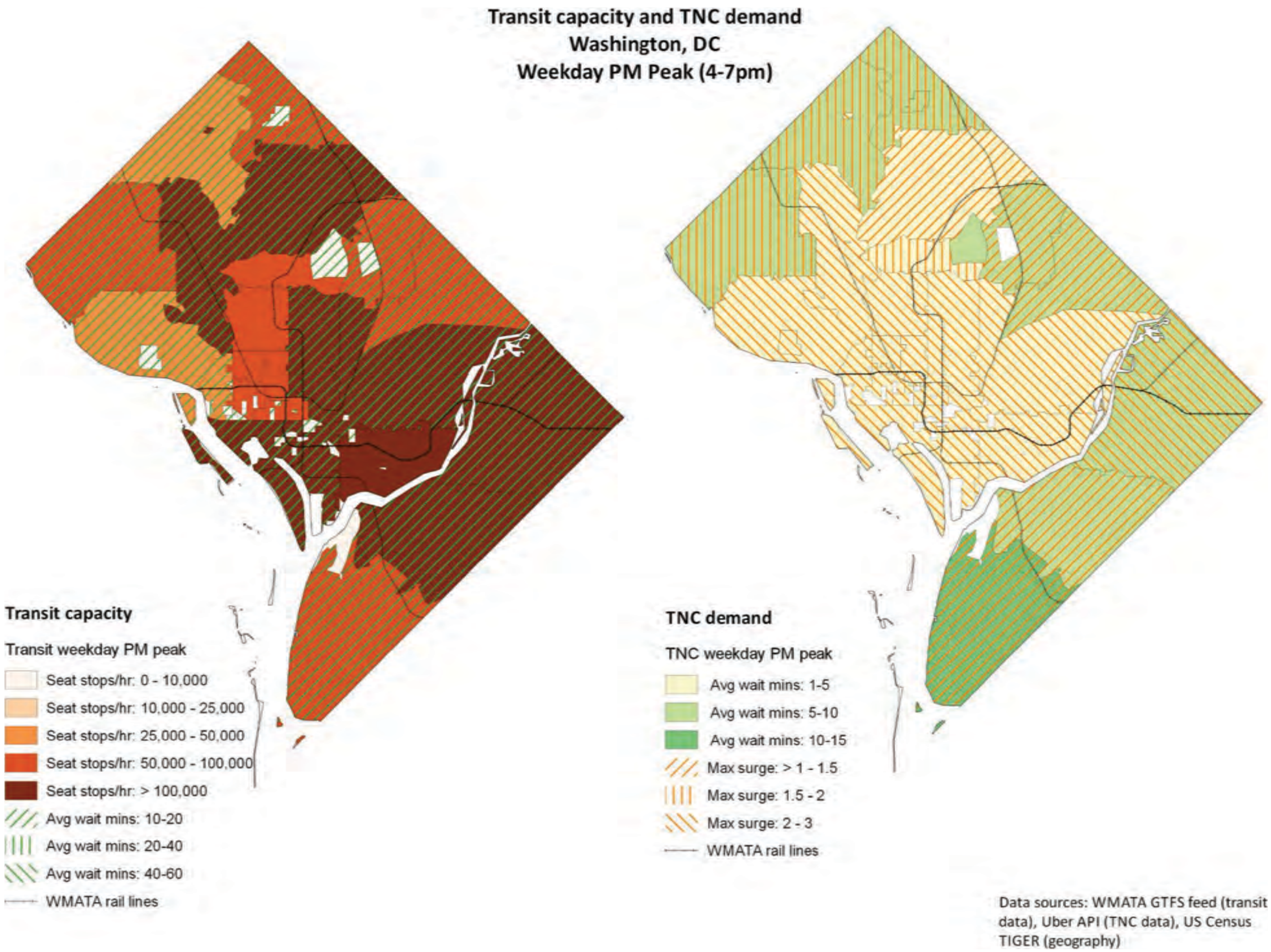


Figure F-20. Transit capacity and TNC demand, Weekday PM peak, Washington, DC.

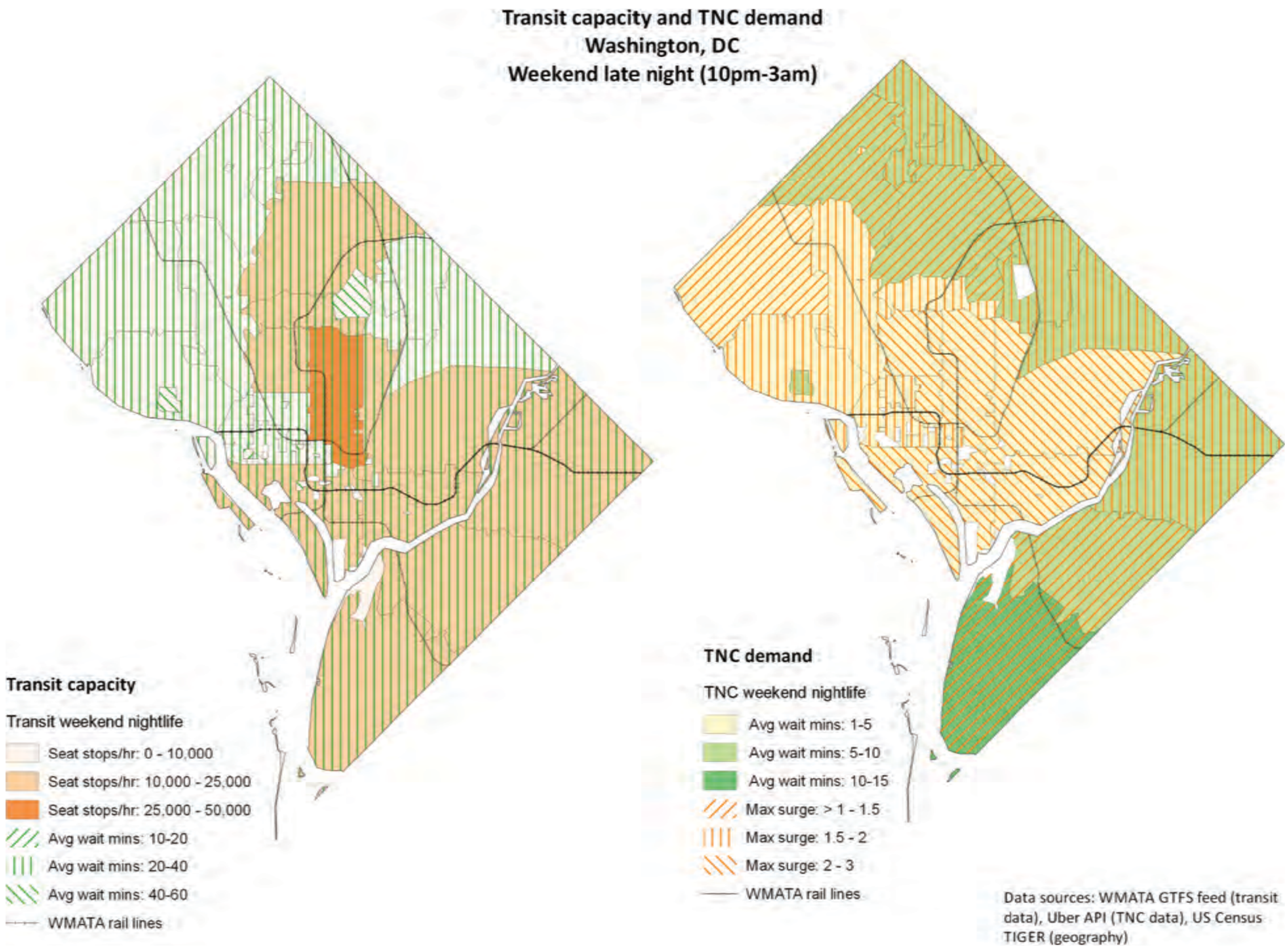


Figure F-21. Transit capacity and TNC demand, Weekend late night, Washington, DC.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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