Accountability Through Accessibility:

Measuring What Matters for Departments of Transportation

White Paper

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To accurately measure the impacts generated by the actions of Departments of Transportation (DOTs), changes to land use and land value that result from changes to the transportation network must be included. We argue in this paper for the use of Accessibility measures in system performance and project prioritization for DOTs, to fully account for DOT decisions. Accessibility, or measurement of how easily people can connect to their desired destinations, is not a new concept, yet progress has been slow in adopting measures which focus on people rather than vehicle movement and delay. To spur further consideration of Accessibility, we document the theoretical and practical basis for Accessibility, describe available data, explore change in metrics over short and long time scales, and recommend approaches for inclusion into DOT decision making. Ultimately the full impact of DOT actions cannot be fully captured by the vehicle movement metrics which comprise the status quo. Accessibility metrics offer a way to evaluate what DOTs are providing, where, and to whom, in terms of connection to destinations and changes in land use.

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ACCOUNTABILITY THROUGH ACCESSIBILITY:

MEASURING WHAT MATTERS FOR DEPARTMENTS OF TRANSPORTATION

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EXECUTIVE SUMMARY

Departments of Transportation control the apportionment of tax dollars to build and operate the transportation system which people use to connect to their destinations. The ways that people and businesses use the system on a daily basis and through long-term investments shape the land uses and built environment of our communities. In common practice, however, evaluating how transportation investments shape land use is *not* part of the planning or evaluation of transportation projects. Rather, the movement, speed, and especially delay of cars and trucks is the primary measurement by which agencies and the public evaluate transportation network success. **To accurately measure the impacts generated by the actions of these Departments of Transportation (DOTs), changes to land use and land value that result from changes to the transportation network must be included.** We argue in this paper for the use of Accessibility measures in system performance and project prioritization for DOTs, to fully account for DOT decisions. Accessibility, a measurement of how easily people can connect to their desired destinations, is not a new concept, yet progress has been slow in adopting measures which focus on people rather than vehicle movement and delay. To spur further consideration, we document the theoretical and practical basis for Accessibility, describe available data, explore change in metrics over short and long time scales, and recommend approaches for inclusion into DOT decision making. Ultimately the impact of DOT actions cannot be fully captured by the vehicle movement metrics which comprise the status quo. Accessibility metrics offer a way to evaluate the destination opportunities DOT projects provide, who they serve, and how they change land use over the short- and long-term.

SUMMARY OF KEY POINTS

1. Accessibility quantifies the choices provided to residents and businesses by the transportation system.
2. Accessibility is consistent, comparable, scales well across geographic resolution, and can be calculated in advance of any proposed network change. These properties make it an excellent planning and system performance measure.
3. Investments and changes to transportation networks by DOTs directly change Accessibility.
4. Accessibility changes create cascading changes in land value, and ultimately land use, in predictable ways.
5. Accessibility is a summary of full impact (benefit and disbenefit) which can be included in benefit-cost analyses used to prioritize and evaluate DOT actions.

Transportation can connect people with jobs and other economic opportunities, health care, education, recreation and all the other necessities of a full life. The level of this access can be quantified. Using accessibility metrics we can measure the progress of DOTs toward connecting people to essential quality of life destinations. Knowing the speed and delay of the average auto trip on the average day is no longer enough. It is time for DOTs to measure what matters. Our transportation systems are primarily there to provide access. Measuring how easily people can reach the destinations they need offers DOTs the opportunity to build projects that account for all travel choices, improve our collective quality of life, and benefit our economy.

CHAPTER 1: INTRODUCTION

1.1 A BRIDGE OVER THE ST. CROIX

In 2017, a new bridge opened connecting Minnesota and Wisconsin across the St. Croix River. The cable-and-concrete structure spanned the gorge of the scenic waterway, the product of hundreds of millions of dollars, and years of federal legislative effort from delegations in both states (including then-Congressman Sean Duffy, now Secretary of the US Department of Transportation). An aged, flood-prone trestle bridge nearby was retired into service as a pedestrian and bicycle crossing.

What was the impact of this significant investment? Traditional measurements of transportation performance evaluate roadway segments, and would celebrate the increased volume, and especially the speed, along the bridge and its connected roadways. It was now much easier for people to drive cars and trucks across the river. And in the first few years after the bridge opened, people did travel more on the Minnesota state highway segment just west of the bridge—in fact daily traffic was almost 40% higher even in the teeth of the COVID-19 pandemic. So, the bridge was clearly being used. But where were people and freight coming from, or going to? Would these trips have happened without the bridge investment? What other consequences might arise from this initial increase in speed and capacity? These questions fall squarely outside of the benefit-cost analysis used to justify the years and dollars of effort.

Figure 1.1: St. Croix Crossing bridge under construction (photo credit: HDR Inc).

But people travel from origins to reach destinations, and the question of which trips were made easier, can be answered. One way is through a concept called **Accessibility**, which captures how easy it is for people to reach desired destinations. In this paper we explore the application of Accessibility to better measure what it is state and local Departments of Transportation (DOTs) are providing for their residents, and what taxpayers are getting for their money.

1.2 SYNTHESIZING LAND USE AND TRANSPORTATION

Accessibility measures the ease of reaching potential destinations, capturing the interaction between transportation infrastructure and land use. The measurement summarizes potential opportunities reachable from a given place, at a given time, traveling using a certain mode, for a certain amount of time. Also called Access to Destinations or Access to Opportunity, this set of metrics has been the focus of theoretical and empirical development in transportation research for fifty years.[1] Recent advances in data availability and computing approaches, however, have led to an increase in variety and application of these metrics.[2]

Traditional evaluation of transportation systems largely focuses on vehicle speed: where is speed low or constrained? Where is congestion causing delay? How many vehicles can move through a single point, or along a segment of roadway? This type of approach is mandated for federally funded (that is, nearly all) roadway projects, both in planning and prioritizing, and in studies of impact after infrastructure is built. What these measurements miss is twofold: whether the infrastructure changes lead to improvement in peoples' ability to reach desired destinations in the short term, and what the land use changes resulting from the infrastructure mean for peoples' ability to reach desired destinations in the long term.

In this paper, we describe how Accessibility metrics can help agencies:

- Better measure short term changes in how opportunities for travel are provided
- Better understand where and for whom project investments will produce benefits
- Better predict what long-term land use changes are likely

Together, these functions of Accessibility metrics mean performance evaluation, cost-benefit analysis, and other accountability measures can be applied more directly to what is under agency control.

[1] https://www.transportist.net/p/the-accessibility-turn

[2] A recommended overview for transportation planners and analysts is *Accessibility Measures in Practice: a Guide for Transportation Agencies.* 2022. Transportation Research Board; National Cooperative Highway Research Prpgram (NCHRP) Research Report 1000.

1.2.1 Calculating Accessibility Metrics

Measuring access requires information on the *potential* trips that people might take. In brief, the following are required to calculate accessibility:

- A set of geographic origins
- A set of geographic destinations
- A representation of the network with potential connections between origins and destinations
- A specific cost of travel, usually time

For example, a health care accessibility metric might identify residences in an area as origins, specified clinics as destinations, and the roadway and pedestrian paths from each to each as the network. Then the cost of travel is measured by planning a trip for each residence origin to all reachable clinic destinations. Those data are summarized into metrics: how long does it take to reach the nearest clinic by driving? How long would it take via transit, or even walking? Calculating these accessibility values describes how well the land use and transportation systems are working together for residents.

1.2.2 Access to Jobs

One popular metric of Accessibility is the number of jobs reachable in a given travel time from a given origin.[3] For instance, the number of total existing jobs at destinations reachable in 30 minutes by auto from a residential block gives a relative sense of what the opportunities are for someone who lives in that block (Figure 1.2). Maps like these make clear that accessibility is a synthesis of two systems. The first is land use, as the strong imprint of density of opportunity in the center of Houston means access to jobs is highest, closest to those urban areas. But the transportation system matters as well, and residences close to highway connections stand out on the map as having higher access than surrounding regions. This access measurement was developed with observed roadway travel speeds, reflecting typical congestion levels on weekday mornings in 2023.

[3] The Accessibility Observatory produces annual data and reports on these metrics in the Access Across America series, available at https://www.cts.umn.edu/programs/ao/aaa.

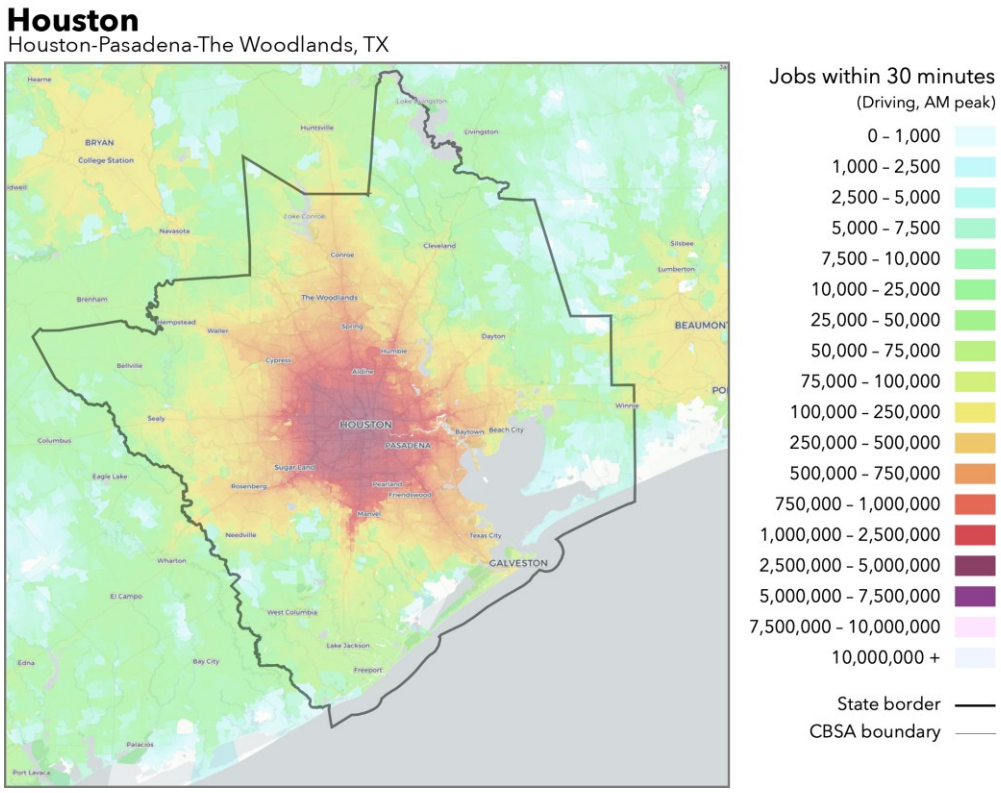

Figure 1.2: Access to jobs in 30 minutes by auto for the Houston region, on a typical weekday morning in 2023.

This map is a summary of what the transportation and land use systems together provide to residents. It captures a relative measure of what economic and social interactions are possible, from each starting place on the map. The map is *not* a measure of how far residents travel, or how much, or by what mode; those attributes of travel behavior are influenced by accessibility, but also by many other socio-demographic variables, individual decisions and preferences. But the map does depict where opportunities are greater or lesser in the region, and by how much. In 2023 Houston's county-based statistical area outlined on the map contained around 3 million jobs.[4] The typical resident of the region, however, could only reach on average about 875,000 job destinations in in 30 minutes of driving on a typical weekday.

Put another way, the typical Houstonian can only reach 29% of the region's jobs in a reasonable drive commute time. If the transportation system has a primary mission of connecting residents to economic opportunities, should this be considered good performance? If not, what can be done to improve it?

[4] Authors' calculations from U.S. Census Bureau's Longitudinal Employer-Household Dynamics program (LEHD), http://lehd.ces.census.gov/data/

1.3 WHAT DO TRANSPORTATION AGENCIES CONTROL?

Staff at transportation agencies, especially state DOTs, will emphasize that they oversee the transportation system, and don't control land use. This is not strictly true in terms of direct oversight, and at best incomplete in terms of indirect impacts. Guerra et al. (2024) used detailed information on urban roadways nationwide to demonstrate that up to 25% of urbanized areas were dedicated to transportation (mostly roadway) infrastructure. Valued at trillions of dollars, the collective holdings of public transportation authorities like state DOTs makes them among the country's most important real estate owners.[5]

Indirectly, DOTs also influence land use. Investments in roadway capacity, whether in the name of alleviating congestion or simply because a better route is available, create areas of changed accessibility. Land use changes follow, because residents and businesses rearrange themselves to take advantage of the connections. These in turn change long-run patterns of daily travel, typically consuming if not overwhelming the original increase in potential capacity. This is a form of *induced demand,* whereby the travel patterns change in response to transportation investments, mediated by the changes in accessibility (through both origins and destinations). In this pathway, additional transportation infrastructure drives eventual demand.

DOTs respond to ongoing land use change. In a stereotypical version, origins or destinations appear in the form of greenfield development, and then generate regional travel demand through new residents or opportunities, followed by political pressure for transportation systems to be altered to allow these new residents to realize the same level of access provided to others in a region. This is the familiar mechanism of *suburban sprawl*. Land use changes first, followed by the transportation system responding to new travel needs; transportation supply follows demand, through accessibility.

These pathways can co-exist, and are both mediated by accessibility, as depicted in Figure 1.3. The relationship between land use and accessibility is reciprocal and complex. Increased accessibility can increase the desirability of one type of land use over another, and promote development of origins and destinations in areas of new access. Land use decisions increase or decrease access differently by modes. However, the sign and directionality of the transportation pathways are more straightforward. For the auto mode, investments in roadway infrastructure increase accessibility, through additional capacity, new connections, or increased speeds. The increased accessibility results in increased travel in the form of more, and longer trips,[6] though this tendency is also influenced by a myriad of social and economic factors at the household and individual level. This additional trip making leads to capacity constraints, and congestion, which in turn feeds back to *reduce* the accessibility provided by the original infrastructure. In other words, accessibility is consumed by the travel behavior. At this point, additional

[5] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4922853

[6] Millard-Ball, Adam, and Michael Rosen. 2025. "Road Capacity as a Fundamental Determinant of Vehicle Travel," February 2025. Institute of Transportation Studies Research Report. https://doi.org/10.7922/G2Q52N05.

investment is called for by residents who have experienced a loss of auto accessibility due to the increased use of the infrastructure, and the cycle begins anew.[7]

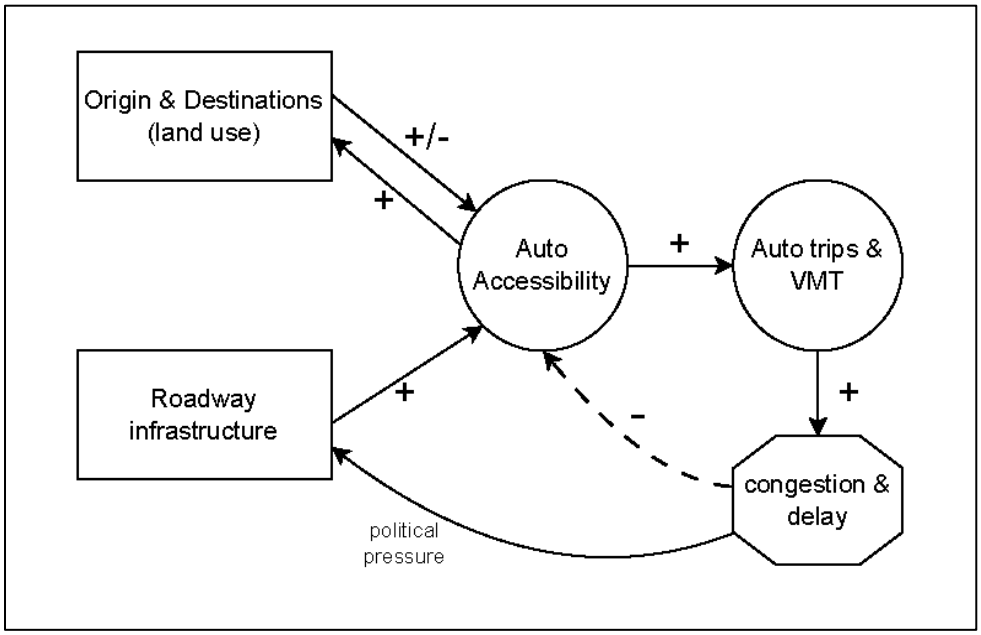

Figure 1.3: Conceptual diagram of accessibility mediating roadway infrastructure, land use, and travel behavior.

1.4 ACCESS ACROSS THE BRIDGE

In the case of the St. Croix crossing, roadway infrastructure was the starting point in the cycle. Mapping accessibility change before and after the bridge opening in fall 2017 reveals important details about the results of this infrastructure (Figure 1.4):

- the overwhelming access benefit of the project accrued to places in Wisconsin (to the east), concentrated along the corridor leading to the new bridge
- there was little to no accessibility benefit to places in Minnesota (to the west) along the corridors leading to the new bridge, and most places saw higher access before the bridge opened.

[7] Robert Cervero theorized and tested a similar set of dynamics in Los Angeles freeway development. His key insight was that speed mediated the demand and development feedbacks. Here we specify that access to destinations, which is part enabled by speed changes, is the key mediator. Cervero, Robert. 2003. "Road Expansion, Urban Growth, and Induced Travel: A Path Analysis." *Journal of the American Planning Association* 69 (2): 145–63. https://doi.org/10.1080/01944360308976303.

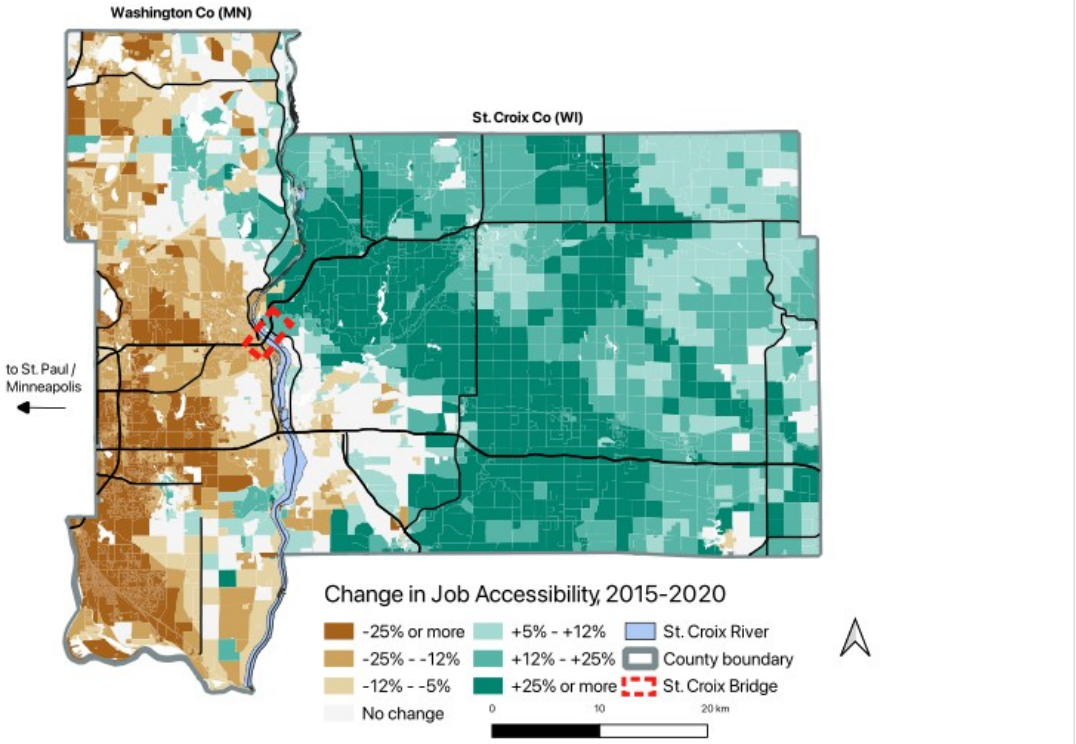

Figure 1.4: Change in 30-minute job accessibility by auto by Census block before and after construction and opening of St. Croix crossing bridge (dashed red box) in 2017.

This summary of the impact of this large project reflects two facts:

- the vast majority of regional destinations are located on the Minnesota side
- the vast majority of the regional population is located on the Minnesota side

While not quite a “bridge to nowhere,” the St. Croix project at first glance appears to concentrate its benefit in places few people lived, in only one of the two states involved. It may have served to facilitate long-distance, rather than daily regional travel, which certainly suits those heading from the Twin Cities to a weekend lake home in northern Wisconsin. But is alleviating congestion for a few summer Fridays truly the main impact of this massive piece of infrastructure?

Looking beyond opening day to long-term impacts, consider the transportation impact on land use decisions. Specifically, since the largest hotspots of accessibility are in places with few people, we would expect that developers and residents would seek to take advantage of those locations as origins which now have much greater potential to reach destinations easily. A first question is whether the resulting increase in accessibility shows up in the value of the land which experiences it. In two ways, it becomes clear that this investment in a river crossing had tremendous finacnial benefit for individual land holders and the tax rolls of towns in Wisconsin. Examining parcel data which include annual tax assessment

values from 2016-2020, we estimate a valuation elasticity of 0.35 overall, meaning each 10% increase in accessibility adds 3.5% to the value of parcels experiencing it, all other things constant.[8] And some communities were experiencing more than double that increase in accessibility following bridge opening (Figure 1.4).

Second, examining permits issued for residential development, we move to the municipal level, where relative change in access thanks to the bridge is notable across the northern tier of the study area. For this evaluation we divide St. Croix County into two halves, the North corridor along State Hwy 64 and the South corridor along Interstate 94. Those areas seeing increases in access to destinations by auto, are exactly the places where housing permits increased the most from 2015 to 2021 (Figure 1.5).

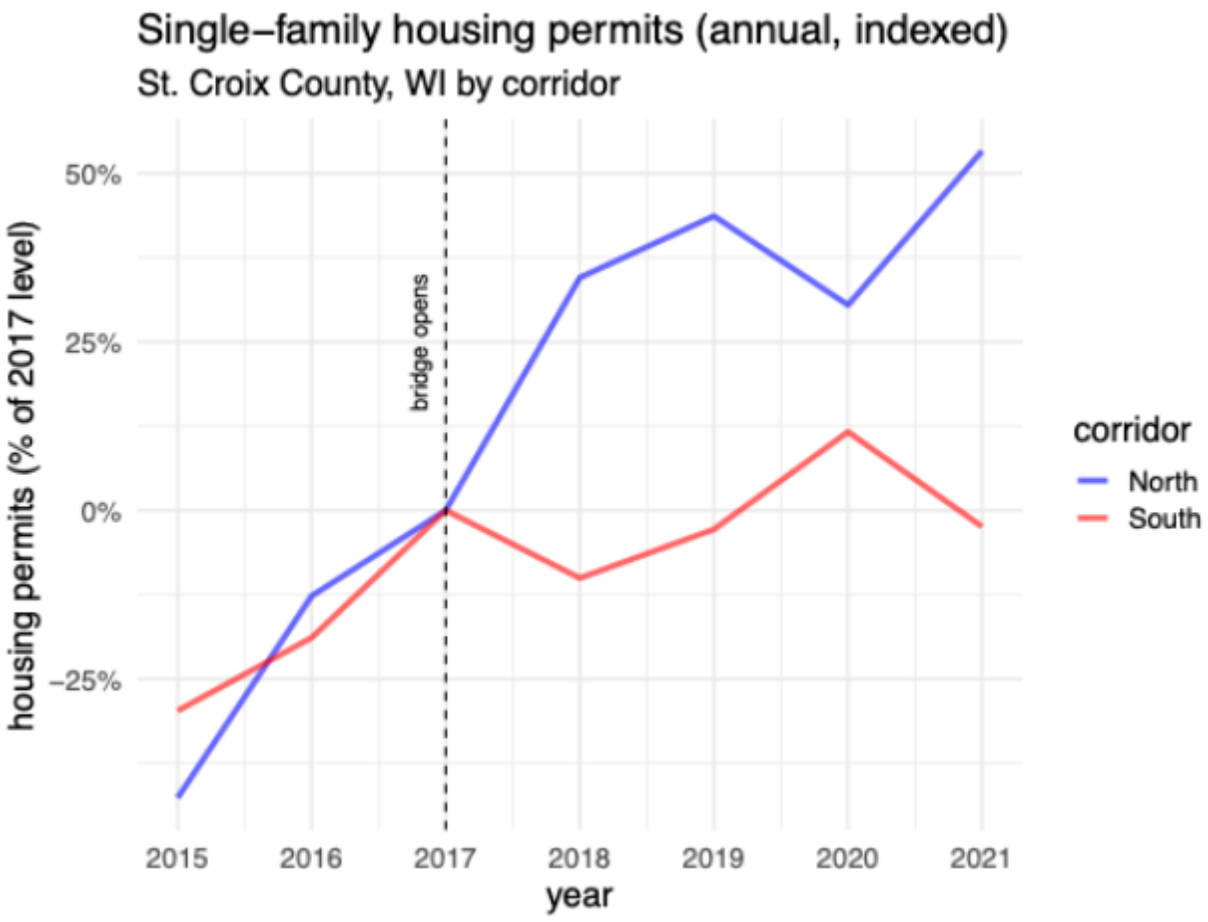

Figure 1.5: Annual single family housing permits issued in western Wisconsin, indexed to 2017, by corridor.

[8] Hockert, Matthew & Eric Lind. *In review*. Transportation Changes Land Use: How the St. Croix Bridge Shaped Accessibility, Housing Values, and Travel Behavior. Transportation Research Board Annual Meeting 2026.

There are most definitely new residences, and new residents, following the access that was created by the bridge. The Minneapolis Star-Tribune[9] profiled some of the new residents, wondering whether they had arrived "by happenstance or by design." But perhaps most interestingly, residents described themselves as "still Minnesotan" with the author noting the divisive cultural marker of Minnesota Vikings football pennants flying in Wisconsin. This feeling arises because the destinations they associate with being Minnesotan, with places they frequented while living in Minnesota, are still highly accessible from the far side of the bridge. Roadway infrastructure changes accessibility, which changes the value and use of land.

[9] McKinney, Matt. 2024. "Build It and They Did Come. Western Wisconsin Sees Big Growth after New Bridge." https://www.startribune.com/new-residents-flood-wisconsin-over-st-croix-crossing-bridge/601197830.

CHAPTER 2: SHORT-TERM CHANGES IN ACCESSIBILITY

Dramatic land-use change in response to new major infrastructure is rare by definition. In the absence of such major intervention, or in the short-term, how do more regular changes in access come about? Both land use and transportation are constantly evolving, as transportation agencies modify the network and as economic activity fluctuates and is redistributed across a region. How can agencies understand these more gradual fluctuations in access, and use them as performance measures?

Using data from the National Accessibility Evaluation (NAE), it is possible to take a close look at how short-term changes in job access are influenced by changes in both transportation and land use patterns. Between 2022 and 2023, the number of jobs that the average worker in Minneapolis, MN, could reach within 30 minutes by driving increased by +2.1%, from 1,566,769 to 1,599,611. Over that same period the number of jobs reachable within 30 minutes by public transit decreased by −0.4%, from 88,074 to 87,744. These aggregate job access metrics provide a good way to track how the relative usefulness of different travel modes evolves over time; additional analysis can help clarify what is driving the changes in access, which varies by geography (Figure 2.1).

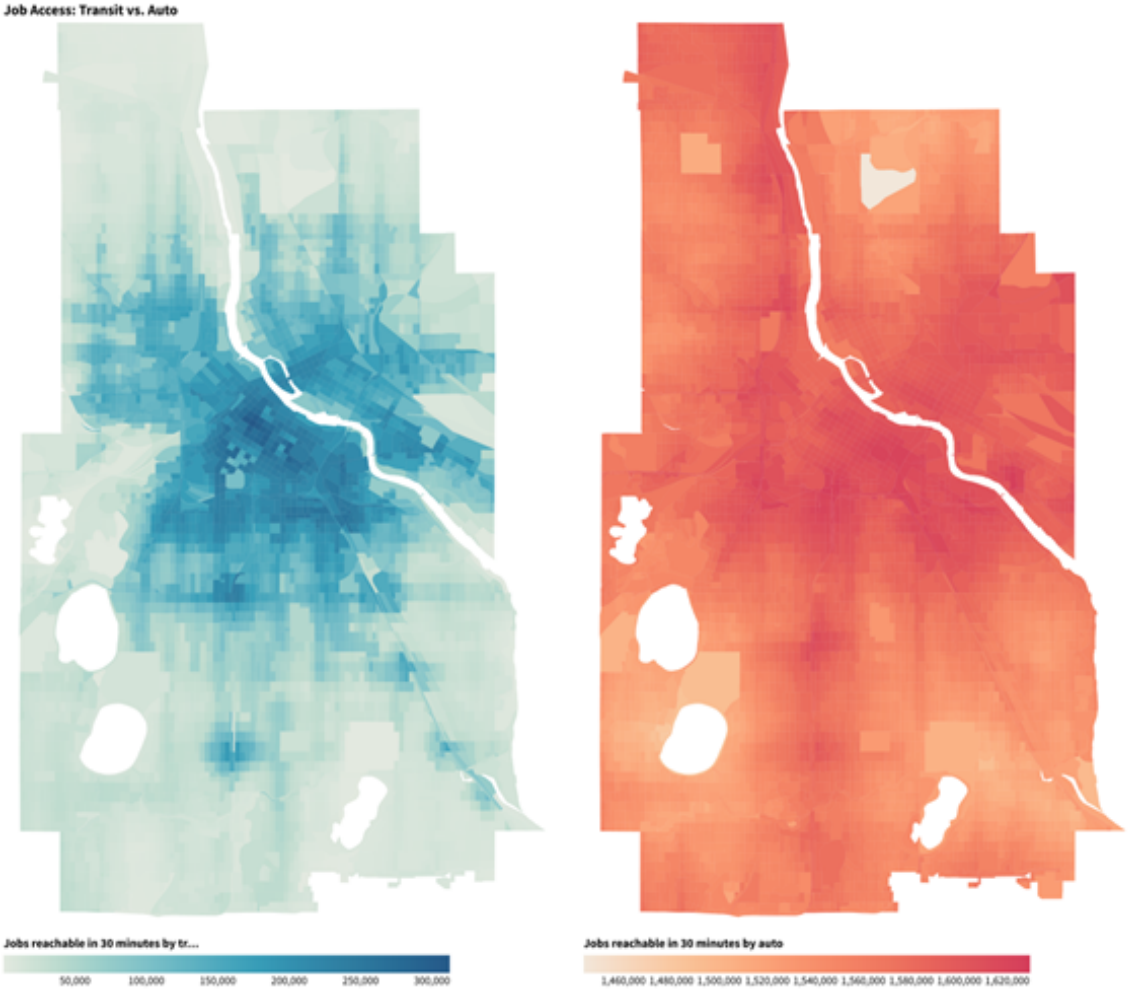

Figure 2.1: Accessibility to jobs in each Census block of Minneapolis, by walking plus public transit (left) and by driving (right), 2023 travel year.

2.1 SEPARATING INFLUENCES OF LAND USE AND TRANSPORTATION

The access changes experienced in 2023 reflect changes in both transportation (travel times by auto and transit) and land use (locations of workers and jobs). By varying these inputs individually against the common baseline of 2022, it is possible to get a sense of how much influence they each have on the overall change in job access. For example, combining 2022 travel times with 2023 jobs provides a counterfactual indication of how access would have changed if job and worker locations had changed while travel times remained static. And in the converse, using 2023 travel times with 2022 job destinations, provides the counterfactual indication of how access would have changed strictly due to the transportation network (Table 2.1).

Table 2.1: Summary of methods for decomposition of change in accessibility by source, where 2022 is base year for all comparisons.

Decomposition of accessibility change method, 2022-2023		
Access change metric	**Change Transportation network year**	**Change Job destinations year**
Land Use Change	2022	2023
Travel Time Change	2023	2022
Total Change	2023	2023

2.1.1 Auto accessibility changes

When changing auto travel times alone, virtually all locations in Minneapolis see a decline in job access, with local values typically ranging from a loss of −5,000 jobs to a loss of −40,000 jobs (Figure 2.2, “Travel Time Change”), and the average access experienced by Minneapolis workers decreases by −1.0%. This is due to increased travel resulting in congestion, which feeds back to reduce access. When changing job locations alone, all Minneapolis locations see consistent access gains of between 45,000 and 53,000 jobs (Figure 2.2, “Land Use Change”), and average access increases by 3.2%.

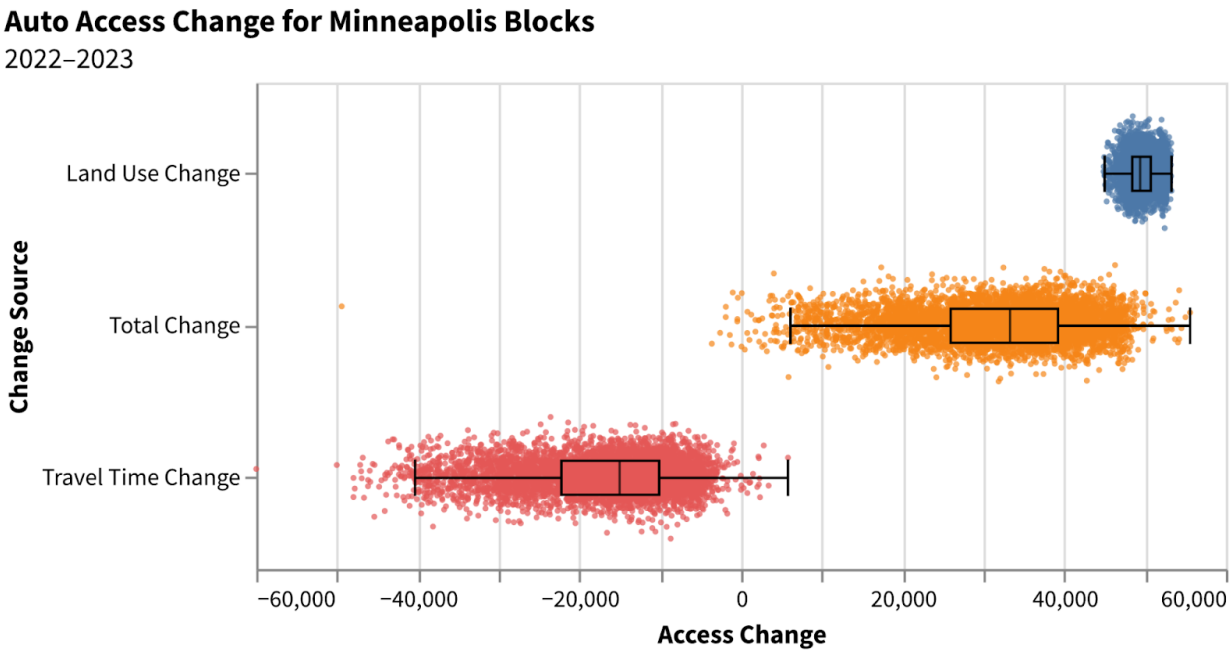

Figure 2.2: Block-level changes in job accessibility by auto, under decomposition scenarios.

These focused analyses provide a more complete interpretation of the overall change in access by auto: between 2022 and 2023, access losses due to increasing congestion were more than offset by overall growth in regional jobs, with most Minneapolis locations gaining access to between 10,000 and 50,000 jobs, and average access increasing by +2.1%. *It simultaneously became more congested, and easier to reach more destinations on average.*

2.1.2 Transit accessibility changes

The same analysis for reaching jobs via public transit shows strikingly different patterns. When changing transit travel times alone, locations in Minneapolis see both gains and losses in job access, with most falling between a loss of −18,000 and a gain of +13,000 (Figure 2.3, "Travel Time Change"). Average job access for Minneapolis workers decreases by −2.5%. When changing job locations alone, access changes for Minneapolis locations range from a loss of −4,000 to a gain of +7,000 (Figure 2.3, "Land Use Change"), and average job access increases by +2.0%.

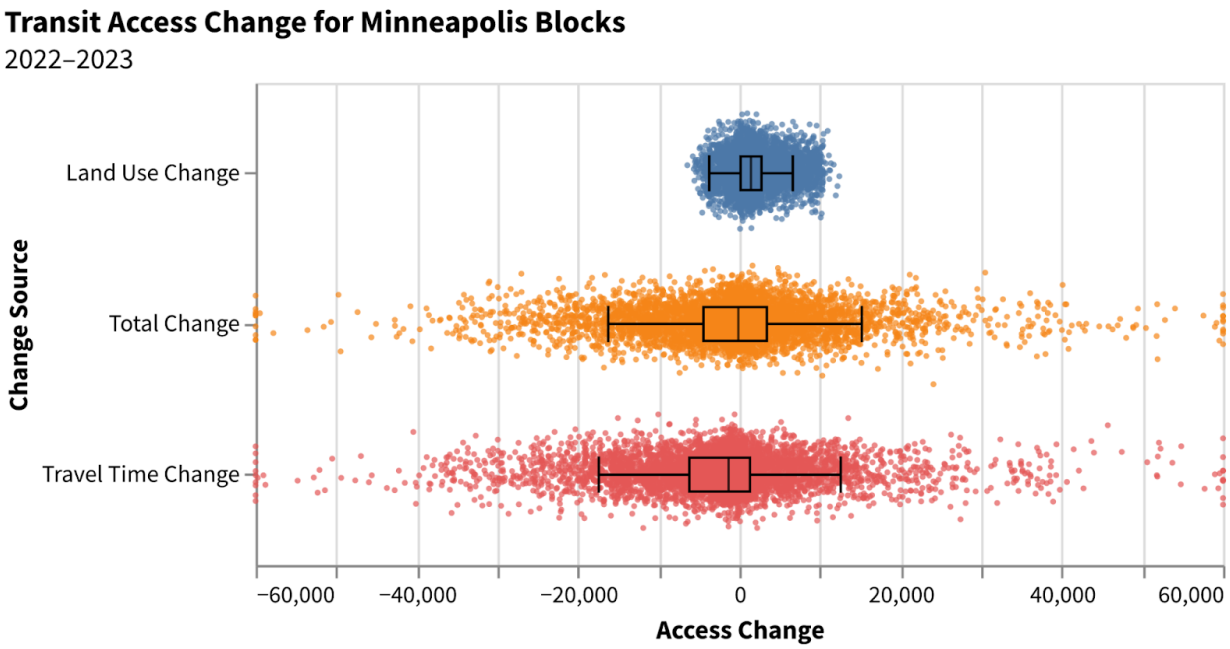

Figure 2.3: Block-level changes in job accessibility by public transit, under decomposition scenarios.

The variability of access change from block to block is much greater in transit than auto, with significant gains and losses both observable in the same year. In contrast to auto access decomposition, the travel time change corresponds much more closely to the total change, indicating the importance of travel times, which in turn reflect the scheduled frequency and speed of transit service (accessibility via transit is measured using the published schedule in this analysis). The location of land use change, especially its coordination with transit stations and stops, also explains the variability in year-to-year differences.

2.2 SYNTHESIZING SHORT-TERM ACCESSIBILITY CHANGE

It is important to recognize that the evaluations of job access by auto and job access by transit reflect the *same changes in land use*. The changes in job locations between 2022 and 2023 produce a clear, consistent increase in job access by auto for all Minneapolis locations, while the impact on job access by transit is minor overall, and many locations see a small decrease.

How do the same changes in land use have such disparate access impacts for different modes? The answer can be found through understanding that access depends both on the quantity and the location of destinations. Between 2022 and 2023, the metropolitan area that contains Minneapolis saw a net increase of +56,700 jobs (about 3% of the regional total number of jobs). That is good news, and it would be reasonable to expect to see a comparable increase in job access. But that total job growth figure doesn't provide any information on *where* the new jobs are located. If all the job growth happened in places that are hard to reach, we'd expect a small increase in access; if all job growth was in places that are easy to reach, we'd expect a larger increase in access.

Another complication is that the net increase in jobs is not only from growth. In reality, jobs are also lost and change locations as businesses close, shrink, and/or relocate. Just as with job growth, the impact

that these changes have on job access depends on location. If a business was located in a very hard-to-reach location, its closure might have only a small negative impact on job access. If a business moves to a location that is easier to reach, the number of jobs doesn't change but access to jobs increases.

These insights help interpret the diverging trends in auto access versus transit access in Minneapolis. Every location in Minneapolis saw a clear and consistent increase in job access by auto associated with the 2022-2023 land use changes. From this we can conclude that the overall trend was that jobs increased in places easily reachable by car. Moreover, the coordination between job locations and ease of reach (by auto) improved enough to overcome measurable increased road congestion and produce a net positive change in job access by auto.

For transit, the 2022-2023 land use changes are associated with a mix of job access gains and losses, with a small net positive change. This implies that overall, job growth, loss, and location were unrelated to ease of reach by transit. New jobs were about equally likely to arrive in locations easy or hard to reach by transit, and an easy-to-reach location had a roughly even chance of gaining or losing jobs. Lacking coordination with ease of reach by transit, and combined with a wide range of both negative and positive access changes from transit travel times, these job changes contributed to a largely static level of job access by transit. Meanwhile, changes in transit schedules resulted in widely varying changes in travel times to those jobs depending on the location of the origin.

This analysis accounts for the geographic change experienced in places within a single city. A third dimension to consider is who lives in the places which have changing access–for whom is it becoming easier or harder to reach these economic opportunities? Where might additional residences lead to higher average accessibility for the region by connecting people to destinations, without even changing the transportation network? These questions take performance measurement toward the long term.

CHAPTER 3: LONG-TERM CHANGES IN ACCESSIBILITY

If short-term changes in accessibility can be usefully decomposed to examine relative influences of land use and transportation network change, the long-term accessibility trends represent the combined evolution of these two forces over many years. The direct and indirect influences of DOTs on mobility and land use are captured over time through the accessibility in each place. Long-term trends in job accessibility in urban areas will synthesize economic conditions (growth or shrinkage of job opportunities), as well as the transportation conditions (infrastructure investments and congestion).

The NAE has used consistent methodology to describe accessibility in each residential block of the US since 2017. The resulting values can be explored using time series of average access, experienced by the typical resident of each of the top 50 most populous urban areas in the US. Importantly, the years in which daily travel was most disrupted by the COVID-19 pandemic (2020-2022) are included in the timeseries, allowing the access performance measure to reveal how the dynamics of infrastructure, land use, and travel behavior have responded in the COVID era.

3.1 TRENDS IN AUTO ACCESS

The most notorious and instructive example of transportation infrastructure as land use change in the US involves interstate freeway segments used to destroy particular communities in order to provide access to others. From Houston to St. Louis to Minneapolis, from Rochester, NY to Portland, OR, freeway construction projects were planned to bisect, disrupt, and simply replace neighborhoods inhabited by the poor, racial minorities, and other disfavored groups. *These freeways were not built to accommodate existing travel demand.* Instead, they served the dual purpose of land use change: through the primary mechanism of destruction of unwanted neighborhoods, and the secondary mechanism of providing accessibility to the remaining urban core to new areas of land development. In other words, the supply of urban freeways supply increased accessibility from suburban origins, created changes in suburban land use at the origins of that new accessibility, and thus induced demand for travel. The negative feedbacks on accessibility eventually occurred, generating political pressure to continue freeway expansion and shore up accessibility. In places like Minneapolis-St. Paul, the freeway infrastructure investments have continued, leading to nearly uniform job accessibility across the region in both urban and suburban areas, for those can and are able to afford to drive a car (Figure 3.1).

Through the end of the previous decade, the job accessibility by auto changed little across most urban areas, and reflected stability in both the travel time and job destinations in this period. Figure 3.2 depicts the time series of job accessibility in the top 50 urban areas of the US. Each line represents the average number of jobs the typical resident of the area could reach, driving for 30 minutes from their residential origin block.

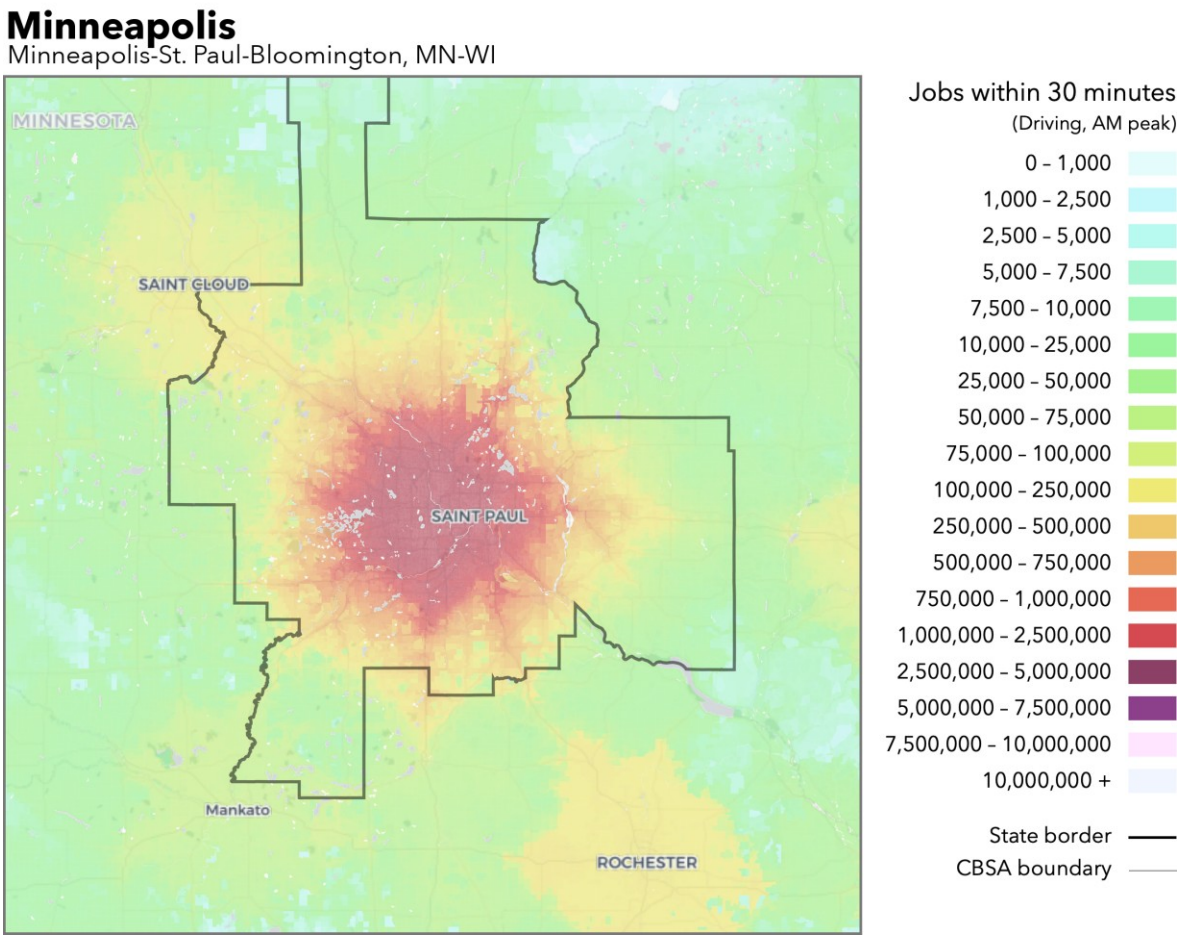

Figure 3.1: Access to jobs in 30 minutes by auto for the Minneapolis-St. Paul region, on a typical weekday morning in 2023.

In spring 2020, the worldwide COVID-19 pandemic arrived in the US. The policy response differed across the country, but whether formal lockdowns were introduced or not, daily travel was significantly disrupted, especially for higher-income workers who were able to transition quickly to working from home. Because this same demographic typically commutes by car, congestion vanished and observed roadway speeds approached free-flow throughout the day in many urban areas. Because the NAE uses observed roadway speeds to calculate travel times from each block to all possible job destinations, the average observed job accessibility by auto spiked significantly (Figure 3.2; travel year 2020 reflected speeds observed the year prior to June 2020, and thus mostly pre-COVID conditions).

In 2021, the jobs reachable in an auto commute were universally higher, and mostly much higher. There is a surface irony in that the disappearance of trip making by auto was the main determinant of this increased auto access; essentially the suppression of the feedback cycle in Figure 1.3 by outside forces. But the feedback cycle did return, and by 2023 the easy access to destinations available to drivers had shrunk back toward pre-COVID levels. But not all the way, and not everywhere.

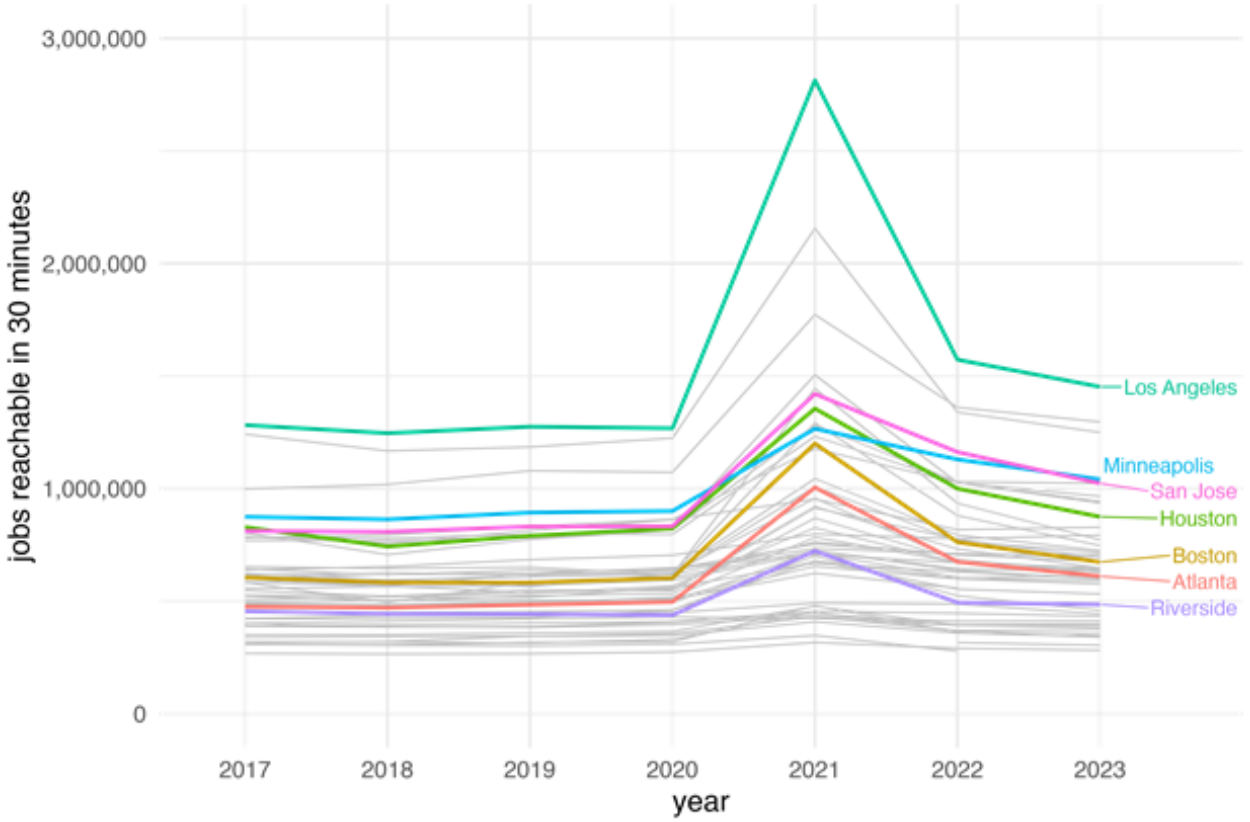

Figure 3.2: Average job accessibility by auto in 30 minutes on a typical weekday, annual 2017-2023, top 50 US urban areas.

3.1.1 Why would anyone own a car in Los Angeles?

By any number of methodologies Los Angeles has the worst auto congestion in the country, by far.[10] This phenomenon begs the question of whether it is worth the trouble and expense to own and operate a car there at all (for those who have the resources and ability to be car owners and drivers). Remarkably, when measured by accessibility, Los Angeles is also the *best place in the country to drive to destinations*. Specifically, in 30 minutes in LA one can reach more potential job opportunities than anywhere else in the country, even more than the New York City region (which has more jobs overall). The excellent access to destinations via auto provided by the years of roadway investment and auto-oriented development is limited only by the fact of many people wanting to enjoy it simultaneously.

Los Angeles also typifies the trends in accessibility during the COVID era. In 2022 and 2023, congestion returned as the accessibility observed during the peak of the pandemic encouraged people to drive to their destinations, creating the negative feedback and reducing available access. However, the level of

[10] for example, https://www.tomtom.com/traffic-index/ranking/?country=US

accessibility remained elevated compared to 2019. Economic improvement (more jobs), transportation improvements (infrastructure), and the interaction with travel behavior (partially reduced congestion from 2019 levels as at least some telework continued) combined to result in around 14% higher job accessibility by auto in the latest year available, over pre-COVID levels. The average LA driver is significantly better off in destinations reachable for the same travel time.

Other urban areas saw even smaller reductions in accessibility from the COVID peaks. Residents of Boston experienced a 38% higher access to jobs by car in 2023 than in 2019; for the typical resident of San Jose it was 23% higher, in Atlanta, 26% higher. Accessibility gains were smaller but still measurable in Minneapolis (17%), and Houston (11%), among others. There were certainly infrastructure improvements made in some, if not all, of these cities in the intervening years, but the accessibility changes were most likely due to the reduced feedback from trip making. While that higher accessibility induces demand from behavioral and land-use changes, the social factor of telework means it is difficult to predict a steady return to pre-COVID accessibility levels, or whether there is enough reduction in trip making to keep accessibility levels high and dampen the negative feedback loop.

3.2 TRENDS IN TRANSIT ACCESS

Influencing land use through transportation investment is not only a freeway mechanism. Going back to the electric streetcar era, public transit systems in the U.S. have been used as tools to change land use patterns.[11] The concept of transit-oriented development (TOD) as practiced reflects the idea that the high-quality, frequent transit line comes first, increasing accessibility to destinations from station locations, followed by development which aims to take advantage of that increased access.

Transit accessibility is influenced by the coordination of land use and travel networks, as is auto accessibility. However, access via transit is structurally constrained differently than auto accessibility. Transit access is defined by slower vehicle travel times, the walk or roll times to get to and from stops and stations, and especially the need to coordinate trip departures with vehicle schedules. The wait between desired departure time and transit vehicle departure (or the wait between necessary arrival and desired arrival at the destination), reduces the number of opportunities reachable in a given amount of time. The influence on reducing wait time to increase access has led to the slogan “frequency is freedom” when considering changes to schedules.[12] Regardless, transit job accessibility is often more spatially constrained and variable than auto access (Figure 3.3, compare to Figure 3.1).

[11] Xie, Feng and David Levinson (2010) How Streetcars Shaped Suburbanization: A Granger-Casality Analysis of Land Use and Transit in The Twin Cities .Journal of Economic Geography 10(3), pp. 453-470

[12] Walker, Jarrett. 2024. *Human Transit: How Clearer Thinking about Public Transit Can Enrich Our Communities and Our Lives*. Revised edition. Washington, DC: Island Press.

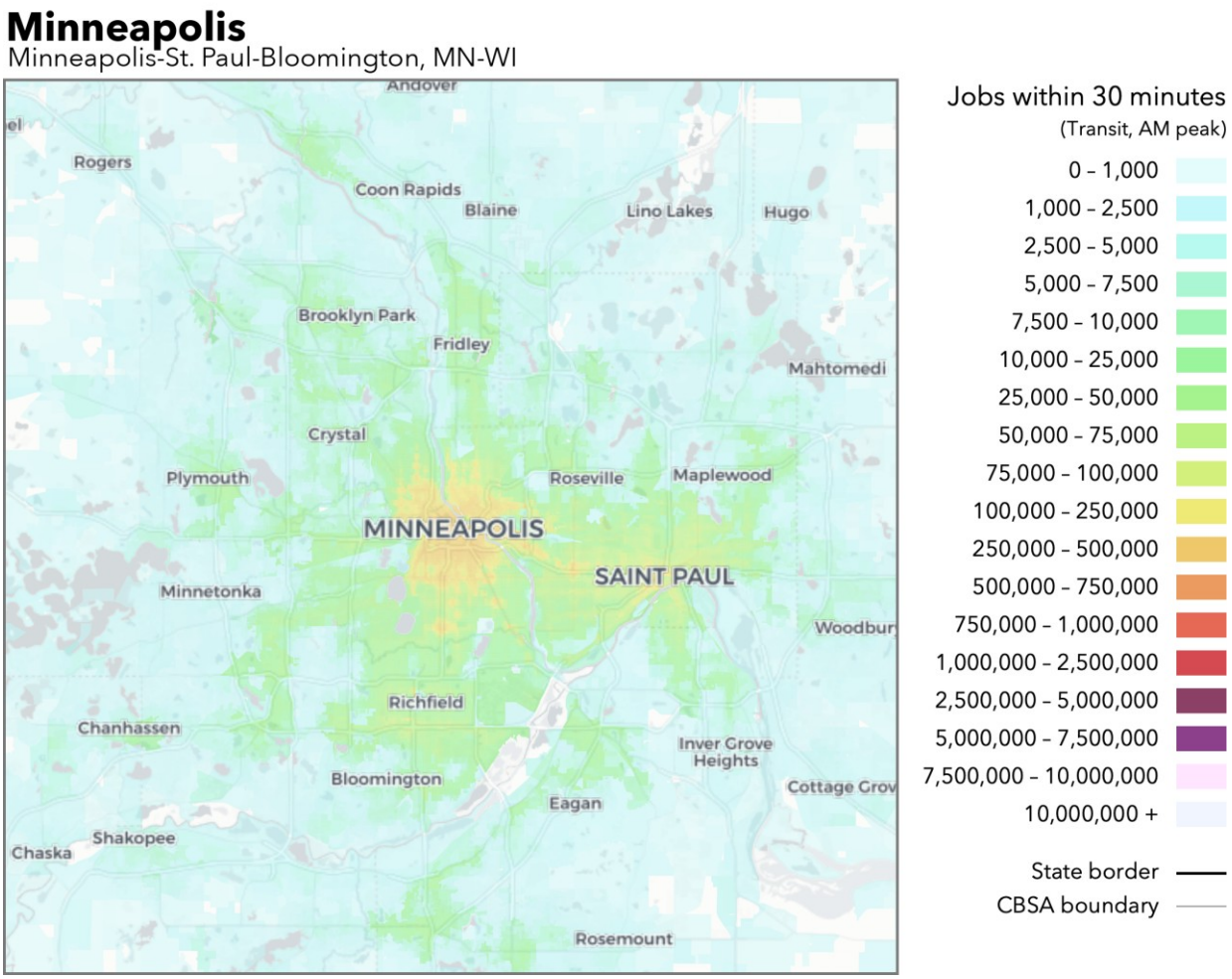

Figure 3.3: Access to jobs in 30 minutes by public transit for the Minneapolis-St. Paul region, on a typical weekday morning in 2023.

The time series of transit accessibility across the US looks different than the auto mode, because of the difference in how transit accessibility feedbacks work. Rather than being constrained by increased demand, as is auto accessibility through congestion, transit accessibility is almost entirely determined by the level of service provided by an agency. Increased use in the form of ridership does not feedback to limit accessibility except in edge cases of near-full capacity. Instead, more riders can provide a diffuse positive feedback on transit accessibility by increasing the revenue available for providing service. As explored in section 2.1.2 , the differences in travel times from place to place, and the coordination of destinations with transit service, can produce large variability in accessibility. This is true within urban areas, but also over time as well.

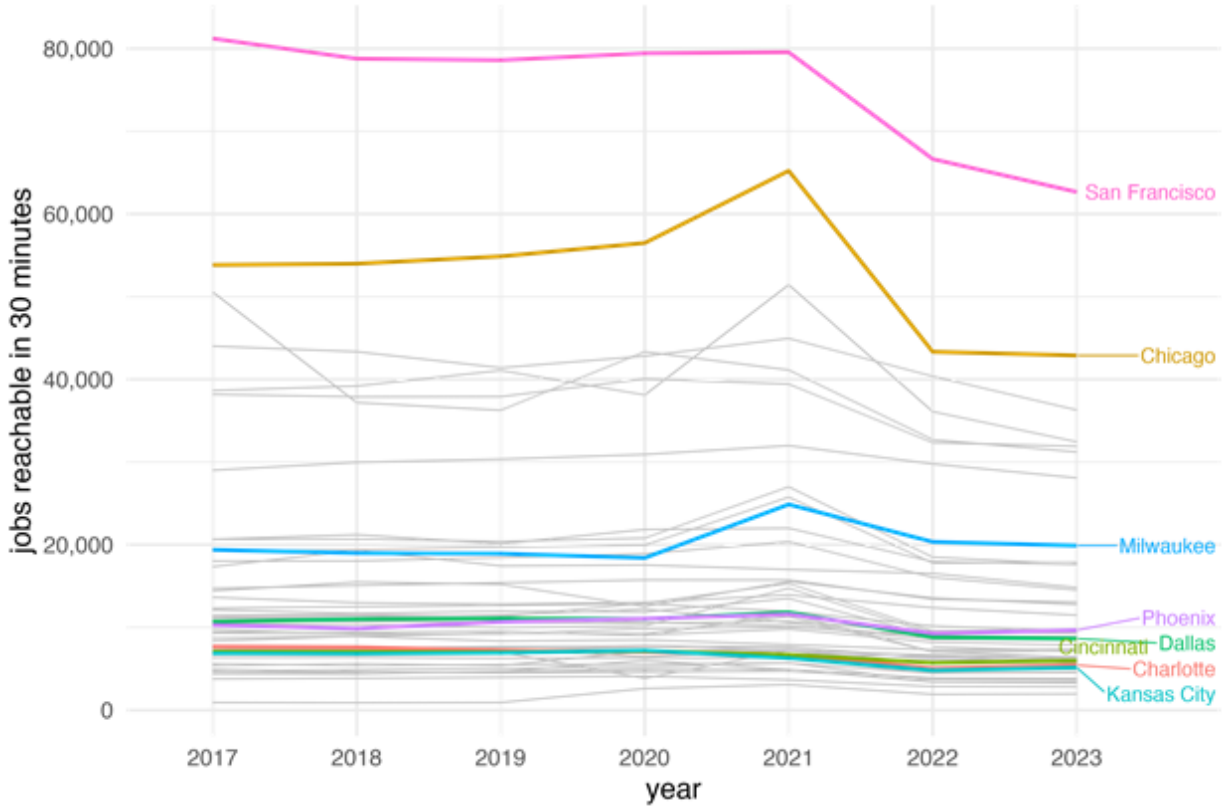

Figure 3.4: Average job accessibility by public transit in 30 minutes on a typical weekday, annual 2017-2023, top 50 US urban areas.

Prior to COVID-19, this variability is evident in the timeseries (Figure 3.4), as individual lines representing urban area averages change from year to year. The arrival of the pandemic outbreak in 2020 had a similar impact on transit ridership as on congestion, in the form of 50% or more reductions in transit ridership.[13] **Unlike with auto congestion, the drop in ridership did not feed back to cause drastic changes in accessibility**. In 2021, some places experienced overall increases, some small decreases, as transit agencies used federal funds to replace their disappearing fare revenue, and kept services fairly constant. By 2022 and 2023, however, the broader social travel behavior changes led agencies to begin to reduce offerings, especially to downtown office commuters, but also reducing service in general.[14] Residents in the majority of the top 50 urban areas experienced lower average job accessibility than they had in 2019. In some of the largest transit systems, the declines were the biggest. In the San Francisco Bay area, the typical resident could reach 20% fewer jobs in 2023 than in 2019. In Chicago, the decline from 2019 was 22%; even more dramatically, the average jobs reachable in 30 minutes in the

[13] https://transitapp.com/APTA

[14] The lack of available bus drivers, mechanics, and other frontline personnel constrained service, and thus accessibility via transit, more than any travel behavior changes or ridership declines.

Chicago region had actually increased in 2021 as commuter services stayed running, but by 2023 access was down 34% from that COVID-era peak.

Some urban areas did see modest increases from 2019 to 2023, among them Milwaukee, where residents could reach 5% more jobs on average. Phoenix held fairly steady, with only about a loss of a thousand jobs reachable in 30 minutes. Still, because of the poor accessibility in the region even before COVID, this represented a 10% decrease in access for the average resident. In 2023 there were 2.2 million jobs in the Phoenix region, and in 30 minutes using transit the average resident could reach just about 10,000 of them.

3.3 SYNTHESIZING LONG-TERM ACCESSIBILITY TRENDS

As with short-term change in accessibility, long-term changes are influenced by transportation network changes and land use influences. The land use influences become more important in the long run, as accessibility is absorbed into the value of the land, changing its potential use, as with the St. Croix bridge example. The social and demographic factors influencing travel behavior clearly have long-term impact as well. The main pathway of influence of demographics is through peak travel demand, which reduces accessibility through congestion. Not fully explored here is the idea that the spatial distribution of residents (and thus origins) is also a mechanism to change accessibility over the long term, without changing the transportation infrastructure. Especially considering the lack of negative effects or even mild positive feedbacks of increased ridership on transit accessibility, increased density of residents in an area of high transit accessibility can be an effective way of managing the transportation system.

CHAPTER 4: CONCLUSION: MEASURING WHAT MATTERS

Long term, state and local departments of transportation directly and indirectly change land use. The indirect land use change can be anticipated by mapping places where accessibility will change given a new network investment. Especially with roadway infrastructure, this may or may not be coordinated with existing plans for development of an area. But the increase in accessibility will be captured in land value to a certain extent, and business and residential investment will follow. As this development plays out, with people following the ease of travel, trips taken from these origins increase, until over the long run there is congestion at peak demand.

In the short term, accessibility change from year to year depends on the network type. Small improvements in the network speeding travel to connected destinations can improve access for transit trips. But year over year changes in auto access are much more driven by the regional economy than by changes in transportation. Importantly, the access to opportunities for residents can go up even as congestion goes up! Adding reachable jobs is clearly beneficial even if congestion increases at the same time. But how should this be evaluated by DOTs?

4.1 ACCESSIBILITY AS A SYSTEM PERFORMANCE METRIC

Performance metrics currently in use by DOTs, such as volumes, hours of delay, reliability indices, and so on, concentrate on mobility. That is, they measure the performance of the network in terms of how vehicles are traveling on it. There is a twofold problem with these measurements. First, they treat faster vehicle movement as the priority, which runs counter to other goals of DOTs. Safety is reduced at higher speeds, other things being equal. And infrastructure which facilitates moving vehicles quickly is a barrier to moving at all in more sustainable modes (walking, cycling, and public transit). Second, even with respect to auto trip making, mobility metrics fail to distinguish the importance of delay and congestion in the context of origins and destinations. As discussed above, if congestion increases but does not materially impact the destinations reachable in a reasonable time, is there really a performance issue?

Accessibility metrics consider both origins and destinations. Importantly, the access to destinations measured for each origin reflects **potential connection, not observed trip-making.** This means the accessibility metrics are measuring the combined impact of land use and transportation infrastructure, on what opportunities are being provided to residents and constituents. It also provides context to congestion, which does after all reduce accessibility. Measuring accessibility directly means an evaluation of the transportation and land use systems as a whole, not a limited analysis of roadway segments of high demand.

Accessibility metrics such as the number of job destinations reachable in 30 minutes, have useful qualities for performance evaluation: they are comparable and consistent, people-scaled, and can measure outcomes.

4.1.1 Accessibility is Comparable and Consistent

A strength of accessibility metrics is that the numbers are strictly comparable across places, times, modes, and people, given the relatively straightforward assumption that time is a universal cost. For instance, calculating accessibility as the number of jobs reachable in 30 minutes results in integer counts that are on the same scale whether traveling by biking, transit, or private auto. A number ten times as high in one mode over another, means ten times the opportunities that are reachable at the same time cost. Examining accessibility for the same mode in the same place over time, the resulting timeseries is easily understood to reflect positive or negative change, with a magnitude of change in integer units. Looking within a geographic region for a single mode, accessibility metrics can highlight where higher or lower origins of access occur. This is a small precursor to a more powerful analysis of *who* lives in these origins, and thus who benefits from changes (and who does not). Here the advantage of accessibility metrics over traditional metrics of vehicle flow on segments is obvious, as the deleterious effects of congestion are assumed to apply equally to all residents of a region, whether their access is influenced by a particular slow roadway or not.

Accessibility is originally calculated as a location metric, as a property of an origin place. The value of access, however, is only realized when it is experienced by people. To reflect this fact, aggregation metrics of access are averaged across origin blocks, with each block's contribution weighted by the number of workers living in that residential block. The resulting metric represents the access experienced by an average worker in that region. These summaries form the basis of the spatial and temporal comparisons and allow time series to be built for areas of interest, up to and including an entire state (Figure 4.1).

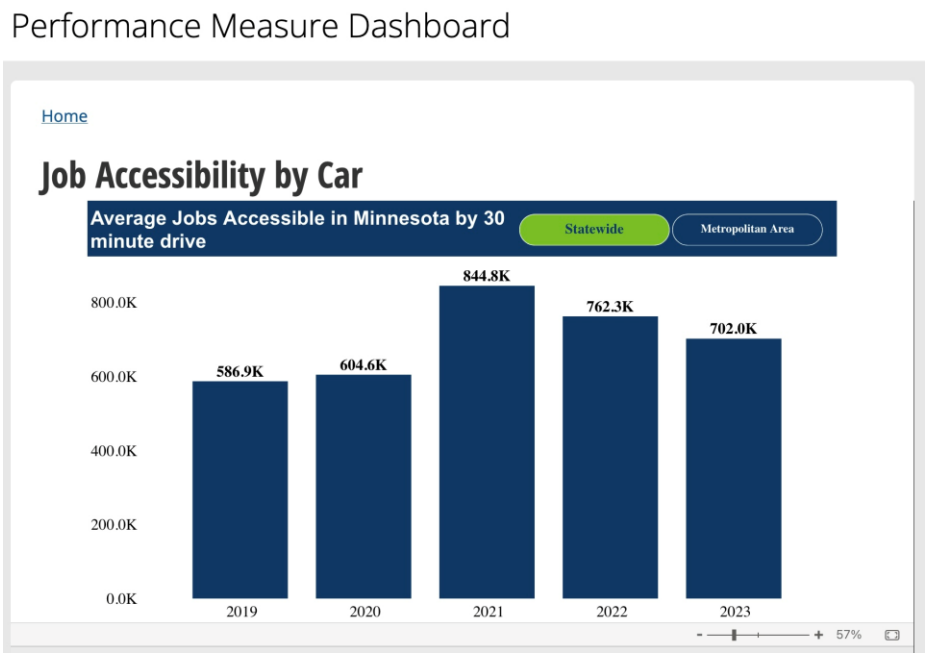

Figure 4.1: Snapshot from MnDOT Performance Measure Dashboard, displaying statewide average accessibility by auto over time.

4.1.2 Accessibility measures what people could do

The heart of accessibility measures are potential opportunities. This characteristic means that as a performance metric, it assumes much less about the resources, preferences, and habits of users of the transportation network. Put another way, **accessibility measures the choice landscape available to daily travelers.** What individual travelers or households decide to choose from that landscape, how often, or by what mode, are separate questions (and ones continuously under study in travel behavior research). By measuring possibility in the form of accessibility, DOTs are redefining performance from moving vehicles efficiently to providing meaningful choices and opportunities for residents in their jurisdictions. It is self-evident that more opportunities and choices is better than fewer; there is clear directionality to the metric, although the question of *how much* accessibility change is meaningful would remain a point of discussion influenced by the values of the agency.

4.1.3 Accessibility measures outcomes of DOT action

Transportation agencies should seek to measure their performance in terms of what is provided to residents as a function of their decisions. Accessibility metrics fulfill that requirement by quantifying the outcome of decisions in terms of travel opportunities, across different modes, destination types, geographic locations, time periods, and population characteristics.

System performance metrics should reflect improvement across all areas of DOT responsibility. Relative investment in different modes will produce different opportunities for people using those modes, which is captured fully by comparing accessibility at origins across modes. Roadway infrastructure improvements can create additional accessibility, as can improvements to bicycle facilities, walking paths, and transit frequency. Changes in access can be compared at the same scale, or on a comparative (percent change) basis over time or across geographic areas. The relative return of accessibility from DOT investments becomes straightforward, as units of bike accessibility match auto accessibility, just as easily as the dollar value of freeway investments can be compared to dollars spent on separated bikeways.

As acknowledged in Figure 1.3, accessibility is influenced by (and influences) both land use and travel behavior. However, the strong, direct connection between infrastructure and accessibility reinforces the idea that the accessibility is a good outcome metric for infrastructure. Travel behavior changes are downstream of changes in accessibility, and congestion and delay metrics are downstream of those individualized decisions. In comparison to the diffuse, lagged, and mediated impact of infrastructure on metrics like segment speed variability, accessibility changes definitionally with changes to the transportation network. The final advantage of this approach is that unlike the travel behavioral measurements of vehicle congestion, accessibility can be measured on *planned* investments before they happen, providing a baseline expectation to compare against once projects are completed and opened, and before the induced demand impacts of land use change and travel behavior appear.

4.2 ACCESSIBILITY IN BENEFIT-COST ANALYSIS

Under typical evaluation of the costs and benefits provided by a transportation network investment, planned changes in speed and reduction in delay of vehicles is monetized, typically by assigning a value to time lost in congestion, or to the travel time reductions forecast to be provided by the project. There are two fundamental objections to this approach. First, the travel time or congestion reductions are often estimated for pieces of the network (roads, intersections) without respect to the origin and destination of the potential users. In other words, a travel time differences along a segment are expanded and applied on average to the region, whether a person would be likely to use that segment regularly or not. Second, even when origins and destinations are included in the analysis, such as the with output of a travel demand forecast model, the value of time multipliers treat seconds and minutes of travel time savings at a constant value of time. These may multiply out to become a large average benefit across many vehicles and many days to across a regional daily travel average (indeed they have to, in order to balance the costs). But the benefit to individuals may be trivial, especially if they are already well connected to their destinations.

Accessibility, especially its connection to land value, provides a tractable way to measure the full benefit of projects. By forecasting the change in access from a transportation project, especially *where* that change is going to manifest, the expected land value increase can be modeled. This can be a heuristic multiplier, the same way that travel time savings are monetized (e.g., 1000 newly reachable jobs from an area raise land values by $50/acre). Alternatively, models such as the ones explored here can be used to estimate elasticities (a 10% increase in job access leads to a 3.5% increase in land value for a residential parcel, for instance). These values will differ across contexts and regions, but that is not different than current practice of valuing time through speed increases.

Finally, using accessibility to analyze potential benefit has one significant advantage over other measurements of benefit. By mapping **where changes in access will occur** as the outcome of a project, agencies can project **who is likely to experience those changes**. These analyses are straightforward as accessibility benefits are mapped to residential blocks, which are well-connected to census data and other descriptors of the beneficiaries. For instance, will travel time savings from highway expansion accrue to low-income edge communities, or high-income areas? Similar analysis can be constructed for commercial benefit, given the origins and destinations of interest to freight can be specified. Benefits of transportation projects are not spread evenly across a town, county, or region, and using accessibility metrics makes it easy to demonstrate how the actions of DOTs will manifest to the residents of the agency's jurisdiction.