Transit Accessibility, Last Mile Issues & Equity

Assessment using Chicago as a Case Study

Nebiyou Y. Tilahun, Ph.D.
Assistant Professor
Department of Urban Planning and Policy
University of Illinois at Chicago

URBAN PLANNING AND POLICY
COLLEGE OF URBAN PLANNING AND PUBLIC AFFAIRS
UIC

Motivations

- Accessibility refers to the ease with which one can reach destinations (jobs, groceries, parks, etc.)

- Why study accessibility? Reasons include…

  - It is a measure that combines land use and mobility. It better encapsulates the derived nature of travel than mobility measures alone.

  - A variety of research has shown that better accessibility is associated with better employment outcomes, with reduced welfare usage, improved employment rates, etc. for disadvantaged populations.

  - It forces us to think about the transportation system as integral to the urban context in which it is situated and explicitly consider the questions of <u>who</u> is connected to <u>what</u>.

Metropolitan Chicago Accessibility Explorer

Accessibility | Travel Time

Travel Mode: Transit

Departure Time: 8 am

Show rail lines

Show Chicago Community Areas

Travel Time:
10 min
20 min
30 min
45 min
60 min
75 min
90 min
105 min
120 min
120 min+

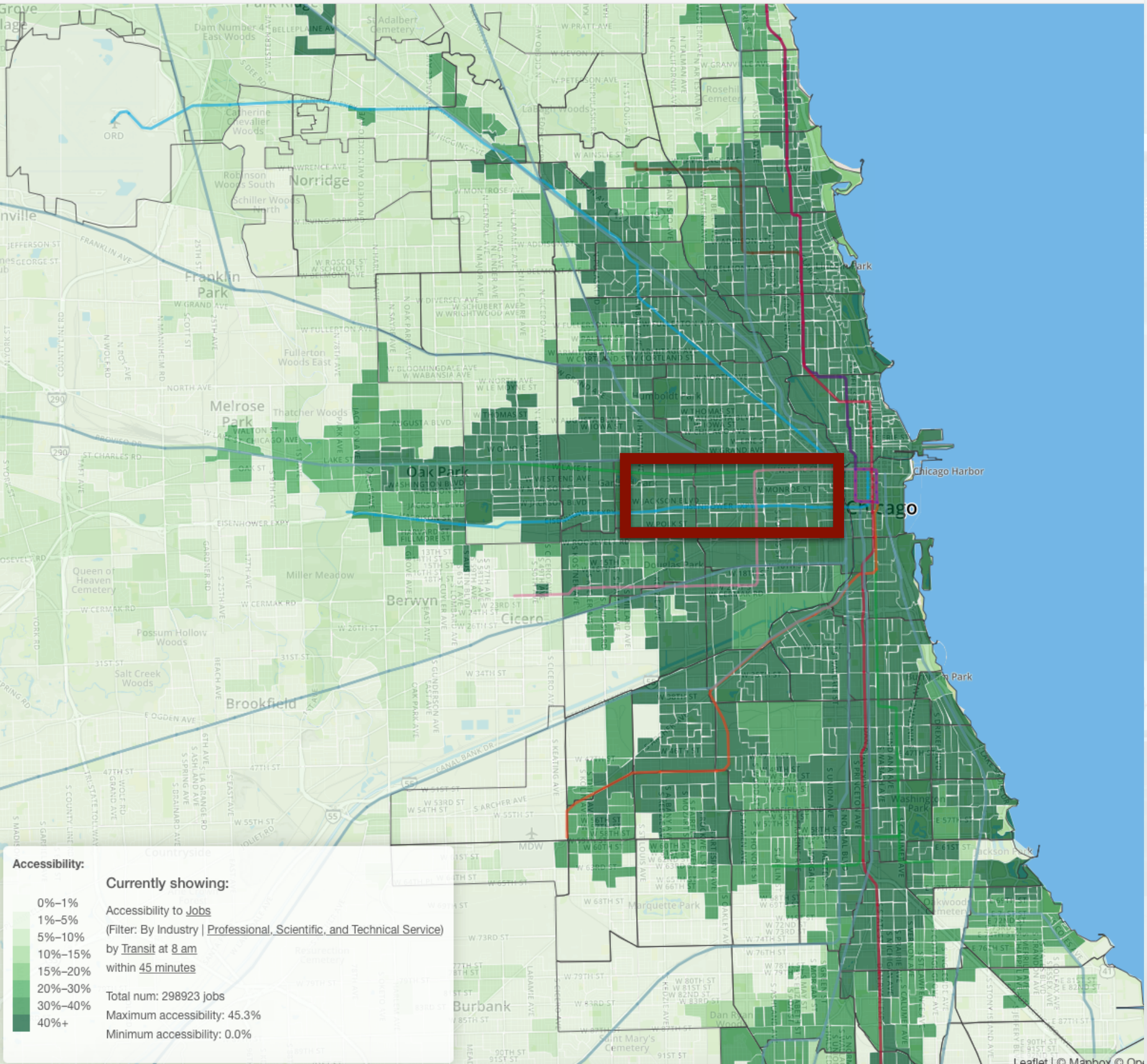
East Garfield Park IsoChrone

Metropolitan Chicago Accessibility Explorer

Accessibility To: Jobs | Travel Mode: Transit | Departure Time: 8 am | Travel Time Threshold: 45 minutes | Filter: By Industry | Select Industry: Professional, Scientific, an | Scale: Fixed Scale

Show rail lines

Show Chicag



45 minutes Transit Accessibility

Professional, Scientific and Technical Service Jobs

Metropolitan Chicago Accessibility Explorer

Accessibility To: Jobs | Travel Mode: Transit | Departure Time: 8 am | Travel Time Threshold: 45 minutes | Filter: By Industry | Select Industry: Professional, Scientific, an | Scale: Fixed Scale

Show rail lines

Show Chicago

Accessibility:

0%–1%
1%–5%
5%–10%
10%–15%
15%–20%
20%–30%
30%–40%
40%+

Currently showing:

Accessibility to Jobs
(Filter: By Industry | Professional, Scientific, and Technical Service)
by Transit at 8 am
within 45 minutes

Total num: 298923 jobs
Maximum accessibility: 45.3%
Minimum accessibility: 0.0%

45 minutes Transit Accessibility

Professional, Scientific and Technical Service Jobs

Metropolitan Chicago Accessibility Explorer

Accessibility To: Jobs | Travel Mode: Transit | Departure Time: 8 am | Travel Time Threshold: 45 minutes | Filter: By Industry | Select Industry: Manufacturing | Scale: Fixed Scale

Show rail lines

Show Chicago

Accessibility:

0%–1%
1%–5%
5%–10%
10%–15%
15%–20%
20%–30%
30%–40%
40%+

Currently showing:

Accessibility to Jobs
(Filter: By Industry | Manufacturing)
by Transit at 8 am
within 45 minutes

Total num: 371876 jobs
Maximum accessibility: 13.5%
Minimum accessibility: 0.0%

45 minutes Transit Accessibility

Manufacturing Jobs

Metropolitan Chicago Accessibility Explorer

Accessibility To: Jobs | Travel Mode: Transit | Departure Time: 8 am | Travel Time Threshold: 45 minutes | Filter: By Industry | Select Industry: Transportation and Warehc | Scale: Fixed Scale

Show rail lines

Show Chicag

Accessibility:

0%–1%
1%–5%
5%–10%
10%–15%
15%–20%
20%–30%
30%–40%
40%+

Currently showing:

Accessibility to Jobs
(Filter: By Industry | Transportation and Warehousing)
by Transit at 8 am
within 45 minutes

Total num: 169656 jobs
Maximum accessibility: 31.8%
Minimum accessibility: 0.0%

45 minutes Transit Accessibility

Transportation and Warehousing Jobs

Questions

- How is transit accessibility distributed? Does the distribution show that mobility disadvantaged areas are getting a significant proportion of the accessibility provided by transit?
- What are the transit access/egress issues that contribute to reduce the ease of using transit systems? Can we identify and value them?

Assessing Equity

- What is the thing whose distribution is being measured?
    - **Cumulative opportunities reachable by transit**
- Who is the recipient of service?
    - **Individuals or households in Chicago (depending on data)**
- Who is the reference group?
    - **The Chicago population or households (depending on data)**
- What is your inequality thermometer?
    - **Lorenz curve (Lorenz, 1905) ; Parade of Dwarfs (Pen, 1971)**
    - **Gini coefficient**

Amiel, Yoram, and Frank Cowell. Thinking about inequality: Personal judgment and income distributions. Cambridge University Press, 1999.

Approach

Measure Accessibility

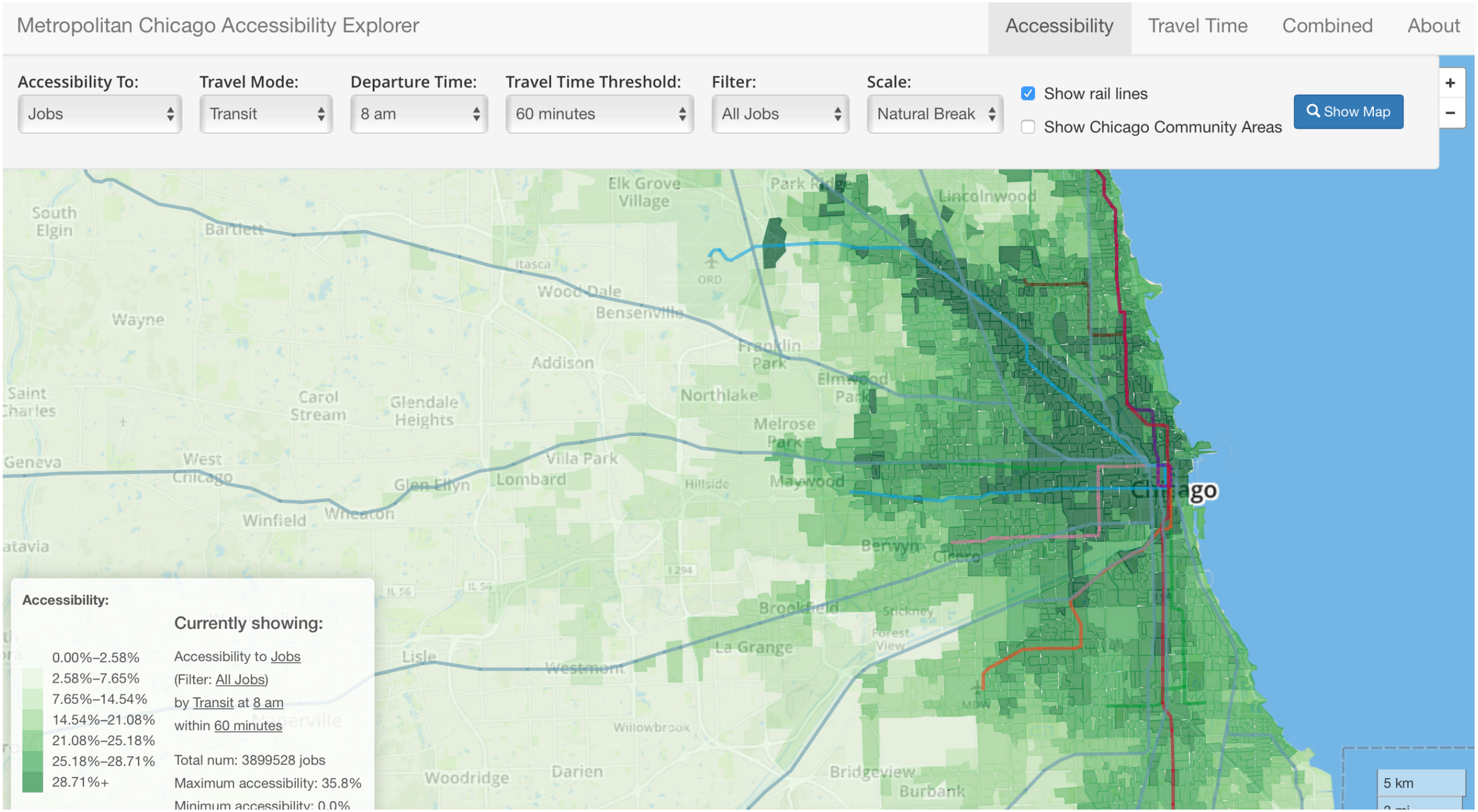
Classify region into census tracts with high and low accessibility

Study inequality based on off-the-shelf inequality measures

Find regional socio-demographic data

Classify census tracts by population vulnerability

Compare alignment of “needs” with provision of access



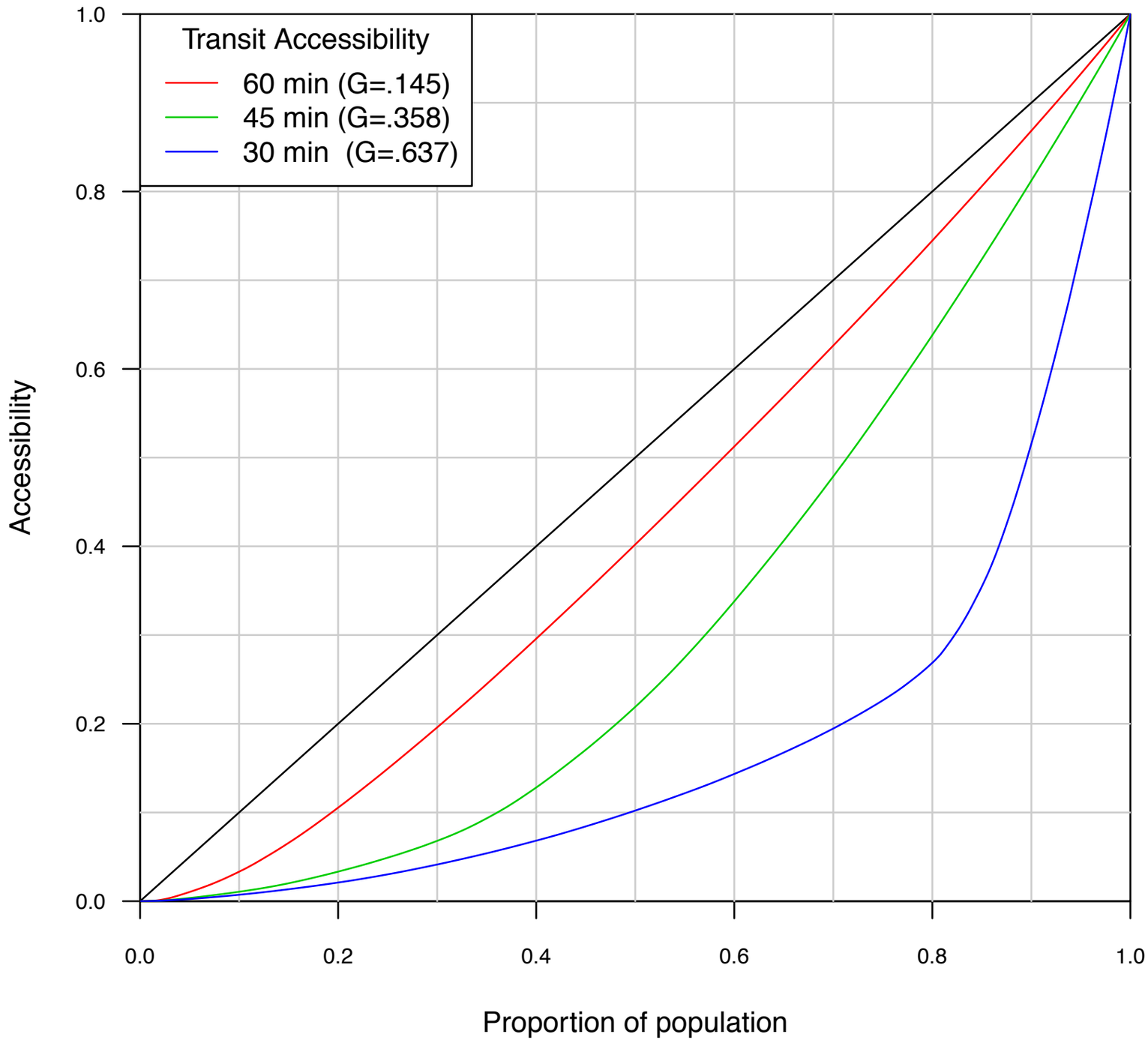
Metropolitan Chicago Accessibility Explorer

- http://www.urbanaccessibility.com
- Jobs: Longitudinal Employer Household Dynamics; Other categories (Groceries, Libraries, Parks, etc.): City of Chicago
- Travel Time: Transit Schedules; Network Travel Times based on OSM

Lorenz Curve for Transit Accessibility

- Transit Accessibility by Travel Time

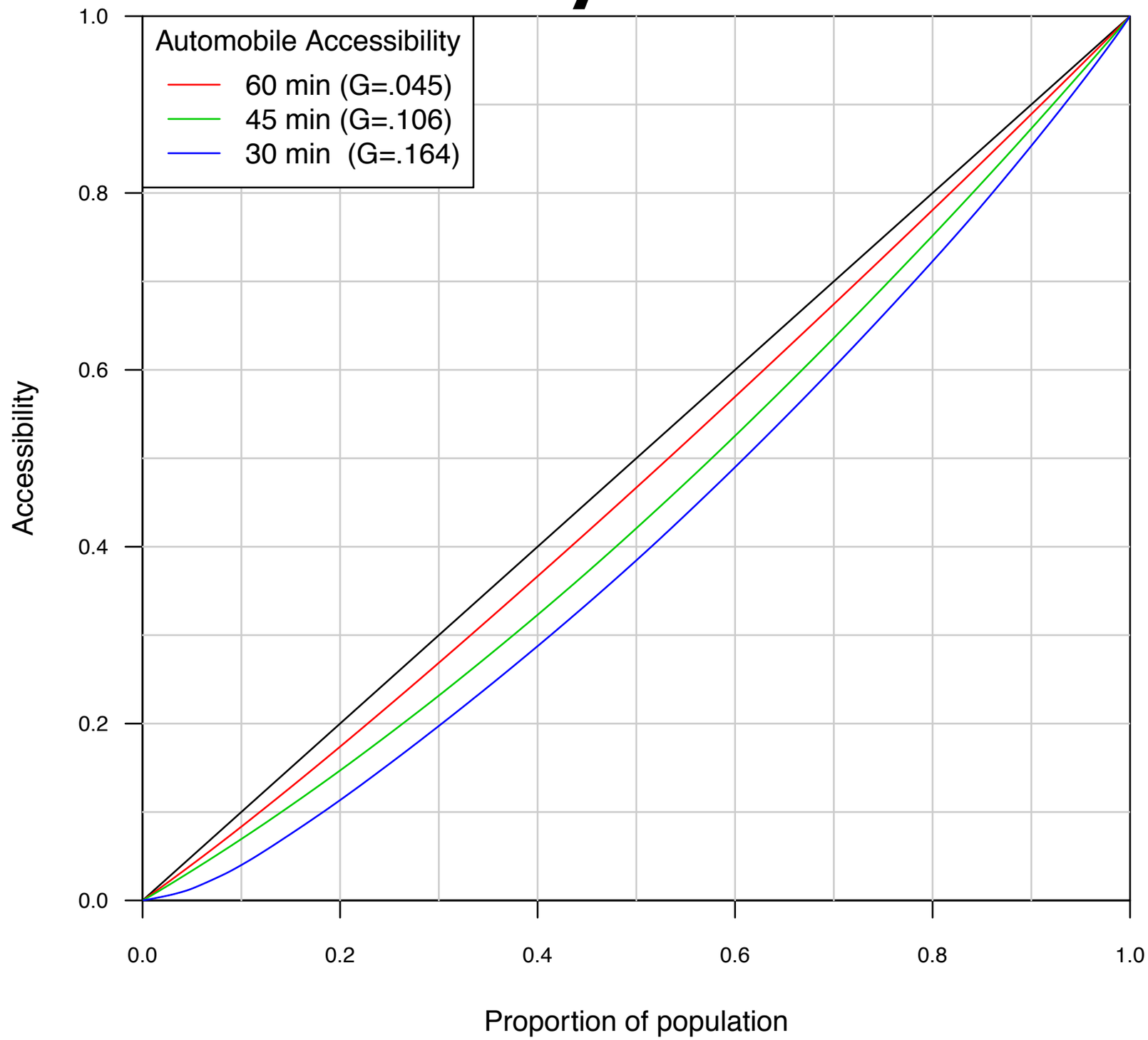
- As the time threshold increases, the distribution of access becomes more equitable



Lorenz Curve for Automobile Accessibility

- Automobile Accessibility by Travel Time

- In contrast automobile accessibility is more equitably distributed

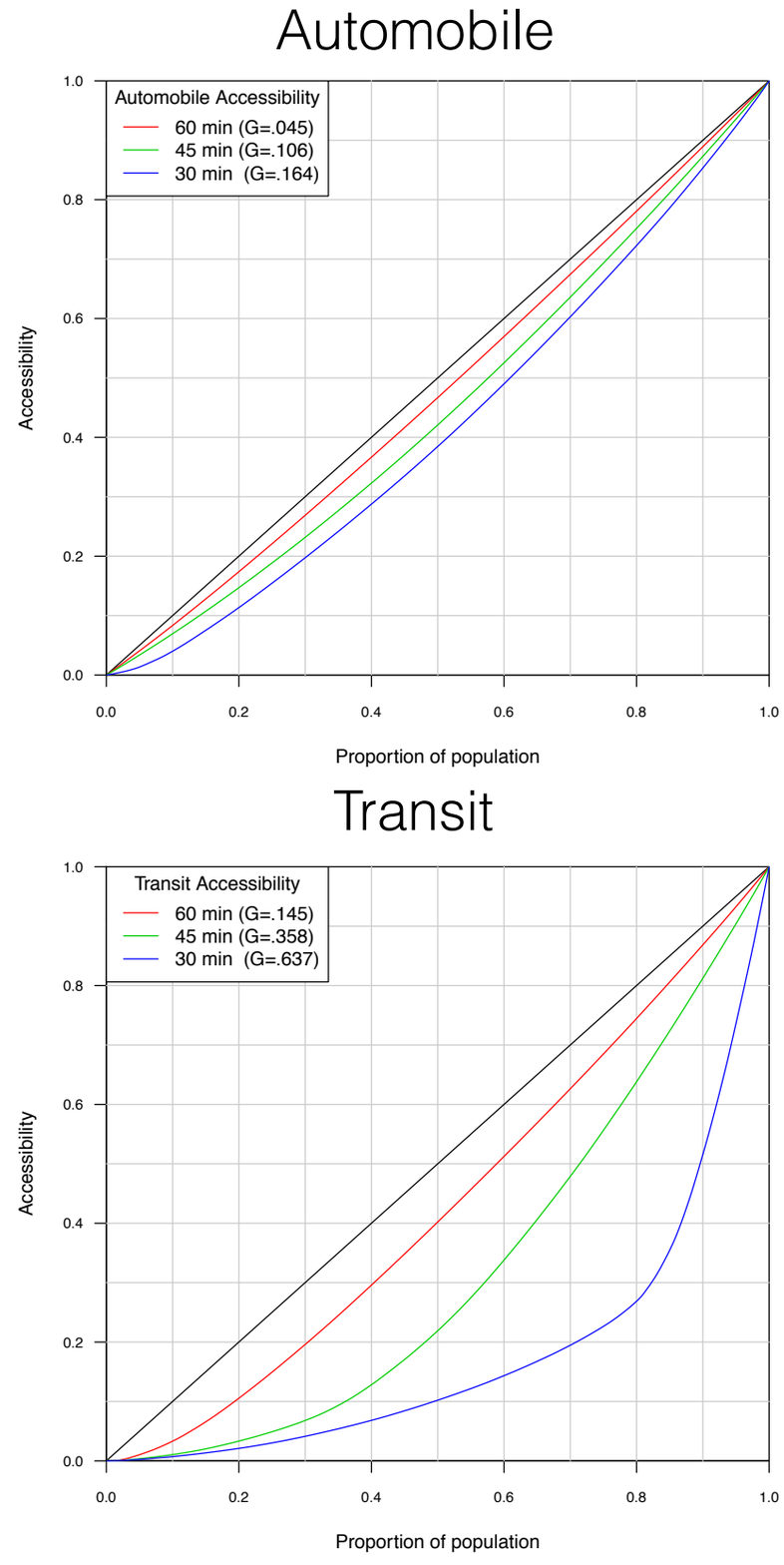


Accessibility Auto vs. Transit

	Min	Max	Median
30 min Transit	1K	783K	53K
30 min Auto	200K	2000K	1270K
45 min Transit	3K	1000K	61K
45 min Auto	1460K	3110K	2428K
60 min Transit	8K	1300K	102K
60 min Auto	2500K	3690K	3340K

- Several orders of magnitude higher accessibility with the automobile than with transit

- A more equal distribution of access with automobiles than with transit

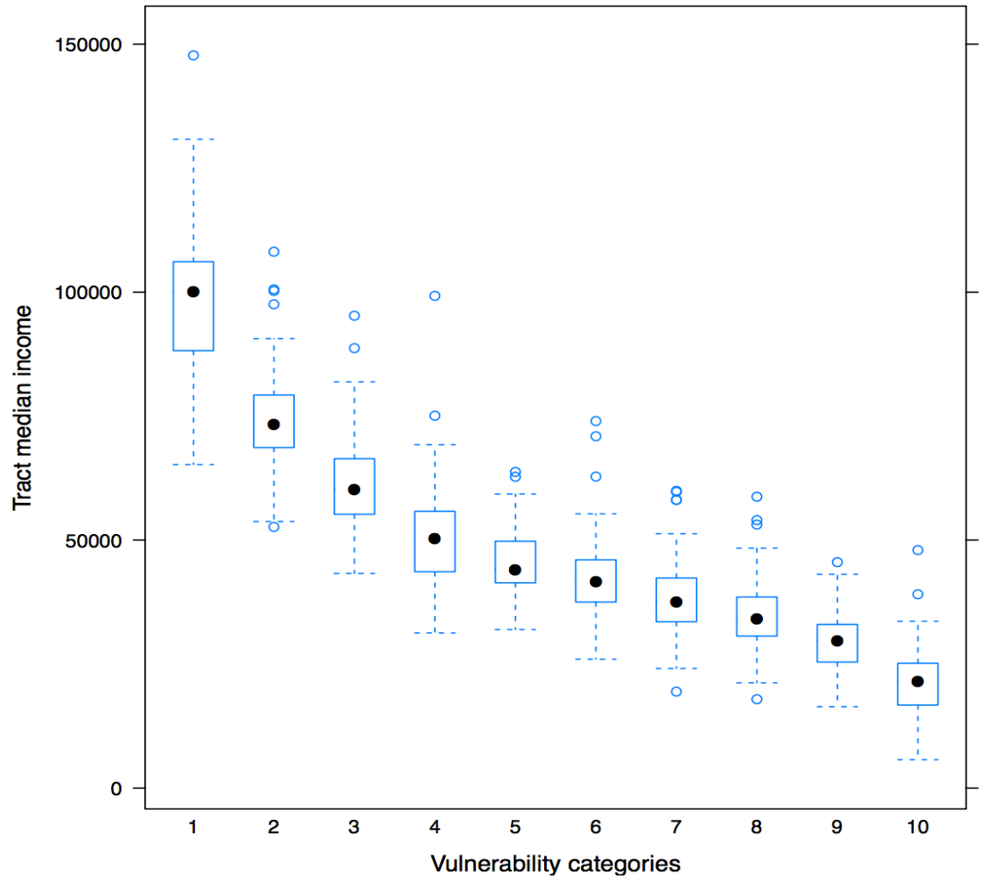


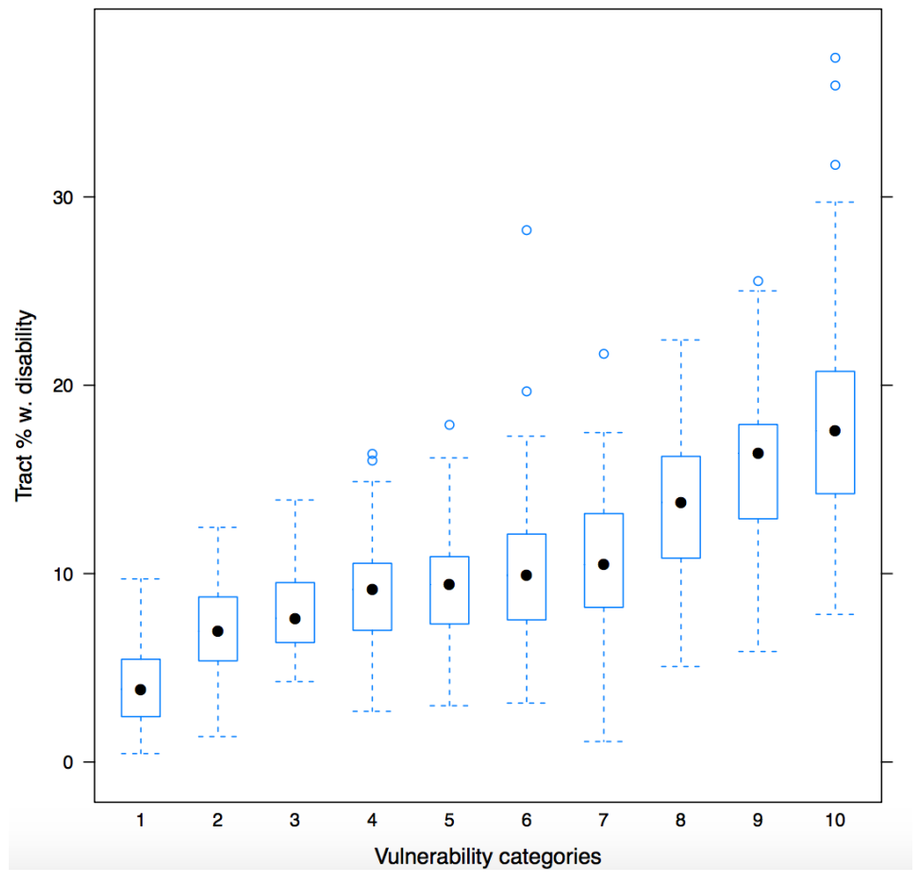
Does the unequal distribution of transit accessibility represent a distribution of service according to need and vulnerability of the population?

Vulnerable Population

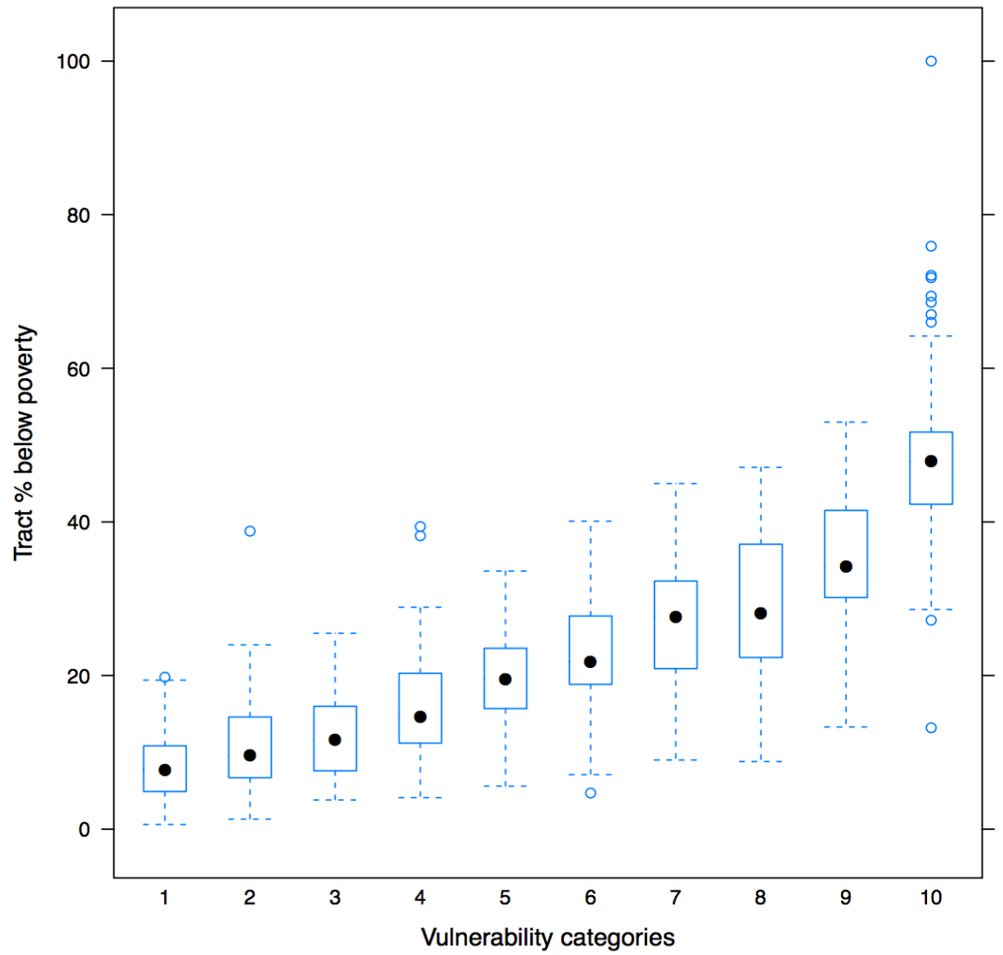
- Vulnerability defined as a composite measure of tract:
  - Unemployment
  - Disability
  - Income
  - Percent of households under poverty
- Score each neighborhood by standardizing each variable and take sum
- Classify neighborhoods by their final score, such that each class contains 10% of regional population

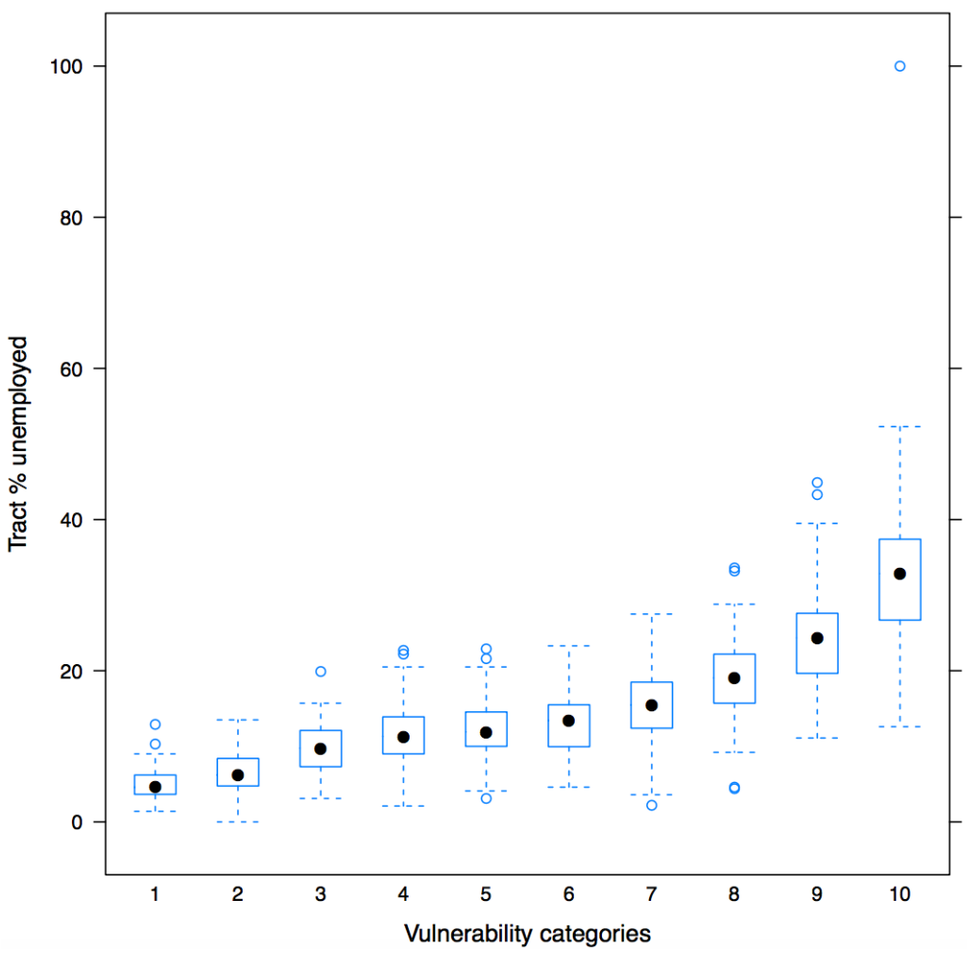
Categories



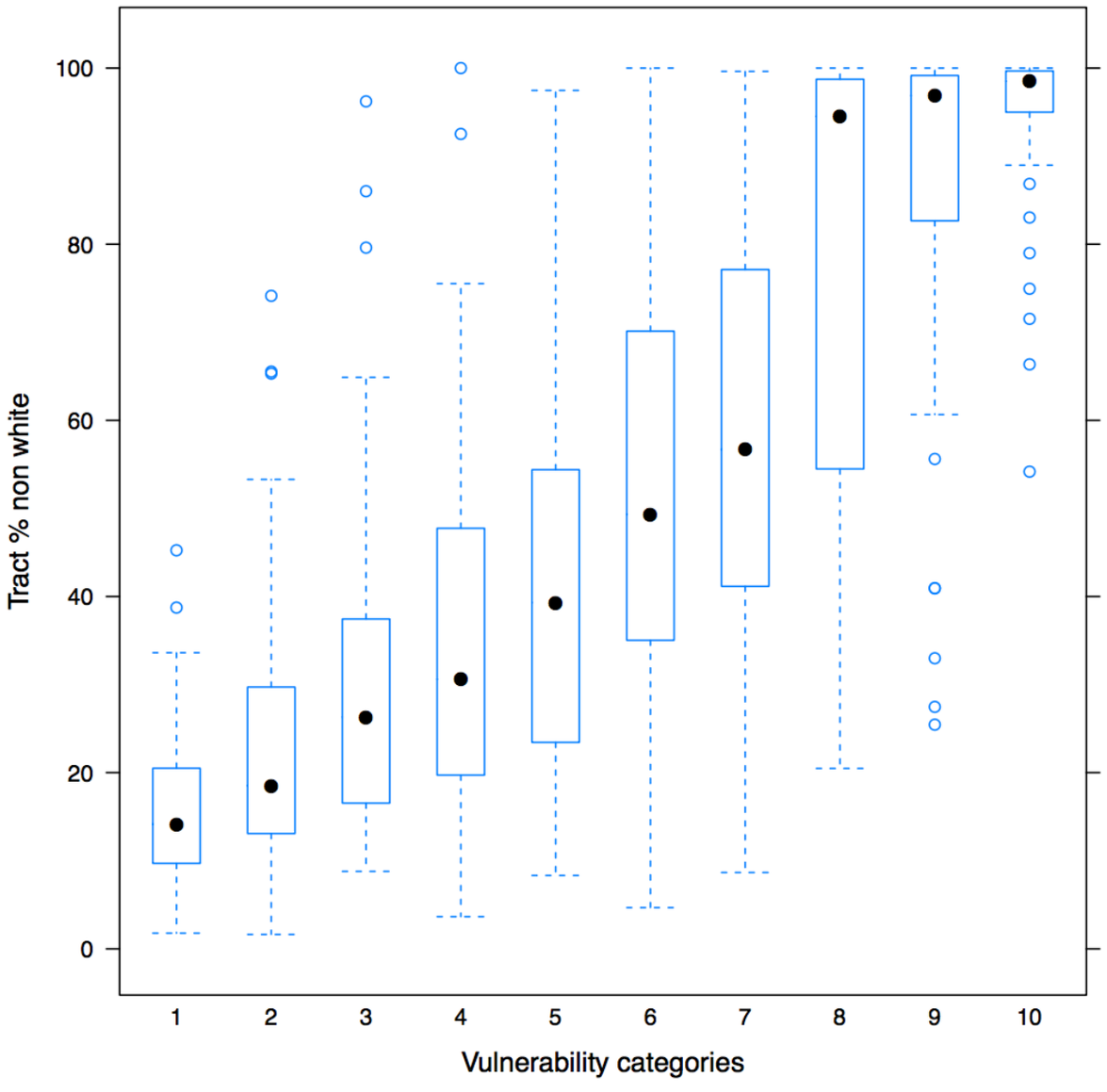


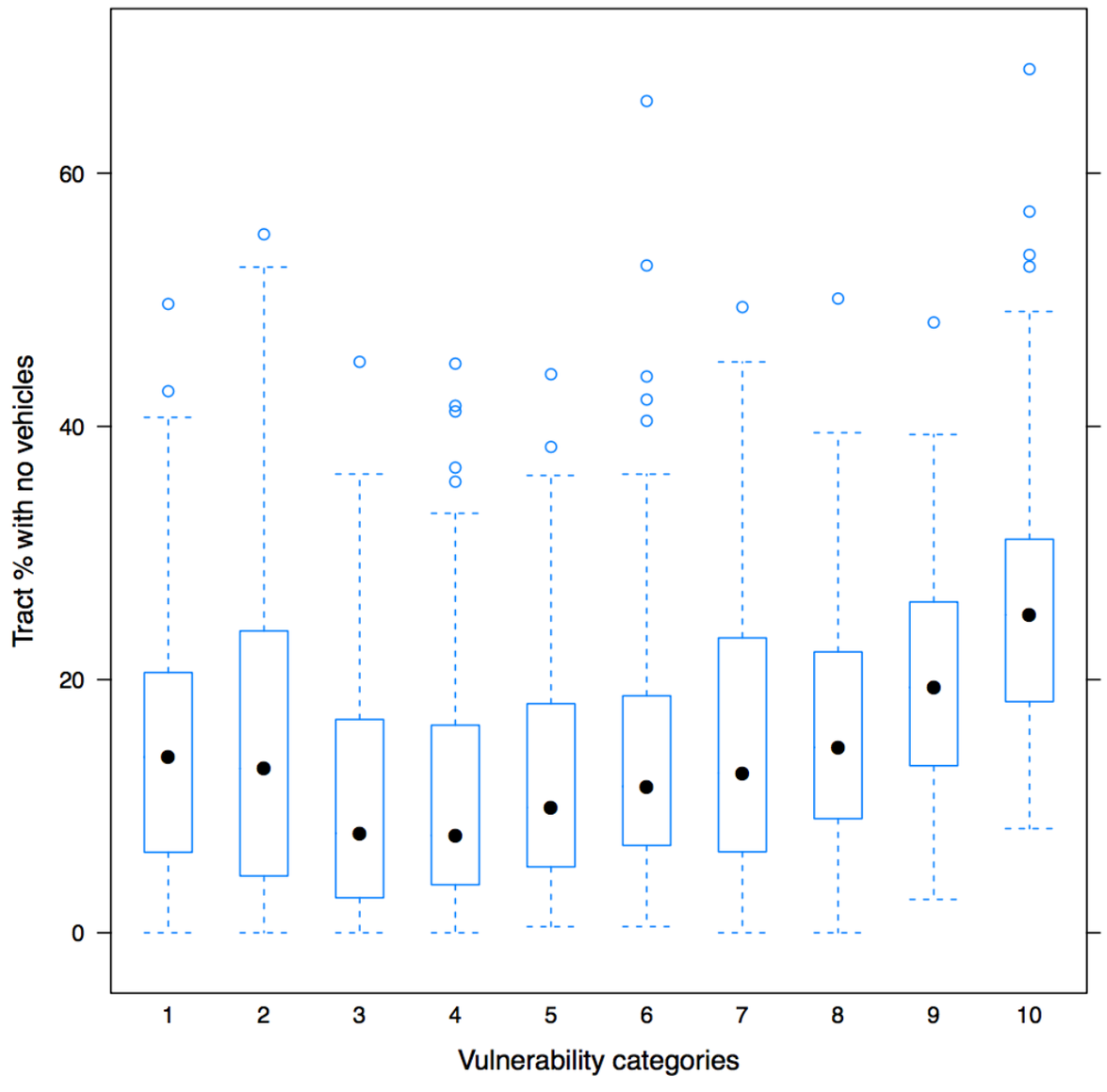
Vulnerability



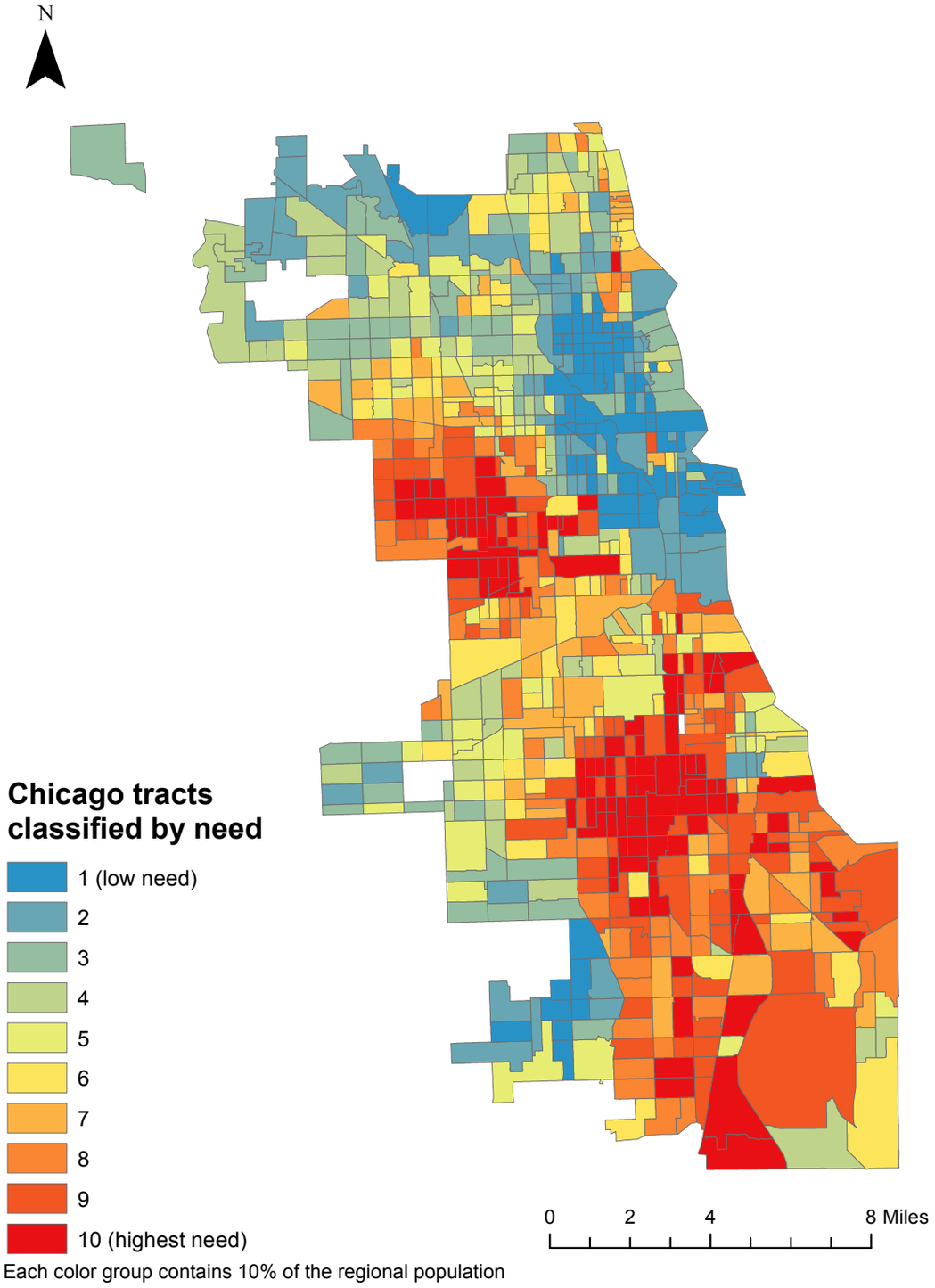


Race and Vehicle Ownership by Vulnerability Group

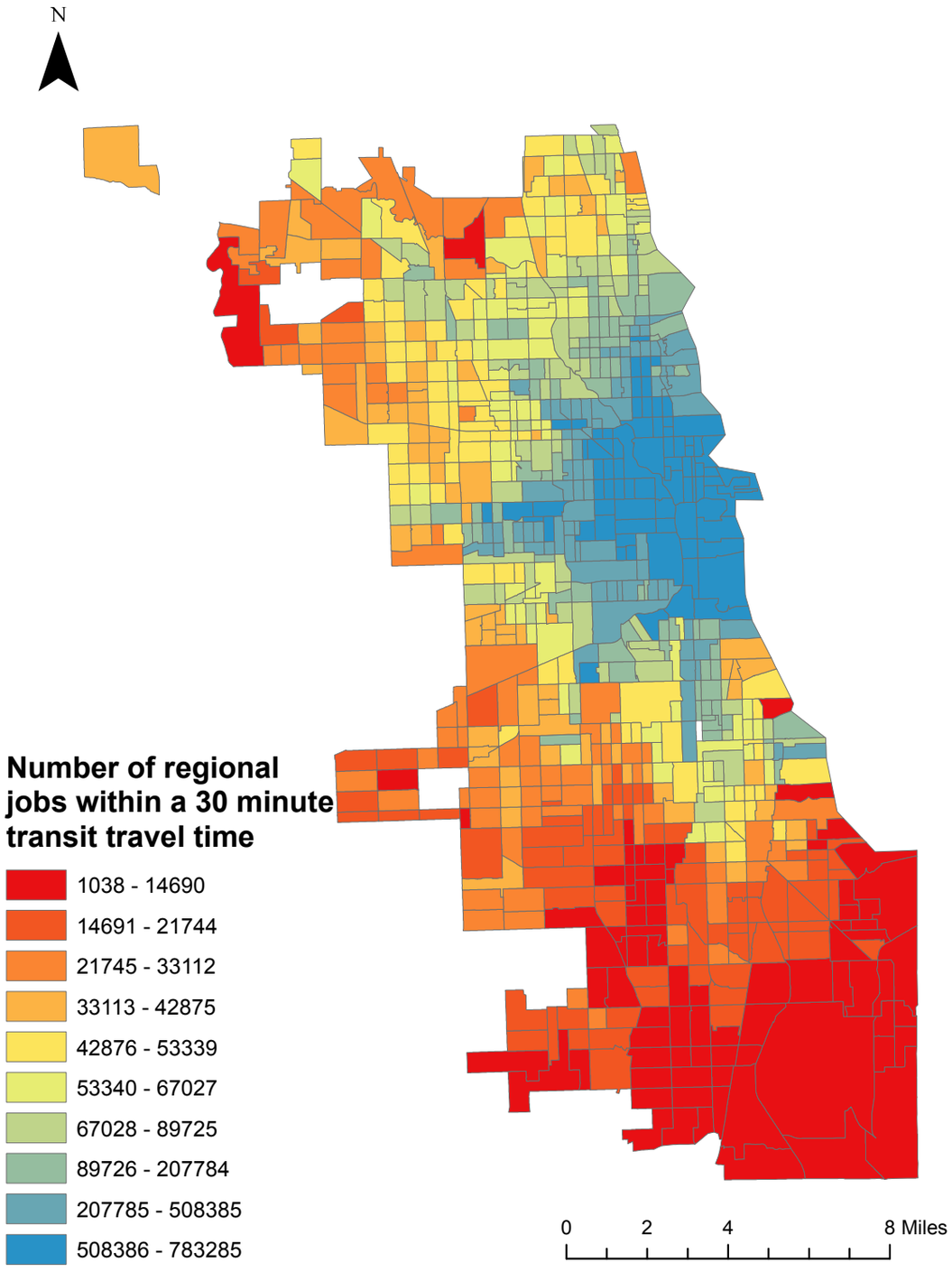




Vulnerability and Accessibility

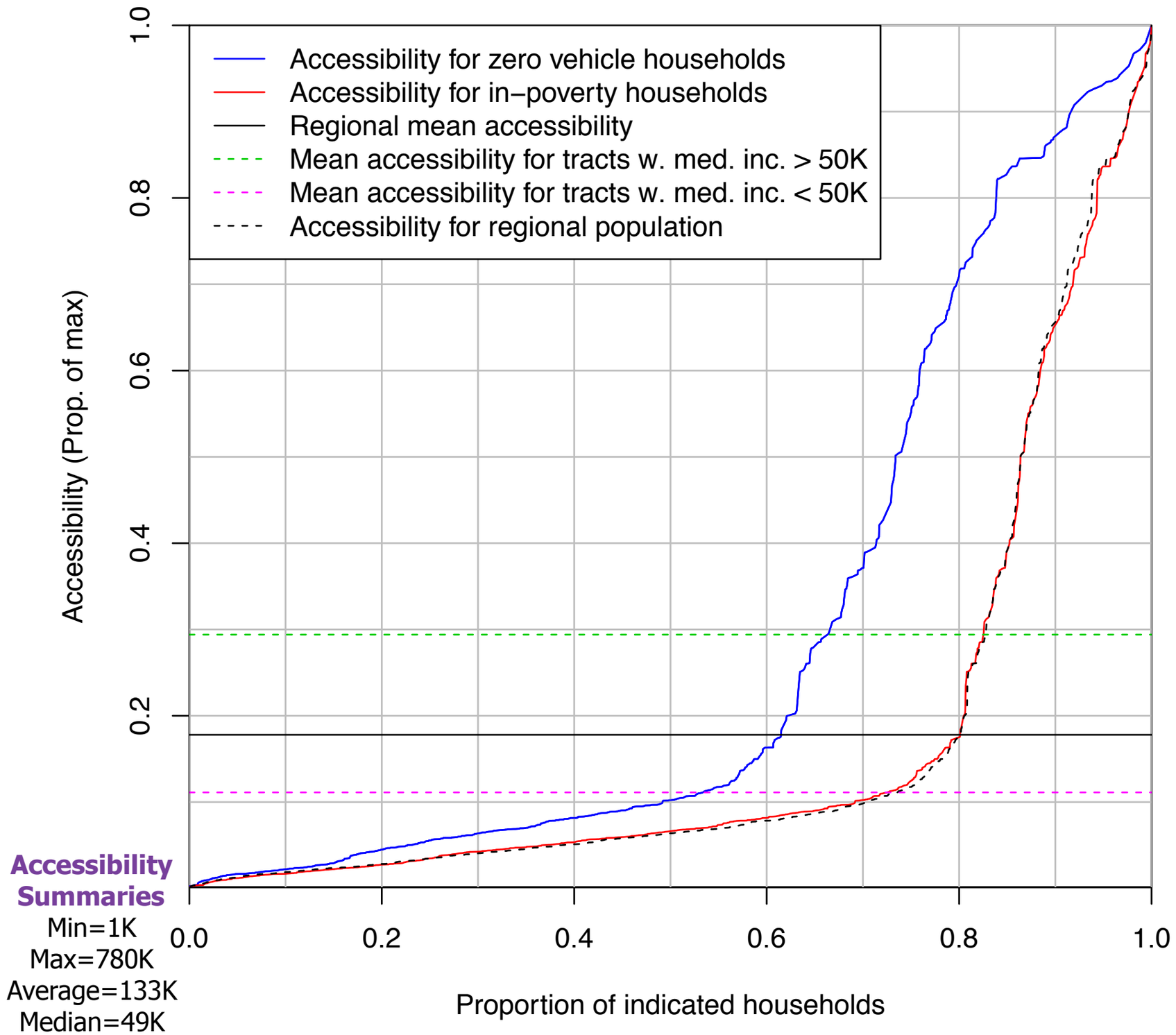


Vulnerability



Accessibility

Vulnerability and Accessibility



40% : no-vehicle households that have accessibility above the Chicago mean.

20% : percent of in poverty households that have accessibility above the Chicago mean.

20% : percent of Chicago's population that has accessibility above the Chicago mean.

18% : gap between the average accessibility of neighborhoods where average incomes are above $50K and below $50K

If we conceive of accessibility as resulting from resource allocation decisions, these findings raise questions about whether service provision aligns with the needs of the Chicago's disadvantaged population.

Thus far, we have treated the travel time threshold as if it were the same in all environments. However, the experience of a short walk to or from a transit stop can be very different depending on where it is taking place.

source: http://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/

source: http://dssg.dsapp.org/2013/07/11/cook-county-land-bank-part-1-the-problem/

source: http://dssg.dsapp.org/2013/07/11/cook-county-land-bank-part-1-the-problem/

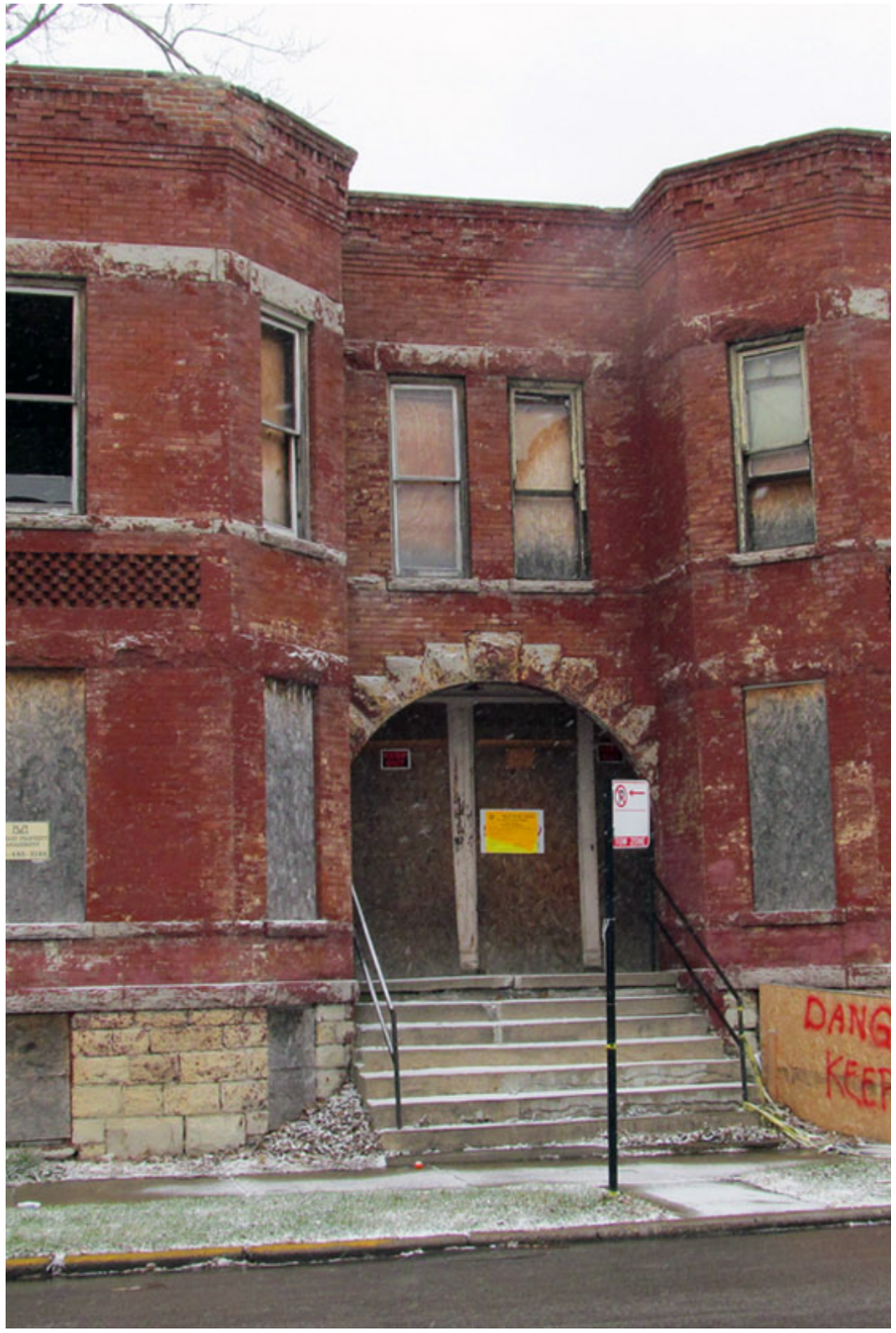
Source: http://www.gettyimages.com/detail/news-photo/chicago-police-investigate-the-murder-of-a-24-year-old-man-news-photo/165201937

source: http://www.denverpost.com/politics/ci_29534469/denver-residents-push-city-take-charge-needed-sidewalk

source: https://kcdisabilityadvocacy.wordpress.com/tag/curb-cut/

source: http://s478.photobucket.com/user/tradephoric/media/Transportation%20Pictures/Random/Orlando-ConroyKirkman_zps5938ff9a.jpg.html


K992


DANG
KEEP

The Transit Last-Mile Problem

- Thus far, we have treated the travel time thresholds as if they were the same in all environments. However, the experience of a short walk to or from a transit stop can be very different depending on where it is taking place.

- The last mile problem focuses on the difficulties in bridging the gap between the last stop of transit and an activity location.

- Contributing factors to the last-mile problem can include …
  - Access distance
  - Quality of sidewalk and path
  - Sense of safety from street level violence
  - Intersections & Safety from automobiles etc.

Approach

Assessing Last Mile Issues

- Revealed Preference Study using CMAP's Travel Tracker data
  - CMAP's one or two day diaries from the travel tracker data. Focused on work, school and related trips
- A web-based Stated Preference study
  - Mail advertised to a random sample of 5000 households in the metro area with oversampling in minority and poor areas.
- A Focus Group using regional stakeholders
  - Municipality, Persons with disabilities, Workforce development, Health and community organizations

Why three approaches?

- In the RP analysis we use the entire trip from home to the final destination of the trip (work, school or related destination).

- In the SP study, we ask questions about the access portion of a transit trip recently taken and modify its attributes in the SP context.

- Different audience in the focus group.

Revealed and Stated Preference

	Revealed Preference	Stated Preference
What people ...	do	say they would do
Constraints are ...	real	specified
Consequences ...	experienced	not experienced
Alternatives ...	constrained	not constrained
Environment...	not controlled	controlled
Source...	many sources	survey
Survey design	important	important

Stated Preference Survey

- Questions anchored in a recent transit trip.
  - Origin and boarding location? How long did it take them to arrive?
  - Assess the walking path based on safety from crime, sidewalks availability, traffic safety, parking availability, presence of shelter, and transit information availability (on a 5 point scale)
- In SP, the path is closed for construction and an alternative path connecting to the same transit stop is available.

Variable	Factor Level
Access time	5, 12, 25 min
Safety from street crime	1 (one of the worst), 3 (average), 5 (one of the safest)
Traffic safety	1 (one of the worst), 3 (average), 5 (one of the safest)
Sidewalk	0 = no; 1 = yes
Parking available	0 = no; 1 = yes (with fee or not)

Stated Preference Survey

- Three factors with three levels and two factors with two levels:108 combinations possible
- Questions randomly assigned to one of 12 groups (9 SP questions each).
- Twelve surveys questions were created - identical in every sense except for the SP questions.
- Each respondent was randomly assigned to one of the 12 surveys.
- Incentives - random draw $15 gift certificates and kindles
- 85% of respondents had made at least one trip by train or bus in the past 3 months.

SP Respondent Profile

Variable	Survey Data (%)	Regional Data (%)
Gender		
Female	50.6	51.1
Male	49.4	48.9
Race		
White	66.9	64.3
African-American	24.5	17.7
Asian	8.2	6.1
Native American	0.4	0.2
Pacific Islander	0.0	0.0
Hispanic	6.0	21.3
Income ($)		
<10,000	6.8	2.0
10,000–19,999	7.6	4.9
20,000–29,999	8.1	10.2
30,000–39,999	7.6	15.9
40,000–49,999	11.4	21.0
50,000–59,999	9.3	15.9
60,000–69,999	7.2	11.5
70,000–79,999	5.1	7.5
80,000–89,999	5.5	4.5
90,000–99,999	5.9	2.2
100,000–150,000	14.0	3.7
>150,000	11.4	0.7
Household size		
1 person	25.0	28.0
2 persons	38.7	29.2
3 persons	16.4	15.8
≥4 persons	19.9	27.0
Household vehicles		
1	18.4	35.6
2	41.4	36.2
3	29.7	11.4
≥4	10.6	4.3

Model Estimates

Predicting the log-odds of choosing a walk-transit mode

Category	Factor	Estimate	Standard Error	z-Value	Pr(>|z|)
Neighborhood factors (SP)	(Intercept)	–0.798	0.410	–1.95	.057
	Access time, ΔT	–0.063	0.008	–7.98	.000
	Crash safety, ΔS	0.055	0.042	1.29	.198
	Crime ΔC	–0.392	0.048	–8.23	.000
	Sidewalk, W	0.370	0.151	2.45	.014
Neighborhood factors (actual)	Crime (current), E_c	–0.767	0.201	–3.81	.000
	Sidewalk unavailable (current), E_w	–0.944	0.335	–2.81	.005
Sociodemographic variables	Sex (female = 1), G	–0.487	0.168	–2.89	.004
	Age, A	0.023	0.005	4.43	.000
	Household size, Z	0.157	0.070	2.24	.025
	No vehicle, V	0.945	0.201	4.71	.000
	Household income, I	–0.006	0.002	–2.82	.005
	Education, Ed	0.299	0.181	1.65	.098
Travel cost	Destination parking fee, F	0.563	0.1765	3.19	.001

NOTE: Goodness of fit: null deviance = 1,269.6 on 916 degrees of freedom; residual deviance = 1,056.7 on 903 degrees of freedom; pseudo-R^2 = .168; Akaike information criterion = 1,084.3. Pr = probability.

Valuing Safety and Sidewalk Availability

- A shift in 1 scale of the safety perception has the same impact as a 6.2 minute increase in travel time.

- A shift in sidewalk availability had the same impact as 5.9 minutes.

- Average respondent reported access time to station was ~8 minutes.

Revealed Preference Model

Multinomial logit model of mode choice with alternative specific variables for time, out-of-pocket costs and crime exposure.

	Shared ride			Transit (auto accessed)			Transit (walk accessed)			Bicycle			Walk		
	Est.	t-stat		Est.	t-stat		Est.	t-stat		Est.	t-stat		Est.	t-stat	
Intercept	-0.122	-0.194		-5.314	-4.625	***	0.848	1.742	.	-0.182	-0.176		1.467	1.861	.
Sex (1=Male)	-0.313	-1.613		-0.272	-0.983		0.094	0.678		0.691	2.354	*	-0.089	-0.392	
Age	-0.006	-0.798		-0.003	-0.261		-0.018	-3.347	***	-0.045	-3.708	***	-0.007	-0.913	
Zero veh. HH. (1=Y)	2.546	3.648	***	2.600	2.57	*	3.741	5.808	***	3.129	3.784	***	2.648	3.513	***
Veh. per adult	-2.206	-5.721	***	-0.557	-1.47		-2.084	-7.987	***	-2.235	-3.565	***	-2.457	-4.864	***
HH size	0.184	2.354	*	-0.005	-0.038		-0.106	-1.66	.	-0.172	-1.227		-0.274	-2.351	*
Origin Access. (log)	-0.002	-0.026		-0.735	-5.417	***	-0.104	-1.636		0.355	2.696	**	0.234	1.745	.
Dest. Access. (log)	0.191	3.343	***	0.913	6.535	***	0.492	9.612	***	0.331	2.96	**	0.060	0.513	
Peak-period (1=Y)	-0.200	-1.025		1.010	3.162	**	0.497	3.468	***	0.403	1.398		0.166	0.713	
Work trip (1=Y)	-0.237	-1.018		1.882	2.535	*	0.594	2.972	**	0.770	1.815	.	0.077	0.273	
% 0 veh. HH Tract	-0.999	-1.241		-0.310	-0.262		1.514	2.481	*	-0.463	-0.387		2.642	2.906	**
Price (P/I)							-2.836			-7.641***					
Travel time (T)							-0.028			-10.191***					
Violent crime (V_c)							-0.052			-3.447***					
Goodness of fit:	Log-Likelihood: -1780.8 McFadden R^2: 0.293 N: 1948 Likelihood ratio test : $\chi^2 = 1476.3$ ($p.value =< 2.22e-16$)														

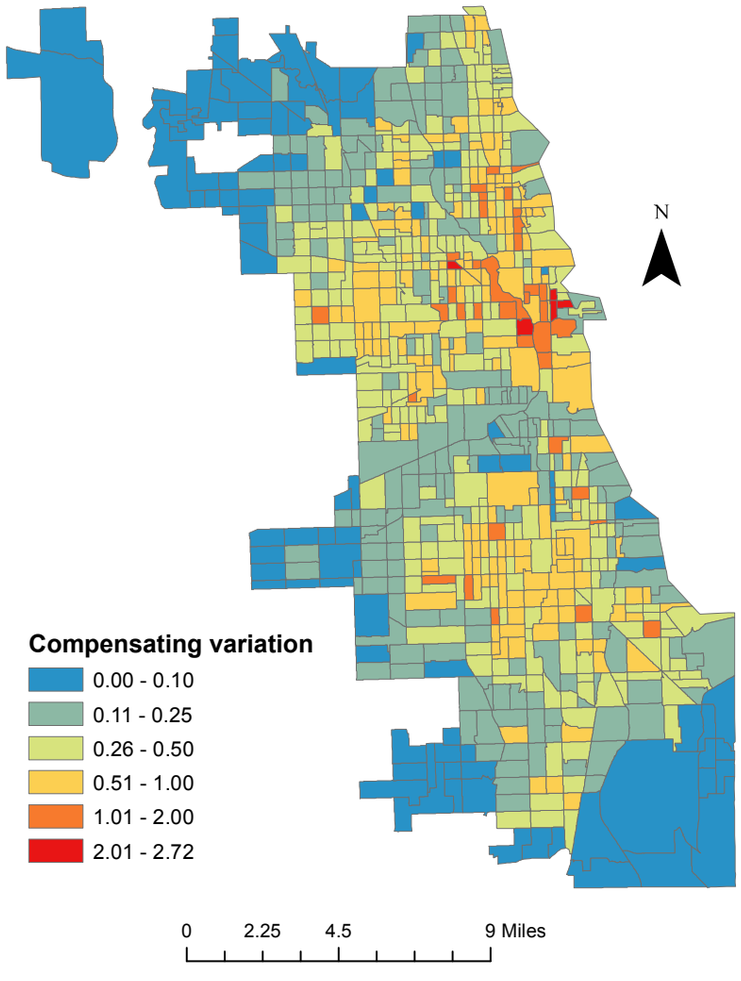
Significance: $***< 0.001$, $**< 0.01$, $*< 0.05$, .0.10

Compensating Variation (RP)

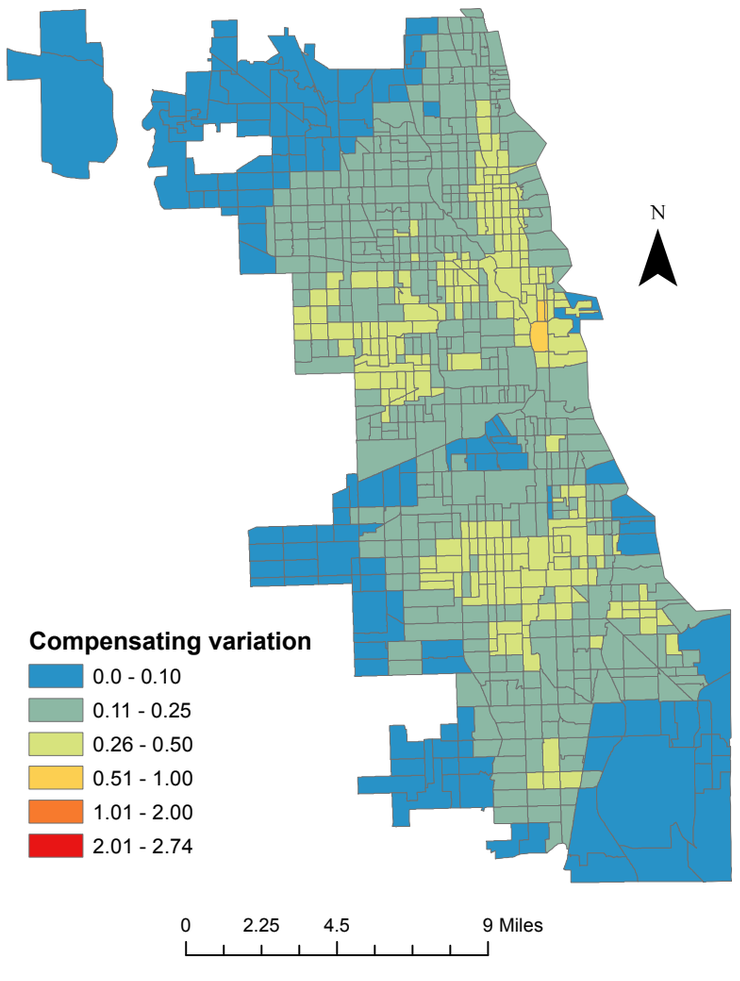
If a policy or program can achieve a 10% reduction in crime, how much can you take from a resident and still leave them at the same utility as before the policy/program change.

Depending on destination, the CV can be as high as $0.50 (low destination accessibility) or as high as $2.72. Estimates use characteristics of current tracts and residents.

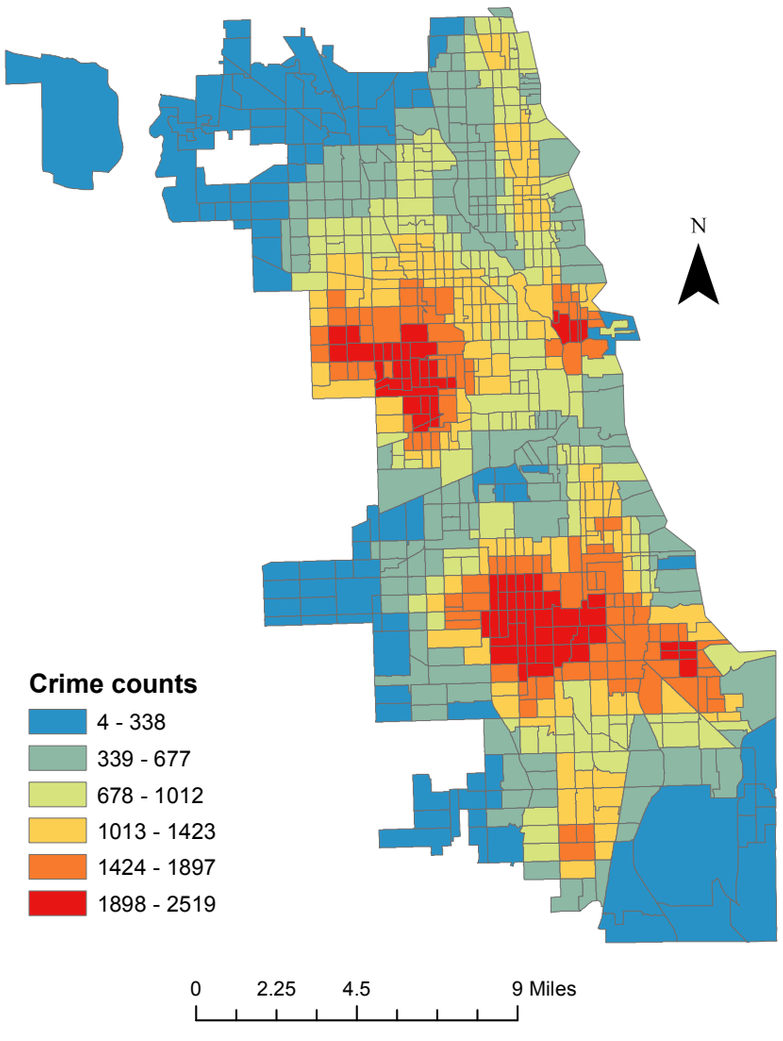
Person with median income has a willingness to pay of $28/hour and a willingness to pay $0.86 per hundred high crime reductions.



CV when destination is high accessibility



CV when destination is low accessibility



Crime within 1 mile of tract centroid

Summary

- Accessibility: Mismatch between need and current access levels.
- Need to think about the role of transit and find ways of addressing need and moving toward a more equitable distribution of access.
- Though not captured in the current accessibility measures, the last-mile can make places less accessible than appears from just looking at travel times.
- There is room to improve these environments by creating better last-mile environments. In particular, creating a sense of safety in walking corridors and neighborhoods can lead to significant benefits.

Thank you!

Nebiyou Tilahun
ntilahun@uic.edu
http://ntilahun. people.uic.edu

Chicago Metropolitan Accessibility Explorer
http://urbanaccessibility.com

Acknowledgements: Moyin Li, Yaye Keita, Shi Yin, Piyushimita (Vonu) Thakuriah