



**Herbert Wertheim
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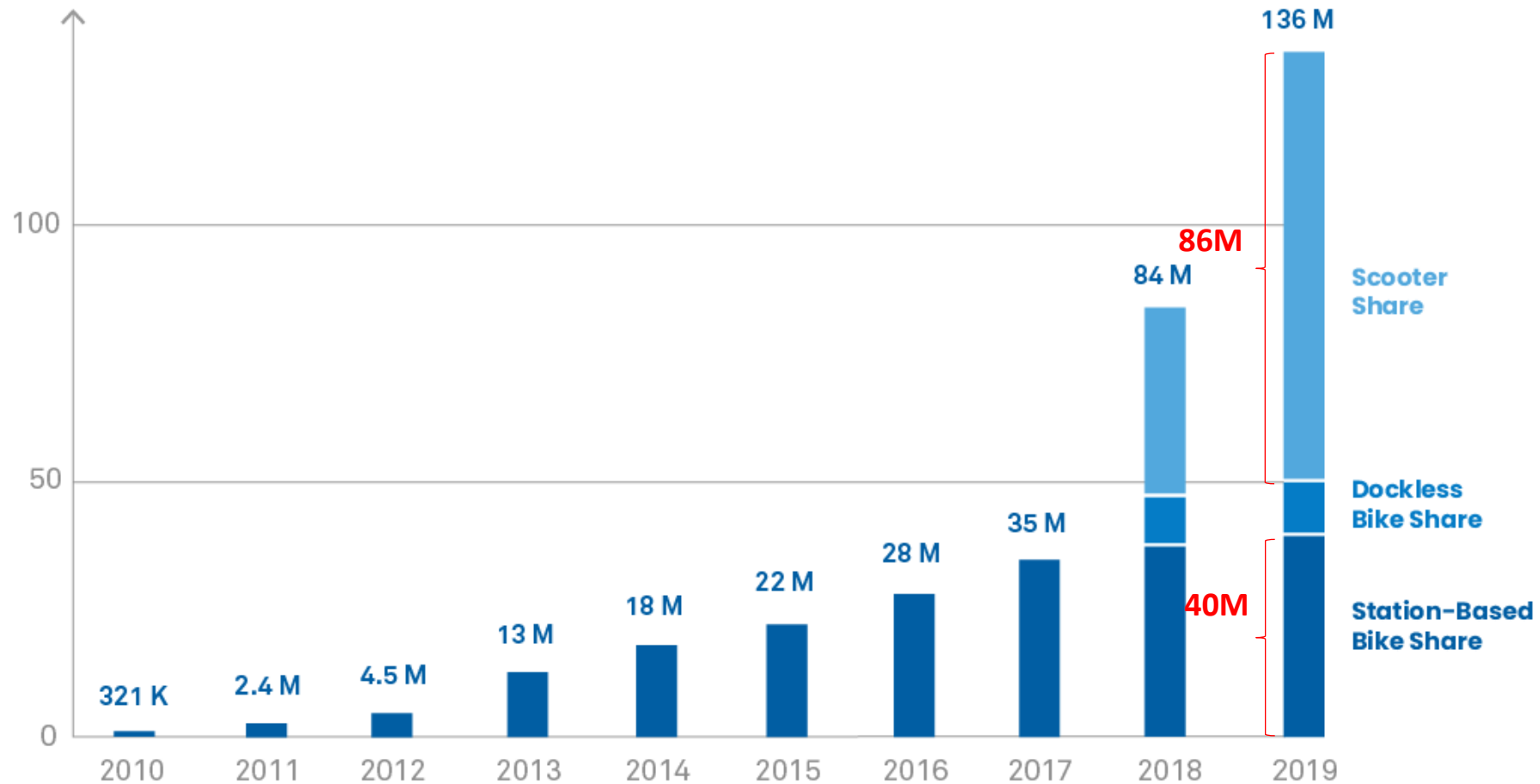
Micromobility equity: A comparison of shared e-scooters and station-based bikeshare in Washington DC

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7th Annual UTC Conference for the Southeastern Region & FAU

Background: the rise of shared e-scooters



Equity in shared micromobility systems

Motivation:

Can shared micromobility benefit everyone equally? Existing studies suggest that **bikeshare use is lower in low-income communities**.

Research questions:

1. Are dockless e-scooter services equitable across neighborhoods?
2. Are shared e-scooter services less equitable than station-based bikeshare?

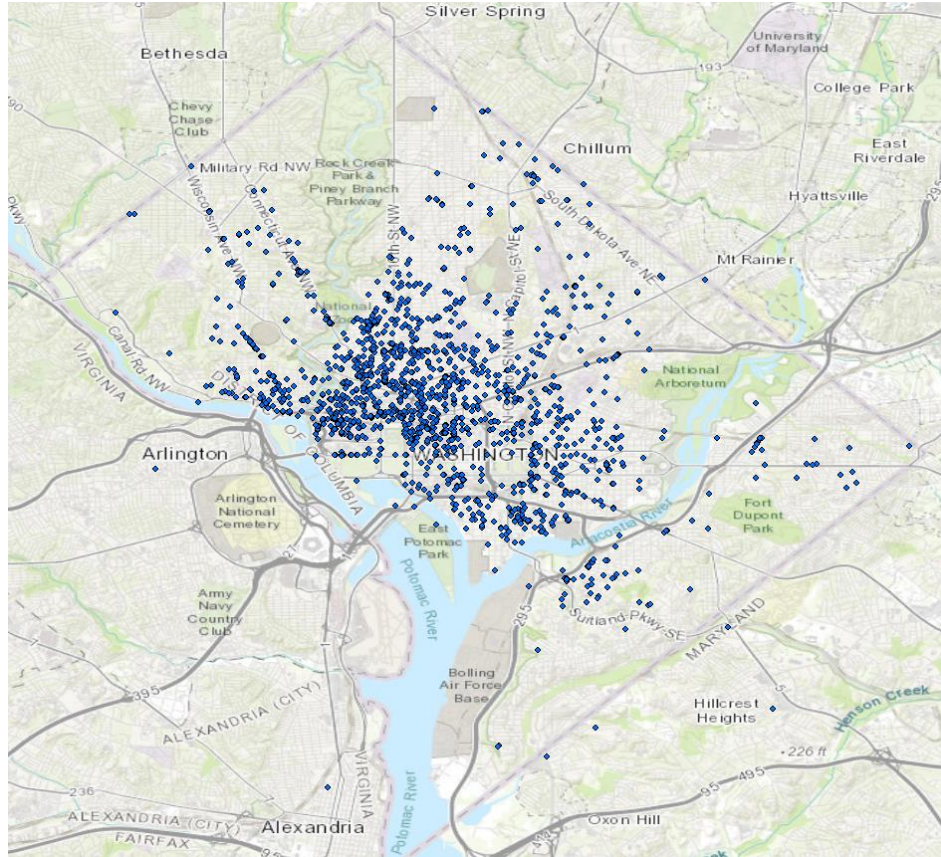
The General Bikeshare Feed Specification (GBFS) data

- **Real-time data feeds** (JSON files)
 - Data scrapped from public APIs
 - API updates every 1 min or 5 min
 - Records e-scooter/e-bike status in real time

```
{ "last_updated": 1582683409, "ttl": 0, "version": "1.0", "data": { "bikes":  
  : [ { "bike_id": "8bb53ddb-2503-492f-a7c1-75340b8709c6", "lat": "38.8954",  
    "lon": "-76.9295", "is_reserved": 0, "is_disabled": 0, "vehicle_type":  
    "scooter"}, { "bike_id": "c6536c15-8354-4f21-bdaf-480da2da52af", "lat":  
    "38.9248", "lon": "-77.0321", "is_reserved": 0, "is_disabled": 0,  
    "vehicle_type": "scooter"}, { "bike_id":  
    "bfcf6499-52a0-4b4f-9f07-4d131f9279ac", "lat": "38.915", "lon":  
    "-76.9778", "is_reserved": 0, "is_disabled": 0, "vehicle_type": "scooter"  
  }, { "bike_id": "72b6e82c-3102-4cde-a568-271caf21d485", "lat": "38.8937",
```

raw GBFS data

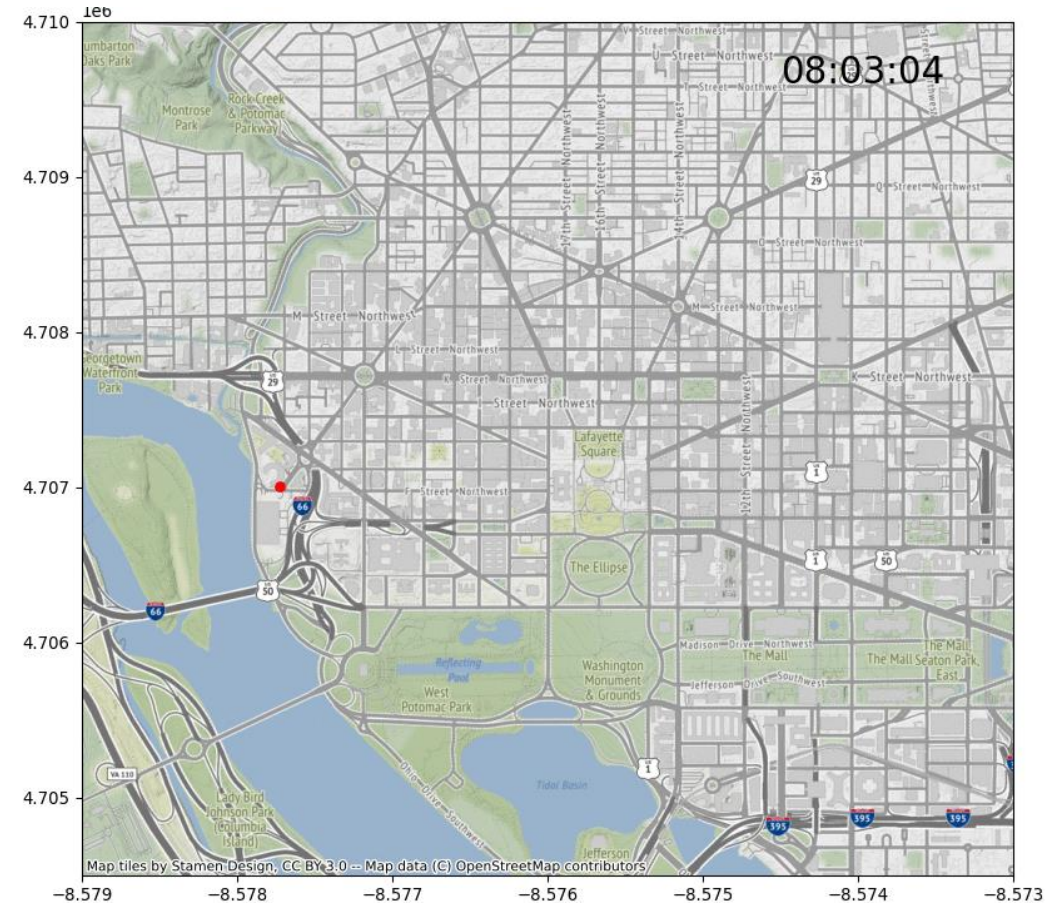
Understand the data



Available e-scooters at 7:00 am on June 20, 2019



Supply-side analysis

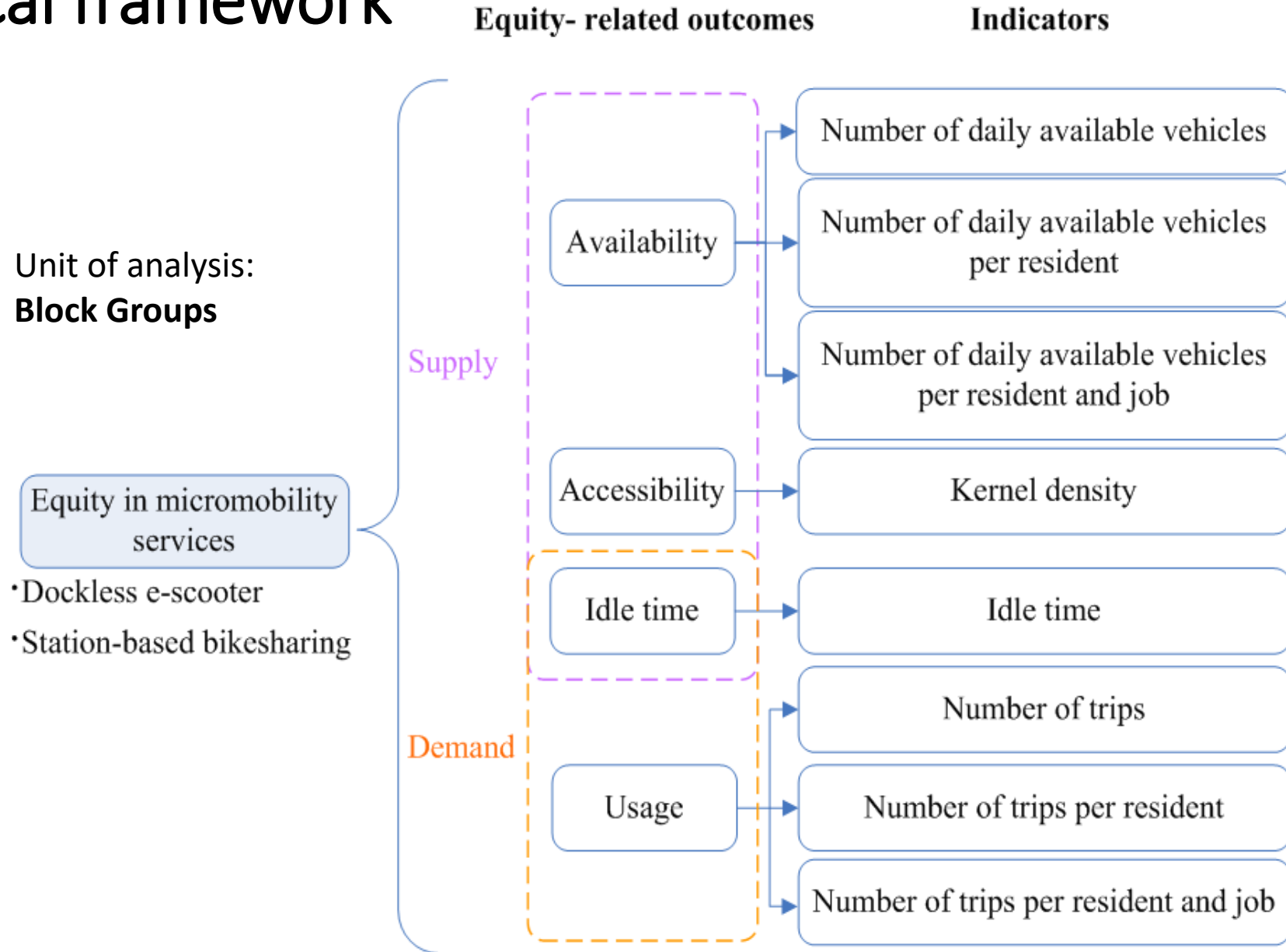


GPS trajectory of an e-scooter on June 20, 2019



Demand-side analysis

Analytical framework



Availability of e-scooters

	No. Daily Available E-scooters
	Mean
Block groups divided by EEA status	
EEA	23.68
Non-EEA	36.84
Block groups divided by median household income	
Low	23.86
Middle	37.47
High	26.03
Block groups divided by racial compositions	
Black majority	15.64
White majority	43.59
No majority	21.80

Disadvantaged block groups (EEA, low-income, and Black-majority) have fewer available e-scooters.

Availability of e-scooters (normalized)

	Availability		
	No. Daily Available E-scooters	No. Daily Available E-scooters Per <i>Resident</i>	No. Daily Available E-scooters Per <i>Resident and Job</i>
	Mean	Mean ($\times 10^{-2}$)	Mean ($\times 10^{-2}$)
Block groups divided by EEA status			
EEA	23.68	1.66	0.97
Non-EEA	36.84	2.40	1.27
Block groups divided by median household income			
Low	23.86	1.52	0.95
Middle	37.47	2.36	1.18
High	26.03	1.83	1.15
Block groups divided by racial compositions			
Black majority	15.64	1.18	0.87
White majority	43.59	2.72	1.21
No Majority	21.80	2.66	1.74

Findings are the same after normalization.

Accessibility of e-scooters (kernel density + zonal statistics)

	Accessibility (kernel density value)	
	Median($\times 10^3$)	Mean($\times 10^3$)
Block groups divided by EEA status		
EEA	412.58	1,123.65
Non-EEA	802.65	1,679.40
Block groups divided by median household income		
Low	281.79	748.53
Middle	860.79	1,759.48
High	747.64	1,320.35
Block groups divided by racial compositions		
Black majority	255.87	588.59
White majority	1,284.54	2,000.12
No majority	1,947.70	2,304.05

Solves the “boundary effect” problem.

Similar findings as using availability measures.

Availability and accessibility of shared bikes

	Availability			Accessibility	
	No. Daily Available Bikes	No. Daily Avail. Bikes Per <i>Resident</i>	No. Daily Avail. Bikes Per <i>Resident and Job</i>	Kernel Density	
	Mean	Mean ($\times 10^{-2}$)	Mean ($\times 10^{-2}$)	Median ($\times 10^3$)	Mean ($\times 10^3$)
Block groups divided by EEA status					
EEA	3.80	0.26	0.18	99.93	192.76
Non-EEA	6.16	0.41	0.23	149.06	279.21
Block groups divided by household income					
Low	3.02	0.22	0.16	71.75	128.69
Middle	6.06	0.40	0.23	168.17	280.20
High	4.67	0.32	0.19	141.25	251.80
Block groups divided by racial composition					
Black majority	2.99	0.22	0.18	70.50	118.29
White majority	7.26	1.27	0.21	293.81	330.28
No Majority	5.75	0.39	0.27	222.24	337.58

Disadvantaged block groups have fewer available bikes.

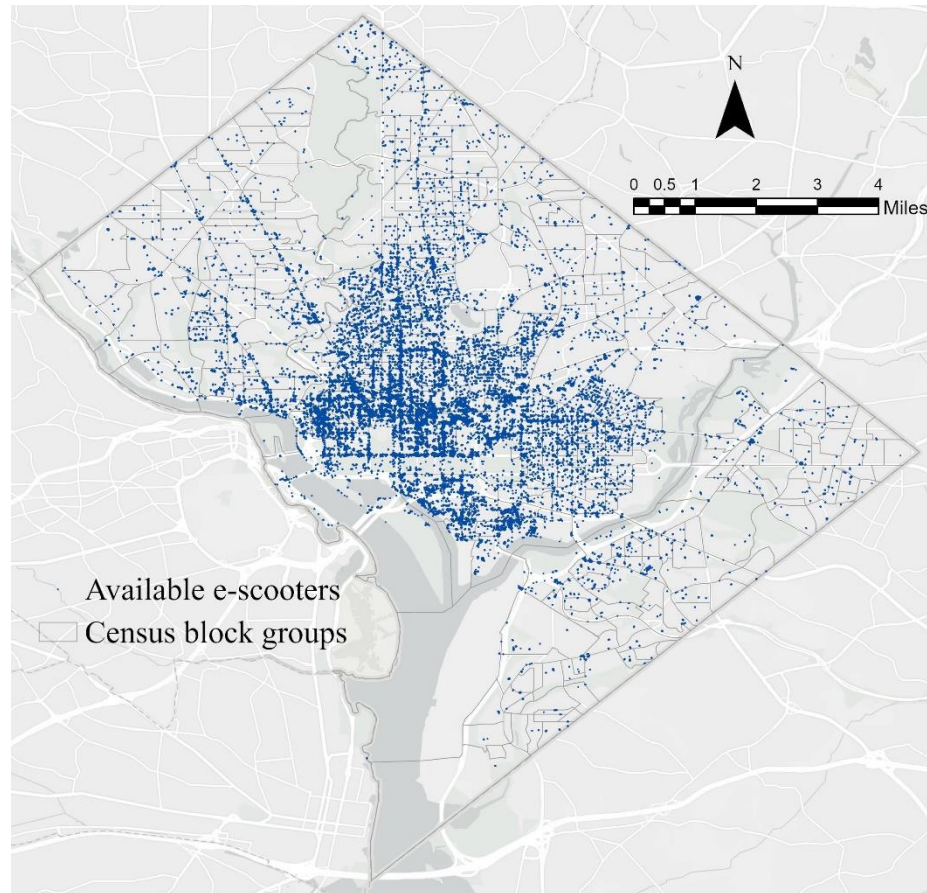
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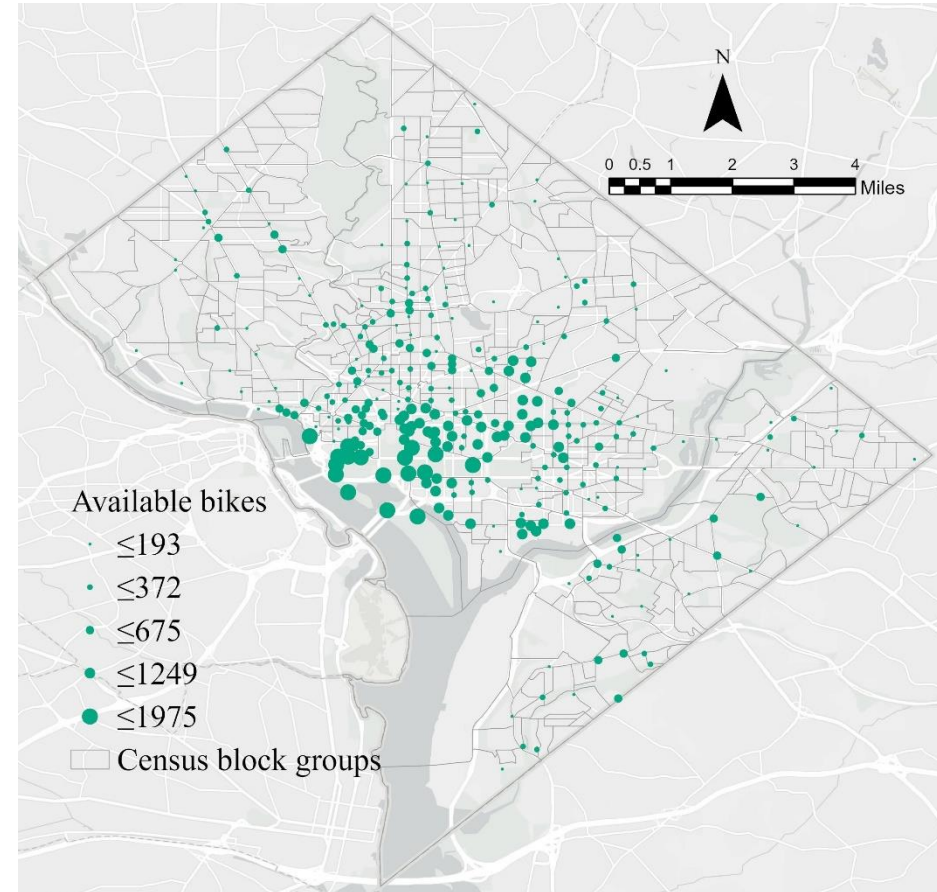
Disadvantaged block groups have fewer available bikes.

The disparities between advantaged & disadvantaged block groups are smaller compared to e-scooters.

Spatial distribution of shared e-scooters and bikes



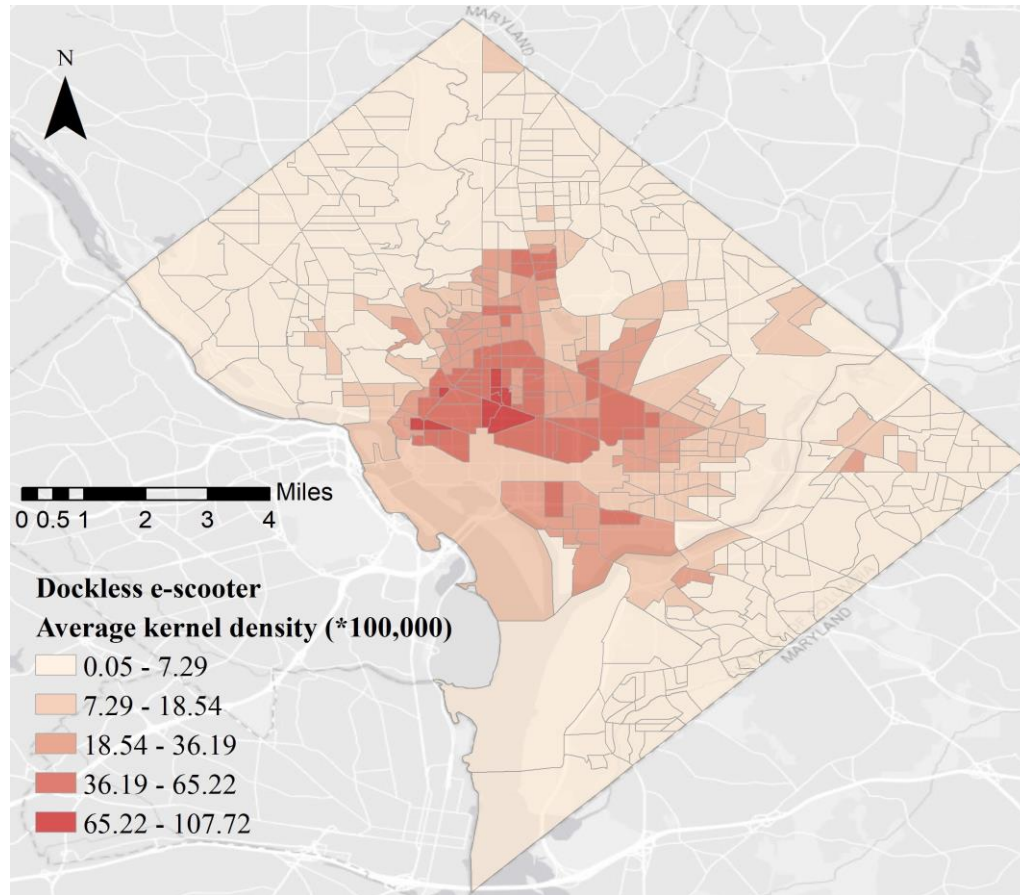
(a) Dockless e-scooter



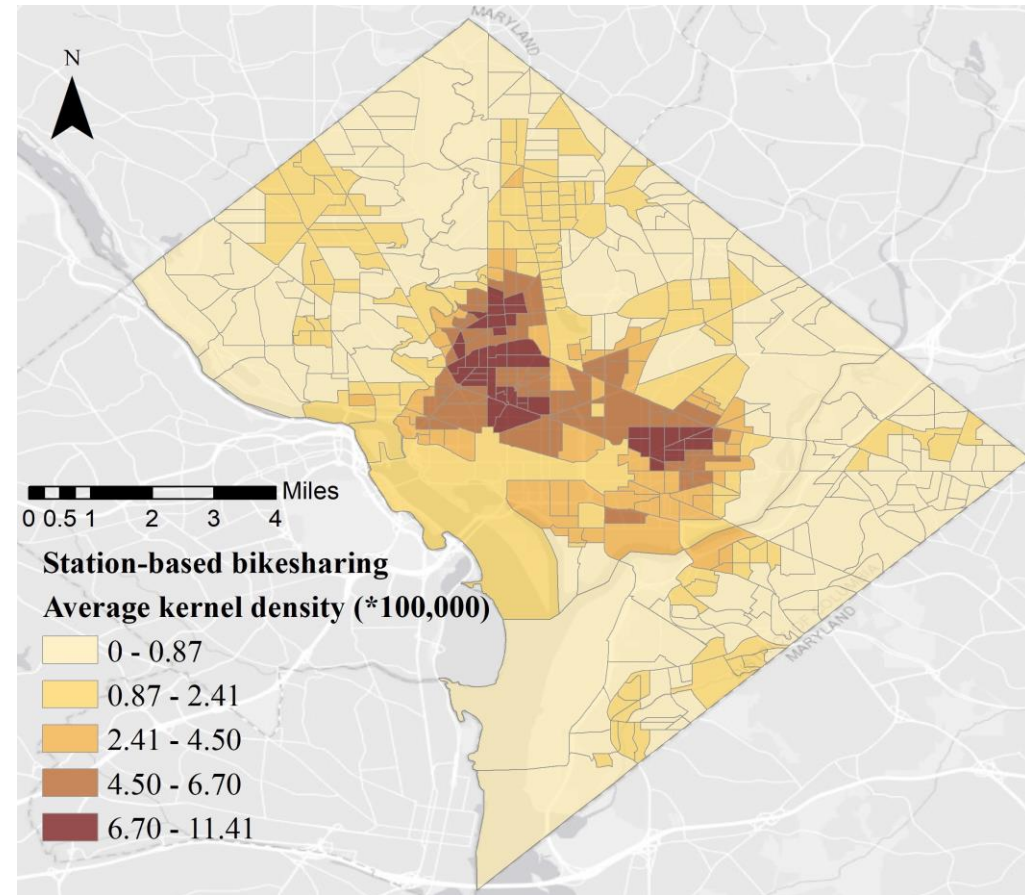
(b) Station-based bikesharing

Spatial distribution of shared e-scooters and bikes

Shared bikes are more evenly distributed than shared e-scooters.



(a) Dockless e-scooter



(b) Station-based bikesharing

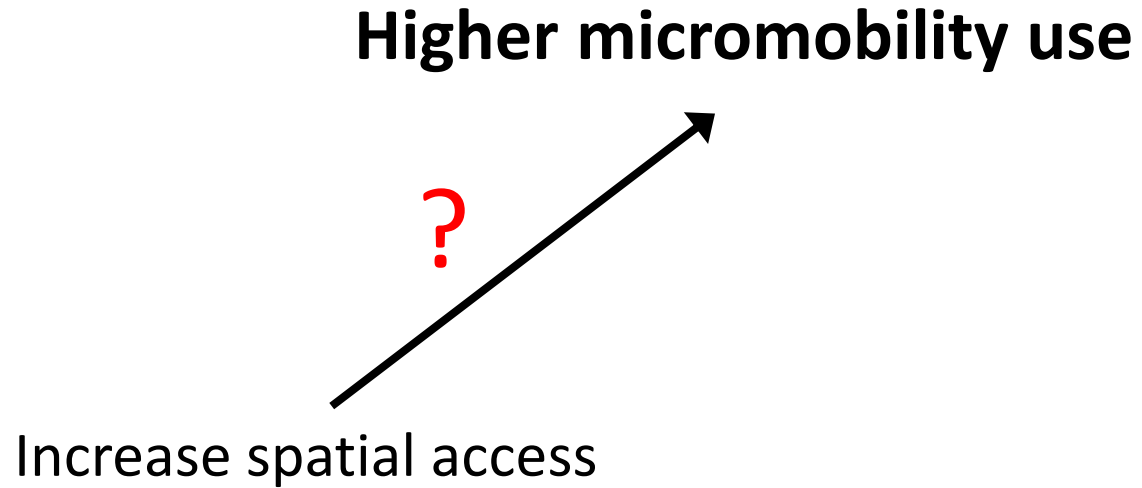
Use of shared e-scooters and bikes

	E-scooter			Bikesharing		
	No. Trips	No. Trips Per Resident	No. Trips Per Resident and Job	No. Trips	No. Trips Per Resident	No. Trips Per Resident and Job
	Mean	Mean	Mean	Mean	Mean	Mean
Block groups divided by EEA status						
EEA	609.10	0.43	0.16	452.7	0.31	0.15
Non-EEA	1269.20	0.79	0.30	1270	0.78	0.32
Block groups divided by household income						
Low	325.67	0.18	0.09	236.83	0.13	0.07
Middle	1196.30	0.78	0.26	1194	0.75	0.32
High	10050	0.69	0.29	781.1	0.53	0.23
Block groups divided by racial composition						
Black majority	145.83	0.09	0.07	159.05	0.10	0.09
White majority	1820.00	1.17	0.38	1597	1.00	0.36
No majority	712.10	0.55	0.28	796.4	0.57	0.34

Fewer trips in disadvantaged block groups for both systems.

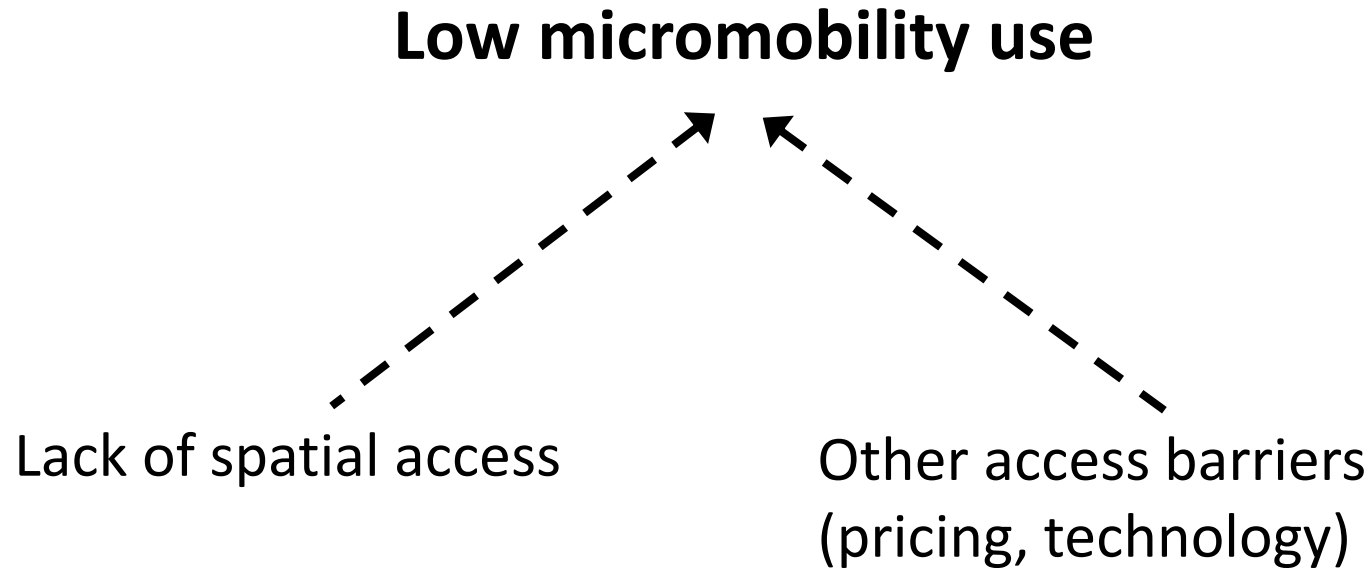
Low micromobility use and spatial access in disadvantaged neighborhoods.

Promote micromobility use by increase spatial access?

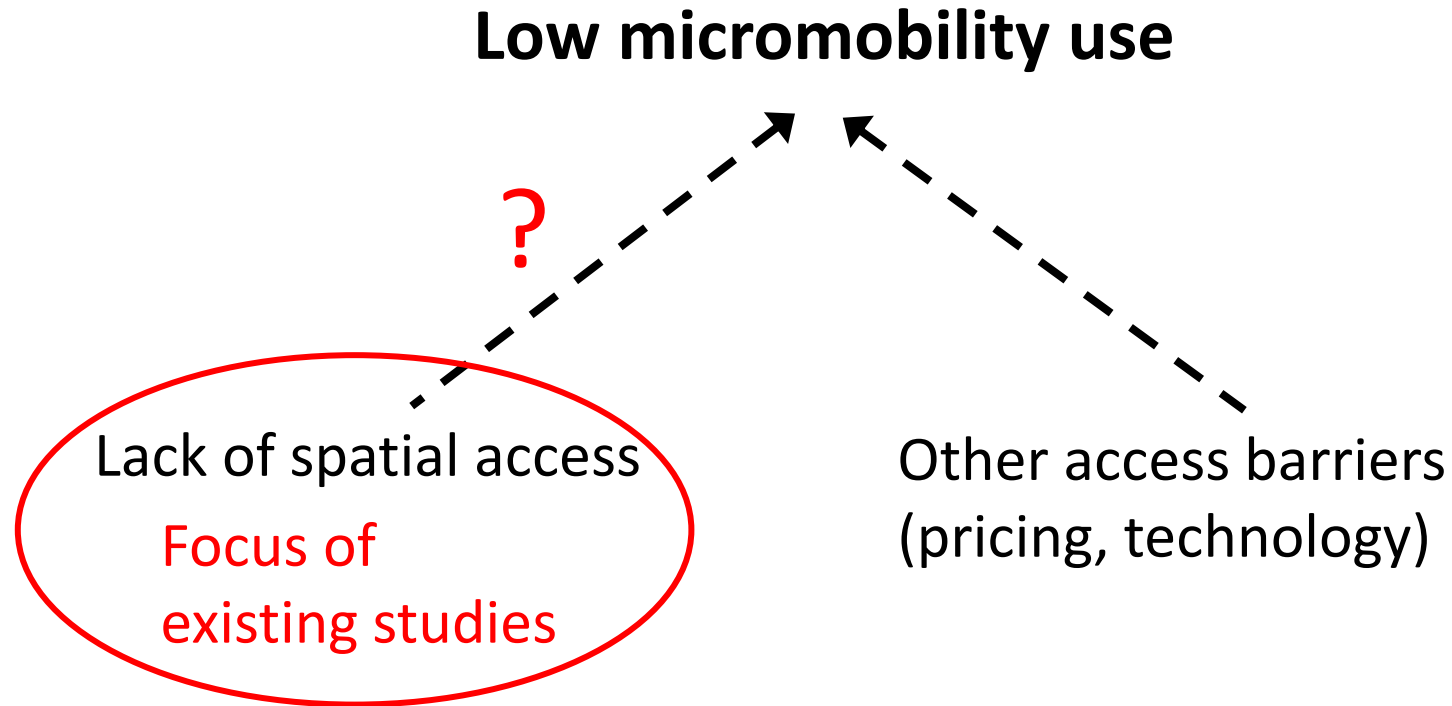


Existing studies have commonly made this assumption.

Will improve spatial access effectively promote micromobility use?



Will improve spatial access effectively promote micromobility use?



We measured idle time to shed light on this question.

Idle time of shared e-scooters and bikes

	E-scooter		Bikesharing	
	Median (hour)	Mean (hour)	Median (hour)	Mean (hour)
Block groups divided by EEA status				
EEA	3.9	5.1	1.9	3.3
Non-EEA	4.4	5.4	1.3	2.6
Block groups divided by household income				
Low	4.7	5.3	1.1	2.7
Middle	4.1	5.3	1.4	2.7
High	4.4	5.5	1.7	3.0
Block groups divided by racial composition				
Black majority	4.5	5.6	2.4	4.0
White majority	4.4	5.3	1.3	2.6
No majority	3.7	5.1	1.8	3.0

In EEA and Black-majority block groups, longer idle time for both shared e-scooters and bikes.

However, in low-income block groups, idle time of shared e-scooters and bikes is NOT longer.

Probably an outcome of micromobility equity policies!

Idle time of shared e-scooters and bikes

	E-scooter		Bikesharing	
	Median (hour)	Mean (hour)	Median (hour)	Mean (hour)
Block groups divided by EEA status				
EEA	3.9	5.1	1.9	3.3
Non-EEA	4.4	5.4	1.3	2.6
Block groups divided by household income				
Low	4.7	5.3	1.1	2.7
Middle	4.1	5.3	1.4	2.7
High	4.4	5.5	1.7	3.0
Block groups divided by racial composition				
Black majority	4.5	5.6	2.4	4.0
White majority	4.4	5.3	1.3	2.6
No majority	3.7	5.1	1.8	3.0

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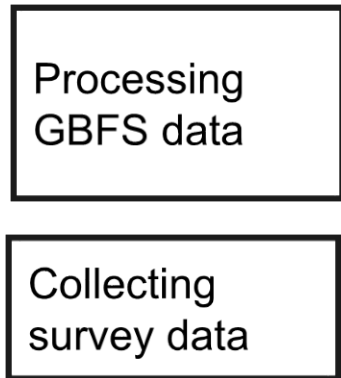
Bikeshare's equity program appears more effective than e-scooter's.

Summary of main findings

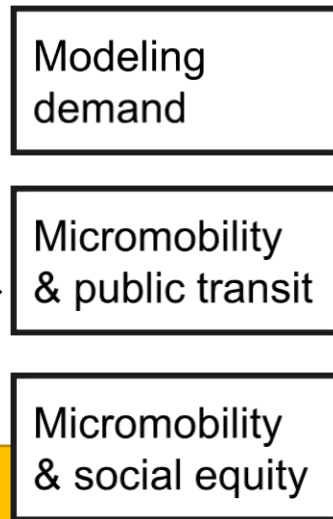
- E-scooter services increase access but widen spatial disparities.
- Low micromobility use results from not only a lack of spatial access but also other barriers (e.g., affordability and technology).
- Compared to e-scooters, bikeshare's equity program appears to be more effective.

Micromobility collaborative research program

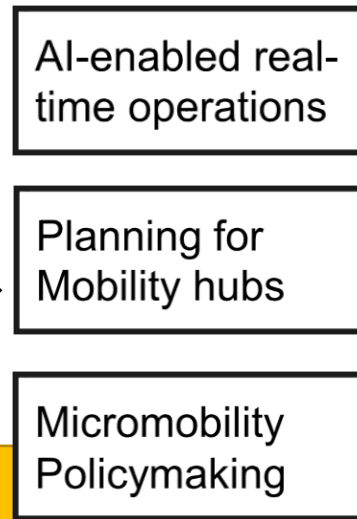
Data



Research areas



Policy/practice



Tech transfer



Collaborators



RESEARCH PROJECTS





Transportation Institute
UNIVERSITY of FLORIDA

Thank you for your
attention!

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