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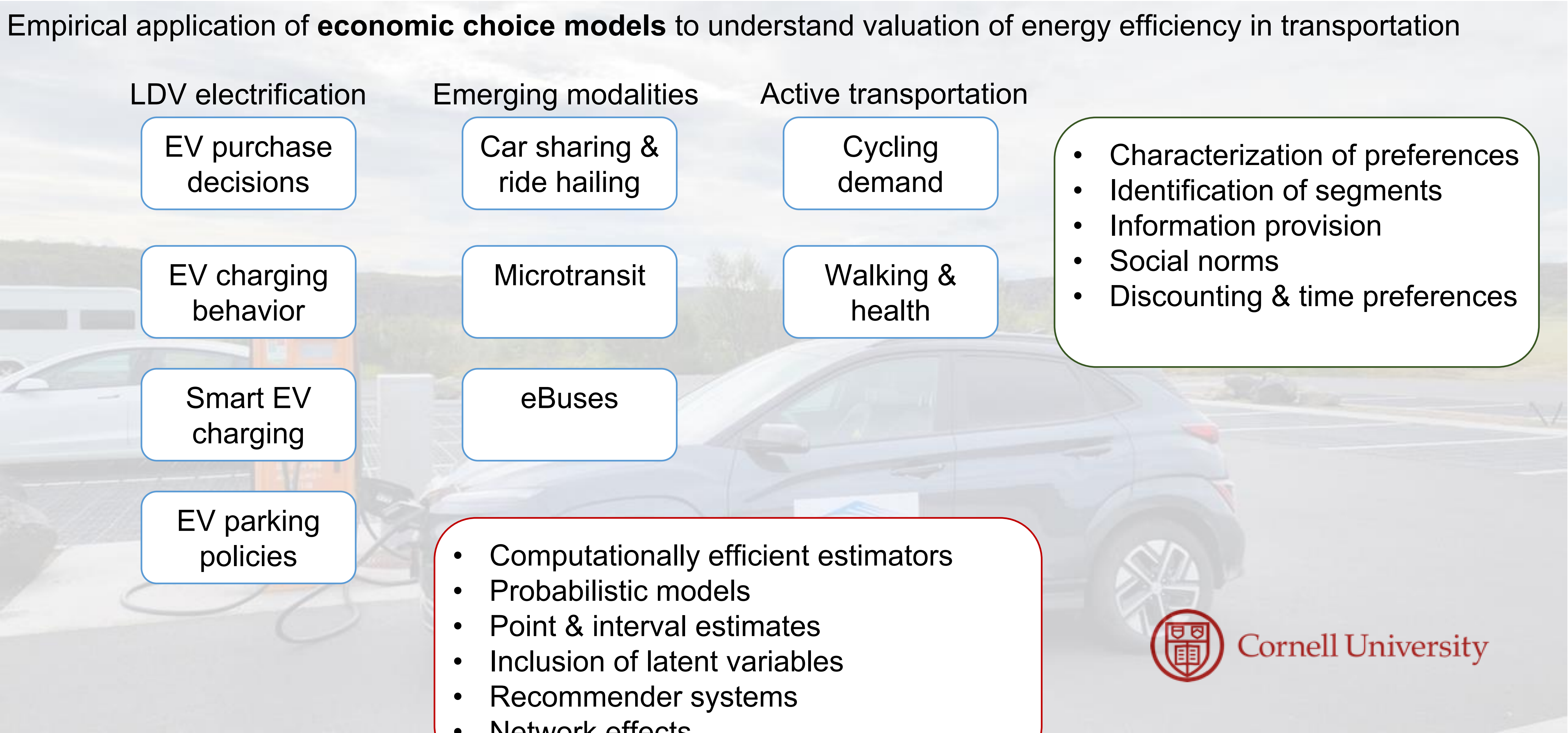
Demand response to decarbonization of transportation (& related research)

Ricardo A. Daziano, *choice modeler, holds a PhD in Economics from Université Laval and is an associate professor of Civil and Environmental Engineering and of Systems Engineering at Cornell University. He is a fellow of the Cornell Atkinson Center for Sustainability. His work focuses on estimation of microeconometric choice models, applied to better understand the interplay of consumer behavior with engineering, investment, and policy choices for energy-efficient technologies. In 2013, he received an NSF CAREER award.*

Demand response to decarbonization research

Empirical application of **economic choice models** to understand valuation of energy efficiency in transportation



LDV electrification
- EV purchase decisions
- EV charging behavior
- Smart EV charging
- EV parking policies

Emerging modalities
- Car sharing & ride hailing
- Microtransit
- eBuses

Active transportation
- Cycling demand
- Walking & health

- Characterization of preferences
- Identification of segments
- Information provision
- Social norms
- Discounting & time preferences

- Computationally efficient estimators
- Probabilistic models
- Point & interval estimates
- Inclusion of latent variables
- Recommender systems
- Network effects

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Adoption of electric buses in Rome

Electric buses (e-buses) are rapidly becoming pivotal for the widespread adoption of clean technologies in road transport

- European Commission has proposed to make all new city buses zero-emission as of 2030
- 411 battery electric buses expected to be introduced in Rome (110 starting operation around the end of 2024)
- By 2028 whole fleet expected to be low or zero-emission
- Research question: will e-buses attract new users?
- Online survey of 600 commuters in Rome to understand preferences

Electric buses in Santiago

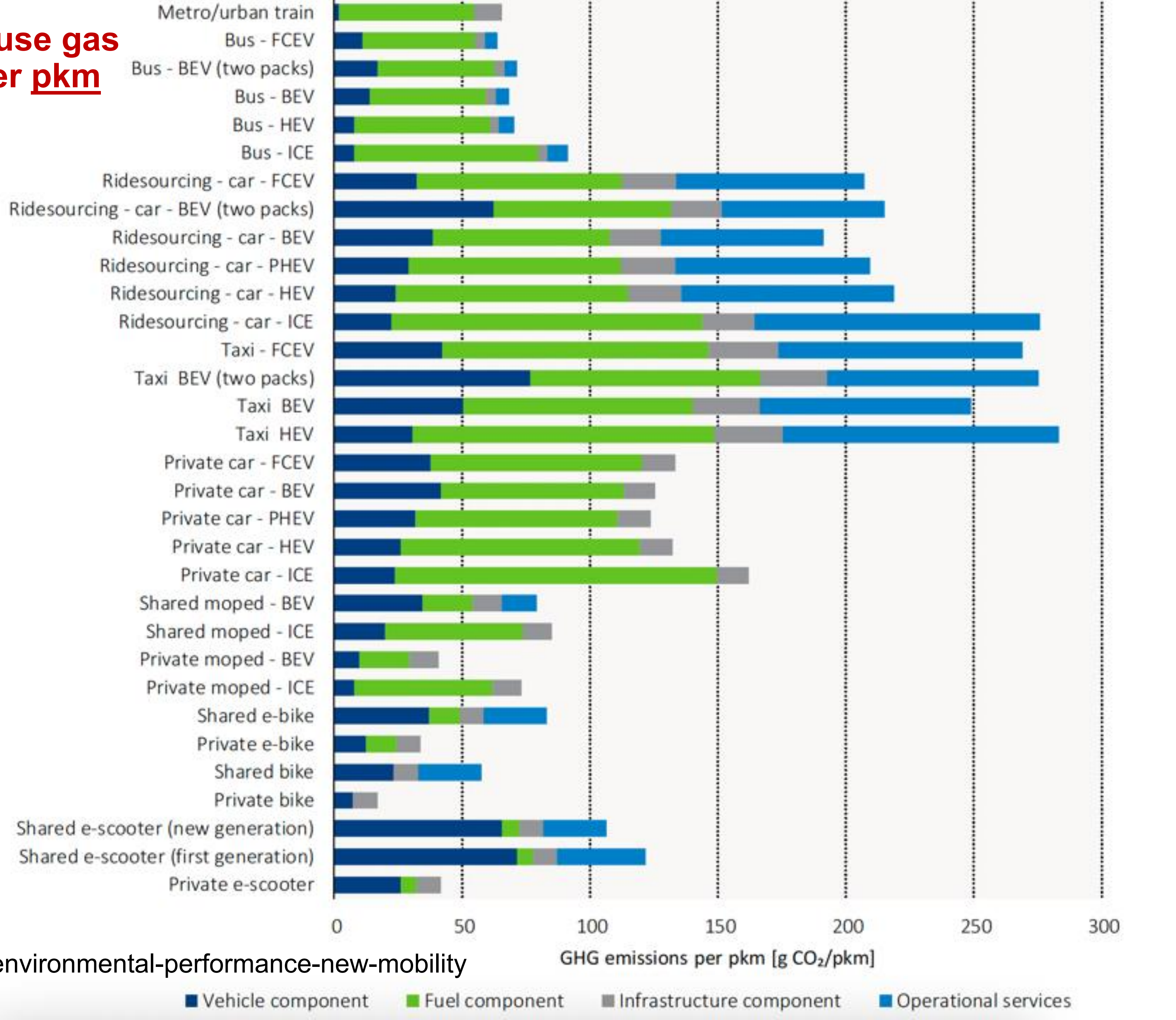
31% of buses already electric –100% electrification by 2035

- Second largest electric bus fleet in the world
- 60% of users and 75% of drivers report noise has decreased

Research project with Matías Navarro and Shanjun Li (Cornell): contractual incentives and strategic behavior in public transit provision

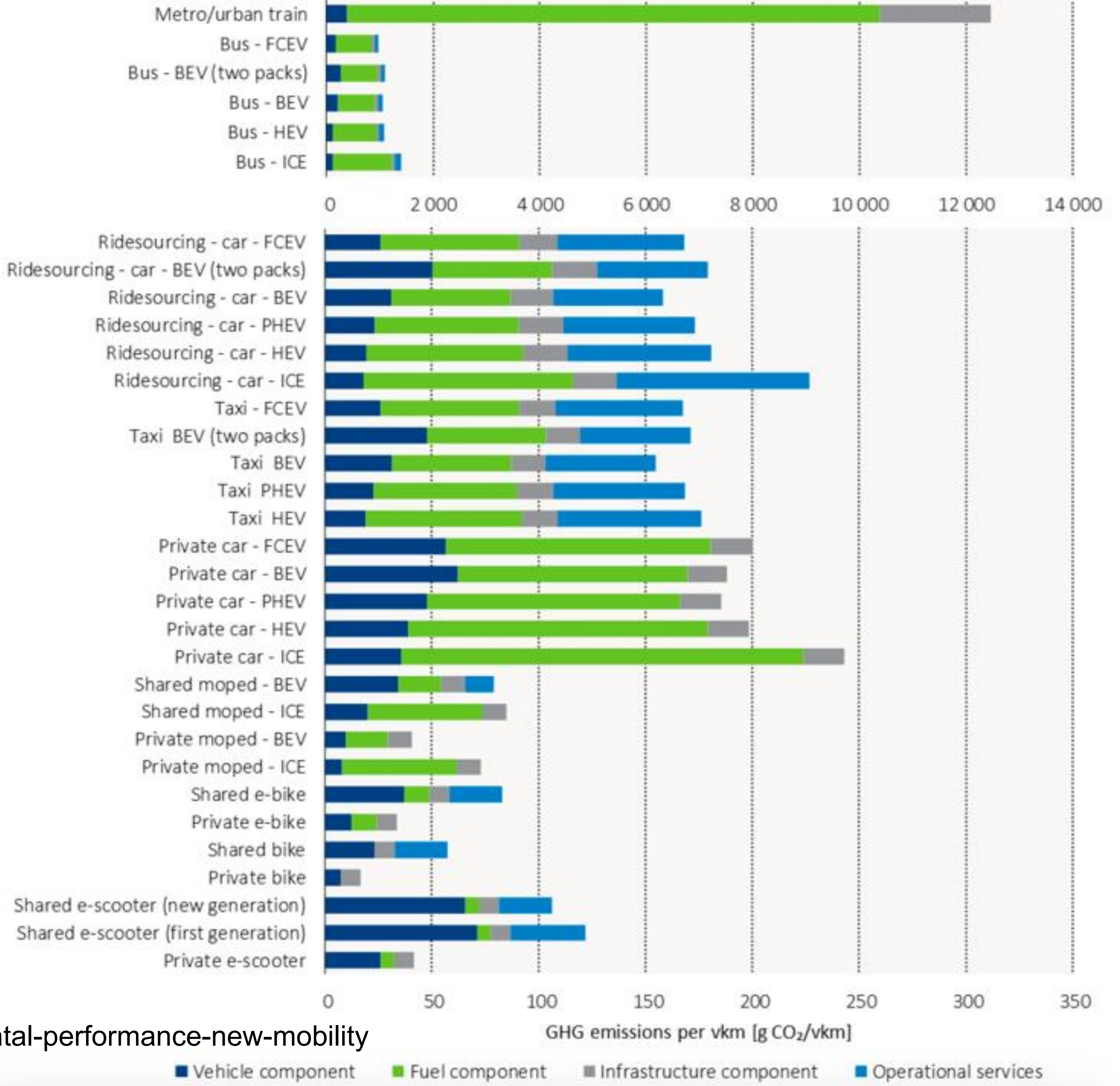
- Exploit changes in incentive contracts to study how private bus operators' strategic operational responses and electric bus adoption affect demand behavior in the short and long runs

Central estimates of life-cycle greenhouse gas emissions of urban transport modes per pkm



Source: https://www.itf-oecd.org/good-go-assessing-environmental-performance-new-mobility

Central estimates of life-cycle greenhouse gas emissions of urban transport modes per vkm



Source: https://www.itf-oecd.org/good-go-assessing-environmental-performance-new-mobility

Transit is almost always better than LDVs

Private cars over 2× the energy and greenhouse gas emissions per passenger-kilometer compared to buses and significantly more than any form of micromobility

- A standard 40-passenger diesel bus requires a minimum of **seven riders** to surpass the efficiency of a typical passenger vehicle
- Train cars must be at least **19% full** to outperform individual passenger LDVs in energy efficiency

Cities must **boost ridership** for **optimal emission reductions**

- But: risk of overcrowding
- Willingness to accept crowding given efficiency gains?

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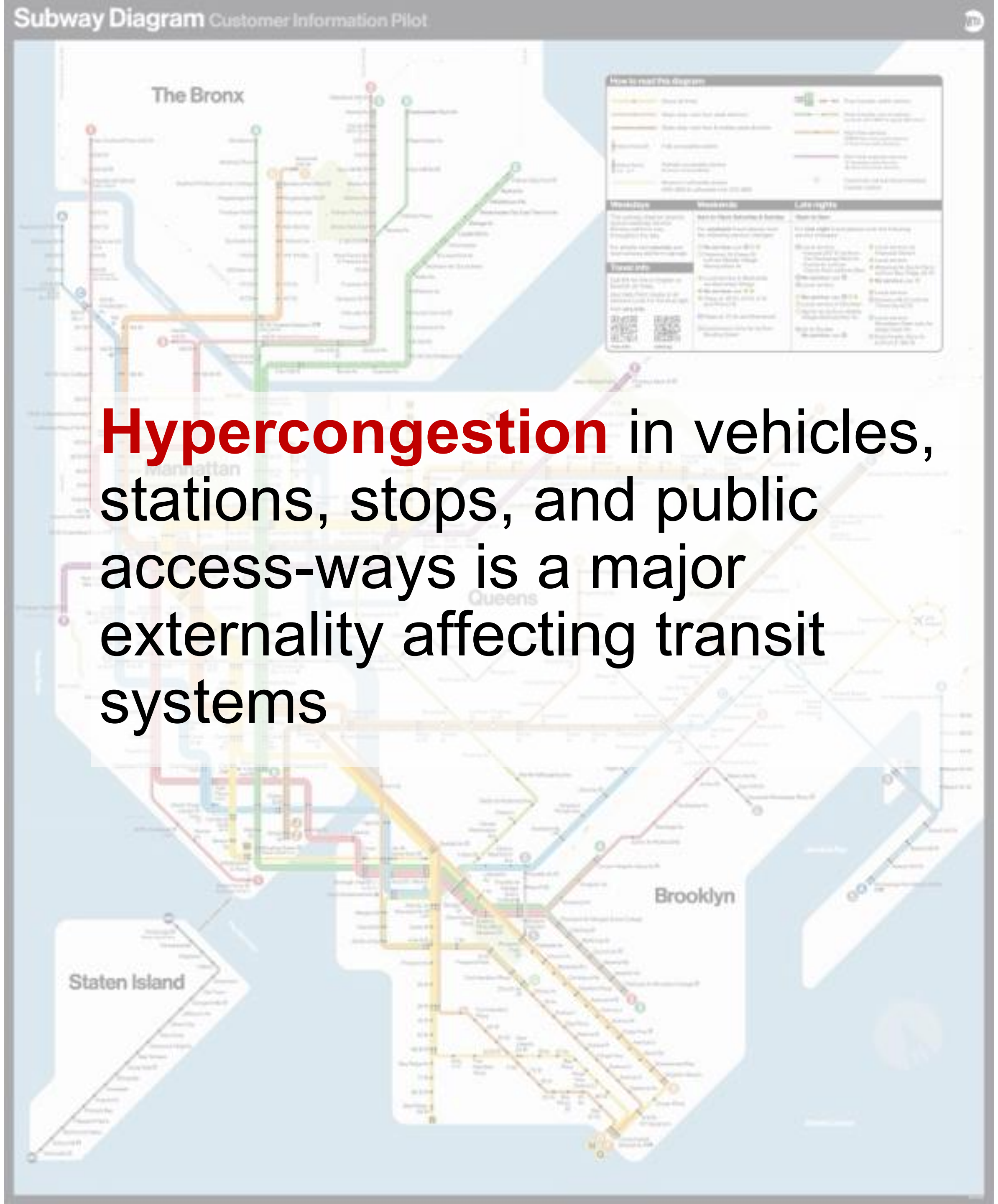


Hypercongestion in vehicles, stations, stops, and public access-ways is a major externality affecting transit systems

The New York Times

Surge in Ridership Pushes New York Subway to Limit

Give this article 590

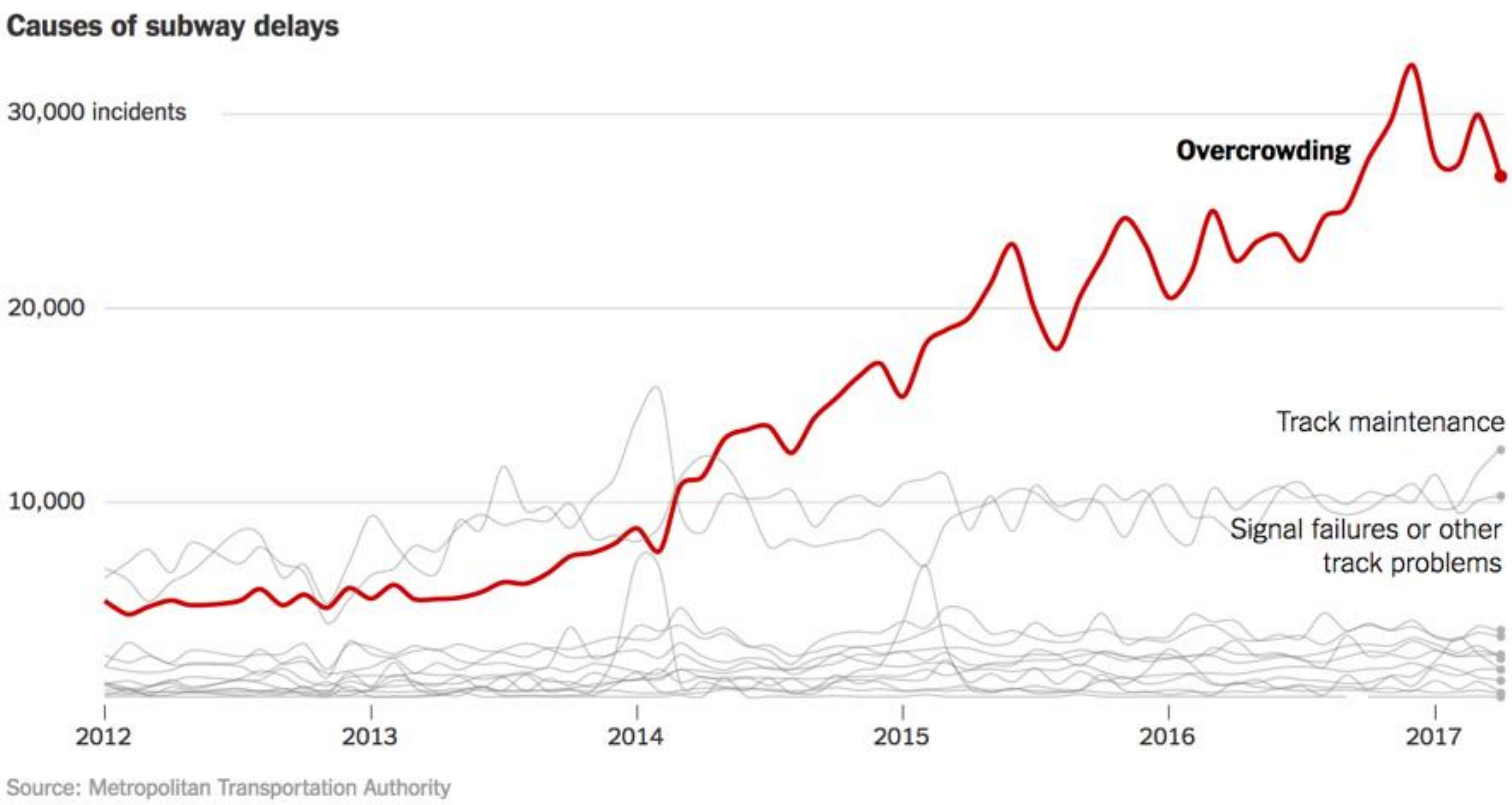
Riders waiting for the L train on a packed subway platform at Union Square in Manhattan last month. Subway use, now at nearly 1.8 billion rides a year, has not been this high in New York City since 1948. Sam Hodgson for The New York Times

By Emma G. Fitzsimmons

May 3, 2016

4 MIN READ

Delays: major externality from subway overcrowding



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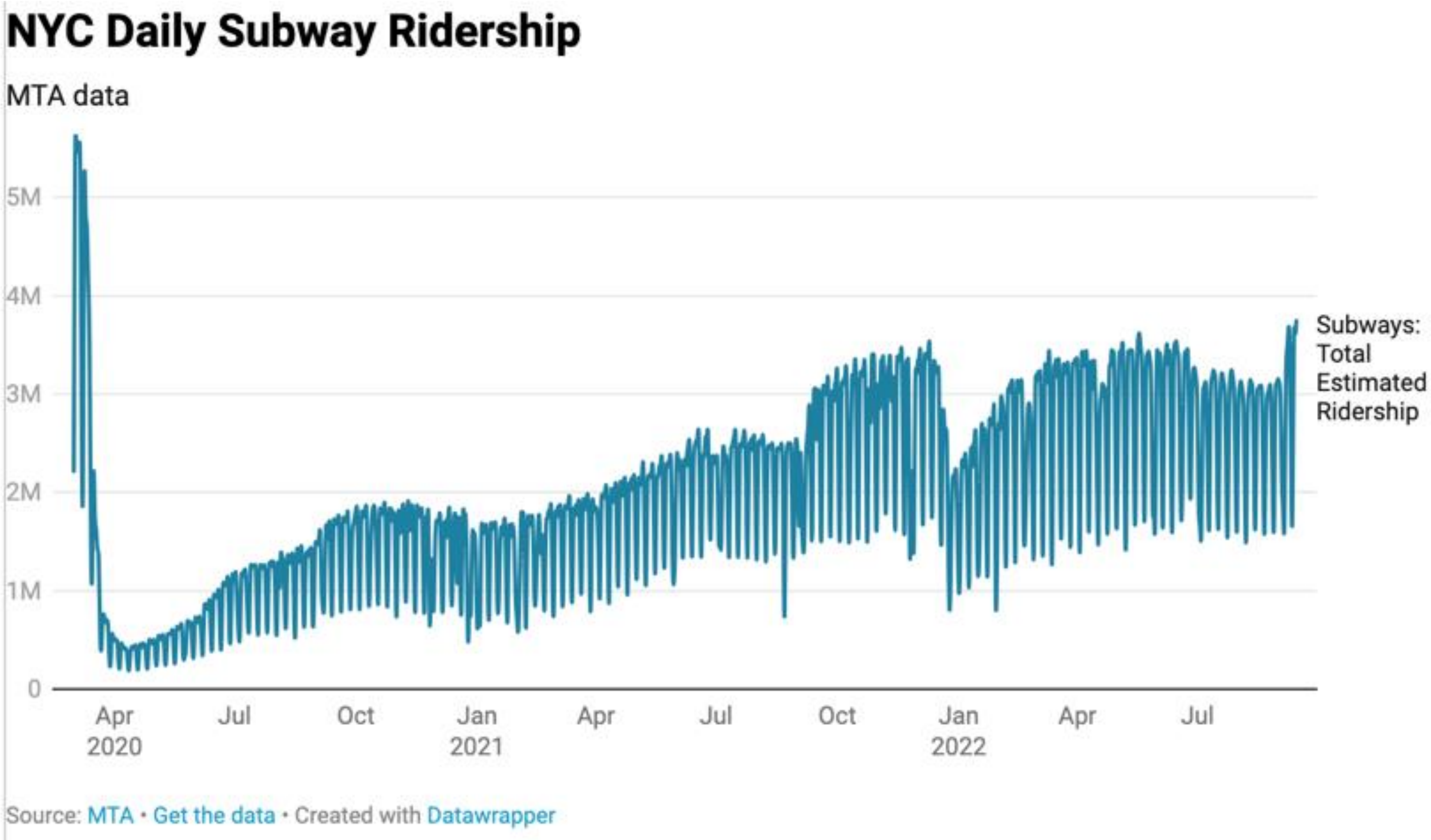

In 2019, the typical weekday subway load was 5.5M

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Hypercongestion, reflected in overcrowding, has a direct impact on transit users' decisions leading to unexpected behavioral patterns in mode and route choices that are neglected in strategic models used for planning

Furthermore, demand and service shocks (general disruptions and hazards, social unrest, pandemics) lead to crowd avoidance behaviors that need better understanding and modeling

Open research question: effects on optimal pricing of transit (value of time affected by density – crowding multiplier)

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How I travelled (but added 30 mins to trip)

What I avoided

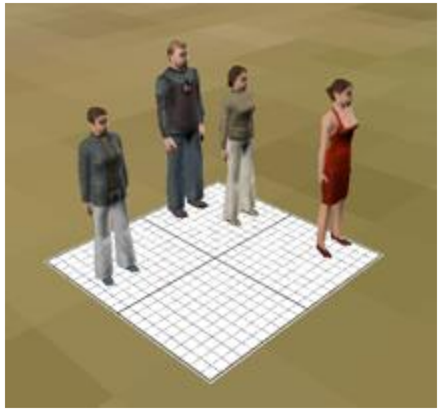
Time perceptions in transportation economics

Subjective time is measured by its **marginal disutility**

Travel choices are a function of subjective time, not objective time

Value of Time (VoT): marginal rate of substitution between travel time and cost

- VoT of on-trip time less than VoT of walking, waiting times
- Value of waiting time may be less than that of on-trip for TNCs



Passengers per square meter =

pass/m²

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(Before the pandemic)

Estimation of crowding multipliers (CM)

- Measurement of the impact of passenger density on the value of travel time savings
- No official US estimates: MTA uses London values

Crowding Level	Density Equivalent	Diagram
1	0 standees	
2	1 pax/m^2	
3	2 pax/m^2	
4	4 pax/m^2	
5	6 pax/m^2 (Technical Capacity)	

ELSEVIER

Journal of Choice Modelling

Volume 31, June 2019, Pages 124-140

Flexible estimates of heterogeneity in crowding valuation in the New York City subway

Prateek Bansal [a], Ricardo Hurtubia [b], Alejandro Tirachini [c], Ricardo A. Daziano [a]

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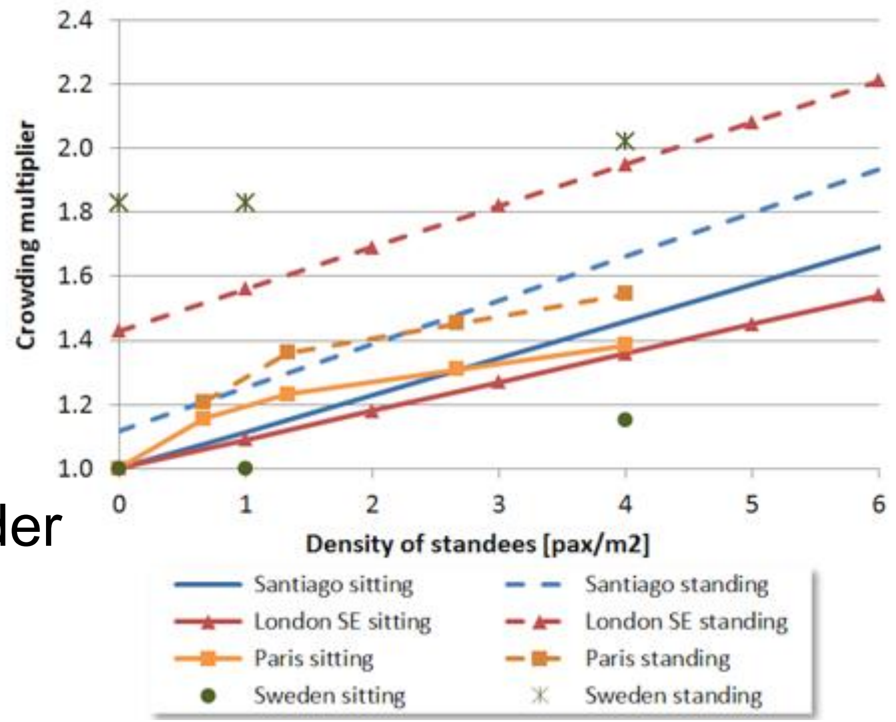
Crowding multipliers stylized facts



Conditional logit

- CM is higher if the passenger is standing
- CM of **2.65** at technical capacity (6 pax/m^2), for a standing rider (vs. **2.13** when sitting)

  On average standing riders are willing to pay:

  $8.06 per hour at technical capacity vs $3.05 in non-crowded conditions

Semiparametrics (Logit with Dirichlet prior)

- Median estimates at technical capacity: **2.80-4.09** (standing); **2.11-3.25** (sitting)

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Virtual Reality
https://doi.org/10.1007/s10055-022-00713-8

ORIGINAL ARTICLE

Affective experience in a virtual crowd regulates perceived travel time

Saeedeh Sadeghi[1] · Ricardo Daziano[2] · So-Yeon Yoon[3] · Adam K. Anderson[1]

Received: 3 December 2021 / Accepted: 19 October 2022

Abstract

Time sometimes feels like it is flying by or slowing down. Previous research indicates objective number of items, subjective affect, and heart rate all can influence the experience of time. While these factors are usually tested in isolation with simple stimuli in the laboratory, here we examined them together in the ecological context of a virtual subway ride. We hypothesized that subjective affective experience associated with objective crowding lengthens subjective trip duration. Participants ($N=41$) experienced short (1–2 min) immersive virtual reality subway trips with different levels of public crowding. Consistent with the immersive nature of decreased interpersonal virtual space, increased crowding decreased pleasantness and increased the unpleasantness of a trip. Virtual crowding also lengthened perceived trip duration. The presence of one additional person per square meter of the train significantly increased perceived travel time by an average of 1.8 s. Degree of pleasant relative to unpleasant affect mediated why crowded trips felt longer. Independently of crowding and affect, heart rate changes were related to experienced trip time. These results demonstrate socioemotional regulation of the experience of time and that effects of social crowding on perception and affect can be reliably created during a solitary virtual experience. This study demonstrates a novel use of Virtual Reality technology for testing psychological theories in ecologically valid and highly controlled settings.

Keywords Time perception · Crowding · Virtual reality · Emotion · Heart rate

In-lab VR experience

Results showed that crowding level inside the subway car had a significant effect on one’s perception of travel time:

one additional passenger per m^2 on average increased perceived duration of a **1-minute trip** by around **1.8 seconds**

This effect was explained by **subjective feelings**

- Increased virtual crowding made a trip feel longer and more unpleasant
- It was this latter subjective feeling that mediated the former effect of crowding on time perception: A more crowded trip was perceived longer to the extent that it induced negative feelings

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Dynamic environments as a **primer** to traditional surveys

- Demand for shared modalities affected by crowd aversion?

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Crowding multipliers on shared transportation in New York City: The effects of COVID-19 and implications for a sustainable future

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Value of time on microtransit

	Subway	Uber	Microtransit
Price	$2.75	$25.00	$10.00
Time	20 min.	28 min.	45 min.
Other passengers	Not very crowded	0	4
Masked passengers	Everyone	0	3
Excelsior pass req.	No	Yes	Yes

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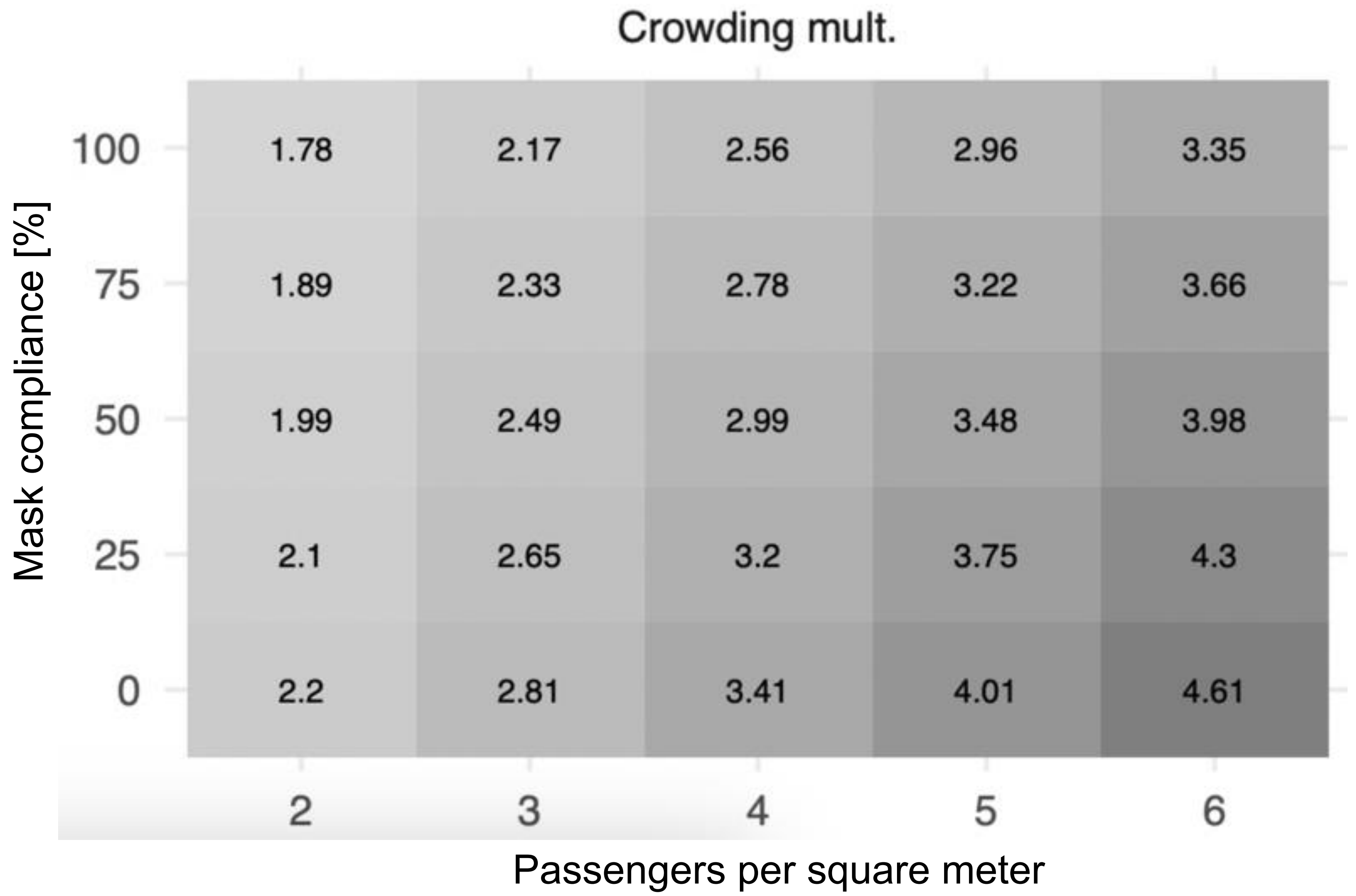
Subway crowding multipliers as a function of mask compliance



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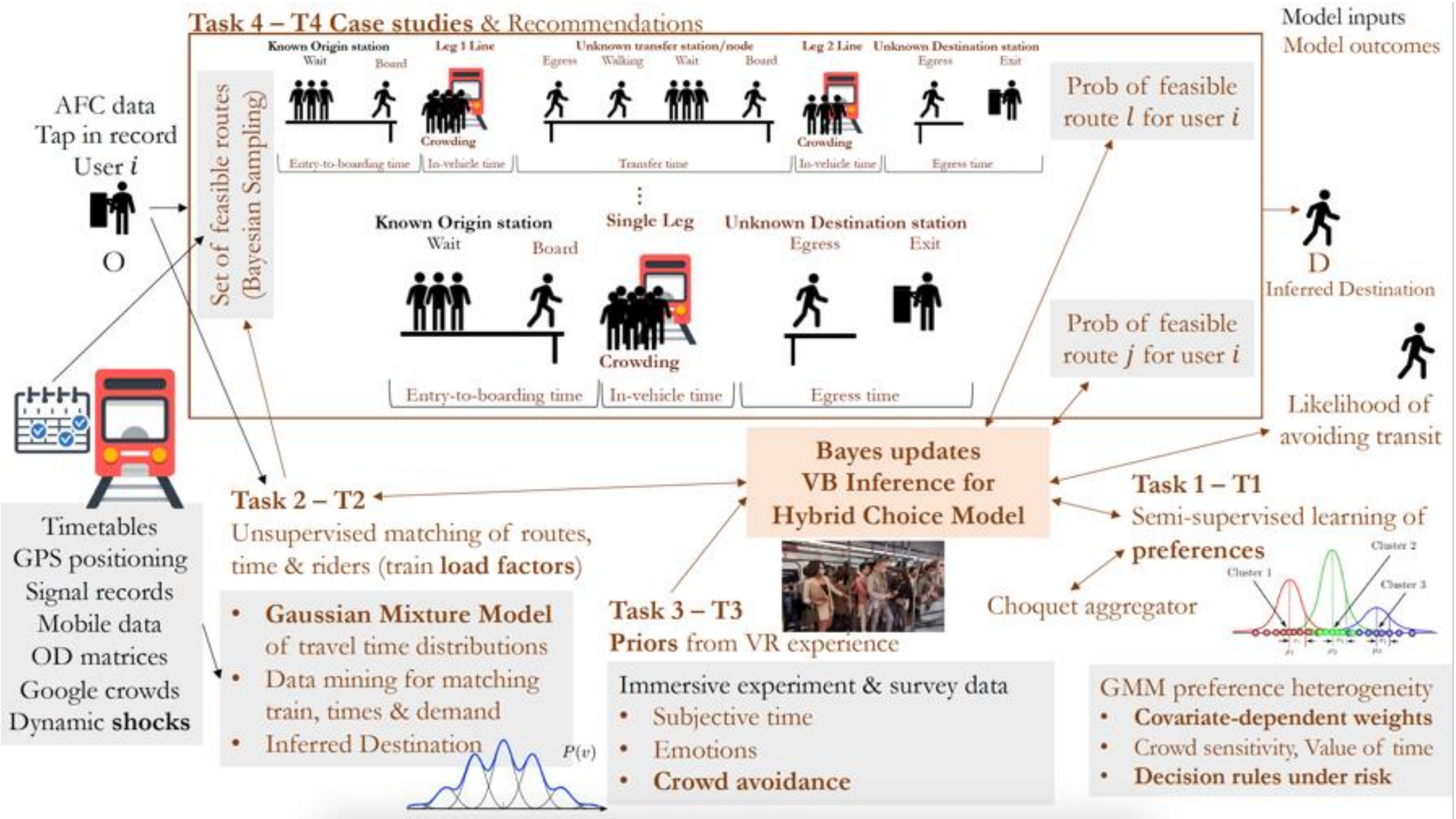
Future research




Thank you!
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