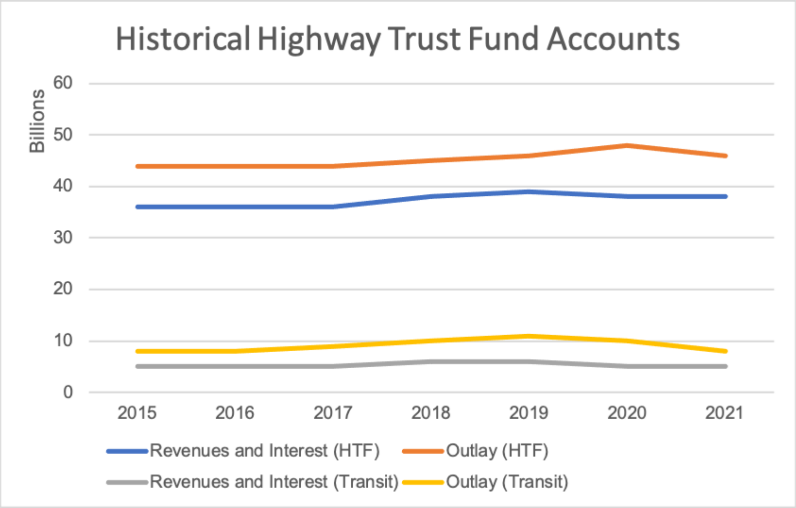
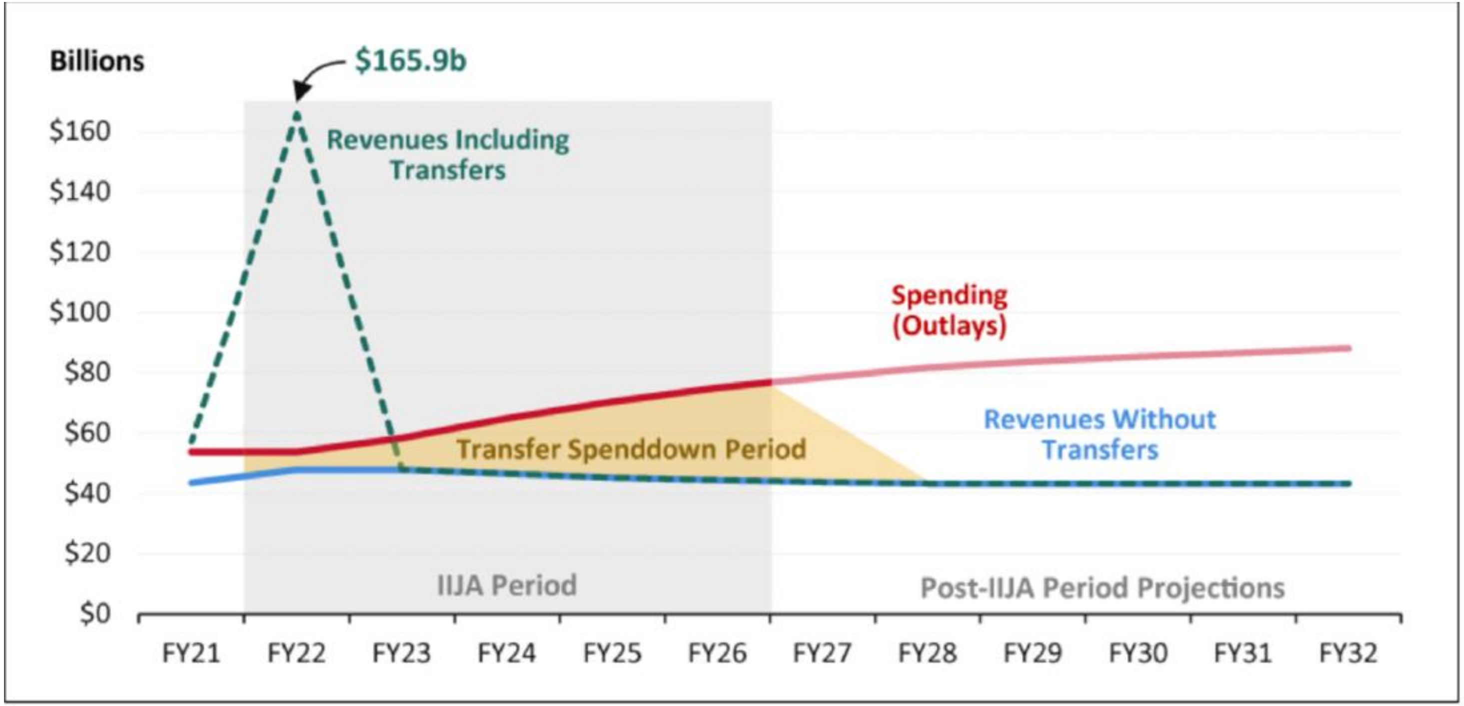
# The Inadequacy of the gas tax & Highway Trust Fund

Historical Highway Trust Fund Accounts



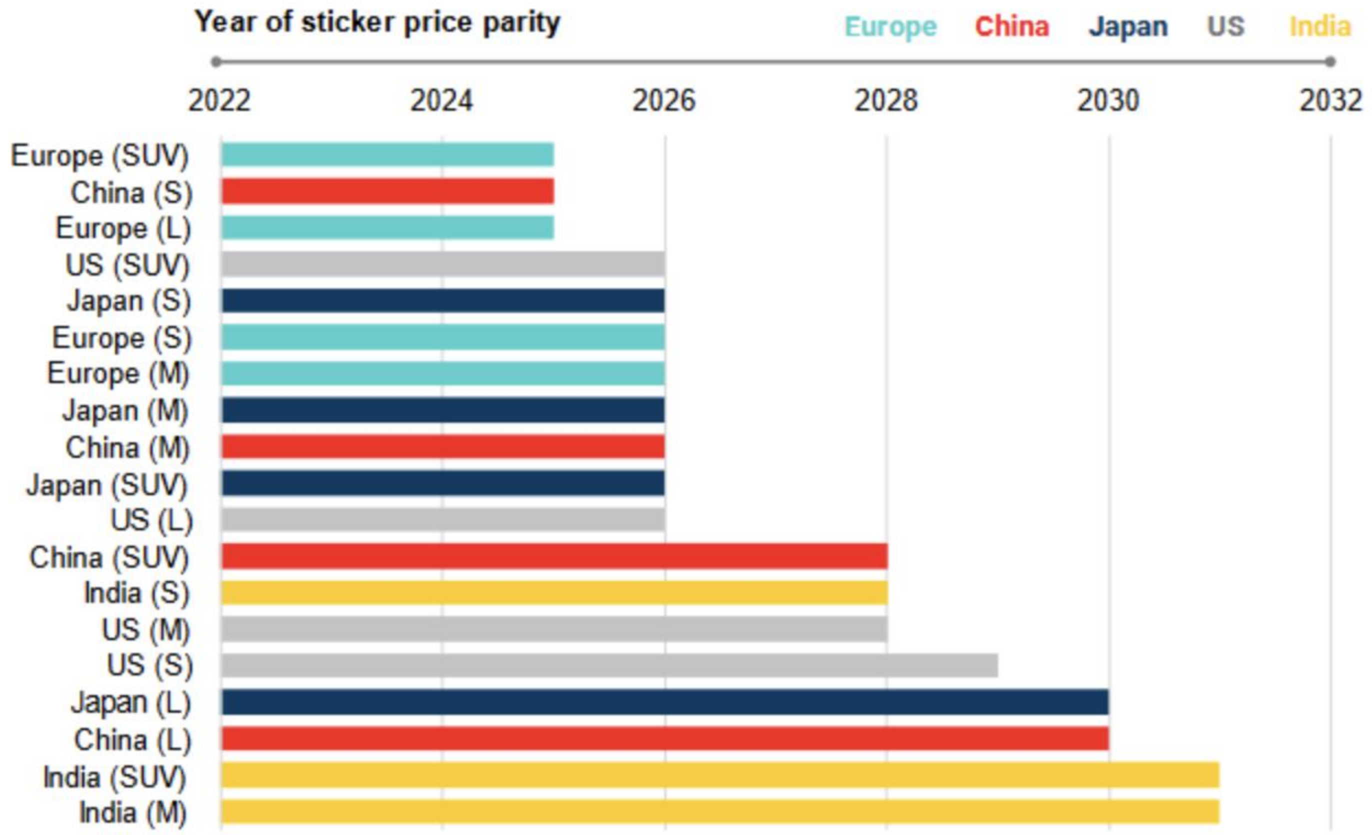

**Highway Trust Fund revenues and interest have been insufficient to pay for outlays from the fund**

Source: Congressional Budget Office 2020. Highway Trust Fund Accounts. https://www.cbo.gov/data/baseline-projections-selected-programs#8




**Source:** Figure created by CRS based on CBO, *Highway Trust Fund Projections: May 2023 HTF Baseline 2022-2033*. Data for FY2021 and FY2022 are actual revenues and outlays.

## *Figure 8: Date of sticker price parity in key markets*




**Source:** BNEF. Note: S = small, M = medium, L = large, SUV = sports utility vehicle

# EV Registration Fees

| State | Average annual gas taxes paid per vehicle | Annual EV registration fees |
|---|---|---|
| Alabama | $247 | $200 EV/$100 PHEV |
| Alaska | $142 | |
| Arizona | $194 | |
| Arkansas | $224 | $200 EV/$100 HEV |
| California | $433 | $100 EV (increase in accordance with the consumer price index) |
| Colorado | $216 | $50 EV/$50 PHEV |
| Connecticut | $225 | |
| Delaware | $215 | |
| District of Columbia | $271 | |
| Florida | $280 | |
| Georgia | $250 | $212.78 EV |
| Hawaii | $191 | $50 EV and PHEV and HEV |
| Idaho | $267 | $140 EV/$75 PHEV |
| Illinois | $424 | $100 EV |
| Indiana | $423 | $150 EV/$50 PHEV and HEV |
| Iowa | $251 | $130 EV/$65 PHEV |
| Kansas | $225 | $100 EV/$50 PHEV and HEV |
| Kentucky | $230 | |
| Louisiana | $204 | $110 EV/$60 HEV |
| Maine | $258 | |
| Maryland | $318 | |
| Massachusetts | $235 | |
| Michigan | $364 | $135 EV up to 8,000 lb; $235 EV over 8,000 lb; $47.50 HEV up to 8,000 lb; $117.50 HEV over 8,000 lb |
| Minnesota | $244 | $75 EV |
| Mississippi | $191 | $150 EV/$75 HEV |
| Missouri | $212 | $75 EV/$37.50 PHEV |
| Montana | $271 | |
| Nebraska | $229 | $75 EV |
| Nevada | $219 | |
| New Hampshire | $219 | |
| New Jersey | $316 | |
| New Mexico | $193 | |
| New York | $187 | |
| North Carolina | $297 | $130 EV |
| North Dakota | $215 | $120 EV/$50 PHEV |
| Ohio | $295 | $200 EV and PHEV/$100 HEV |
| Oklahoma | $199 | $110 EV/$82 PHEV, up to 6,000 lbs; $158 EV/$118 PHEV, 6,000 – 10,000 lbs; $363 EV/$272 PHEV, 10,000 – 26,000 lbs; $2250 EV/$1687 PHEV, over 26,000 lbs |
| Oregon | $293 | $110 EV |
| Pennsylvania | $400 | |
| Rhode Island | $278 | |
| South Carolina | $245 | $120 biennial fee EV/$60 biennial fee HEV |
| South Dakota | $251 | $50 EV |
| Tennessee | $238 | $100 EV |
| Texas | $199 | |
| Utah | $264 | $90 EV/$15 HEV/$39 PHEV |
| Vermont | $287 | |
| Virginia | $286 | $64 EV |
| Washington | $367 | $225 EV/$75 PHEV and HEV |
| West Virginia | $281 | $200 EV/$100 PHEV |
| Wisconsin | $266 | $100 EV/$75 HEV |
| Wyoming | $220 | $50 EV annual |

Note: The average annual gas taxes paid per vehicle is calculated based on a vehicle with an average fuel economy of 22.2 mpg driven 11,520 miles in 2019. Gas taxes include federal and state gasoline tax, along with other per-gallon fees, such as leaking underground storage tank fees in July 2022.

# Our framework: what are the policy objectives?

## Possible policy goals

Dollar-for-dollar replacement of gas tax

Dollar-for-dollar replacement + new revenue to fill funding gaps

Dollar-for-dollar replacement + pricing to address traffic congestion

Dollar-for-dollar replacement + new revenue to fund sustainable non-auto transport projects

Annual cost of the vehicle economy in Massachusetts

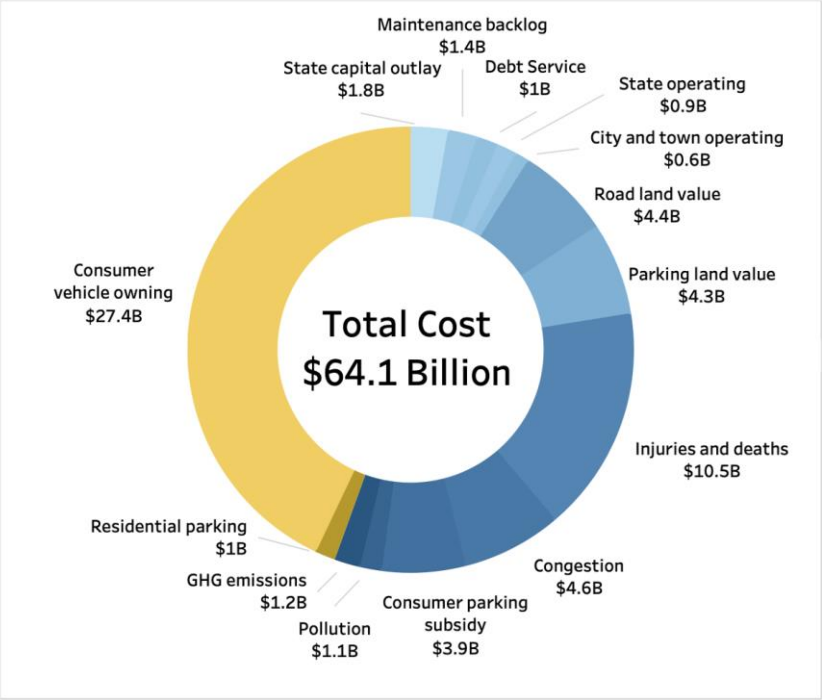



Chart source: Olson et al., "The $64 Billion Massachusetts Vehicle Economy," Harvard Kennedy School faculty working paper, 2019.

# Our framework: what are the sources?

Transportation sources or non?

Non transport sector sources like the sales tax or income tax are highly unpopular politically & place the transport sector in competition with other worthy governmental & societal needs.

## Possible transport sector revenue sources

Assess ownership

- Fees scaled by weight
- Flat fees
  - Parking assessments

Assess use

- Vehicle miles traveled (VMT) charge
- Road pricing (conventional tolls and/or congestion charge)
- Tax electricity used for charging

# Summary of Alternatives Evaluation

| | Ease of administration | Potential for evasion | Stability over time | Fairness |
|---|---|---|---|---|
| ***Gas tax*** | *Easy* | *Low* | *Low* | *Medium* |
| **Flat fees** | Easy | Low | High | Low |
| **Parking pricing** | Easy | Medium | Medium | Medium |
| **VMT charge** | Medium | Medium | High | High |
| **Road pricing** | Medium | Low | Medium | Medium |
| **Charging tax** | Hard | High | High | Medium |

How does each implementation tool respond to key externalities of vehicular mobility?

# Why Model?

- Cannot look at variables independently
- Need a systems perspective on the impacts of:
  - Policy & Regulation
  - Consumer behaviour and choice
  - Industry Challenges & Preference
  - Environment
    - Not looking at battery minerals availability and emissions impact in this analysis
- Why didn't you use Excel?
  - Excel is the 2nd best tool for any analysis
  - Interdependency of variables makes it unsuitable for Excel
    - Circular reference error

# Overlying Assumptions & Simplifications

- Looking only at Light Duty Vehicles (LDVs) – 90% of US VMT
- Only looking at Gas vehicles – no diesel (3.7% of LDVs), fuel cell etc.
- US LDV Fleet – 266 million
  - New sales annually – 16.68M
  - 28% of new car buyers are first car buyers
    - Not replacing a car
- 6% of new car sales assumed to be BEV currently
- 100% BEV new car sale Mandate – 2035 – can be edited on the fly
- 17-year average life of an LDV in the US
- Avg ICE Car weight = 4094 pounds, EV Car = 5094 pounds

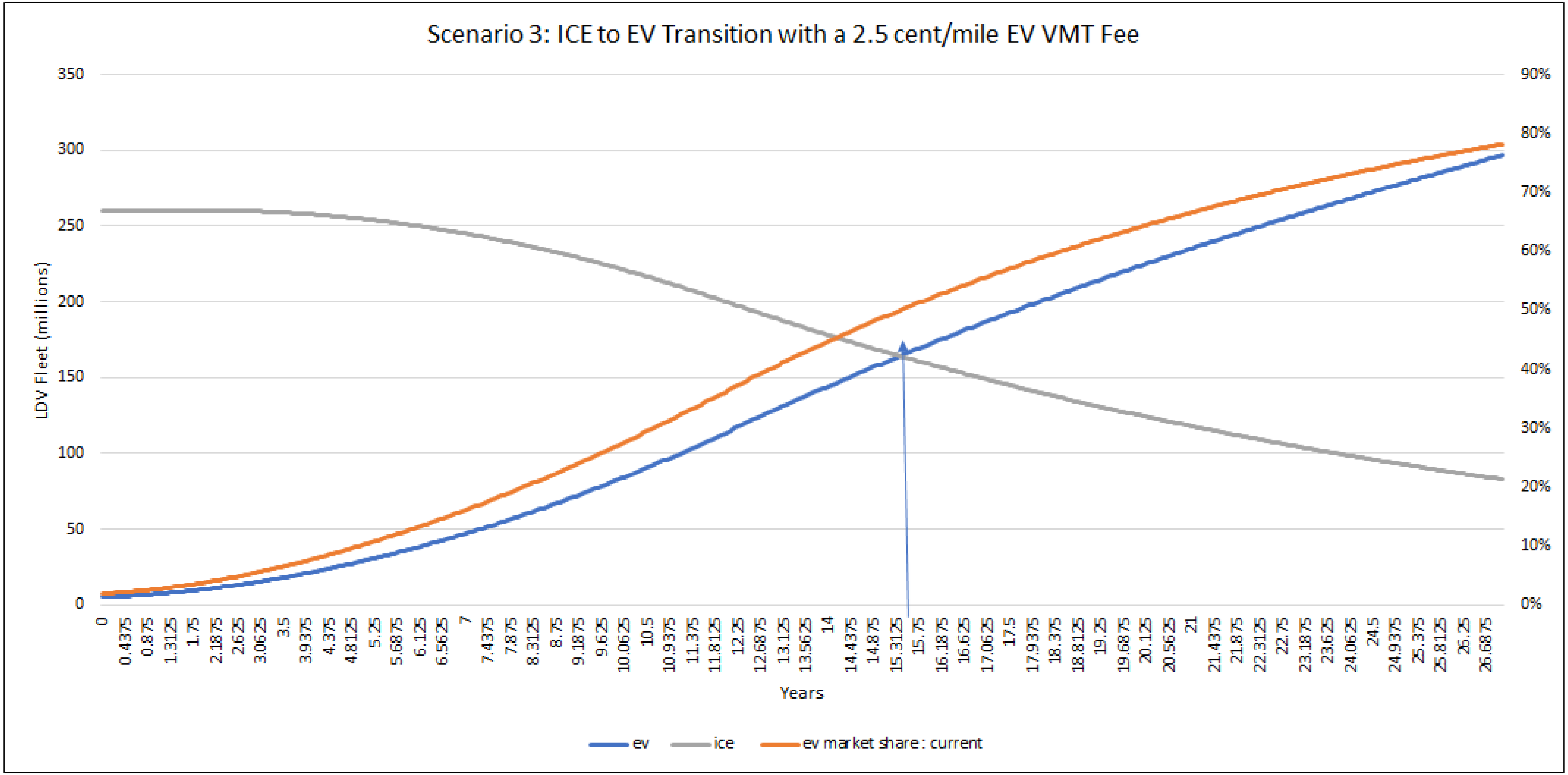
# Overlying Assumptions & Simplifications

- 13,475 miles driven on average annually – can be edited on the fly
- 22.8 mpg current LDV efficiency – CAFÉ standards can be edited, and fuel efficiency trends can be changed on the fly
- Federal + state gax tax collection used for deficit calculations = $105B ($90B for LDVs)
  - Can be edited to model different states
- Volume weighted average of state gas taxes is added to the 18.4 cents per gallon federal gas tax to give a total of 57.09 cents per gallon
  - Can be edited to model different states
- $331.4 Average annual federal + state gas tax paid per LDV per year
  - 2.5 cents per mile
- Year 1 is 2023 and the simulation runs till 2050

# What does the model tell us?

- Under most scenarios it takes 14-17 years for the EV fleet market share to cross 50%
  - Most of this is driven by the 2035 mandate
  - Can be even slower (maybe faster?)
- Reducing ICE vehicles and increasing fuel efficiency standards means the gas tax collection will fall by half in 14-17 years
  - Land at between 20-30% of current collections by 2050
- 2.9 cent/mile VMT fee and weight-based fees are the most promising measure to counter this fall.

# LDV Fleet Transition to EVs is Slow - https://web.mit.edu/gastaxmodel/



# DEMAND-RESPONSIVE MICROTRANSIT

Alexandre Jacquillat

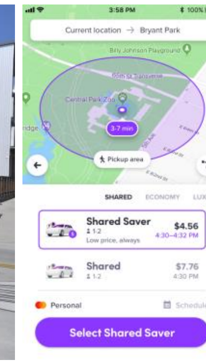
Associate Professor of Operations Research and Statistics

MIT Sloan School of Management

# A research agenda in large-scale optimization to promote efficient, reliable and sustainable mobility

## Air traffic management

## Demand-responsive transit

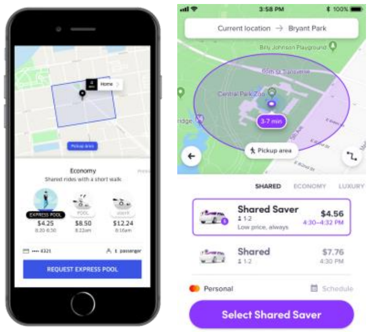



## Logistics decarbonization

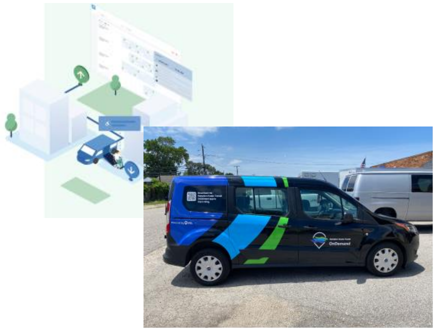

## Transportation for social good

# Analytics and optimization across demand-responsive microtransit landscape, in collaboration with Via

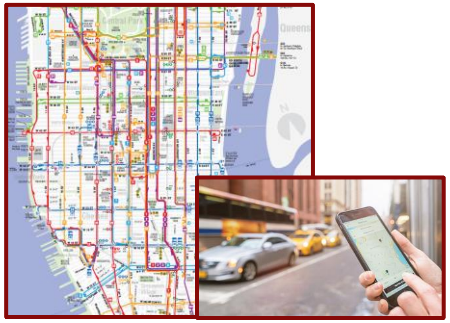
**Virtual bus stops**




**Paratransit**



**Microtransit**



**Multi-modality**

**Benefits of optimization to support emerging operating models**

**Benefits of even a little flexibility in demand-responsive operations**

**Win-win outcomes of demand-responsive operations: coverage, level of service, operating costs, and environmental footprint**

# Microtransit as an array of solutions in the mobility landscape from fixed-route transit to ride-sharing

The New York Times October 11, 2019

**Who's Afraid of a Transit Desert?**

CURBED June 4, 2021

**Why Your Uber Ride Is Suddenly Costing a Fortune**

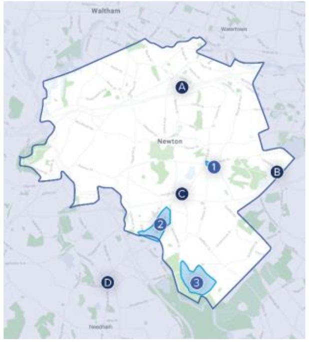



**"Shared transportation system(s) that can offer fixed routes and schedules, as well as flexible routes and on-demand scheduling" (DoT)**

# Core objective: bringing on-demand flexibility into the realm of transit, with limited detours and delays

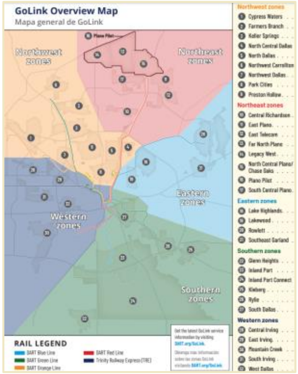
## Small-occupancy ride-pooling

## Small service region





## Zone-based regularization


## Line-based regularization


TRANSPORTATION SCIENCE
Vol. 40, No. 3, August 2006, pp. 351–363
ISSN 0041-1655 | EISSN 1526-5447 | 06 | 4003 | 0351
DOI 10.1287/trsc.1050.0137
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Performance and Design of Mobility Allowance Shuttle Transit Services: Bounds on the Maximum Longitudinal Velocity

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Daniel J. Epstein Department of Industrial and Systems Engineering, University of Southern California, Los Angeles, California 90089-0193 {quadrifo@usc.edu, rwhall@usc.edu, maged@usc.edu}

ELSEVIER
Transportation Research Part E: Logistics and Transportation Review
Volume 149, May 2021, 102331

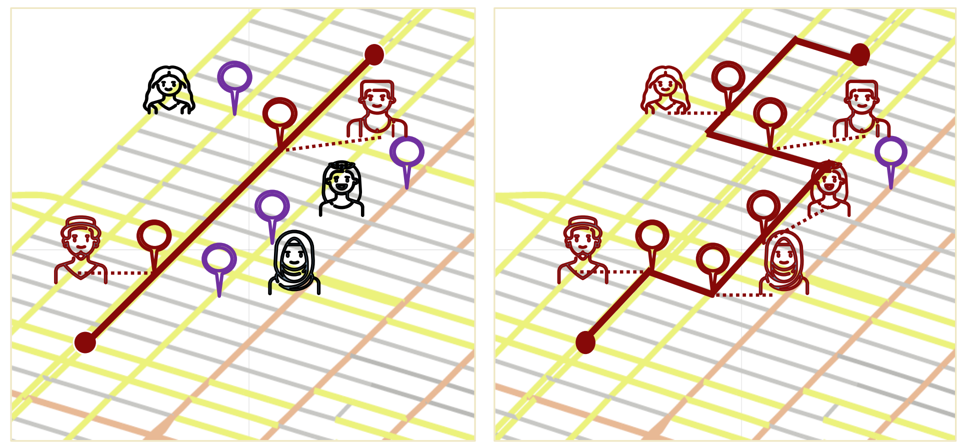
Improving flex-route transit services with modular autonomous vehicles

Xiaohan Liu [a], Xiaobo Qu [b], Xiaolei Ma [a c]

# This research: models and algorithms to optimize the design and operations of line-based microtransit

**Strategic optimization:**
**network and frequency planning**

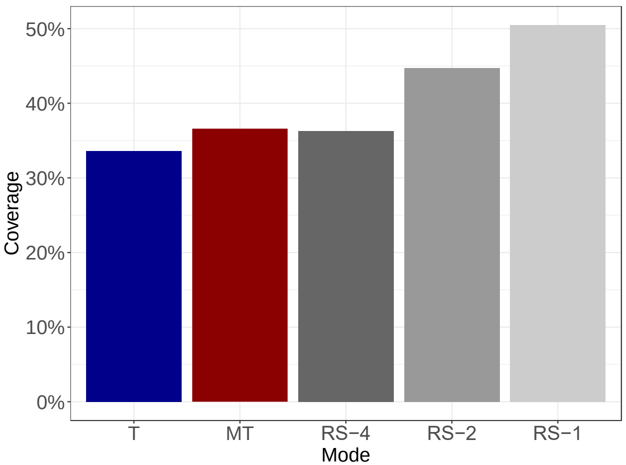
**Tactical optimization:**
**demand-responsive operations**



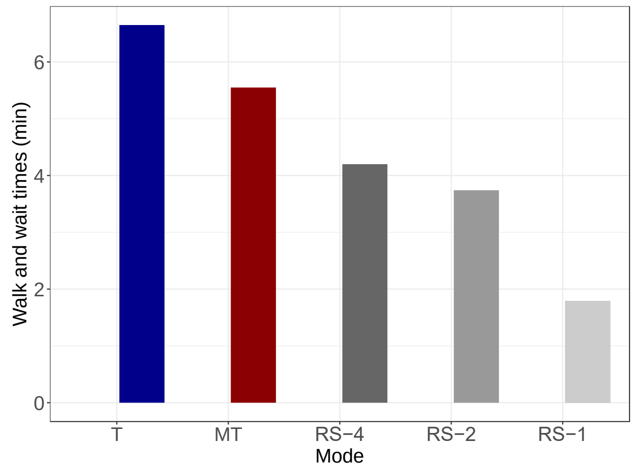
**How to design and operate emerging hybrid microtransit systems, enabled by mobility-as-a-service technology platforms?**

# Line-based microtransit defines a true middle ground between fixed-line transit and ride-sharing

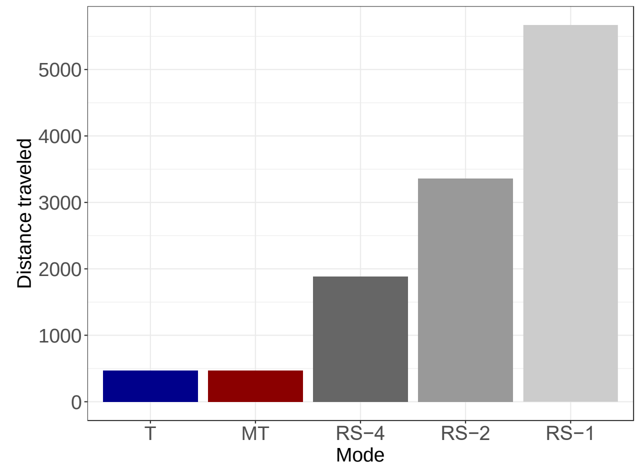
## Demand coverage




## Walk & Wait




## Distance traveled

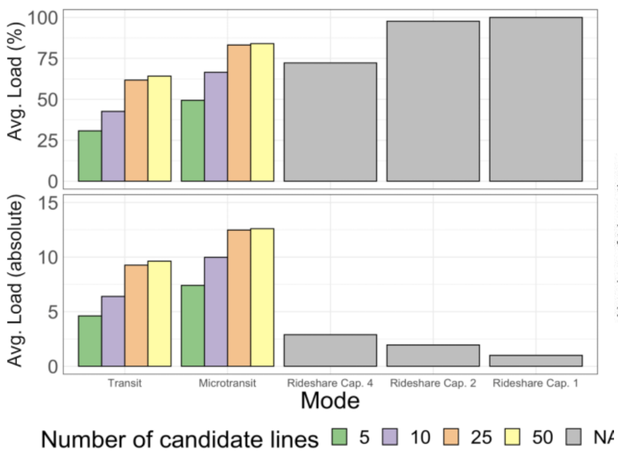


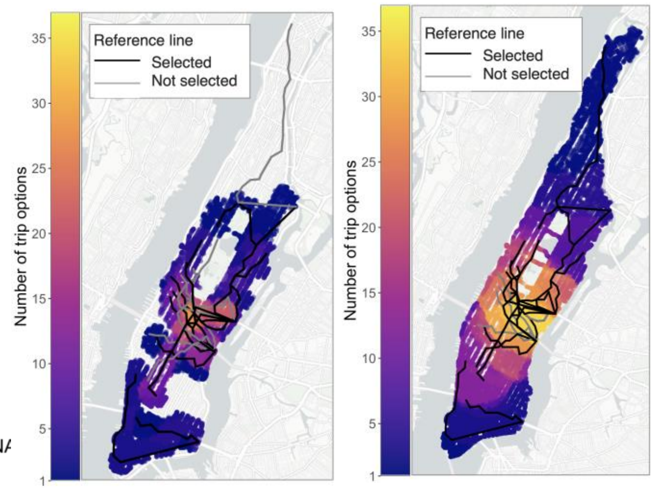

**Benefits of demand-responsive flexibility vs. fixed-line transit: less walk, shorter wait times, higher demand coverage**

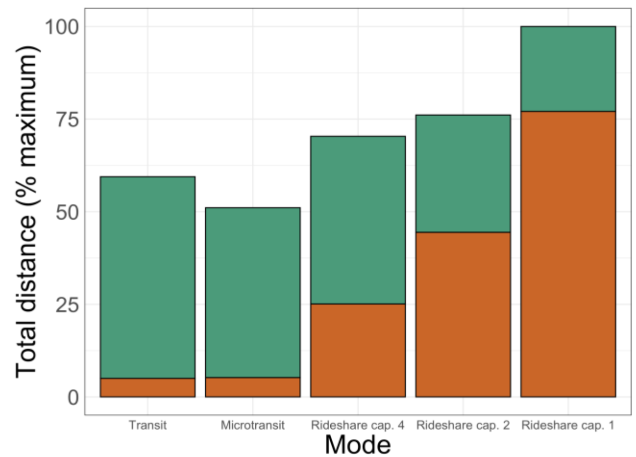
**Demand consolidation in high-occupancy vehicles vs. ride-sharing**

# Win-win-win outcomes of microtransit toward more efficient, equitable and sustainable urban mobility

| Efficiency | Equity | Sustainability |
|---|---|---|



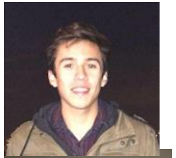

**Operating benefits: demand coverage, high vehicle loads**

**Impact on network planning: broader geographic reach**

**Consolidation: environmental footprint mitigation**

# Thank you!

# Flexibility & Coordination in On-Demand Mobility: From Micromobility to Ridehail

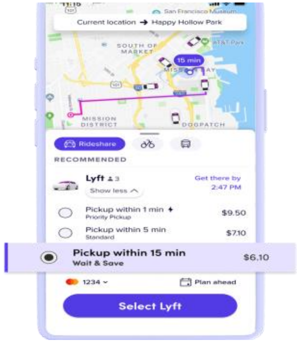


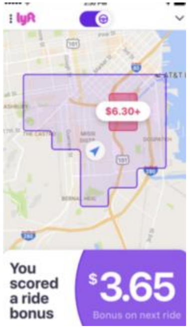


Daniel Freund

Assistant Professor of Operations Management

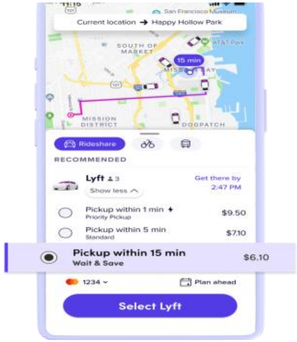
Sloan School of Management



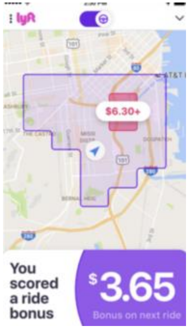





# Research Interests



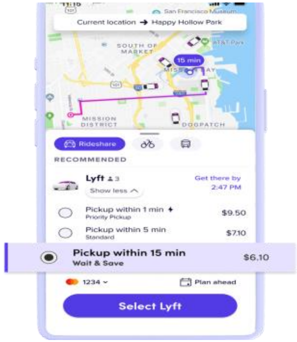

Exploiting flexibility in ride-hailing (*WP*)




Optimizing ride-hail driver incentives (*IJAA'20, OR'22*)

bike angels


Research Interests

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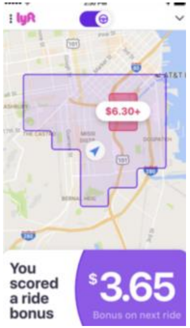


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Optimizing Bike-sharing station sizes (*OR,'22*)

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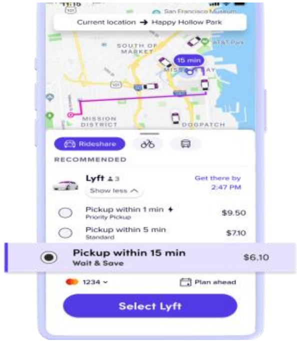


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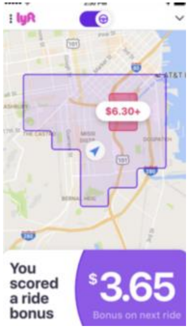


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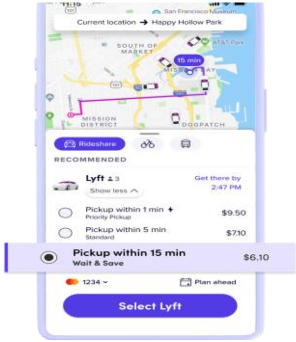


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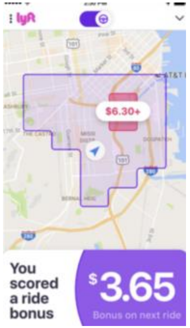


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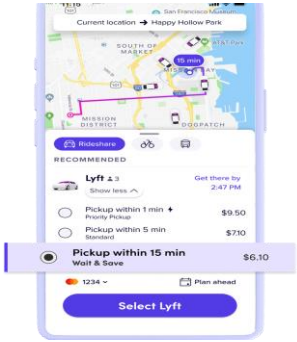
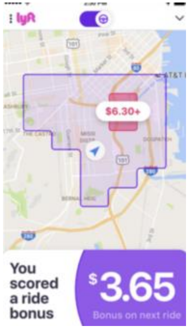
Optimal online resource allocation (*MOR'23, OR'23, MS'23*)

Research Interests




Exploiting *flexibility* in ride-hailing (*WP*)

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bike angels


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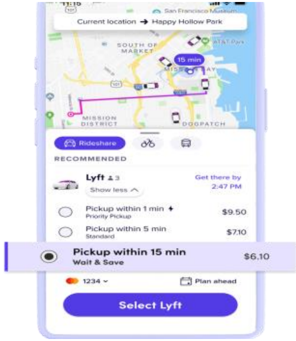


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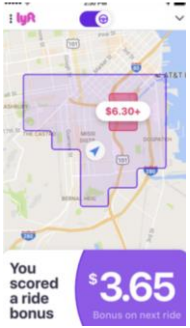


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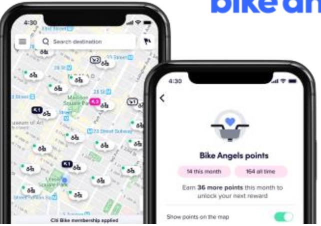
bike angels

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*Optimizing* EV charging Infrastructure (*MMI Grant*)

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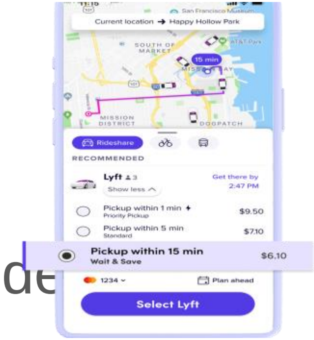
Research Interests

# Managing flexibility on platforms

Demand side

- Bike Angels
- Wait & Save
- Scheduled rides




- Willingness to try AVs

# Managing flexibility on platforms

## Demand side

- Bike Angels
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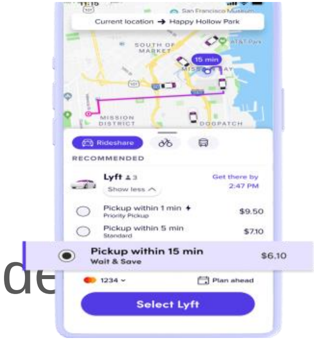



- Willingness to try AVs

How to leverage these operational tools?

# Managing flexibility on platforms

How to leverage these operational tools?

Supply side

- Bike valets
- Car seats
- Green cars
- Safety drivers in AVs

# Managing flexibility on platforms

Demand side

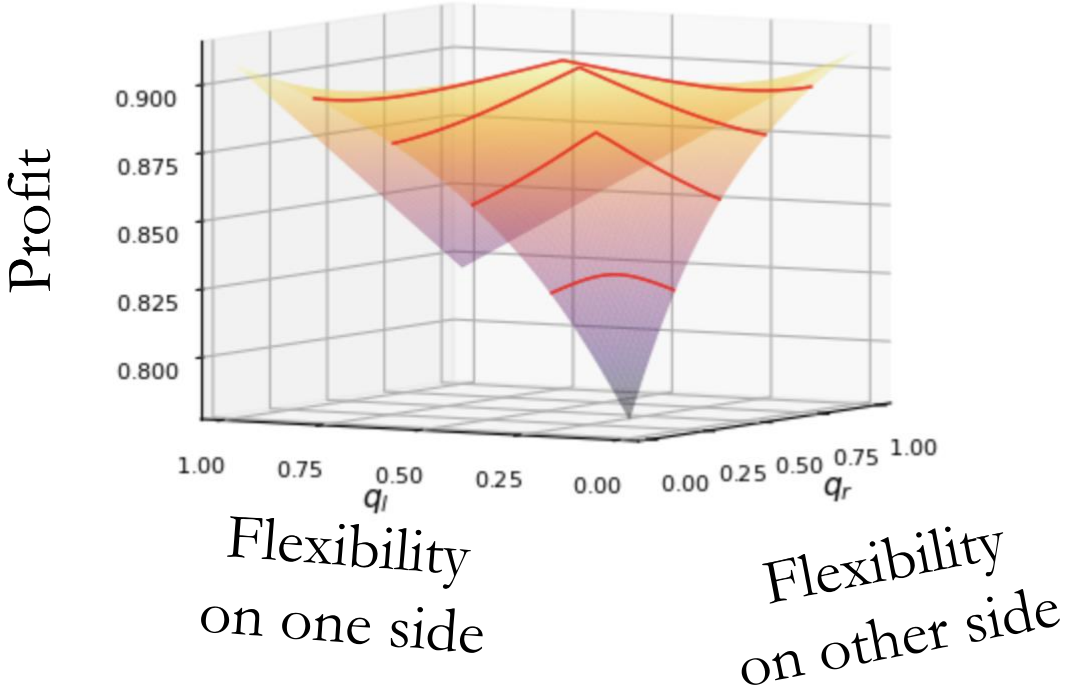
- Bike Angels
- Wait & Save
- Scheduled ride
- Willingness to try AVs

Supply side

- Safety drivers in AVs

Holistically optimizing flexibility on both market sides

# Managing flexibility on platforms




1) Flexibilities interact in complicated manners
2) Even with just two perfectly symmetric flexibility types!

# Coordinating AV Deployments in Hybrid Fleets

Contracting

1. Aligning interests of platforms (Uber/Lyft)

& AV owners  (???)

2. Fleet size, vehicle utilization, AV capabilities

# Coordinating AV Deployments in Hybrid Fleets

Contracting

1. Aligning interests of platforms (Uber/Lyft)

& AV owners (???)

2. Fleet size, vehicle utilization, AV capabilities

Capabilities

1. Optimizing new AV capabilities

2. For a standalone AV platform (Waymo One) or by taking into account an external platform's (Uber/Lyft) dispatch policy

# Coordinating AV Deployments in Hybrid Fleets

Contracting

Capabilities

1. Aligning inte
platforms (Ube
& AV owners

2. Fleet size, vehicle utilization, AV capabilities

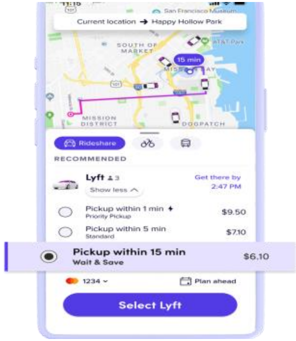
Holistically optimizing the deployment by incorporating capabilities, fleet size, and contracting

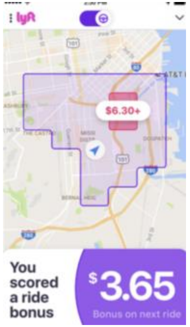
AV platform
r by taking into account an external platform’s (Uber/Lyft) dispatch policy

# Coordinating AV Deployments in Hybrid Fleets

<u>Utilization</u>

Contracts need to include utilization guarantees!


Current location → Happy Hollow Park
Rideshare
RECOMMENDED
Lyft
Get there by 2:47 PM
Show less
Pickup within 1 min
Priority Pickup
$9.50
Pickup within 5 min
Standard
$7.10
Pickup within 15 min
Wait & Save
$6.10
1234
Plan ahead
Select Lyft


lyft
$6.30+
You scored a ride bonus
$3.65
Bonus on next ride


bike angels
Bike Angels points