Sustainable Vehicle Technologies

Market & Policy Analysis

US-China Relationship

John Paul Helveston

Dept. of Engineering Management and Systems Engineering

November 12, 2021

Hello World!

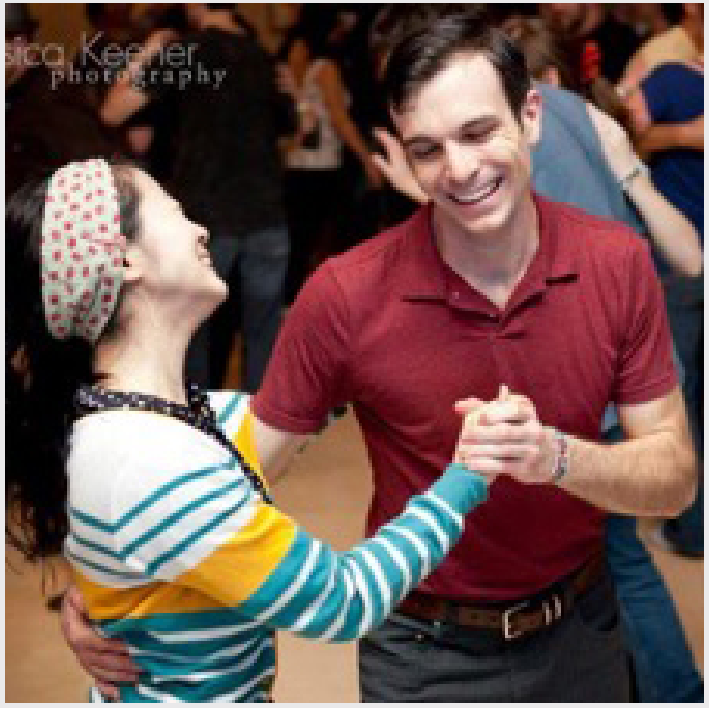
John Paul Helveston, Ph.D.

Assistant Professor, Engineering Management & Systems Engineering
Website: www.jhelvy.com

- 2010 BS in Engineering Science & Mechanics at Virginia Tech
- 2015 MS in Engineering & Public Policy at Carnegie Mellon University
- 2016 PhD in Engineering & Public Policy at Carnegie Mellon University
- 2016-2018 Postdoc at Institute for Sustainable Energy, Boston University

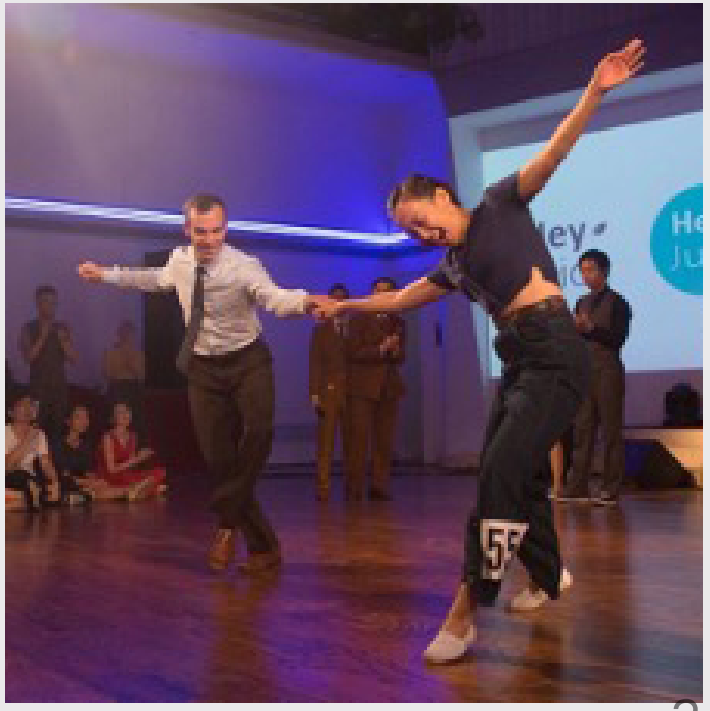
Three random facts about me

I swing dance



I worked in China

I swing dance in China

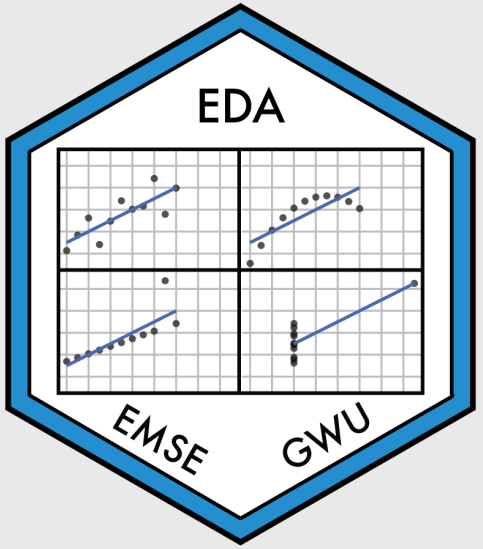


I use  for everything

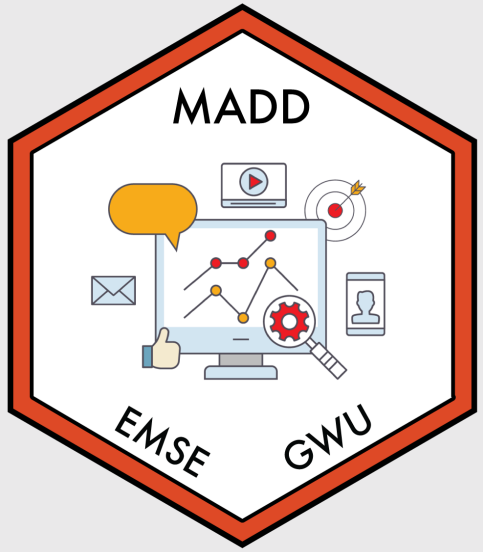
...seriously...even these slides

EMSE 4571:
Intro to Programming for Analytics (Spring)

EMSE 4572:
Exploratory Data Analysis (Fall)



EMSE 6035:
Marketing Analytics for Design Decisions (Fall)



Technology Change Lab

Laura Roberson
Ph.D. Student

Lujin Zhao (赵鲁晋)
Ph.D. Student

Leah Kaplan
Ph.D. Student

Saurav Pantha
Visiting Scholar

Amelia Jacquat
Undergraduate

Helena Row
Undergraduate

Eliese Ottinger
Undergraduate

Kazi Ashrafi
Undergraduate

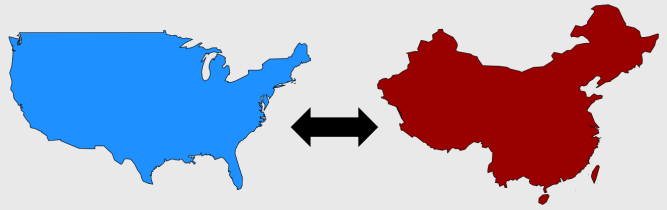
Technology Change Lab

I study how consumers, firms, markets, and policies affect technology change to facilitate transitions to sustainable and low-carbon technologies.

Electric & Sustainable Vehicle Technologies

Market & Policy Analysis

U.S. - China Climate Relationship



I'm interested in questions like...

- How can we get people to buy more efficient vehicles?

- How will emerging technology like autonomous and electric vehicles compete against existing technologies in the market?

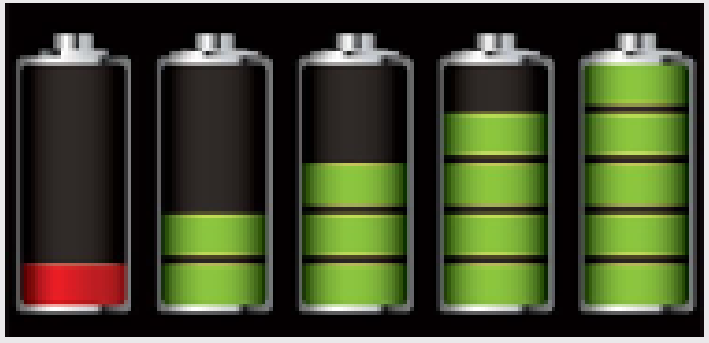
- Would people be willing to pay a premium to reduce pollution?

Answers depend on knowing what people want

So I try to figure out what people want

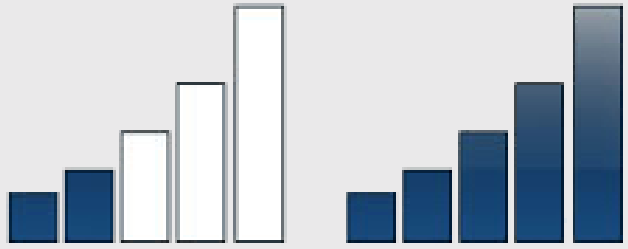
Which feature do you care more about?

Battery Life?



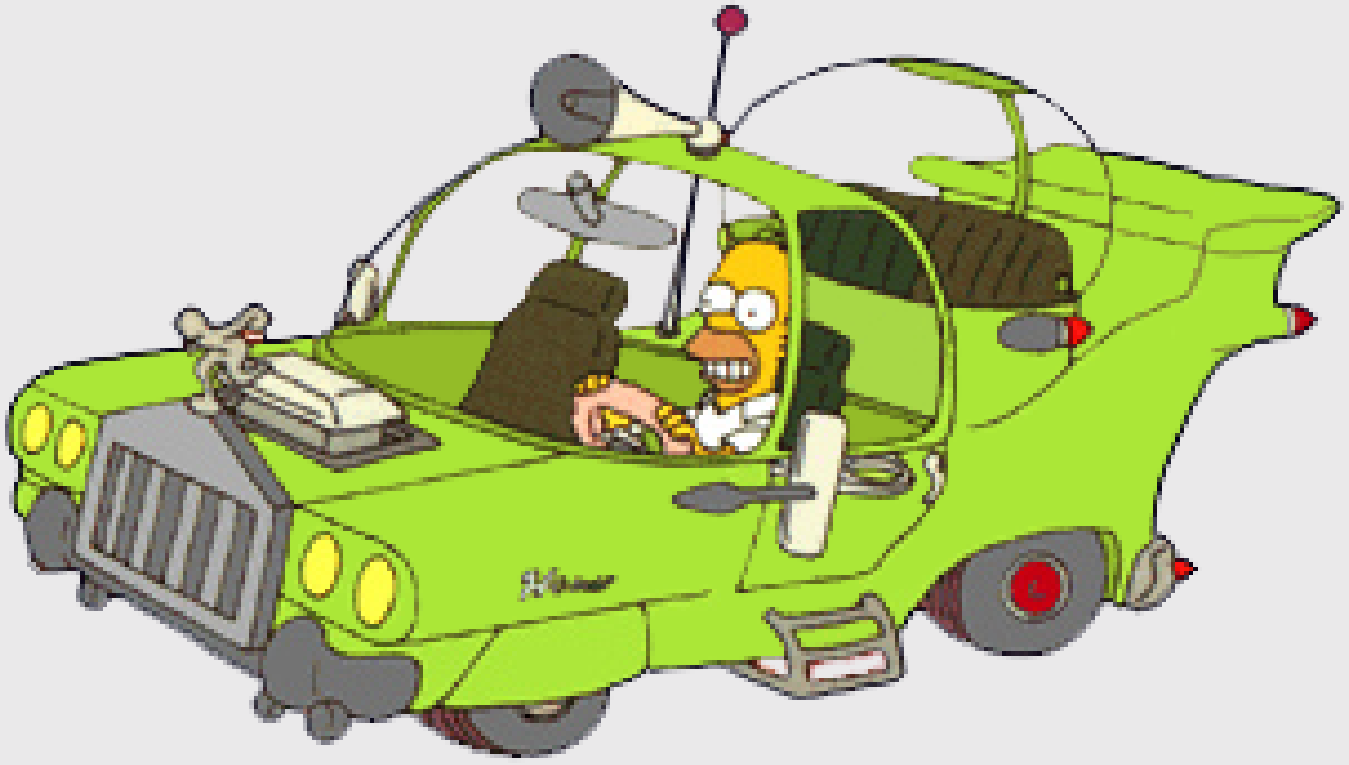
Brand?

Signal quality?



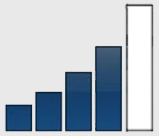
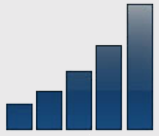
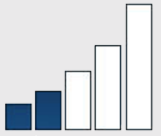
Directly asking people what they want usually isn't helpful

(People want everything)



Conjoint Analysis:

Use choice data to model preferences

Attribute	Phone 1	Phone 2	Phone 3
Price	$400	$450	$350
Brand			
Battery Life			
Signal Quality			

Use random utility framework to predict probability of choosing phone *j*

1. $u_j = \beta_1 \mathbf{price}_j + \beta_2 \mathbf{brand}_j + \beta_3 \mathbf{battery}_j + \beta_4 \mathbf{signal}_j + \varepsilon_j$

2. Assume $\varepsilon_j \sim$ iid Gumbel distribution

3. Probability of choosing phone *j*: $P_j = \frac{e^{\beta' x_j}}{\sum_k^J e^{\beta' x_k}}$

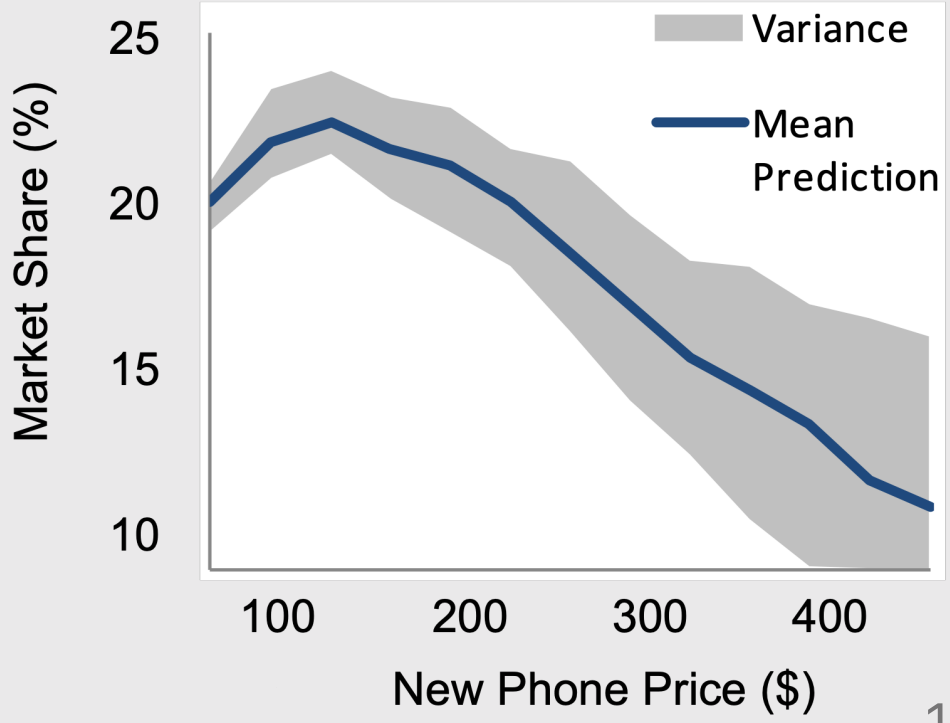
4. Estimate $\beta_1, \beta_2, \beta_3, \beta_4$ via maximum likelihood estimation

Willingness to Pay

Respondents on average are willing to pay $XX to improve battery life by XX%

Make predictions

$$P_j = \frac{e^{\hat{\beta}' x_j}}{\sum_k^J e^{\hat{\beta}' x_k}}$$



Choose your own adventure

Electric Vehicles

Low-carbon Fuels

Multi-modal Trips

Autonomous Vehicles

Electric Vehicle Incentives

Will subsidies drive electric vehicle adoption? Measuring consumer preferences in the U.S. and China

Helveston, John P., CMU

Yimin Liu, Ford

Elea M. Feit, Drexel U.

Erica R.H. Fuchs, CMU

Erica Klampfl, Ford

Jeremy J. Michalek, CMU

Transportation Research Part A: Policy and Practice, 73, 96–112. (2015) DOI: 10.1016/j.tra.2015.01.002

Suppose these 3 vehicles below were the only vehicles available for purchase, which would you choose?

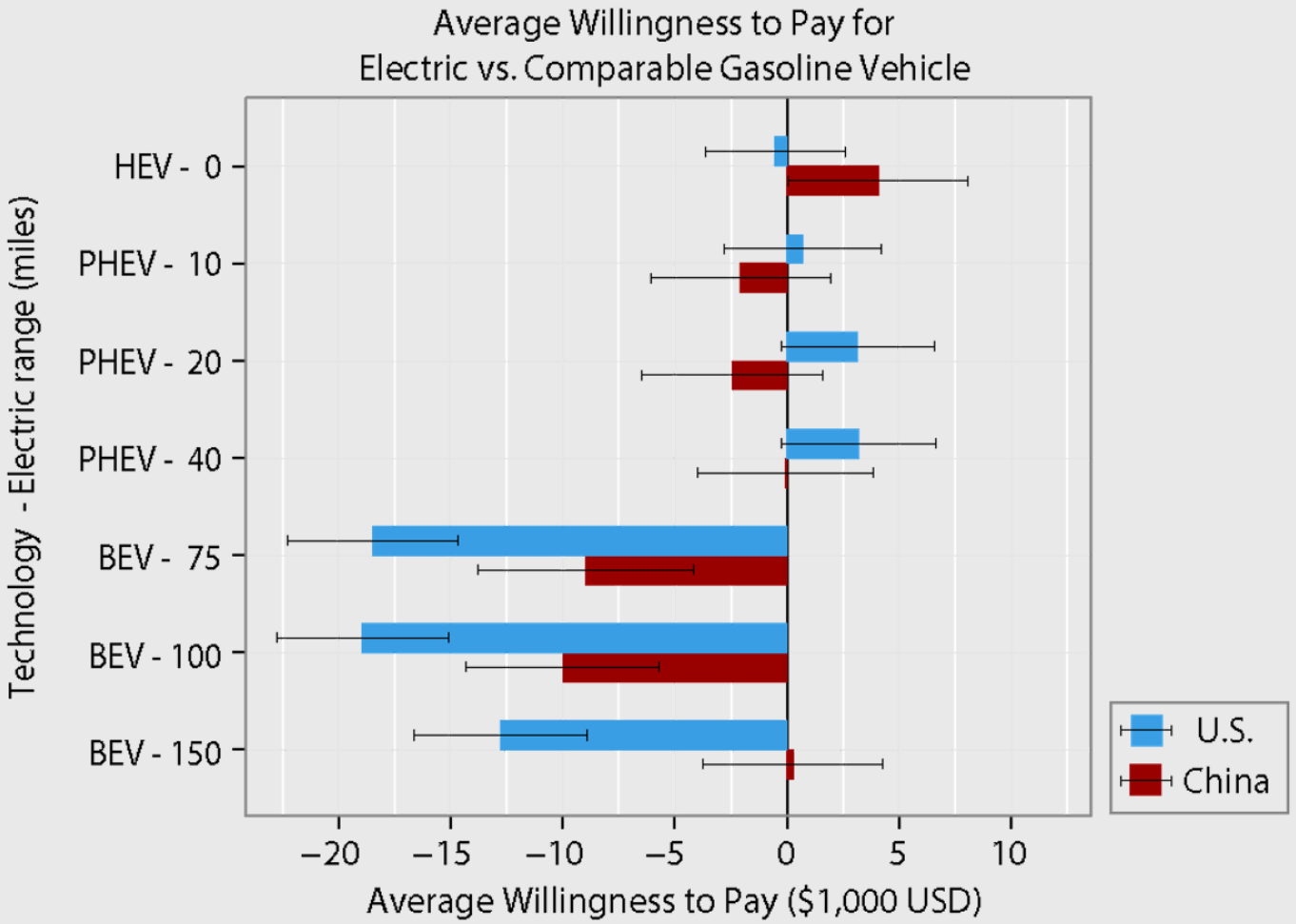
Each option will look like this:

Attribute*	Option 1	Option 2	Option 3
Vehicle Type	Conventional 300 mile range on 1 tank	Plug-In Hybrid & 300 mile range on 1 tank (first 40 miles electric)	Electric 75 mile range on full charge
Brand	German	American	Japanese
Purchase Price	$18,000	$32,000	$24,000
Fast Charging Capability	--	Not Available	Available
Operating Cost (Equivalent Gasoline Fuel Efficiency)	19 cents per mile (20 MPG equivalent)	12 cents per mile (30 MPG equivalent)	6 cents per mile (60 MPG equivalent)
0 to 60 mph Acceleration Time**	8.5 seconds (Medium-Slow)	8.5 seconds (Medium-Slow)	7 seconds (Medium-Fast)
	○	○	○

*To view an attribute description, click on:

**The average acceleration for cars in the U.S. is 0 to 60 mph in 7.4 seconds

Chinese car buyers may be more willing to adopt full electric vehicles than Americans.



Return to choices

Choice at the Pump: Measuring Preferences for Lower-Carbon Combustion Fuels?

John P. Helveston, GWU

Stephanie M. Seki, CMU

Jihoon Min, CMU

Evelyn Fairman, CMU

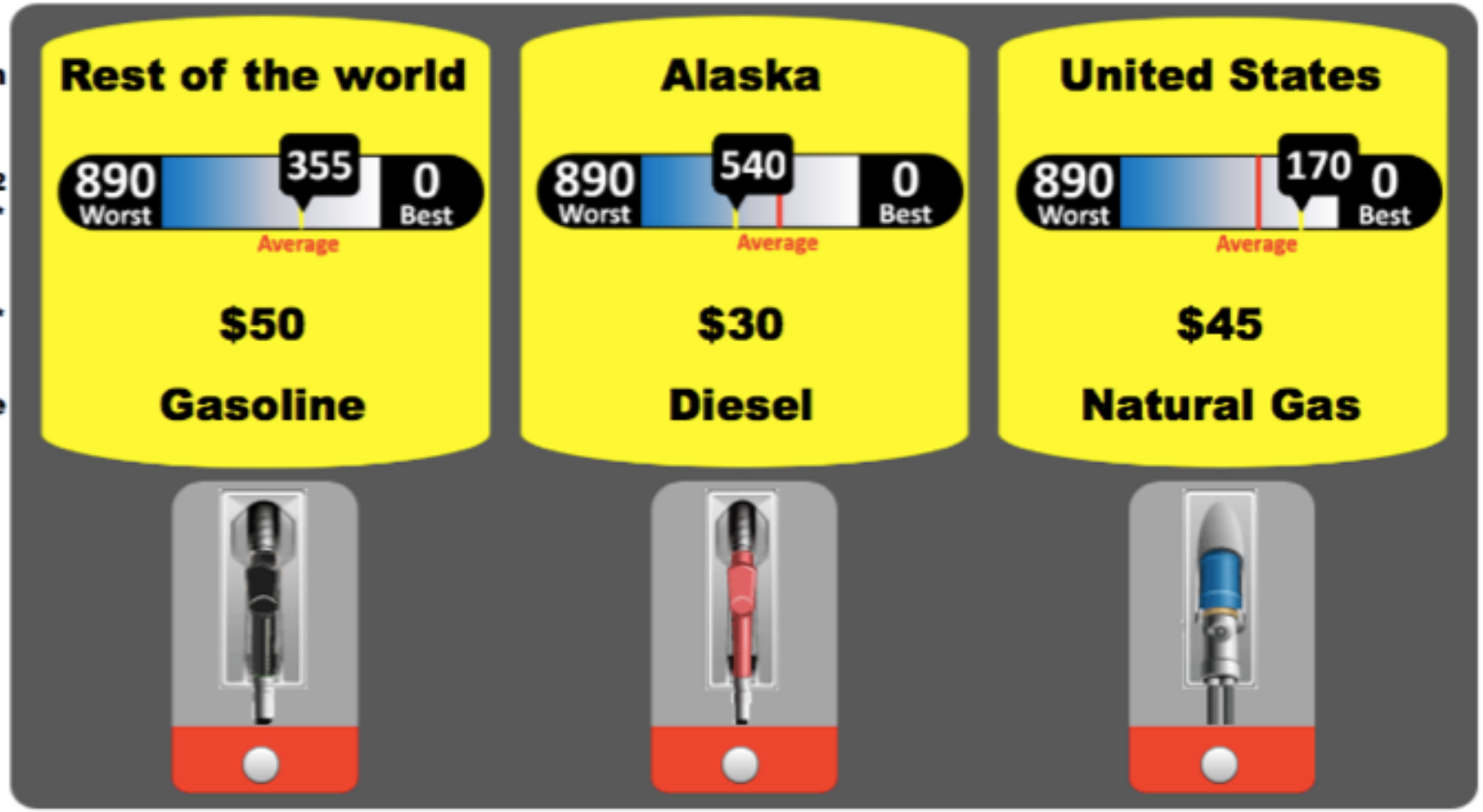
Arthur A. Boni, CMU

Jeremy J. Michalek, CMU

Inês M. L. Azevedo, CMU

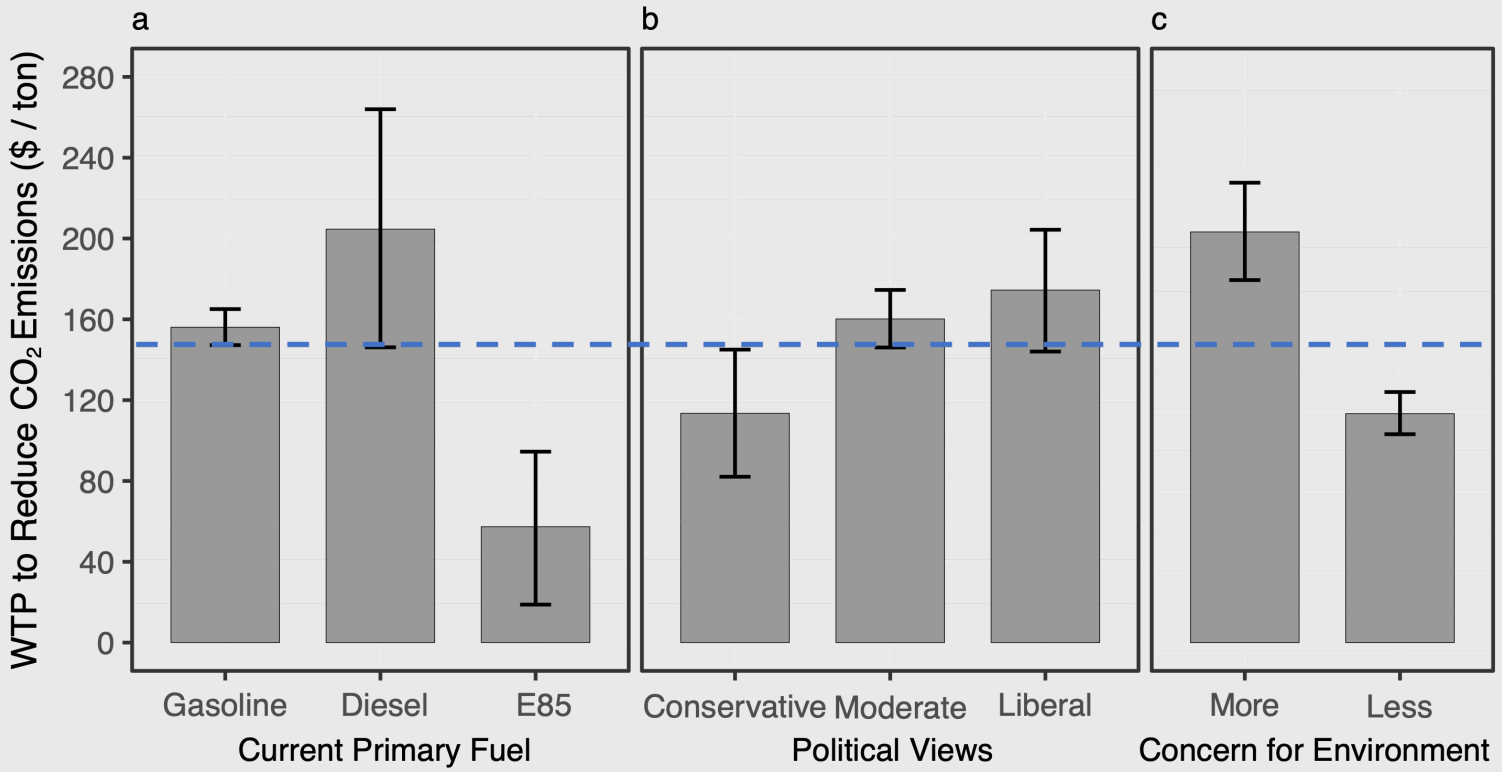
Environmental Research Letters, 14(8) (2019) DOI: 10.1088/1748-9326/ab2bd2

If these were your only fueling options, which fuel would you choose? (2 of 13)



Note: * Each tank allows the vehicle to travel 300 miles.
** Tailpipe emissions for light duty vehicles (in grams of CO_2 per mile)

On average, respondents WTP $150/ton CO2 avoided



Example:

- 26 mpg car
- 12-gallon tank
- Gas: $3/gallon

A WTP of $150/ton CO2 avoided means increasing fuel price by 45%!

Return to choices

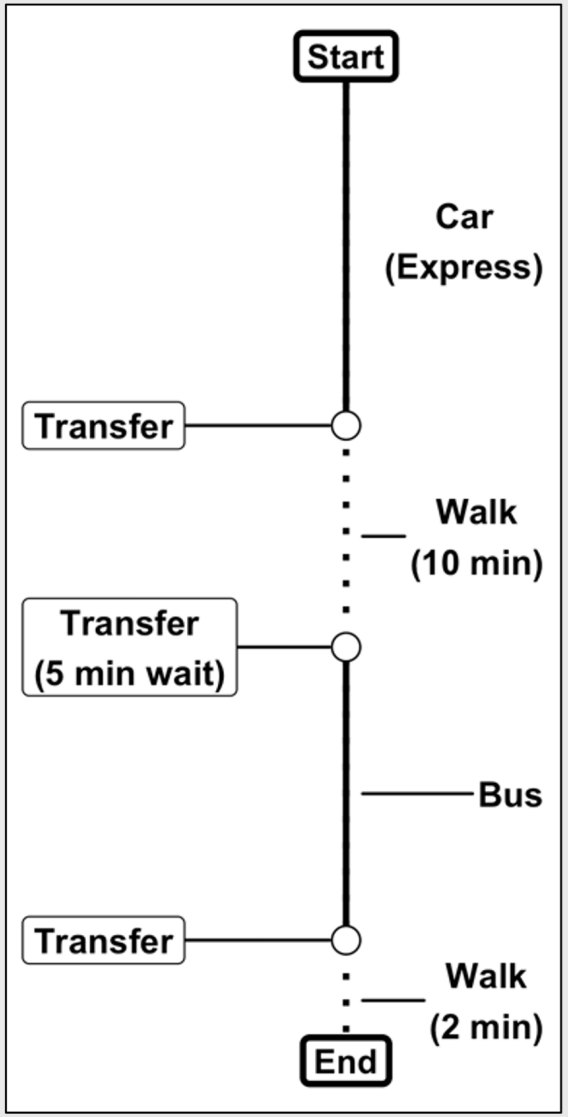
Measuring consumer preferences for multi-modal trips

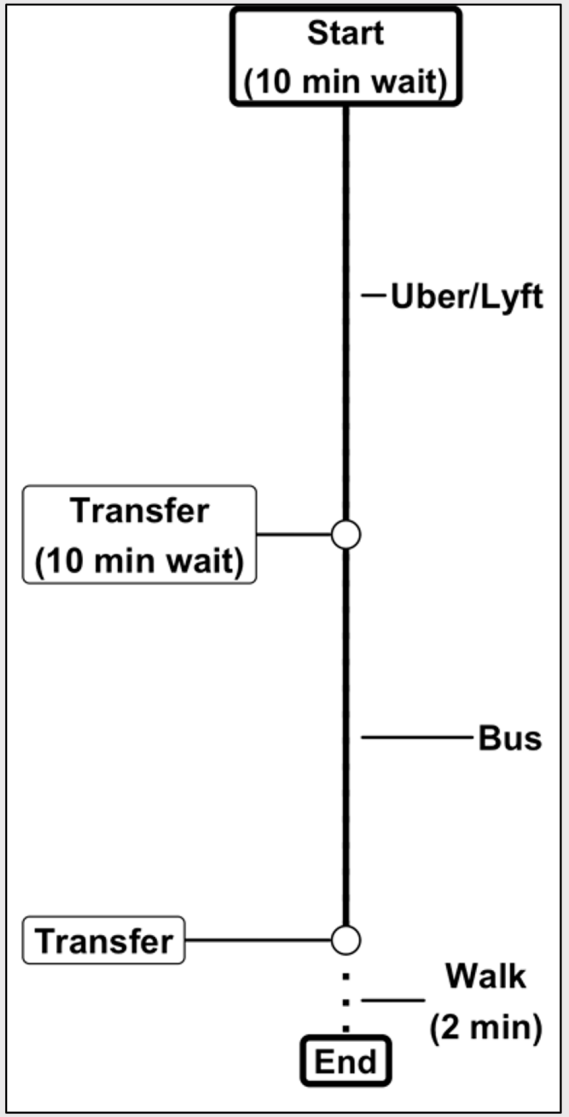
John P. Helveston, Assistant Professor, EMSE

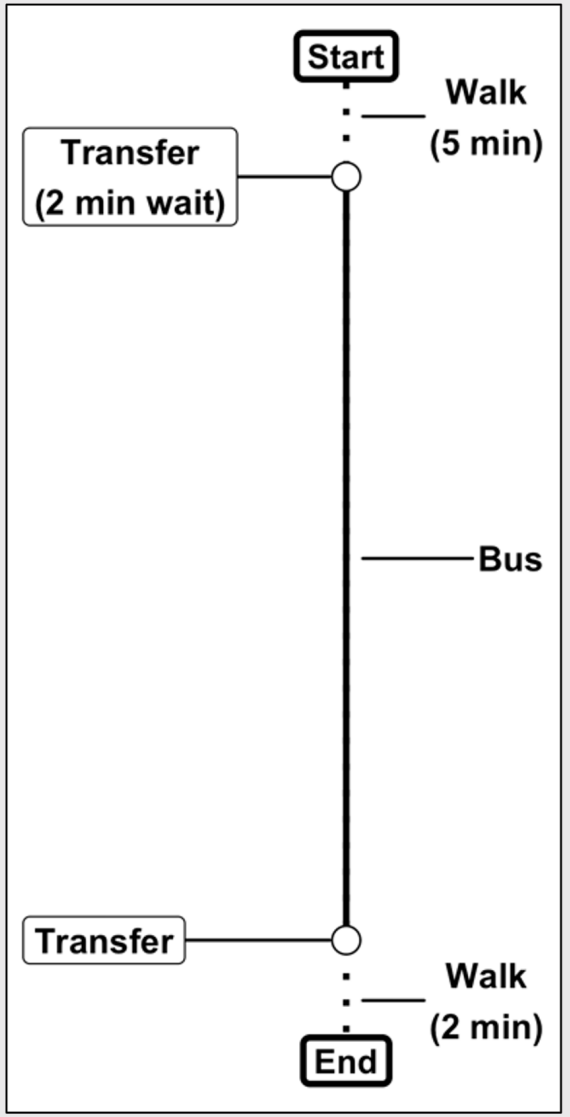
Lujin Zhao, Ph.D. Student, EMSE

Saurav Pantha, MS Alumni & Visiting Scholar, EMSE

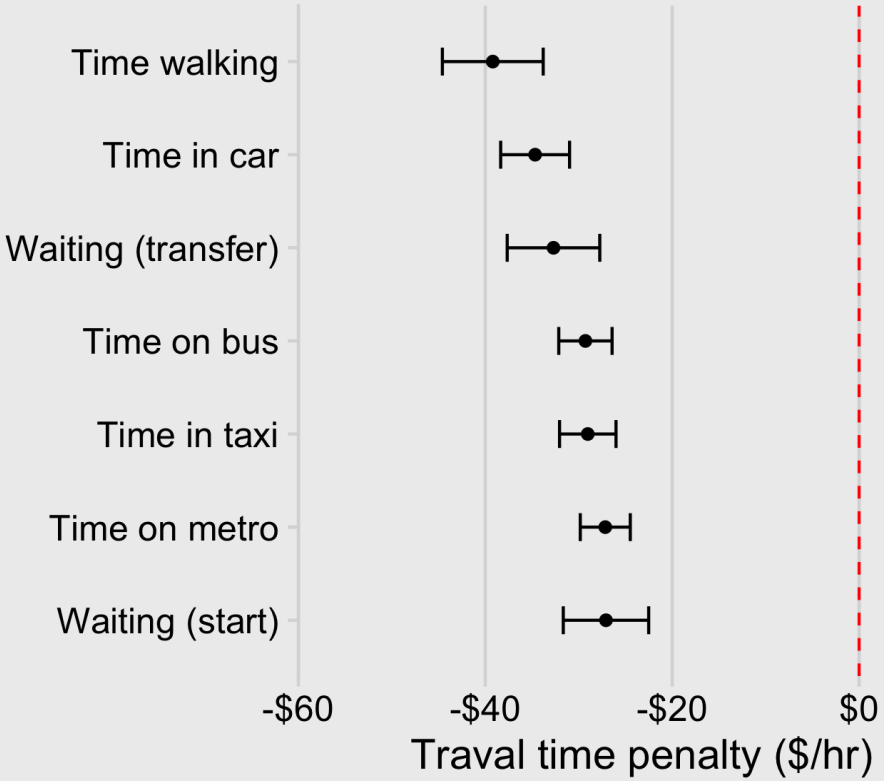
If these were your only trip options, which would you choose?



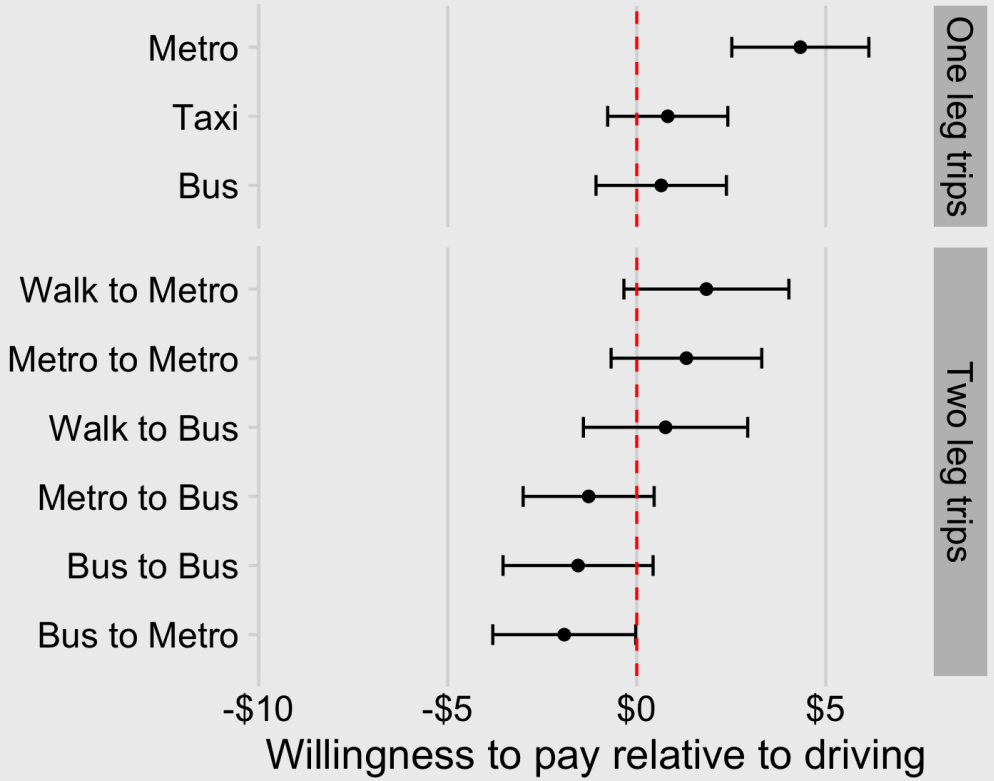


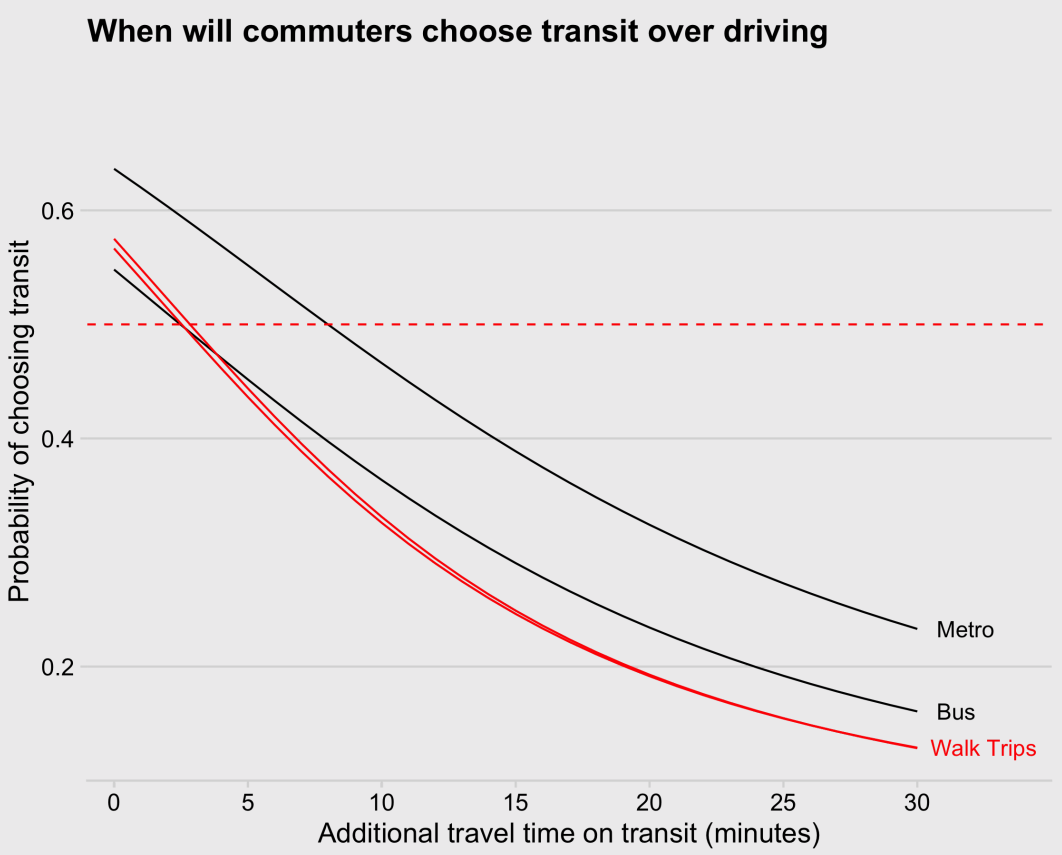


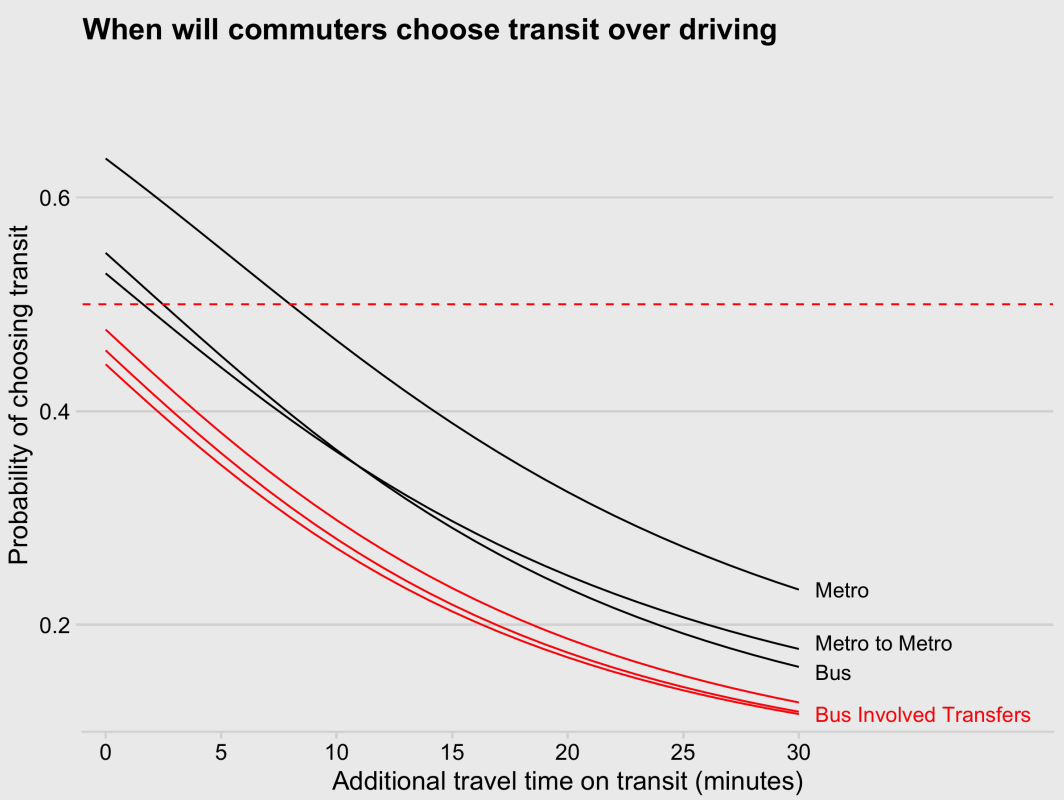
Value of time



Value of mode




When will commuters choose transit over driving
Probability of choosing transit
0.6
0.4
0.2
0
5
10
15
20
25
30
Additional travel time on transit (minutes)
Metro
Bus
Walk Trips


When will commuters choose transit over driving
Probability of choosing transit
0.6
0.4
0.2
0
5
10
15
20
25
30
Additional travel time on transit (minutes)
Metro
Metro to Metro
Bus
Bus Involved Transfers

Return to choices

Designing more efficient & equitable EV incentives

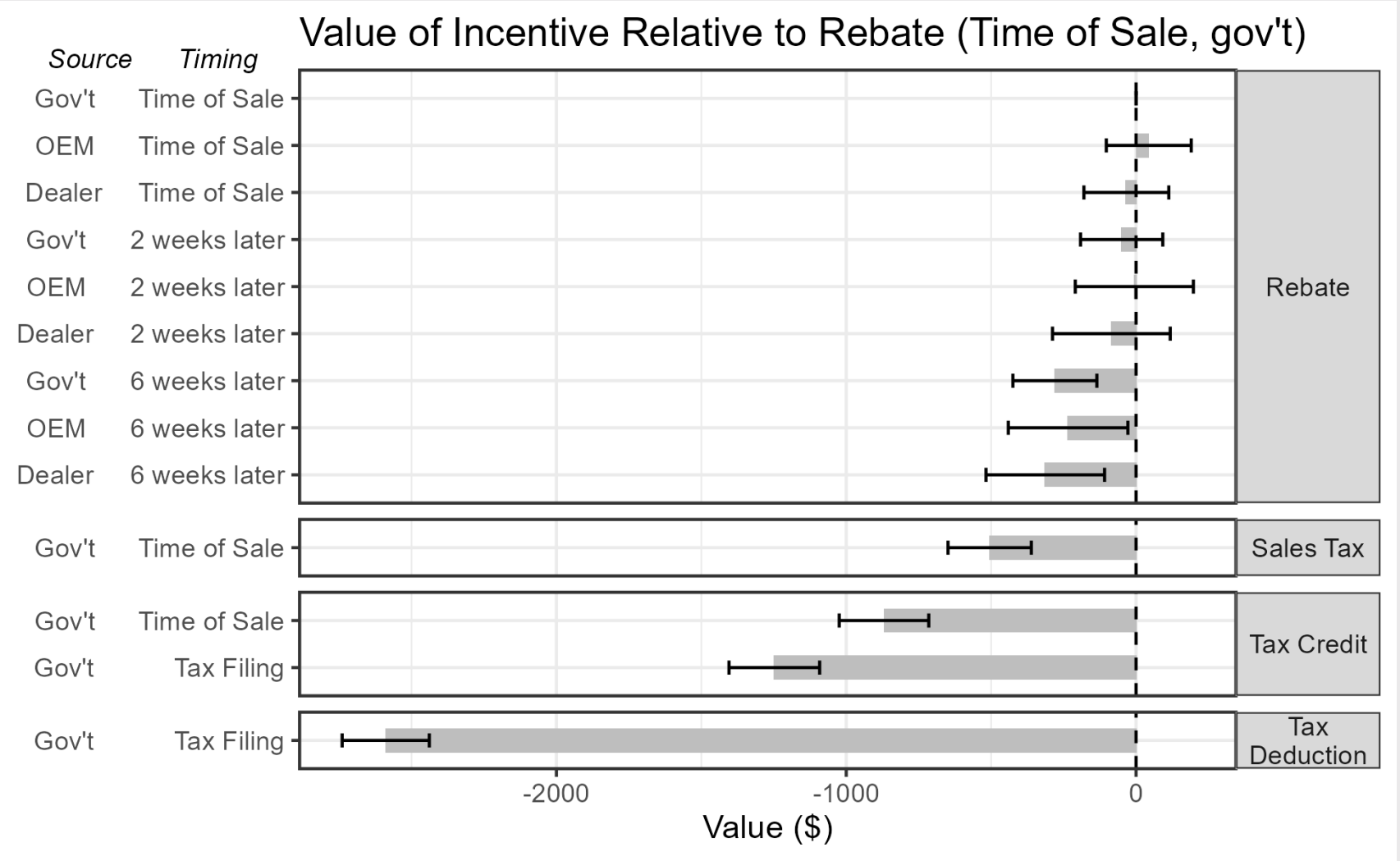
John P. Helveston, Assistant Professor, EMSE

Laura Roberson, Ph.D. Student, EMSE

Which incentive option would you prefer?

Sales Tax Exemption	**Tax Credit**	**Tax Deduction**	**Rebate from *Dealer***
Amount: $1,900	**Amount**: $2,500	**Amount**: $2,000	**Amount**: $2,000
Time Frame: Time of Sale	**Time Frame**: Time of Sale	**Time Frame**: At Tax Filing (approx. April 2022)	**Time Frame**: Time of Sale
			From: Dealer

Immediate rebate is $1,200 more valuable than current federal tax credit



Return to choices

Undercutting Transit?

Exploring potential competition between autonomous vehicles and public transportation in the U.S.

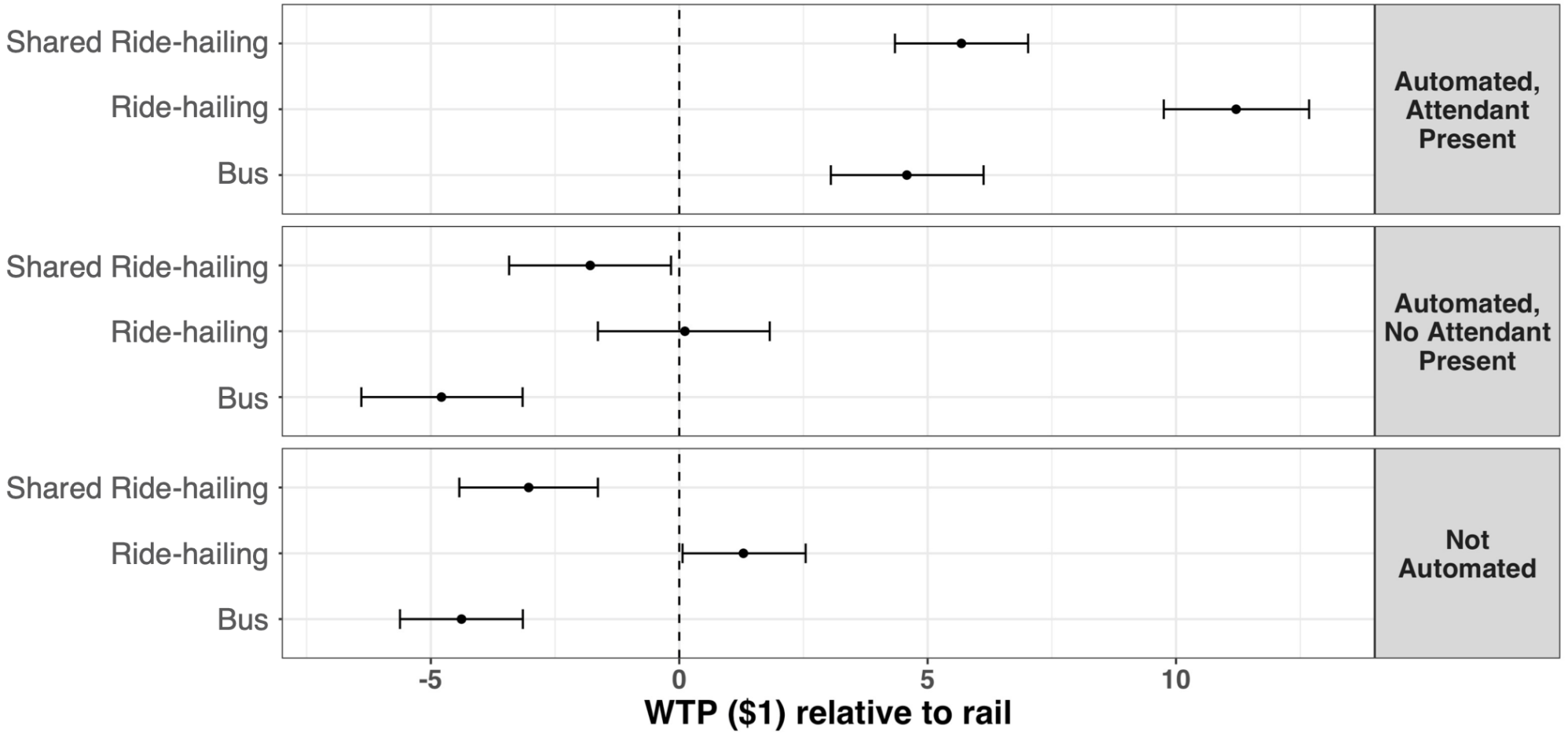
John P. Helveston, Assistant Professor, EMSE

Leah Kaplan, Ph.D. Student, EMSE

Imagine you are going out for an evening leisure activity - Which transportation option would you choose/

Bus	Rail	Ride-hailing	Shared Ride-hailing
Automated, Attendant Present 	Not Automated 	Automated, No Attendant Present 	Automated, Attendant Present 
Price: $1 **Total Trip Time**: 20	**Price**: $3 **Total Trip Time**: 30	**Price**: $15 **Travel Time**: 30	**Price**: $10 **Total Trip Time**: 35

AVs only preferred when attendant present



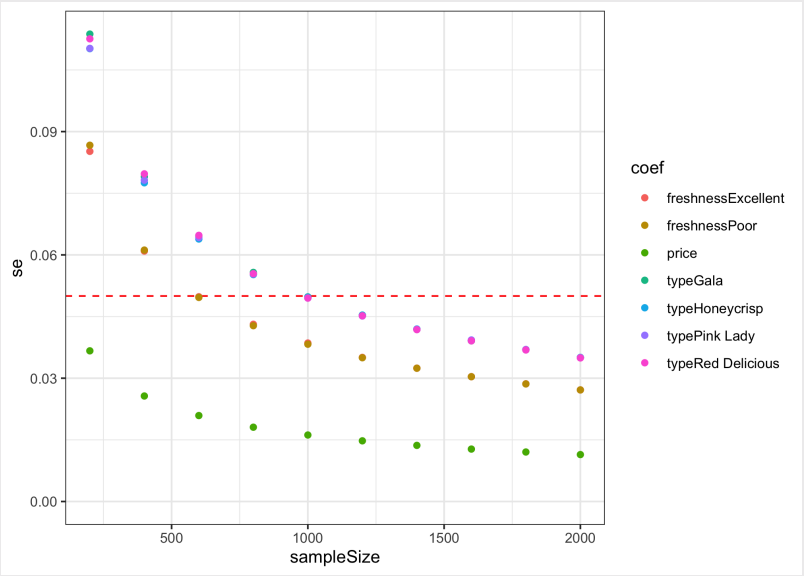
Return to choices

logitr

Fast estimation of multinomial and mixed logit models in R with “Preference” space or “Willingness-to-pay” space utility parameterizations.

https://jhelvy.github.io/logitr/

conjointTools



Tools for designing choice based conjoint survey experiments.

https://jhelvy.github.io/conjointTools/

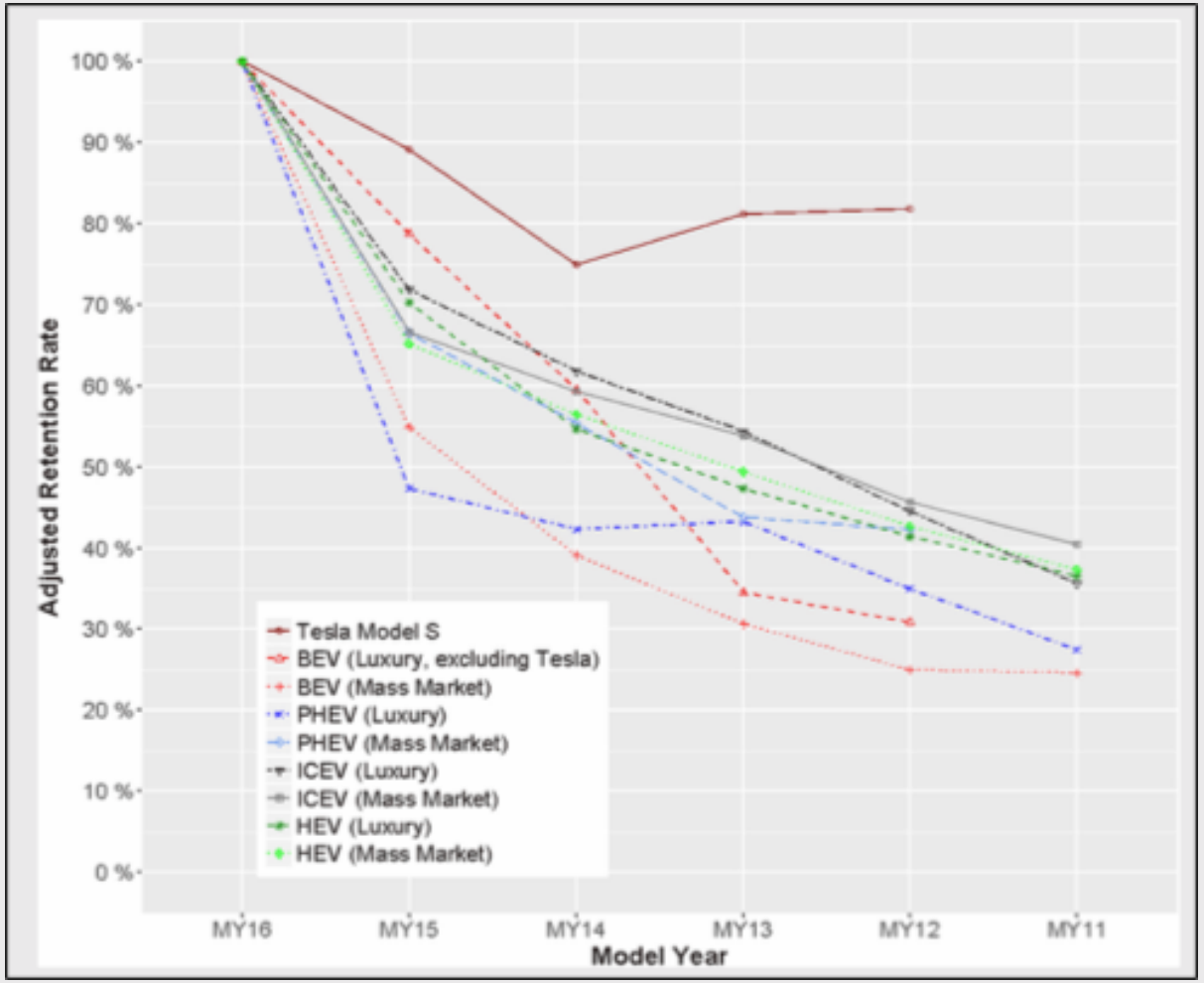
Analyzing historical vehicle listings data

- 900,000,000 vehicle listings
- New and used cars from 2015-2020
- ~55,000 dealerships

Estimating residual value of EVs

John P. Helveston,
Assistant Professor,
EMSE

Laura Roberson, Ph.D.
Student, EMSE

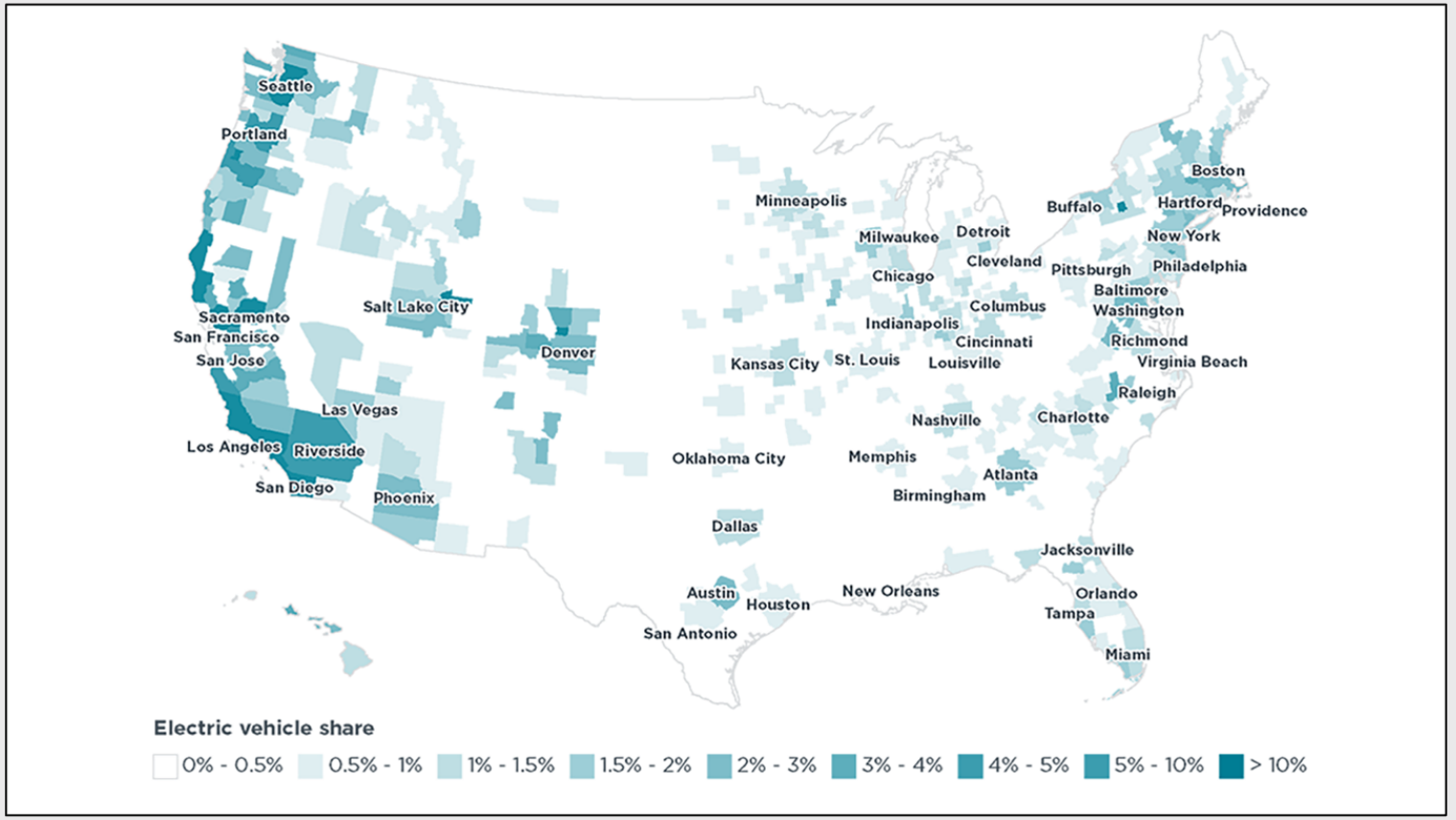


Where are the EVs?

John P. Helveston,
Assistant Professor,
EMSE

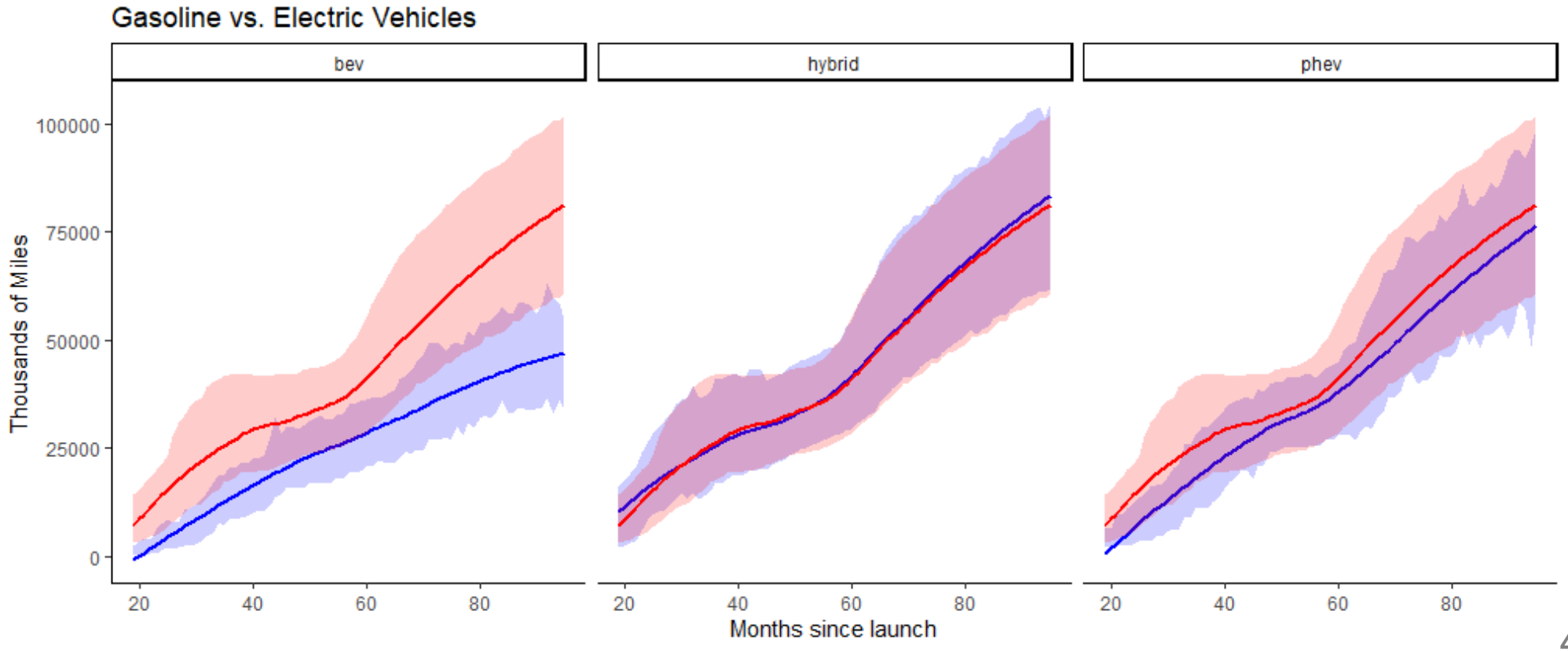
Kazi Asifa,
Undergraduate Student,
EMSE

2019 study be Sierra Club found that 74% of dealerships are not selling EVs



Do EV owners drive as much as gasoline car owners?

John P. Helveston, Assistant Professor, EMSE
Eliese Ottinger, Undergraduate Student, EMSE



Thanks!

Slides: https://github.com/jhelvy/intro

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