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Evolving views of transit service: Inter-temporal analysis of safety interventions and satisfaction

Joint work with **Spencer Aeschliman** (PhD student, NSF GRFP fellow). Collaboration with the Regional Transportation Authority, Amy Hofstra and Peter Fahrenwald

Regional Transportation Authority

NSF Graduate Research Fellowship Program

Context-changes

Medium-Long term dynamics

Pandemic shock

* **Schedule/activities**
Accelerated e-commerce
Lasting telework/hybrid

* **People**
Values and priorities
Equity and climate
Mobility changes
Localization preferences

* **Employers/Businesses**
Hybrid policies

* **Technology**
Tele-everything
Hybrid substitution

* **Society/Governance/Politics**
Low trust in gov & 'experts'
Economic stress
Electrification, Climate policy

Stress & Isolation

Economic decline

Active mobility

Transit abandonment

Social distancing

COVID-19

Public transport ridership

Safety & Health

Residential location

Business locations

Mobility business models

Public transport service & funding

Social equity & DEI

Polarization & distrust in authorities

Urban decentralization / depopulation / renewal

Setting the scene

- Transit fiscal cliff
- Lapsed ridership (choice riders)
- WFH and Safety key issues
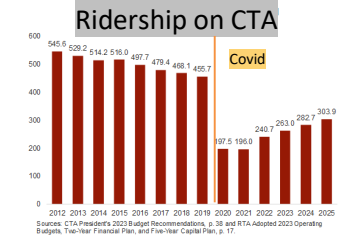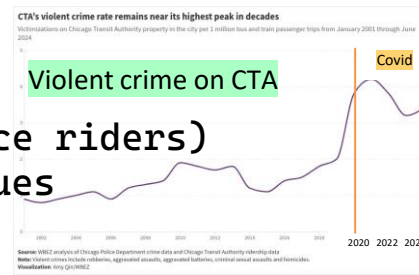
Safety & transit

- "Safety is kind of a hard issue because how safe people feel is just as important, sometimes more important, than actual safety," (CTA's Citizens Advisory Board)
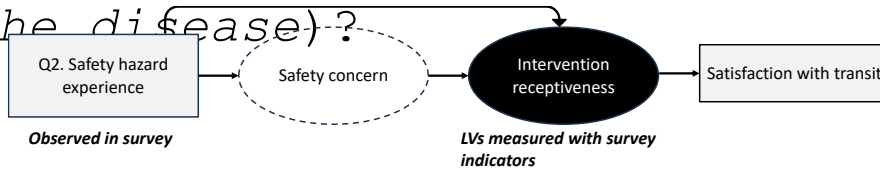
A complex issue

- Different views of safety
- Different views of safety measures
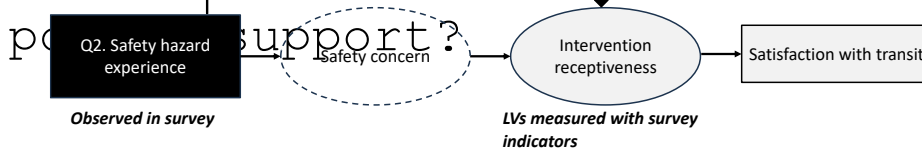- Balance interventions
- Reality and Perceptions don't match
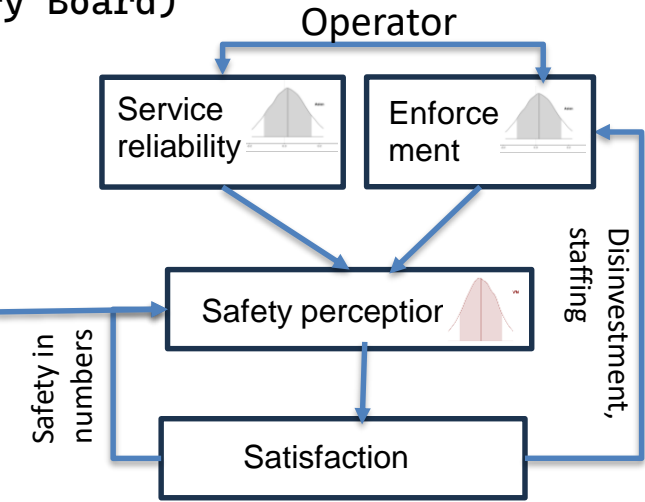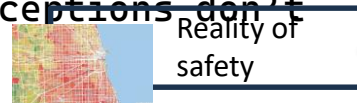
Modeling evolving transit satisfaction dynamics? 3 investigations

- **3 avenues to capture evolving behavior**
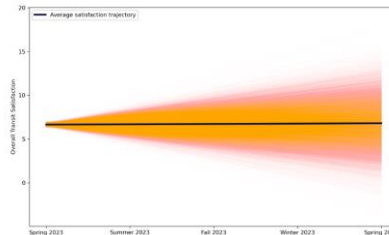
Q1: How can we model policy trade-offs in a divided society (*Is the cure worse than the disease*)?

Q2: Do safety hazard experiences shape policy support?

Q3: How do we capture at trajectories (Variation noise)?

Data

- Data for **Q1 & Q2**
- Shared by the RTA
- Spring '23
- #2292 transit riders
- Focus on service, safety & enforcement
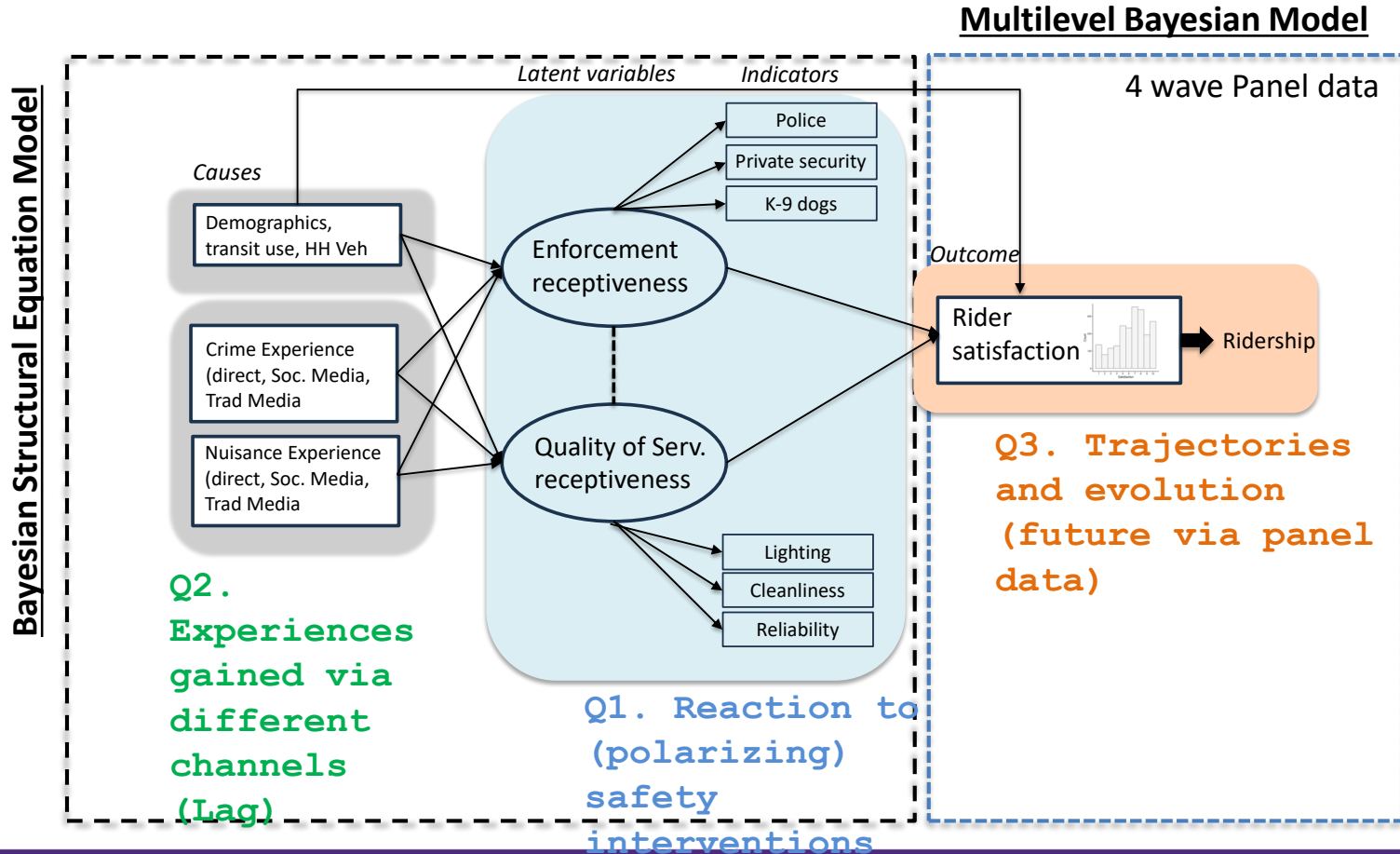- Service Satisfaction
- Responder profile

- Panel Data for **Q3**
- 4 waves of panel data spring '23 - spring '24
- 460 respondents in all 4 waves
- Satisfaction focus

Q1. Is the cure worse than the disease?

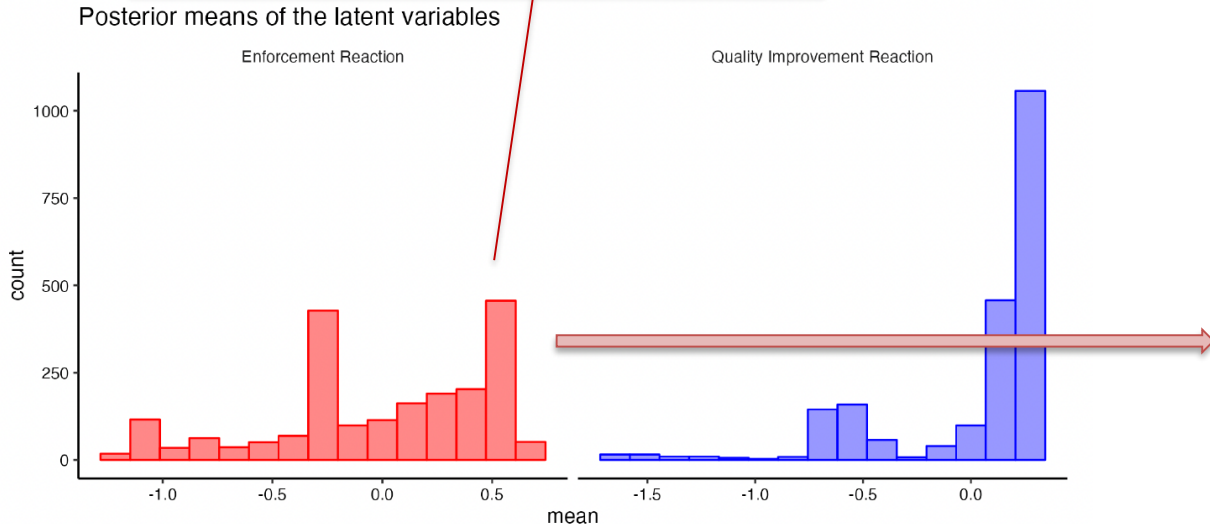Figure 1: Rider responses to potential safety interventions

Research Methods

Difference by ethnic groups: Black resp. may have a slightly positive enforcement receptiveness

'Enforcement' has wider spread of values

Posterior means of the latent variables

Histogram of individual means of sampled latent variable values, with 3000 draws for each ind. in the sample. Higher values → more positive reactions to transit safety measures.
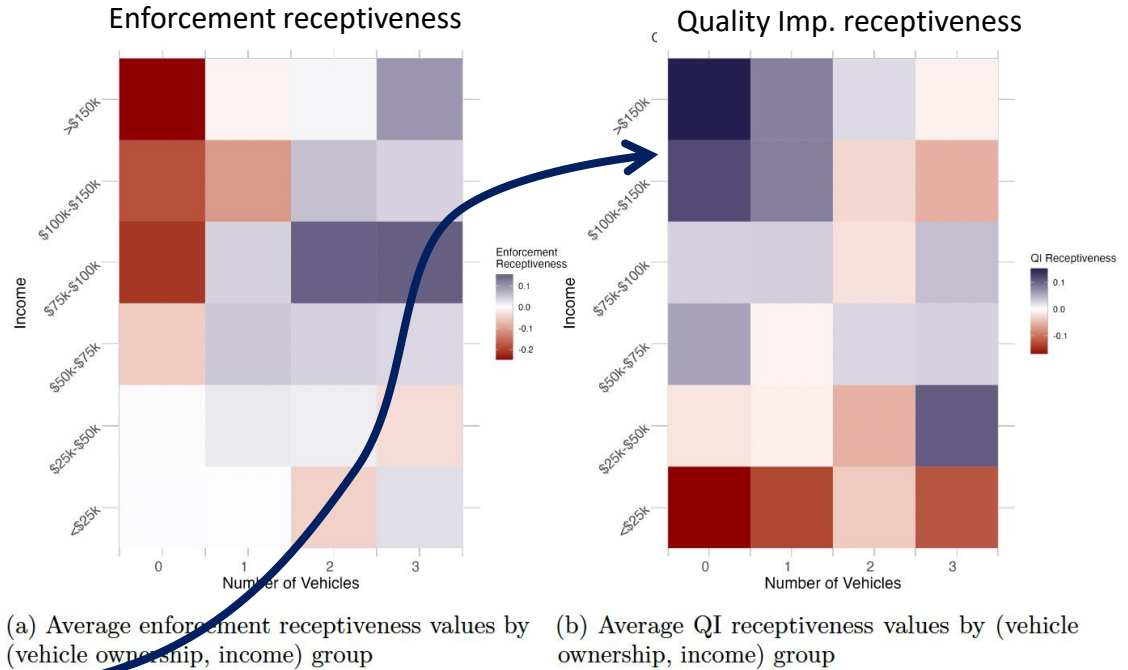
Q1: Enforcement-related policies have stronger association with satisfaction, *but* also come with the downside of 10-20% of riders feeling less safe.

Metric of note: show nuanced policy trade-off for different rider segments, with implications for equity across groups.
E.g. "choice riders"

Enforcement receptiveness

Quality Imp. receptiveness

(a) Average enforcement receptiveness values by (vehicle ownership, income) group

(b) Average QI receptiveness values by (vehicle ownership, income) group
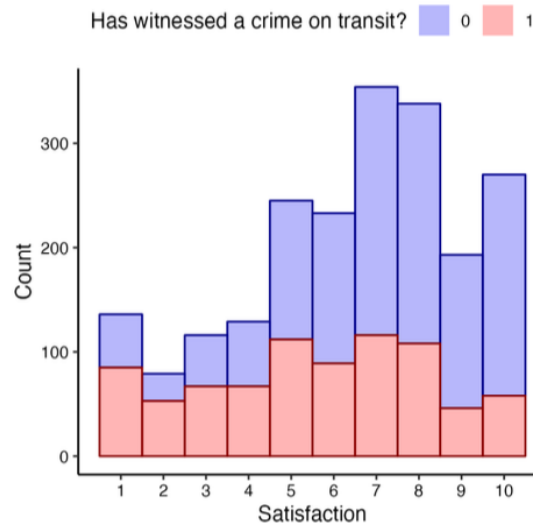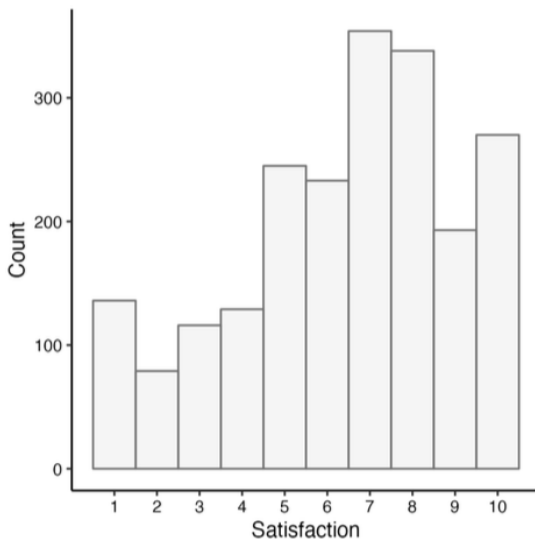
2. Experiential shaping

Figure 2: Distributions of overall transit satisfaction in the Chicago region. Left: the full sample used in the model. Right: the full sample, but colored by if those riders have witnessed a crime (assault, robbery, harassment) on transit or not.

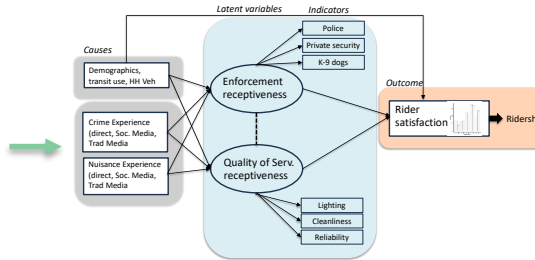# Results Q2: experience of hazards

Q2: We examined experience channels and impacts
- 2 types of experiences (Crime, Nuisance) via 3 channels

Experience → enforcement receptiveness

Witnessed crime

Heard via WOM or social media

Heard via trad. media

Experience → QI receptiveness

Witnessed nuisance

Heard via WOM or social media

Heard via trad. media

Impact differs Traditional media leads to higher enforcement support
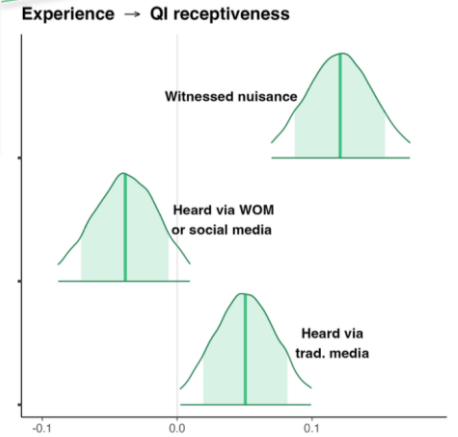
Experience	Description	Channel
Crime Experience	Experience of assault, robbery or harassment on transit	-Witness 1st hand -Social media /WOM -Traditional news
Nuisance Experience	Experience of dirtiness, loud noise, damage, substance abuse, or people using transit as shelter	Same as above

Q2 Take-aways: Divided reaction to issues and policies

Q2. How experiences are gained matters
Finding:
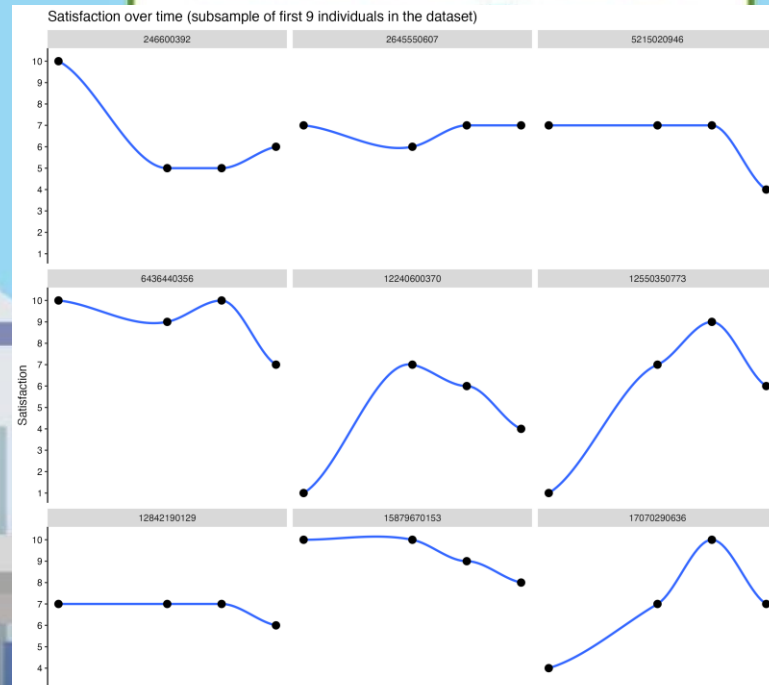- Poor experiences lead to higher acceptance of safety policies, and lower satisfaction (*crime:witnessed is most impactful)*
- We learn that own experience > social media, but the ordering is different for crime vs nuisance.

Impact & Metrics.
- Visualize how people acquire information about safety hazards.
- Suggests different strategies by experience channel, e.g. social media lowers support for policy measures.

How satisfied were commuters with Public Transport Services in 2023?

3. Capture satisfaction trajectories

Satisfaction over time (subsample of first 9 individuals in the dataset)

Panel data summary

Satisfaction distribution across waves

Mean: 6.7
SD: 2.4

Mean: 7.0
SD: 2.2

Mean: 6.9
SD: 2.3

Mean: 6.8
SD: 2.4

w 8 → 10 → 11 → 12

Spring '23　　　**Fall '23**　　　**Winter '24**　　　Spring '24
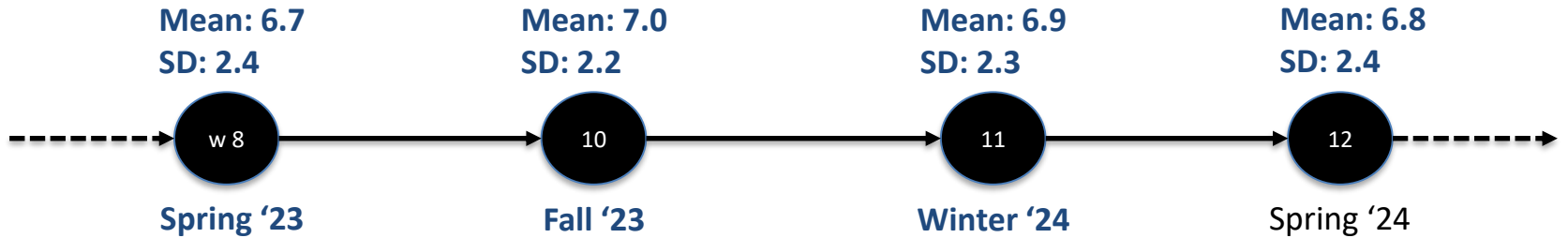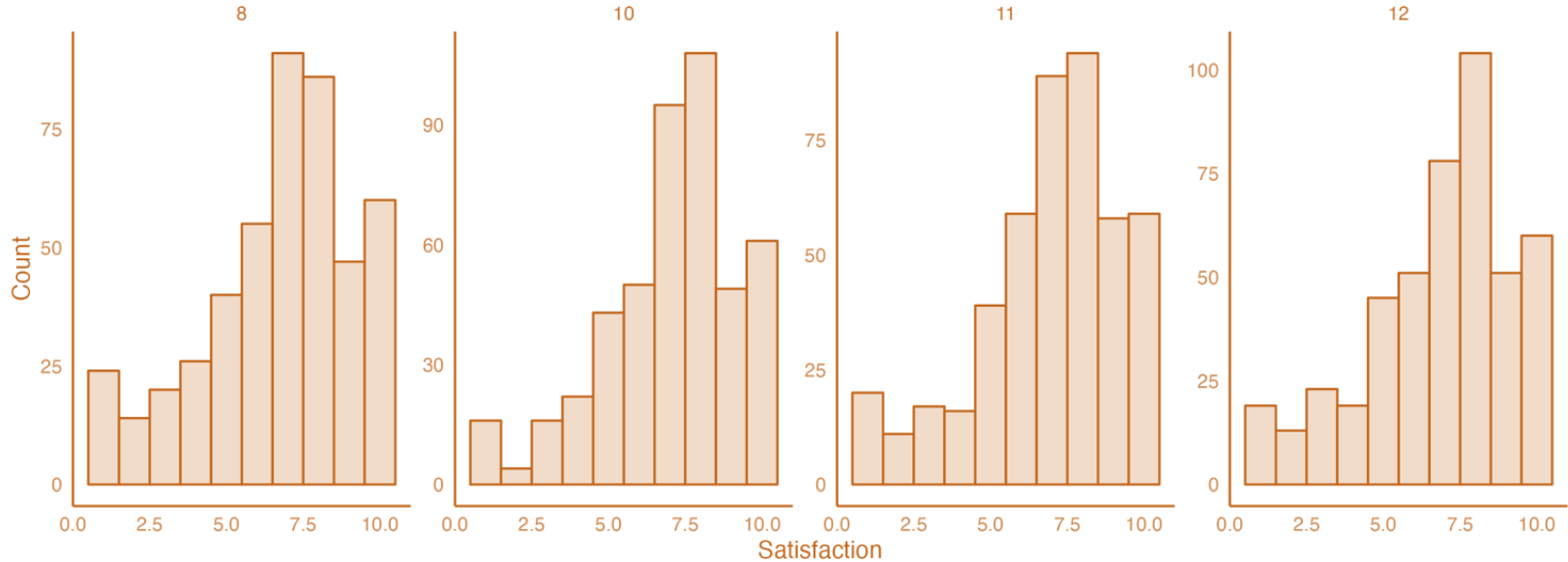
Multilevel approach – partial pooling over groupings
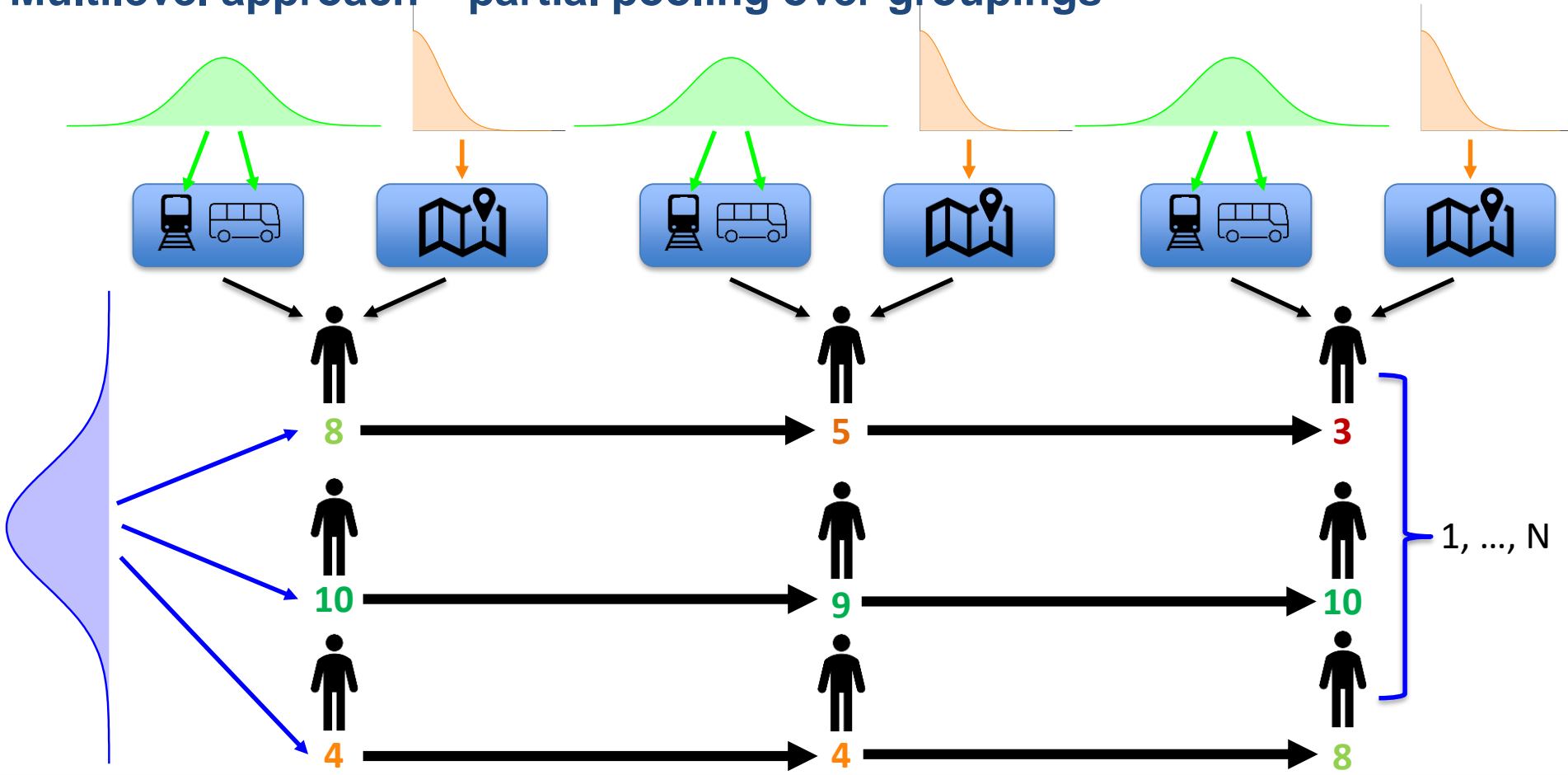
Multilevel predictions (simple structures)

Most variance in partial pooling model owed to individual time effect
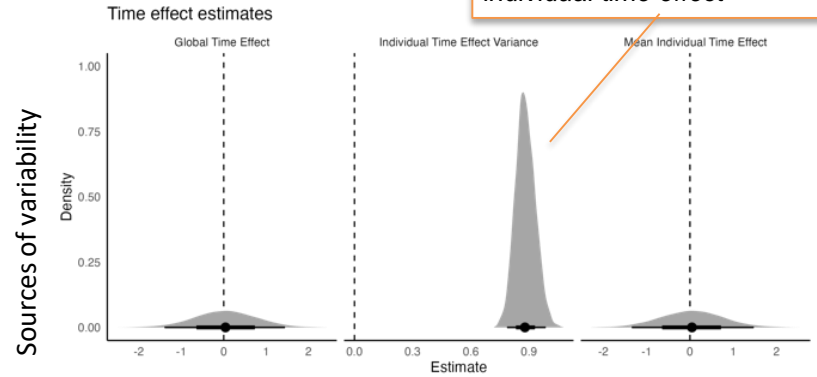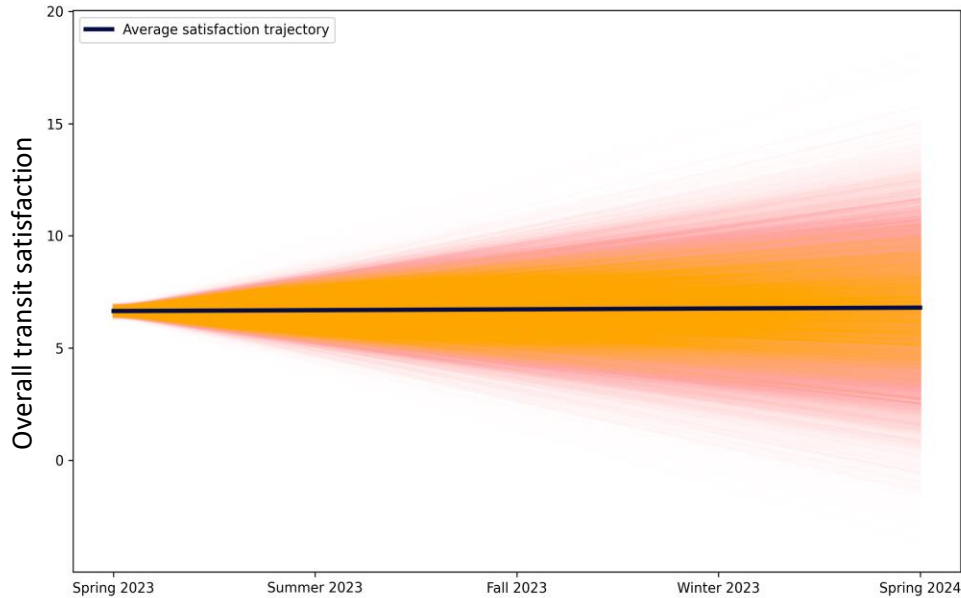
Age *has largest impact on satisfaction (older more satisfied)*

Q3: In what way is transit satisfaction changing, how rapid is that change, and how dispersed are opinions at each time period?

- Find home to variance
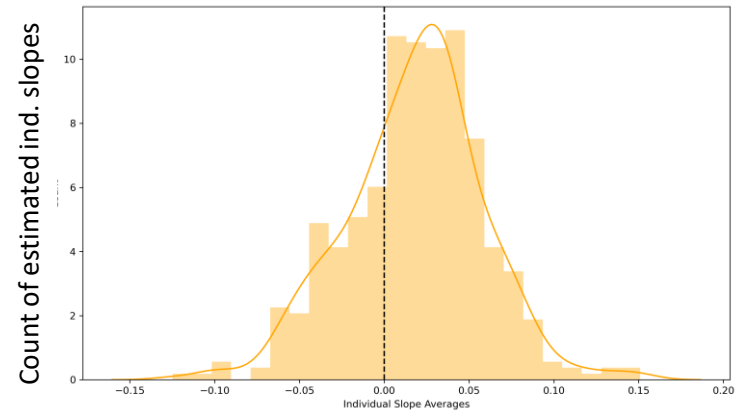- Explore sources of variability (individual, mode, location, time)
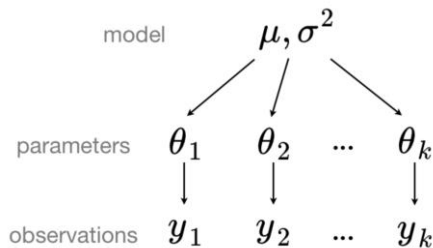
Coefficient estimates - individual characteristics

Black ethnicity shifts satisfaction to lover level (not highly sig)

Posterior beta estimates for key covariates

Northwestern

Controls for income, transit tenure

15
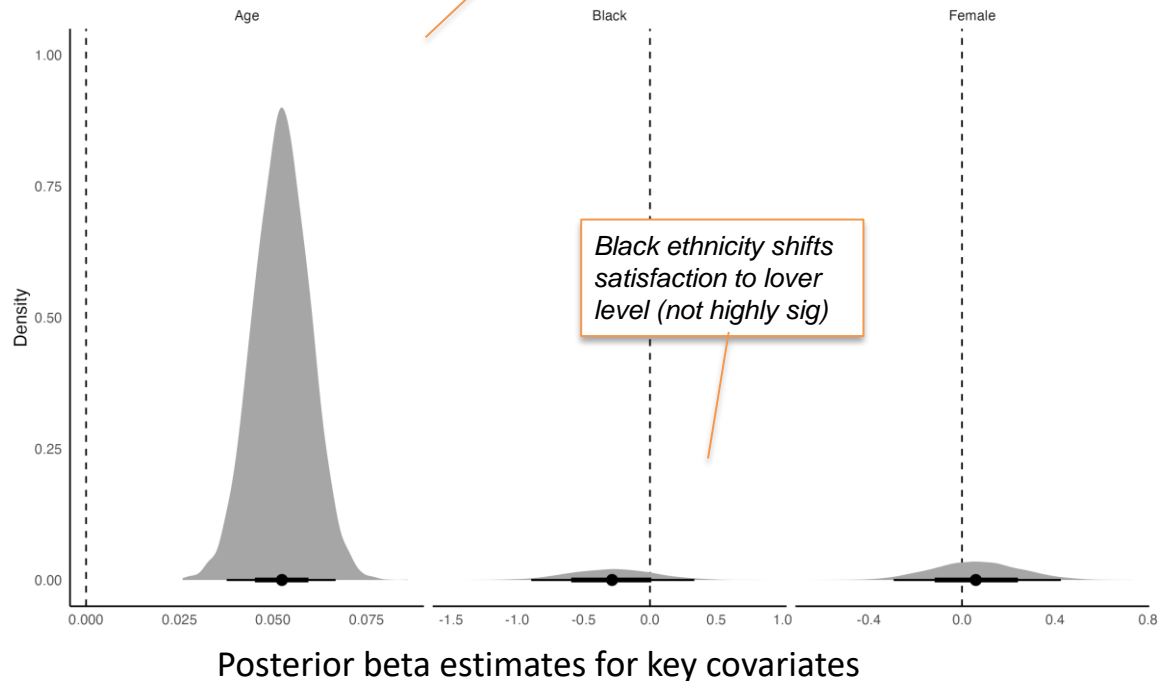
Peak into spatial spillover (ongoing work)
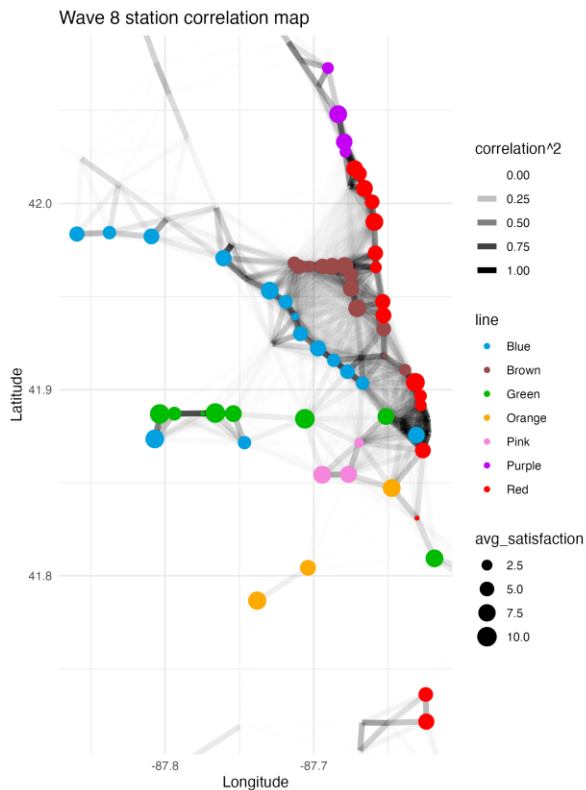
Summary of insights

Q1. Divided reaction to safety measures

Finding: Pro enforcement ↔ higher overall transit satisfaction, but is also divisive

Impact/Metric : Account for heterogeneity & tailor safety programs by knowing rider profiles

(a) Average enforcement receptiveness values by (vehicle ownership, income) group   (b) Average QI receptiveness values by (vehicle ownership, income) group
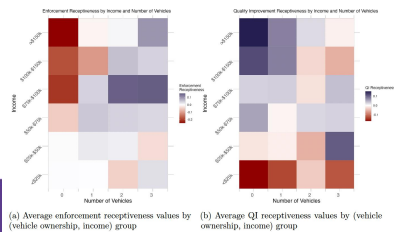
Q2. Experience sources matter

Finding: safety hazard experience → enforcement acceptance → satisfaction (stronger for Enforcement).
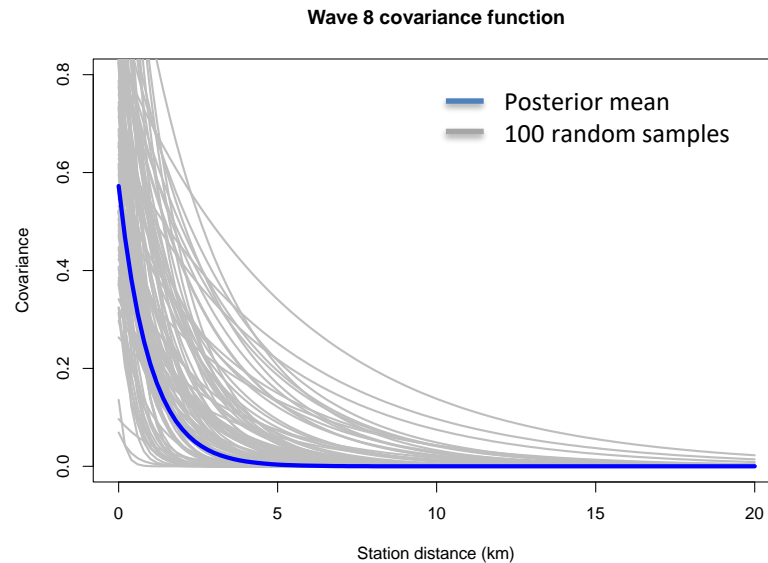
Impact/Metric: Account for experience channel. Quantify impact

Q3. Trajectory MLM Bayesian modeling

Finding: Partial pooling reveals source of variance: slopes mainly vary by individual time 'drift'

Impact/Metric: Account for both main trend and variability. Allocates sources of variance
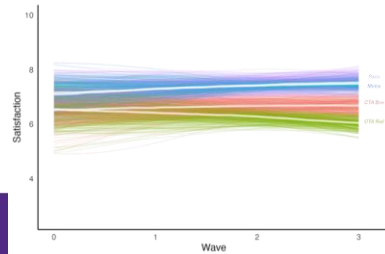
Questions

- As modelers how should we contend with divisive "cure is worse than the problem" scenarios (e.g. social distancing, climate policy, road pricing, enforcement and safety)
  - Bayesian marginal posterior distributions give new insight
- How can we account for politicization and ideological aspects in transportation decisions.
  - Can the 'winners' really compensate the 'losers': should we apply a different weight for a vulnerable group, e.g. transit-reliant household?
  - Does illustrating divisiveness help make practical decisions?

Question about modeling learning/experiences

- How can we account for different **learning** channels in a model setting (e.g. direct experience or WOM)?
  - Own experience > Word-of-mouth → satisfaction
  - Traditional media vs. social media have different ranking by safety measure

- Can MLM partial pooling approach help model attitude evolution (esp. with small samples, complex hierarchy, longitudinal data)?

- Should agents be allowed a 'discordant' view of attributes and <u>policies</u>?

- Should we give agents prior experiences? Are they predisposed for updating preferences in some way?

- Should individual agent trajectories change endogenously (or be more/less deterministic informed by MLM)

Credibility of research – some thoughts

Method and data transparency: availability of design details, analytic choices, and underlying data);

If a finding reported with lower levels of transparency is to be considered less credible → behavioral research may be penalized (possibly also some big-data sets)

Sophisticated modeling starts out with simple exploration of data, e.g., unexpected or nuanced relations traced through modeling

Analytic reproducibility: ability of reported results to be reproduced by repeating the same data processing and statistical analyses on the original data);

Worked with different data-cleaning and exclusion practices, rerun model

Convergence and Model Checks as subsection in paper; compare posterior to data

Analytic robustness: robustness of results to different data-processing and data-analytic decisions); and

Tested different priors: e.g. weakly-informative priors, diffuse priors

Effect replicability: ability of the effect to be consistently observed in new samples, at a magnitude similar to that originally reported, when methodologies and conditions similar to those of the original study are used

Advancement of machine learned models more difficult to replicate: Challenging to understand how transferability is verified in complex models developed using large (opaque) training data sets

Posterior predictive and observed satisfaction distributions
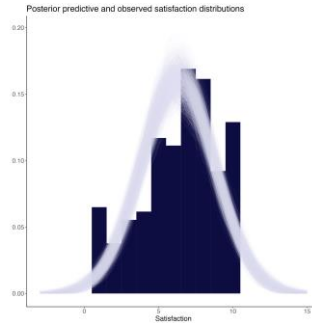
Thank you! Questions?

- Papers and Resources
- Aeshliman & Stathopoulos "Trade-offs in transit public safety interventions: balancing enforcement and service quality improvements" under review in Transportation Research Part A: Policy and Practice.
  - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4989514
- Working paper: Aeshliman & Stathopoulos "Tracking public transit satisfaction trajectories with longitudinal multilevel models"
 - to be presented at TRB 2025

Other references

- *Currie, G., Delbosc, A., and Mahmoud, S. (2013). Factors influencing young peoples 'perceptions of personal safety on public transport. Journal of public transportation, 16(1):1–19.*

- Guerra, E. (2022). What the heck is a choice rider? A theoretical framework and empirical model. Journal of Transport and Land Use, 15(1):165–182. Publisher: Journal of Transport and Land Use.

- Klein, N. J., Ralph, K., Thigpen, C., and Brown, A. (2022). Political partisanship and transportation reform. Journal of the American Planning Association, 88(2):163–178.

- Barajas, J. M. (2021). Biking where Black: Connecting transportation planning and infrastructure to disproportionate policing. Transportation Research Part D: Transport and Environment, 99:103027.
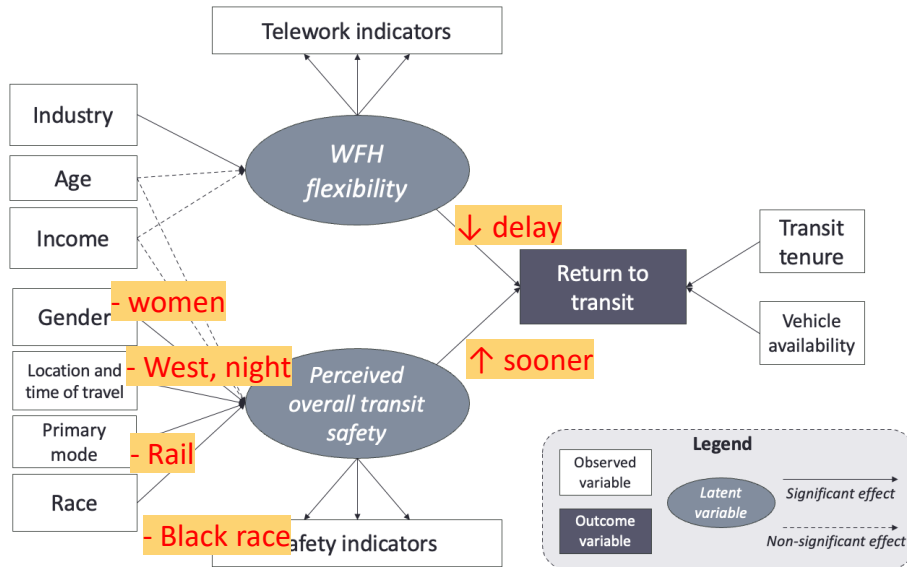
Primary Hypotheses

1. Increased sense of safety/security shortens RTT timelines
2. Increased WFH flexibility extends RTT timelines
3. Circumstances of regular transit use (mode, time of day, etc.) play a role in formation of perceived safety
4. Longer-tenured transit riders return sooner

Latent variables *Indicators*

Causes

Demographics, transit use, HH Veh

Crime Experience (direct, Soc. Media, Trad Media)

Nuisance Experience (direct, Soc. Media, Trad Media)

Enforcement receptiveness

Quality of Serv. receptiveness

Police

Private security

K-9 dogs

Lighting

Cleanliness

Reliability

Outcome

Rider satisfaction

Ridership