TRB TRANSPORTATION RESEARCH BOARD
Conference on
Innovations in Travel Analysis and Planning
Indianapolis, IN • June 4–6, 2023

Improving the Representation of Telecommuting in Activity-Based Travel Models

Sijia Wang, WSP

Project Team

- Rebekah Straub, Ohio DOT
- Zhuojun Jiang, Ohio DOT
- David Ory, WSP
- Greg Giaimo, WSP

Agenda

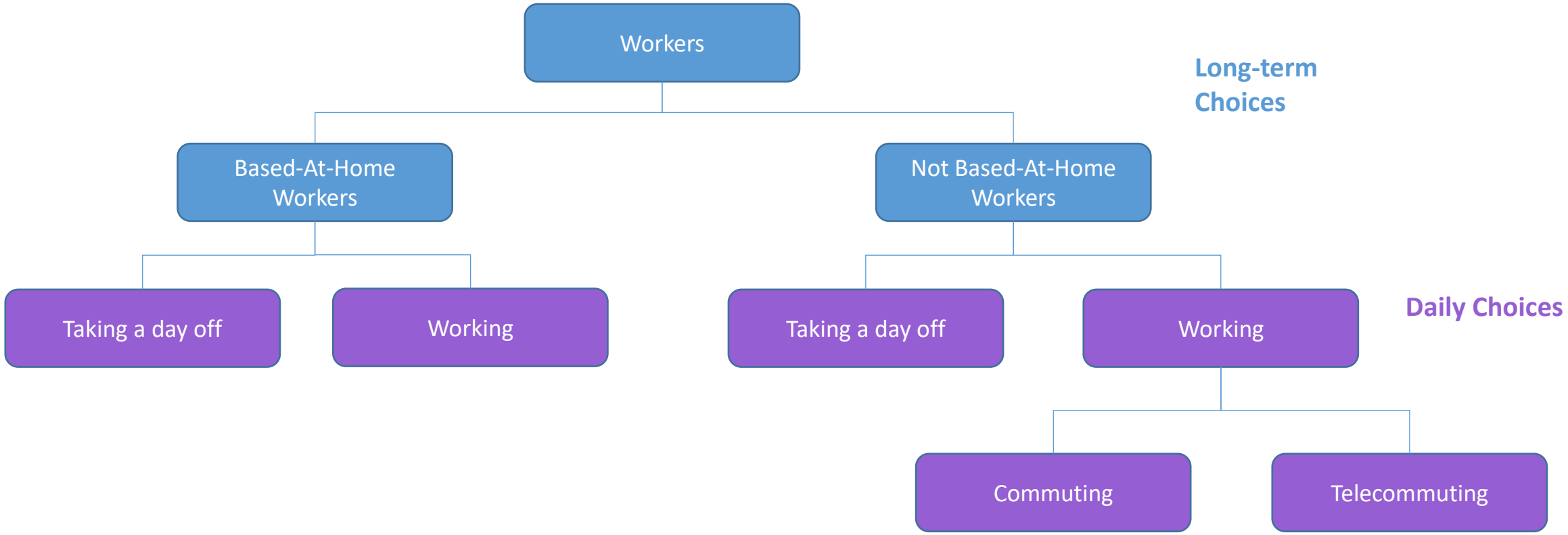
- Desired Telecommuting Features
- Ohio “3C” Model Improvements
- Ohio “3C” Model Results
- Potential Areas for Future Development

1. Desired Telecommuting Features

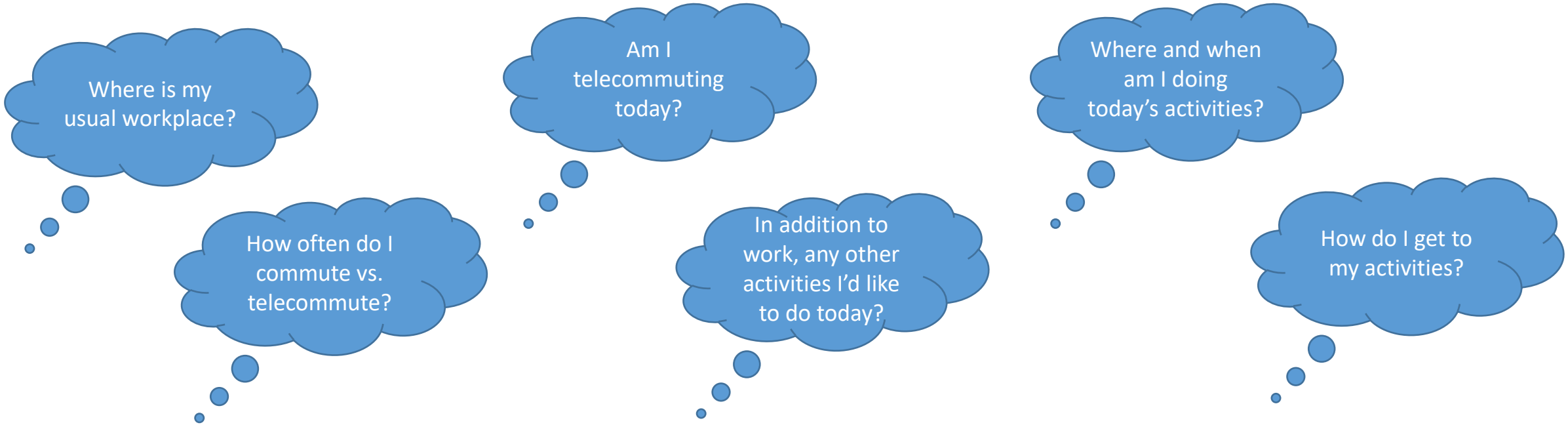
Why do we need to model telecommuting

- Project planning and design
- Long Range Transportation Plan
- Economic analysis
- Infrastructure investment
- Air quality conformity
- Equity analysis

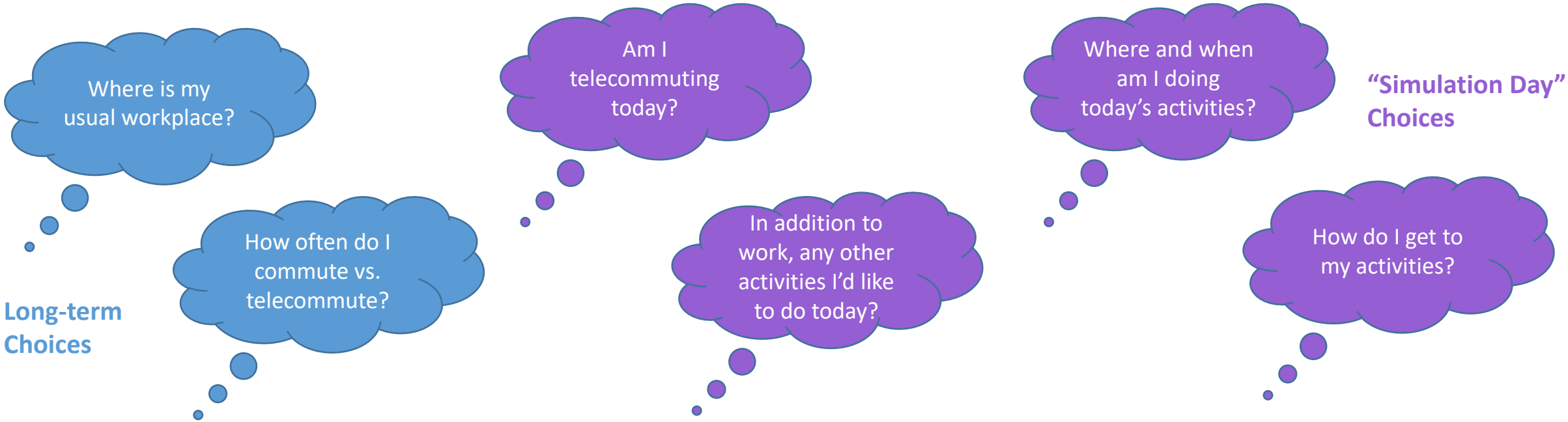
Setting the stage - definitions



Decision making points of a worker



Decision making points of a worker



Existing activity-based models all:

- Simulate some of these decision points
- Chain the decision-making points differently

Desired model features of telecommuting

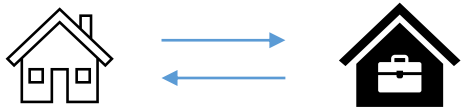
Who	Telecommuters should be explicitly identified in the model simulation.
What	Time spent working at home should be identified as such, i.e., a work activity.
When	Time spent telecommuting at home should be explicit, i.e., scheduled.
Where	Telecommuters should have an out-of-home work location, i.e., we know where they are not traveling to.
Why	Telecommuters' occupations and industries should align with ability of those types of jobs to telecommute; commute impedance should influence telecommuting choice.

2. Ohio “3C” Model Improvements

Model features of telecommuting

		Other ABMs (CT-RAMP, …)	Ohio ABM (CT-RAMP 2)
Who	Telecommuters should be explicitly identified in the model simulation.	✗	✓
What	Time spent working at home should be identified as such, i.e., a work activity.	✗	✓
When	Time spent telecommuting at home should be explicit, i.e., scheduled.	✗	✓
Where	Telecommuters should have an out-of-home work location, i.e., we know where they are not traveling to.	✓	✓
Why	Telecommuters' occupations and industries should align with ability of those types of jobs to telecommute; commute impedance should influence telecommuting choice.	✓	✓

Fundamental differences between the Ohio ABM and the other ABMs on telecommuting

	Other ABMs (CT-RAMP, …)	Ohio ABM (CT-RAMP 2)
Travel Generation	Focus on out-of-home tours 	Focus on activities and their locations 
For Telecommuters	➢ What? Should have fewer tours to out-of-home workplace ➢ How? Make them not working in the simulation; More days telecommuting leads to higher propensity for not working ➢ Shortcoming? Telecommuters cannot be identified in the simulation; they are the same as workers taking the day off	➢ What? Should have fewer tours to out-of-home workplace ➢ How? They are working, their work location in the simulation is home; Telecommuters are explicitly identified ➢ Why better? Telecommuters are working, they follow work schedule

Model features of telecommuting

		Other ABMs (CT-RAMP, …)	Ohio ABM (CT-RAMP 2)
Who	Telecommuters should be explicitly identified in the model simulation.	✗	✓
What	Time spent working at home should be identified as such, i.e., a work activity.	✗	✓
When	Time spent telecommuting at home should be explicit, i.e., scheduled.	✗	✓
Where	Telecommuters should have an out-of-home work location, i.e., we know where they are not traveling to.	✓	✓
Why	Telecommuters' occupations and industries should align with ability of those types of jobs to telecommute; commute impedance should influence telecommuting choice.	✓	✓

The first time a practical ABM includes an explicit representation of telecommuters engaged in working while at home

3. Ohio “3C” Model Results

Ohio model explicitly identifies the telecommuters on the simulation day …

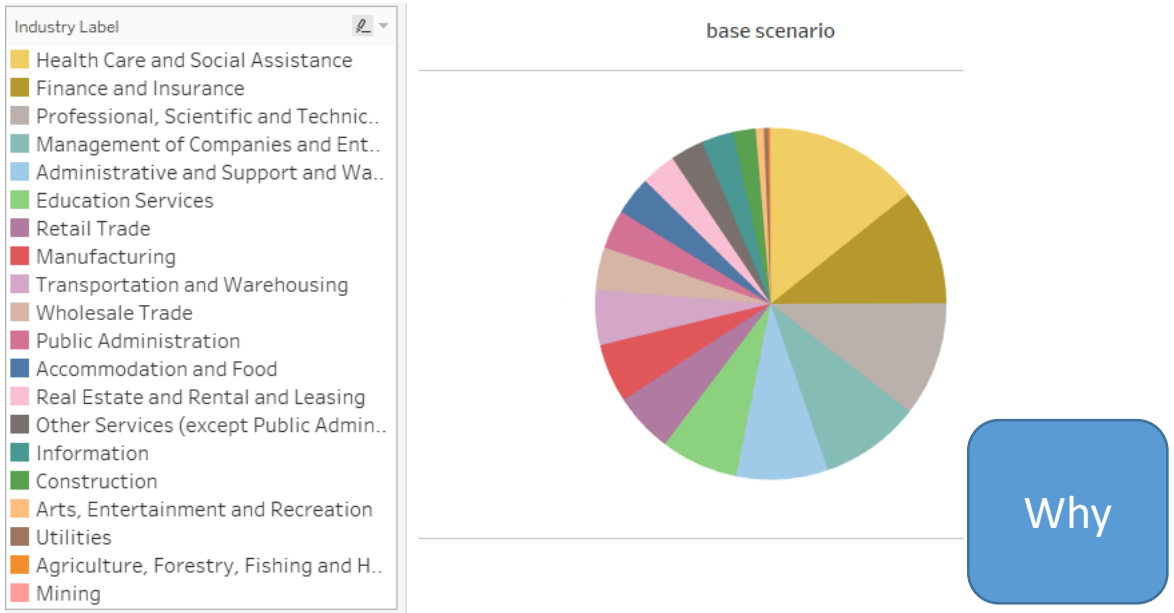
We can calculate the telecommute rate based on the number of workers telecommuting on the simulation day …

Workers on the Simulation Day

Commuting Type	Scenario: base scenario
Commuter	699,981
Telecommuter	16,019
Based-at-home worker	42,243
Worker taking a day off	119,275
Grand Total	877,518

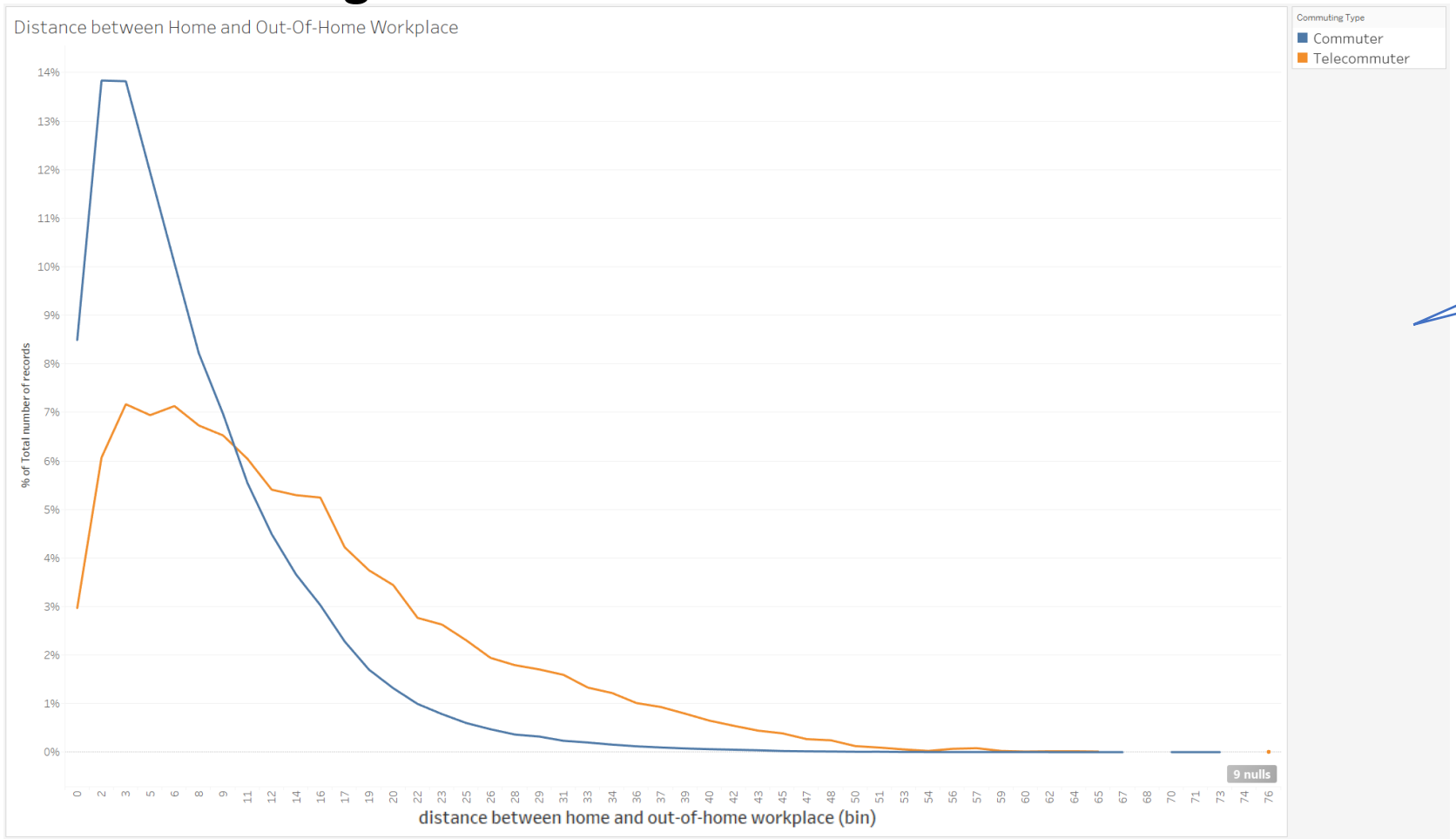
Who

… and profile telecommuters by, e.g., industry type



Why

By identifying telecommuters on the simulation day, we know where they are not traveling to …

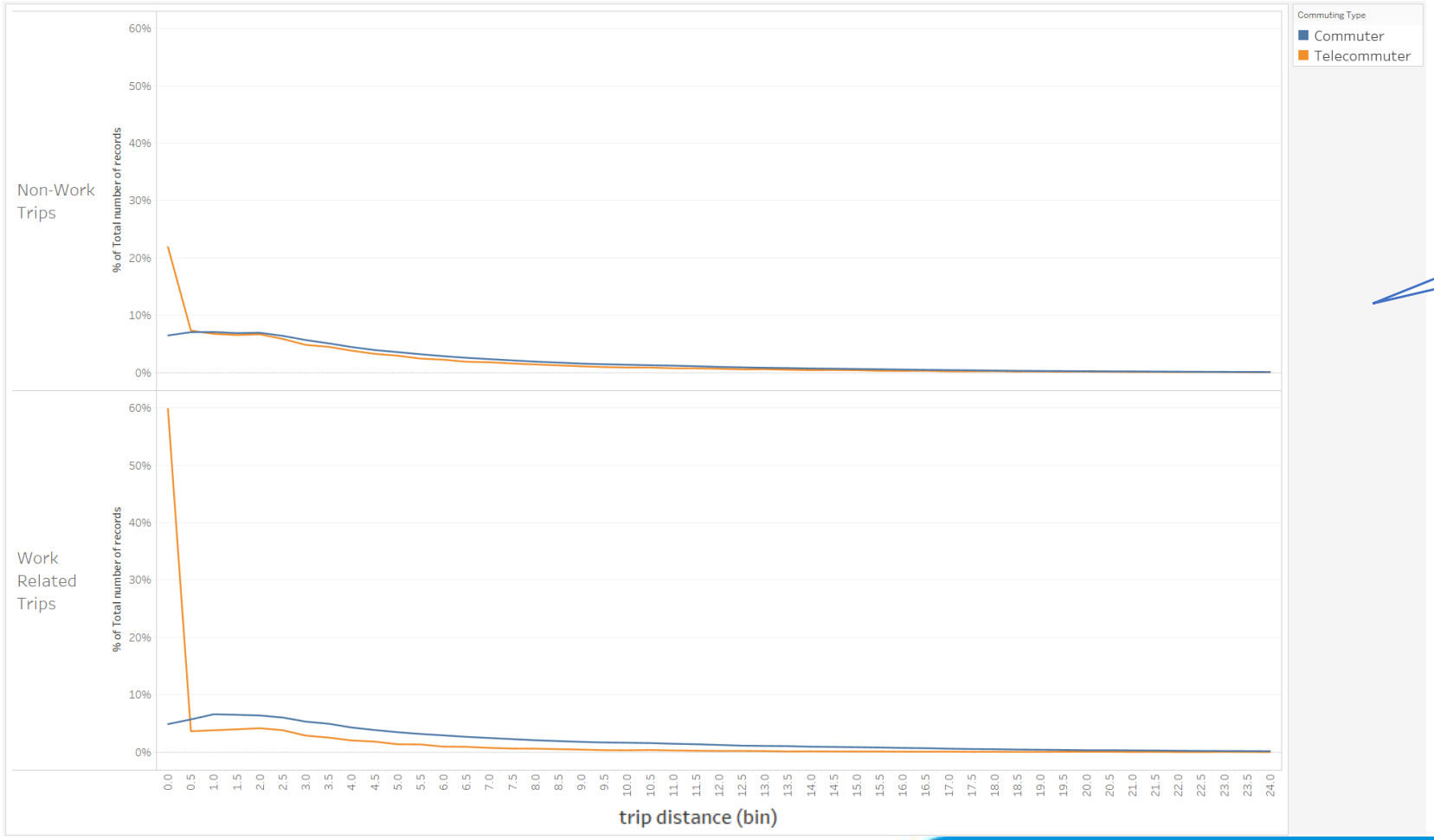


Telecommuter's out-of-home workplace is farther than commuter's

Where

Why

Ohio model generates telecommuter's other non-work activities …



Telecommuter's trips are shorter than commuter's

Where

Ohio model enables detailed VMT saving analysis from telecommuting

Scenario	persType label	Commuting Type	Daily Trip VMT	number of persons
base scenario	Full-time Worker	Commuter	30.2	590,393
		Worker not working	20.2	74,611
		Telecommuter	17.4	13,502
		Based-at-home worker	14.6	30,953
	Part-time Worker	Commuter	26.0	109,588
		Worker not working	14.3	44,664
		Telecommuter	16.4	2,517
		Based-at-home worker	13.4	11,290
	University Student	not a worker	14.4	96,347
	Non-worker	not a worker	16.2	251,853
	Retiree	not a worker	10.1	162,738
	Driving-age School Child	not a worker	7.6	61,919
	Pre-driving-age School Child	not a worker	0.2	245,041
	Pre-school Child	not a worker	0.5	129,017
Grand Total			17.2	1,824,433

Telecommuters have lower VMT compared to Commuters

Who

Ohio model honors telecommuters' work activities and schedules …

Commuting Type	number of persons	work activities per person	out-of-home work trips per person	non-work activities per person	out-of-home non-work trips per person
Commuter	699,981	1.3	1.3	2.6	2.6
Telecommuter	16,019	1.4	0.6	2.6	2.6
Based-at-home worker	42,243	1.4	0.6	2.7	2.7
Worker taking a day off	119,275	0.0	0.0	2.7	2.7

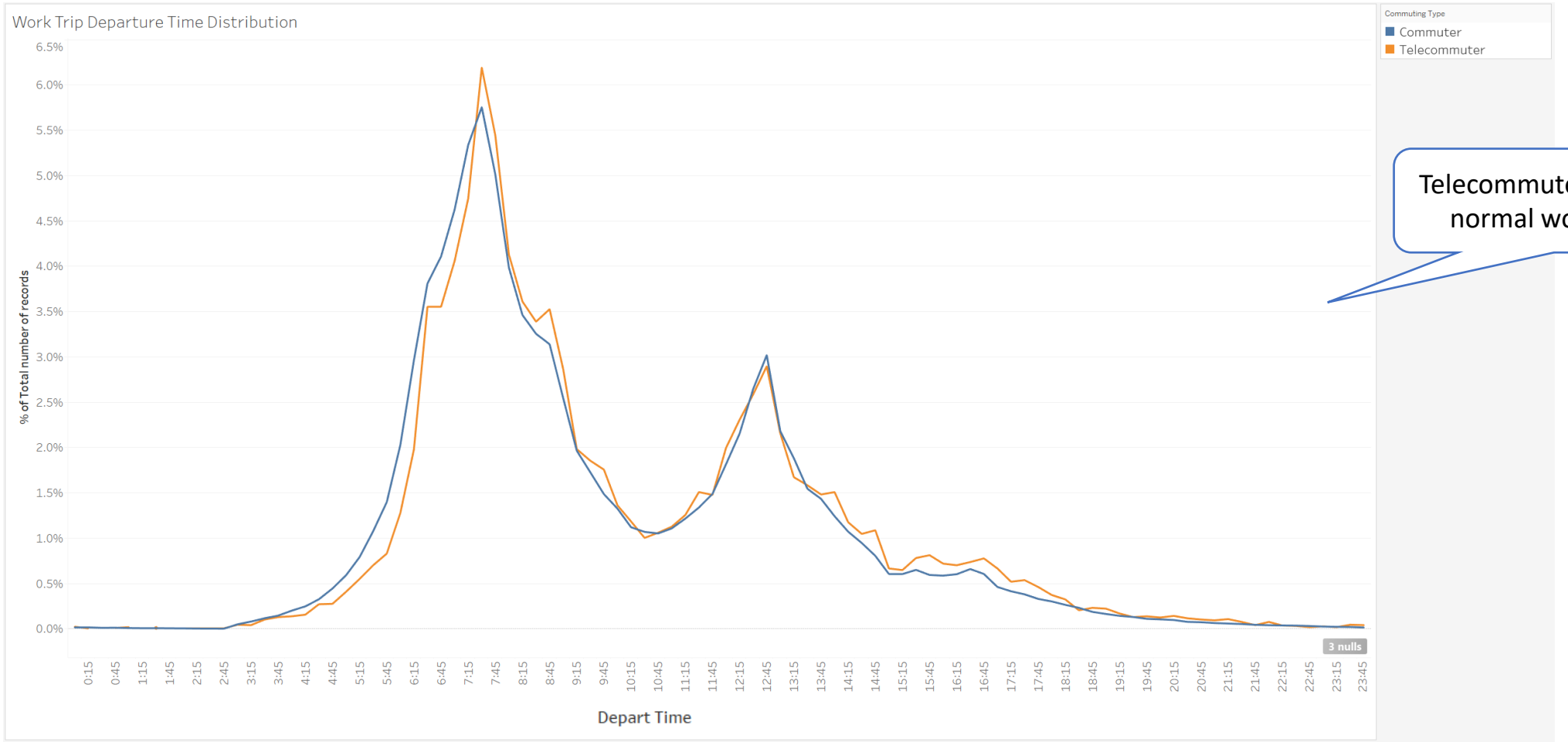
One step closer to true Activity-Based modeling

What

Commuting Type	number of persons	work activity duration per person (minutes)	non-work activity duration per person (minutes)
Commuter	699,981	453	122
Telecommuter	16,019	463	118
Based-at-home worker	42,243	448	118
Worker taking a day off	119,275	0	135

When

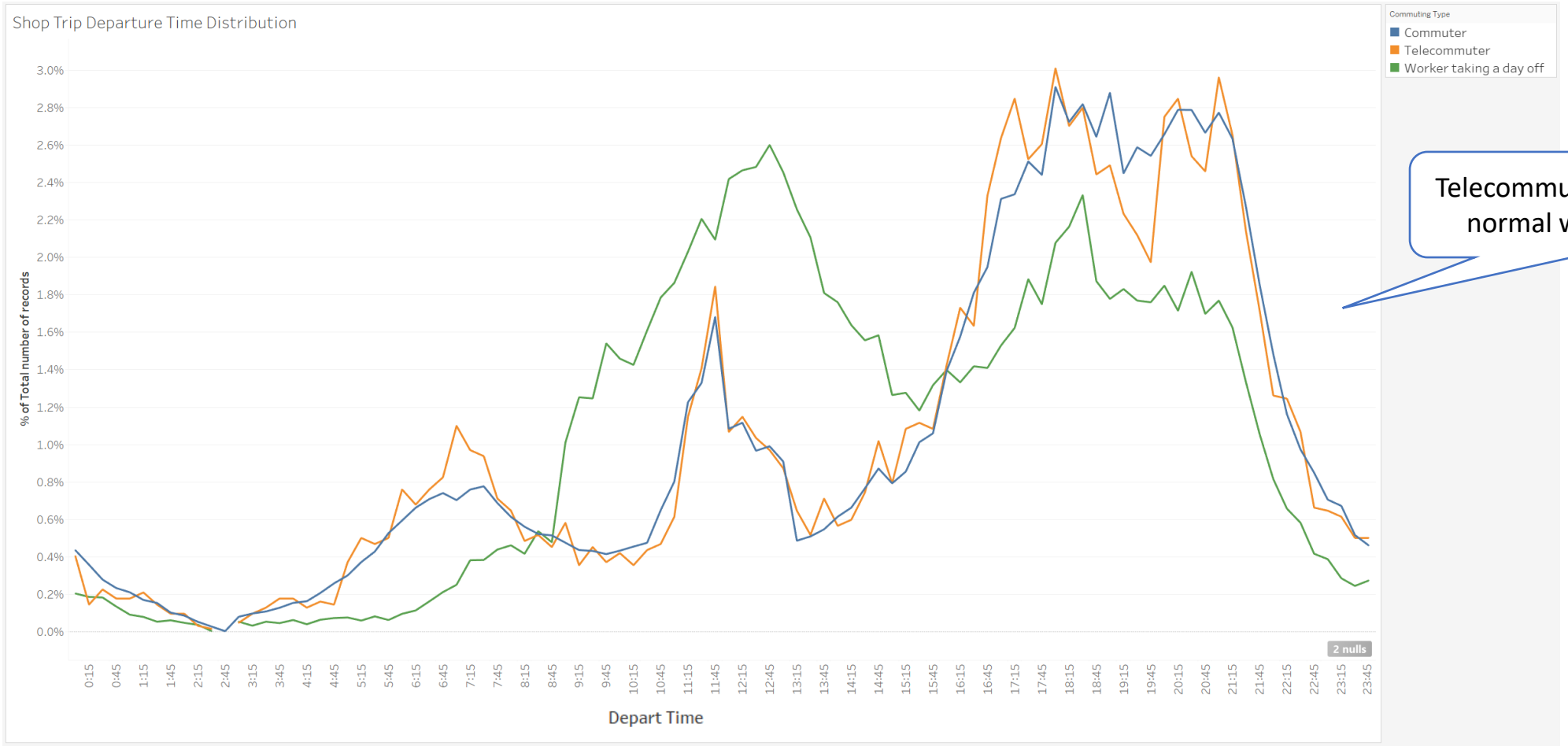
Ohio model schedules a “departure” time for telecommuter’s work activity



Telecommuters stick to their normal work schedules

When

Ohio model respects telecommuters' work schedule, as they cannot engage in other activities as freely as workers taking a day off



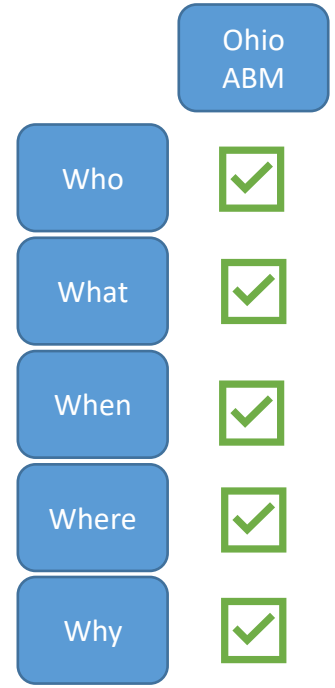
Telecommuters stick to their normal work schedules

When

An example itinerary of a telecommuter in the Ohio model

Activity	Start Time	End Time	Location	Mode
--	3:00 am	7:36 am	Home	--
Travel	7:36 am	7:46 am	--	Driver Shared Ride 2
Escort Child	**7:46 am**	**7:48 am**	**School**	**--**
Travel	7:48 am	8:02 am	--	Drive Alone
Work	**8:02 am**	**11:07 am**	**Home**	**--**
Travel	11:07 am	11:11 am	--	Drive Alone
Shopping	**11:11 am**	**11:43 am**	**Shop**	**--**
Travel	11:43 am	11:48 am	--	Drive Alone
Work	**11:48 am**	**4:22 pm**	**Home**	**--**
Travel	4:22 pm	4:33 pm	--	Drive Alone
Pickup Child	**4:33 pm**	**4:37 pm**	**School**	**--**
Travel	4:37 pm	4:40 pm	--	Driver Shared Ride 2
--	4:40 pm	3:00 am	Home	--

Telecommuters are allowed to make stops on the work tours to their home work places



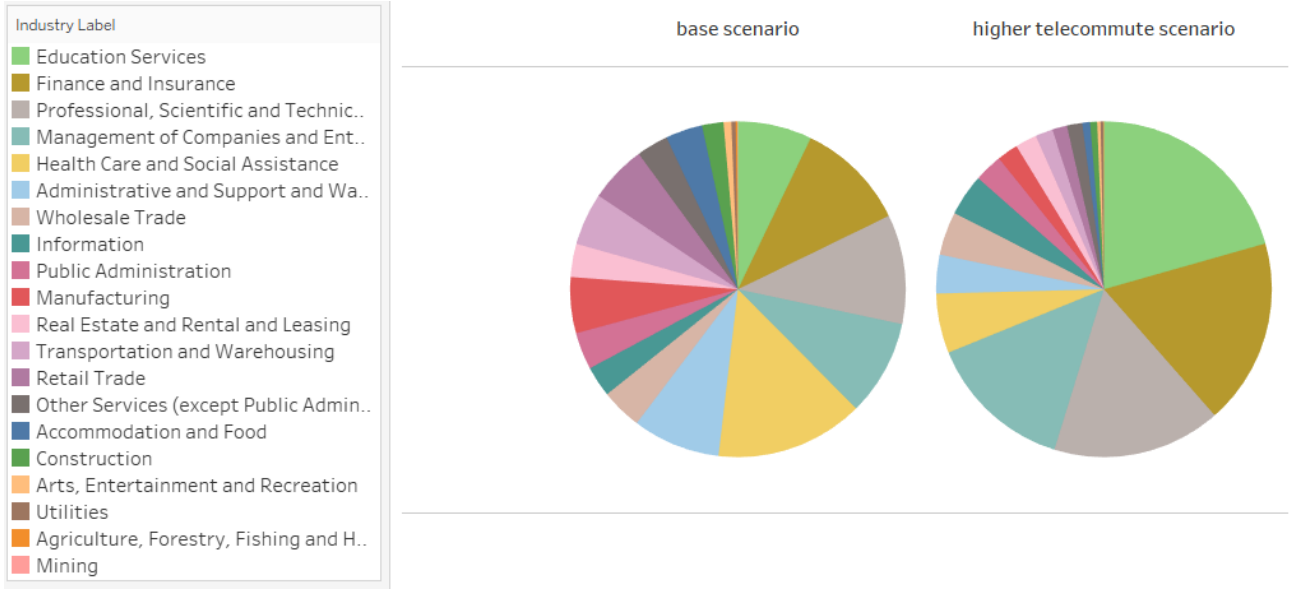
The model has a telecommute constant, which can be adjusted for higher telecommute rate …

By changing the constant, we can create a scenario with higher telecommute rate …

Workers on the Simulation Day

Commuting Type	Scenario: base scenario	Scenario: higher telecommute scenario
Commuter	699,981	585,333
Telecommuter	16,019	93,530
Based-at-home worker	42,243	81,195
Worker taking a day off	119,275	117,458
Grand Total	877,518	877,516

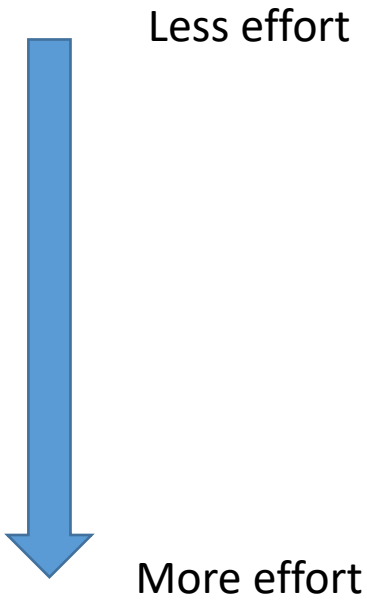
… and predict how different industries respond to telecommuting changes



4. Potential Areas for Future Development

Potential areas for future development

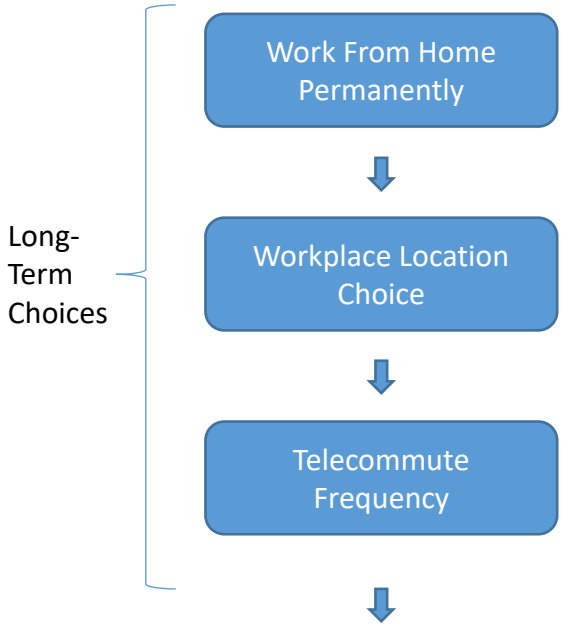
- Auto-calibrate the telecommute constants to reach a pre-defined telecommute rate
- Re-estimate sub-models with new surveys that have detailed telecommuting questions
- A first best solution would be a broader move to a truer “activity-based” formulation than those currently used in practice.
  - Such an approach would first create a work activity and then locate the work activity (either at home or at the usual workplace)



5. Thank You!

Appendix

Ohio ABM and the other ABMs have similar representation of "Where" and "why"



	Other ABMs (CT-RAMP, …)	Ohio ABM (CT-RAMP 2)
Is this worker a Base-At-Home Worker?	Yes or No for each worker. If yes, then there will be no out-of-home workplace location for this worker.	Same
The out-of-home workplace location	Simulates the location for non-BAH workers	Same
How many days does the worker telecommutes in a week	1, 2, 3, 4, … days Occupations and industries impacts the propensity to telecommute; Commute impedance should influence telecommuting choice.	Same

Ohio ABM improves telecommuting representation of "Who", "What", and "When"

ABM Model Steps
Continued
(*showing just relevant ones)

Simulation Day Choices

- Coordinated Daily Activity Pattern
- Explicit Telecommuting
- Downstream Models

	Other ABMs (CT-RAMP, …)	Ohio ABM (CT-RAMP 2)
Fundamental difference	• **Simulates out-of-home tours directly** • **Ignores activities happen at home or virtually** • **No time-space constraint** • **No schedule intelligence**	• **Simulates activities, then forms tours from activities** • **Has time-space constraint** • **Has schedule intelligence, e.g., can cancel activities if not able to accommodate the schedule**
On the simulation day, the person's CDAP pattern are one of: M, N, H	M = has Mandatory tour N = only has Non-mandatory tour H = has No tour ➢ Workers with higher telecommute frequency are more likely to be N or H	M = has Mandatory activity N = only has Non-mandatory activity H = has No Activity ➢ Workers with more days working are more likely to be M
Explicitly Identifies Telecommuters	No	Yes. Based on CDAP and the frequency of commuting and telecommuting. ➢ Assert the work location on the simulation day to be home location
How tours and trips are generated	• Generates out-of-home mandatory tours • Generates out-of-home non-mand tours • Insert stops onto tours	• Generate activities (mand, non-mand) • Form tours and/or subtours from all activities