A Comparative Illustration of Trip- and Activity-Based Modelling Techniques

Hayden Atchley

Committee: Greg Macfarlane (chair)
Grant Schultz
Gustavious Williams

BYU Civil & Construction Engineering
IRA A. FULTON COLLEGE OF ENGINEERING

Introduction

- Activity-based models considered superior
  - Focus on theoretical benefits
  - Lack of discussion of practical benefits

- This research addresses the practicality of activity-based models
  - Not focused necessarily on model *accuracy*
  - Intended for agencies considering switching models

- Three scenarios
  - Land use change
  - Infrastructure change
  - Behavior change

Overview of Model Types

- Trip-based model
  - Aggregate population data, by TAZ
    - Number of households/people
    - Average income
    - Number of workers
  - Trips modeled at TAZ level

- Activity-based model
  - Synthetic population
    - Individual households/people
    - Individual income
    - Worker status
  - Trips modeled individually
  - Trips organized into “tours”

Difficulties with Activity-Based Models

- Computational inefficiency
  - More data in activity-based model
  - Longer runtimes/more resources required
- Complicated design
  - More steps
  - Complicated choice models
- Lack of interoperability
  - Models specific to an area

Methods

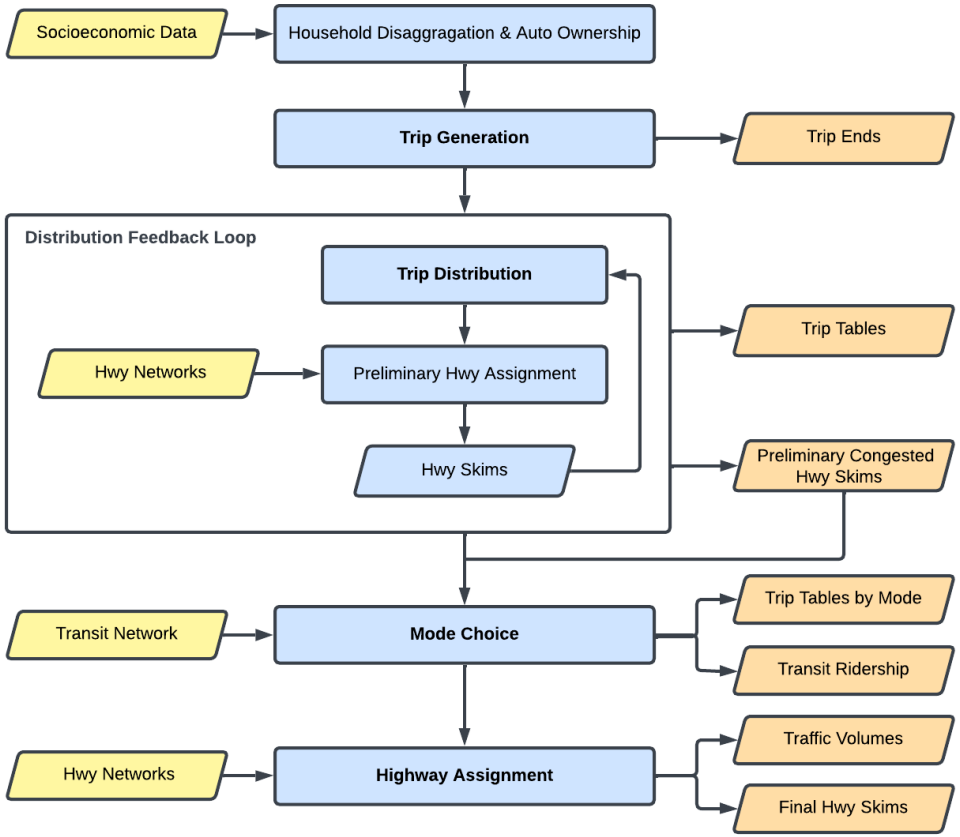
- Representative trip-based model: WFRC Model
  - Current production model for WFRC
  - Implemented in CUBE software

- Representative activity-based model: ActivitySim
  - Non-production, research implementation
  - Same model area as WFRC model
  - Synthetic population from PopulationSim
  - Network skims from WFRC model

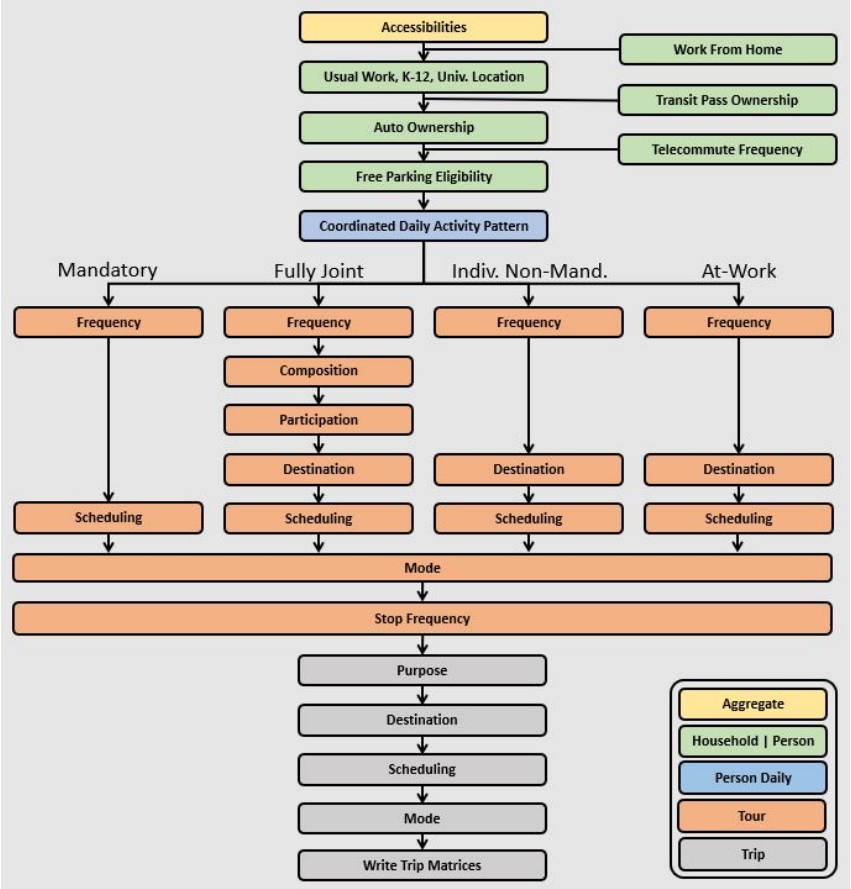
Model Flowcharts

BYU Civil & Construction Engineering

WFRC Model

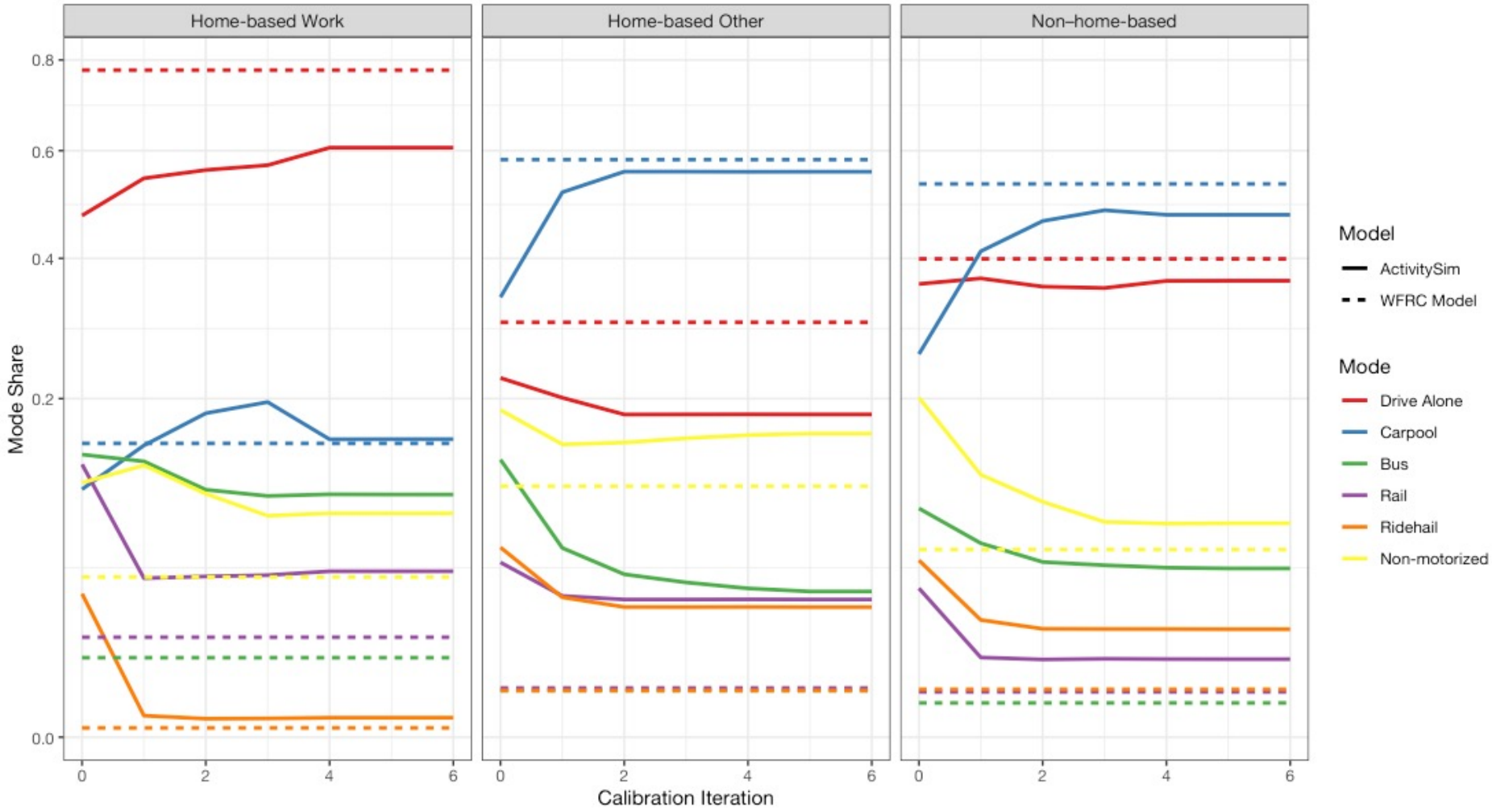


ActivitySim



Mode Choice Calibration

BYU Civil & Construction Engineering



Scenarios Overview

Land Use Scenario	Transit Scenario	Remote Work Scenario
• New development at old Draper prison site • Projected 2050 SE data for The Point Utah	• Increase frequency and speeds of FrontRunner • New Frontrunner stations • Based on WFRC 2050 plan	• Higher WFH and telecommute • Calibrated to WFRC 2050 projections

Land Use Scenario

WFRC Model:

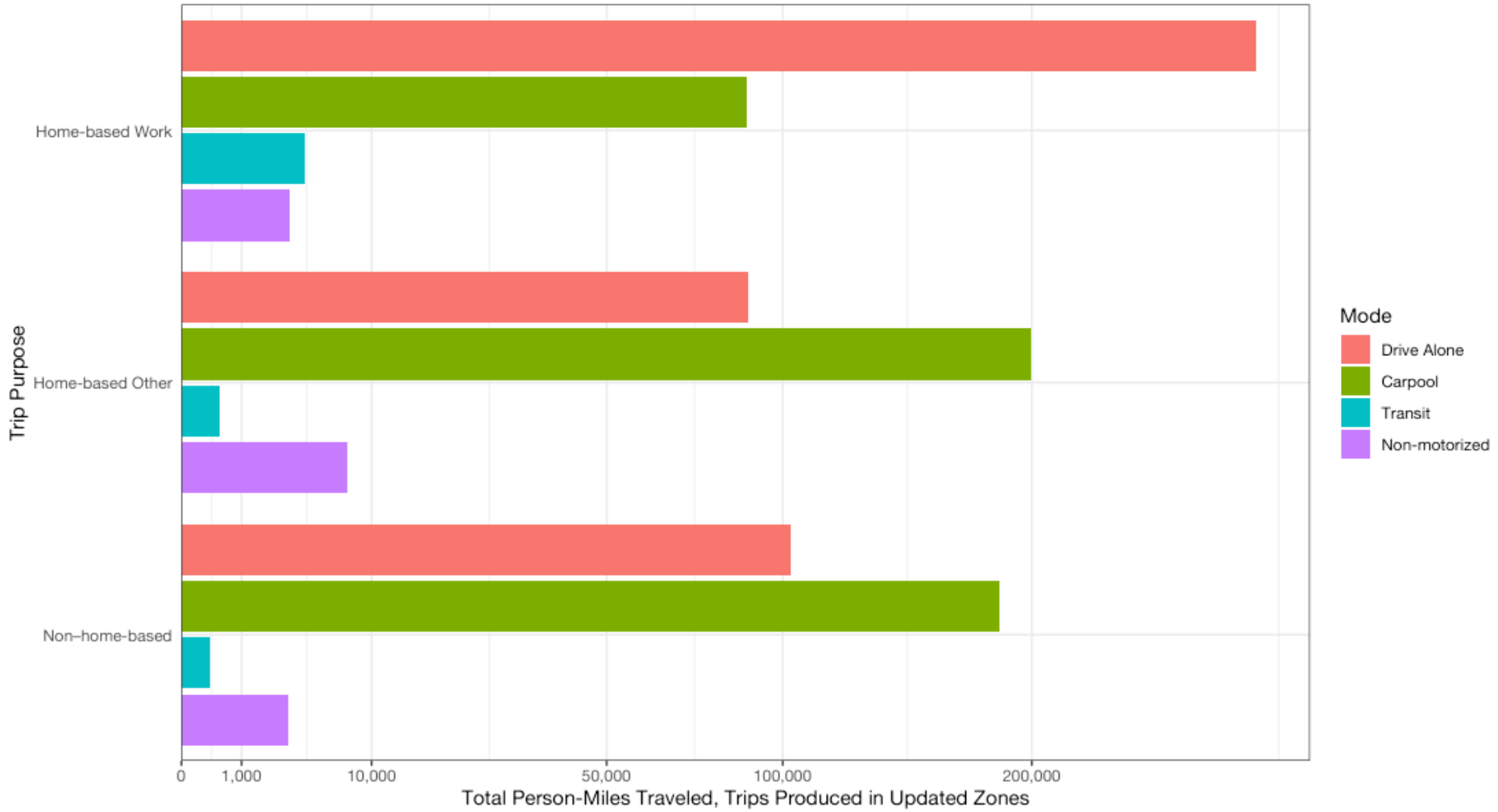
- Changed land use data for The Point area (Draper)
  - Match 2050 data
    - 7,430 New Households
    - 22,200 New Employments

ActivitySim:

- Updated PopulationSim
  - Re-run only The Point area
  - New Census targets from Gateway area (SLC)
  - Joined with base year population

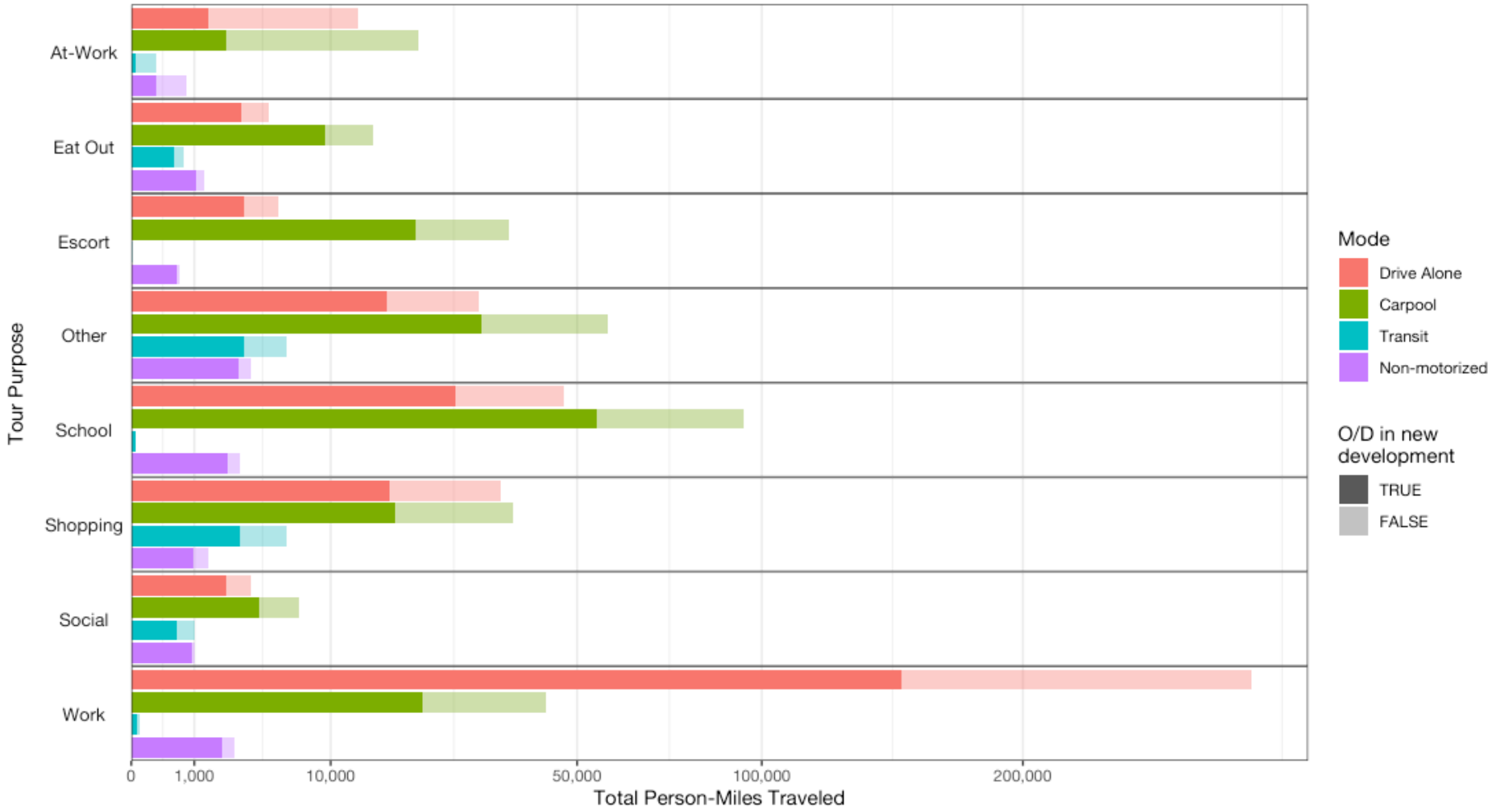
WFRC: Person-miles

BYU Civil & Construction Engineering



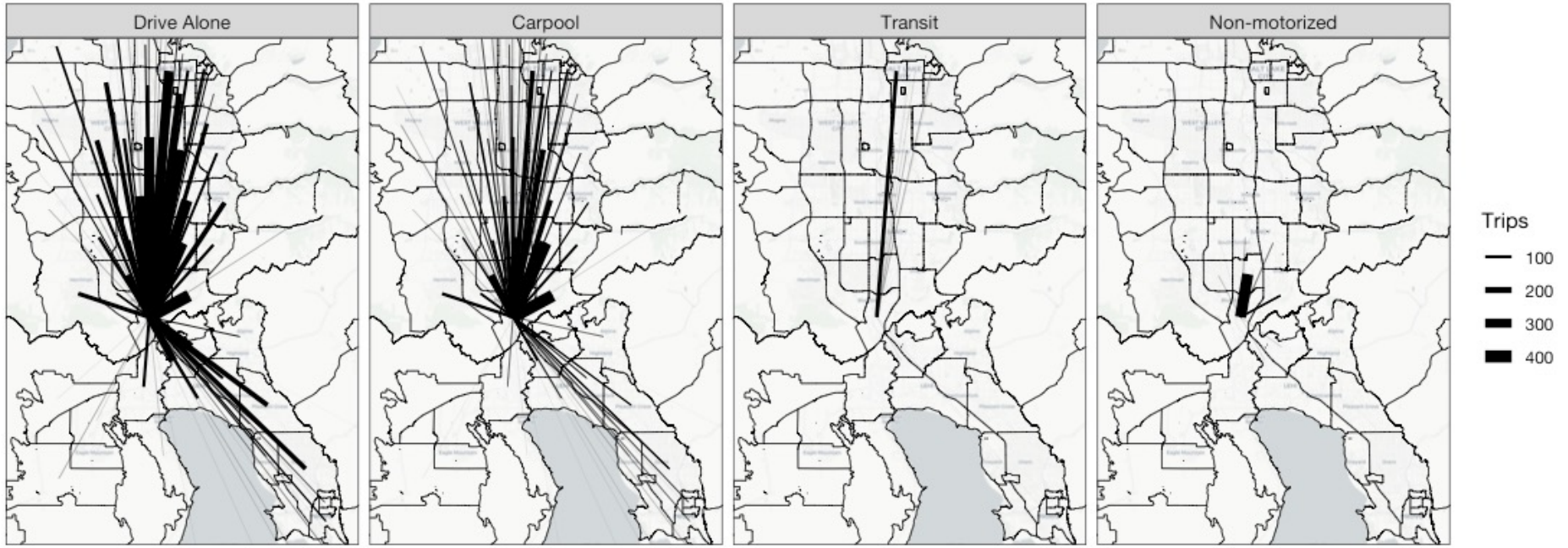
ActivitySim: Person-miles

BYU Civil & Construction Engineering

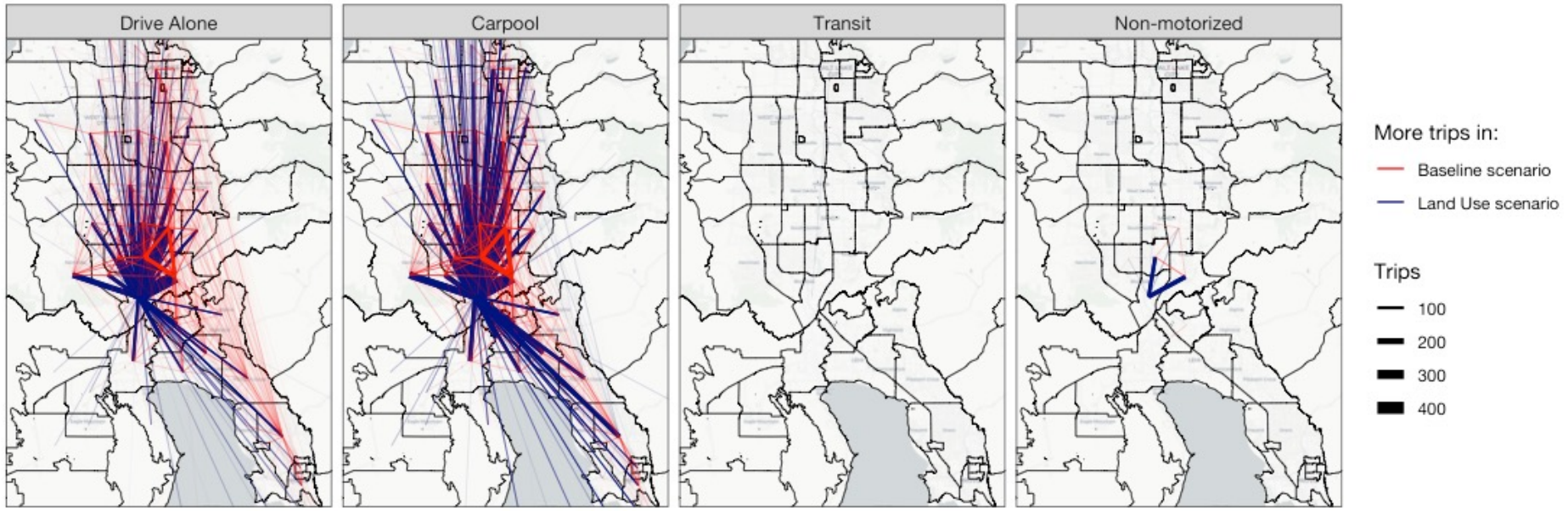


WFRC: Home-Based Trips

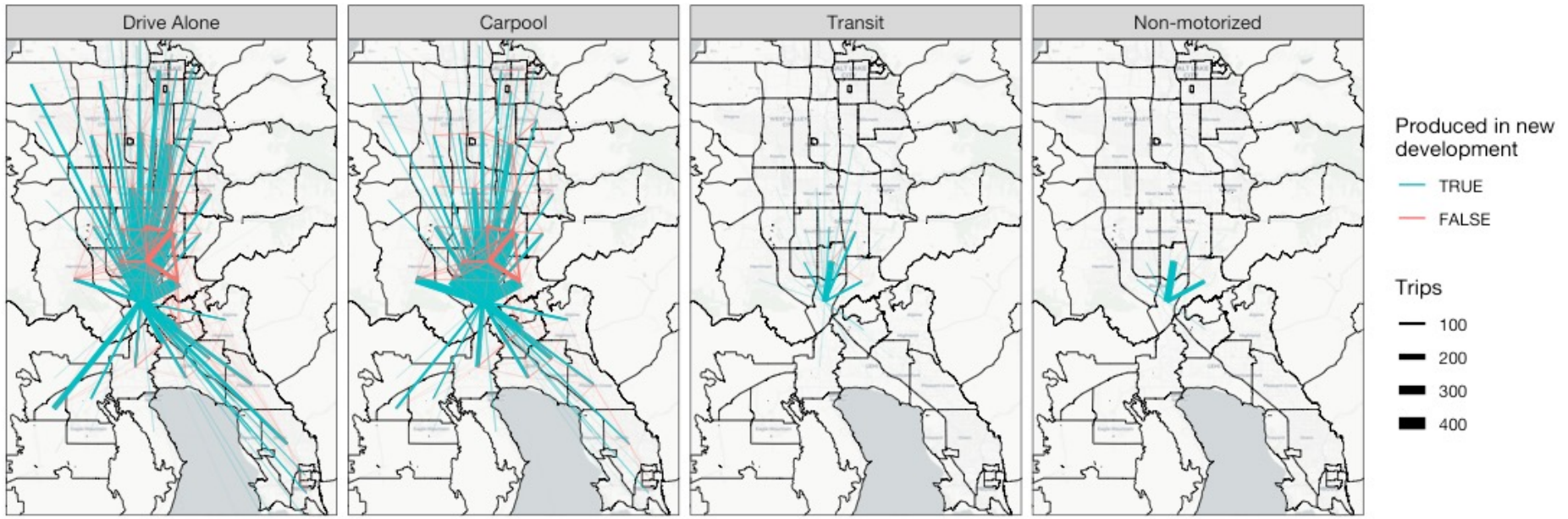
BYU Civil & Construction Engineering



WFRC: Non–Home-Based Trips



ActivitySim: New Resident Trips



Transit Scenario

WFRC Model:

- Adjusted FrontRunner headways from 60/30 to 30/15
- Used future speed and track extensions
  - Additional stations in Vineyard, Springville, Spanish Fork, and Payson

ActivitySim

- New skims from CUBE

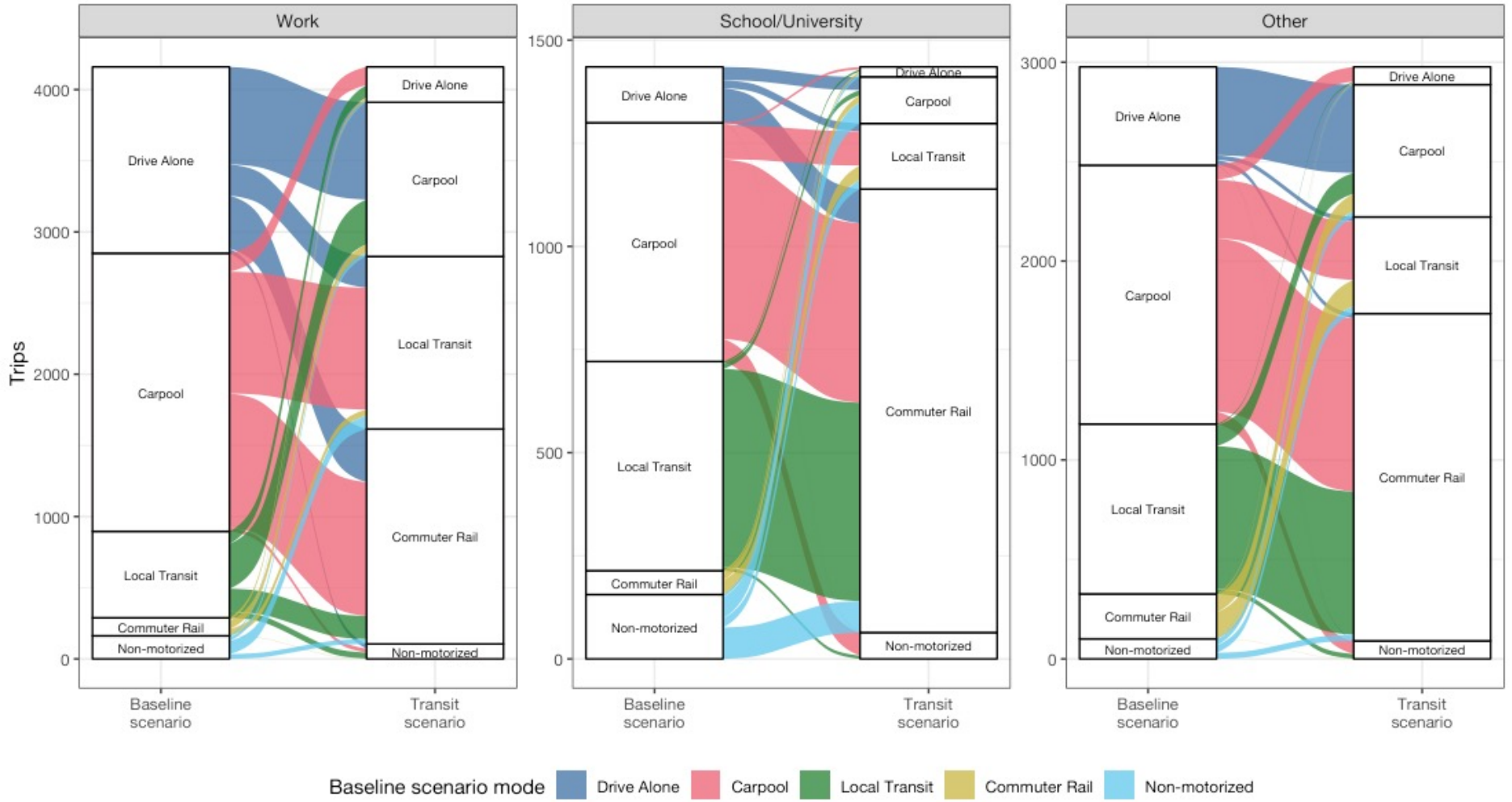
Change in Mode Split

BYU Civil & Construction Engineering

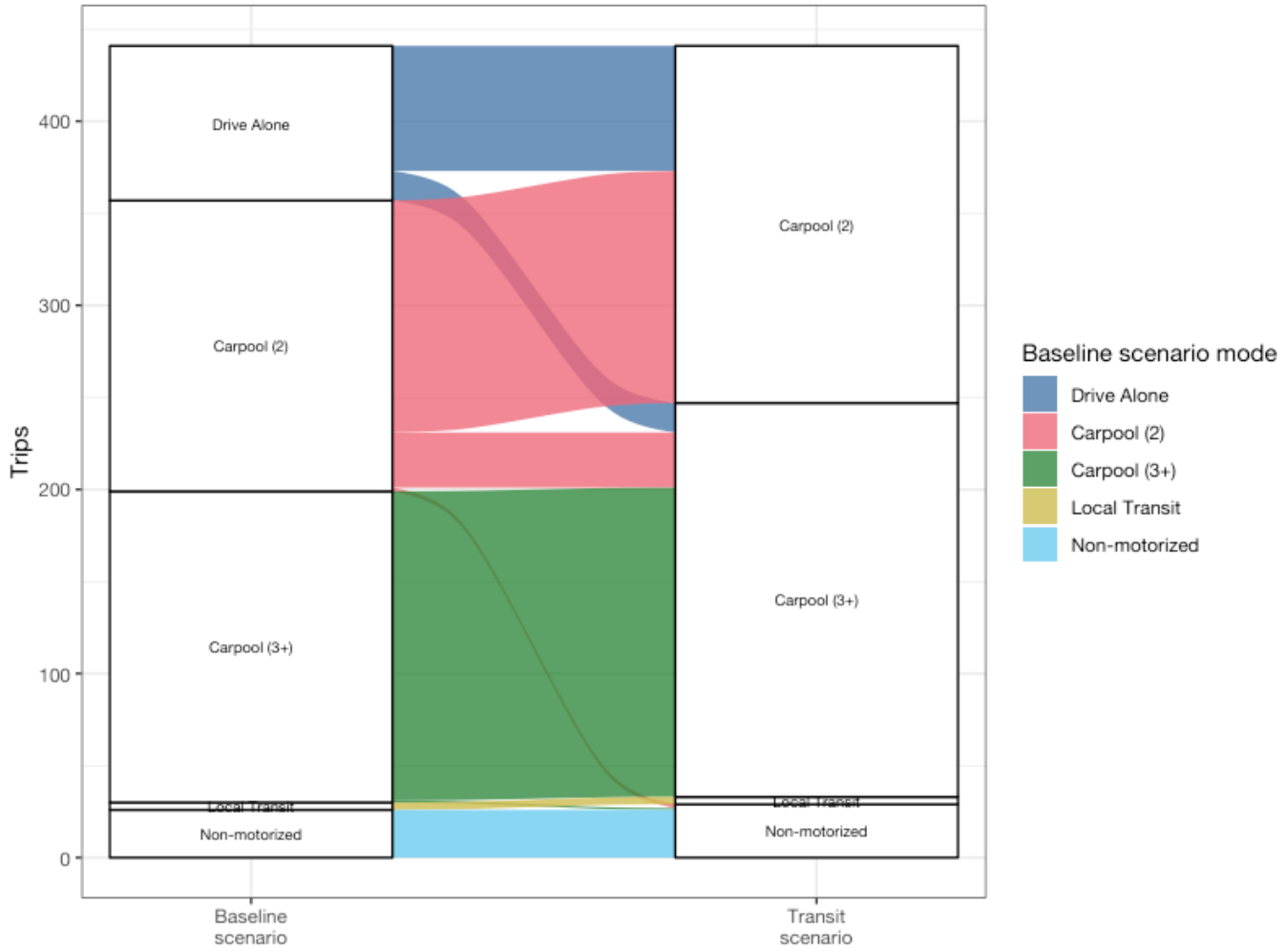
		WFRC Model			ActivitySim		
Purpose	Mode	Baseline Trips	Transit[1] Trips	Change	Baseline Trips	Transit[1] Trips	Change
Home-based Work	Drive Alone	1328609	1326191	-0.2%	1012180	1010565	-0.2%
	Carpool	257783	256654	-0.4%	258459	256550	-0.7%
	Local Transit	37935	36494	-3.8%	232222	233426	0.5%
	Commuter Rail	10821	15891	46.9%	19846	22265	12.2%
	Ridehail	—	—	—	1108	1099	-0.8%
	Non-motorized	76506	76396	-0.1%	145957	145845	-0.1%
Home-based Other	Drive Alone	1394415	1394095	0.0%	700133	698809	-0.2%
	Carpool	2702277	2701039	0.0%	2148429	2145135	-0.2%
	Local Transit	33168	32583	-1.8%	195062	194649	-0.2%
	Commuter Rail	4180	6332	51.5%	81094	87337	7.7%
	Ridehail	—	—	—	113624	113538	-0.1%
	Non-motorized	510143	510103	0.0%	613134	611996	-0.2%
Non–home-based	Drive Alone	951561	951407	0.0%	716143	714854	-0.2%
	Carpool	1273279	1272977	0.0%	938056	936408	-0.2%
	Local Transit	12213	12068	-1.2%	107526	108395	0.8%
	Commuter Rail	1243	1806	45.3%	12317	13344	8.3%
	Ridehail	—	—	—	40092	40061	-0.1%
	Non-motorized	146404	146409	0.0%	156819	156587	-0.1%

[1] "Transit" here refers to the Transit scenario, not the mode of travel

Mode Switching

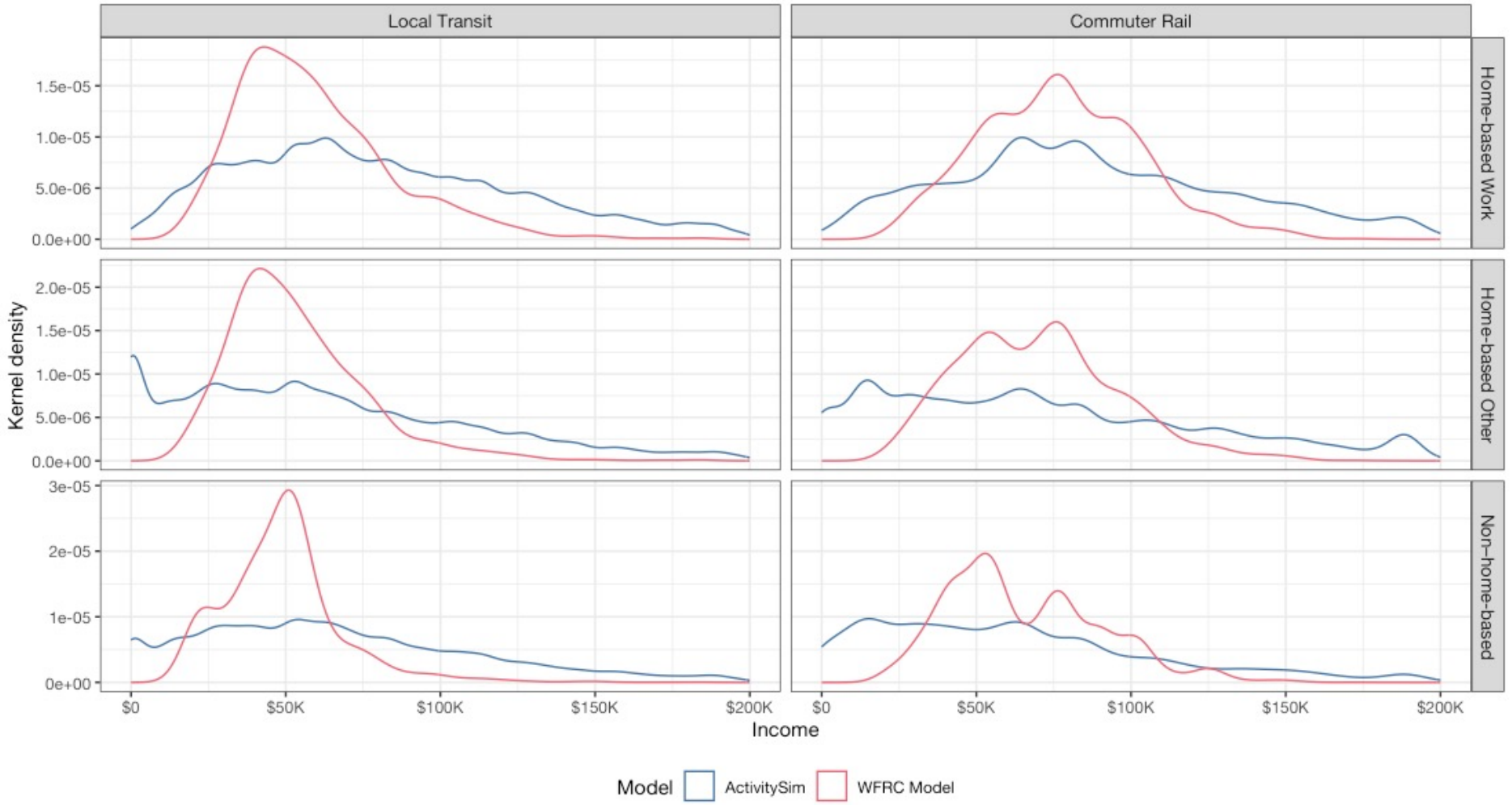


At-Work Mode Switching



Transit Riders Income Distribution

BYU Civil & Construction Engineering



Remote Work Scenario

WFRC Model:

- Used 2050 remote work rates
  - WFH average increase from 2.9% to 3.5%
  - Telecommute average increase from 3.7% to 10.2%

ActivitySim:

- Recalibrated remote work to WFRC 2050 rates
  - WFH matches WFRC data
  - Telecommute matches % by job type

Remote Work Considerations

- “Rebound effect”
  - Fewer work trips may cause more non-work trips

- Trip length
  - Longer commute more likely to work remotely
  - Drop long, work trips in favor of shorter, non-work trips

Change in Number of Trips

BYU Civil & Construction Engineering

		WFRC Model Trips			ActivitySim Trips		
Purpose	Mode	Baseline	Remote Work Scenario	Change	Baseline	Remote Work Scenario	Change
Home-based Work	Drive Alone	1328609	1244451	-6.3%	1012180	950306	-6.1%
	Carpool	257805	238669	-7.4%	258459	242497	-6.2%
	Transit	48752	44977	-7.7%	253176	237881	-6.0%
	Non-motorized	76506	71063	-7.1%	145957	137684	-5.7%
Home-based Other	Drive Alone	1394415	1395196	0.1%	700133	709957	1.4%
	Carpool	2702272	2702625	0.0%	2148429	2171566	1.1%
	Transit	37346	37359	0.0%	389780	396815	1.8%
	Non-motorized	510143	508869	-0.2%	613134	617480	0.7%
Non–home-based	Drive Alone	951561	938653	-1.4%	716143	687935	-3.9%
	Carpool	1273317	1254548	-1.5%	938056	922662	-1.6%
	Transit	13453	13199	-1.9%	159935	158366	-1.0%
	Non-motorized	146404	144126	-1.6%	156819	152688	-2.6%

WFRC: Trip Count vs Length

BYU Civil & Construction Engineering

		Trips			Person-miles		
Purpose	Mode	Baseline Scenario	Remote Work Scenario	Change	Baseline Scenario	Remote Work Scenario	Change
Home-based Work	Drive Alone	1328609	1244451	-6.3%	12736970	12070213	-5.2%
	Carpool	257805	238669	-7.4%	3204552	2945150	-8.1%
	Transit	48752	44977	-7.7%	547804	500953	-8.6%
	Non-motorized	76506	71063	-7.1%	132216	122930	-7.0%
Home-based Other	Drive Alone	1394415	1395196	0.1%	6088804	6122517	0.6%
	Carpool	2702272	2702625	0.0%	13420596	13448784	0.2%
	Transit	37346	37359	0.0%	264203	264432	0.1%
	Non-motorized	510143	508869	-0.2%	591297	590349	-0.2%
Non–home-based	Drive Alone	951561	938653	-1.4%	4777297	4736979	-0.8%
	Carpool	1273317	1254548	-1.5%	7650625	7538596	-1.5%
	Transit	13453	13199	-1.9%	73563	72018	-2.1%
	Non-motorized	146404	144126	-1.6%	136914	134784	-1.6%

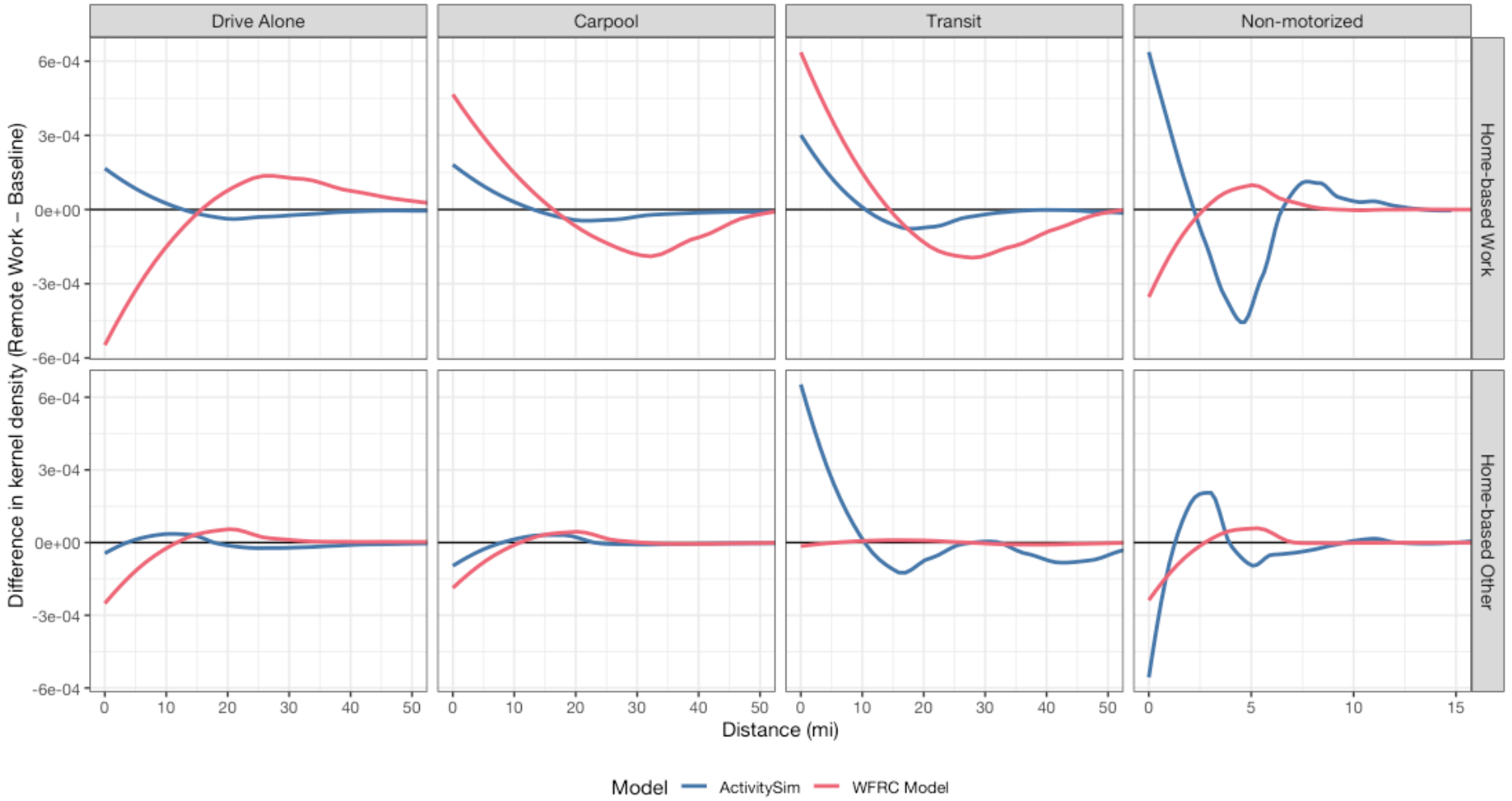
ActivitySim: Trip Count vs Length

BYU Civil & Construction Engineering

		Trips			Person-miles		
Purpose	Mode	Baseline Scenario	Remote Work Scenario	Change	Baseline Scenario	Remote Work Scenario	Change
Home-based Work	Drive Alone	1012180	950306	-6.1%	9632251	9021681	-6.3%
	Carpool	258459	242497	-6.2%	2631886	2463552	-6.4%
	Transit	253176	237881	-6.0%	2911616	2728897	-6.3%
	Non-motorized	145957	137684	-5.7%	353246	332978	-5.7%
Home-based Other	Drive Alone	700133	709957	1.4%	4280006	4332319	1.2%
	Carpool	2148429	2171566	1.1%	11498994	11624928	1.1%
	Transit	389780	396815	1.8%	3547052	3583630	1.0%
	Non-motorized	613134	617480	0.7%	1090176	1098043	0.7%
Non–home-based	Drive Alone	716143	687935	-3.9%	3984191	3804674	-4.5%
	Carpool	938056	922662	-1.6%	3962840	3898220	-1.6%
	Transit	159935	158366	-1.0%	867867	852243	-1.8%
	Non-motorized	156819	152688	-2.6%	194493	189483	-2.6%

Difference in Trip Length Distribution

BYU Civil & Construction Engineering



Conclusions

- Computationally similar
  - Similar runtime on same hardware

- Model complexity
  - ActivitySim easier to interpret
    - Non–home-based trips
    - Each step simply assigns a value to household/individual
  - Trip-based aggregate data harder to interpret

- Interoperability/extensibility
  - ActivitySim remote work sub-models taken from SEMCOG
  - Simple to add/edit parameters

Cited difficulties may not be applicable!