

COVID & Telecommuting-Induced Changes in Travel Patterns: Evidence from the Puget Sound Region

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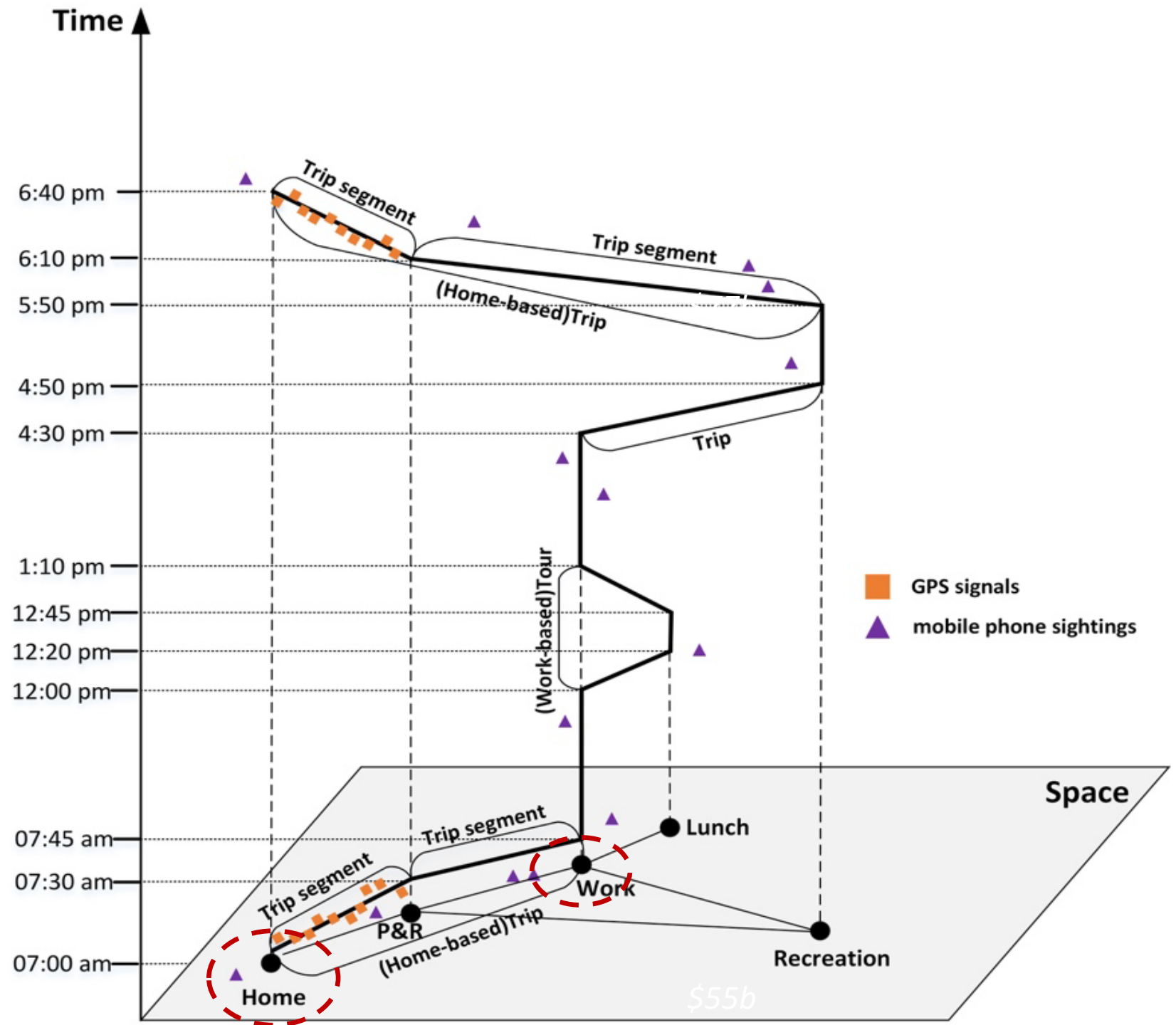
Work performed by my awesome students: Grace Jia, Kaitlyn NG, and Ekin Ugurel, with the help of many from PSRC (Brian Lee, Suzanne Childress, and Joanne Lin)

Outline

- Motivation
- Terminology
- Methodology
- Research questions
- Data
- Results




Motivation

With workplace now removed, how do people reschedule those trips previously associated with the workplace?



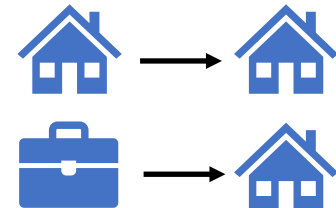
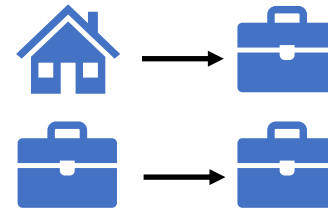
Terminology

- **Anchor locations vs. maintenance and discretionary ones**

-  home  workplace  Shops, restaurants, banks, etc.
- Anchor locations are more temporally and spatially fixed compared to maintenance and discretionary ones.

- **Mandatory trips vs. Maintenance and discretionary trips**

- Four types of mandatory trips exists:



- Maintenance and discretionary trips:
 - Maintenance trips: shopping, banking, etc.
 - Discretionary trips: social/recreational, etc.

Terminology

Simple trip chain vs. complex trip chain

- Trip chains are a set of temporally ordered locations that begin and end at home.
- Simple trip chain has one intermediate stop.
 - E.g. home – work – home
- Complex trip chain has multiple intermediate stops.
 - E.g. home – work – bank – home
 - E.g. home – work – bank – grocery store – home



Trip complexity increases as the stops increase

Specific Research Questions

- **Trip generation**
 - Are they simply forgone?
- **Spatial re-distribution**
 - Are they now clustered around home?
 - Has one's activity space changed?
 - Have trip chaining behaviors changed?
- **Temporal re-distribution**
 - How are they distributed temporally?
- **Mode of transportation used and VMT**
 - How are different modes of transportation used?
 - Have VMT changed?

Datasets

- PSRC household travel surveys (HTS): 2017-2019 and 2021
 - The HTS study encompassed the entire The survey collected household-and person-level activity and pattern information on a typical weekday.
 - When was the data collected? 9 weeks in April-June 2017, 7 weeks in April-June 2019, and 11 weeks in April–June of 2021.
- four-county PSRC region, including King, Pierce, Kitsap, and Snohomish counties. The region is home to over four million individuals and approximately 1.6 million households¹.

1. Estimated residential household population from the American Community Survey 2015–2019 five-year estimates.



		2017-2019		2021	
		Share	Count	Share	Count
Sample Size	Individuals	-	11,940	-	6,482
	Households	-	6,319	-	2,793
Household Size	1 person	41.30%	2,610	28.40%	793
	2 people	39.90%	2,522	38.60%	1,077
	3 people	10.00%	633	14.90%	417
	4+ people	8.76%	554	18.10%	506
Race	Asian only	12.70%	1,513	12.80%	832
	Black only	2.15%	257	3.86%	250
	Hispanic	3.18%	380	4.32%	280
	Other, including multi-race	3.71%	443	5.26%	341
	White only	58.70%	7,007	50.90%	3,299
Vehicle Ownership (in household)	No response	19.60%	2,340	22.80%	1,480
	0 (no vehicles)	17.60%	1,111	275	9.84%
	1 vehicle	48.00%	3,033	1,171	41.90%
	2 vehicles	26.60%	1,681	922	33.00%
Household Income	3+ vehicles	7.79%	494	425	15.30%
	Under \$25,000	10.00%	633	11.60%	324
	\$25,000-\$49,999	14.80%	937	17.50%	488
	\$50,000-\$74,999	15.00%	948	14.80%	413
	\$75,000-\$99,999	13.20%	835	13.40%	374
	\$100,000-\$199,000	30.10%	1,904	25.50%	711
	\$200,000 or more	10.10%	641	10.20%	284
	No answer	6.66%	421	7.13%	199

Map credit to PSRC

Methodology: Propensity Score Matching

1. Respondent filtering

Kept individuals who were:

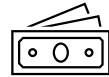
- 18+
- Currently employed
- Did not skip questions on telecommuting frequency

Removed:

- Missing entries on trip origin/destination, purpose, departure/arrival times

2. Covariate selection & logistic regression

Covariates:



Household income (binary; greater/less than \$100k)



Household size



Age (binary; middle-aged (25-54) or other)



Population density



Number of jobs accessible (45 minutes of transit)



Accessibility to supermarkets, restaurants

Covariates used as independent variables in logistic regression → predict likelihood of telecommuting

Logistic regression output

Covariates	Definition	Estimated value
Household income	Binary, 1 if income over \$100,000	0.38**
Household size	Family members in the household	0.03
Middle-aged	Binary, 1 if aged between 25-54	0.16**
Population density	The census tract's population density	0.07
Number of jobs accessible	Number of jobs accessible within 45 minute transit ride	-0.59**
Accessibility to supermarkets	The weighted distance to the closest supermarket from the census tract	0.02
Accessibility to restaurants	The weighted distance to the closest restaurant from the census tract	-0.07
Intercept (-0.85**)		

Methodology: Propensity Score Matching

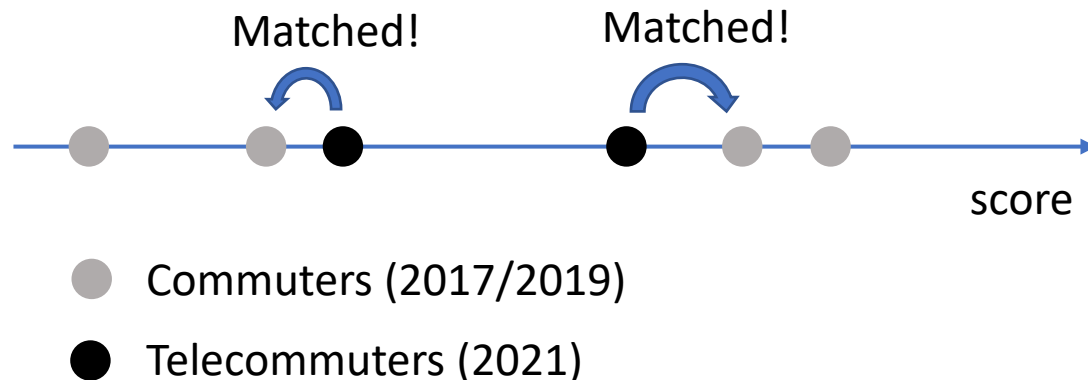
3. Nearest neighbor on propensity scores

A telecommuter is matched to a commuter who is “closest” (distance as measured by the probability from the logistic regression regression, aka “propensity score”)

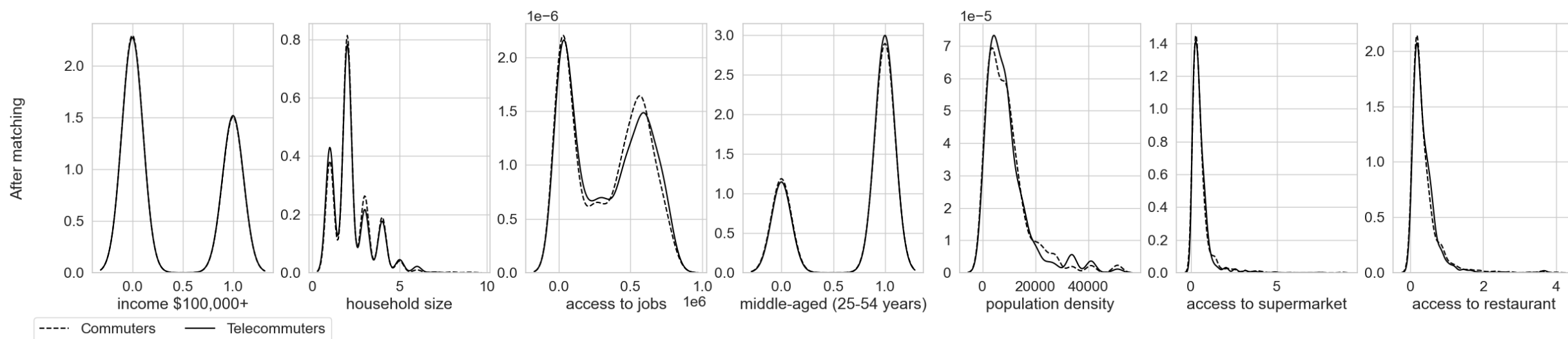
4. Balance check (statistically and visually)

From propensity score matching, telecommuter and commuter groups should have similarly distributed covariates.

- A t-test on the mean values of the covariates → not significantly different at $p = 0.05$.



The below visual check showed that, after matching, the covariates distributed similarly among commuters and telecommuters



Descriptive statistics for the matched individuals

		Commuters (2017-2019)		Telecommuters (2021)	
		Share	Count	Share	Count
Sample Size	Individuals	-	2,153	-	520
	Households	-	1,734	-	516
Household Size	1 person	22.46%	489	25.68%	559
	2 people	47.68%	1,038	46.76%	1,018
	3 people	15.43%	336	12.95%	282
	4+ people	14.43%	290	14.60%	318
Race	Asian only	12.49%	272	17.04%	371
	Black only	2.94%	64	3.40%	74
	Hispanic	4.00%	87	5.37%	117
	Other, including multi-race	4.59%	100	6.98%	152
	White only	68.86%	1,499	62.74%	1,366
	No response	7.12%	155	4.45%	97
Vehicle Ownership (in household)	0 (no vehicles)	9.97%	217	12.31%	268
	1 vehicle	38.26%	833	42.67%	929
	2 vehicles	37.99%	827	35.00%	762
	3+ vehicles	13.78%	300	10.01%	218
Household Income	Under \$25,000	5.93%	129	4.50%	98
	\$25,000-\$49,999	14.15%	308	9.09%	198
	\$50,000-\$74,999	16.90%	368	17.91%	390
	\$75,000-\$99,999	15.94%	347	21.08%	459
	\$100,000-\$199,000	29.63%	645	23.75%	517
	\$200,000 or more	8.17%	178	13.50%	294
	No answer	9.28%	202	10.15%	221

Trip generation

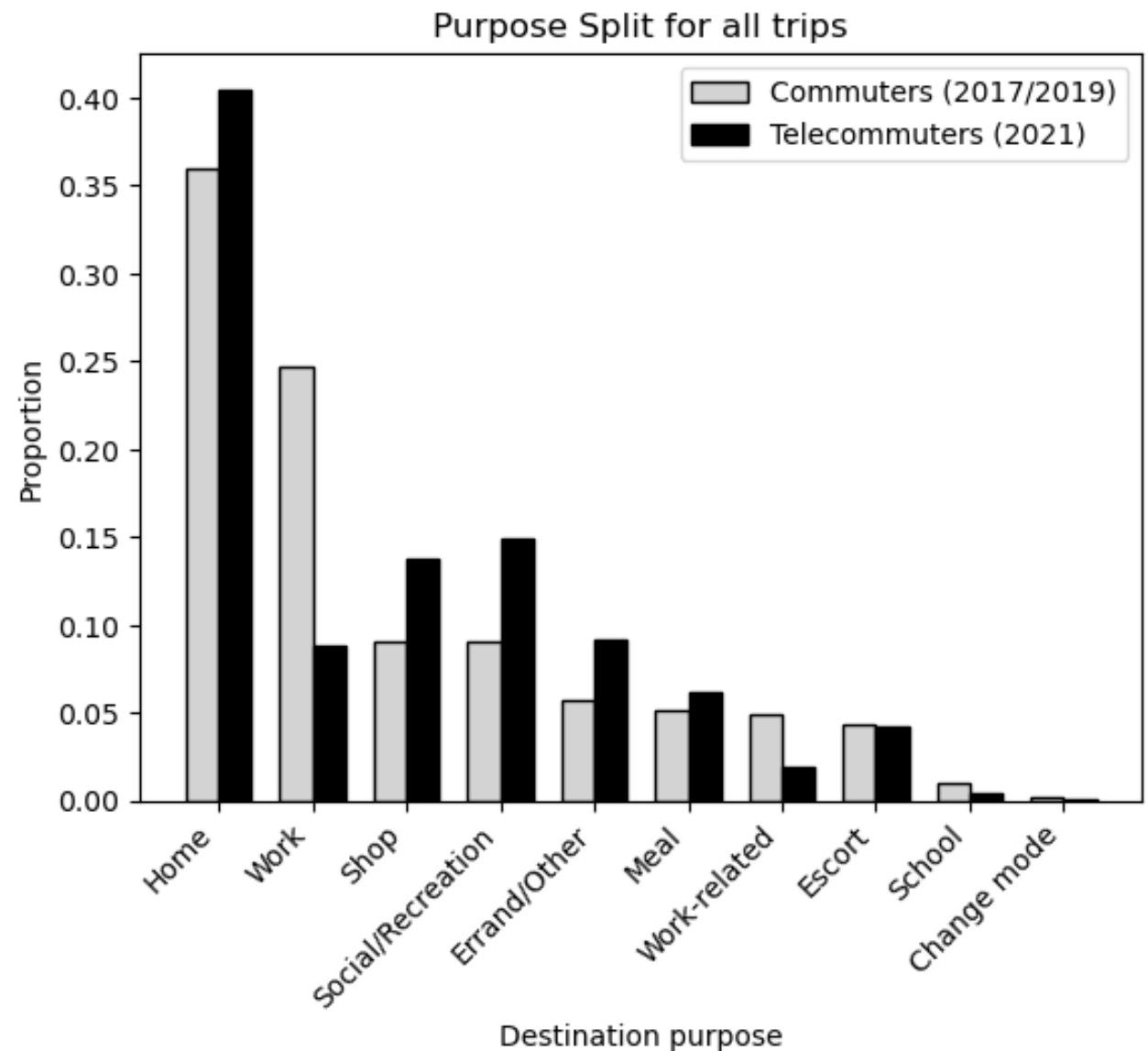
Do telecommuters make fewer number of maintenance and discretionary trips?

Do telecommuters chain fewer number of trips?



Summary statistics	Commuters (2017/2019)	Telecommuters (2021)
Sample size	2130	517
trips per person per day	3.89	3.32
Non-mandatory trips per person per day	2.37	2.75
simple chains per person per day	0.84	0.9
complex chains per person per day	0.55	0.41

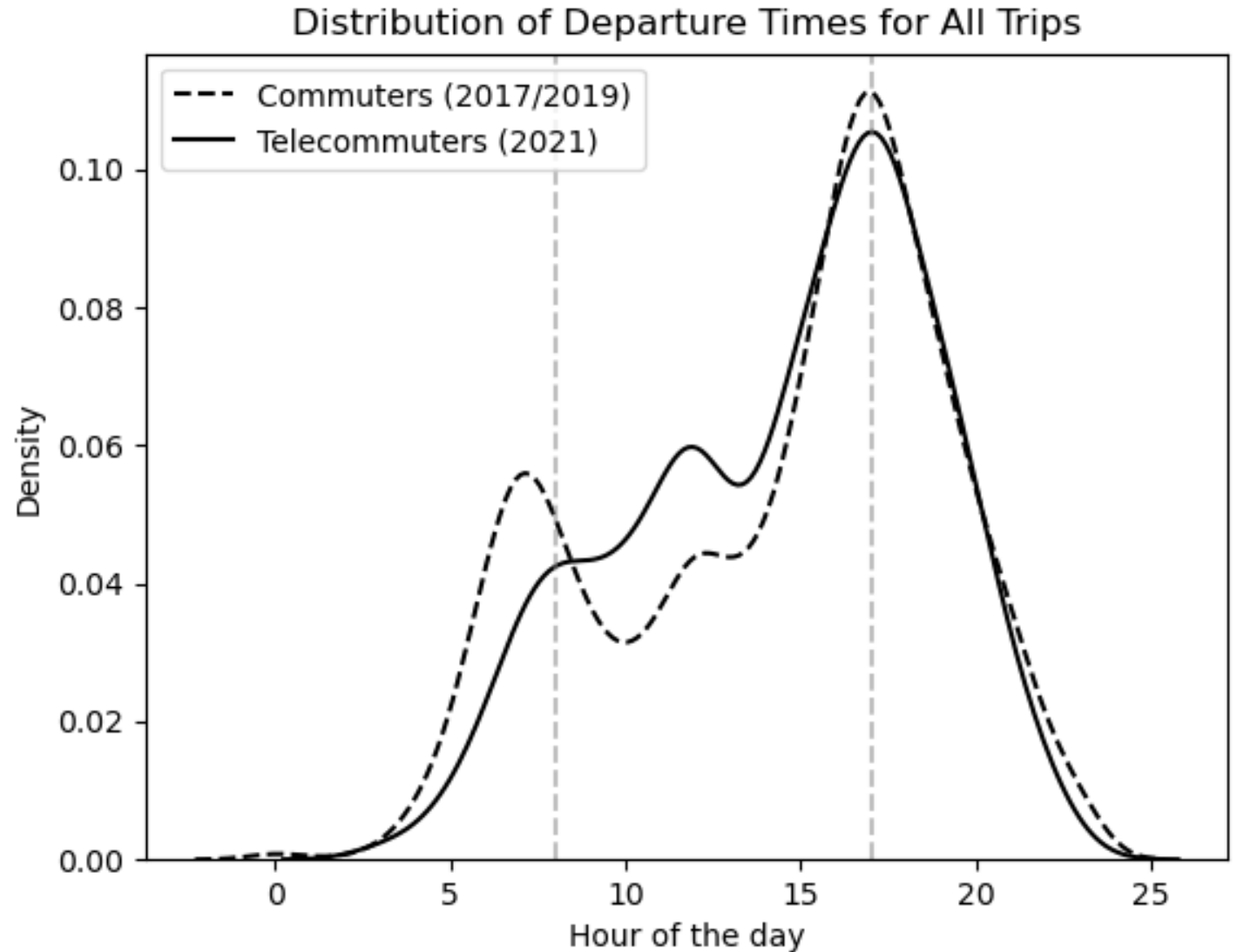
Do telecommuters
complete trips for different
purpose now?



Telecommuter's trip purposes are significantly **less diverse** compared to commuters (at $p = 0.05$) : Summary statistics showed that the mean (std) diversity index of telecommuters is 1.20 (0.39) compared to commuters' 1.38 (0.42)

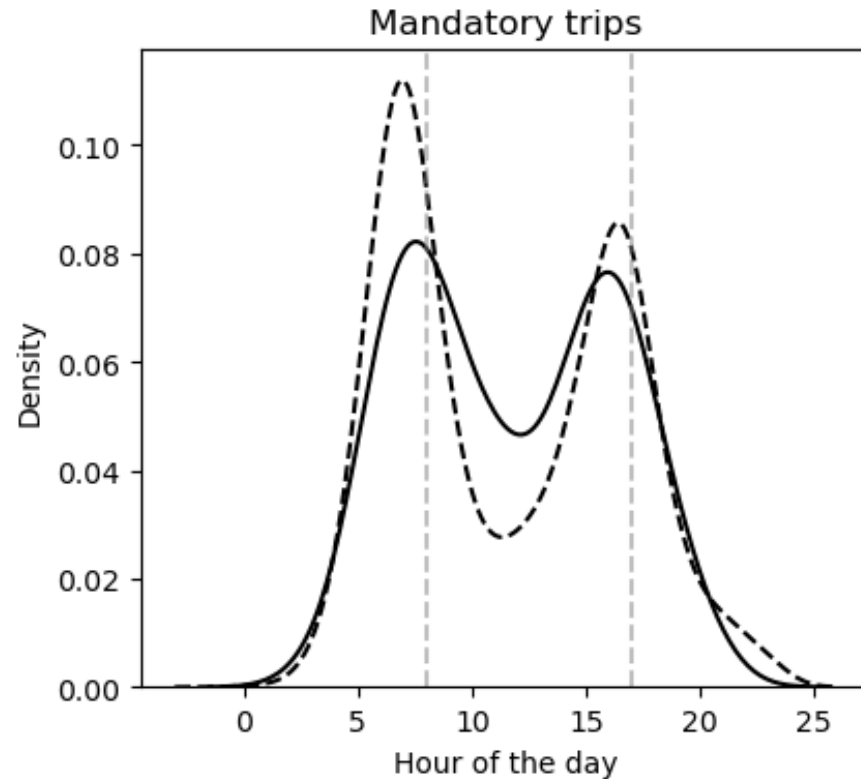
Temporal rescheduling

Since telecommuters are less constrained temporally, at what times do they complete trips?



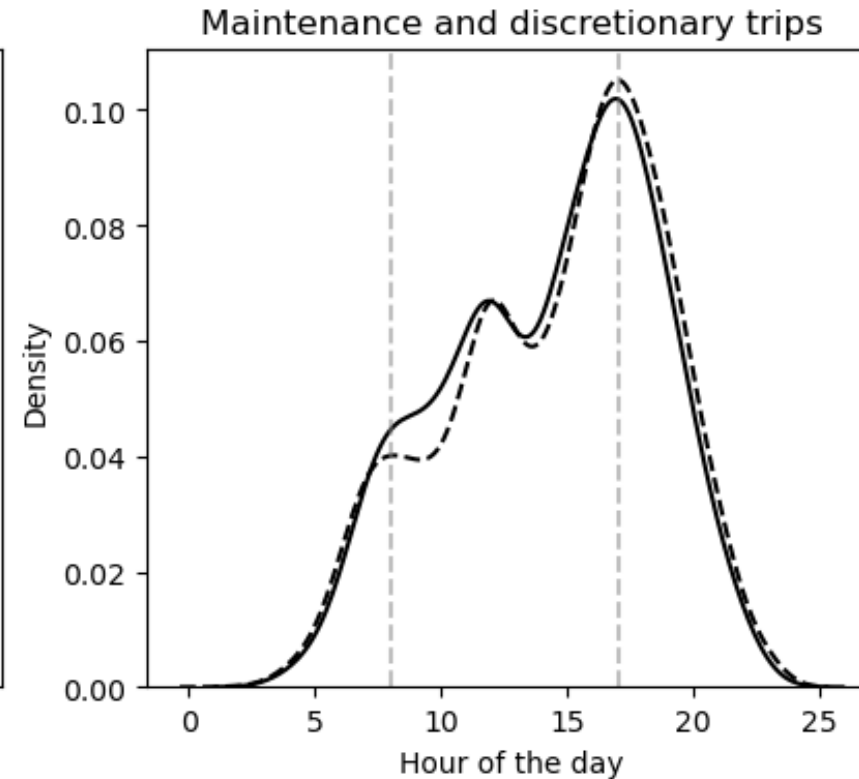
Telecommuters **did not have a dominant morning peak** for trips, but **the evening peak** stood out. Telecommuters also had an elevated mid-day peak, especially at noon time, to complete trips. Thus, more trips are reassigned from morning peak to mid-day.

Temporal rescheduling



--- Commuters (2017/2019), number of trips = 3017
— Telecommuters (2021), number of trips = 248

Telecommuters' mandatory trips are more spread out, but somewhat fixed temporally.



--- Commuters (2017/2019), number of trips = 4716
— Telecommuters (2021), number of trips = 1355

Maintenance and discretionary trips are similar for commuters and telecommuters, need to break down the trips further (next slide).

Temporal rescheduling

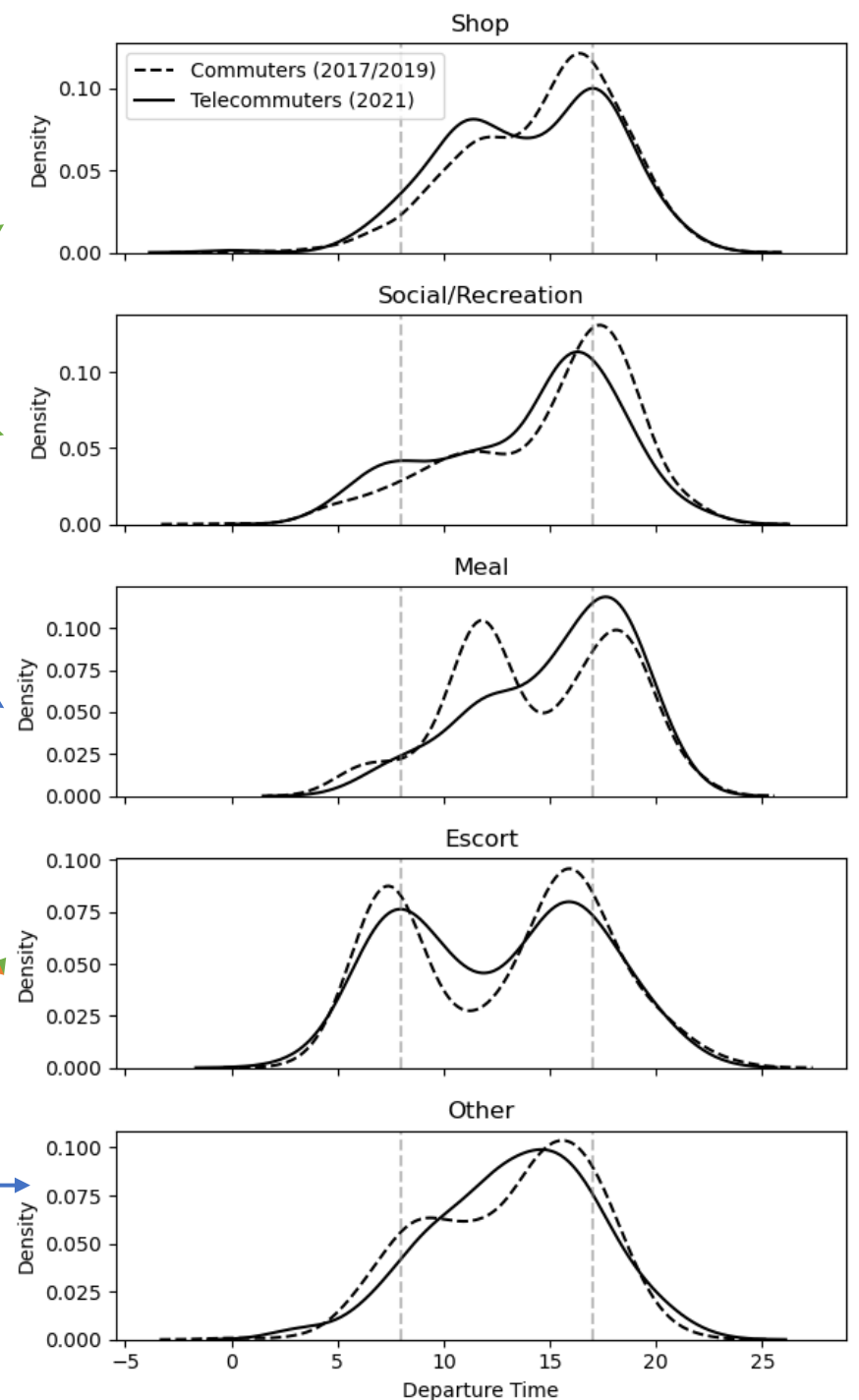
Observations:

Trips for shopping and social/recreation and escort are flattened – they are **scheduled more evenly** throughout the day.

Telecommuters made **fewer trips for meal at noon time** but go out for food more around the evening peak.

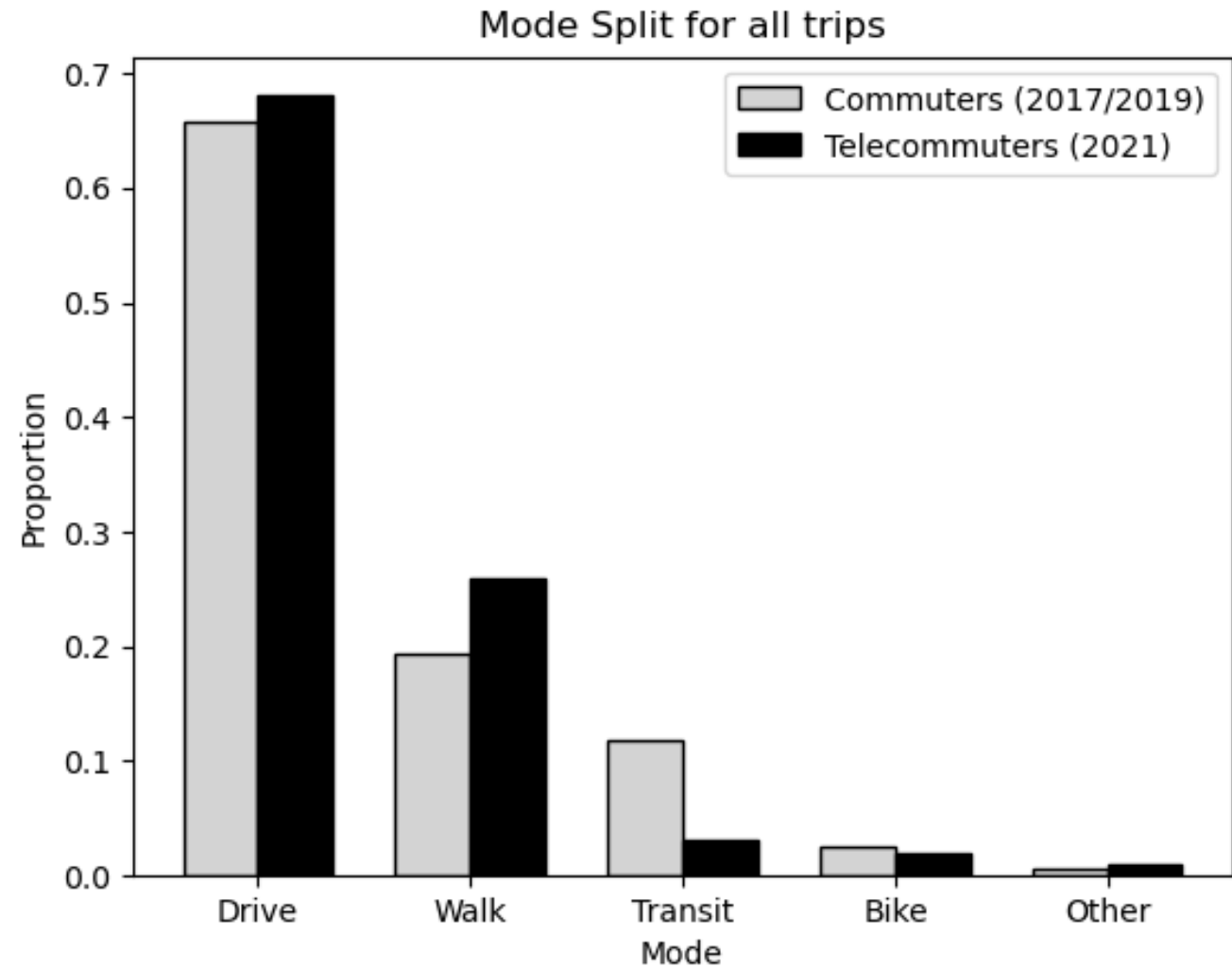
Telecommuters' escort trips were **still clustered around the morning and evening peaks**, more constrained than other trip purposes.

More personal businesses and medical appointments (84% of other trips) related trips were conducted by telecommuters (compared to commuters) during mid-day.



Mode of transportation used

Do telecommuters still rely on car when they do not need to commute to work?
How does the reduced number of commute trips affect VMT?

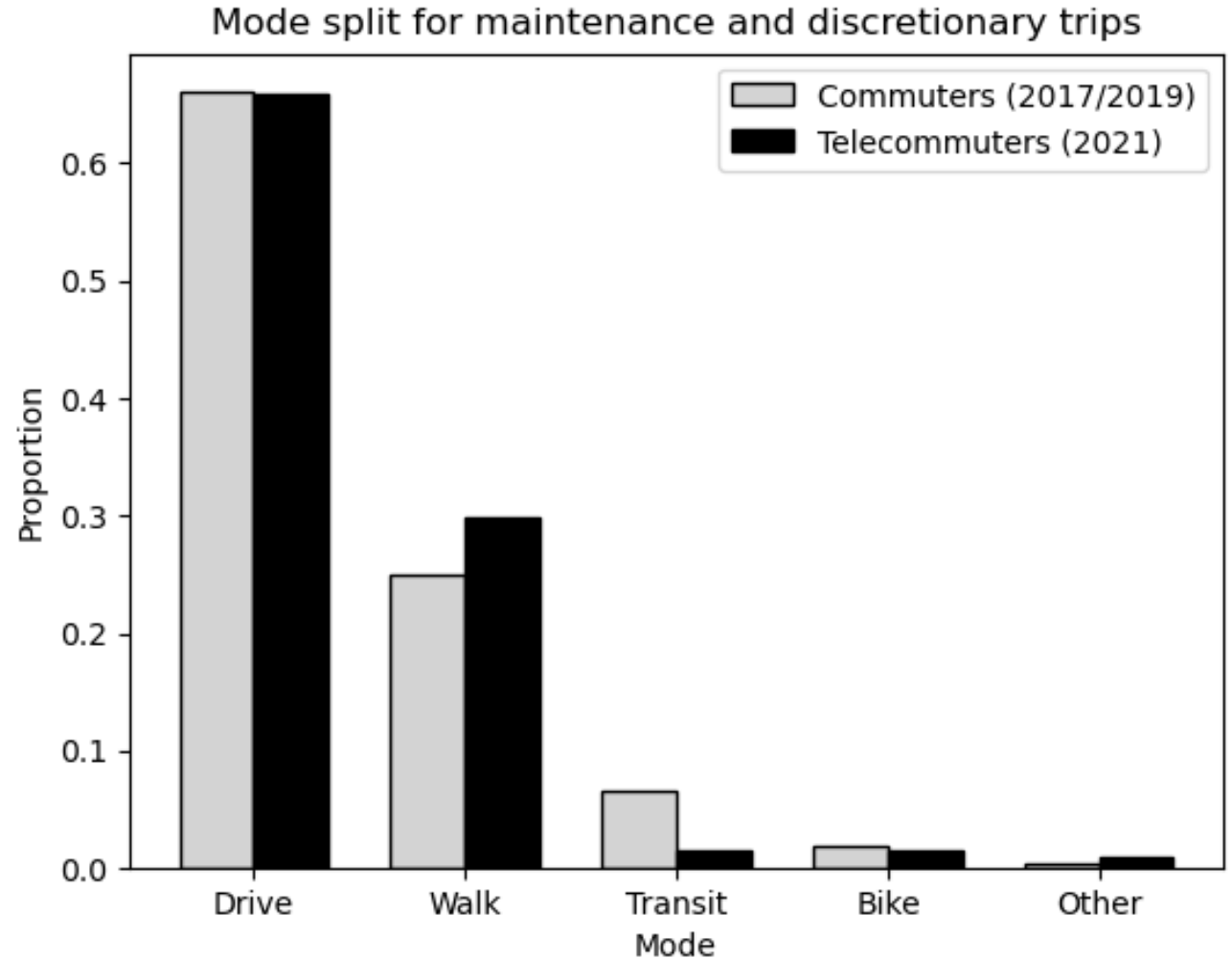


Telecommuters' median vehicle miles traveled via driving per person per day (VMT) calculated to be **7.9**, and commuters' median VMT was reported to be **12.74**.¹ Telecommuters travelled significantly less distance (mean = 13.16 miles) compared to commuters (mean = 18.63 miles).¹

¹. Difference in mean is statistically significant at $p = 0.05$

Mode of transportation used

What about the modes of transportation used for non-mandatory trips?

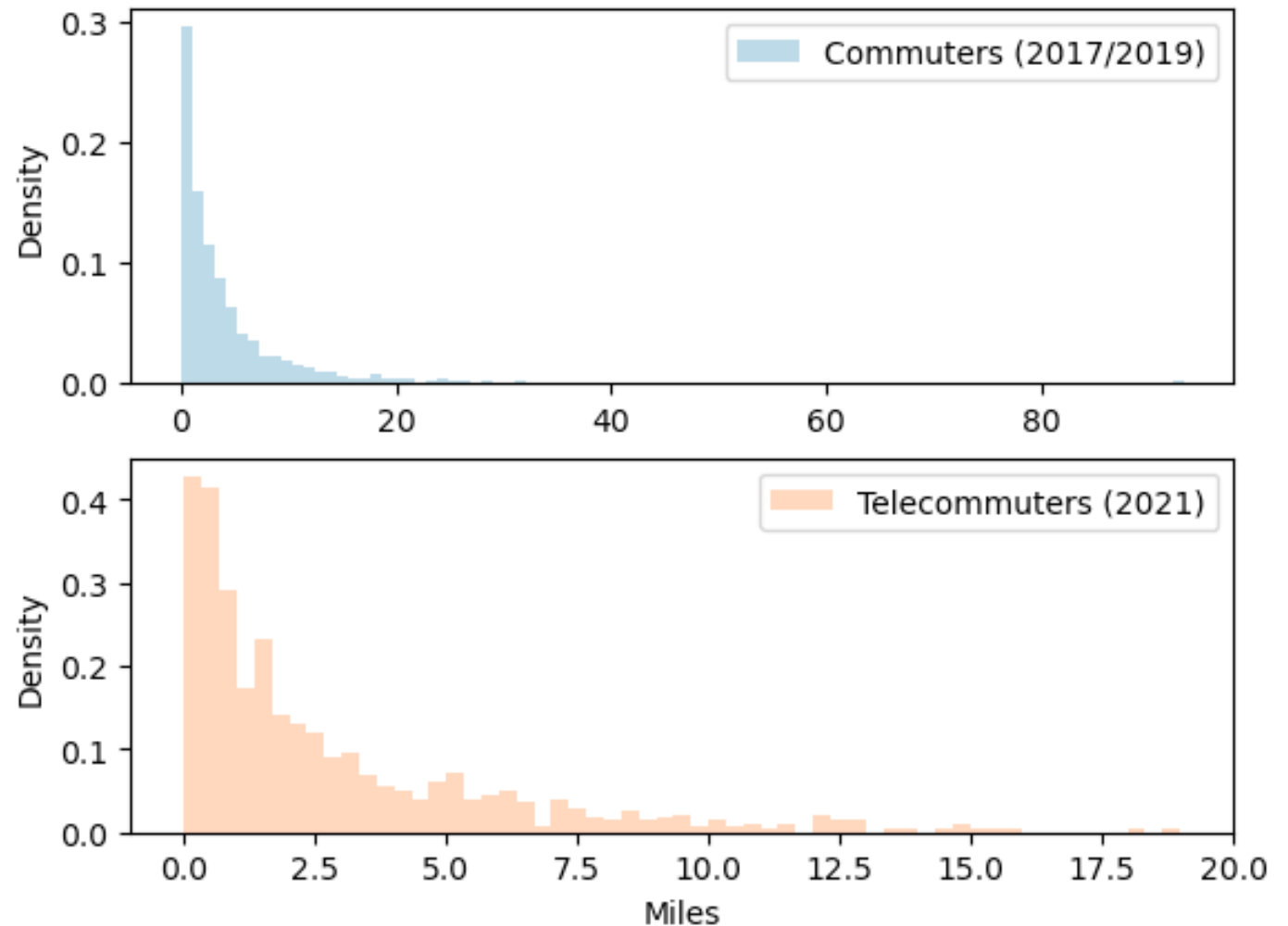


Telecommuters still favor driving out of all modes when conducting non-mandatory trips.

Spatial re-distribution

With home as the only anchor, do telecommuters complete non-mandatory trips closer to home?

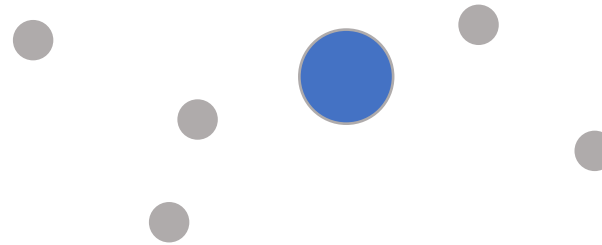
Maintenance and discretionary trip distance distribution from home



YES. Telecommuters did complete non-mandatory trips **closer** to home compared to commuters, as shown by the higher peak in the black solid line.

Spatial re-distribution

Radius of gyration (ROG) measures the dispersion of one's activities throughout the day from a given point, for example, home location, workplace, or a centroid of all trip destinations.



Commuters' ROG from home (5.99 miles) is not significantly different to telecommuters' ROG (5.83).

Summary (telecommuters compared to commuters)

- **Trip generation**

- Are they simply forgone? Fewer number of trips in total, but more non-mandatory trips.

- **Spatial re-distribution**

- Are they now clustered around home? Yes.
- Has one's activity space changed? One's travel space has not shrunk.
- Have trip chaining behaviors changed? Less trip chaining.

- **Temporal re-distribution**

- How are they distributed temporally? More spread out overall; muted morning peak, mid-day and evening peaks stand out

- **Mode of transportation used and VMT**

- How are different modes of transportation used? More driving, walking and less transit and decreased variety of modes used.
- Have VMT changed? Fewer VMT by driving.

Additional work to be finished

- Gendered household responsibility?
 - How do telecommuting shape household responsibilities for females vs males?
- How have travel patterns changed for downtown workers? What about those who are not relying on automobiles?
- Downtown workers? Non-auto-dependent workers?