




CTR PROGRAM-BASED CONGESTION MITIGATION, WHAT TOOLS STILL WORK?

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Commute Trip Reduction
for Washington State Agencies

Research Objectives


- Evaluate the effectiveness of CTR tools, employers' perspective
- Examine Travel Mode Change Incentivized by CTR tools, employees' perspective

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Background

History

- From late 1980s, US Congress and EPA initiated CTR in selected states;
- Washington State initiated its CTR programs from 1991;
- At late 1990s, most participated states ceased CTR programs;
- Washington State implemented CTR programs for three decades.

Trend

- Decentralization (from Federal to States);
- Localized preferences (the needs from employers & employees);
- Technique-involved mobility services.

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Introduction	<h2>Background</h2> <h3>Key to Success</h3> <ul style="list-style-type: none"> ▪ Rich choice set; ▪ Employee transportation coordinator (ETC); ▪ Collective bargain; ▪ Incentives and subsidies (both employer and employee). <h3>Core Measurements</h3> <ul style="list-style-type: none"> ▪ Average Vehicle Ridership (AVR) /Vehicle Trip Rates (VTR) ▪ Vehicle Miles Traveled (VMT) ▪ Greenhouse Gas Emission (GHG)
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Introduction	<h2>CTR Policy Tools</h2> <ul style="list-style-type: none"> ▪ CTR program promotion/ collective bargain ▪ Alternative transportation modes ▪ Parking strategies ▪ Employee transit pass/subsidy ▪ Compressed work schedule ▪ Telework ▪ Flexible work schedule ▪ Employer provided vehicles ▪ Ride match/carpool/vanpool ▪ Short distance mobility services
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Study 1: the effectiveness of CTR tools

>Question

- What CTR policy tools work?
- Which CTR policy tool is more efficient?

>Outcome Measurements

- **VTR:** The number of vehicle trips per employee on a worksite, in vehicles per person
- **VMT:** Vehicle miles traveled per employee in a worksite in miles

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CTR in WA

■ CTR Tracts
■ CTR Counties
■ WA Counties

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County	# of Worksites	VTR				VMT			
		Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Clark	5	0.87	0.11	0.69	0.95	11.07	2.17	8.38	14.23
King	341	0.59	0.28	0.07	0.98	15.00	3.20	6.43	25.43
Kitsap	28	0.84	0.11	0.46	0.96	13.76	2.41	9.88	21.56
Pierce	39	0.90	0.04	0.80	0.97	14.89	2.62	11.36	21.86
Snohomish	71	0.85	0.08	0.59	0.98	14.68	2.15	10.01	21.16
Spokane	41	0.85	0.09	0.58	0.94	11.62	1.95	7.65	15.90
Whatcom	13	--	--	--	--	--	--	--	--
Yakima	8	0.88	0.09	0.71	0.95	9.57	1.97	7.61	12.80
Total	546	0.69	0.26	0.07	0.98	14.43	3.11	6.43	25.43

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Variable	
1. Random Effects	
Company name	The name of the company that the worksite belongs to
Zip code	The zip code of the worksite
2. Independent Variables	
Employer Features	
Employer Features	
Location (King County)	If a worksite locates in King county, 1; else, 0
Size (# of employees)	The total number of employees at a worksite
IT-related industry	If the business is information services/software/technical, 1; else, 0
Gov. & Edu. related	If the business is military, government, education, 1; else, 0
Manufacturing, transport and utility	If the business is manufacturing, public utilities, construction, or transportation, 1; else, 0
Finance and professional service	If the business is finance, insurance, real estate, professional/personal services, or retail/trade, 1; else, 0
Health care	If the business is health care, 1; else, 0
Agriculture and fishing	If the business is agriculture or fishing, 1; else, 0

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<ul style="list-style-type: none"> Introduction Policy Data Pre-analysis Model Results Limitation Prospect 	Variables	VTR			VMT			
		Estimate	P-value	Elasticity	Estimate	P-value	Elasticity	
	Employer Features							
	Location (King County)	-0.145 (***)	<0.001	-18.15%	2.271 (***)	<0.001	5.31%	
	Size (# of employees)	-0.009 (*)	0.027	-0.83%	0.033	0.724		
	IT-related industry	--	--		--	--		
	Gov. & Edu. related	0.11 (**)	0.001	12.50%	0.126	0.868		
	Manufacturing, transport and utility	0.097 (**)	0.003	18.44%	1.811 (*)	0.016	6.20%	
	Finance and professional service	0.058 (*)	0.048	0.26%	0.306	0.659		
	Health care	0.129 (***)	<0.001	10.54%	-0.718	0.372		
	Agriculture and fishing	0.082 (**)	0.010	3.99%	-0.682	0.360		
	Marketing and Engagement							
	Promoting efforts	-0.008	0.108		-0.052	0.643		
	Collective bargaining	-0.058 (*)	0.020	-2.21%	1.058 (*)	0.047	2.83%	
	Access to Alternative Transportation Modes and Amenities							
	Transit access	-0.011	0.714		-1.283 (*)	0.046	-4.87%	
	Sidewalks	-0.092 (.)	0.085	-12.03%	-0.443	0.692		
	Amenities	-0.007	0.827		-0.938	0.208		

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	Monetary Incentives							
	Transit pass	-0.001 (***)	<0.001	-3.15%	-0.001	0.860		
	Transit subsidy	0.002 (.)	0.094	0.73%	0.043	0.154		
	Carsharing subsidy	0.001	0.383		0.040 (*)	0.033	0.73%	
	Bike/walk subsidy	-0.006 (*)	0.015	-0.65%	-0.129 (*)	0.014	-0.70%	
	Tax credit received	0.016	0.341		0.691 (.)	0.080	2.52%	
	Alternative Work Hours							
	Compressed workweek	-0.038 (*)	0.043	-0.91%	0.464	0.293		
	Flexible work hours	-0.026	0.244		-0.054	0.915		
	Telecommuting	-0.016	0.422		0.102	0.815		
	Site Services							
	Parking fee	-0.028	0.364		0.132	0.851		
	Employer-provided vehicles	0.040 (*)	0.025	6.17%	0.473	0.245		
	Short-distance mobility services	0.038	0.137		0.843	0.163		
	Emergency rides	0.066 (**)	0.009	1.35%	0.046	0.937		
	Ride match	0.003	0.915		-0.852	0.133		
	Rental cars	-0.015	0.500		-0.546	0.284		
	CTR-affected worksites	0.004	0.308		0.081	0.349		

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Introduction	<h2>Results on VTR</h2> <ul style="list-style-type: none"> Companies in King County have a lower VTR. Larger employers with more employees suggest a lower level of VTR. Employees in IT-related industries have the lowest VTR in comparison with the other industries. The process of collective bargain shows a negative association with VTR. Sites with good access to pedestrian facilities suggest a negative correlation with VTR. Providing transit passes encourages employees to drive less while providing transit subsidies encourages employees to drive more. A compressed workweek suggests a negative association with VTR. Both employer-provided vehicles and emergency rides suggest positive associations with VTR.
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Results on VMT

- Employees working in King County tend to have a higher VMT.
- Employees working in manufacturing, transportation, and utility industries commute for longer distances than employees in the IT industry.
- VMT shows a positive association with collective bargaining.
- VMT suggests a negative association with distributing transit passes to employees.

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Conclusions

- When rewarding employees for their pro-environmental behavior, distributing transit passes is the preferred strategy.
- Free employer-provided goods, such as transit subsidies, vehicles, and emergency rides, are not recommended.
- Governmental agencies should lead other employers to better advertise CTR programs and engage employees for collective bargaining.

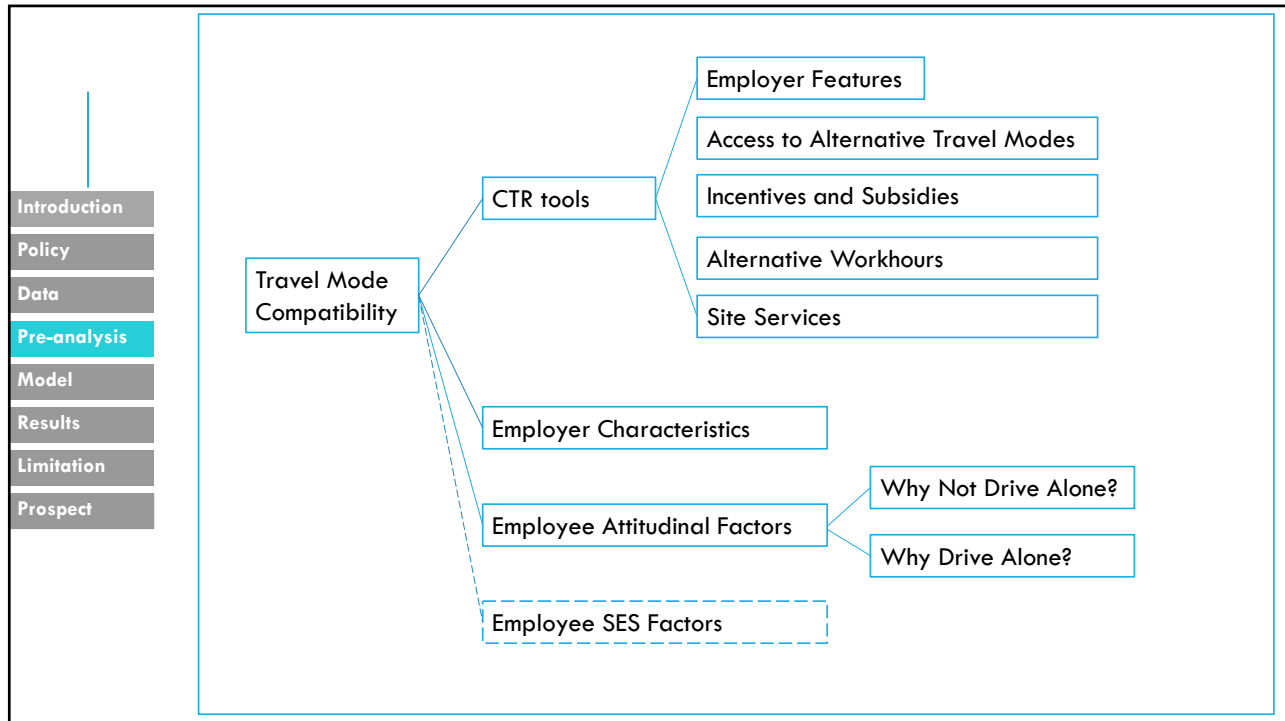
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Introduction	<h2 style="margin: 0;">Study 2: travel mode change incentivized by CTR</h2> <p>>Background</p> <ul style="list-style-type: none"> ▪ Some employees are loyal to driving alone, while others are open to using alternative travel modes. ▪ Travel mode change may happen when individuals are provided with multiple choices and incentivized with TDM tools.
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Introduction	<p>>Outcome Measurement: Travel Mode Compatibility</p> <ul style="list-style-type: none"> ▪ No Change: employees driving alone to access workplaces in the week <ul style="list-style-type: none"> • Driving alone always ▪ Change to alternative travel modes: employees driving alone for some days while using alternative modes for the other days within the week <ul style="list-style-type: none"> • Driving alone to carpooling • Driving alone to riding transit • Driving alone to telecommuting • Driving alone to walking and biking
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Introduction	<h2 style="color: #0056b3;">Variable</h2> <h3 style="color: #0056b3;">Employee Attitudinal Factor</h3> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #0056b3; color: white;"> <th style="text-align: left; padding: 5px;">Why not drive alone?</th> <th></th> </tr> </thead> <tbody> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">incentive</td> <td style="padding: 5px;">If the employee does not drive because of receiving incentives, subsidies, or free services, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">health</td> <td style="padding: 5px;">If the employee does not drive for personal health or well-being, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">parking</td> <td style="padding: 5px;">If the employee does not drive for the cost of parking or the lack of parking, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">time</td> <td style="padding: 5px;">If the employee does not drive for saving time by using HOV lanes, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">convenience</td> <td style="padding: 5px;">If the employee does not drive because of teleworking, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">physical constraints</td> <td style="padding: 5px;">If the employee does not drive because driving myself is not an option, 1; else, 0</td> </tr> <tr style="background-color: #0056b3; color: white;"> <th style="text-align: left; padding: 5px;">Why drive alone?</th> <th></th> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">convenience</td> <td style="padding: 5px;">If the employee drives alone for the convenience of having the car or the inconvenience of alternative modes, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">information</td> <td style="padding: 5px;">If the employee drives alone for lacking information on alternative modes, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">job requirement</td> <td style="padding: 5px;">If the employee drives alone for the requirement of the job, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">distance</td> <td style="padding: 5px;">If the employee drives alone because the commuting distance is too long, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">family obligation</td> <td style="padding: 5px;">If the employee drives alone for family care or other similar obligations, 1; else, 0</td> </tr> <tr style="background-color: #e6f2ff;"> <td style="padding: 5px;">safety</td> <td style="padding: 5px;">If the employee drives alone because bicycling or walking isn't safe, 1; else, 0</td> </tr> </tbody> </table> <p style="color: #0056b3; margin-top: 10px;">CTR tools and Employer Features...</p>	Why not drive alone?		incentive	If the employee does not drive because of receiving incentives, subsidies, or free services, 1; else, 0	health	If the employee does not drive for personal health or well-being, 1; else, 0	parking	If the employee does not drive for the cost of parking or the lack of parking, 1; else, 0	time	If the employee does not drive for saving time by using HOV lanes, 1; else, 0	convenience	If the employee does not drive because of teleworking, 1; else, 0	physical constraints	If the employee does not drive because driving myself is not an option, 1; else, 0	Why drive alone?		convenience	If the employee drives alone for the convenience of having the car or the inconvenience of alternative modes, 1; else, 0	information	If the employee drives alone for lacking information on alternative modes, 1; else, 0	job requirement	If the employee drives alone for the requirement of the job, 1; else, 0	distance	If the employee drives alone because the commuting distance is too long, 1; else, 0	family obligation	If the employee drives alone for family care or other similar obligations, 1; else, 0	safety	If the employee drives alone because bicycling or walking isn't safe, 1; else, 0
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Mixed Multinomial Logit Model (MMNL)

Utility Function

$$U_i = \beta_{0i} + \beta_{ji}X_j + \gamma_k Z_k + \varepsilon_i$$

Probability Function

$$P(Y = i) = \frac{e^{U_i}}{1 + \sum_{i=1}^{N-1} e^{U_i}}, \text{ where } i = 1, 2, \dots, N - 1$$

$$P(Y = N) = \frac{1}{1 + \sum_{i=1}^{N-1} e^{U_i}}$$

$$\ln\left(\frac{P(Y = i)}{P(Y = N)}\right) = U_i = \beta_{0i} + \beta_{ji}X_j + \gamma_k Z_k + \varepsilon_i$$

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Variable	DA - Car sharing		DA - Public transport		DA - Telework		DA - Walk & Bike	
	Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)
Intercept	-2.86	***			-3.44	***		
Employer-Related Features								
Collective bargaining	-0.17		0.85		1.19	***	3.30	
Promoting efforts	0.01		1.01		0.05		1.05	
IT-related industry								
Gov. & Edu. related	0.54		1.72		-1.21	***	0.30	
Manufact, transport and utility	-0.21		0.81		-2.48	***	0.08	
Finance and professional service	-0.14		0.87		-0.75	**	0.47	
Health care	0.00		1.00		-0.88	**	0.42	
Agriculture and fishing	0.10		1.10		-1.36	***	0.26	

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	Variable	DA - Car sharing		DA - Public transport		DA - Telework		DA - Walk & Bike	
		Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)
	CTR tools								
	Collective bargaining	-0.17	0.85	0.13	1.14	1.19***	3.30	-0.36	0.70
	Promoting efforts	0.01	1.01	-0.05	0.95	0.05	1.05	-0.07	0.93
	Transit access	-0.27	0.76	1.84*	6.29	-1.11**	0.33	-0.18	0.84
	Amenities	0.03	1.03	1.18*	3.25	0.28	1.32	0.74	2.09
	Transit pass	0.08	1.09	0.64*	1.90	-0.03	0.97	0.48.	1.61
	Transit subsidy	0.17	1.18	-0.3	0.74	0.19	1.2	0.04	1.05
Introduction	Car-sharing subsidy	0.03	1.03	-0.16	0.86	-0.58**	0.56	-0.05	0.95
Policy	Bike/Walk subsidy	0.14	1.15	-0.4	0.67	0.08	1.08	0.28	1.32
Data	Compressed workweek	-0.45*	0.64	0.38	1.46	0.61*	1.84	-0.47*	0.62
Pre-analysis	Flexible work hours	0.18	1.20	0.58*	1.79	1.37***	3.92	0.97**	2.65
Model	Parking fees	0.64**	1.91	2.14***	8.53	0.63**	1.88	0.69*	1.99
Results	Employer-provided Vehicle	-0.19	0.82	0.35	1.42	-0.71**	0.49	-0.23	0.79
Limitation	Short-distance mobility service	0.60*	1.82	-0.25	0.78	-1.43***	0.24	0.32	1.38
Prospect	Emergency ride	-0.29	0.75	-0.16	0.85	-0.23	0.79	0.03	1.03
	Ride match	0.11	1.12	0.28	1.33	0.76*	2.14	-0.45	0.64
	Rental car	0.19	1.21	0.48*	1.62	-0.33	0.72	1.00***	2.72
	ETC time	0.01	1.01	0.01	1.01	0.01	1.01	0.01	1.01

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	Variable	DA - Car sharing		DA - Public transport		DA - Telework		DA - Walk & Bike	
		Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)	Estimate	Exp(B)
	Why don't drive alone?								
	Incentive	0.48***	1.62	2.20***	8.98	-0.33***	0.72	-0.16	0.85
	Health	0.93***	2.54	1.11***	3.04	0.06	1.06	3.04***	20.84
	Parking	0.80***	2.23	1.20***	3.31	0.05	1.05	-0.09	0.92
	Time	1.50***	4.50	-0.22.	0.80	0.00	1.00	-1.94***	0.14
	Convenience	-2.05***	0.13	-1.78***	0.17	2.02***	7.51	-1.79***	0.17
	Physical constraints	-0.70**	0.50	-0.36.	0.70	-1.37***	0.26	-1.83***	0.16
	Why drive alone?								
	Convenience	-0.60***	0.55	-0.72***	0.49	-0.00	1.00	-1.19***	0.31
	Information	-1.07***	0.34	-1.22***	0.29	-0.32*	0.73	-0.88**	0.42
	Job requirement	-0.09	0.91	0.00	1.00	-0.45***	0.64	-0.52.	0.59
	Distance	-0.78***	0.46	-1.50***	0.22	-0.34***	0.71	-0.01	0.99
	Family obligation	-0.03	0.97	-0.13	0.88	0.11	1.12	-0.07	0.94
	Safety	-0.41***	0.66	-1.48***	0.23	-0.22.	0.80	-0.40*	0.67

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Random effects	post. Mean	I-95% CI	U-95% CI	Eff. Samp.
Zip code	0.093	0.051	0.135	192.2
SiteID	0.669	0.461	0.879	234.9
VMT	0.472	0.098	1.151	1000

DIC: 19,783.23

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Results	
<ul style="list-style-type: none"> 46% of employees have a lower level of car dependence, and are subject to the occasional use of carsharing (10%), telecommuting (3%), riding public transit (29%), and walking and biking (4%); Employees in the IT-industry are more likely to change from driving alone to telecommuting; Employees in the IT-industry are more likely to change driving alone to riding transit in comparison with employees in manufacturing and health care; Employees in the IT-industry are more likely to change driving alone to walking and biking in comparison with employees in finance and professional service; 	

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Results	<h2>Results</h2> <ul style="list-style-type: none"> ▪ Employees who actively bargaining for CTR policies are more likely to change from drive alone to telecommute; ▪ Promoting transit access encourages the travel mode change towards riding transit, while discourages the change towards telecommuting; ▪ Providing transit pass does promote the travel mode change towards riding transit; ▪ Providing carsharing subsidy discourages the travel mode change towards telecommuting; ▪ Compressed workweek is positively associated with the travel mode change towards telecommuting, while negatively associated with the change towards to carsharing, walking and biking; ▪ Flexible work hours are positively associated with the travel mode change towards telecommuting, walking and biking;
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Results	<h2>Results</h2> <ul style="list-style-type: none"> ▪ Parking fee is an effective tool to promote the travel mode change from driving alone to all alternative modes; ▪ Employer-provided vehicles and short-distance mobility services both are negatively associated with the travel mode change towards telecommuting; ▪ The availability of rental cars on worksites is negatively associated with the travel mode change towards walking and biking; ▪ Attitudinal factors confirm the self-selection effect in making travel mode choices. ▪ In general, employees may choose alternative travel modes for incentives, health, time availability, or saving parking fees, while not for convenience or physical constraints; ▪ Employees who always drive show a high level of loyalty to driving, and the reasons are many, such as safety, family obligation, convenience, commuting distance, and job requirement.
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	<h2>Conclusions</h2> <ul style="list-style-type: none">▪ There is a great proportion of employees are apt to use alternative travel modes beyond driving alone;▪ Promoting transit access and providing transit pass are effective tools in encouraging transit use;▪ IT-industry employees have more choices and greater flexibility in choosing travel modes;▪ Parking scheme is an effective tool in incentivizing travel mode change;▪ Alternative work hours, such as compressed workweek, flexible work hours, all encourage the travel mode change towards telecommuting;▪ Attitudinal factors play a key role in explaining travel mode choices.
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	<h2>Implications</h2> <ul style="list-style-type: none">▪ Promote transit access and provide transit pass to employees;▪ Optimally use parking schemes (employers won't favor);▪ Increase working schedule flexibilities, especially alternative workhour policies, which have great potential to reduce traffic and mitigate congestion in the future;▪ Stop providing or optimally regulate free rides to employees, such as employer provided-vehicles, emergency rides, and transit/carsharing subsidies;▪ The joint effect of different TDM tools cannot be ignored, and the interplayed relationship among different tools needs to be carefully considered.
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Limitations

General issue

- Generalizability or research significance (Despite CTR is no longer popular, it can be treated as a package of TDM tools)

The 1st study

- Fail to include factors related to household location choice, and the VMT model involves internal validity issues

The 2nd study

- Employees' SES factors, home locations' BE factors;
- Limit to King County;

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Future Research

CTR Tools' Evaluation (Internal, Item Response Theory-IRT)

- The Difficulty of CTR in Practice (Capacity, Difficulty, and Discrimination)

GHG Reduction Simulation

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Acknowledgement

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