

TRANSPORT FINDINGS

Changes in Perceived Work-from-Home Productivity during the Pandemic: Findings from Two Waves of a Covid-19 Mobility Survey

Xiao Shi¹ , Mary Richards² , Anne Vernez Moudon¹ , Brian H.Y. Lee² , Qing Shen³ , Xuegang Ban⁴ ¹ Urban Form Lab, Department of Urban Design and Planning, University of Washington, ² Puget Sound Regional Council, ³ Department of Urban Design and Planning, University of Washington, ⁴ Department of Civil & Environmental Engineering, University of Washington

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Findings

A two-wave survey of workers in Seattle revealed an increase in self-reported work productivity over time for those who shifted to work from home (WFH) since the outbreak of Covid-19. Teleworkers with higher household income adapted better and were more likely to report an increase in productivity as they continued WFH. While those living with friends and relatives were more likely to report a decrease in productivity as they telework for longer. Commute trip reduction programs might encourage the portion of the population with such characteristics to continue WFH after the pandemic subsides and provide support to those with fewer recourses to telework productively if they choose to.

1. Questions

The Covid-19 pandemic has impacted all aspects of life, most noticeably that of transitioning to work from home (WFH) for hundreds of millions of workers worldwide (Soares, Bonnet, and Berg 2021). By eliminating commute trips, WFH can contribute to transportation efficiency and environmental quality. Understanding the impact of the current mandated and prolonged WFH situation on work productivity (Kazekami 2020; Nakrošienė, Bučiūnienė, and Goštautaitė 2019; Pignini and Staffolani 2019) might inform commute trip reduction policies after the pandemic subsides. Complementing previous research (Shi et al. 2020), this study explores the impact of WFH on teleworkers' productivity over time. We ask:

1. Did perceived work productivity change as workers continued to WFH over time?
2. Did the relationships between socioeconomic status (SES), lifestyle, and perceived teleworking productivity differ between spring and fall 2020?

2. Methods

Study and Survey Design

Two waves of a cross-sectional survey were conducted in the spring (April-June) and fall (October-November) of 2020. The data were pooled for analysis to identify differences over time, but the results do not infer causal relations. Consistent questions asked respondents about changes in their work productivity, daily routines, and mental well-being since transitioning to WFH per state restrictions following Covid-19. Sampling targeted a population of adults 18 years old or older, living in the Seattle region (King, Kitsap, Pierce,

and Snohomish Counties). The survey provided no financial incentive for participation. Both surveys were distributed online through professional email lists, including public agencies, non-governmental organizations, community groups, universities and colleges. Protocols were approved by the University of Washington Internal Review Board.

Survey respondents came from 87% of the region ZIP codes. They totaled 4,151 with 3,402 responding to the spring survey and 749 to the fall. The present study included the 2,678 (65%) who had shifted from working away to WFH since March 2020. Respondents from the two survey waves shared similar characteristics ([Table 1](#)). Compared to the region's population (US Census Bureau 2019), more respondents identified as female (69% in spring and 64% in fall vs. 50% in the region), had a graduate degree (52% and 54% vs. 17% region), and belonged to households with incomes above \$150,000 (34% and 38% vs. 27% region). There were fewer 18-to-29-year-old adults (18% and 13% vs. 22% region).

Variables

Analyses were conducted at the respondent level. The outcome variable was self-reported change in productivity since respondents started WFH. Three response options were provided: no change, a decrease, or an increase in productivity. Productivity was treated as an ordinal variable with decrease in productivity as the reference.

To explain changes in teleworking productivity over time, we used factors identified as significantly associated with teleworking productivity in our previous study (Shi et al. 2020). Factors were organized into four domains: socioeconomic status (SES), pre-pandemic commute trip mode and duration, lifestyle changes, and mental wellbeing ([Table 1](#)). All respondents reported commute duration for each mode (walking, biking, transit, SOV, and HOV), with four ordinal levels (0-do not use, 1- <30min, 2- 31-60min, 3- >1 hour). Depression was evaluated using two questions from the Patient Health Questionnaire (Kroenke, Spitzer, and Williams 2003): how often respondents felt depressed or had little interest in doing things on a 4-point Likert scale (0 = Not at all; 1 = Several days; 2 = More than half the days; 3 = Nearly every day). The depression measure was indexed by summing all scaled question results, with higher scores indicating higher levels of perceived depression (range = 0 to 6). The measures have been tested for validity in previous studies (Cohen-Cline, Turkheimer, and Duncan 2015).

Change over the time of the pandemic was captured by adding a dummy variable that identified respondents from the spring and fall survey waves.

Statistical Analysis

Ordered logit models served to assess factors associated with self-reported changes in productivity. We first tested univariate models for all hypothesized predictors, with survey wave dummy added to examine the effect of time.

Table 1. Characteristics of survey respondents who shifted from working away to WFH: their SES, pre-pandemic commute trip mode and duration, mental wellbeing status, and lifestyle changes since Covid-19 (N=2,678).

Variables	Spring 2020 (N=2,174)	Fall 2020 (N=504)	Overall (N=2,678)
Outcome			
Productivity			
Less productive	839 (39%)	150 (30%)	989 (37%)
No change in productivity	817 (38%)	224 (44%)	1041 (39%)
More productive	518 (24%)	130 (26%)	648 (24%)
Domain: SES			
Age			
18 to 29	389 (18%)	65 (13%)	454 (17%)
30 and above	1782 (82%)	439 (87%)	2221 (83%)
Missing	3 (0.1%)	0 (0%)	3 (0.1%)
Gender			
Female	1499 (69%)	322 (64%)	1821 (68%)
Male	646 (30%)	176 (35%)	822 (31%)
Other	29 (1%)	6 (1%)	35 (1%)
Employment			
Professional/Business	1753 (81%)	283 (56%)	2036 (76%)
Education/Research	371 (17%)	139 (28%)	510 (19%)
Other	50 (2%)	82 (16%)	132 (5%)
Educational attainment			
High school/Associate degree	251 (12%)	60 (12%)	311 (12%)
Bachelor degree	777 (36%)	171 (34%)	948 (35%)
Graduate degree	1129 (52%)	270 (54%)	1399 (52%)
Other	17 (1%)	3 (1%)	20 (1%)
Household Income			
Below \$150,000	1380 (63%)	297 (59%)	1677 (63%)
Above \$150,000	735 (34%)	194 (38%)	929 (35%)
Missing	59 (2.7%)	13 (2.6%)	72 (2.7%)
Housing Tenure			
Own	1411 (65%)	348 (69%)	1759 (66%)
Rent	715 (33%)	147 (29%)	862 (32%)
Other	48 (2.2%)	9 (1.8%)	57 (2.1%)
Living arrangement			
Partner (without children)	876 (40%)	218 (43%)	1094 (41%)
Live alone	316 (15%)	70 (14%)	386 (14%)
Roommates, friends, relatives	308 (14%)	70 (14%)	378 (14%)
Children (with or without partner)	619 (28%)	135 (27%)	754 (28%)
Other	55 (3%)	11 (2%)	66 (2%)
Vehicle Ownership			
Yes	2029 (93%)	476 (94%)	2505 (94%)
No	145 (7%)	28 (6%)	173 (6%)
Having a dog			
Yes	756 (35%)	171 (34%)	927 (35%)
No	1418 (65%)	333 (66%)	1751 (65%)
Domain: lifestyle changes			
Sleep quality and quantity			

1-Decreased a lot	176 (8%)	36 (7%)	212 (8%)
2-Decreased somewhat	531 (24%)	129 (26%)	660 (25%)
3-No change	725 (33%)	188 (37%)	913 (34%)
4-Increased somewhat	610 (28%)	126 (25%)	736 (27%)
5-Increased a lot	132 (6%)	24 (5%)	156 (6%)
Not Applicable	0 (0%)	1 (0%)	1 (0%)
Amount of food consumed			
1-Decreased a lot	21 (1%)	6 (1%)	27 (1%)
2-Decreased somewhat	258 (12%)	56 (11%)	314 (12%)
3-No change	1060 (49%)	286 (57%)	1346 (50%)
4-Increased somewhat	738 (34%)	142 (28%)	880 (33%)
5-Increased a lot	97 (4%)	14 (3%)	111 (4%)
Not Applicable	0 (0%)	0 (0%)	0 (0%)
Amount of Exercise			
1-Decreased a lot	567 (26%)	155 (31%)	722 (27%)
2-Decreased somewhat	552 (25%)	155 (31%)	707 (26%)
3-No change	297 (14%)	68 (13%)	365 (14%)
4-Increased somewhat	542 (25%)	90 (18%)	632 (24%)
5-Increased a lot	207 (10%)	36 (7%)	243 (9%)
Not Applicable	9 (0%)	0 (0%)	9 (0%)
Time on social media			
1-Decreased a lot	23 (1%)	12 (2%)	35 (1%)
2-Decreased somewhat	76 (3%)	30 (6%)	106 (4%)
3-No change	828 (38%)	175 (35%)	1003 (37%)
4-Increased somewhat	781 (36%)	182 (36%)	963 (36%)
5-Increased a lot	293 (13%)	48 (10%)	341 (13%)
Not Applicable	173 (8%)	57 (11%)	230 (9%)
Time on personal hobby			
1-Decreased a lot	118 (5%)	40 (8%)	158 (6%)
2-Decreased somewhat	194 (9%)	68 (13%)	262 (10%)
3-No change	862 (40%)	206 (41%)	1068 (40%)
4-Increased somewhat	701 (32%)	139 (28%)	840 (31%)
5-Increased a lot	193 (9%)	36 (7%)	229 (9%)
Not Applicable	106 (5%)	15 (3%)	121 (5%)
Domain: pre-pandemic commute trip duration (one-way) by mode			
Walking			
0-Do not use	1603 (74%)	375 (74%)	1978 (74%)
1-<30 min	414 (19%)	78 (15%)	492 (18%)
2-31 to 60 min	123 (6%)	43 (9%)	166 (6%)
3->1 hour	34 (2%)	8 (2%)	42 (2%)
Biking			
0-Do not use	1830 (84%)	399 (79%)	2220 (83%)
1-<30 min	195 (9%)	58 (12%)	253 (9%)
2-31 to 60 min	122 (6%)	37 (7%)	159 (6%)
3->1 hour	27 (1%)	10 (2%)	37 (1%)
Transit			
0-Do not use	1018 (47%)	220 (44%)	1238 (46%)
1-<30 min	391 (18%)	96 (19%)	487 (18%)
2-31 to 60 min	593 (27%)	140 (28%)	733 (27%)

3->1 hour	172 (8%)	48 (10%)	220 (8%)
Single Occupancy Vehicle (SOV)			
0-Do not use	946 (44%)	207 (41%)	1153 (43%)
1-<30 min	735 (34%)	184 (37%)	919 (34%)
2-31 to 60 min	424 (20%)	98 (19%)	522 (19%)
3->1 hour	69 (3%)	15 (3%)	84 (3%)
High Occupancy Vehicle (HOV)			
0-Do not use	1882 (87%)	444 (88%)	2326 (87%)
1-<30 min	152 (7%)	30 (6%)	182 (7%)
2-31 to 60 min	118 (5%)	25 (5%)	143 (5%)
3->1 hour	22 (1%)	5 (1%)	27 (1%)
<i>Domain: mental wellbeing</i>			
Depression measure			
Mean (SD)	1.45 (1.48)	1.42 (1.48)	1.44 (1.48)
Median [Min, Max]	1.00 [0, 6.00]	1.00 [0, 6.00]	1.00 [0, 6.00]
Anxiety measure			
Mean (SD)	4.02 (4.14)	3.96 (4.17)	4.01 (4.15)
Median [Min, Max]	3.00 [0, 24.0]	3.00 [0, 24.0]	3.00 [0, 24.0]

A base model was estimated with all variables significant in the univariate models as well as the survey wave dummy. We then tested interaction terms between each factor and the survey wave dummy and only reported those that were significant at $p < 0.05$ level. We conducted brant tests on the proportional odds assumption and results showed the assumptions were not violated (Brant 1990).

3. Findings

In our sample, productivity appeared to increase over the course of the pandemic. More respondents reported experiencing no change in productivity in the fall than in the spring (44% vs. 38%) or being more productive (26% vs. 24%) ([Table 1](#)). After controlling for SES, pre-pandemic commute trip duration, lifestyle changes, and mental wellbeing status, fall respondents were 48% more likely than spring respondents to report experiencing no change or an increase in productivity ([Table 2](#) Model 1). This suggested that people have adapted to teleworking gradually and positively as the pandemic subsisted.

Table 2. Association between reported productivity, SES, pre-pandemic commute trip mode and duration, lifestyle changes, and mental wellbeing (N=2,287).

Domains	Predictors	Model 1		Model 2		Model 3	
		OR	p	OR	p	OR	p
Temporal Effect	Spring 2020	Reference		Reference		Reference	
	Fall 2020	1.48	<0.001	1.16	0.266	1.62	0.002
SES	Age						
	- 18 to 29	0.52	<0.001	0.51	<0.001	0.51	<0.001
	- 30 and above	Reference		Reference		Reference	
	Employment						
	- Professional/business	Reference		Reference		Reference	
	- Education/research	0.52	<0.001	0.52	<0.001	0.51	<0.001
	- Others	0.71	0.069	0.72	0.089	0.71	0.073
	Education						
	- High school/Associate degree	1.41	0.012	1.42	0.011	1.43	0.010
	- Bachelor's degree	1.34	0.001	1.36	0.001	1.34	0.001
	- Graduate and above	Reference		Reference		Reference	
	- Other	2.37	0.077	2.38	0.076	2.59	0.055
	Household income						
	- Below \$150,000	Reference		Reference		Reference	
	- Above \$150,000	1.16	0.102	1.03	0.791	1.16	0.100
	- Above \$150,000 * Fall 2020			1.87	0.003		
	Living arrangement						
	- Partner	Reference		Reference		Reference	
	- Live alone	0.96	0.725	0.97	0.789	1.00	0.981
	- Friends and relatives	1.04	0.739	1.05	0.711	1.18	0.251
	- Children	0.66	<0.001	0.67	<0.001	0.64	<0.001
	- Other	0.71	0.197	0.71	0.198	0.87	0.636
	- Live alone * Fall 2020					0.78	0.423
	- Friends and relatives * Fall 2020					0.52	0.045
	- Children * Fall 2020					1.21	0.439
	- Other * Fall 2020					0.31	0.094
Lifestyle Changes	Sleep quality and quantity	1.10	0.019	1.10	0.019	1.10	0.017
	Time on social media	0.86	0.002	0.86	0.002	0.85	0.002

		Model 1		Model 2		Model 3	
	Time on personal hobby	1.10	0.024	1.10	0.028	1.10	0.024
<i>Pre-pandemic Commute Trip Duration</i>	Walking	0.85	0.012	0.86	0.015	0.85	0.012
	SOV	1.24	<0.001	1.24	<0.001	1.24	<0.001
<i>Mental Wellbeing</i>	Depression measure	0.82	<0.001	0.82	<0.001	0.83	<0.001

Note: Model 1- Base Model; Model 2- Household income*Fall 2020; Model 3-Living arrangement*Fall 2020. Grey cells: variables capturing temporal changes.

Table 3. Simple Main Effect for Productivity Change Overtime by Income.

	Below \$150,000		Above \$150,000	
	OR	p	OR	p
Fall 2020 – Spring 2020	1.16	0.27	2.17	<0.001***

***p<0.001 **p<0.01 *p<0.05

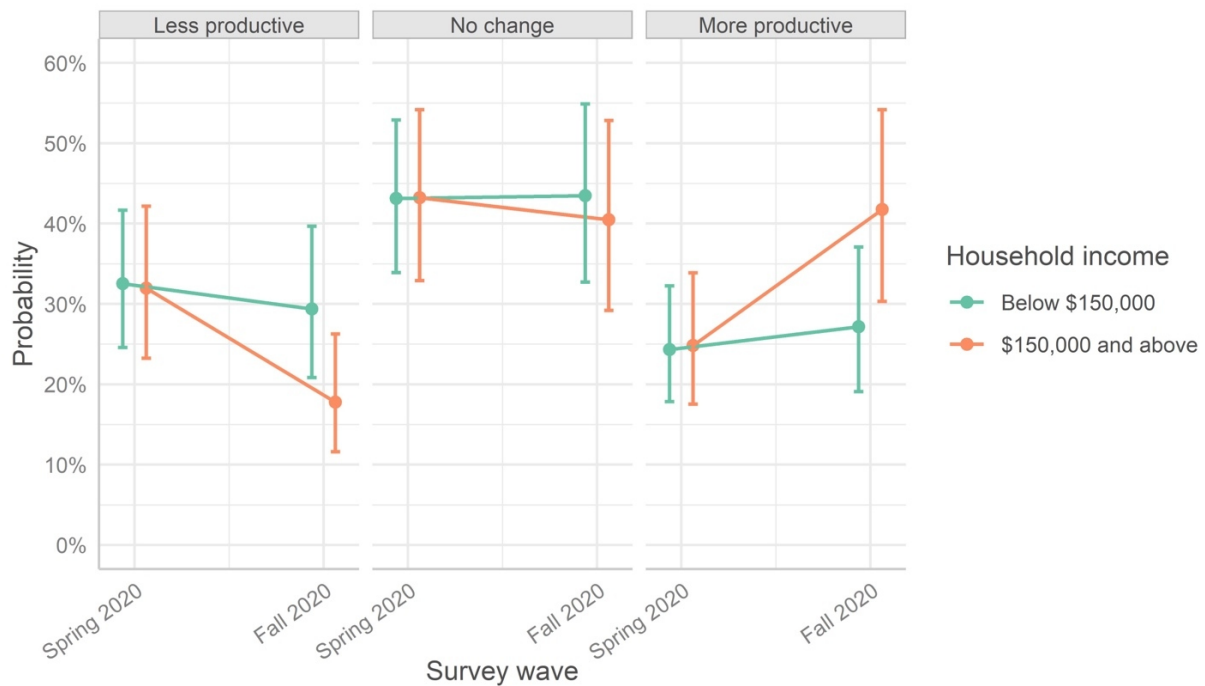


Figure 1. Modeled differences in the effect of income between the spring and fall survey.

Income and living arrangement had a moderating effect on the capacity to adapt to teleworking. Change in self-reported productivity was different for people coming from different household income brackets (Table 2 Model 2). A significantly higher proportion of people with household incomes above \$150,000 reported being more productive compared to spring respondents (Table 3, Figure 1). Therefore, people who were more financially advantaged appeared to be better able to adapt to teleworking than those with lower incomes. A likely explanation is that higher income translates into greater access to resources and the ability to make timely adjustments, such as enhancing internet infrastructure, having a spare room for work, having satisfactory child care, etc. (Cox et al. 2020; Prime, Wade, and Browne 2020), all conditions that may lead to greater productivity.

Living arrangement had a moderating effect on productivity change. Compared to other living arrangements, people living with roommates and friends experienced a decrease in productivity (Table 2 Model 3). However, the effect was no longer significant after considering that of income (Appendix

[Table A1](#) Model 4), likely because household income and living arrangement were correlated, where people living with friends and relatives tended to also have household incomes below \$150,000 (Appendix [Table A2](#)).

Other factors found to influence teleworking productivity in the spring survey (Shi et al. 2020) (age, pre-pandemic commuting patterns, lifestyle changes, and mental wellbeing status) remained significant after considering the temporal effect. The pooled data structure used did not infer causal relations, however, findings strongly suggested that many higher income workers could continue to WFH past the pandemic while remaining productive, and could potentially reduce the number of future commute trips. Extra effort should be made to support those with fewer resources to telework productively if they choose to.

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Appendix

Table A1.

		Model 4	
<i>Domains</i>	<i>Predictors</i>	<i>OR</i>	<i>p</i>
Temporal Effect	Spring 2020	<i>Reference</i>	
	Fall 2020	1.25	0.231
SES	Age		
	- 18 to 29	0.51	<0.001
	- 30 and above	<i>Reference</i>	
	Employment		
	- Professional/business	<i>Reference</i>	
	- Education/research	0.51	<0.001
	- Others	0.72	0.085
	Education		
	- High school/Associate degree	1.43	0.009
	- Bachelor's degree	1.36	0.001
	- Graduate and above	<i>Reference</i>	
	- Other	2.61	0.054
	Household income		
	- Below \$150,000	<i>Reference</i>	
	- Above \$150,000	1.05	0.663
	- Above \$150,000 * Fall 2020	1.72	0.015
	Living arrangement		
	- Partner	<i>Reference</i>	
	- Live alone	0.97	0.825
	- Friends and relatives	1.15	0.343
	- Children	0.65	<0.001
	- Other	0.87	0.626
	- Live alone * Fall 2020	0.98	0.953
	- Friends and relatives * Fall 2020	0.62	0.152
	- Children * Fall 2020	1.17	0.513
	- Other * Fall 2020	0.31	0.098
Lifestyle Changes	Sleep quality and quantity	1.10	0.018
	Time on social media	0.85	0.001
	Time on personal hobby	1.10	0.028
Pre-pandemic Commute Trip Duration	Walking	0.86	0.015
	SOV	1.24	<0.001
Mental Wellbeing	Depression measure	0.82	<0.001

Note: Model 4 - Household income*Fall 2020 + Living arrangement*Fall 2020.

Table A2. Distribution of Household Income by Living Arrangement.

Living Arrangement Household Income	<i>partner</i>	<i>live alone</i>	<i>roommates, friends, relatives</i>	<i>children</i>	<i>other</i>
<i>Below \$150,000</i>	632 (58%)	350 (91%)	300 (79%)	354 (47%)	41 (62%)
<i>Above \$150,000</i>	437 (40%)	29 (8%)	54 (14%)	387 (51%)	22 (33%)
<i>Missing</i>	25 (2%)	7 (2%)	24 (6%)	13 (2%)	3 (5%)
Correlation	0.34 (p<0.001)				