Changes in activity-travel behaviour of London Underground users during and after the COVID-19 pandemic

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- COVID-19 transmission occurs via droplets/aerosols (World Health Organization, 2020).
- Infections are more likely in confined spaces with poor ventilation (Chen et al., 2021; World Health Organization, 2020).
- Public health officials mandate non-pharmaceutical interventions including masks, social distancing, working from home.
- There is an actual and a perceived risk of COVID-19 infection on public transportation and during various activities.

Motivation

• The COVID-19 pandemic has resulted in significant changes in activity-travel behaviour:

- Drop in public transport ridership
- Wide-spread adoption of working from home (WFH)

Travelmede	All	vorkers (N	=798)	Workers who commuted			
Travel mode	Nov-19	Jun-20	Jan-21	Nov-19	Jun-20	Jan-21	
Bus/tram	74	54	62	9%	13%	14%	
Underground	542	168	190	69%	39%	42%	
Car	39	69	67	5%	16%	15%	
Taxi/ridesharing/ Carpool	2	12	12	1%	4%	4%	
Bicycle/walk	30	84	73	4%	20%	16%	
Rail	93	38	41	12%	9%	9%	
I did not travel to work	14	371	349				

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Motivation

- There is an urgent and essential need to understand how the **epidemic situation** and **(non-)pharmaceutical interventions** influence **activity-travel behaviour** in the short-, medium- and long-term.
 - Advanced epidemiological modelling and simulation
 - Supply of transportation infrastructure and services
 - Integrated transport and land use planning

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• Estimate demand for public transport (London Underground) and working-from-home (WFH) relative to epidemic situation and (non-)pharmaceutical countermeasures

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Survey design

- Discrete choice experiments
 - Travel profile choice for trips by London Underground
 - Willingness to work from home
- Background guestions
 - Socio-economic characteristics
 - Lifestyle, travel patterns
 - Attitudes towards public health measures and working from home

Travel profile choice

Attributes	Travel profile 1	Travel profile 2
Crowding density (persons per meter ²)	[0,1,2,4,6]	[0,1,2,4,6]
Standing?	[Yes, No]	[Yes, No]
Travel time (minutes)	[-30%, current,15%, 30%]	[-30%, current,15%, 30%]
Daily new COVID-19 cases (per 100,000)	[10,30,50,70,90]	[10,30,50,70,90]
Mask compulsory	[Yes, No]	[Yes, No]
Vaccinated population in the UK	[5%,20%,35%,50%,65%,80%]	[5%,20%,35%,50%,65%,80%]

- Travel time is pivoted on the travel time of the respondent's most frequent trip by London Underground.
- Partial profile design (8 choice situations, 3 blocks).

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Travel profile choice

Attributes	Travel profile 1	Travel profile 2
Crowding levels	anifation anifation anifation anifation anifation anifation	en e
	1 person / square metre	6 persons / square metre
Standing in the tube?	No	No
In-vehicle (on-board) travel time (minutes)	21 minutes	30 minutes
Daily new COVID-19 cases in the UK (per 100 thousand	50	10
inhabitants)		
Mask compulsory?	Yes	Yes
Vaccinated population in the UK	50%	80%

- Dual response design:
 - Which of the two travel profiles would you prefer the most?
 - Would you really take the chosen travel profile in practice or not?

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WFH choice

Daily new COVID-19 cases in the UK	
(per 100 thousand people)	30
COVID-vaccinated population in the UK	20%
Mask compulsory at the workplace	Yes, only while NOT seated at desk
Mask compulsory during travel to work	Yes

- 3 choice situations per respondent
- Attributes and levels:
 - Mask comp. at workplace: no/ yes, at desk / yes, always
 - Mask comp. during travel: no / yes (with logical constraint)
- Single response design: Would you work from home or travel to work under these circumstances?
- Respondents instructed to assume that employer has given flexibility to work from either home or at the workplace.

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Data collection and cleaning

- Eligibility criteria:
 - Older than 18 years,
 - Used London underground for 3 or more round trips per week in 2019,
 - Spent more than 9 months in London during 2020,
 - Plan to spend more than 9 months in London during 2021.
- Conducted Between March and May 2021.
- Cleaning, i.e. removed respondents with
 - response time < 0.4 * median response time,
 - household size < (no. of workers + no of children),
 - straight liners (chose same choice across all eight choice situations).

Sample composition and representativeness

- 1080 respondents completed the survey; 961 respondents remain for the final analysis after cleaning.
- Demographic distribution across sample and population:

	2011 United Kingdom census (London Population)	Sample proportions (N=961)
Gender		
Male	49.5%	48.3% (464)
Female	50.5%	51.7% (497)
Age		
19 to 39 years	47.4%	41.7% (401)
40 to 59 years	32.0%	36.3% (349)
60+ years	21.7%	22.0% (211)

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Travel profile choice: MXL estimates

	Posterior	Posterior	Subject		
Term	Mean	Std Dev	Std Dev	Lower 95%	Upper 95%
crowding_dens	-0.50543121	0.0305589032	0.452919040	-0.568659	-0.449734
standing	-0.28445461	0.0624124644	0.490855179	-0.403305	-0.165472
travl_time	-0.04692682	0.0063402584	0.068294540	-0.059084	-0.034123
new_case	-0.03328551	0.0024202372	0.039583083	-0.038027	-0.028603
mask_compulsory	1.58665269	0.0942828854	1.433754714	1.401651	1.7759008
vaccination_prop	3.80023759	0.2163816815	2.410170684	3.3937252	4.1951443



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Preferences for WFH (yes/no): MNL estimation results

	Value	Std err	t-test	p-value
ASC	0.770	0.220	3.503	0.000
B_{female}	-0.270	0.051	-5.290	0.000
B_age_18_29	-0.294	0.137	-2.141	0.032
B_age_50_59	0.183	0.134	1.365	0.172
B_age_60_plus	-0.059	0.152	-0.388	0.698
B_num_child	-0.177	0.069	-2.548	0.011
B_single_hh	-0.145	0.122	-1.181	0.238
$B_spec_attention$	0.396	0.178	2.221	0.026
B_edu_bachelor_plus	0.463	0.107	4.326	0.000
$B_emp_professional$	0.474	0.109	4.369	0.000
B_equipment_okay	0.981	0.115	8.532	0.000
$B_manage_1_5$	-0.231	0.122	-1.897	0.058
B_manage_21_plus	-0.696	0.153	-4.540	0.000
B_manage_6_20	-0.262	0.143	-1.836	0.066
B_mask_travel	-0.465	0.244	-1.908	0.056
B_mask_work_always	0.045	0.233	0.193	0.847
B_mask_work_ex_desk	-0.226	0.228	-0.989	0.323
B_new_case	0.009	0.003	3.280	0.001
B_vaccination_prop	-2.081	0.257	-8.099	0.000

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Attitudes and preferences for WFH

	Agree	Somewhat agree	Somewhat disagree	Disagree
I have appropriate space and equipment to work from home.	46.1%	32.5%	9.3%	12.2%
I enjoy interacting with colleagues at the workplace.	57.5%	34.2%	7.0%	1.3%
It is important to me that my colleagues and managers recognise my workload.	57.6%	35.8%	5.0%	1.5%
Working is one of the most important aspects of my life.	30.2%	47.1%	15.9%	6.8%
I prefer in-person meetings over online (e.g., Zoom/Skype) meetings.	42.5%	31.3%	19.3%	6.9%

	WFH allowed	WFH wanted
Not at all	25.06%	17.17%
1 day	3.38%	4.39%
2 days	5.39%	18.05%
3 days	8.65%	22.56%
4 days	3.51%	9.27%
5 days	54.01%	28.57%

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Preferences for WFH

Special attention			Preference	for WFH		
required	Not at all	1 day	2 day	3 day	4 day	5 day
Yes	11%	1%	24%	17%	9%	37%
No	18%	5%	17%	23%	9%	28%

	Preference for WFH					
Education	Not at all	1 day	2 day	3 day	4 day	5 day
Below bachelor's degree	24.4%	5.1%	13.8%	17.7%	6.7%	32.3%
Bachelor's degree or above	13.8%	4.0%	20.0%	24.8%	10.5%	26.8%

		Preference for WFH						
Employment	Not at all	1 day	2 day	3 day	4 day	5 day		
Others	18%	4%	19%	22%	9%	29%		
Professional	8%	6%	17%	30%	11%	29%		

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Conclusions and outlook

- Respondents are sensitive to epidemic situation and (non-)pharmaceutical interventions when making activity-travel choices.
- Next steps:
 - Estimation in crowding multiplier space in analogy to willingness to pay space.
 - Explore utility specifications with interaction effects.
 - Develop latent class models to explain heterogeneity in preferences.
 - Develop integrated choice and latent variable models to include attitudes.

Thank you

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