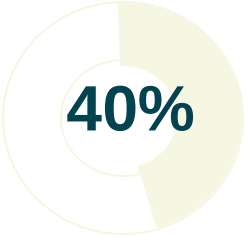
Household or individual carbon emissions? Differentiating the drivers

Ting Liu
Post-doc Research Associate
Centre for Environmental Policy, Imperial College London

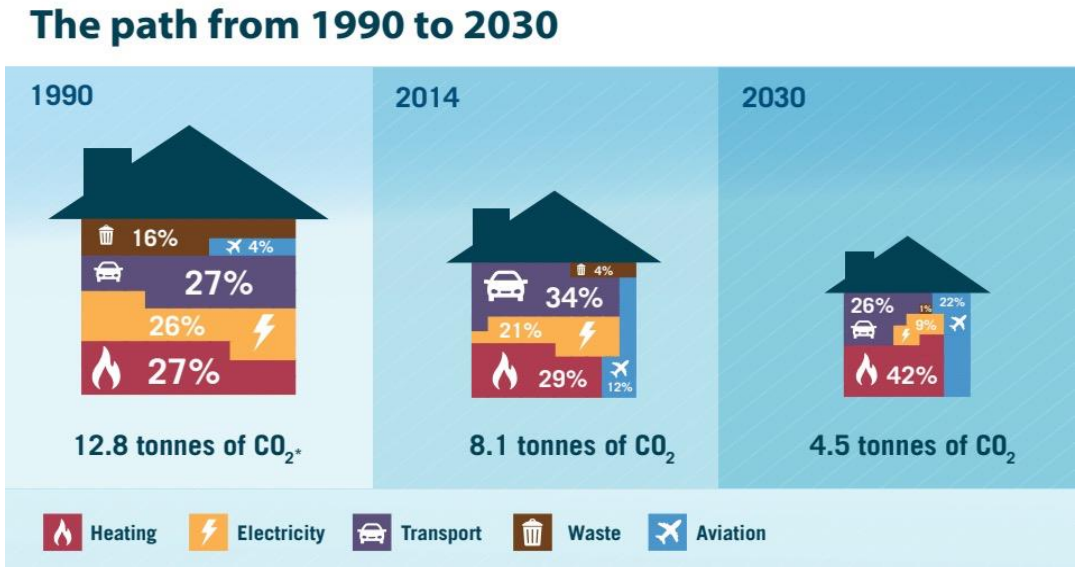
PhD in Social Statistics, Cathie Marsh Institute
Department of Social Statistics, The University of Manchester

Source: Liu, T.*, Shryane, N. & Elliot, M. (2023). Micro-macro multilevel analysis of day-to-day lifestyle and carbon emissions in UK multiple occupancy households. *Sustainable Production and Consumption, 39*. 13-29.

Background



of UK emissions come from households. Since 1990, UK home carbon footprints dropped 4.7 tonnes in 2014. Cutting 3.6 more by 2030 keeps us on track for 2050 climate goals.



Source: Fifth Carbon Budget of the Climate Change Committee (2016).

Existing Literature

Household expenditure (e.g., car and most probably air travel within transport, meat and dairy within food, building structures, energy-using within the housing (Druckman & Jackson, 2015).

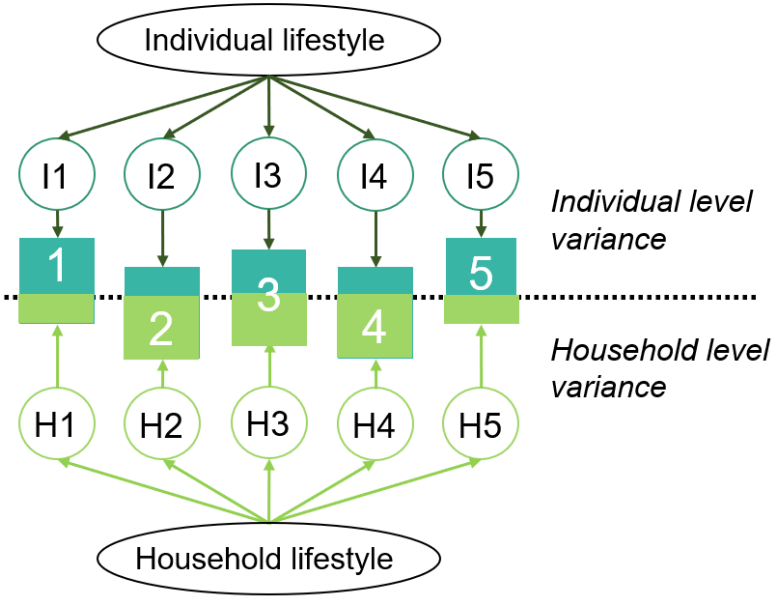
Housing-related Lifestyle (HRL) (e.g., tenure, number of cars, occupancy levels, energy choices, employment are the main driver of emissions across the income spectrum, Burgess & Whitehead, 2020).

Activity-driven lifestyle (e.g., the share of eating out in total food expenditures, Li et al., 2019).

Gaps

1. More attention on consumption and expenditure, less attention on specific lifestyle behaviours.

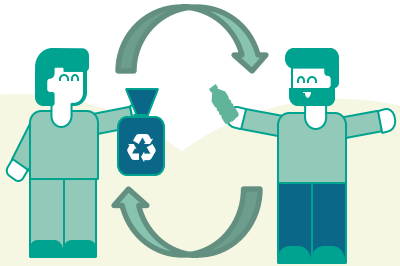
2. Single level analysis ignores hierarchically structured lifestyle data and variance decomposed into within and between household.

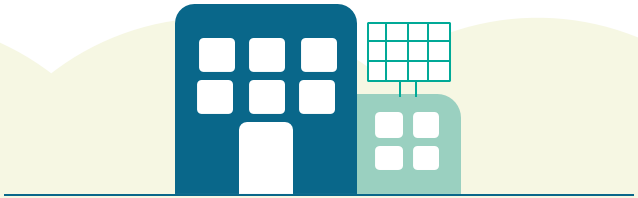


Day-to-day lifestyle sustainablity (DTDLS)

Sustainable lifestyles: A living pattern of people who individually or in co-existence with others (e.g., family, generation) aim to reduce their carbon footprint by choosing suitable means of transportation and energy using (Lubowiecki-Vikuk, 2021).

- Sharing a household means influencing & being influenced by others in the household.
- Behaviours driven by individual preferences (micro) & household norms (macro).





Goals and research questions

1. How do individual (micro level) DTDLS indicators relate to household (macro level) latent DTDLS factors?

2. To what extent are household carbon emissions associated with DTDLS within the household?

3. What are the contributions of household income and housing-related lifestyle (HRL) on household carbon emissions?

Methods

Data: UK Household Longitudinal Study, wave 10, 2018-2022.

Sample: 8618 multiple occupancy households of 19816 individuals, excluding London.

Measurement:

a. DTDLS: 11 items about appliance using, energy consuming, transport, etc. 5 Likert scale, 1 to 5, Never to Always.

b. Covariates: Household income, HRL including tenure, dwelling, number of cars, etc.

c. Response variables: Housing fuel using emissions & Motor emissions

Statistical analysis

1. **Intraclass correlation (ICC):** How many proportion of variance in household DTDLS?

2. **Multilevel EFA & CFA:** How does individual DTDLS load at two levels?

3. **Micro-macro multilevel model:** Which emit most? DTDLS, HRL, or household income?

Results-Household level variance in DTDLS

Table 1. Univariate statistics & ICC of DTDLS

DTDSL indicators	Mean	SD	ICC
L1. Leaving TV on standby	2.85	1.78	.48
L2. Switch off lights	4.33	.99	.15
L3. Tap running	3.51	1.53	.30
L4. Put on clothes when cold	3.36	1.21	.25
L5. Avoid excessive packaging	1.92	.98	.26
L6. Buy recycled paper	2.52	1.26	.31
L7. Take own shopping bag	4.34	1.08	.24
L8. Use public transport	2.10	1.17	.34
L9. Walk/cycle short journeys	2.64	1.33	.29
L10. Car share	1.82	1.10	.20
L11. Take fewer flights	2.08	1.37	.32

ICC = 0, no clustering, no variance between individuals.
ICC = 1, no variance within individuals.

Results-Latent DTDLS factors at two levels

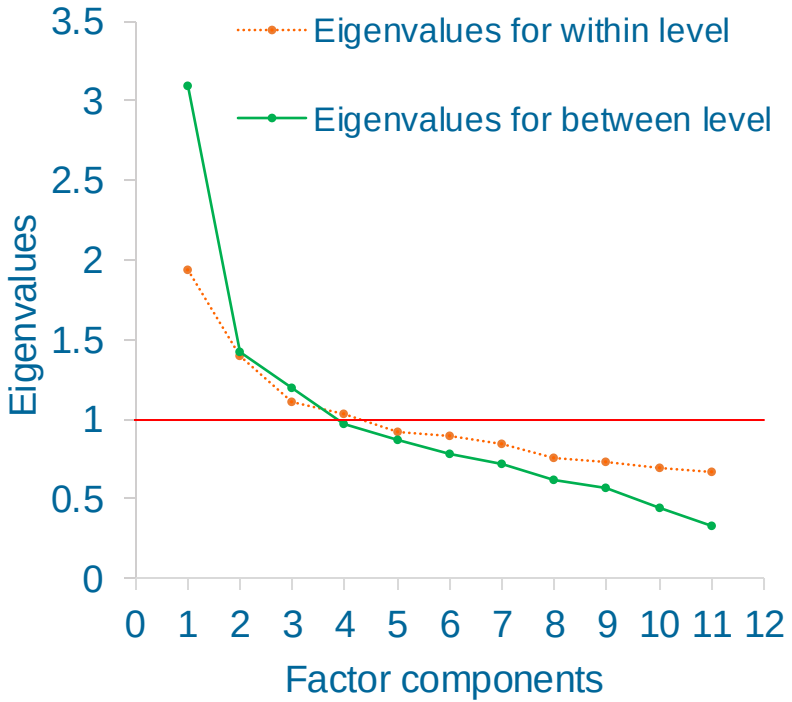


Table 2. Fit indices for MEFA of DTDLS.

FW	FB	AIC	Chi²	df	CFI	RMSEA	SRMR
1	1	648998.34	4332.03*	88	.66	.05	W=.06, B=.11
2	1	646859.39	2287.29*	78	.82	.04	W=.04, B=.11
3	1	645916.67	1377.80*	69	.89	.03	W=.03, B=.08
4	1	645535.22	1059.85*	61	.92	.03	W=.02, B=.08
1	2	648115.10	3888.85*	78	.69	.05	W=.06, B=.11
2	2	646054.26	1593.88*	68	.88	.03	W=.04, B=.07
3	2	645508.11	1076.42*	59	.92	.03	W=.03, B=.07
4	**2**	**645133.83**	**644.38***	**51**	**.95**	**.02**	**W=.02, B=.06**
1	3	647311.25	2752.26*	69	.78	.04	W=.06, B=.07
2	*3*	*645653.37*	*1071.23**	*59*	*.92*	*.03*	*W=.03, B=.05*
3	*3*	*645132.67*	*57.97**	*50*	*.96*	*.02*	*W=.02, B=.04*
4	*3*	*644851.59*	*286.71**	*42*	*.98*	*.02*	*W=.02, B=.04*

Note. Models with problems of nonidentification are in italic.

DTDLS factor loadings at two levels?

DTDSL indicators	Standardised factor loadings					
	Within level				Between level	
	FW1	FW2	FW3	FW4	FB1	FB2
L1. Leaving TV on standby				.10	**.41**	
L2. Switch off lights	.43				.30	
L3. Tap running	.13				**.73**	
L4. Put on clothes when cold	.40				.36	
L5. Avoid excessive packaging		.57				.79
L6. Buy recycled paper		.53				.69
L7. Take own shopping bag	.45				.46	
L8. Use public transport			.59			.42
L9. Walk/cycle short journeys			.59			.57
L1. Car share				.63		.41
L11. Take fewer flights				.45		.62

Latent DTDSL factors	Factor correlations					
	FW1	FW2	FW3	FW4	FB1	FB2
FW1: Energy-saving						
FW2: Resource consumption	.45***					
FW3: Low-carbon transportation	.14***	.19***				
FW4: Reducing transportation & Switching off standby	.10**	.30***	.59***			
FB1: Energy-saving						
FB2: Green transportation & consumption					.54***	

Model build

SEM 1 accounted for DTDSL

SEM 2 accounted for household income

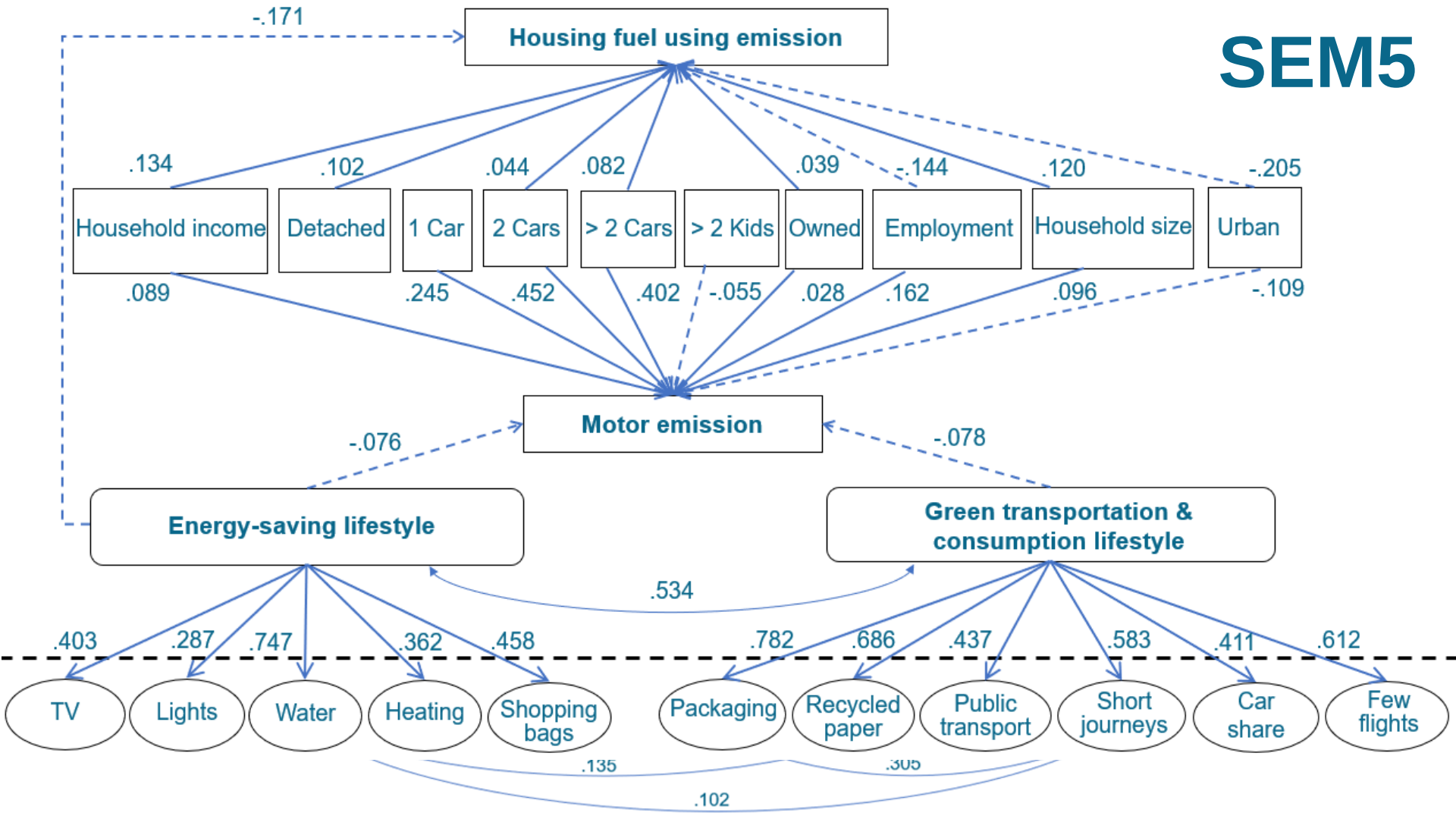
SEM 3 accounted for DTDSL and household income

SEM 4 accounted for DTDSL, household income, and HRL excluding number of cars

SEM 5 accounted for DTDSL, household income, and HRL

Roles of DTDLS, HRL & household income

Housing fuel using emissions	St.β (SE)		
	SEM 1	SEM 3	SEM 5
DTDLS			
Energy-saving	-.091** (.027)	-.079** (.026)	-.171*** (.027)
Green transportation & consumption	-.063* (.029)	-.082** (.029)	.049 (.026)
Household income		.184*** (.016)	.134*** (.018)
HRL (omitted)			
Motor emissions	**SEM 1**	**SEM 3**	**SEM 5**
DTDLS			
Energy-saving	-.042 (.029)	-.021 (.028)	-.076*** (.020)
Green transportation & consumption	-.213*** (.038)	-.242*** (.038)	-.078*** (.019)
Household income		.280*** (.023)	.089*** (.015)
HRL (omitted, see next slide)			


SEM5
-.171
Housing fuel using emission
.134
.102
.044
.082
.039
-.144
.120
-.205
Household income
Detached
1 Car
2 Cars
> 2 Cars
> 2 Kids
Owned
Employment
Household size
Urban
.089
.245
.452
.402
-.055
.028
.162
.096
-.109
Motor emission
-.076
-.078
Energy-saving lifestyle
Green transportation & consumption lifestyle
.534
.403
.287
.747
.362
.458
.782
.686
.437
.583
.411
.612
TV
Lights
Water
Heating
Shopping bags
Packaging
Recycled paper
Public transport
Short journeys
Car share
Few flights
.135
.305
.102

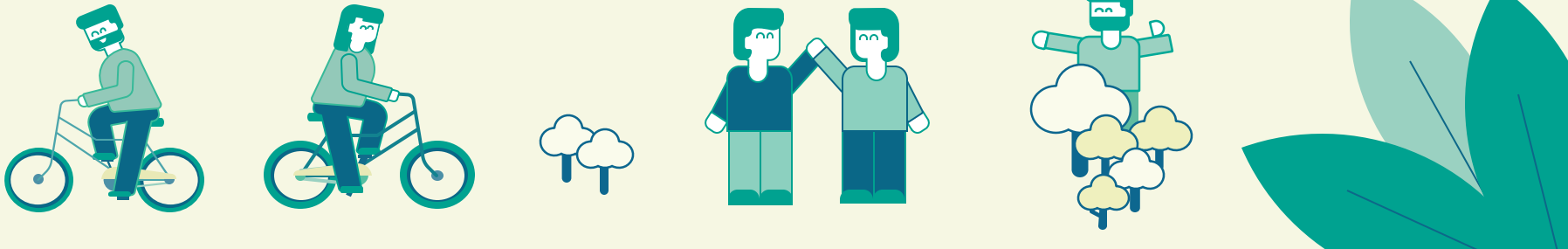
Summary and future work

Main Findings

- Energy-saving's effect is pronounced while green transportation and consumption is weakened controlling for household income & HRL.
- Lifestyle fundamentally drives household carbon emissions, not household income.

Limitations and extensions

- Self-assessment —— Actual behaviour records
- Dietary lifestyle



Thank you for your attention!

ting.liu@imperial.ac.uk

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