Displacement and rebound effects in car sharing

Tamar Meshulam[1], Jozef Cossey[2], David Font Vivanco[3], Tamar Makov[1]

1) Ben Gurion University of the Negev, Beer Sheva, Israel
2) Katholieke Universiteit Leuven (KULeuven) & Universit´e catholique de Louvain (UCLouvain), Belgium
3) Eco Intelligent Growth

Introduction

Transport is responsible for about 23% of total energy-related CO2 emissions worldwide, and expected to double by 2050 (Creutzig et al, 2015)

Urban mobility taking 40% of transport emissions (Berrill et al, 2024)

One proposed solution to mitigate urban transport emissions is carsharing, which is associated with

- Reduced private car use
  (Nijland & van Meerkerk, 2017)
- Reduce private car ownership
  (Becker et al, 2018).
- Increased use of biking, walking and public transport
  (Becker et al, 2018).

However, overall changes to transport consumption patterns, also referred as displacement, might also increase emissions, especially for car free household and rebound effects due to respending of saved expenditure might offset expected benefits

(Meshulam et al, 2023,2024).

What is the rebound effect for car sharing? Using CAMBIO carsharing data to understand user transport behavior

Methods:

Derive km travelled and $ spent before and after carsharing

Per transport mode

Baseline rebound effect (assumes perfect displacement)

1. Calculate Environmental Benefits from carsharing
   Assuming each car sharing km displaces car, use saved expenditure and EXIOBASE to quantify avoided emissions
2. Assess added emissions from re-spending

- Compute how overall economic savings were redistributed between consumption categories using the 'Almost Ideal Demand System' consumer model (Deaton & Muellbauer, 1980).
- Convert from retail value per consumption category to added emissions using EXIOBASE

Rebound effect taking into account displacement

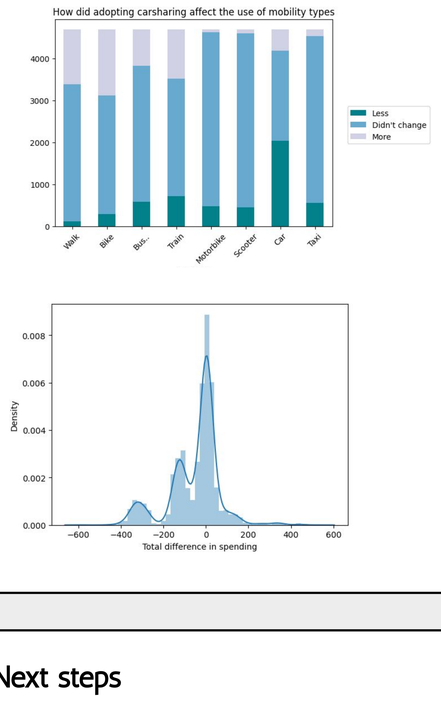
1. Evaluate change to transport emissions from displacement
   Using changes in expenditure per transport mode and EXIOBASE
2. Calculate added GHG emissions from re-spending
   keeping overall expenditure constant, calcalue added (reduced) impacts due to saved (spent) expenditure

Initial Results:

Baseline rebound:

Assuming perfect substitution, rebound effect for car sharing due to respending of saved expenditure is estimated to be 56%

Adding displacement



Cambio user segments

Extract user segments using K-means clustering with different weights

1. Ditched my car (35%)

	Car	Taxi	Car reduce	OwnsCar	Walk	Bike	Bus..	Train	Motorbike
-1	1299.0	150	NaN	NaN	6	16	34	17	142
0	NaN	1065	166.0	1093.0	607	360	729	512	1132
1	NaN	84	1133.0	206.0	686	923	536	770	25

2. Using a car less (15%)

	Car	Taxi	Car reduce	OwnsCar	Walk	Bike	Bus..	Train	Motorbike
-1	650.0	238	NaN	NaN	57	127	186	205	200
0	NaN	401	531.0	508.0	429	377	416	398	444
1	NaN	11	119.0	142.0	164	146	48	47	6

3. Car sharing didn't change my life (40%)

	Car	Taxi	Car reduce	OwnsCar	Walk	Bike	Bus..	Train	Motorbike
-1	NaN	41	NaN	NaN	11	42	150	207	25
0	1034.0	988	1025.0	1034.0	963	925	859	793	1006
1	NaN	5	9.0	NaN	60	67	25	34	3

	Car	Taxi	Car reduce	OwnsCar	Walk	Bike	Bus..	Train	Motorbike
-1	NaN	13	NaN	NaN	6	13	41	49	17
0	468.0	453	347.0	NaN	439	407	411	397	448
1	NaN	2	121.0	468.0	23	48	16	22	3

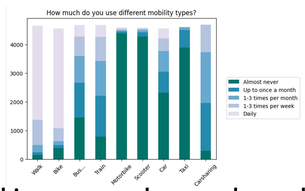
4. Gained access to a car (10%)

	Car	Taxi	Car reduce	OwnsCar	Walk	Bike	Bus..	Train	Motorbike
-1	NaN	38	NaN	NaN	10	51	109	165	29
0	NaN	410	408.0	393.0	380	345	318	260	422
1	462.0	14	54.0	69.0	72	66	35	37	11

Cambio survey data (N=4,689)

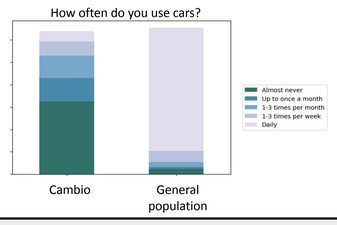
User survey held in Flanders Belgium at 2022

- Current and past mobility patterns
- Changes in car ownership
- Socio-demographics
- Motivation to join carsharing



Cambio users and general population

- ~90% of households in Flanders own a car, in contrast to only ~20% of CAMBIO users
- Might indicate selection bias, or alternatively people using CAMBIO to gain car access



Rebound Effects

Definition:
Consumer and market responses to improved efficiency, which effectively reduces the unit usage price leading to increased demand and increased overall consumption.

Examples: Improved car fuel efficiency, might increase demand for longer or more frequent drives. Within industrial ecology, researches have shown how adopting green behavior might lead to rebound effects
(Khazzoom, 1980, Druckman et al, 2011)

Switching to car sharing

Saved money is used to buy other products and services

Usage price declines leading to added consumption

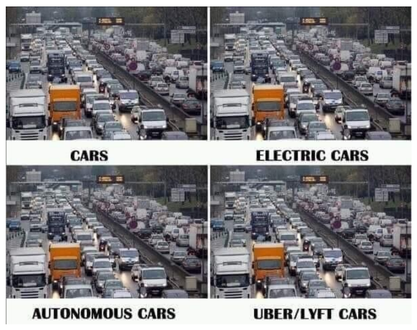
Next steps

1. Evaluate per user rebound effect based on personal transportation patterns

2. Add sensitivity and uncertainty analysis to account for how changes of scale would affect rebound level

Questions or comments?

tamarm@gmail.com
www.linkedin.com/in/tamar-meshulam-3692741/



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