Big data and urban mobility: mapping city transport resilience with tracking records

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1

Introduction

There is increasing debate on the coexistence and regulation of traditional public transport (PT) and micromobility*

Micromobility is seen as:

1. a flexible and sustainable alternative
2. a push towards multimodality and transport resilience (especially after Covid-19)

but also:

3. a "thief" to PT shares
4. a "competition for public subsidies"
5. a disruption to the governance of public spaces (wild parking on sidewalks)

*this presentation is based on: Bergantino A.S. e A. Gardelli, 2024, Looking forward to MAAS: e-scooters tracks to assesslast-mile multimodality. *forthcoming*

2

Paris says au revoir to rental e-scooters

1 September 2023

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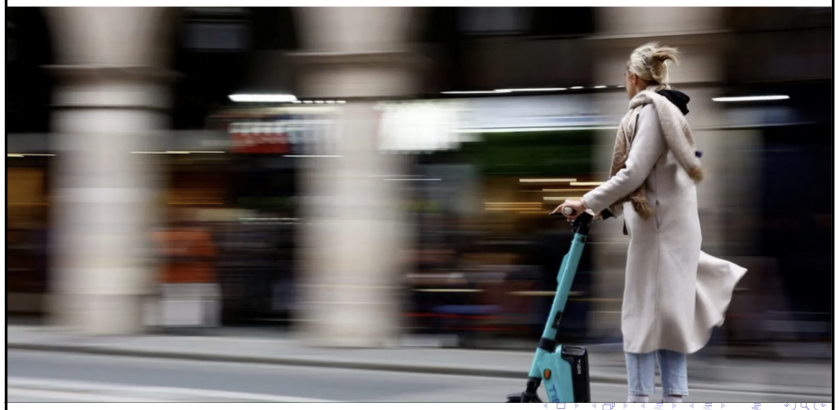
Hugh Schofield
BBC News, Paris



3

Introduction

- *Between-modes redundancy* helps urban networks being more resilient and resiliency implies higher quality of consumers' services
  - Urban transport network are constantly exposed to external shocks
  - Between modes redundancy is the ability of a network to offer several transport options to cope with disruptions

    Bergantino et al. (2024). Assessing transport network resilience: empirical insights from real-world data studies. *Transport Reviews*, 44(4), 834-857.

Disruption are spatially concentrated so we expect the «redundancy effect» to follow a spatial pattern

4

How do we do?

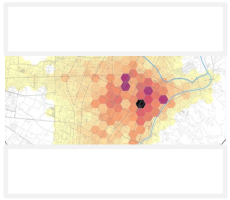
- We identify **PT strikes** as disruption (natural experiment, no reverse causality)
- We study :
  - to what extent e-scooter usership is influenced by the strikes (strike effect);
  - if this effect follows a spatial patterns with change in use **more dense near PT stops** (distance decay function from PT stops)

Strikes' characteristics			partecipation
03/12/21	Friday	18h-22h	30.1%
16/12/21	Thursday	24h except 06-09, 12-15	53.2%
14/01/22	Friday	18h-22h	45.9%
25/02/22	Friday	24h except 06-09, 12-15	59.7%
08/03/22	Tuesday	24h except 06-09, 12-15	35.8%
05/07/22	Tuesday	18h-22h	45.5%
16/09/22	Friday	16h-00h	64.1%
		Mean =	47.8%

5

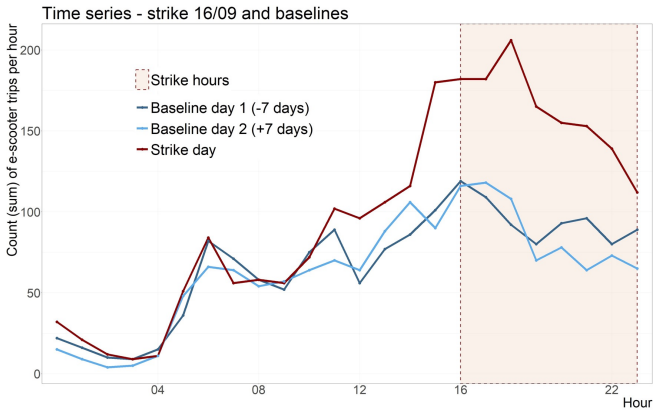
Data - e-scooter trips

Area	Total trips	Trips during strike
Census block 1	174,380	2,195
Census block 2	35,161	433
Census block 3	71,889	891
Census block 4	40,480	463
Census block 5	5,823	54
Census block 6	1,403	11
Census block 7	27,628	326
Census block 8	87,560	1,095
Census block 9	3,521	46
Census block 10	152	1
Census block 11	7,383	85
Census block 12	1,149	12
Census block 13	162	0
	465,062	6,907 (1.49%)



6

Time series strike vs baseline



participation rate of drivers: 64%.

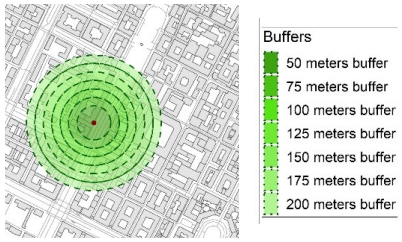
7

Data - PT spatial buffers

Distance decay function

(Cheng et al., 2021; Klingen, 2019; Teixeira and Lopes, 2020; Saberi et al., 2018; Yang et al., 2022; Younes et al., 2019)

Is the effect stronger when reaching proximity to the transit stops (bus, metro, ecc.)?



8

Results in a nutshell

1. Evidence of between-modes redundancy
   Increase in e-scooter trips following the decrease in PT ones
2. Evidence of spatial patterns of micromobility-to-PT redundancy
   The closer the e-scooter to the PT stops, the stronger the effect

9

Results - Distance decay

Variables	IRR 50m	IRR 75m	IRR 100m	IRR 125m	IRR 150m	IRR 175m	IRR 200m
β_1 *strike*	+67%***	+60%***	+57%***	+57%***	+65%***	+58%***	+48%***
β_2 *strike* × inside_buffer w/ BS	+22%***	+14%***	+4%	+4%	-1%	+3%	+13%
β_2 *strike* × inside_buffer no BS	+25%***	+13%*	+4%	-4%	-12%	-9%	-2%

IRR=Incidence rate ratio

L'impatto dello strike (**venerdi alle 18 fuori buffer**) è significativo per ogni ampiezza del buffer, **vuol dire che in un giorno di sciopero l'uso aumenta dappertutto**.
Gli scioperi nei giorni diversi rispetto al venerdì hanno impatti minori
Negli orari 9-12 i scioperi non hanno alcun effetto.
L'effetto buffer bus stop è presente solo entro i 75 metri (distance decay function)

10

Conclusions

- E-scooters provide a spatially heterogeneous redundancy to PT when disrupted
- We find the effect to be stronger in the proximity of bus stops
- We find temporal heterogeneity that may be explained by the male young usership
- Dynamic fleet management based on real data tracking may help alleviate travellers disutility

Note that it is a user-class specific resilience policy, needed to be thought as a piece of a bigger puzzle

11

How to?

We deepen the investigation on the potential multimodality that e-scooters and PT may build.

1. We push for substantial granularity
2. We include significant counfounding factors to isolate the last-mile effect

The same dataset as before is used.

We focus on the metro system, trying to set up a causal inference framework to isolate the last-mile effect of metro onto e-scooter trips.

12

Granularity

Granularity is pushed to 50m cells

13

Counfonding factors - preliminary

We are interested only on spatial variables.
Counting only by area controls for temporal heterogeneity considering that areas are comparable (h: *events impact the neighbouring cells the same way*)

Spatial confounding factors considered:

1. Metro entrance 50m buffer
2. Entropy index for land use mix
3. Road density
4. Census block
5. Accessibility to POIs (forthcoming...)
6. Others ?...

14

Results - preliminary

	Dependent variable:
	Frequency count of started trips aggregated at 50m grid level
Metro entrance	1.72*** (0.12)
Entropy index	1.29*** (0.03)
Road density	0.01*** (0.0002)
Observations	43,909
Log Likelihood	−88,411.05
ϑ	0.24*** (0.002)
Akaike Inf. Crit.	176,854.10
Note:	*p<0.1; **p<0.05; ***p<0.01

15

Dscussion - preliminary

- The *IRR* for *Metro entrance* is 4.56, meaning that 50m around metro entrances the started trips are 456% more (exp(1.72)-1).
- Other confounding factors (accessibility to POI from metro entrances) can strengthen the causality of the "metro effect".
- Possible implications for MAAS?
  - Matching the level of demand with e-scooters availability (maybe real time?)
  - Include also bike-sharing

IRR=Incidence rate ratio

16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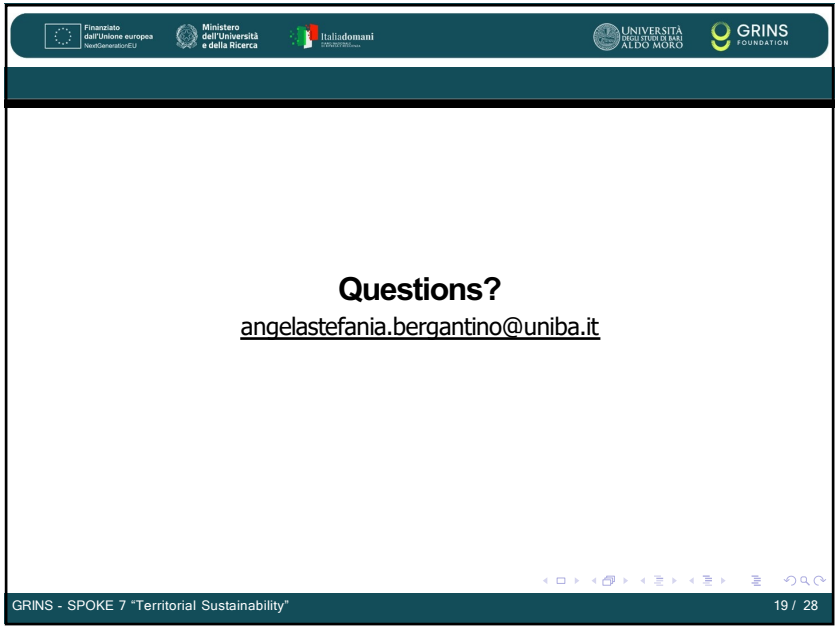
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19