



15TH INTERNATIONAL CONFERENCE ON TRAVEL BEHAVIOR RESEARCH
JULY 15-20, 2018
SANTA BARBARA, CALIFORNIA

Panel Approach: Travel Behaviour and Psycho-Attitudinal Factors Evolution

Eleonora Sottile, Francesco Piras, Italo Meloni

CRiMM (Research Centre for Mobility Modelling)
University of Cagliari, Italy



Outline

- Introduction
- Objectives
- Data collection
- Model Specification: Hybrid choice model
- Results
- Conclusion



Introduction

Psycho-attitudinal factors are generally thought to play an important role in determining people's mode choice and their travel behaviour (Gärling et al., 1998)

Individuals' psycho-attitudinal and motivational characteristics may change over time due to:

- A change of socio-economic (SE) characteristics.
- Implementation of travel demand policies.
- Because of their changing nature, recent works raise questions about the ability to derive policy implications from hybrid models, which include those variables.
 - The data collected is typically cross sectional, but policy is enacted over time.
- Only a few studies have investigated about these issues.

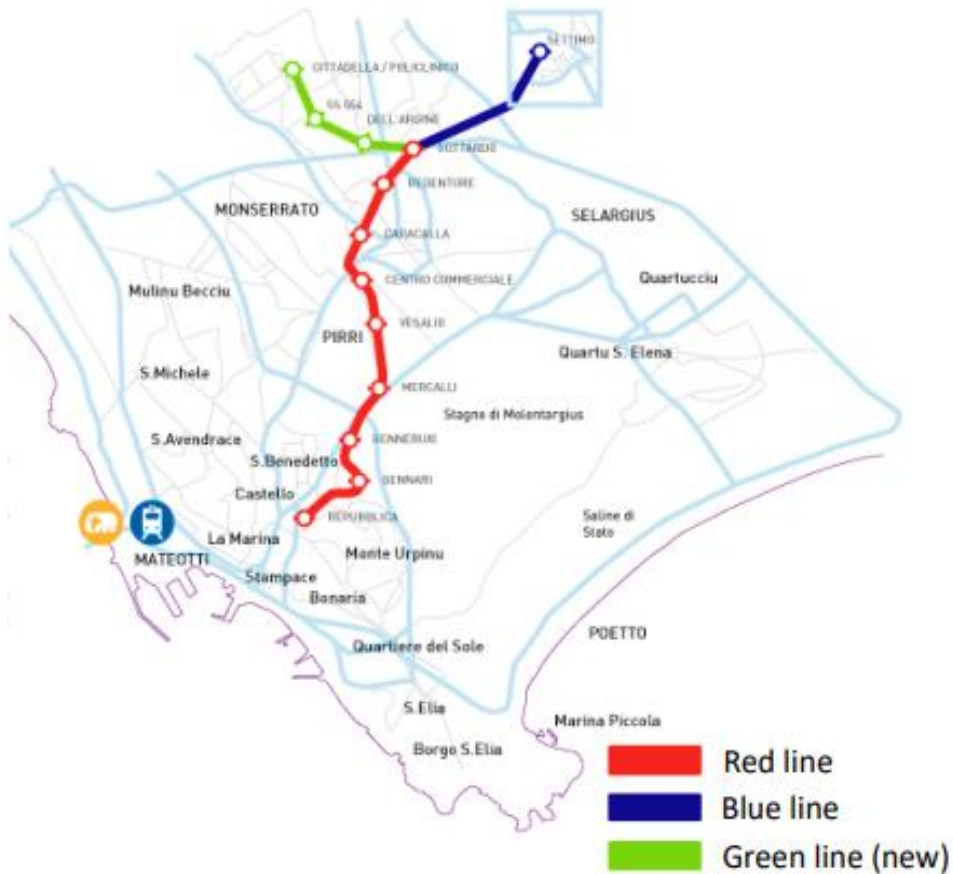


Objective

The objective of this work is to evaluate if and how psychological factors change after a change in the choice context. In particular we aim to:

- Develop a panel survey before and after the implementation of a new light rail line and a bus route in the metropolitan area of Cagliari, Italy
- Study the evolution of psychological factors over time and their effect on mode choice behaviour
- Estimate hybrid choice models to examine the effect of these psychological factors before and after implementation of this measure

The context

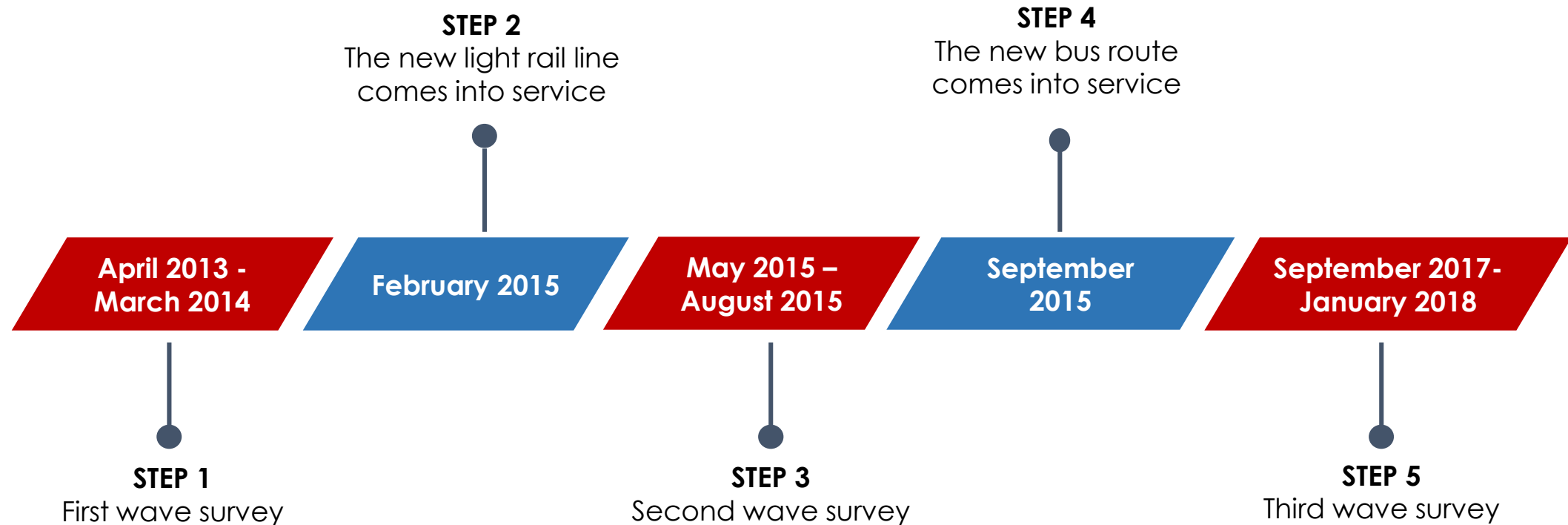


- The transport context chosen for this study is a corridor linking the city center of Cagliari (Italy) to a university/hospital complex (Cittadella Universitaria), where in February 2015 a new light rail route (METROCAGLIARI) went into service and in September 2015 a new bus route was introduced
- The number of people potentially attracted daily to the Cittadella amounts to a little more than 10,200:
 - 17.5% university and hospital employees
 - 77.2% students
 - 5.7% for hospital admissions, medical examinations, visiting patients, etc.



Data collection

The whole program, called Cittadella Mobility Styles, started in April 2013 and comprised six macro-phases





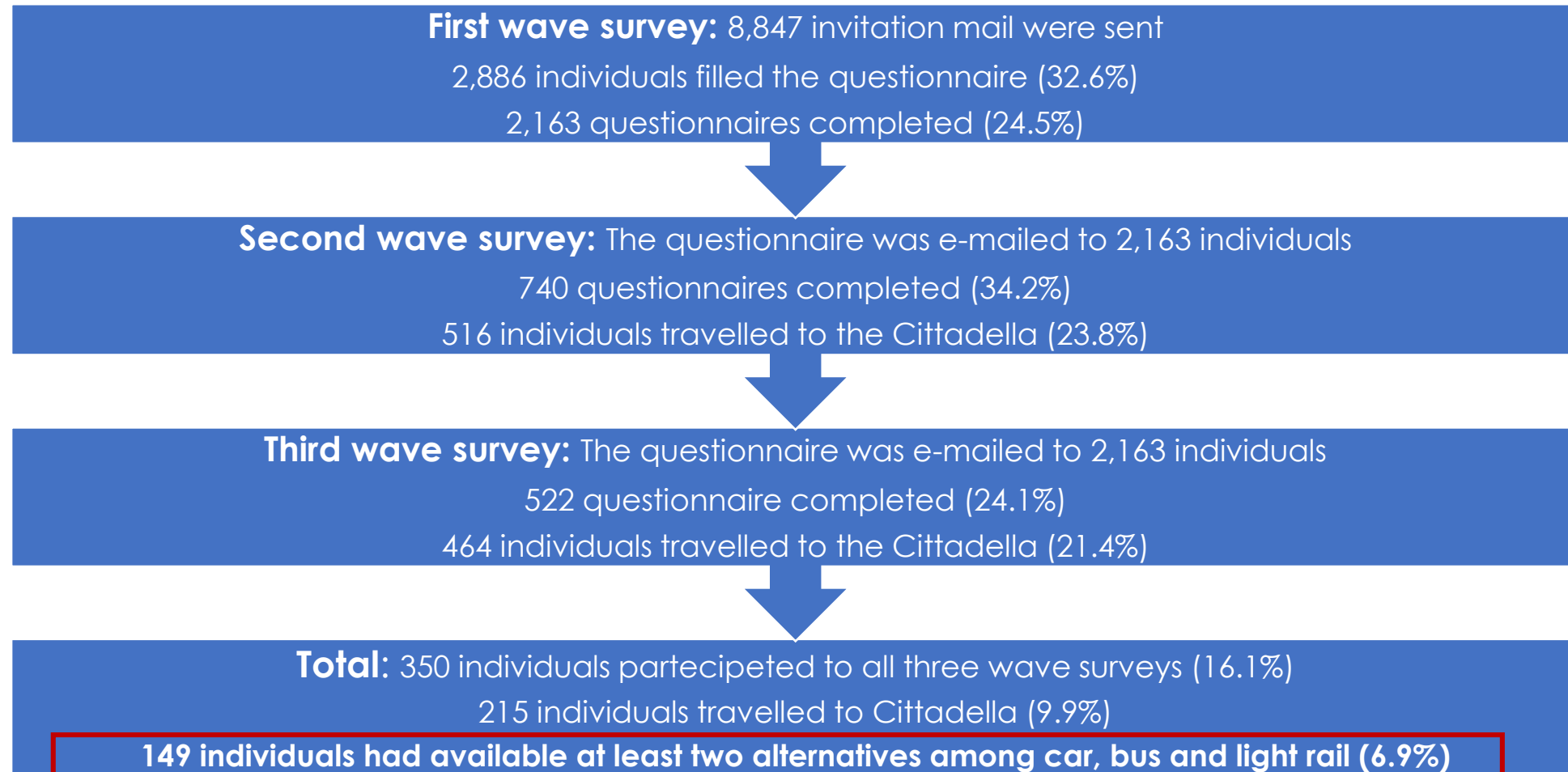
Data collection (cont)

The structure of the survey was the same in all three waves:

- Introduction
 - Questions about the use of the metro
 - Trip description
 - Socioeconomic and household characteristics
 - Personal perceptions, attitudes, propensities, beliefs
- We did not asked personal attitudes and perceptions in the second wave survey because the aim in this step was to evaluate only if there had been any travel behaviour change
 - In first and third wave respondents completed the same attitudinal questions
 - Potential users of light rail were contacted via mailing lists provided by both the university and hospital, requesting them to complete the questionnaires.



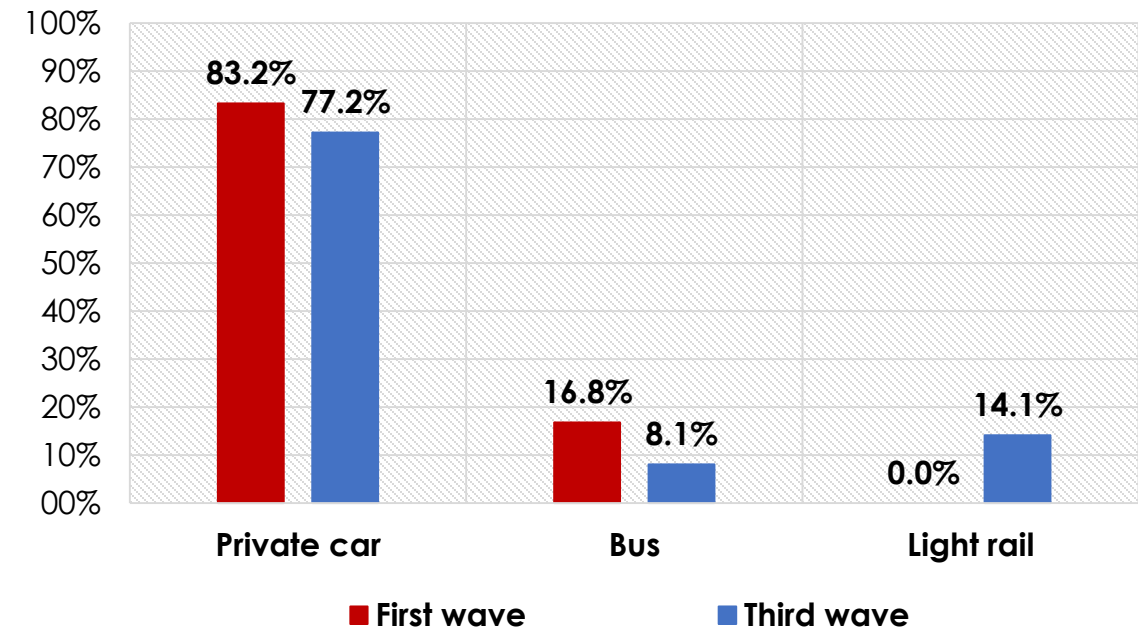
Data collection (cont)



Data analysis (149 individuals)

Variables	First wave survey			Third wave survey		
	N.	%	mean	N.	%	mean
Tot	149	-	-	149	-	-
Gender (male)	66	44.3%	-	66	44.3%	-
Age			35.1			39.1
Age 18_30	73	49.0%	-	60	40.3%	-
Age 31_40	23	15.4%	-	30	20.1%	-
Age 41_60	51	34.2%	-	48	32.2%	-
Over 60	2	1.3%	-	11	7.4%	-
Student	71	47.7%	-	38	25.5%	-
Worker	76	51.0%	-	102	68.5%	-
Number of household components			2.94	-	-	2.8
Children	35	23.5%	-	33	22.1%	-
Own_car	118	79.2%	-	138	92.6%	-
Number of cars per household			1.9	-	-	1.8
Income			-	-	-	-
Income € 0-1000	76	51.0%	-	59	39.6%	-
Income € 1000-2000	50	33.6%	-	66	44.3%	-
Income € 2000-4000	18	12.1%	-	21	14.1%	-
Income > € 4000	5	3.4%	-	3	2.0%	-

Modal share first and third waves



- 10.7% individuals change from bus to private car
- 16.1% individuals changed from private car to bus and light rail



Data analysis: Psycho-Attitudinal Factors

In total there were 36 questions, measured on a 5-point Likert scale, focusing on the peculiarities, benefits/disadvantages, motivation and limits associated with use of the private car and of public transport in general.

A factor analysis was performed prior to modelling choices in order to identify one or more latent dimensions (called factors or components) underpinning a set of items or variables.

The following psycho-attitudinal factors were defined:

- **Attachment to the car**
- **Aversion to public transport**
- **Willingness to use the light rail**
- **Pro-environmental behaviour**



Evolution of indicators over waves

	ITEMS To what extent do you agree with the following statements? (Assign a score from 1=not at all to 5=very much)	Average LIKERT Response		Comparison	
		FIRST WAVE	THIRD WAVE	Difference	T-diff
ATTACHMENT TO THE CAR	A1. The car is the most convenient means of transport in terms of trip time	3.37	3.56	0.19	1.389
	A2. The car offers a high level of comfort (comfort, privacy, flexibility, etc.) that other forms of transport do not provide	3.90	4.03	0.13	1.066
	A3. The car is the only means of transport compatible with daily commitments (work, school runs, shopping etc.)	3.05	3.33	0.27	1.864
	A4. Driving is a pleasurable experience	2.86	2.76	-0.11	-0.662
	A5. Driving gives a feeling of freedom that other means of transport cannot provide	2.98	3.01	0.03	0.18
AVERSION TO THE PUBLIC TRANSPORT	B1. Travel times are too long	3.52	3.44	-0.08	0.619
	B2. Services are not reliable in that they do not guarantee regularity and certainty of travel times	3.44	2.92	-0.52	-3.81
	B3. Comfort is poor (overcrowding, carrying bulky goods, etc.)	3.45	3.17	-0.30	-2.283
	B4. The service is not compatible with daily commitments (work, school runs, shopping etc.)	3.36	3.45	0.09	0.634
	B5. Travelling on public transport is not a pleasurable experience	2.69	2.48	-0.21	-1.647



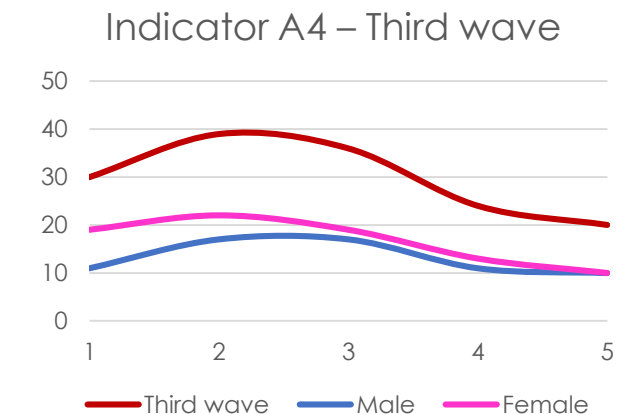
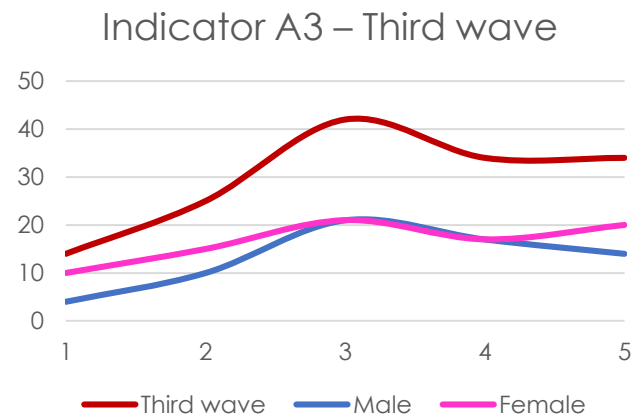
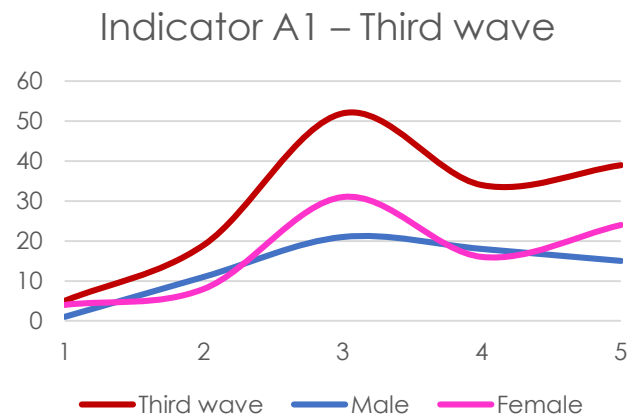
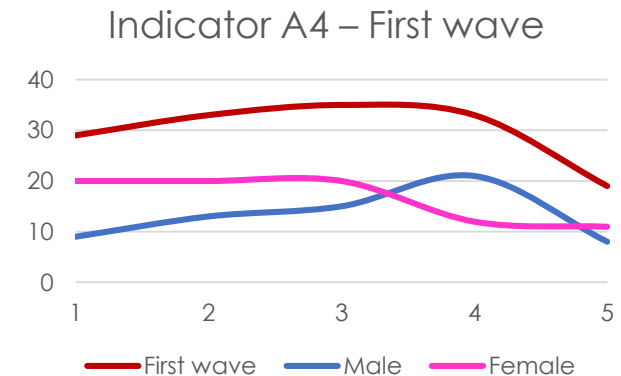
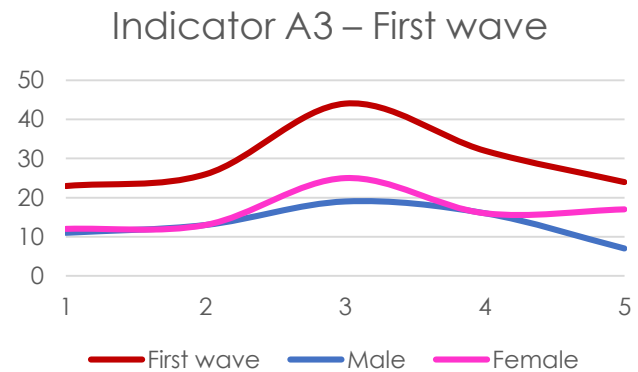
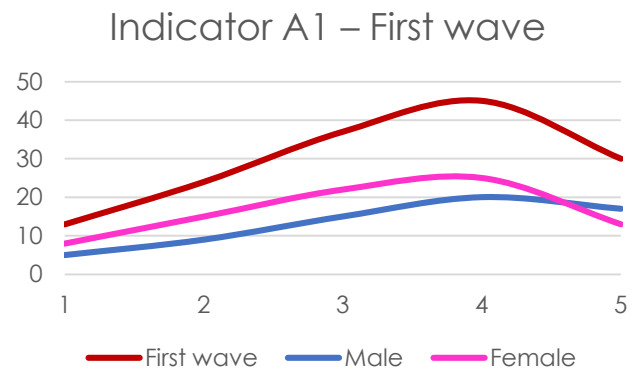
Evolution of indicators over waves (cont.)

	ITEMS To what extent do you agree with the following statements? (Assign a score from 1=not at all to 5=very much)	Average LIKERT Response		Comparison	
		FIRST WAVE	THIRD WAVE	Difference	T-diff
WILLINGNESS TO USE THE LIGHT RAIL	C1. I would use the light rail if there were a reduction of travel time	4.23	3.86	-0.37	-2.72
	C2. I would use the light rail if there were a reduction of travel costs	4.33	3.83	-0.50	-4.01
	C3. I would use the light rail if there were a reduction of CO ₂ emissions	4.30	3.96	-0.36	-2.79
	C4. I would use the light rail if it were less stressful than driving	4.52	4.31	-0.21	-2.01
	C5. I would use the light rail if there were an extension of the network with increase of lines	4.67	4.56	-0.11	-1.29
PRO-ENVIRONMENTAL BEHAVIOUR	D1. I unplug electronic devices when they are not in operation (e.g. TV, phone charger, etc.)	3.98	3.82	-0.16	-1.11
	D2. I use low-energy light bulbs	4.36	4.40	0.04	0.38
	D3. I do not waste water	4.20	4.30	0.10	0.87
	D4. I buy local fruit and vegetables, which are not moved by plane or lorries	3.95	4.12	0.17	1.36
	D5. When doing shopping, I use my reusable own bag instead of the plastic bag of the supermarket	4.46	4.40	-0.04	-0.55

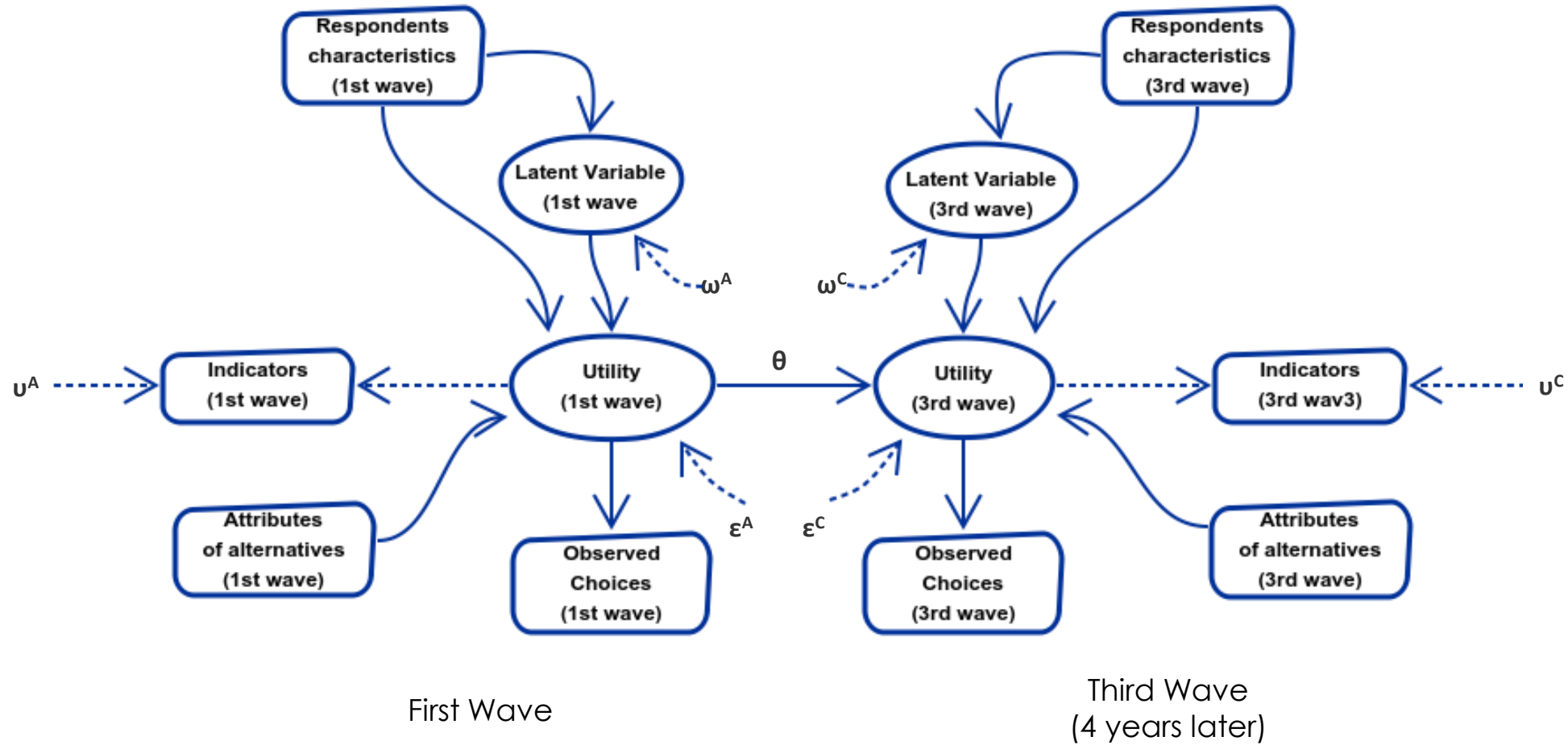


Evolution of indicators over waves (cont.)

Some interesting differences in indicators over waves depending on socio-demographic characteristics



Modeling framework



Model specification

The mathematical model of the Hybrid Choice Framework is formed by:

Structural equations:

$$U_{jn}^{1wave} = ASC_j + \beta_{jLOS} \mathbf{LOS}_{jn}^{1wave} + \beta_{jSE} \mathbf{SE}_n^{1wave} + \beta_{jLV}^{1wave} LV_n^{1wave} + \varepsilon_{jn}^{1wave}$$

$$U_{jn}^{3wave} = \theta (ASC_j + \beta_{jLOS} \mathbf{LOS}_{jn}^{3wave} + \beta_{jSE} \mathbf{SE}_n^{3wave} + \beta_{jLV}^{3wave} LV_n^{3wave} + \varepsilon_{jn}^{3wave})$$

$$LV_n^w = \kappa^w + \lambda^w \mathbf{SE}_n^w + \omega_n^w$$

Measurement equations:

$$Y_{jn}^w = \begin{cases} 1 & \text{if } U_{jq}^w = \max_i \{U_{iq}^w\} \\ 0 & \text{otherwise} \end{cases} \quad \forall i \in A^w(q)$$

$$I_{rn}^w = \gamma_r^w + \alpha_r^w LV_n^w + \upsilon_{rn}^w$$



Model estimation results

Discret choice model	MODEL 1L		MODEL 2L	
	Coefficient	Robust t-stat	Coefficient	Robust t-stat
Constant ASC _{car}	-4.18	-1.51	-4.65	-1.67
Constant ASC _{bus}	-2.21	-1.30	-2.24	-1.35
Travel Time - Car	-0.074	-2.02	-0.074	-2.05
Travel Cost - Car	-0.218	-0.96	-0.217	-0.96
Walking Time from/to parking area - Car	-0.016	-0.67	-0.014	-0.58
Travel Time - Bus	-0.042	-2.52	-0.042	-2.57
Travel Cost - Bus	-0.623	-1.44	-0.594	-1.35
Walking Time from/to Bus stop - Bus	-0.059	-1.83	-0.056	-1.79
Travel Time - Light rail	-0.074	-2.12	-0.075	-2.11
Travel Cost - Light rail	-0.661	-1.36	-0.599	-1.31
Walking Time from/to Light rail stop - Light rail	-0.118	-1.53	-0.121	-1.59
Personal income (specific to car)	0.227	1.01	0.237	1.06
Number of cars per driver (specific to car)	0.457	0.84	0.477	1.00
Car ownership dummy (specific to car)	0.683	1.36	0.650	1.32
Frequency of trips between origin and Cittadella (specific to car)	0.002	1.24	0.002	1.31
Scale factor θ	2.08	0.80*	2.08	0.80*
Latent variable_attachment_to_car_1WAVE (specific to car)	0.399	0.74	0.518	2.09
Latent variable_attachment_to_car_3WAVE (specific to car)	0.203	1.48	0.315	1.28

Model 1L: indicators of the psychosocial factor collected at single time (first wave)

Model 2L: indicators of the psychosocial factor collected at different times (first and third wave)

*t-test against one



Model estimation results (cont.)

Structural model	MODEL 1L		MODEL 2L			
	Attachment to the car 1 WAVE		Attachment to the car 1 WAVE		Attachment to the car 3 WAVE	
	Coefficient	Robust t-stat	Coefficient	Robust t-stat	Coefficient	Robust t-stat
Constant	3.74	10.53	3.83	13.19	4.01	13.53
Sigma	0.80	5.94	0.77	5.80	0.54	3.48
Age					-0.0105	-1.70
Gender	0.33	2.00	0.30	1.90		
Number of cars per driver	0.44	1.40	0.46	1.48	0.285	1.39
Worker dummy	-0.70	-1.91	-0.78	-2.63		
Student dummy	-0.36	-1.03	-0.45	-1.73		



Elasticity and probability

	Elasticity of the demand respect to cost by car		Probability of choosing car	
	MODEL 1L	MODEL 2L	MODEL 1L	MODEL 2L
First wave	-0.0744	-0.0739	83.3%	83.1%
<i>Female</i>	-0.0756	-0.0741	83.5%	83.1%
<i>Student</i>	-0.0827	-0.0833	81.0%	81.0%
<i>Worker</i>	-0.0650	-0.0635	85.4%	85.0%
Third wave	-0.1920	-0.1933	77.9%	78.4%
<i>Female</i>	-0.1936	-0.2024	75.8%	77.1%
<i>Student</i>	-0.3086	-0.3086	67.9%	68.4%
<i>Worker</i>	-0.1441	-0.1480	81.9%	82.7%



Evolution of psycho-attitudinal factors

The following psycho-attitudinal factors coefficients were not significantly different over waves, showing that the impact of the constructs is unchanged over time:

- ***Attachment to the car***
- ***Aversion to public transport***
- ***Pro-environmental behavior***

Only the factor ***willingness to use the light rail*** showed a different effect among two waves:

- The coefficient is positive and significant before the implementation of the new light rail
- The coefficient is negative and not significant after the implementation of the new light rail line



Conclusions and future research

In this study we have explored the evolution of psycho-attitudinal factors over time before and after the implementation of a new light rail and bus service. In particular we found that:

- Gathering data for this kind of analysis is **time-consuming** and **difficult** because of **non-respondents** in subsequent waves (small sample)
- Taking into account **before and after data** allowed us to understand the effectiveness of the policy and in particular its impact on psycho-attitudinal factors
- A larger part of **indicators remained** largely **unchanged** across the waves and the majority of psycho-attitudinal factors coefficient were not significant across the waves
- Explanatory variables in structural equation could be **different** across the waves
- More research are needed to clarify the **role** and **influence** of a **marketing campaign** on latent constructs



Thank you for your attention

Questions, comments... are much welcome

Eleonora Sottile
esottile@unica.it

Francesco Piras
francesco.piras@unica.it

Italo Meloni
imeloni@unica.it



Modal share (215 individuals)

Modal share first, second and third waves

