

Investigating the Value of Travel Time of Sydney Residents by Developing Time-use Activity-based Models

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What is Value of Time (VoT)?

- How much individuals are willing to pay to reduce travel time by one unit
- Value of time (VoT) => Value of travel time saving (VTTS)
- (WTP) => How much individuals are inclined to pay to improve a travel attribute by one unit
- Trade-off between travel attributes and travel cost such that utility remains constant



What is VTTs application in transport?



Generated by Midjourney
AI image generator

- travel time saving => monetary value => cost benefit analysis
- informed decisions about infrastructure and service investments
- significant policy implications for transport planning and pricing
- Investigate travel behaviour of individuals

How to estimate VTTS?

Discrete choice modelling => Utility maximization framework

01

MNL

- **cannot** accommodate **unobserved heterogeneity**
- one fixed WTP value for each travel attribute, which applies to the entire population

02

MMNL

- capture **unobserved heterogeneity** in WTP
- for each travel attribute's WTP, a mixing distribution is **assumed**, and the parameters of this distribution will be estimated
- might be **restrictive** and might **not** have the **desired flexibility** to lead to true underlying WTP distributions.

How to estimate VTTS?

03

LML

- logit mixed logit formulated by Train (2016).
- estimating a non-parametric distribution for WTP of travel attributes
- distributions being revealed by the **data**
- **imposing no restrictions** on their functional forms
- better understand heterogeneity in individuals' travel preferences.

Time-use models

(Jara-Diaz and Guevara 2003)

Econometric time-use model based on consumer theory

- Constrained utility maximisation problem
- Assuming Cobb-Douglas form for Utility
- Can obtain an analytical solution

$$\text{Max } U(X, T, T_w)$$

subject to

$$I + wT_w - \sum_i P_i X_i \geq 0 \quad (\lambda)$$

$$\tau - T_w - \sum_j T_j = 0 \quad (\mu)$$

$$X_i - g_i(T) \geq 0 \quad \forall i \quad (\eta_i)$$

$$T_j - f_j(X) \geq 0 \quad \forall j \quad (\kappa_j)$$

Value of Travel Time Saving
Obtained from travel choice models

Value of Leisure
Obtained from time-use models

Value of Time Assigned to
Travel
can be found

$$\text{VTTS} = \text{VoL} - \text{VTAT}$$

Time-use models

(Bhat 2005, 2008)

MDCEV: Multiple discrete continuous extreme value models

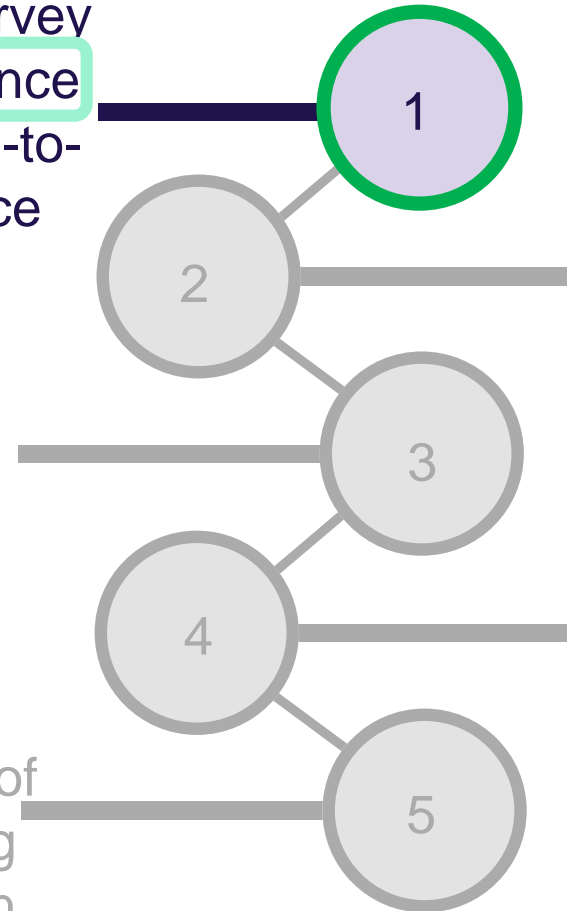
- Accommodate the diminishing marginal utility (satiation) in the consumption of an alternative
- Represents the multinomial logit (MNL) form-equivalent for multiple discrete-continuous choice
- Which activities, each for how long?

My PhD research plan

Empowering revealed preference survey with a **supplementary stated preference survey**: demonstration of willingness-to-pay estimation within a mode choice case

GPS-based smartphone integrated travel diary and time-use data collection: lessons learned and time-use analysis

Investigating activity participation pattern and value of time in presence of **multi-tasking behaviour** by developing multiple discrete continuous model on smartphone-based time-use data



An empirical investigation of the distribution of travellers' willingness-to-pay: A comparison between a parametric and **non-parametric approach**

Extracting components of value of travel time saving by estimating extended consumer theory based econometric time-use model on smartphone-based time-use data

Project 1 – Summary

• Estimation and comparison of VTTS

Across different modes and socio-demographics

• MNL and MMNL models

• On SP, RP, and joint SP/RP datasets

• Impact of a complementary SP data on model estimation based on RP data

Project 1 - Conclusion

It is highly recommended that travel behaviour modellers not only collect RP data for their research but also allocate some time and effort to collect **complementary SP data**. This would bring more benefits than its cost.

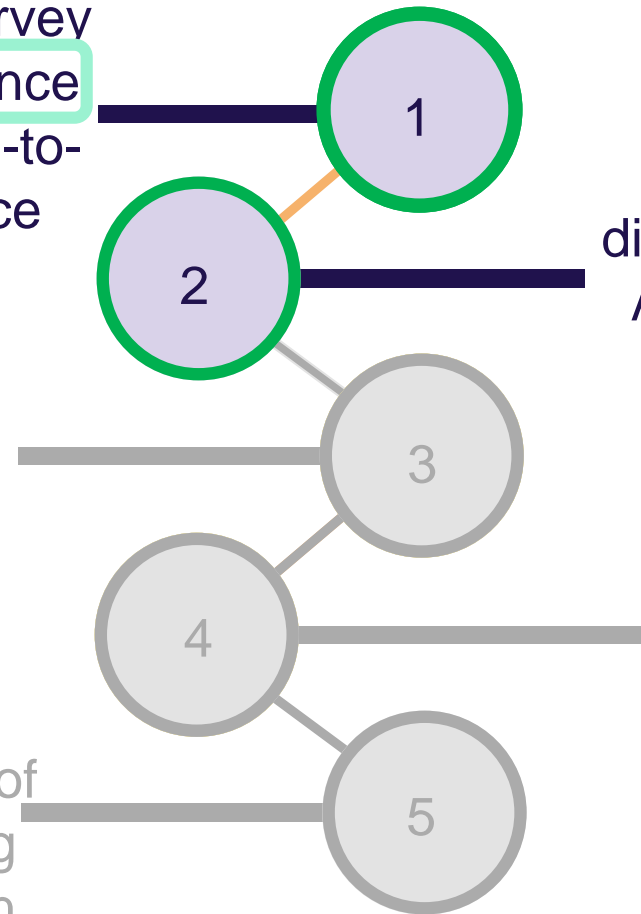


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Project 2 – Summary

- empirically investigating WTP distribution

across six datasets

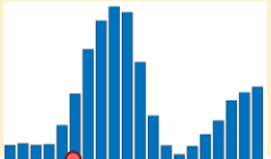
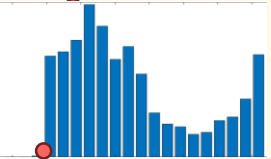
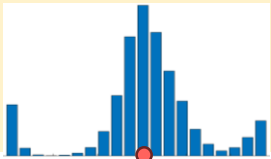
- MNL, MMNL, and LML models.

- compare the WTP distribution

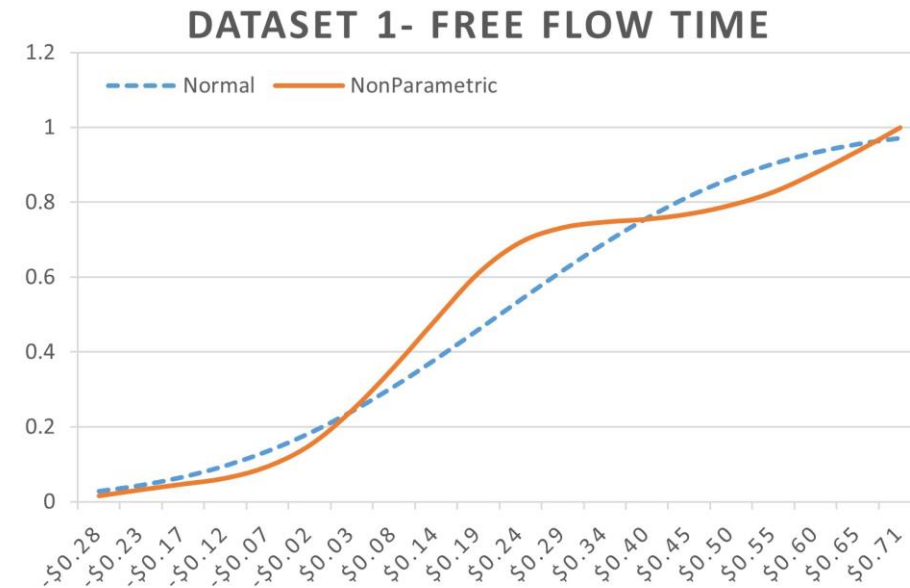
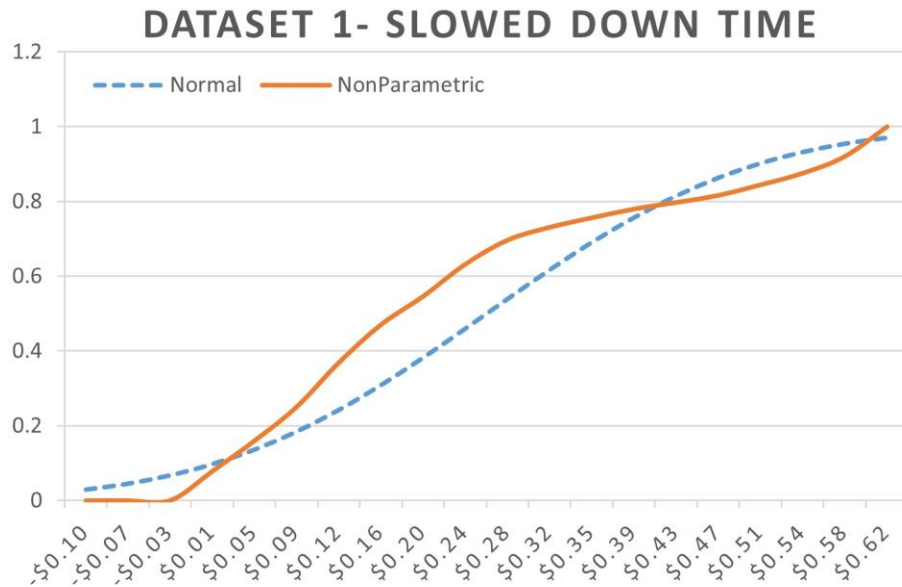
- the possibility that the WTP distribution may be multimodal

the presence of negative WTP

Project 2 - Results- Dataset 1

	MNL	MMNL		LML		
WTP to reduce travel attribute	Mean	Mean	SD	Mean	SD	Distribution
Dataset 1: M4 Sydney noncommuters' mode choice (AUD/min)						
Free flow time	0.193 (21.2)	0.214 (21.2)	0.259 (25.85)	0.228 (13.39)	0.253 (19.17)	
Slowed down time	0.245 (21.6)	0.258 (24.1)	0.191 (28.43)	0.250 (14.03)	0.190 (14.73)	
Time variability	-0.003* (-0.48)	-0.013 (-1.67)	0.148 (13.35)	0.010* (0.48)	0.120 (8.94)	

Cumulative density functions



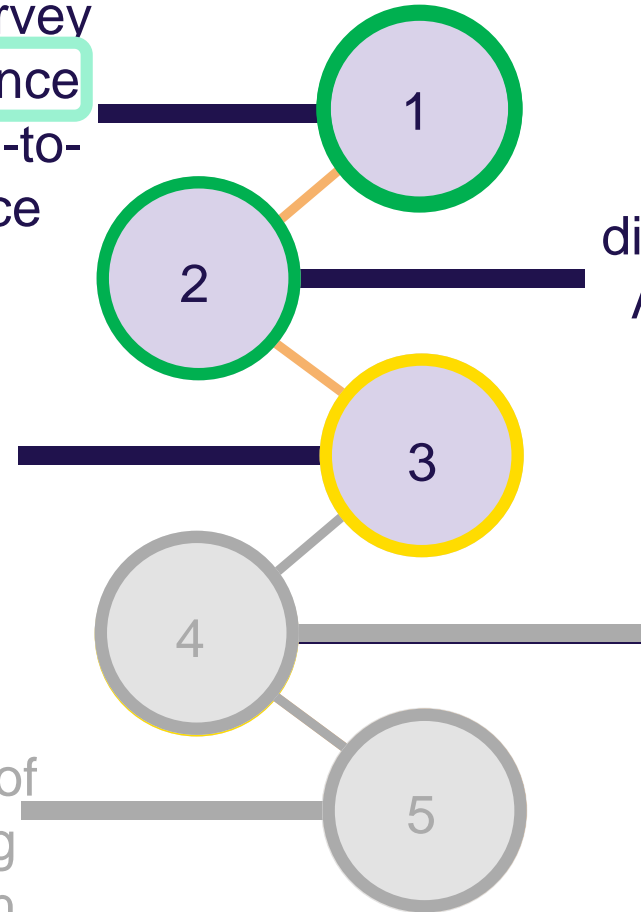
WTP to reduce travel attribute	Positive WTP	WTP larger than the estimated mean
Dataset 1: M4 Sydney noncommuters' route choice (AUD/min)		
Free flow time	81.5	32.5
Slowed down time	94.2	39.2

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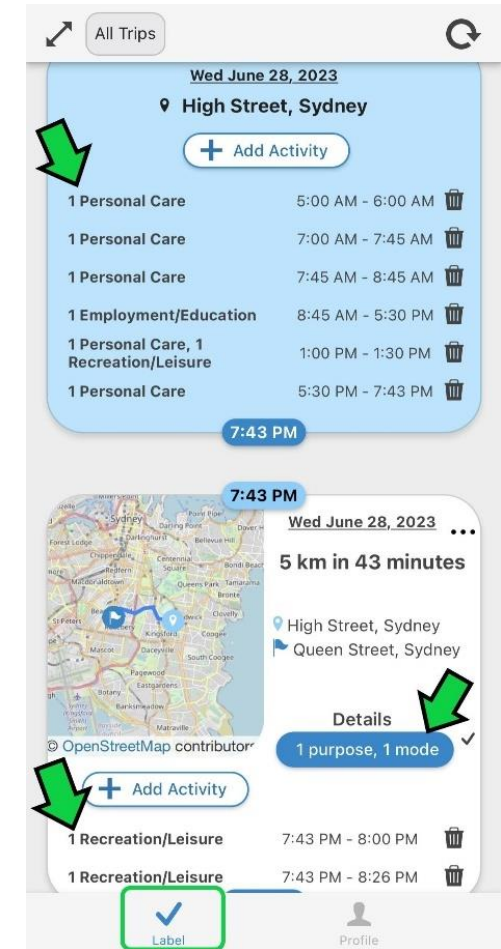
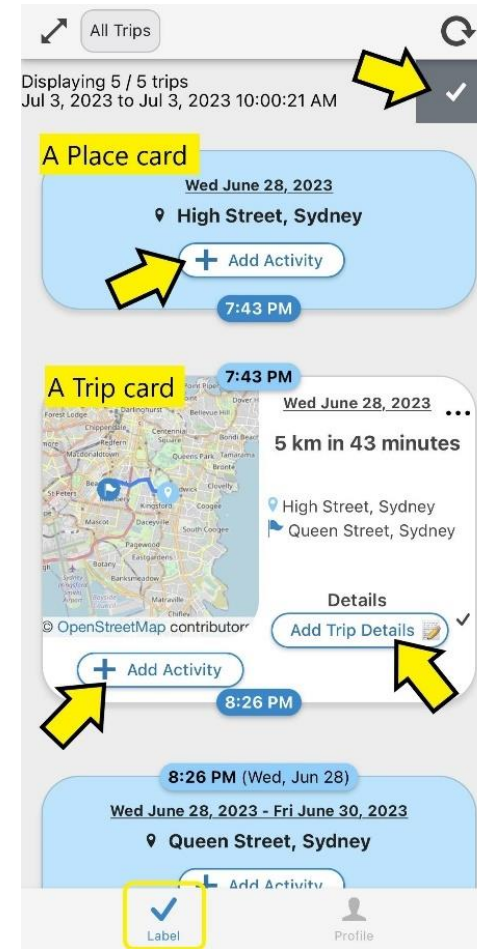


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An example of filled out trip and time-use data in Fourstep app

Screenshot of Fourstep application



Preliminary results - time-use

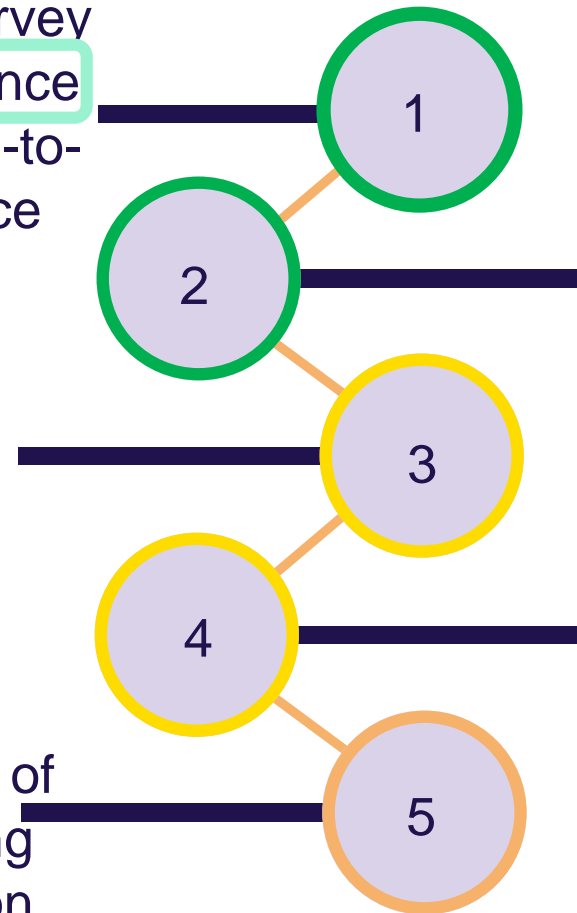
Activity title	Duration hours/day (conditional on participating in that activity)		
	Sydney		
	Mean	Std	Median
Personal care	10.0	2.9	9.3
Maintenance	3.2	3.7	1.4
Employment/Educational	6.5	3.0	7.0
Recreation and leisure	3.8	3.4	3.0
Voluntary work	2.6	3.8	1.3
Other	4.0	4.9	1.0
Travel	1.5	1.3	1.1

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Thank you!

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