
Considering latent attitudes in mode choice: The case of Switzerland

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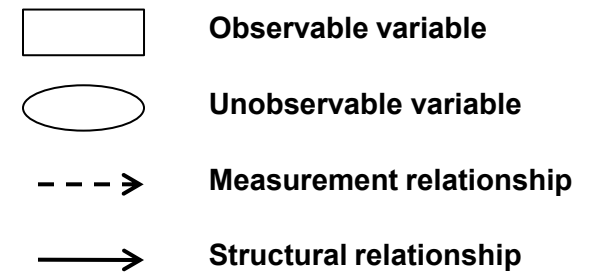
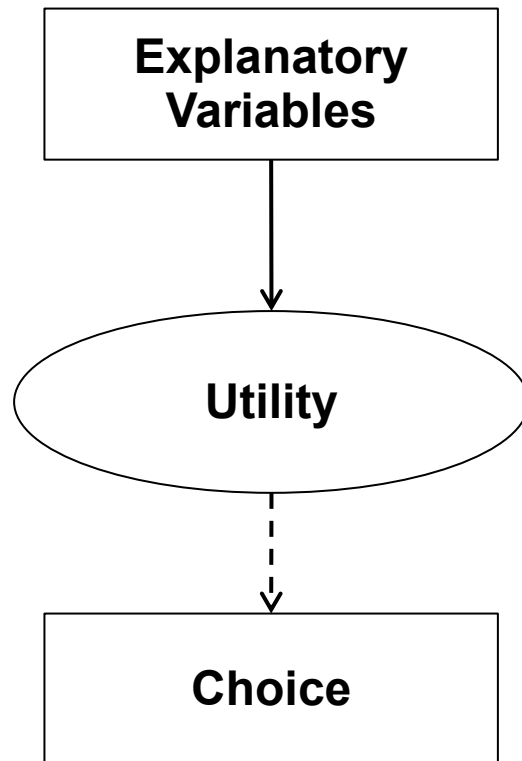
Motivation

- CarPostal: bus service in rural and low density areas of Switzerland

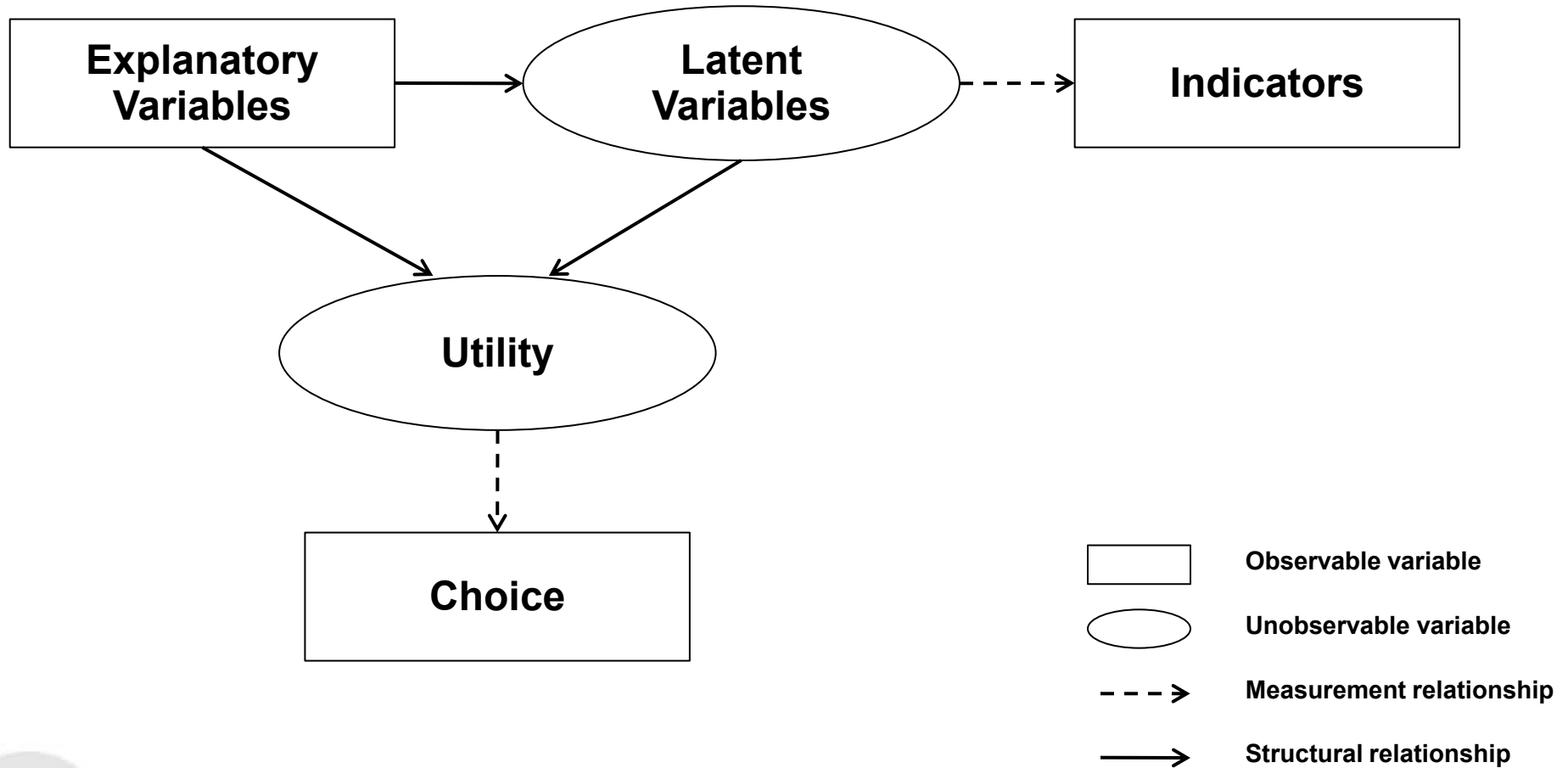


- The OPTIMA project (EPFL-CarPostal):
 - Understand the demand for public transport
 - Relevance of unobserved factors in mode choice (attitudes, perceptions, habits)
 - Combine qualitative and quantitative methods

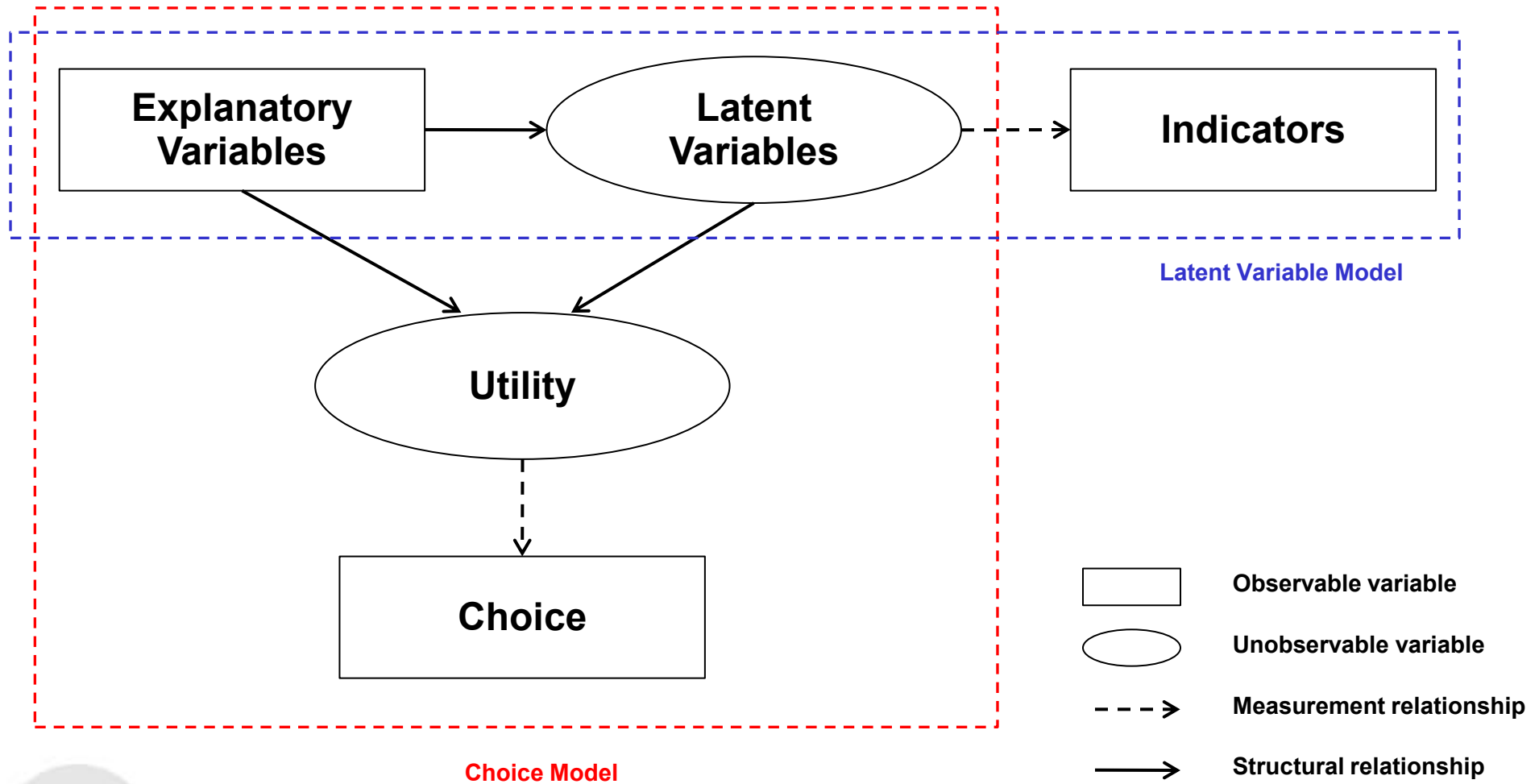
Standard choice model



Integrated model



Integrated model



Data collection

- Preliminary qualitative survey
 - 20 individuals, Canton of Vaud. GPS tracking of travel for 10 days and personal interviews.
 - Identification of main (usually unobserved) factors that affect travel behavior:
 - Constraints
 - Perceptions
 - Habits
 - Lifestyles
 - Generation of a list of potential latent variables:
 - Predisposition towards specific transport modes
 - Perceived travel constraints
 - Environmental concern
 - Benefit from travel
 - Mobility Skills
 - Status seeking
 -

Data collection

- Quantitative Survey (1124 received answers)
 - Trip diary (1 complete day)
 - Socioeconomics
 - Psychometric indicators:

We need more public transport, even if we have to pay higher taxes
Taking the bus helps to make the city more comfortable and welcoming

Attitude towards public transport

It's hard to take public transport when I travel with bags or luggage
If I use public transport instead of my car I have to cancel some activities

Perceived travel constraints

I know the bus schedule by heart
I feel disoriented when I'm in a place I don't know

Mobility skills

Latent variable identification

- Candidates from preliminary survey and literature are just hypothetical
- Selection of variables through Exploratory Factor Analysis

$$I_k = \bar{I}_k + \sum_j \rho_{kj} F_j + \varphi_k$$

- Description of the indicator's variability in terms of unobserved factors through “factor loadings” ρ_{kj}

Latent variables

Ind	Statement	Factor 1	Factor 2	Factor 3
1	<u>We should increase the price of gasoline to reduce congestion and air pollution</u>	-0.333	0.499	-
2	We need more public transport, even if it means higher taxes	-	0.362	-
3	Environmentalism harms the small businesses	-	-0.533	-
4	People and employment are more important than the environment	-	-0.649	-
5	I am concerned about global warming	-	0.619	-
6	We must act and make decisions to reduce emissions of greenhouse gases	-	0.692	-
14	<u>I am not comfortable when I travel with people I do not know</u>	0.392	-	-
15	<u>Taking the bus helps to make the city more comfortable and welcoming</u>	-	-	-
16	<u>It's hard to take public transportation when I travel with my children</u>	0.696	-	-
17	<u>It's hard to take public transportation when I travel with bags or luggage</u>	0.640	-	-
22	<u>I don't like to change transport modes when I travel</u>	0.644	-	-
23	<u>If I use public transport instead of my car, I have to cancel some activities</u>	0.532	-	-
24	<u>The bus schedule is sometimes hard to understand</u>	0.327	-	-0.338
25	<u>I know well which bus or train I must take, regardless of where I'm going</u>	-0.331	-	0.629
26	I know the bus schedule by heart	-	-	0.728
28	I feel very disoriented when I'm in a place I don't know	-	-	-0.458
29	I use the Internet to find out about the bus or train schedule	-	-	0.314
30	I have used public transport all my life	-	-	0.552
32	I know some of the drivers of the buses I take	-	-	0.338

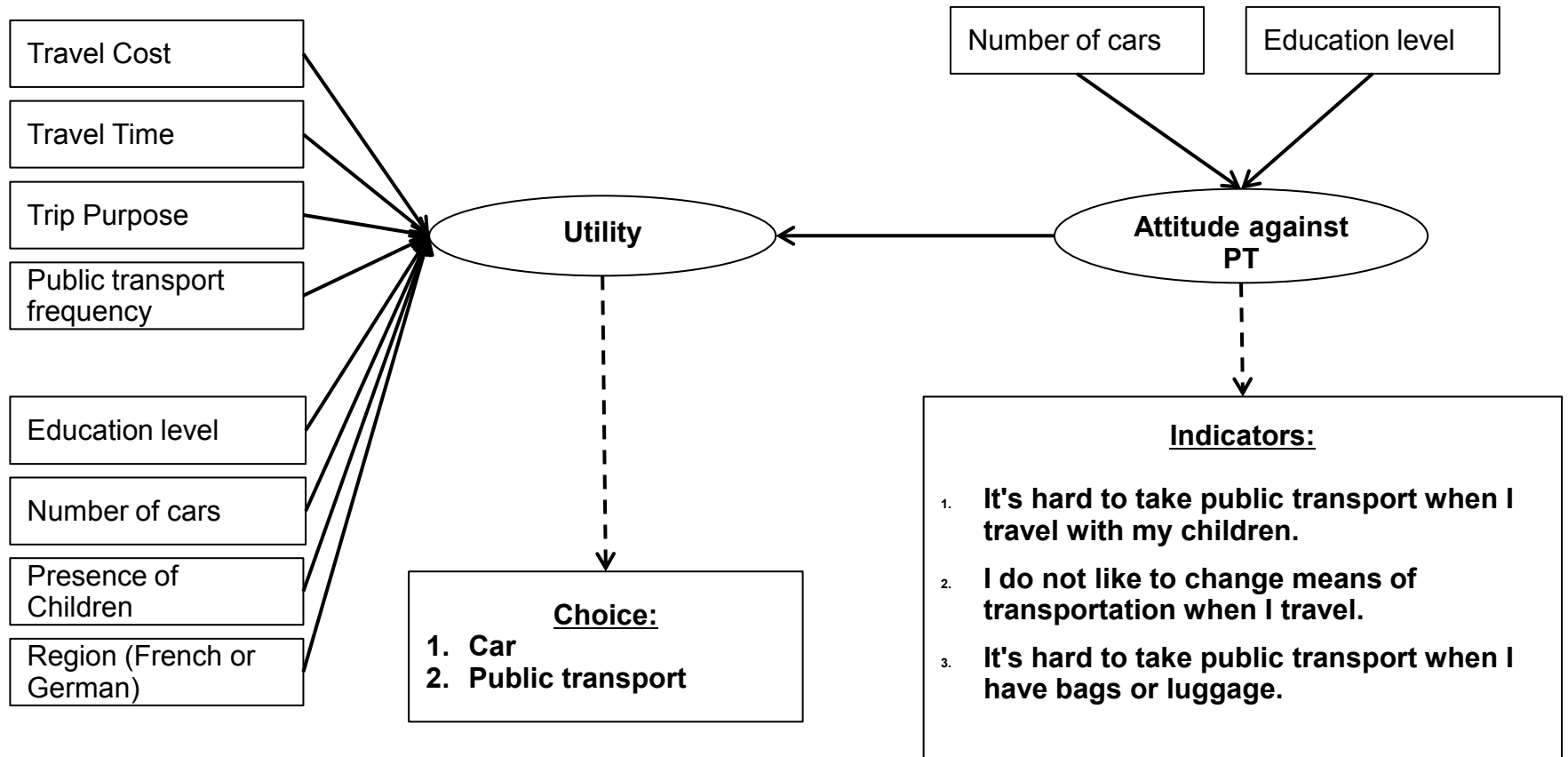


Factor 1 = Attitude against public transport

Factor 2 = Environmental concern

Factor 3 = Public transport awareness

Model structure

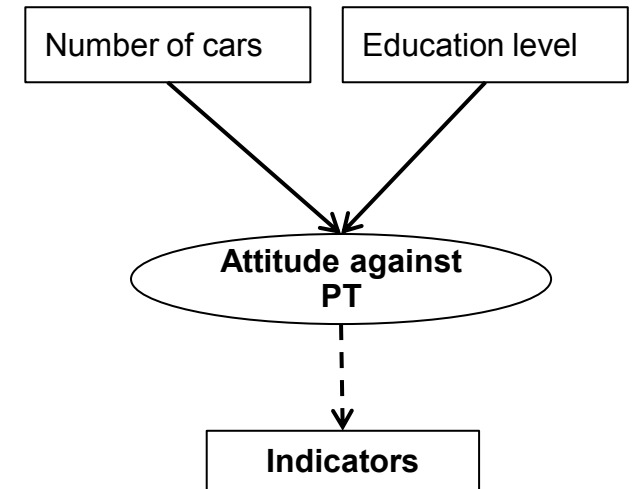


Model specification (Latent variable model)

Structural equation:

$$Att = \overline{Att} + \lambda_{cars} N_{cars} + \lambda_{educ} \delta_{educ} + \omega$$

$$\omega \sim N(0, \theta_{\omega}) \longrightarrow f(Att | X, \lambda, \theta_{\omega})$$



Measurement equation:

$$I_k = a_k + \alpha_k Att + v_k \quad \forall k$$

$$v_k \sim N(0, \theta_{v_k}) \longrightarrow f(I_k | Att, a_k, \alpha_k, \theta_{v_k})$$

Model specification (Choice model)

Structural equation (utilities):

$$V_{CAR} = ASC_{CAR} + \beta_{cost} C_{CAR} + \beta_{TT_{CAR}} TT_{CAR} + \beta_{Att} Att TT_{CAR} + \sum_s \beta_s X_s$$

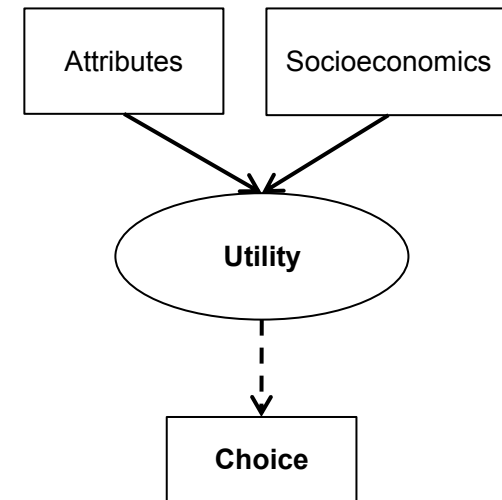
$$V_{PT} = ASC_{PT} + \beta_{cost} C_{PT} + \beta_{TT_{PT}} TT_{PT} + \beta_w \delta_{work} + \beta_{freq} F_{PT}$$

socioeconomics



$$P(i | X, \beta)$$

$$P_{CAR} = \frac{\exp(V_{CAR})}{\exp(V_{CAR}) + \exp(V_{PT})}; \quad P_{PT} = \frac{\exp(V_{PT})}{\exp(V_{CAR}) + \exp(V_{PT})}$$



Estimation

Probability:

$$P(i, I | X; \beta, a, \alpha, \lambda, \theta_-, \theta_+) =$$

$$\int_{Att} P(i | X, \beta) f(I | Att, a, \alpha, \theta_-) f(Att | X, \lambda, \theta_+) dAtt$$

Loglikelihood:

$$LL = \sum_n \sum_{i \in C_n} y_{in} \log P_n(i, I | X; \beta, a, \alpha, \lambda, \theta_-, \theta_+)$$

Estimation results

Parameter	Affected utility		Latent var model		Logit	
	V_{CAR}	V_{PT}	Value	t-test	Value	t-test
ASC_{CAR}	x		-0.336	-0.75*	-0.229	-0.57*
ASC_{PT}		x	0**	-	-	-
β_{cost}	x	x	-0.118	-4.21	-0.058	-4.64
$\beta_{\Pi_{CAR}}$	x		-0.185	-3.77	-0.033	-4.4
$\beta_{\Pi_{PT}}$		x	-0.019	-3.64	-0.014	-3.21
β_{freq}		x	0.562	1.75*	0.488	1.81*
β_w		x	0.607	2.82	0.633	3.39
$\beta_{N_{cars}}$	x		0.691	3.29	0.702	3.48
$\beta_{children}$	x		0.444	1.96	0.328	1.63*
β_{French}	x		0.996	3.36	1.150	4.55
β_{educ}	x		0.672	2.68	0.390	1.92*
β_{Att}	x		0.473	3.4	-	-
Att	x		2.850	38.07	-	-
λ_{cars}	x		0.121	2.9	-	-
λ_{educ}	x		-0.175	-2.84	-	-
a_{16}			0**	-	-	-
a_{17}			0.805	2.47	-	-
a_{22}			0.617	1.77*	-	-
α_{16}			1**	-	-	-
α_{17}			0.879	7.98	-	-
α_{22}			1.060	9.19	-	-
θ_w			-0.519	-6.62	-	-
$\theta_{v_{16}}$			-0.166	-4.41	-	-
$\theta_{v_{17}}$			-0.012	-0.43*	-	-
$\theta_{v_{22}}$			-0.149	-3.74	-	-

(* Statistical significance < 95%)

(** Fixed parameter)

Conclusions

- Effect of high education and number of cars in both the utility function and the latent variable
- Statistical significance of parameters is higher in the latent variable model
- Estimates are more realistic in the latent variable model

Value of Time:

	VoT car (CHF/h)
Latent variable model	25.5
Logit model	34.32
Reference value*	20.98

- Only one latent variable: further work will require simulation techniques for integration of the probability function

Thank you