

Adjectives qualifying individuals' perceptions impacting on transport mode preferences

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Outline

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 - Preliminary analysis of adjectives
- Methodology
 - Integrated choice and latent variable model
- Estimation results
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- Validation
- Conclusion and further work

Introduction

Context:

- In **low-density areas** of Switzerland: **high usage of car** and **few public transport** connections.

Aim:

- **Analyze and predict transport mode choice** to understand better mobility in low-density areas

Introduction

Assumption:

- Choice not only driven by classical variables such as time and cost.



- **Attitudes & perceptions** play an important role in **transport mode decisions**.

Introduction

Research questions:

- How to **measure** in most accurate way **attitudes** and **perceptions**?
- How to **integrate** this information into a **discrete choice model**?
- How does this information **impact on forecasting**?

Data collection: survey

Large-scale survey:

- **Qualitative survey:**
 - Interviews of inhabitants of suburban or rural areas
 - GPS recordings of their trips
 - Trip diaries
- **Quantitative survey:**
 - **Revealed preference (RP) survey** designed on basis of answers to qualitative survey

Data collection: survey

RP survey:

- Conducted between **2009-2010** in low-density areas of Switzerland
- Conducted with **PostBus**
(major bus company in Switzerland, operates in low-density areas)
- **57 towns/villages** connected by post busses
→ representative of whole PostBus network
- Respondents of **16 years and over**

1763 valid questionnaires collected

Data collection: survey

Structure of RP survey:

- Description of all trips performed in one day
- Mobility habits
- Opinions
- Perception of transport modes
- Personal data & household description

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- Mode used
- Activity at destination
- Trip duration
- Cost of fuel / public transport ticket


Data collection: survey

Structure of RP survey:

- Description of all trips performed in one day
 - Mobility habits 
 - Opinions
 - Perception of transport modes
 - Personal data & household description
- Transport modes used for particular trips (work, shopping, etc.)
 - Transport modes used during childhood

Data collection: survey

Structure of RP survey:


- Description of all trips performed in one day:
- Mobility habits
- Opinions 
- Perception of transport modes
- Personal data & household description

Statements about environmental concern, mobility, lifestyle, etc.

- *Taking the bus helps making a town more comfortable and welcoming. [Mobility]*
- Agreement rated on 5-point Likert scale

Data collection: survey


Structure of RP survey:

- Description of all trips performed in one day
- Mobility habits
- Opinions
- Perception of transport modes 
- Personal data & household description

- Free report of three adjectives describing best one transport mode:
 - Car
 - Train
 - Bus/metro/tram
 - Post bus
 - Bike
 - Walk

Data collection: survey

Structure of RP survey:

- Description of all trips performed in one day
 - Mobility habits
 - Opinions
 - Perception of transport modes
 - Personal data & household description
- 
- Classical socio-economic variables: age, gender, etc.
 - Household characteristics: family status, number of persons, etc.

Data collection: survey

Perception of transport modes in the questionnaire
For each of the following transport modes, give three adjectives that describe them best according to you.

		Adjective 1	Adjective 2	Adjective 3
1	The car is:			
2	The train is:			
3	The bus, the metro and the tram are:			
4	The post bus is:			
5	The bicycle is:			
6	The walk is:			

Data collection: preliminary analysis of adjectives

Adjectives freely reported by respondents

➡ **several themes identified:**

- Perception of cost
- Perception of time
- Difficulty of access
- Flexibility
- Efficiency
- Reliability
- Comfort
- Environmental impact
- Appreciation
- Look

Data collection: preliminary analysis of adjectives

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- **Comfort**
- Environmental impact
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Selection of one theme:
Perception of comfort in public transports

Data collection: preliminary analysis of adjectives

Coding of the adjectives related to **comfort**:

Comfort	Scale	Comfort	Scale
hardly full	1	unsuitable with strollers	-1
packed	-1	difficult	-2
bumpy	-2	full	-1
comfortable	1	relaxing	2
hard	-1	restful	2
irritating	-2	without stress	2
tiring	-1	shaking	-2
unsuitable with bags	-1	stressful	-1
uncomfortable	-1	suffocating	-1
bad air	-2	empty	1

Methodology

Model **choice of transport mode**

- Public transport modes (PT)
- Private transport modes (PM)
- Soft modes (SM)

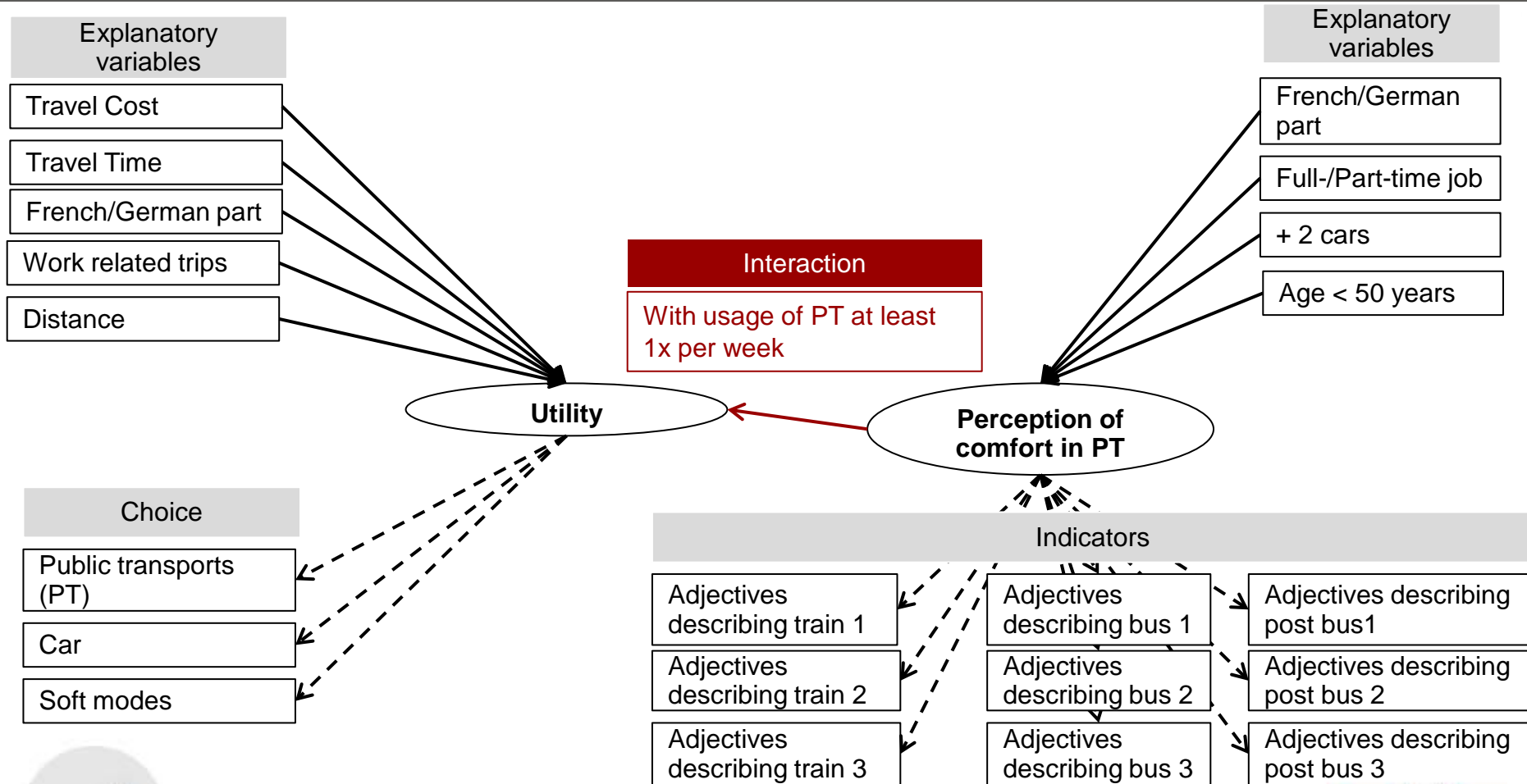
Choice made over **round trips (loops)**

- Home-Work-Home
- Home-Work-Leisure-Home
- Home-Leisure-Home

Methodology

- Integrated choice and latent variable model (Walker, 2001)
- Indicators of latent variable are adjectives
- Discrete indicators

Integrated choice and latent variable model



Integrated choice and latent variable model

Structural equations:

- Choice model:

$$U_{in} = V(X_{in}, X_n^*; \beta) + \varepsilon_{in} \quad \text{with} \quad \varepsilon_{in} \sim EV(0,1)$$

- Latent variable model:

$$X_n^* = h(X_{in}; \lambda) + \omega_{in} \quad \text{with} \quad \omega_{in} \sim N(0, \sigma_\omega)$$

Measurement equations:

$$I_n = m(X_n^*; \alpha) + \nu_n$$

with $\nu_n \sim \text{Logistic}(0,1)$

$$I_n = \begin{cases} -2 & \text{if } -\infty < X_n^* \leq \tau_1 \\ -1 & \text{if } \tau_1 < X_n^* \leq \tau_2 \\ 0 & \text{if } \tau_2 < X_n^* \leq \tau_3 \\ 1 & \text{if } \tau_3 < X_n^* \leq \tau_4 \\ 2 & \text{if } \tau_4 < X_n^* \leq +\infty \end{cases}$$

Integrated choice and latent variable model

- Likelihood function given by:

$$L = \prod_{n=1}^N f(y_{in}, I_n | X_{in}; \alpha, \beta, \lambda, \sigma_\omega) \quad \text{with}$$

$$f(y_{in}, I_n | X_{in}; \alpha, \beta, \lambda, \sigma_\omega) = \int_{X_n^*} P(y_{in} | X_{in}, X_n^*; \beta) \cdot f(I_n | X_{in}, X_n^*; \alpha) \cdot f(X_n^* | X_n; \lambda, \sigma_\omega) dX_n^*$$

$$y_{in} = \begin{cases} 1 & \text{if } U_{in} = \max_j U_{jn} \\ 0 & \text{otherwise} \end{cases}$$

- Estimation by **maximum likelihood**
- Use of software **Biogeme**

Estimation results: choice model

	Private modes		Public modes		Soft modes	
	Estimate	t-test	Estimate	t-test	Estimate	t-test
ASC CAR	2.20	11.64				
ASC SM					1.74	5.16
COST	-0.0223	-2.54	-0.0223	-2.54		
TIME IN PM	-0.0214	-3.91				
TIME IN PT			-0.0085	-3.19		
DISTANCE					-0.208	-4.07
WORK TRIPS	-0.473	-3.96				
FRENCH-SPEAKING REGION	0.698	4.56				
PERCEPTION OF COMFORT IN PT			0.392	2.89		

Estimation results: choice model

Cost affects negatively utility of PT and PM

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An increase of travel time in PM decreases more its utility than for PT

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Distance affects negatively the choice of SM

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Estimation results: choice model

Cost affects negatively utility of PT and PM
 An increase of travel time in PM decreases more its utility that for PT
 Distance affects negatively the choice of SM
PT and SM are preferred for work-related trips

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Estimation results: choice model

Cost affects negatively utility of PT and PM
 An increase of travel time in PM decreases more its utility that for PT
 Distance affects negatively the choice of SM
 PT and SM are preferred for work-related trips
PM are preferred in French-speaking regions

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Estimation results: choice model

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 An increase of travel time in PM decreases more its utility that for PT
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 PT and SM are preferred for work-related trips
 PM are preferred in French-speaking regions

Individuals' perception of comfort in PT favors their choice.

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Estimation results: latent variable model

	Perception of comfort in PT	
	Estimate	t-test
INTERCEPT	7.44	3.06
FULL-/PART-TIME JOB	-0.286	-3.67
BELOW 50 YEARS	-0.277	-4.04
GERMAN-SPEAKING REGION	0.14	2.17
AT LEAST 2 CARS	-0.194	-2.7
SIGMA	-0.222	-3.82

Estimation results: latent variable model

Individuals with full-/part-time jobs have negative perception of comfort in PT.

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Comfort in PT is positively perceived in German-speaking regions.

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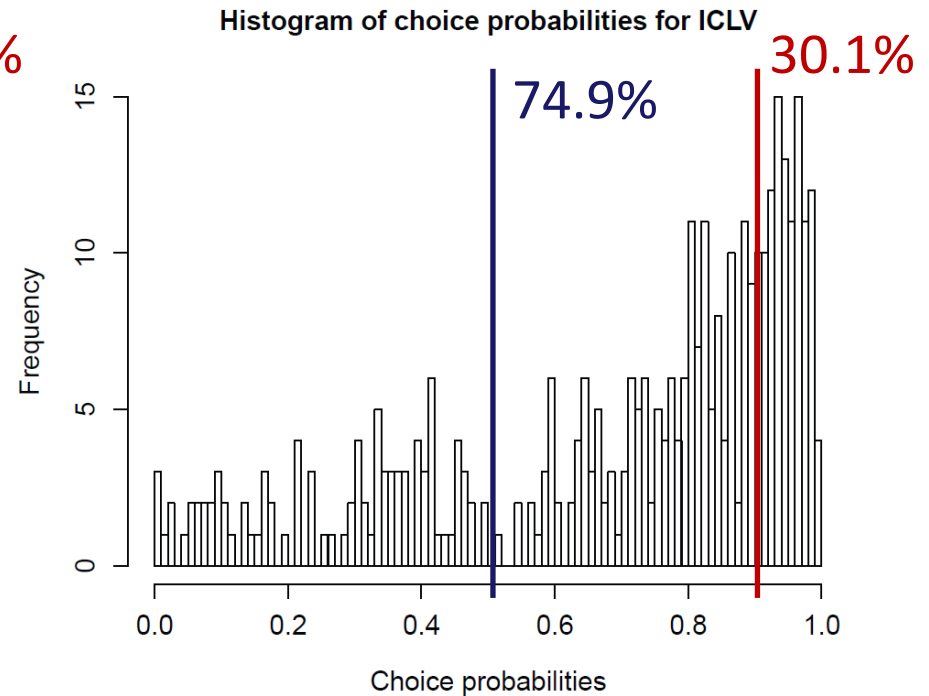
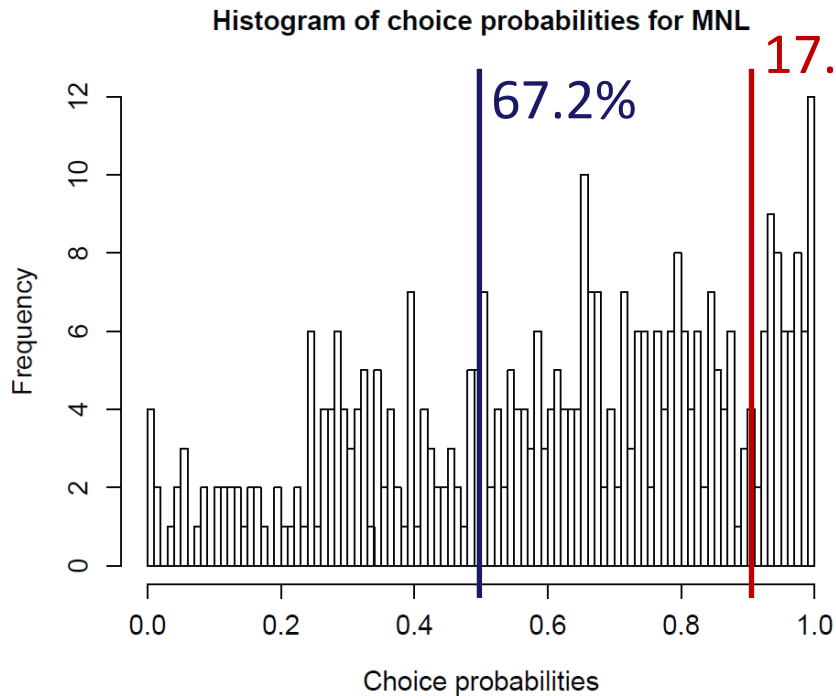
Comfort in PT is positively perceived in German-speaking regions.

Households with at least 2 cars have a negative image of comfort in PT.

	Perception of comfort in PT	
	Estimate	t-test
INTERCEPT	7.44	3.06
FULL-/PART-TIME JOB	-0.286	-3.67
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Validation

Histogram of choice probabilities predicted by MNL and ICLV



Validation

ICLV has better fit than MNL

Value	MNL	ICLV
Log-likelihood	-1206.31	-9818.49
ρ^{-2}	0.420	0.554

Validation

Indicators of demand:

Market shares and their relative elasticities

Indicator	PM	PT	SM
Market share	65.2%	28.5%	6.28%
Elasticity for cost of PM	-0.02	0.05	0.02
Elasticity for cost of PT	0.03	-0.07	0.01
Elasticity for time of PM	-0.15	0.32	0.14
Elasticity for time of PT	0.14	-0.32	0.05

- Demand little elastic to changes in time/cost
- Elasticities relative to time higher than relative to cost

Validation

Scenario with 50% increase of comfort

Perception of comfort	PM	PT	SM
Without increase	65.2%	28.5%	6.28%
With a 50% increase	58.3%	36.1%	5.64%

➔ Increase of comfort in PT can impact in a non-negligible way on individuals' choices

Conclusion and further work

Research questions:

- **Data collection:**

- Measured perception with semi-opened questions with adjectives freely reported

- **New modeling perspectives:**

- Adjectives can be quantified
- Perception of comfort has significant impact on individuals' mode preferences

- **Effect on forecasting:**

- ICLV better prediction power than MNL
- Scenario of 50% increase in perception of comfort results in important increase of PT market share

Conclusion and further work

Improvements & further work:

- **Coding of adjectives** is quite subjective:
 - Improvement in the mapping from adjectives to values
- Need to assess impact of **other types of perceptions**:
 - Perception of comfort in private modes
 - Image of reliability, perception of cost, etc.
- **Frequent PT users** have better perception of their comfort:
 - Model this by integrated choice and latent class model
- More **scenarios** can be tested.

Thanks!