

# MEASURING THE IMPACT OF INDIVIDUALS' PERCEPTIONS ON THEIR TRANSPORT MODE CHOICE

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- Data collection
  - Survey
  - Preliminary analysis of adjectives
- Methodology
  - Integrated choice and latent variable model
- Estimation results
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- Validation
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# 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 network of PostBus
- 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



# Data collection: survey

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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: 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:	<b>convenient</b>	<b>comfortable</b>	<b>expensive</b>
2	The train is:	<b>relaxing</b>	<b>punctual</b>	<b>restful</b>
3	The bus, the metro and the tram are:	<b>fast</b>	<b>frequent</b>	<b>cheap</b>
4	The post bus is:	<b>punctual</b>	<b>comfortable</b>	<b>cheap</b>
5	The bicycle is:	<b>stimulating</b>	<b>convenient</b>	<b>cheap</b>
6	The walk is:	<b>healthy</b>	<b>relaxing</b>	<b>independent</b>

# 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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- Reliability
- **Comfort**
- Environmental impact
- Appreciation
- Look

**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

Scale of strength from -2 to 2.

# Methodology

## Model **choice of transport mode**

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

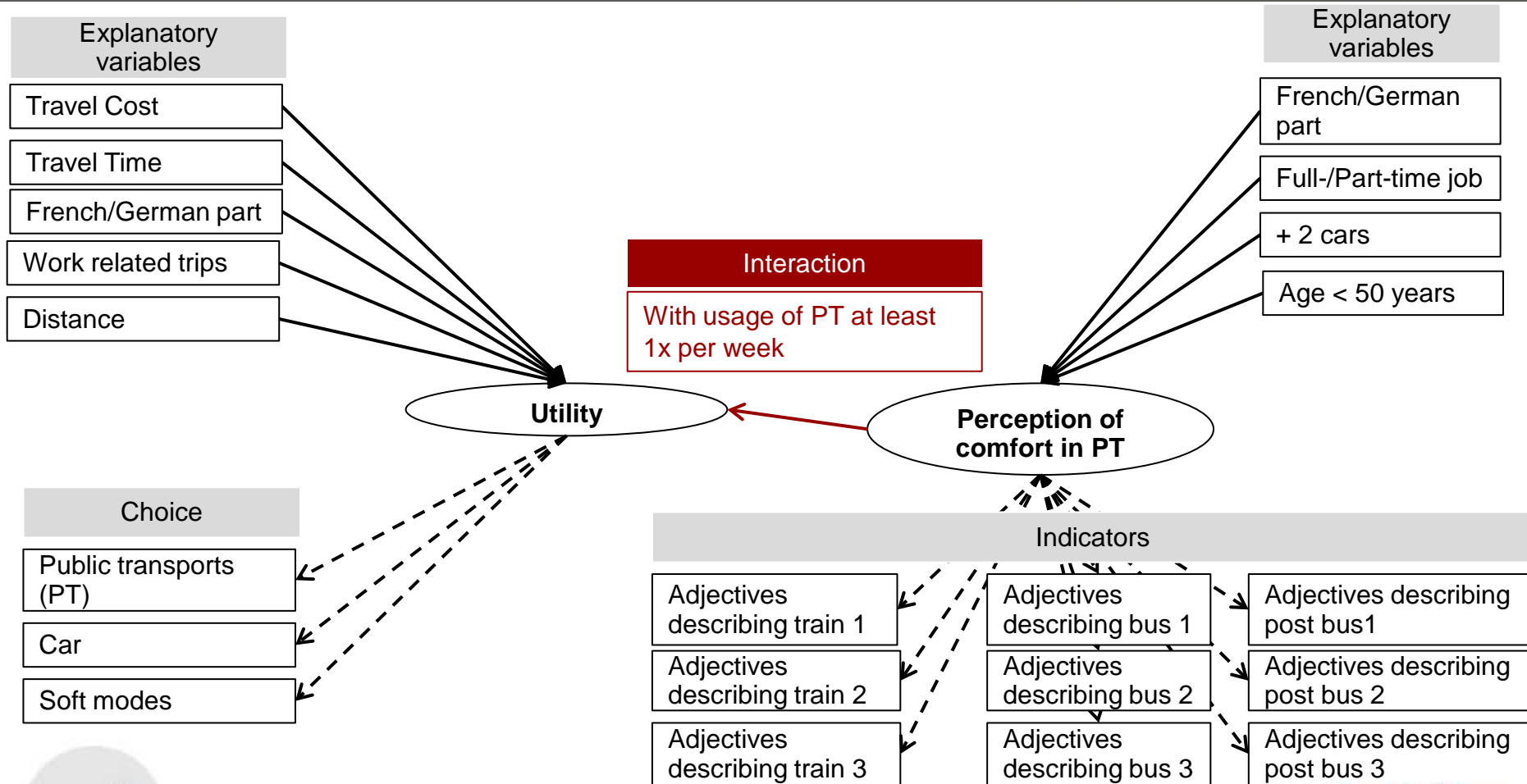
## Choice made over **round trips (loops)**

- 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** (Bierlaire, 2003; Bierlaire and Fethiarison, 2009)

# 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		



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Cost ↗

⇒ Utility of PT and PM ↘

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Travel time ↗

⇒ Utility of PM ↘ more than utility of PT

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**PT and SM are preferred for work-related trips**

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PT and SM are preferred for work-related trips

PM are preferred in French-speaking regions

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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

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# Estimation results: latent variable model

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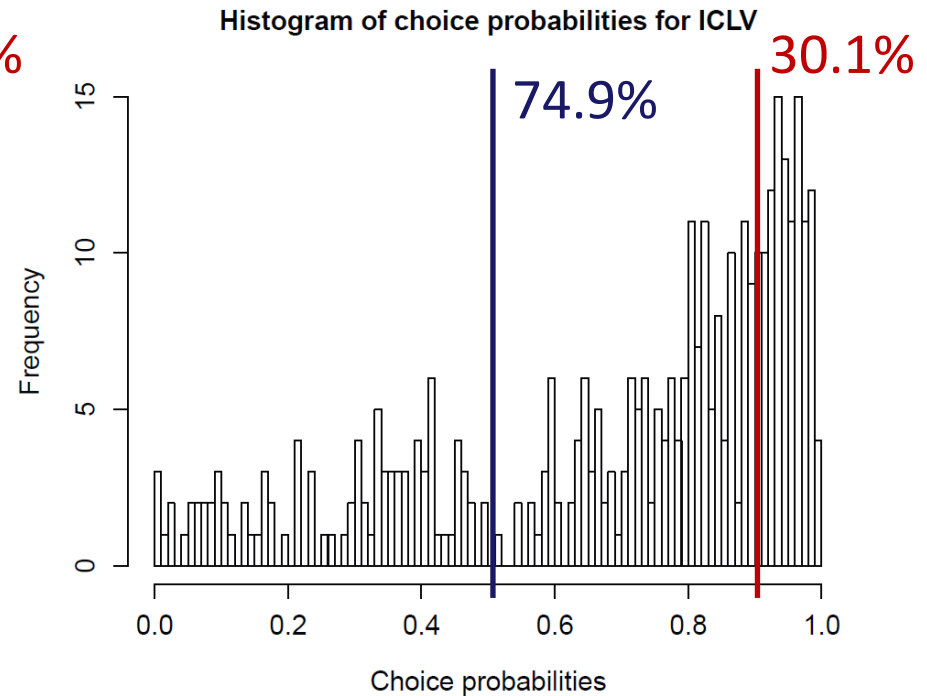
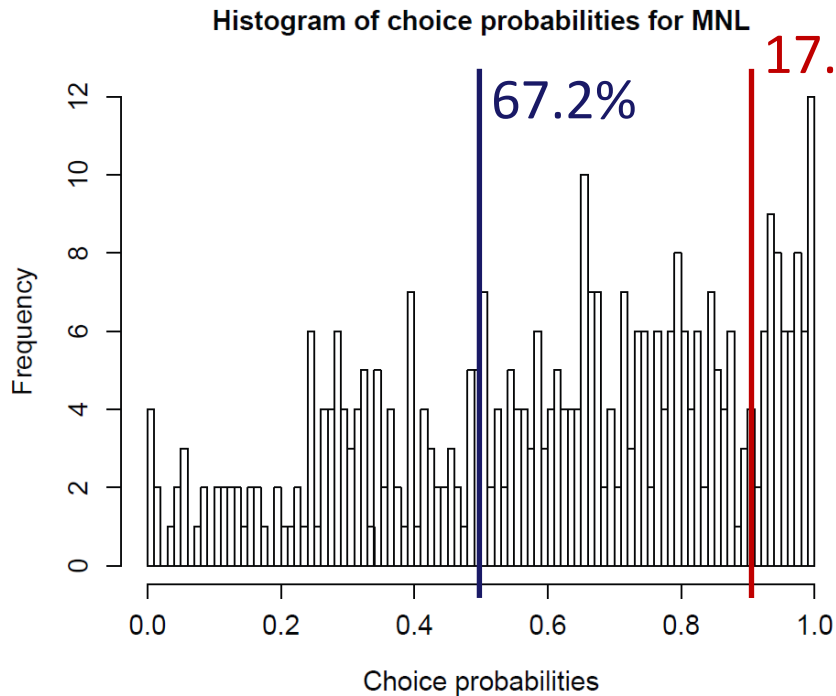
Comfort in PT is positively perceived in German-speaking regions.

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

	Perception of comfort in PT	
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INTERCEPT	7.44	3.06
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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
$\rho^{-2}$	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!