The usage of location based big data and trip planning services for the estimation of a long-distance travel demand model

Predicting the impacts of a new high speed corridor

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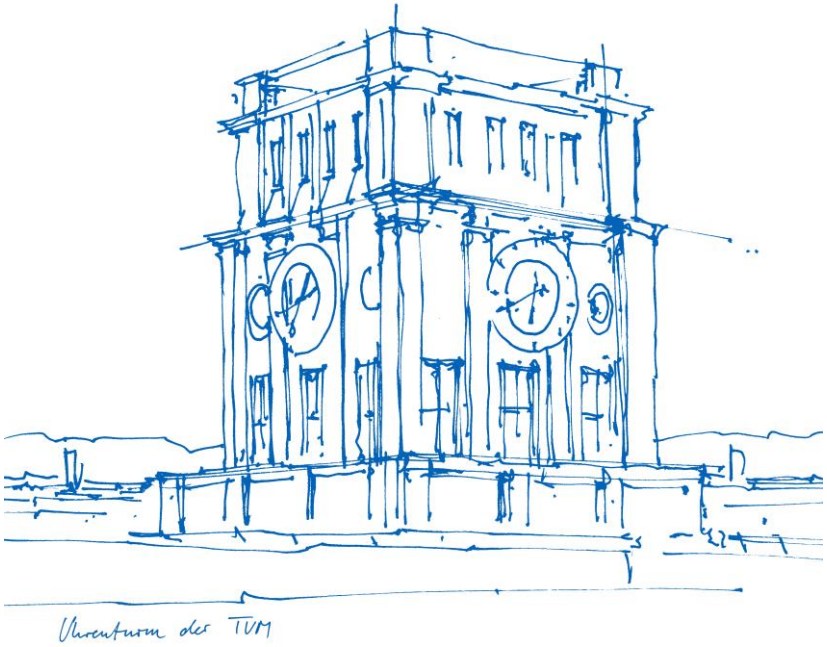
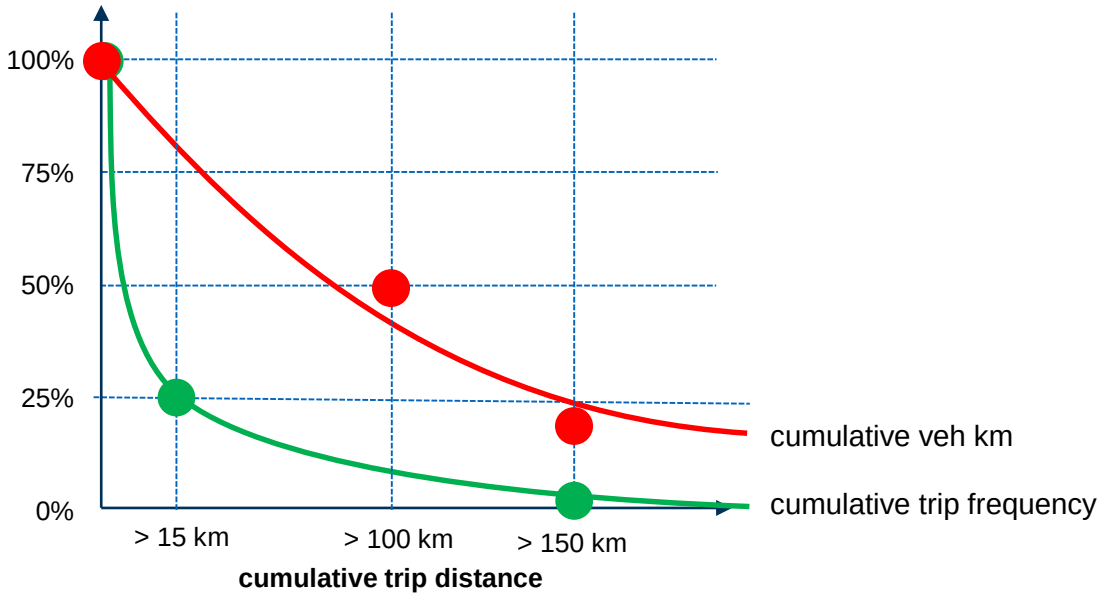


Milan (Italy), September 2017

Introduction

Relative importance of long-distance travel demand:

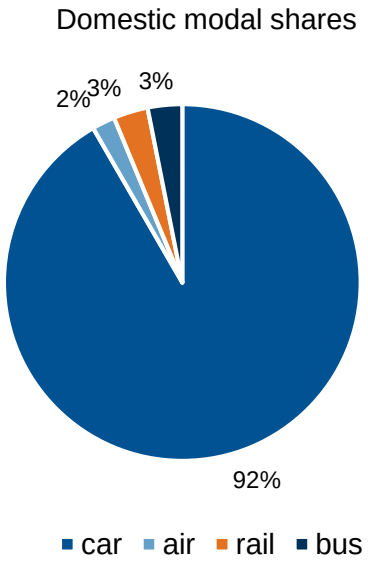


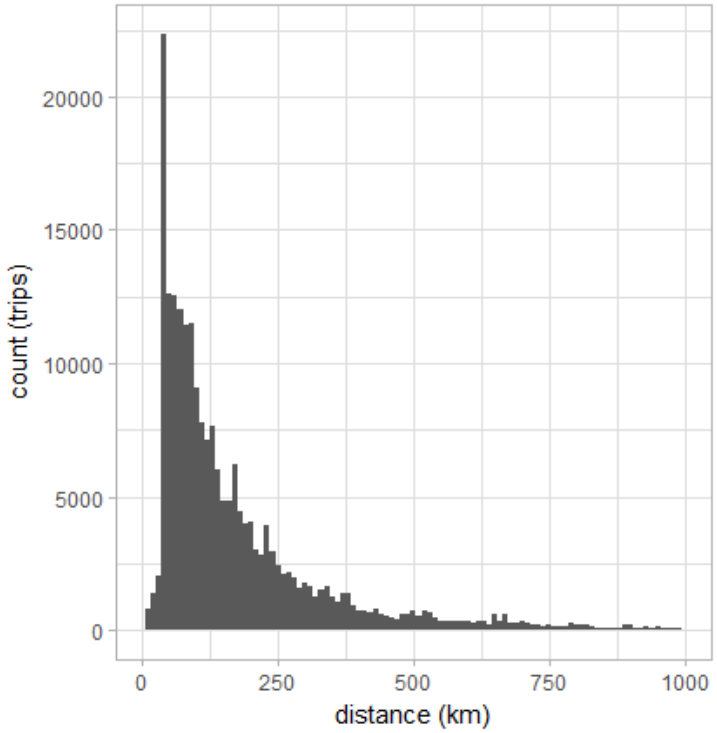
Less research compared to short-distance (urban) travel demand:

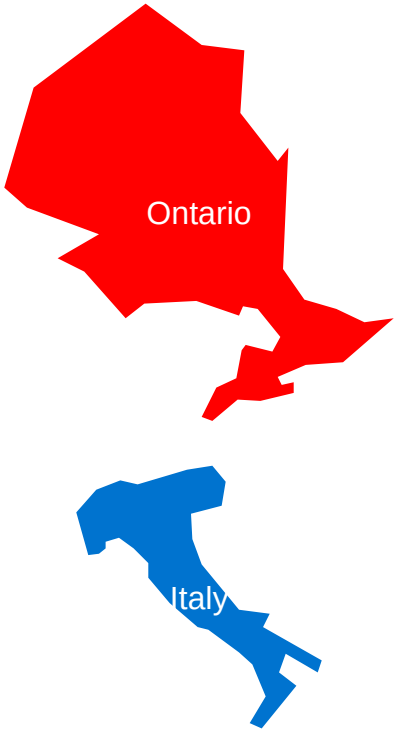
- Case specific or corridor specific
- Long-distance modules for large scale statewide/countrywide models

Framework

- Development of a long-distance passenger model for the provincial model of Ontario (Canada)
- Ontario province:
  - Population = 13.5 M
  - Domestic trips starting in Ontario = 93 M/year



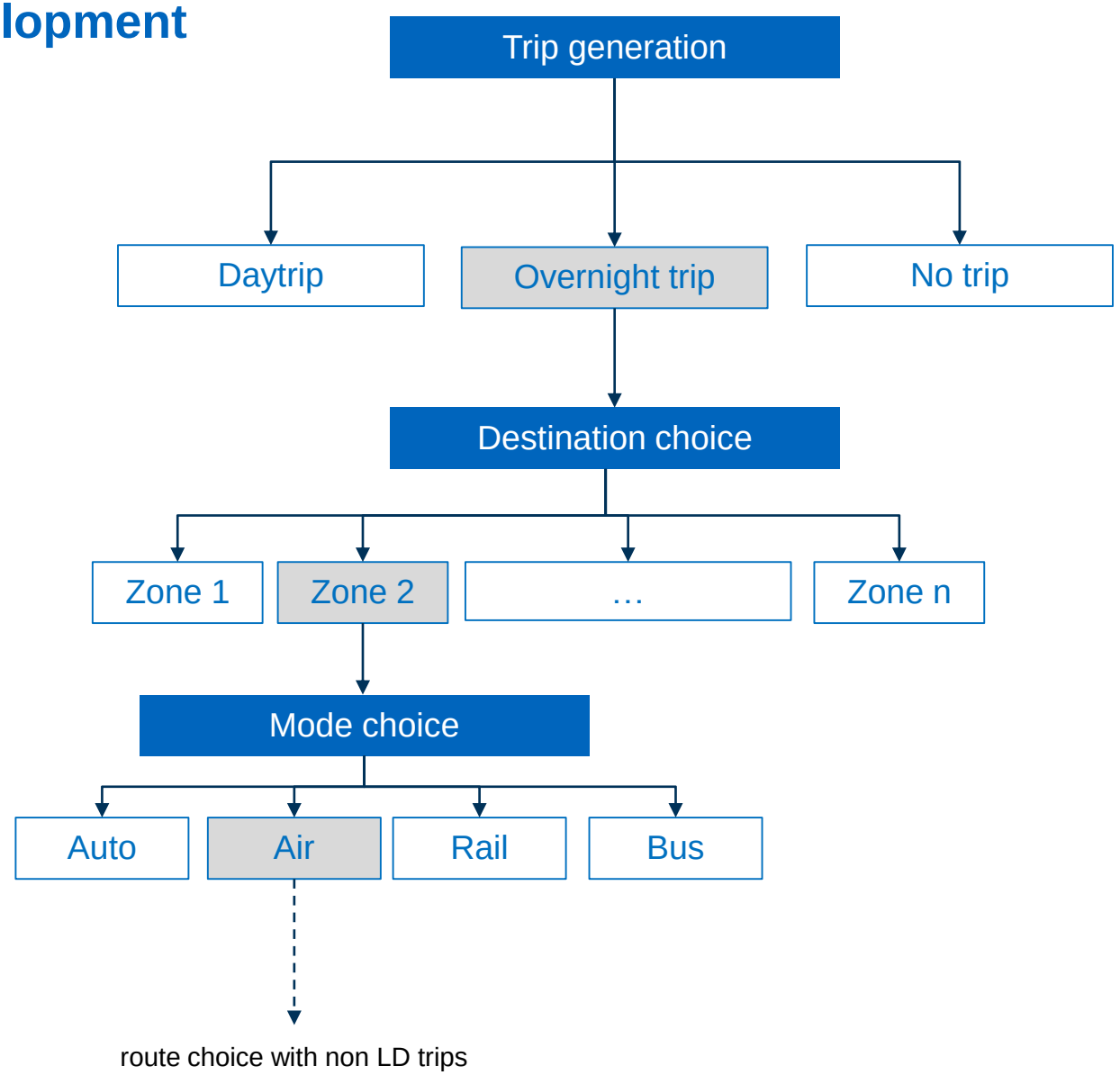




**according to the definition of long-distance trip in Canadian survey data: >40 km daytrip or overnight trip*

Model development

Model structure



Model development

Data collection (1):

Zoning system: 69 zones in Ontario + 175 external zones (38 in Canada and 137 abroad)

Model development

Data collection (2)

Travel survey: Travel Survey of Residents in Canada (TSRC)

Person:
- Id
- Age
- Gender
- Education level
- Employment status
- Household size
- Household income
- Province, census division, census metropolitan area

Trips:
- Traveler id
- Purpose
- Date
- Mode
- Origin
- Destination
- Duration
- Party size

52K records (expanded to 948M trips) during years 2011 to 2014

Informs partially about destination and mode alternatives **selected** by respondents

Model development

Data collection (3):

Destination alternatives – zone characteristics

- Population
- Employment – by industry categories
- **Foursquare: location based social network**
  - Users can:
    - Register places (=venues)
    - Check-in visits to venues
    - Write reviews of venues

Access: foursquare.com

Model development

Foursquare → looking for venues (desktop version)

Example query:

https://foursquare.com/explore?mode=url&near=Milan%2C%20Lombardy%2C%20Italy&nearGeoId=72057594041101371&q=shopping

Model development

Foursquare data processing:

- Define a raster search grid of 1x1 degrees
- Access to the number of check-ins by category by raster cell trough Foursquare-API
- Aggregate to the desired geographical resolution and desired venue categories

- Venue categories (after aggregation for this analysis):
  - Medical
  - Ski area
  - Hotel
  - Outdoors
  - Sightseeing

Summary of data collection for Canada:

- 34,041 venues
- 7,981,458 check-ins

Result → better characterization of diverse land uses at the alternative destinations

Model development

Data collection (4):

Modal level of service (transport supply) → **Rome2Rio**

- Online trip planning service → users search Point to Point trip alternatives

Access in https://www.rome2rio.com/

Model development

Data collection:

4. Modal level of service (transport supply) → Rome2Rio

Example query:

https://www.rome2rio.com/s/Munich/Milan

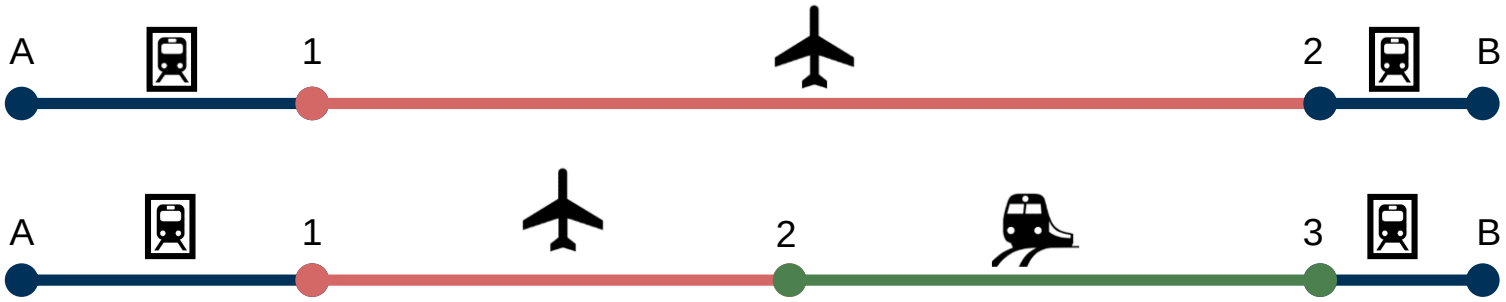
Model development

Data collection:

4. Modal level of service (transport supply) → Rome2Rio

Data processing:

- Access via Rome2rio API
- For each mode alternative:
  - Total travel time, access and egress times
  - Average price
  - Frequency
  - Main mode hierarchy: air > rail > bus > auto
- Example: 2 alternatives with air as main mode:



Result → travel time, travel cost, frequency and number of transfers zone-to-zone matrices

Model development

Model estimation:

- Multinomial logit models → random choices of individuals
- Trip generation
  - Four alternatives: stay at home, daytrip, being away in overnight trip, start or end an overnight trip
  - $Utility(travel) = f(person\ and\ household\ attributes, accessibility\ of\ origin\ zone)$
- Destination choice
  - 69 Alternatives (= number of zones in Ontario)
  - $Utility(destination) = f(population, employment, Foursquare\ attractors, mode\ choice\ logsum, daytrip/overnight)$
- Mode choice
  - Four alternatives: auto, air, rail, bus
  - $Utility(mode) = f\ (person\ and\ household\ attributes, mode\ level\ of\ service)$

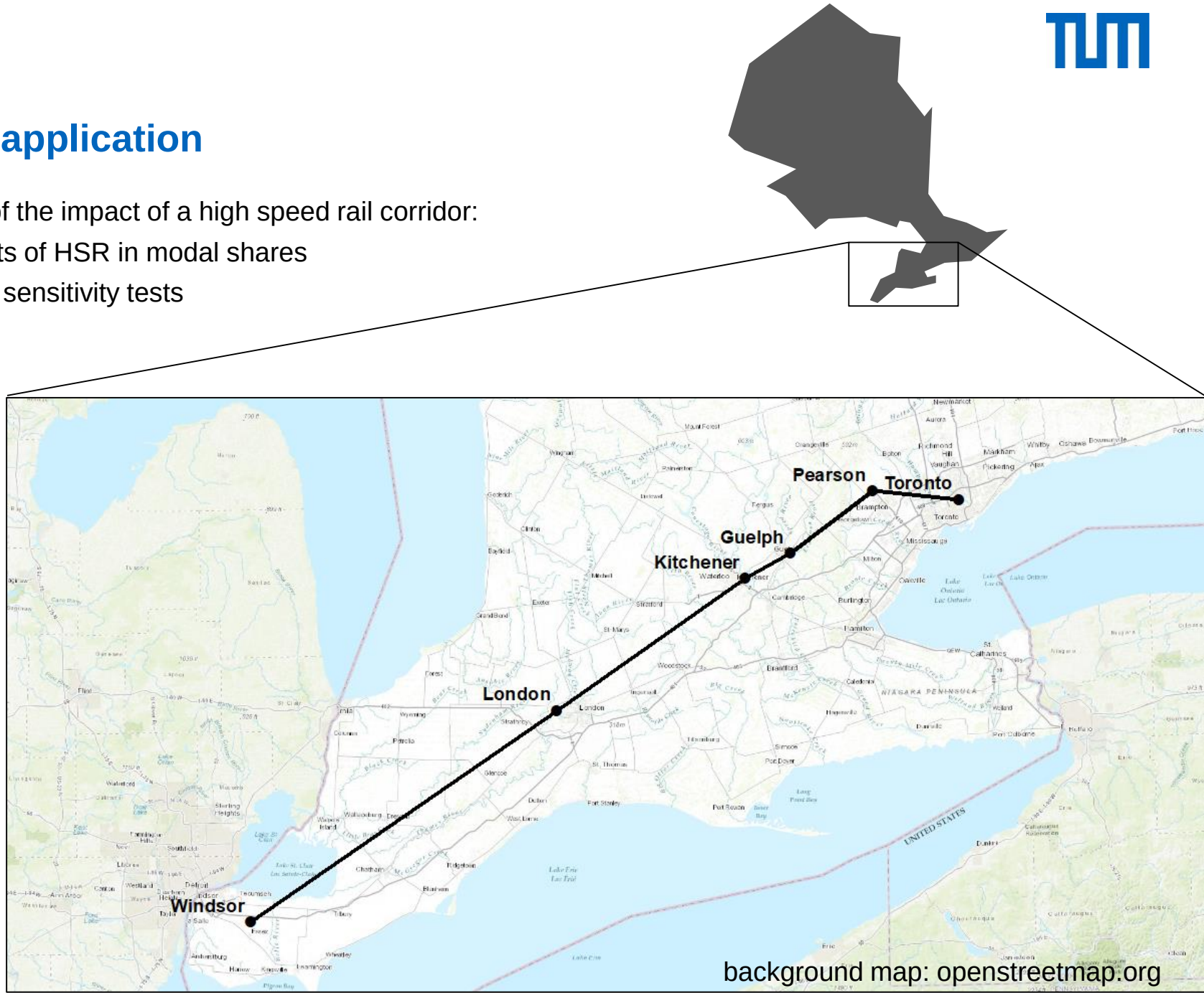
Model calibration:

- Adjustment of logsum coefficients and mode specific constants to match survey average trip length and modal shares (errors < 5%)

Model application

Analysis of the impact of a high speed rail corridor:

- Impacts of HSR in modal shares
- Model sensitivity tests



Model application

Scenarios:

- Travel time* reduction:
  - Base scenario: conventional rail
  - HSR scenarios: 200, 300** and 400 km/h maximum speed (130, 200** and 260 km/h commercial speed)
- Travel cost* increase:
  - Base scenario: current travel cost
  - HSR scenarios: increase by 50%, increase by 100%, increase by 150%
- Service frequency* increase:
  - Base scenario: current service frequency
  - HSR scenarios: no increase, increase by 25%, increase by 50%

- No route choice or assignment models → modification of zone-to-zone matrices:
  - Between zones served by HSR (6 stations) → apply directly the improvement
  - Between zones not served by HSR → applies only to the HSR segment

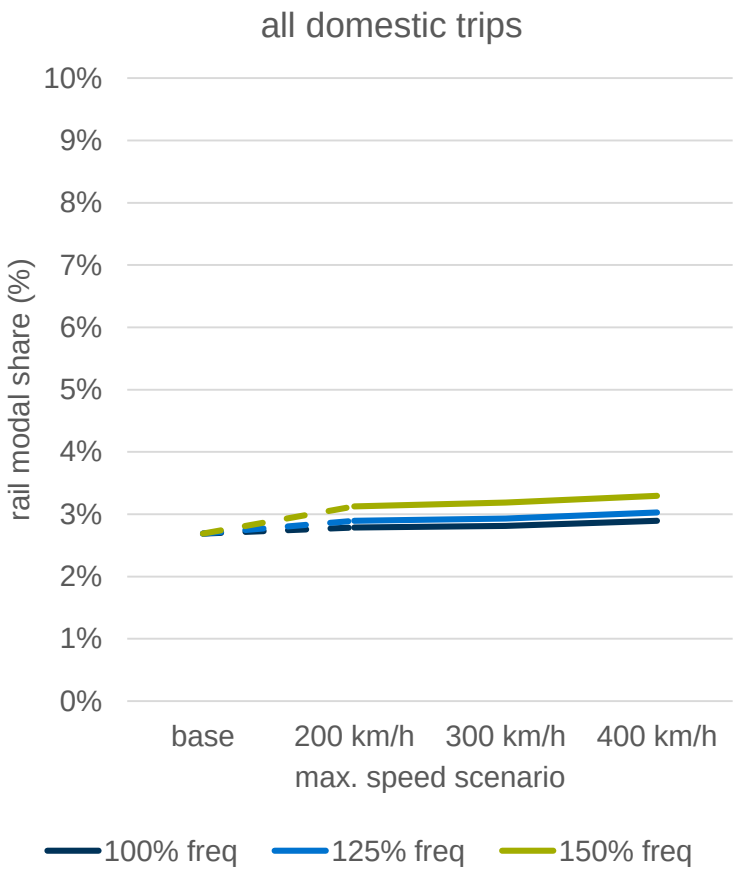
**variables significant at the 99% confidence level in mode choice MNL models*

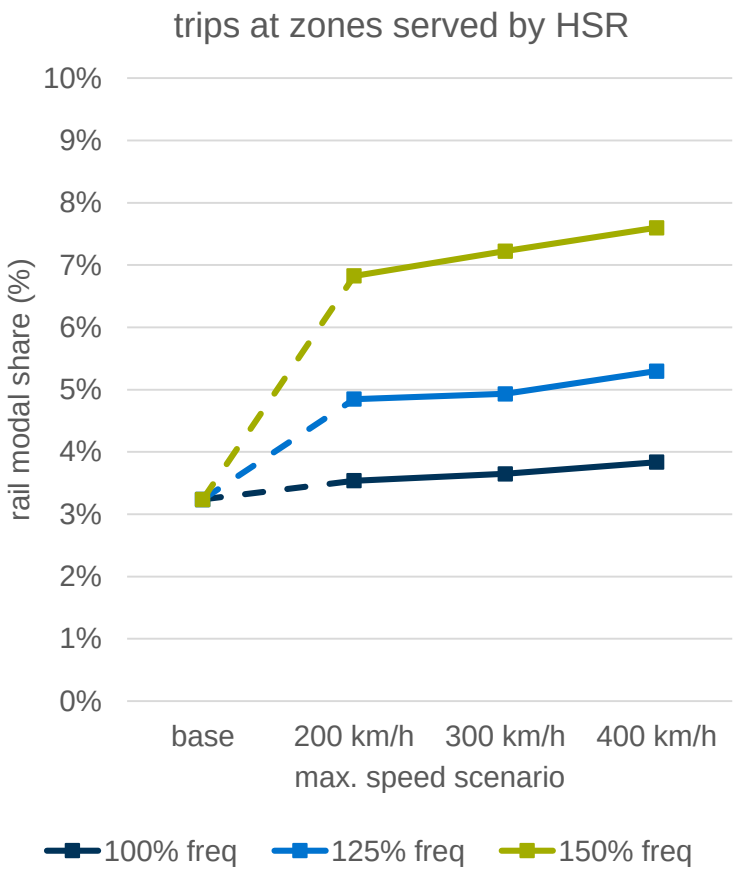
**planned by MTO maximum speed and commercial speed*

Model application

Results:

Modal share by travel time and frequency (without price change):

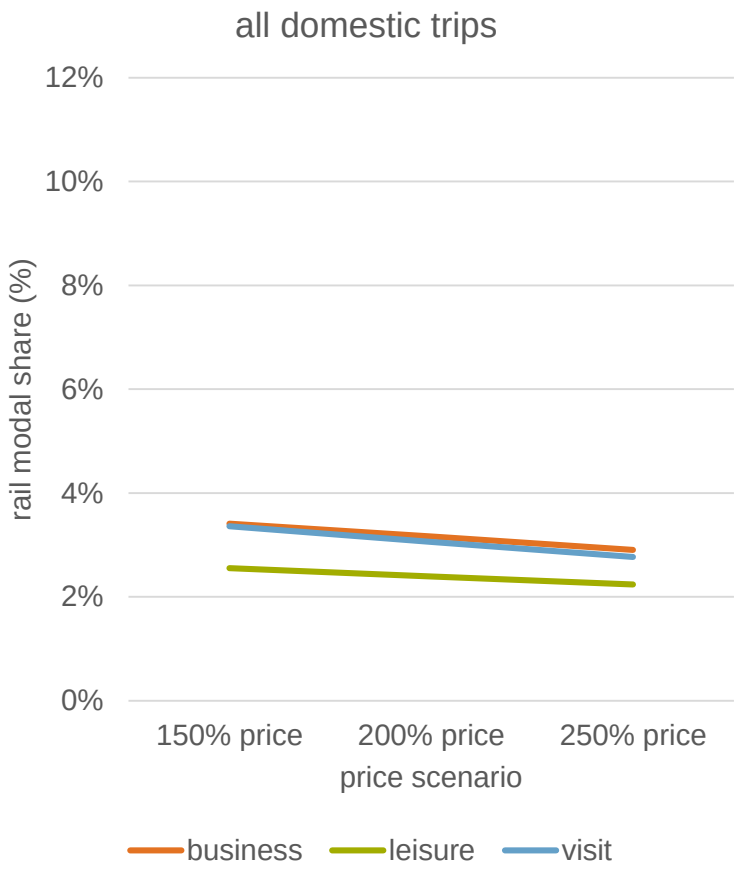


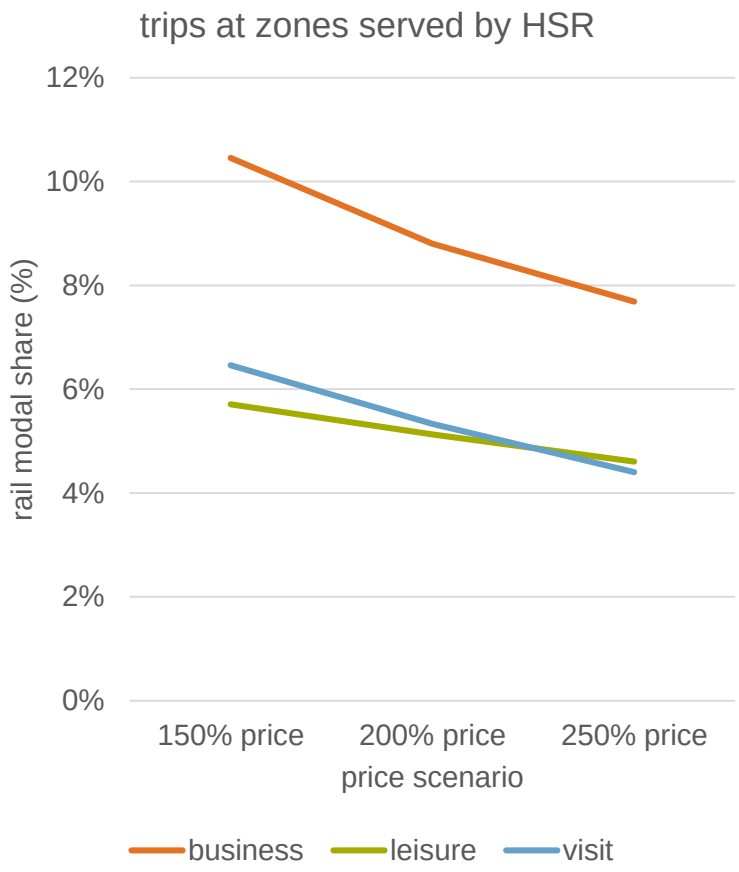


Model application

Results:

Modal share by travel cost and purpose (with max. speed = 400 km/h and frequency increases by 50%)





Discussion and conclusions

Methodological contributions:

- Usage of location-based social network data (Foursquare):
  - Pro: improved goodness of fit of destination choice models – especially leisure (+8% in LL)
  - Cons: prediction of such data in long-term estimations, bias
- Usage of trip-planning services (Rome2rio):
  - Pro: complete, quick and accessible, one single source, no assignment needed, close to users' decision criteria
  - Cons: congestion of modes cannot be directly considered – no assignment performed

Discussion and conclusions

Sensitivity analysis of HSR scenarios:

- Improvement of level of service of existing alternatives (vs. stated preference survey):
  - Complete substitution of rail supply instead of alternative train services
  - No further assumptions on mode perception → travel behavior remains as today
- Impacts are reasonable and seem plausible – but lack of validation:
  - Positive impacts of travel time reduction and increase of frequency
  - Negative impacts of increase in price
- Provincial model for a corridor-specific study:
  - Models are representative of the provincial demand –on average most of trips made by car
  - Suitable to delimitate the area of influence of the corridor measure – planning level

Acknowledgements

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