Method to decompose regional travel demand model - case study of Małopolska region

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Background

complexity of regional travel demand modeling - arising issues:

- non-uniform zone delimitation
  - communes, districts, provinces…
- wider analysis timeframe required
  - single peak-hour not sufficient
- **majority (~90%) of trips - short-distance travel**
- **underestimation risk of long-distance travel**
  - much higher share in terms of **person-kilometers travelled**
  - due to data aggregation, survey sample errors, different trip properties…

Motivation

how to improve the representation of regional travel demand model?

- disaggregate representation of 4-step demand model (FSM)
- stratification of short- and long-distance travel demand
  - distnct FSM formulae for each strata
- stratification of destination choice model:
  - demand satisfied either internally (within zone), if not – travel to another commune / county / city / metropolis

Method (1)

our proposal – a novel structure of 4-step demand model (FSM extension)

- regional travel demand decomposition

CLASSICAL FOUR-STEP DEMAND MODEL

- Trip generation
- Trip distribution
- Mode choice
- Assignment

Method (2)

REGIONAL FOUR-STEP DEMAND MODEL (EXTENSION)

Trip generation: expressed as a function of potential accessibility (Stepniak, Rosik 2013)

$$PA_o = \sum_{d \epsilon Z} \exp(-\alpha * c_{od}) * x_d$$

where:

α - parameter

c_{od} - travel costs from or to given zone

x - zone characteristic used to express its potential

Method (2)

REGIONAL FOUR-STEP DEMAND MODEL (EXTENSION)

Trip destination:

5 destination strata possible with 2-tier destination choice process:

- internal (within-zone) trips,
- **external trips: at the level of: commune / county / main city / central metropolis (Kraków)**

objectives: minimum travel cost + availability of trip purpose (supply) at destination

Method (2)

REGIONAL FOUR-STEP DEMAND MODEL (EXTENSION)

Strata-specific demand model:

- specific formulae at each FSM stage for each strata:

$$q_{od,p,s} = TD(\alpha_s, q_{o,p,s}, q_{d,p,s}, C_{od,p,s})$$

where:

α_s - parameter

$q_{o,p,s}$ - origin production

$q_{d,p,s}$ - destination attraction

$C_{od,p,s}$ - travel cost

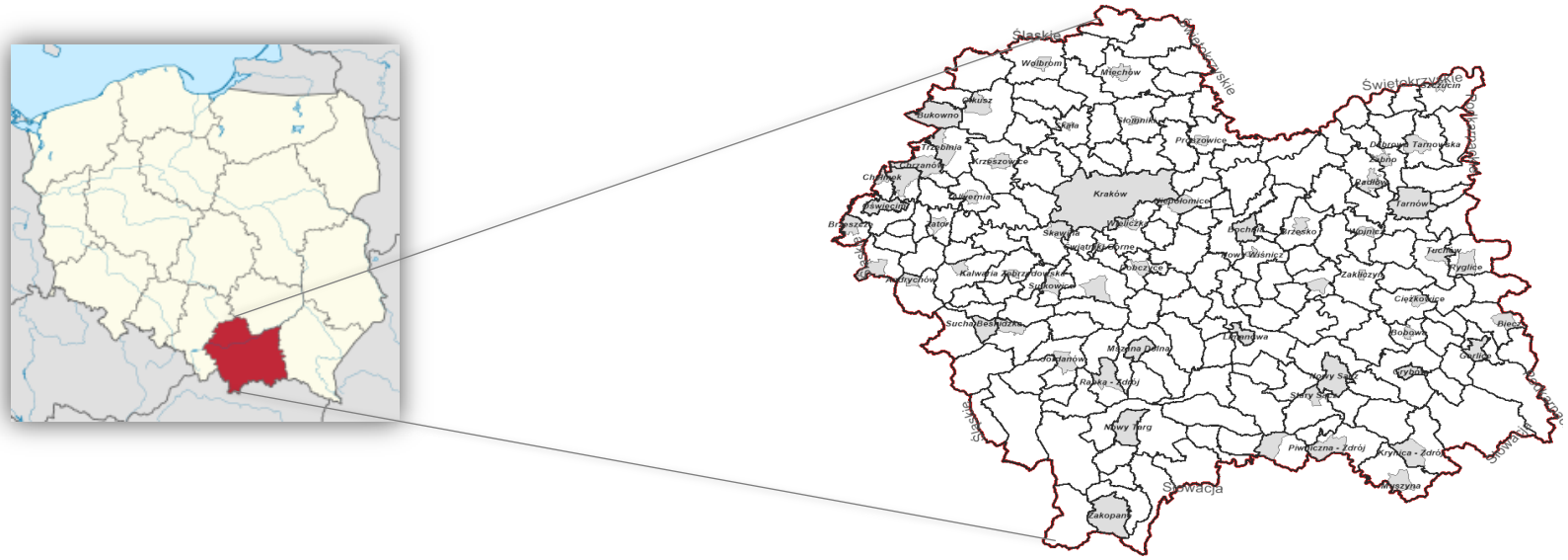
Objective

The proposed framework should fit better with actual travel behaviour

– 2 hypotheses formulated:

- **H1:** Estimated travel behaviour is significantly different in respective strata than estimated from aggregated data - in at least one of FSM steps of each stratum
- **H2:** The results of stratified model allow to better reproduce the observed behaviour, especially in the regional context

Case study - Małopolska Region



- Southern Poland region
- Population: ca. 3.1m inhabitants
- Total area ca. 15 182 sq. km

Case study - Małopolska Region

- Zone delimitation at the commune-level - **in total, 366 zones**

Destination strata:

- central <u>metropolis</u>: Kraków (760k)
- 2 <u>main cities</u>: Tarnów (110k), Nowy Sącz (80k)
- 19 <u>provinces</u>
- 182 <u>communes</u>

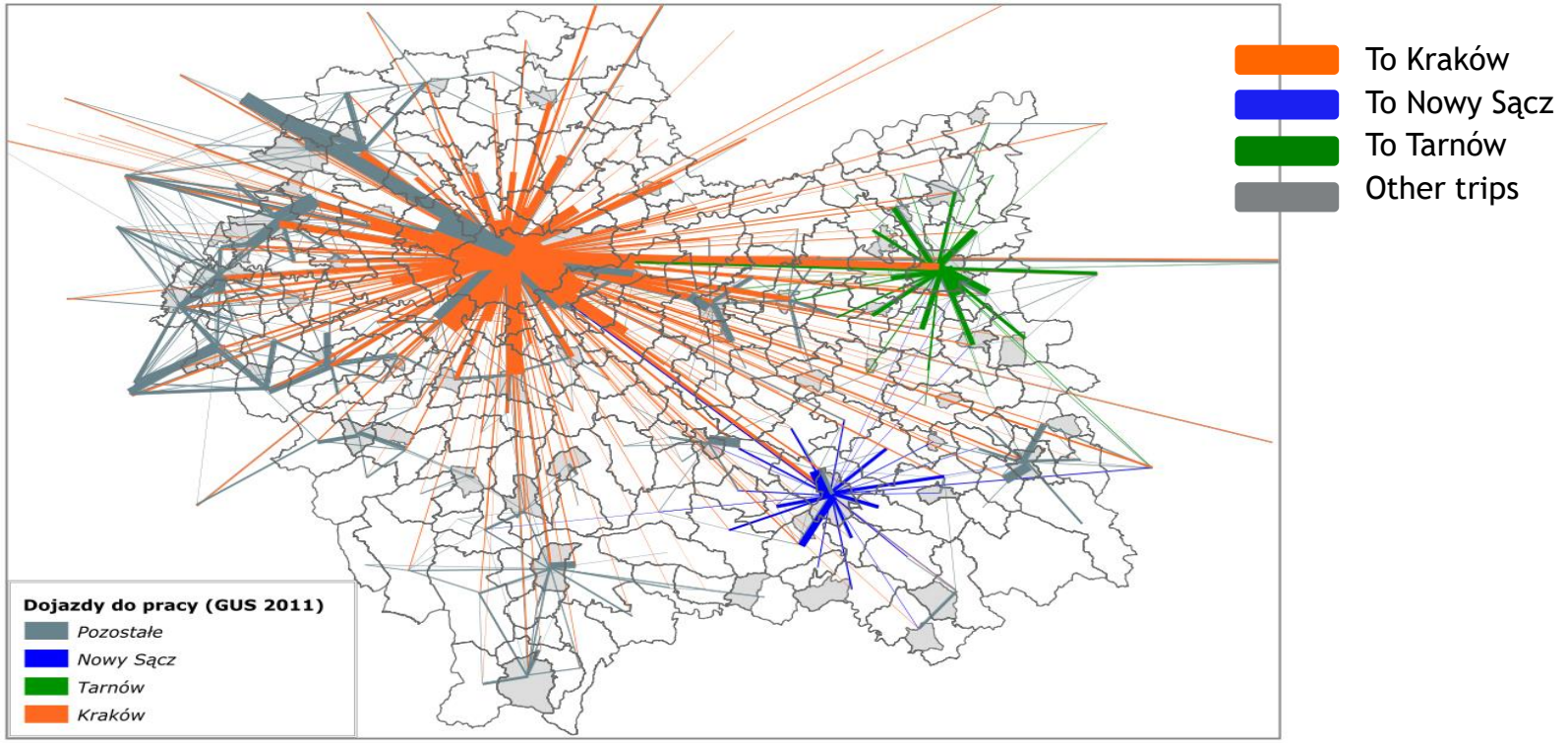
Input survey data

2012 travel survey in Małopolska region:

- Sample size: > 11k respondents over 12 years
- More than 18k observed trips per working day
- Over 90% of surveyed regional travel demand are short-distance trips
- Ca. 60% of these are inner-commune (i.e. within-zone) trips

Results (1)

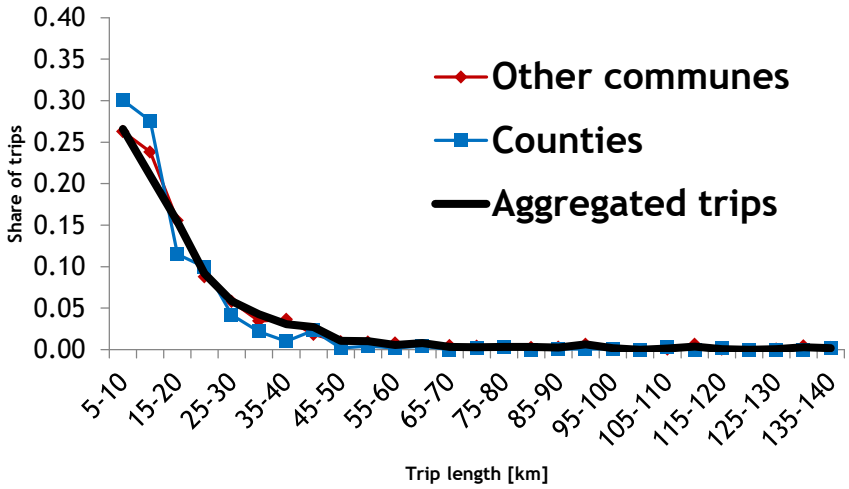
Commuter trip patterns in Małopolska:

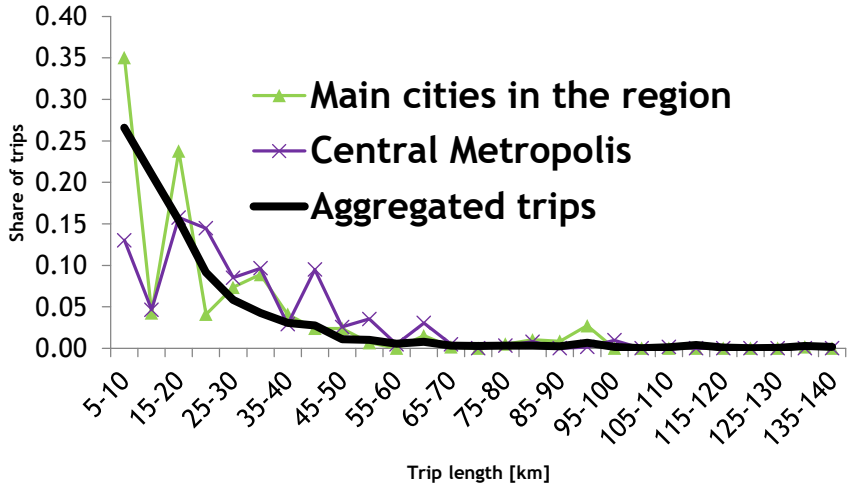


based on 2011 National Census Data
(*Central Statistical Office of Poland – stat.gov.pl*)

Results (2)

Trip length distribution:

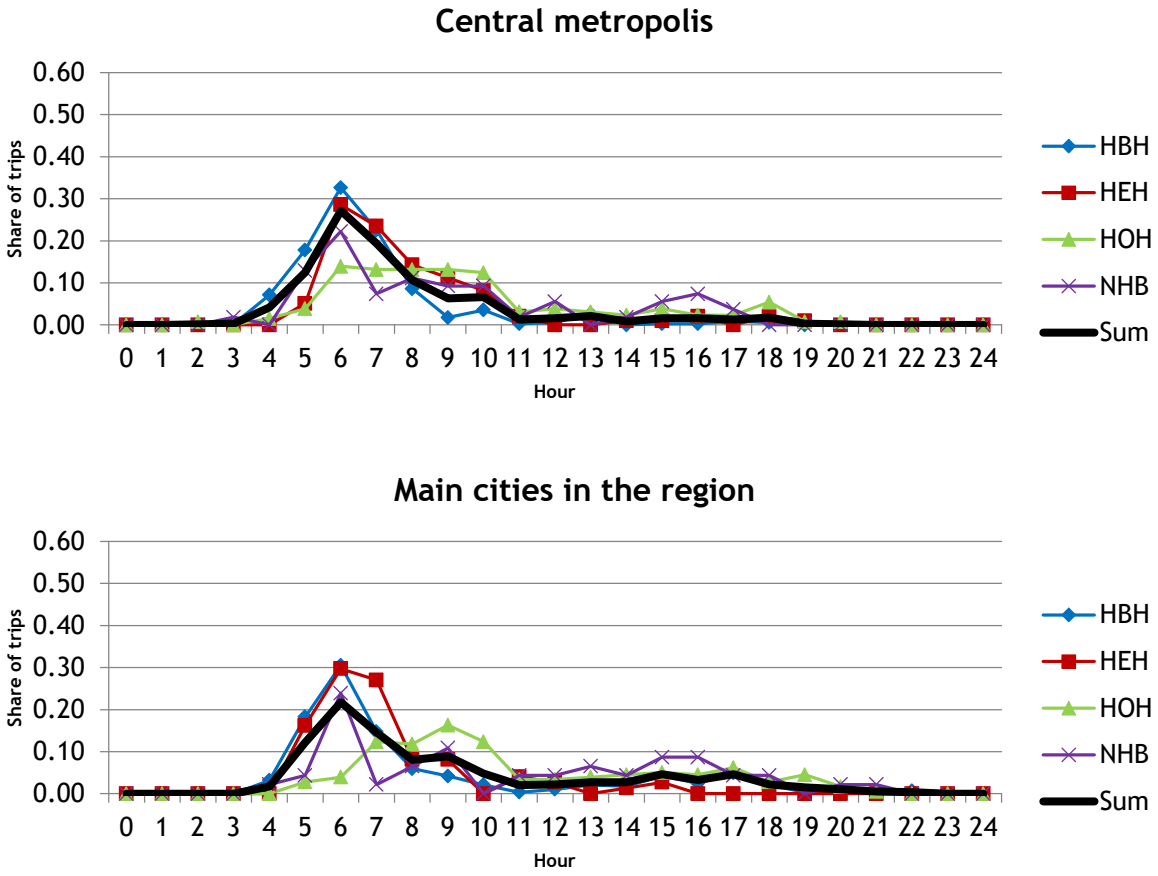




- Trip length distribution significantly varies between demand strata
- **(H1) Disaggregate model reproduces distinct clear-cut travel behaviour patterns for each respective demand strata**
  - especially for city- and metropolis-bound trips

Results (3)

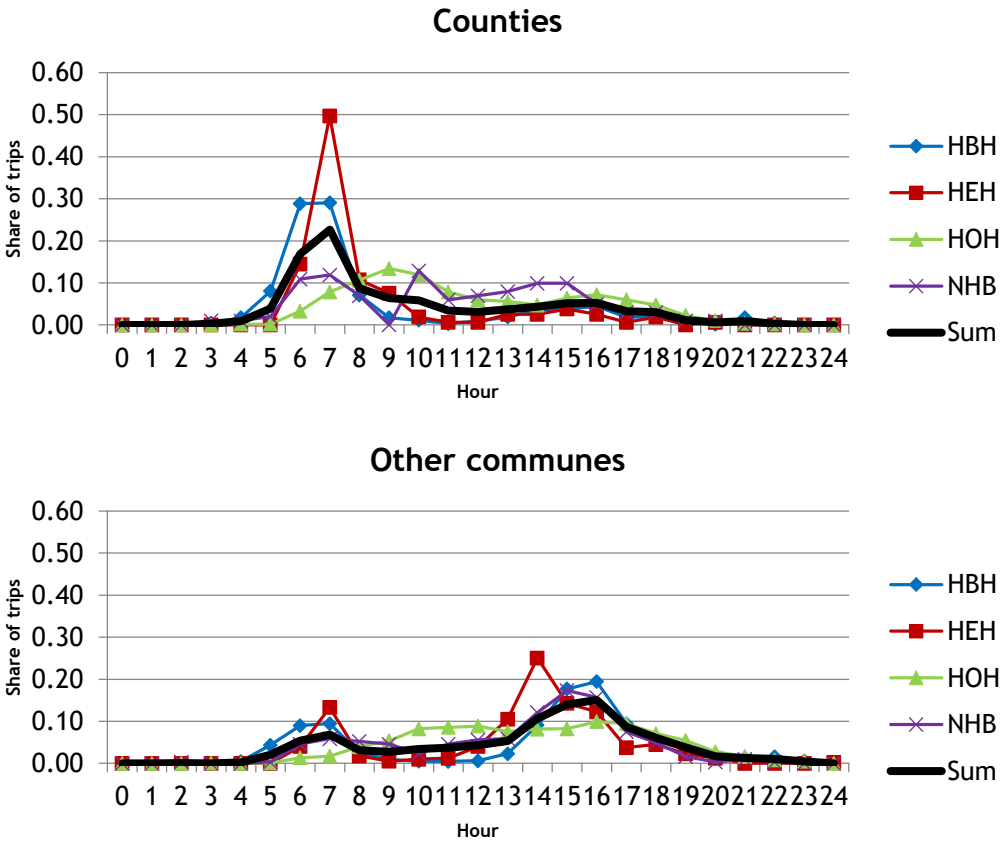
Temporal daily trip distribution:



HB home-based trips:
HBH - work
HEH – education
HOH – other
NHB - non-home-based

Results (4)

Temporal daily trip distribution:



- substantial differences in distribution and peak patterns for each strata
  - morning peak pronounced for long-distance trips
  - distribution of short-distance trips tends to be relatively more uniform
- **(H2) stratified demand model would provide better estimation of actual peak hour share**

R&D project „Intermodal trip models”

- main goals
  - national and regional models development standards
  - example national and regional models
  - procedure of data exchange between models
  - data collection and storage methods

intermodalne
modele
podróży

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GDDKiA

Summary

- The proposed decomposition method aims to reproduce the actual regional travel demand flows with higher reliability and accuracy
- Stratification of demand model at all stages of FSM exposes substantial differences in short- vs. long-distance trips
- FSM extension allows to improve the model fit with actual travel behaviour and match the observed survey data

Thank you for your attention!

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