Investigating field effects on empirical countrywide data from Germany

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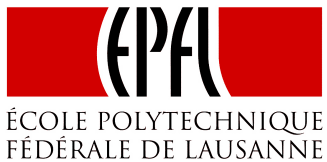

Outline

- Research idea
- German regional data
- Background information empirical data
- Mode choice games in detail
- Implementing field effects
- Future work and tasks

Research idea

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Research idea

- European national norms and regulations often use standardized values of time and thereby standardized mode and route choice models (e.g. Axhausen et al. 2015)
- approach ignores regional differences in behavior, income and purchase power which all can influence an individual's value of time
- significant differences could lead to misallocation of (Federal) investments
- German VOT data allows empirical investigation of regional differences
- individual decisions are influenced by other individuals
- *field effects* try to capture social influences on decision makers in behavioral models

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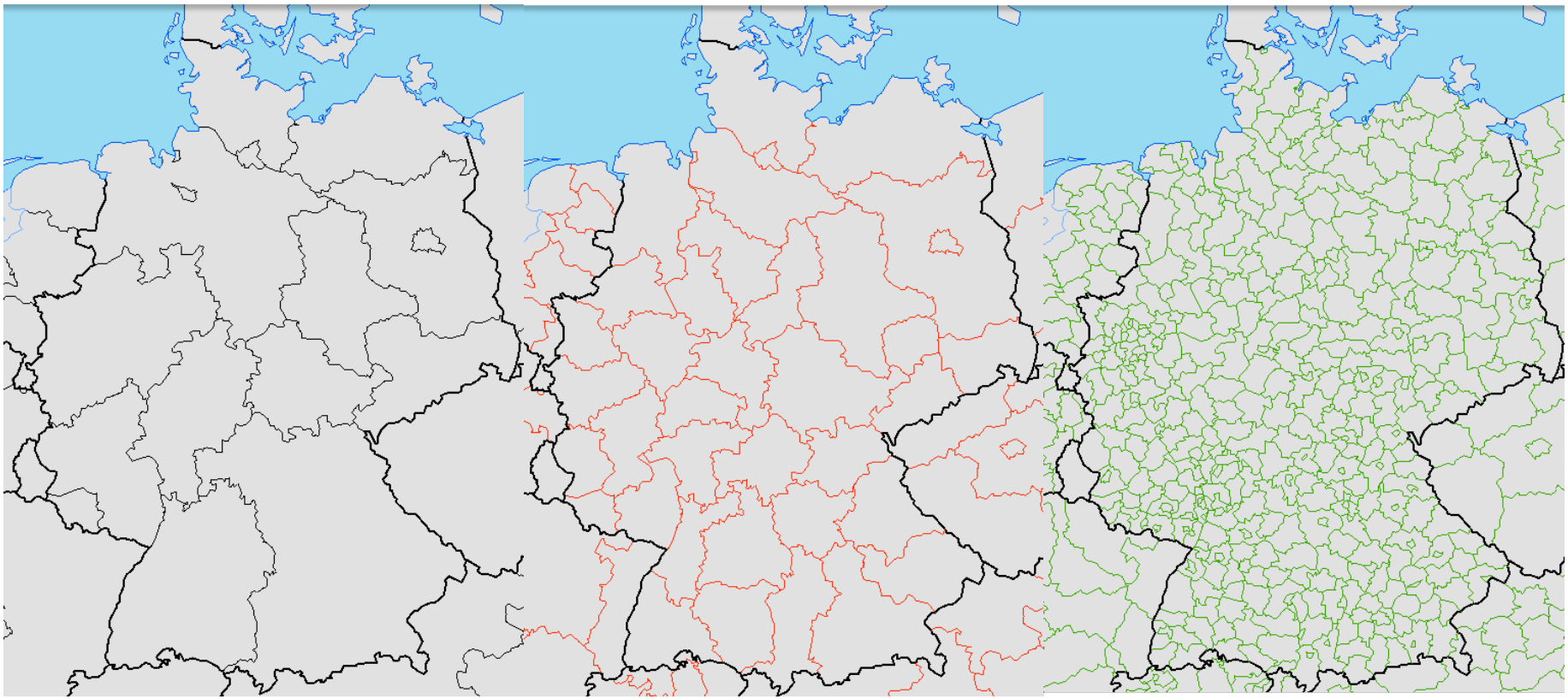
NUTS regions Germany

Source: destatis.de

- Nomenclature des Units territoriales statistiques
- division of territory of the EU into hierarchical levels (0-3)
- NUTS regions Germany (NUTS 0 = DE)
  - NUTS 1 regions correspond to 16 Federal States (Bundeslaender)
  - NUTS 2 regions correspond to 38 governmental regions (Regierungsbezirke)
  - NUTS 3 regions correspond to 402 districts (Kreise and kreisfreie Staedte)
- data privacy in German VOT study permits Kreise and kreisefreie Staedte as lowest aggregation level
- Eurostat provides GDP and income data also on NUTS 3 level

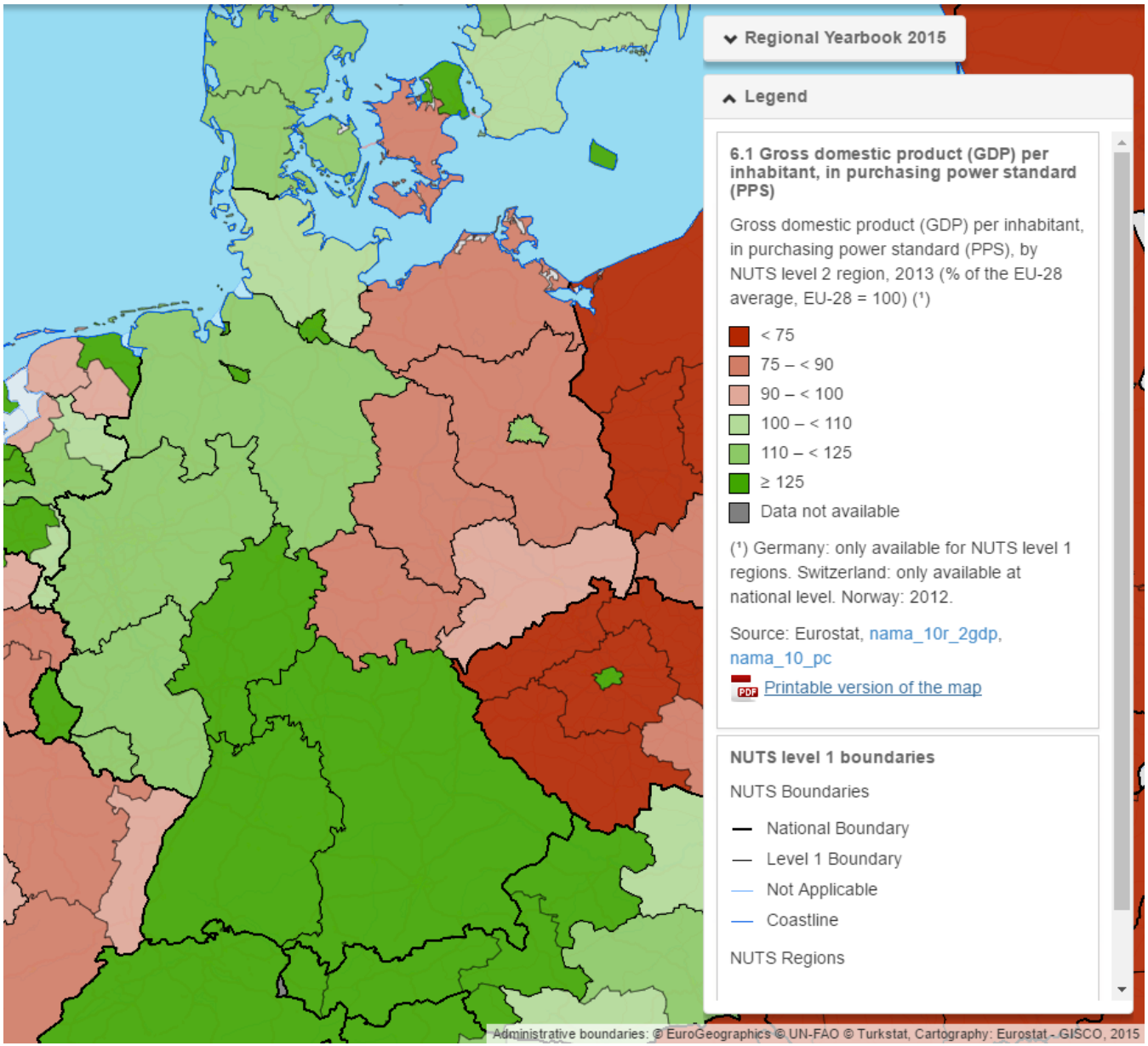
NUTS levels Germany



NUTS 1 NUTS 2 NUTS 3

Source: Eurostat - GISCO

Example: German GDP NUTS 1 level



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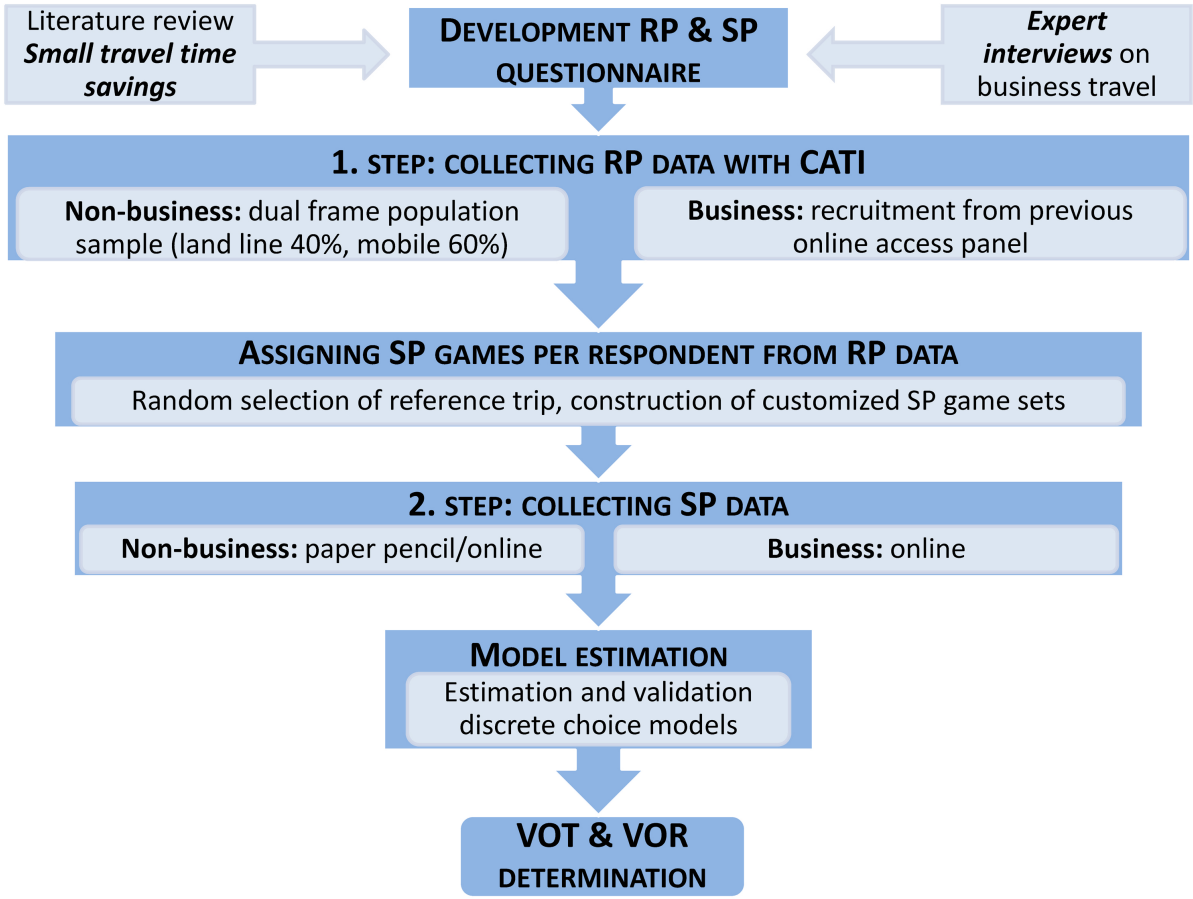
Background information German VOT and VOR study

- Commissioned by the German Federal Ministry of Transport and Digital Infrastructure (BMVI)
- Federal Transport Investment Plan 2015
  - Update of the overall methodology of the CBA
  - Values of Time (VOT) and Values of Reliability (VOR)
- Realisation by TNS Infratest and ETH Zurich
- Data collection
  - January 2012 – January 2013
  - Combined RP/SP survey
  - Business and non-business sample
  - representative sample (weighted)

Data collection process of the study



Types of questionnaires

trip	reported mode	mode choice	route choice	reliability	long term	#
average	walk	walk/put/mpt	--	--	workplace	1
	walk	walk/put/mpt	--	--	residential	2
	bike	bike/put/mpt	--	--	residential	3
	bike	bike/put/mpt	--	--	workplace	4
	put	bike/put/mpt	--	put 1	workplace	5
	put	--	put	put 2	residential	6
	mpt	walk/put/mpt	--	mpt 1	residential	7
	mpt	--	mpt	mpt 2	workplace	8
journey	put	bus/put/mpt	--	put 3	workplace	9
	put	--	put	put 1	residential	10
	mpt	bus/put/mpt	--	mpt 3	residential	11
	mpt	--	mpt	mpt 1	workplace	12
	put	put/mpt/plane	--	put 2	workplace	13
	put	--	put	put 3	residential	14
	mpt	put/mpt/plane	--	mpt 2	residential	15
	mpt	--	mpt	mpt 3	workplace	16
	plane	put/mpt/plane	--	plane 1	workplace	17
	plane	put/mpt/plane	--	plane 2	residential	18

Response

	Non-business	Business
Contacts	9,491	1,112
Completed computer assisted telephone interview (CATI)	3,151	848
Indicated willingness to participate written SC experiments	2,965	-
Indicated willingness to participate online SC experiments	186	848
Completed written SC experiments	2,187	-
Completed online SC experiments	98	786

- over 15,700 mode choice games (SP1)
- over 30,000 route choice games (SP2 9,000 & SP3 21,000)
- over 9,500 workplace choice games (SP4)
- over 8,500 residential choice games (SP5)

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Attributes mode choice experiments

- walk: walking time (min)
- bike: cycling time (min)
- flight & public transport (bus, tram, train, long distance bus):
  - travel time (min): overall, in-vehicle, waiting, access & egress
  - travel cost (EUR): per trip, per month (# trips per month * 2)
  - number of transfers
  - headway
  - share of delayed trips
- motorized private transport:
  - travel time (min): overall, in-vehicle, congestion, access & egress
  - travel cost (EUR): per trip, per month (# trips per month * 2)
  - share of delayed trips

Example mode choice questionnaire

Bike		
Travel time	0:38	h

Public transport		
Travel time	0:27	h
thereof		
In-vehicle time	0:15	h
Waiting time	0:06	h
Access time	0:06	h
Change(s)	1	time(s)
Costs	2,10	€
(17€/month for 4 trips)		
Every	10	min
Share delayed	20	%

Car		
Travel time	0:19	h
thereof		
In-vehicle time	0:13	h
Time in congestion	0:03	h
Access time	0:03	h
Costs	1,70	€
(14€/month for 4 trips)		
Share delayed	5	%

Choice: ☐ ☐ ☐

Utility function German VOT study (travel time & cost)

$$U_i = \Sigma_j ... (\beta_{i,j} * x_{i,j} + \alpha_{i,j} * \ln(x_{i,j} + \gamma_{i,j})) * \left(\frac{z_j}{\mu(z_j)} \right)^{\lambda_{ijz_j}} ...$$

U_i Utility of the alternative $i = 1, ..., n$
x_{ij} attribute j of alternative i
$(\beta, \alpha, \gamma)_{ij}$ parameters associated with $x_{i,j}$
$\lambda_{i,j,z_{i,j}}$ elasticity of the sensitivity to j for i with respect to z_j
$\mu(z_j)$ mean of z_j

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Dugundji and Walker (2005), Walker et al. (2011)

- exact members of social network are unknown
- field effect varibale to capture social influences by share of decision makers within a defined reference peer group (income class and postal code) that choose a particular alternative
- incorporating field effect

$$U(ij) = V(x_{ij}, s_j, \beta) + \gamma F_{ij} + \epsilon_{ij}$$

- unobserved effects influence field effect and are captured in the error term
- field effect and error term may be correlated and the field effect an endogenous variable
- upward bias of field effect parameter
- difficult to define

Correcting for endogenity (Berry, Levinsohn and Pales (2004), Walker et al. (2011))

- decompose error in 2 parts (endogenous and random) and isolate endogenous-causing components

$$U(ij) = [\gamma F_{ij} + \ddot{\epsilon}_{ij}] + V(x_{ij}, s_j, \beta) + \dot{\epsilon}_{ij}$$

- replace the peer group effect with a market specific constant (endogenity occurs at a market level)

$$U(ij) = \alpha_{im} + V(x_{ij_m}, s_{j_m}, \beta) + \dot{\epsilon}_{ij_m}$$

with

$$\alpha_{im} = [\gamma F_{im} + \ddot{\epsilon}_{im}]$$

- last include instrumental variable (correlated with endogenous variable and uncorrelated with the error) in two stage approach (first as explanatory variable for field effect, second as regression of fitted values from field effect from first step on market-specific constant)

Application on German VOT data

- remove income interaction in utility function
- 3 field effect variables
  - social reference group: income class
  - spatial reference group 1: NUTS 3 region
  - spatial reference group 2: German BIK_10 region (population density measure)
- share index of chosen alternative within peer group between -1 and 1 (representing 0 and 100 %)
- simple utility function: ASC, travel time, generic cost coefficient and field effect (probability of choosing a mode with respect to the share of choosing the mode in the peer group)
- preliminary result show highly significant positive field effect estimate of 1.4081 (robust t-value: 12.45) and a significant improvement of the LL from -11151.46 to -10764.27 with 1 DF

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Future work and tasks field effects

- include constants of all 3 NUTS levels (or at least on NUTS 1 and 2) and correct for endogeneity
- determine instrumental variables
- include GDP data and modal split on NUTS 3 level (MiD 2008) as reference groups (not SP data)
- control correlation (e.g. income interaction official utility function)
- implement field effect in long term experiments (workplace and residential choice)
- do field effects make sense in our route choice SPs?
- definition unobserved effect vs. field effect
- include purchase power (percentiles)
- investigate other regional differences

Thank you very much!
Questions?