Estimating bid-auction models of residential location using census data with imputed household income

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DLR

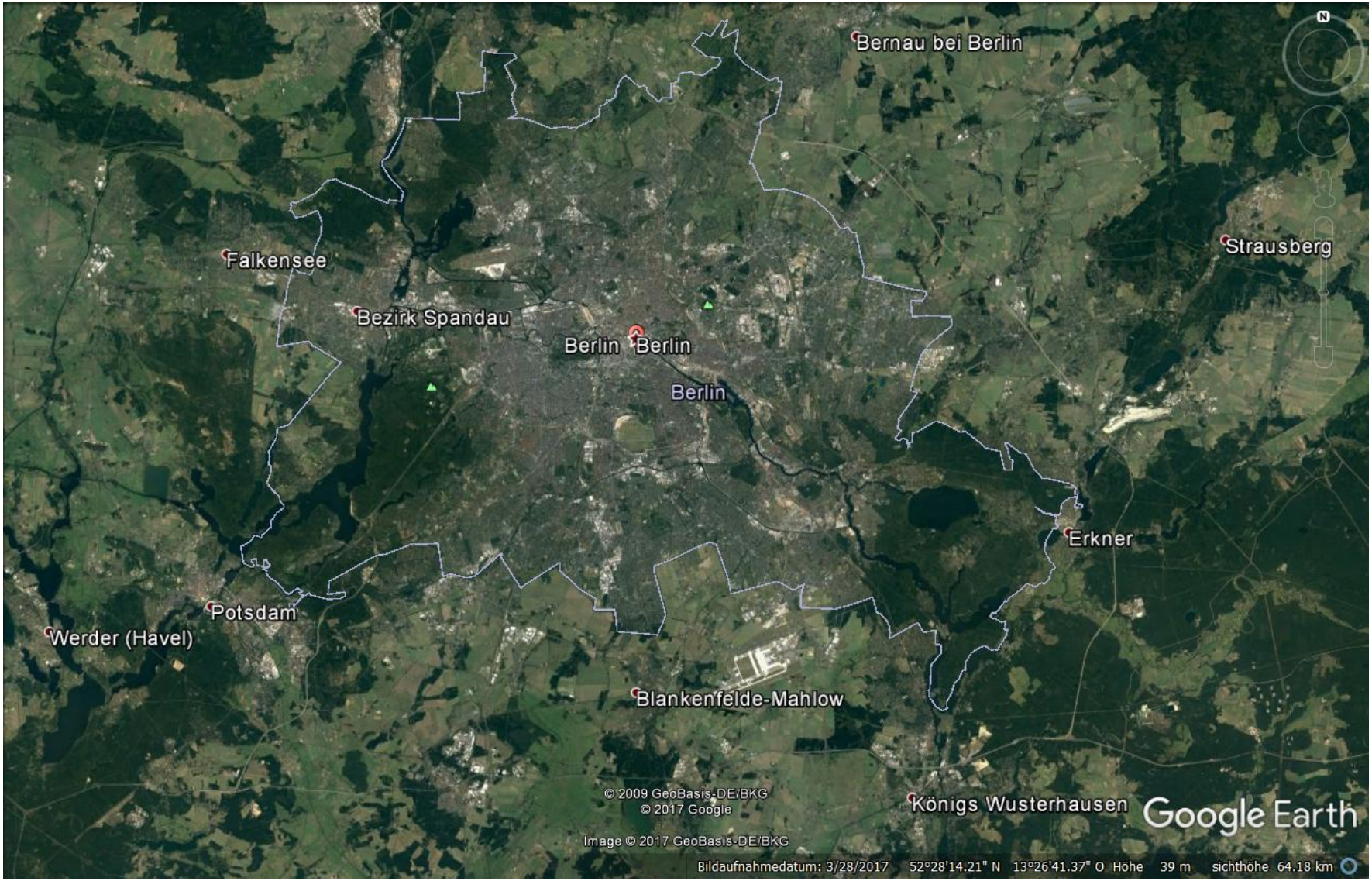
Bernau bei Berlin
Falkensee
Strausberg
Bezirk Spandau
Berlin
Berlin
Berlin
Erkner
Potsdam
Werder (Havel)
Blankenfelde-Mahlow
Königs Wusterhausen
© 2009 GeoBasis-DE/BKG
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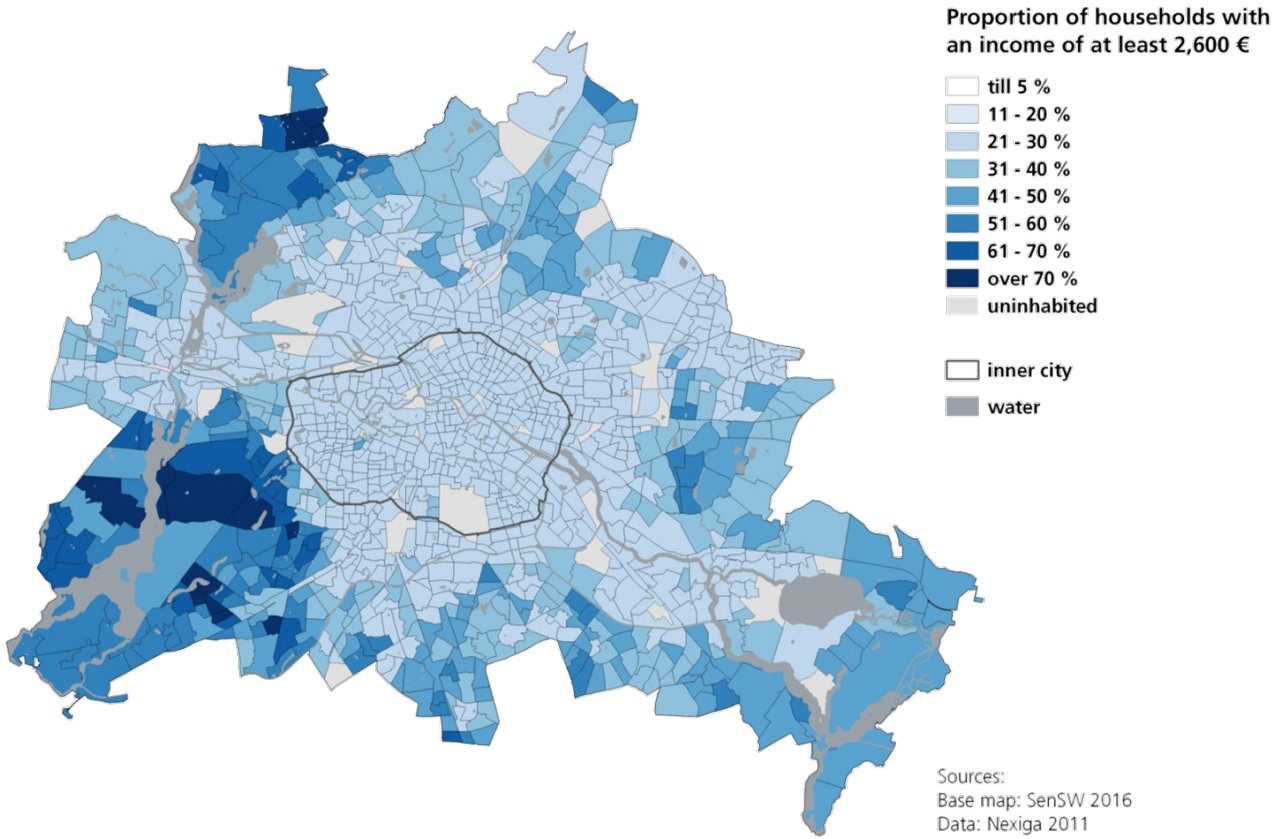
Image © 2017 GeoBasis-DE/BKG
Google Earth
Bildaufnahmedatum: 3/28/2017 52°28'14.21" N 13°26'41.37" O Höhe 39 m sichthöhe 64.18 km

DLR

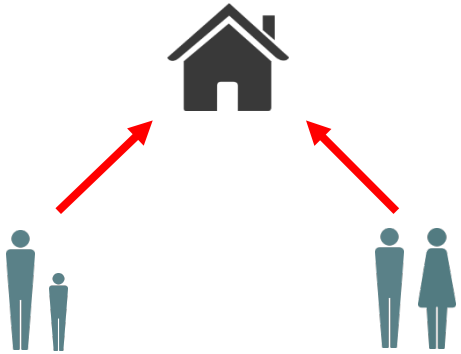
Income determines residential location choice

Which locations can a household afford?
Income influences preferences and life style
Which mobility resources do they have?



Different types of location choice models

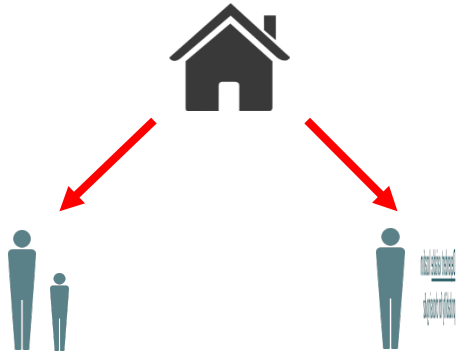
Utility-based models:
Households choose locations that maximise their utility (McFadden 1978)



$$P_{(dz|h)} = \frac{\exp(V_{hdz})}{\sum_{dz} \exp(V_{hdz})}$$

Dependent variable: location probability for choosing ***dz***

Bid-auction - based models:
Owners of locations choose households with highest bid (Alonso 1964, Martínez 1992)



$$P_{(h|dz)} = \frac{H_h \exp(\mu B_{hdz})}{\sum_g H_g \exp(\mu B_{gdz})}$$

Dependent variable: location probability for choosing (tenant) ***h***

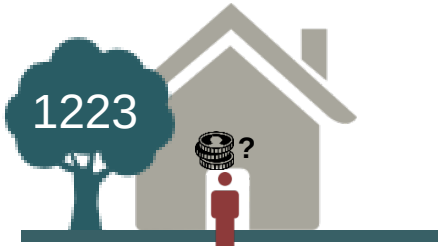
h, g	Household type
d	Dwelling type
z	Zone
B	Bid function
H	Number of househ.
V	Utility

The need for imputing data
(when modeling residential location)

Bid function (linear in parameters)

$$B_{hdz} = f(x_{household}, x_{dwelling}, x_{zones}, x_{accessibility})$$

Zensus 2011



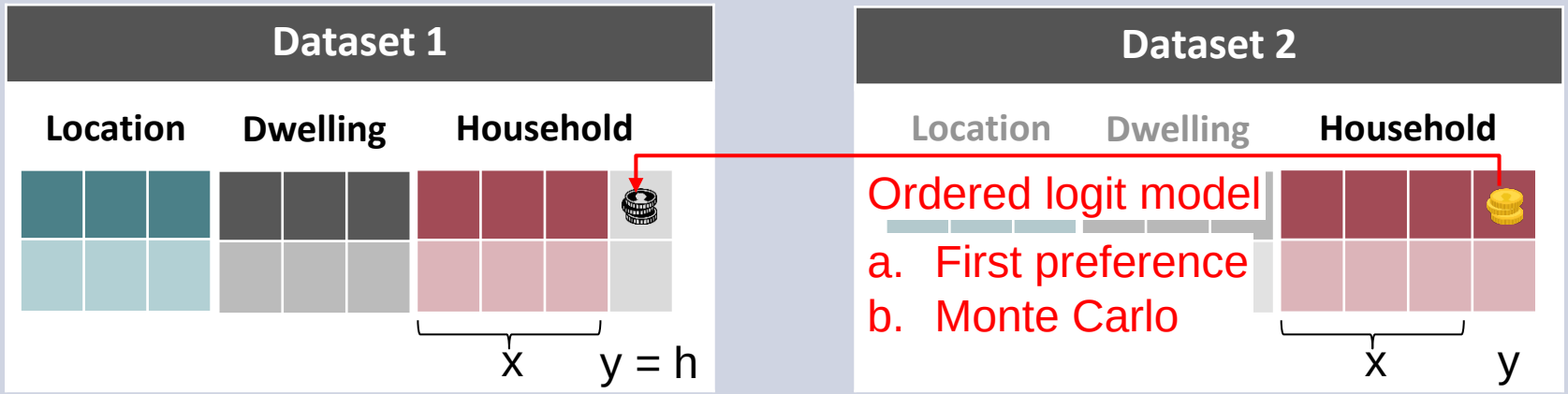
1.800.000 households
Location attributes
No household income

Mikrozensus 2010

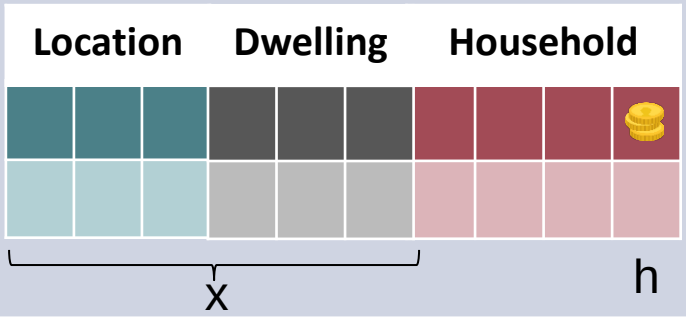
15.000 households
Household income class

Combined imputation and estimation
General methodology

Step 1: Imputation model



Step 2: Estimation of bid function parameters



Multinomial logit model

$$\longrightarrow \quad B_{hdz} = f(x_{household}, x_{dwelling}, x_{zones}, x_{access})$$

a. First preference
b. Monte Carlo

Case study Berlin Step1: Income imputation model

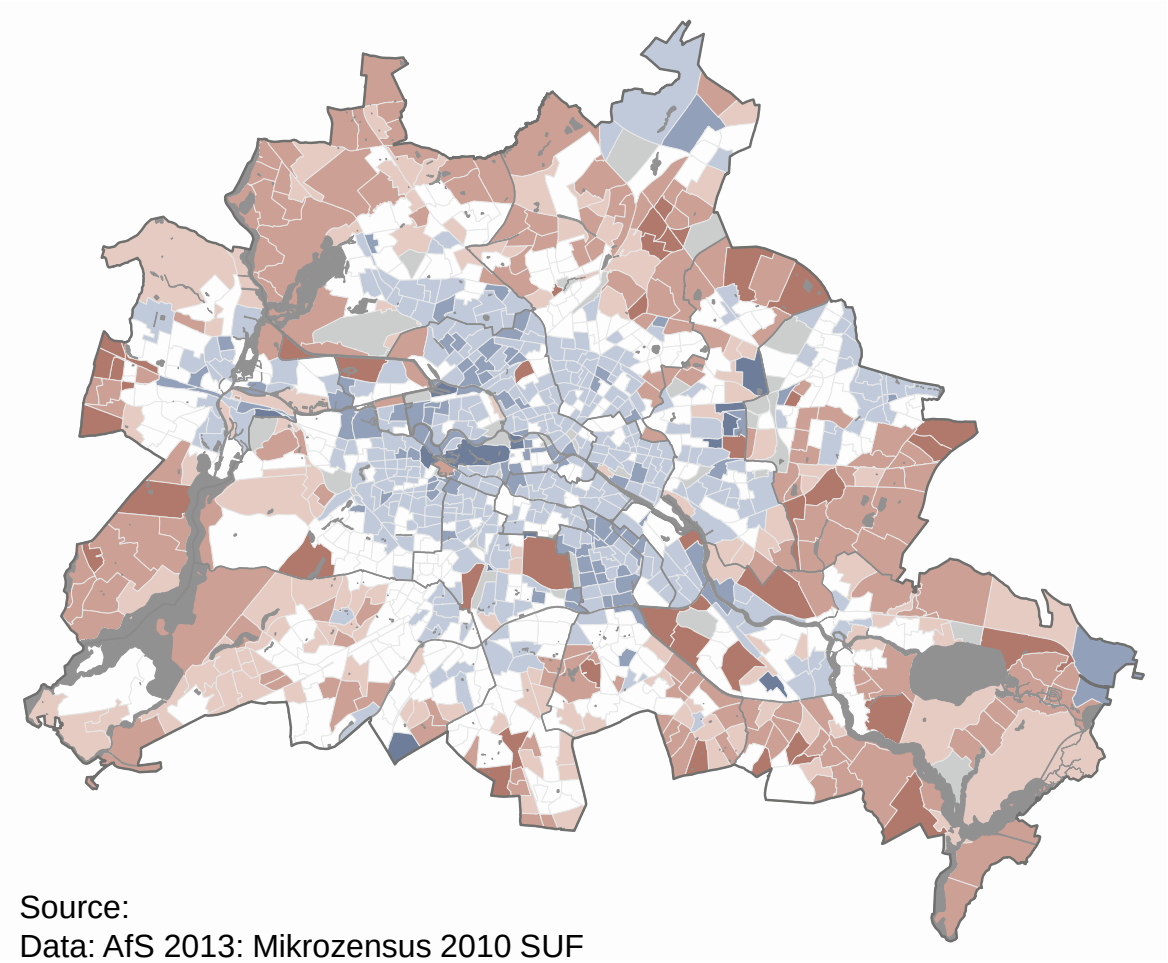
Variable		β
Thresholds for four income classes below 900 € 900 to below 1,500 € 1,500 to below 2,600 € 2,600 € and above	1	-0.631*
	2	-2.704*
	3	-5.089*
Household representative is employed in industry group …	1 (e.g. administration, services)	0.651*
	2 (e.g. retail, construction, health)	1.190*
	3 (e.g. manufacturing, education, arts)	1.960*
	4 (e.g. ITC, science, public services)	2.366*
	5 (e.g. finance and insurance, electricity)	2.998*
Household is single-person household		-0.723*
Household representative has migration background		-0.837*
Number of household members:	below the age of 18	0.438*
	18 until 30	0.867*
	31 until 50	1.820*
	51 until 64	1.835*
	65 and above	2.363*

Log-likelihood at convergence *-15,473*

Log-likelihood at zero *-20,465*

* p < 0.001

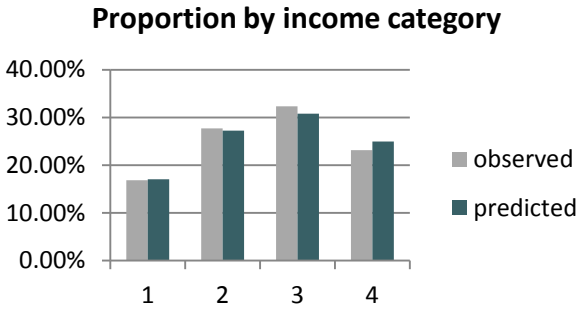
Case study Berlin Step1: Income imputation model



Proportion of households with at least 2,600 net household income € by zone

Standardised values

- less than −1.96
- −1.96 to less than −0.98
- −0.98 to less than −0.49
- −0.49 to less than 0.49
- 0.49 to less than 0.98
- 0.98 to less than 1.96
- 1.96 and higher
- Missing



Source:
Data: AfS 2013: Mikrozensus 2010 SUF
Geodata: SenSW Berlin 2016

Case study Berlin Step 2: Bid functions

Attribute	First preference imputation				Monte Carlo imputation			
Income category	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Constant	0	-0.883*	-3.21*	-5.7*	0	0.0797*	-0.74*	-2.57*
Dwelling size * is multi-family house	0	0.0164*	0.044*	0.0602*	0	0.00565*	0.0151*	0.0257*
Is single-family house	0	1.89*	4.35*	6.25*	0	0.611*	1.59*	2.9*
Proportion of high income hh.	0	3.7*	4.26*	6.03*	0	1*	1.97*	3.1*
Travel time to center	0	0.245*	0.317*	0.388*	0	0.0579*	0.115*	0.143*

Log-Likelihood at 0	-24,833	-24,833	* p < 0.001
Log-Likelihood	-20,671	-22,966	

Conclusions

- Low cost way to deal with missing data (as compared to new survey)
- Ability to determine significant location characteristics
- Probabilistic model considers error term

- Statistical explanation power limited due to increasing error with each step

- Improvement of the approach by:
  - Simultaneous estimation
  - More computatively effective methods (than Monte Carlo)
  - Increase sample size → determine more significant attributes

- Need for research data lobbying

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Data

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Thank you

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