Preferred citation style for this presentation

Axhausen, K.W. (2012) Flächennutzungs- und Verkehrsmodelle: Stand und weitere Entwicklung (am Beispiel Zürich), presentation at the Wegener Zentrum für Klima und Globalen Wandel, Universität Graz, Juni 2012.

Flächennutzungs- und Verkehrsmodelle: Stand und weitere Entwicklung (am Beispiel Zürich)

KW Axhausen

June 2012

IVT Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Acknowledgements: Land use modelling

Collaborators:

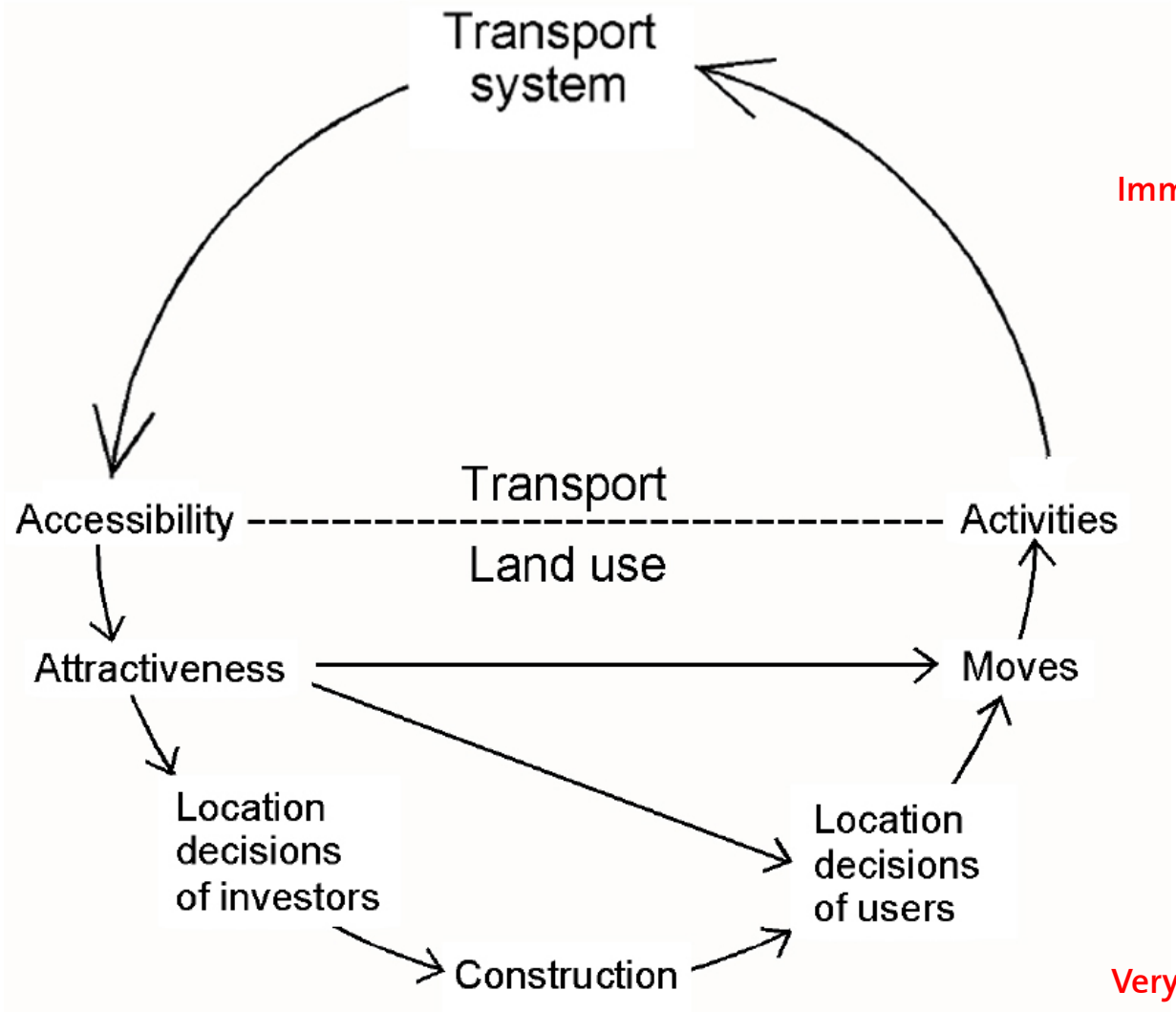
SustainCity	Balz Bodenmann, Kirill Müller, Patrick Schirmer, Christoph Zöllig
Singapore	Manual Lehner, Michael Van Eggermond

Sponsors:

EU 7th Framework Programme,
Singapore NRF,
Swiss Federal Office of Spatial Planning (ARE)
Swiss SNF

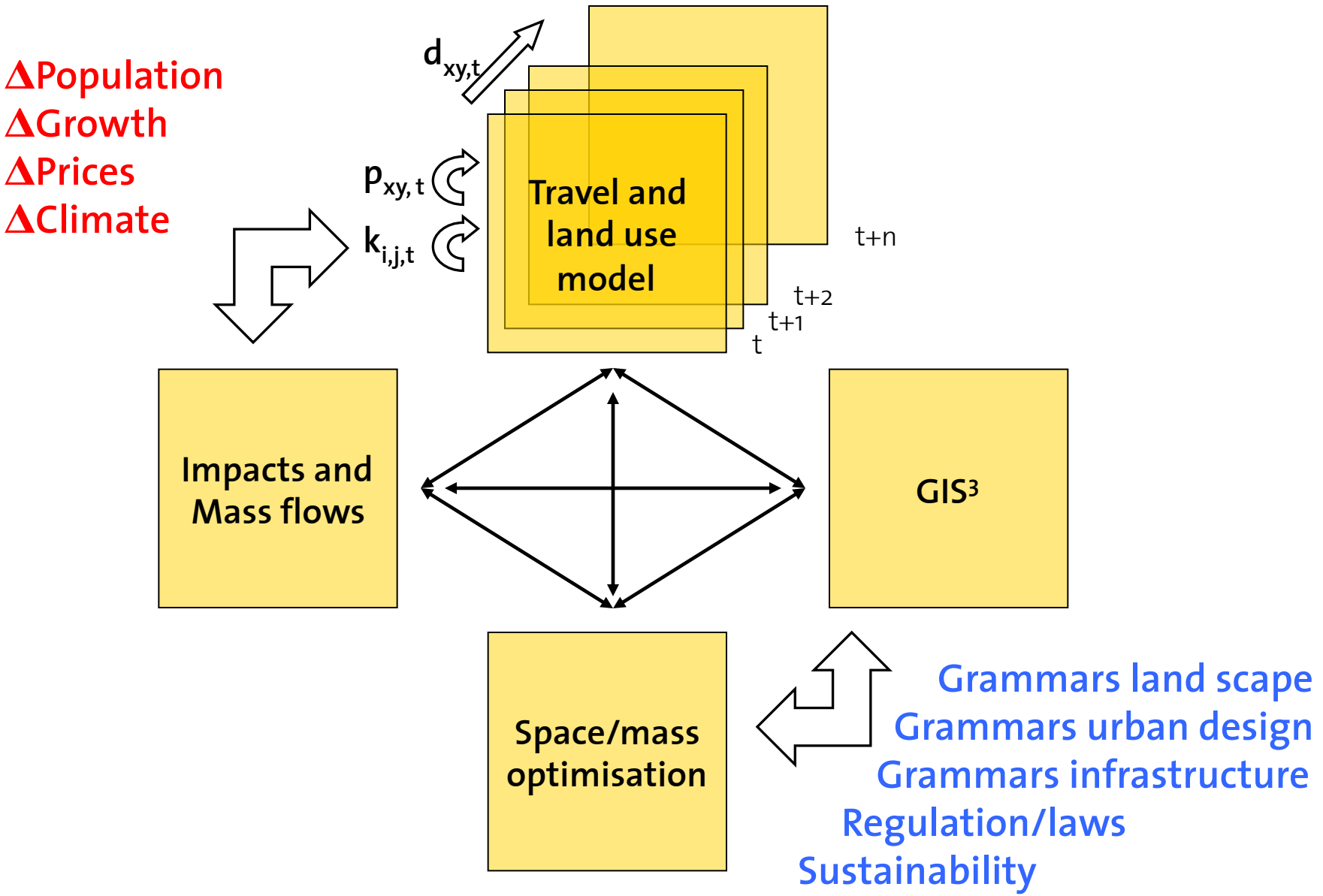
Baden now and then

Framework



Adapted from Wegener and Fuerst, 1999

Integration of land use (optimisation)



Land use models

Model types

Scale:

- macro (regional production functions; governmental units; years):
- micro (agent-based decision processes; parcels; seconds/days)

Structure:

- Unitary
- Modul-based

Equilibrium:

- In each period
- With delay

Travel demand model

- Integrated
- External and seperate model

Established examples

I/O table – derived; equilibrium

- MEPLAN
- TRANUS

Market clearing equlibrium; choice models

- MUSSA
- Alexander Anas

Incremental; choice models

- DELTA
- UrbanSim
- Tigris XL

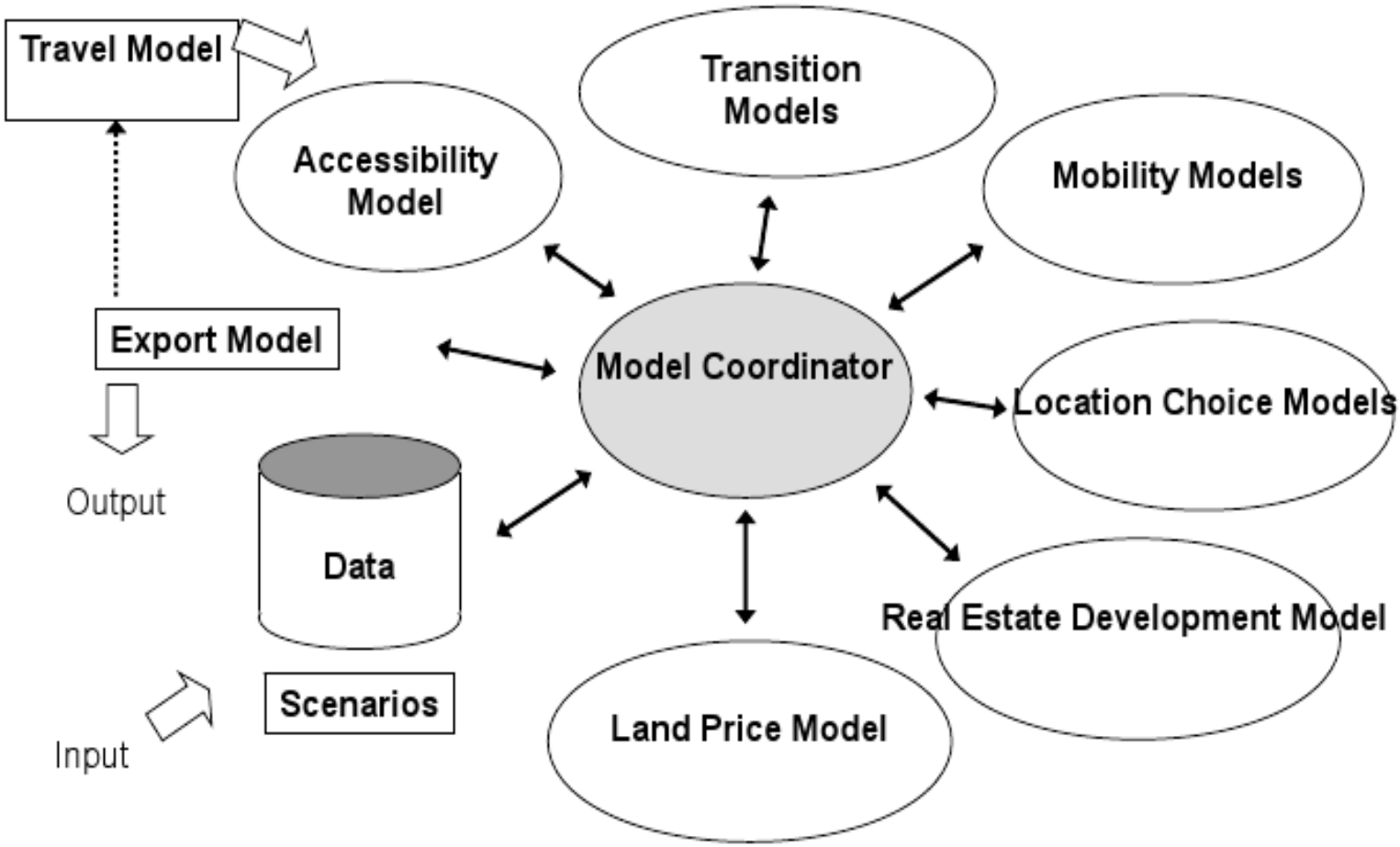
UrbanSim

- Agent-based approach

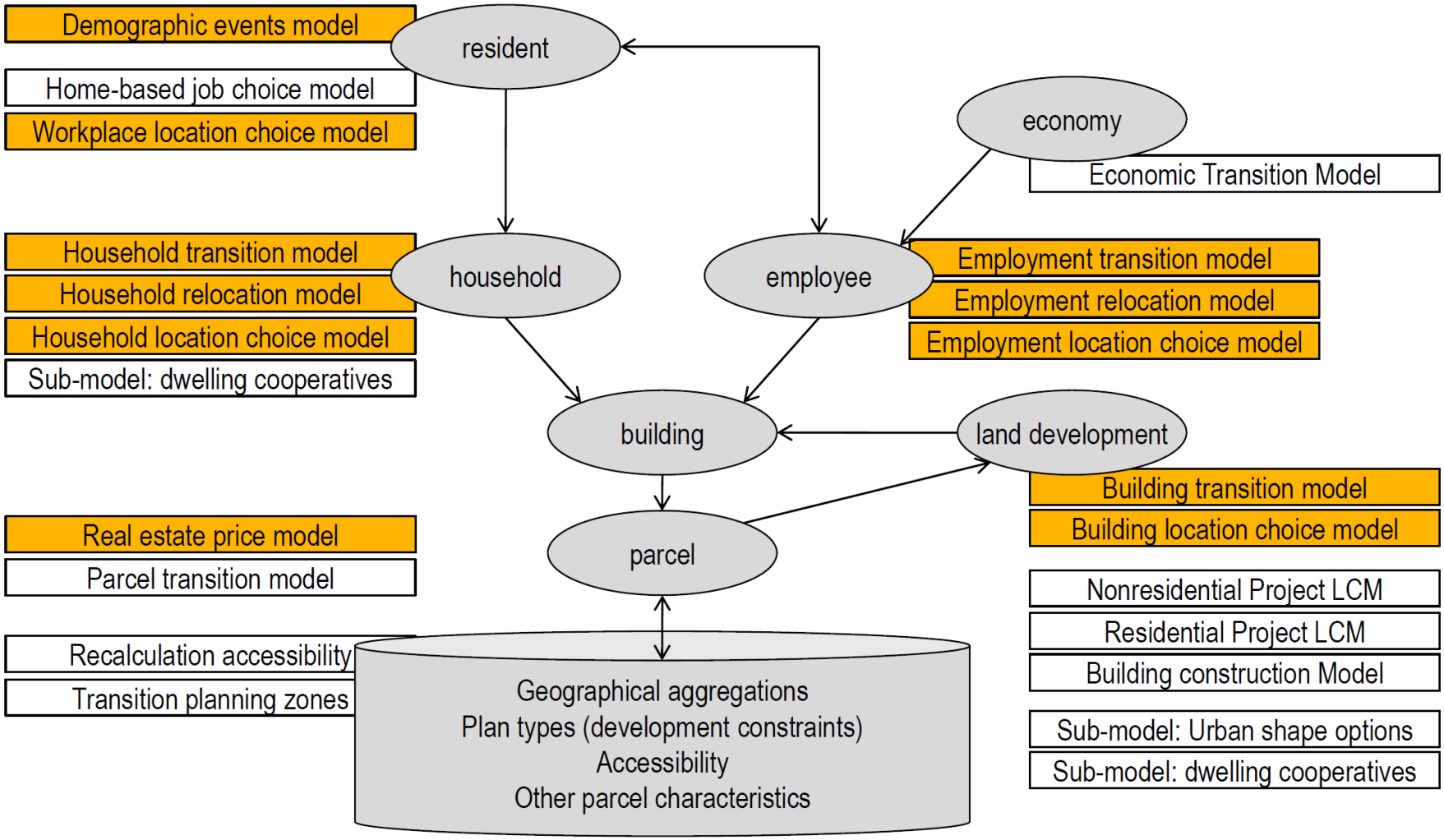
- Resolution:
- yearly updates
- Parcel, grid to municipality

- Open source (www.urbansim.org)
- Phython based

UrbanSim process



Urbansim: Data model for SustainCity



Hedonics: Asking and transaction prices in Singapore

Singapore housing market

HDB sector (~ 80% of flat stock)

Low prices

New sale
- Highly regulated and subsidized
- Citizens / PR only

Resale
- Moderate regulations
- Citizens / PR only

Rental
- Social housing
- Temporary housing

Private sector (~ 20% of flat stock)

High prices

Sale
- Deregulated
- High-income Citizens, Expats

Rental
- Deregulated
- Mainly Expats

Source: Phang (2007), simplified

Data sources

Property listings were gathered from different sources:

- Property Guru (commercial website)

→ **Asking prices (expected preferences)**

- REALIS (governmental website)
- HDB InfoWEB (HDB website)

→ **Transactions (revealed preferences)**

Reference

→ **~ 110'000 observations**

Segmentation for descriptive analysis

HDB or private?

For sale or for rent?

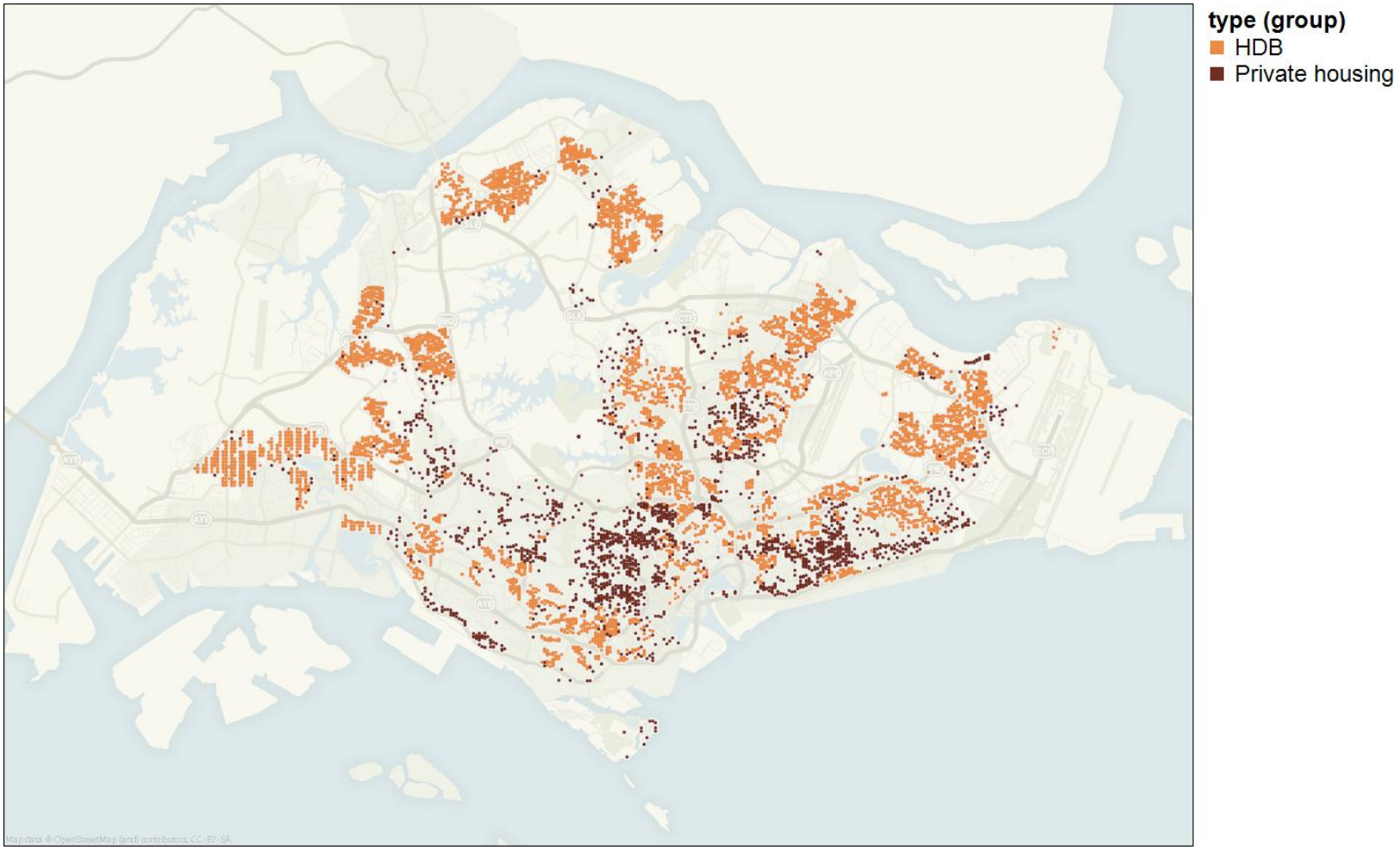
Asking or transaction?

	Asking Data		Transaction data	
	N=	[%]	N=	[%]
Private market				
Sale	33'325	30.6	12'467	11.4
Rental	22'011	20.2	no data	
HDB market				
Sale	2'638	2.4	32'235	29.6
Rental	6'351	5.8	no data	

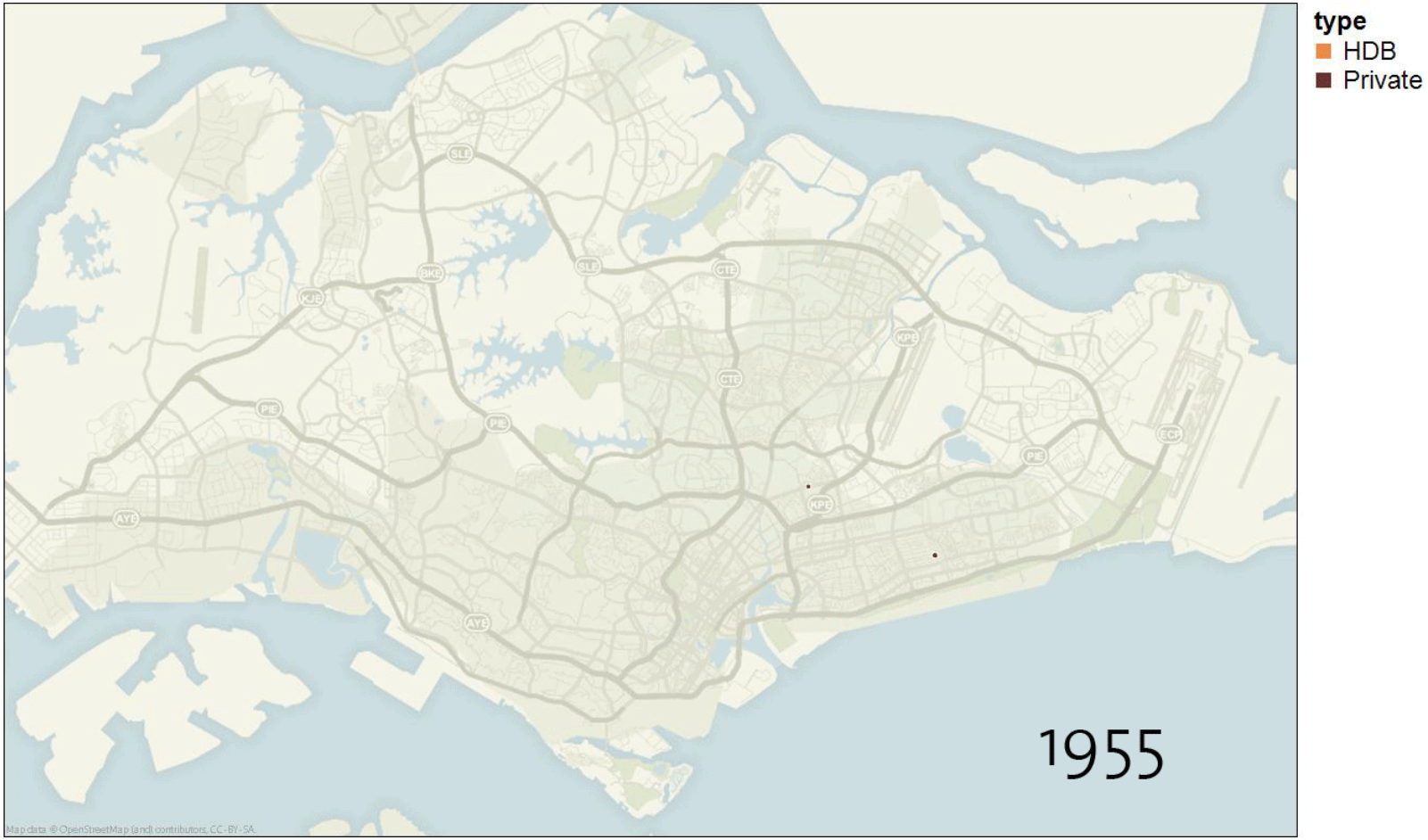
Points of interest and locational variables

Type	Source	Computed variables
Public transport	NAVTEQ (2011)	Distance to nearest bus station Number of lines at nearest station Distance to nearest MRT station
Private transport	Streetdirectory (2011)	Distance to nearest car park Distance to nearest MSCP
Shopping	Streetdirectory (2011)	Distance to nearest shopping mall
Daily supply	Streetdirectory (2011) Giant, NTUC (2011)	Distance to nearest food centre Distance to nearest supermarket
Work places	Streetdirectory (2011)	Distance to nearest industrial estate Distance to central business district
Education	Ministry of Education (2011) PAEXCO (2011)	Distance to nearest primary school Distance to nearest secondary school Distance to nearest junior college Distance to nearest top primary Distance to nearest top secondary

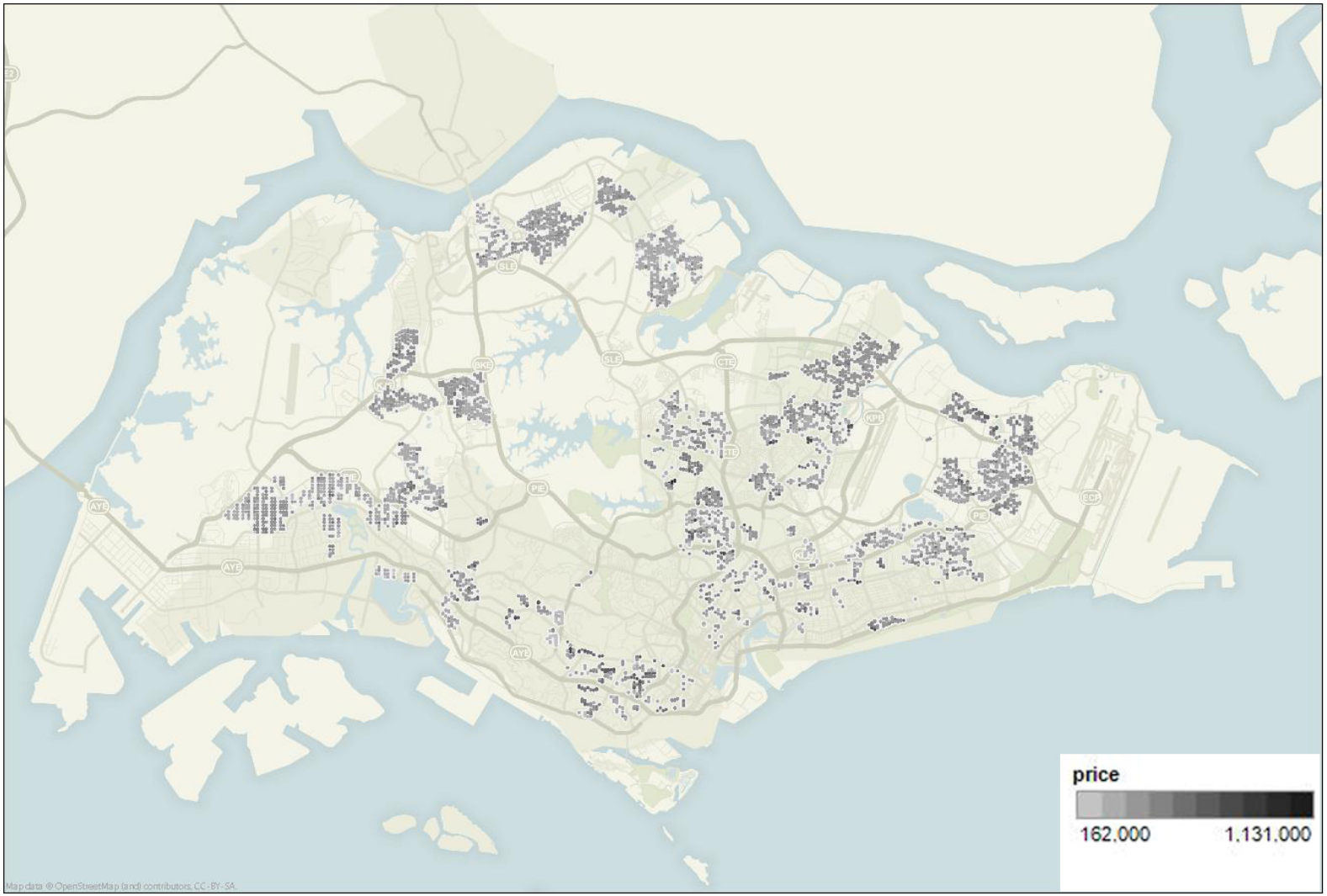
Residential alternatives



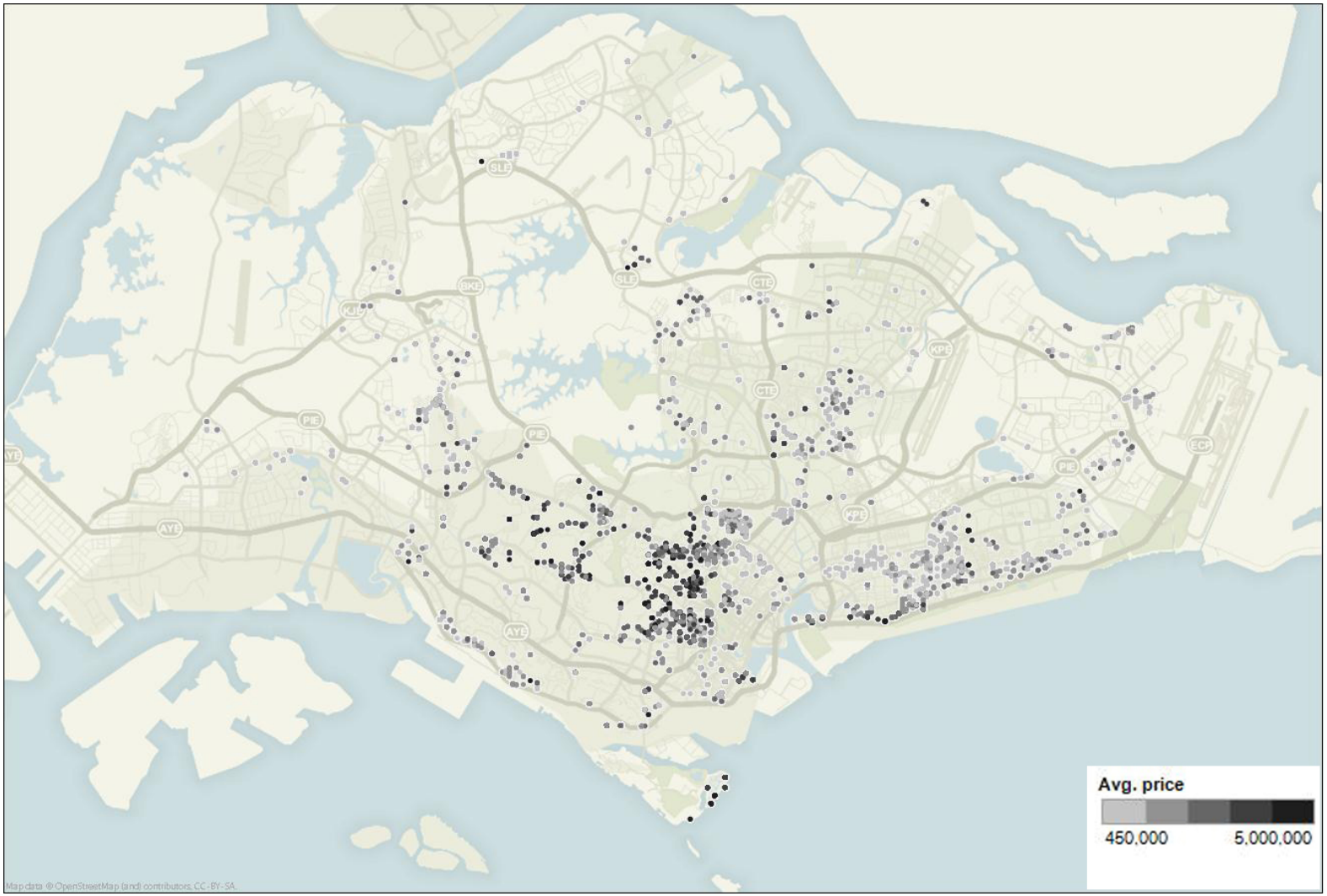
Residential alternatives per year



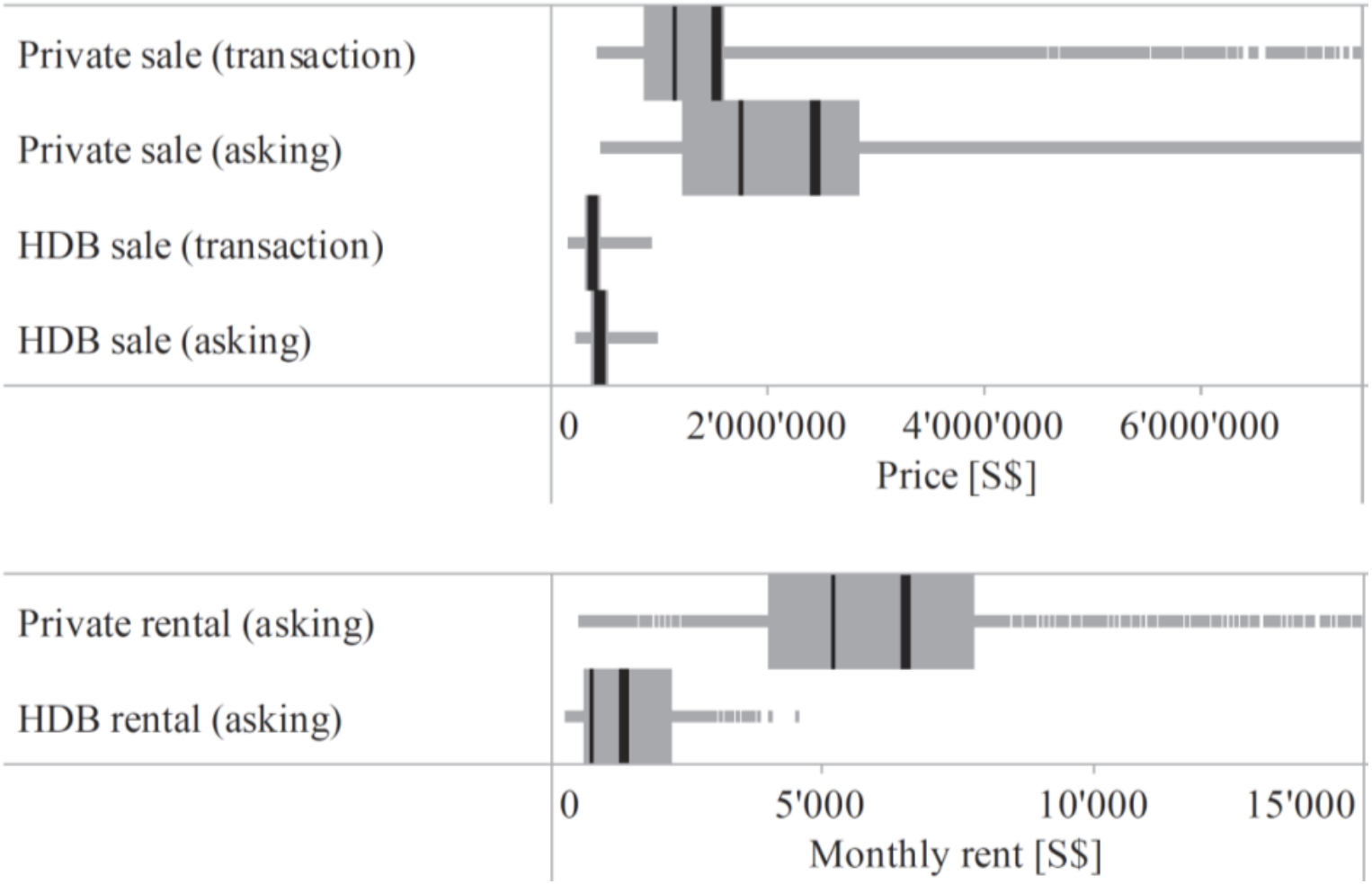
Revealed preferences – HDB Resales (source: HDB / last 12 months)



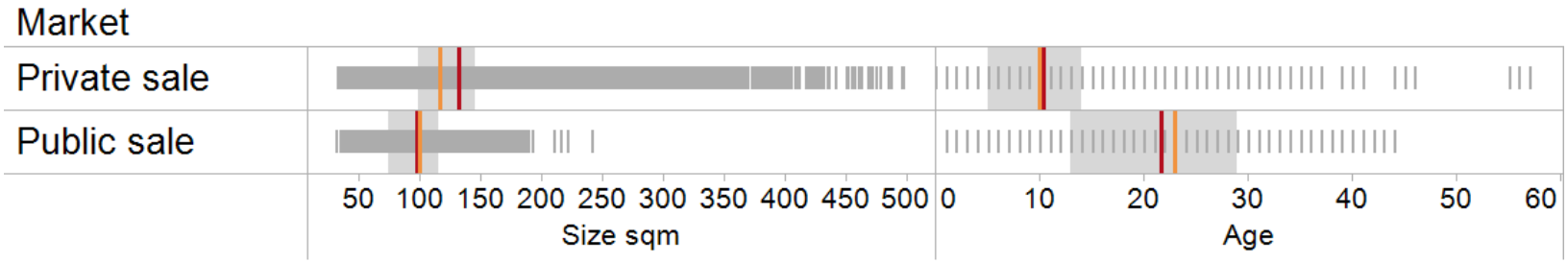
2nd approach – Asking prices Property Guru (private / sale)



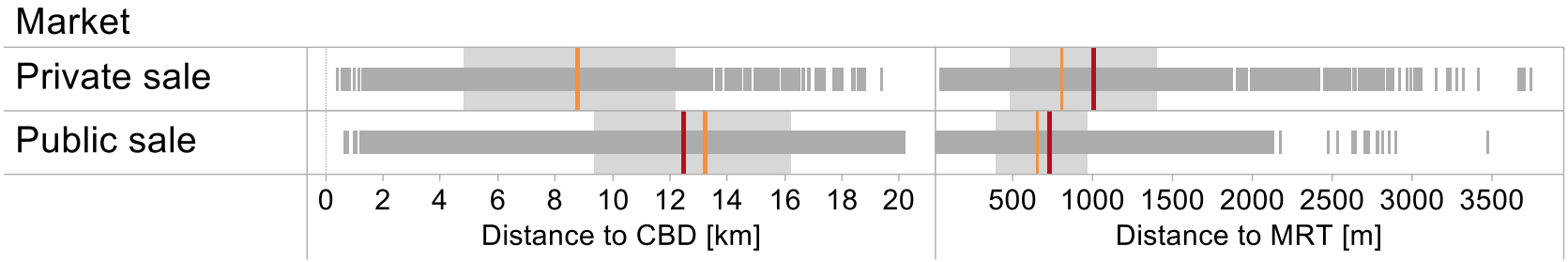
Comparison of submarkets: Price



Comparison of submarkets: Floor area and age



Comparison of submarkets: Locational differences



How to estimate the value of pleasure?

Value residential unit (heterogeneous good)

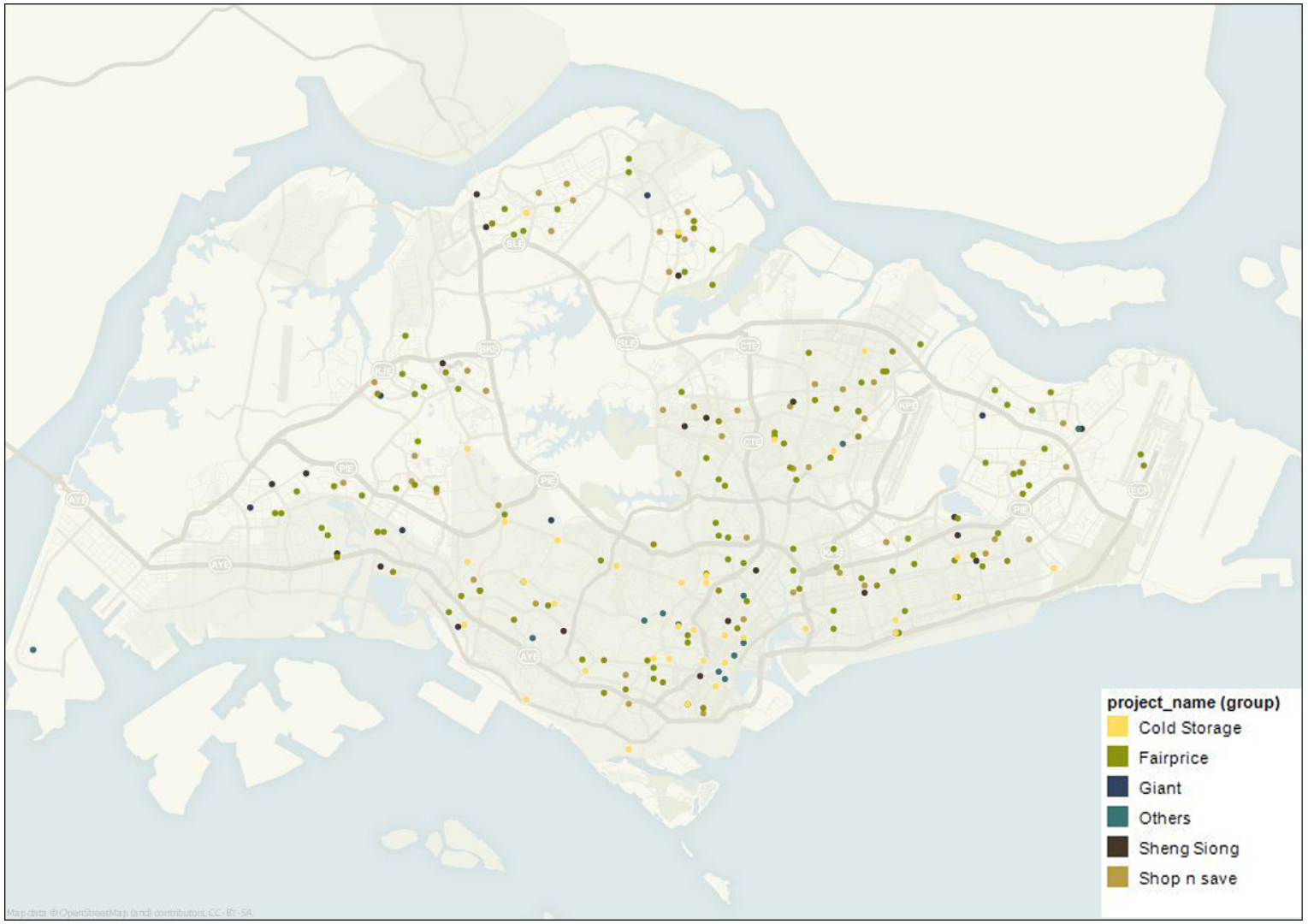
Estimation of **hedonic regression** model (OLS and spatial)

Structural	**Locational**	**Contractual/time**	**Singapore specific**
Floor area, Age, Floor level, Amenities	Distance/travel time to points of interest, district etc.	Tenure, Date of transaction etc.	HDB upgrading, proximity to top schools

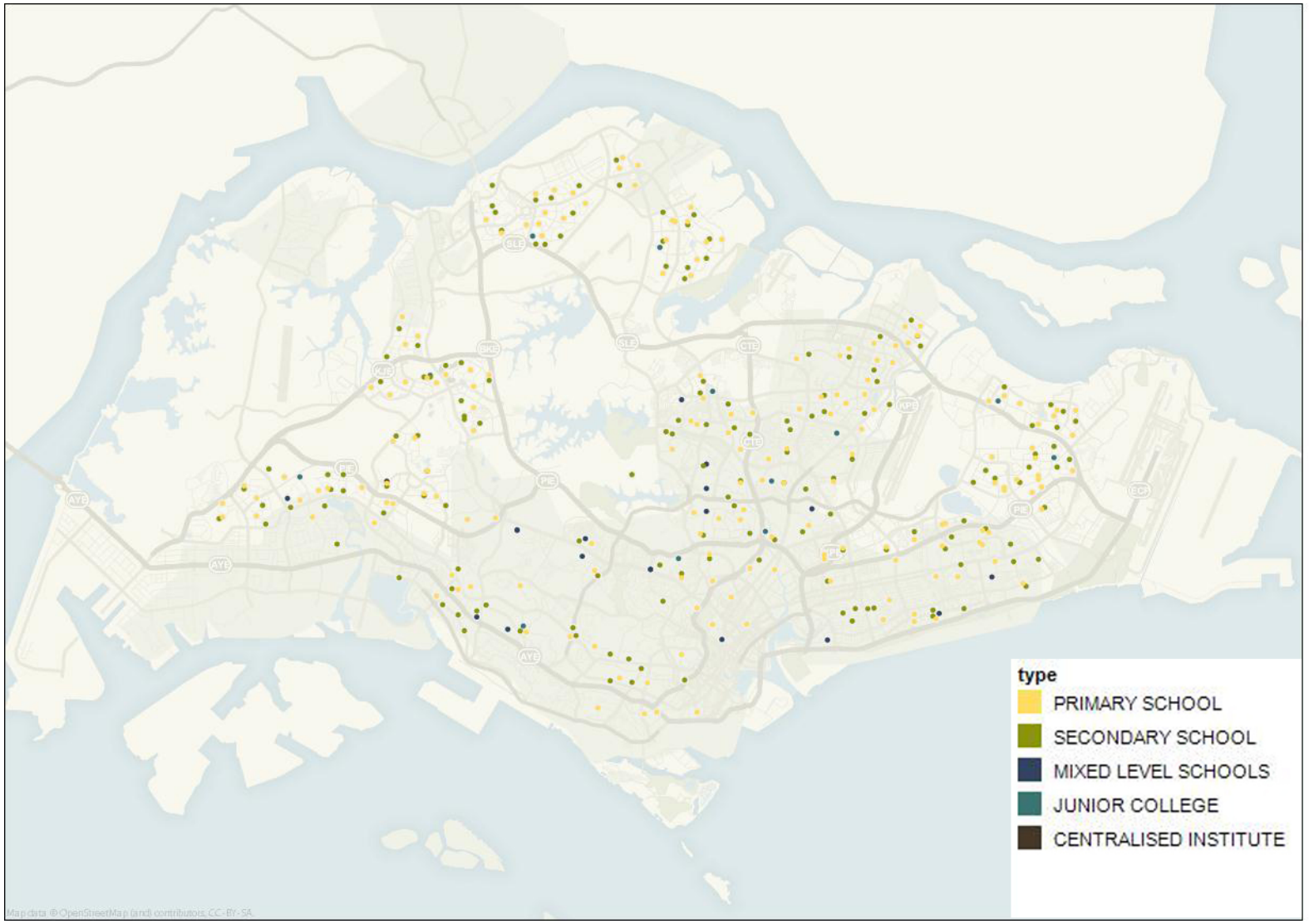
The market: Points of interest

Ministry of Education
SINGAPORE

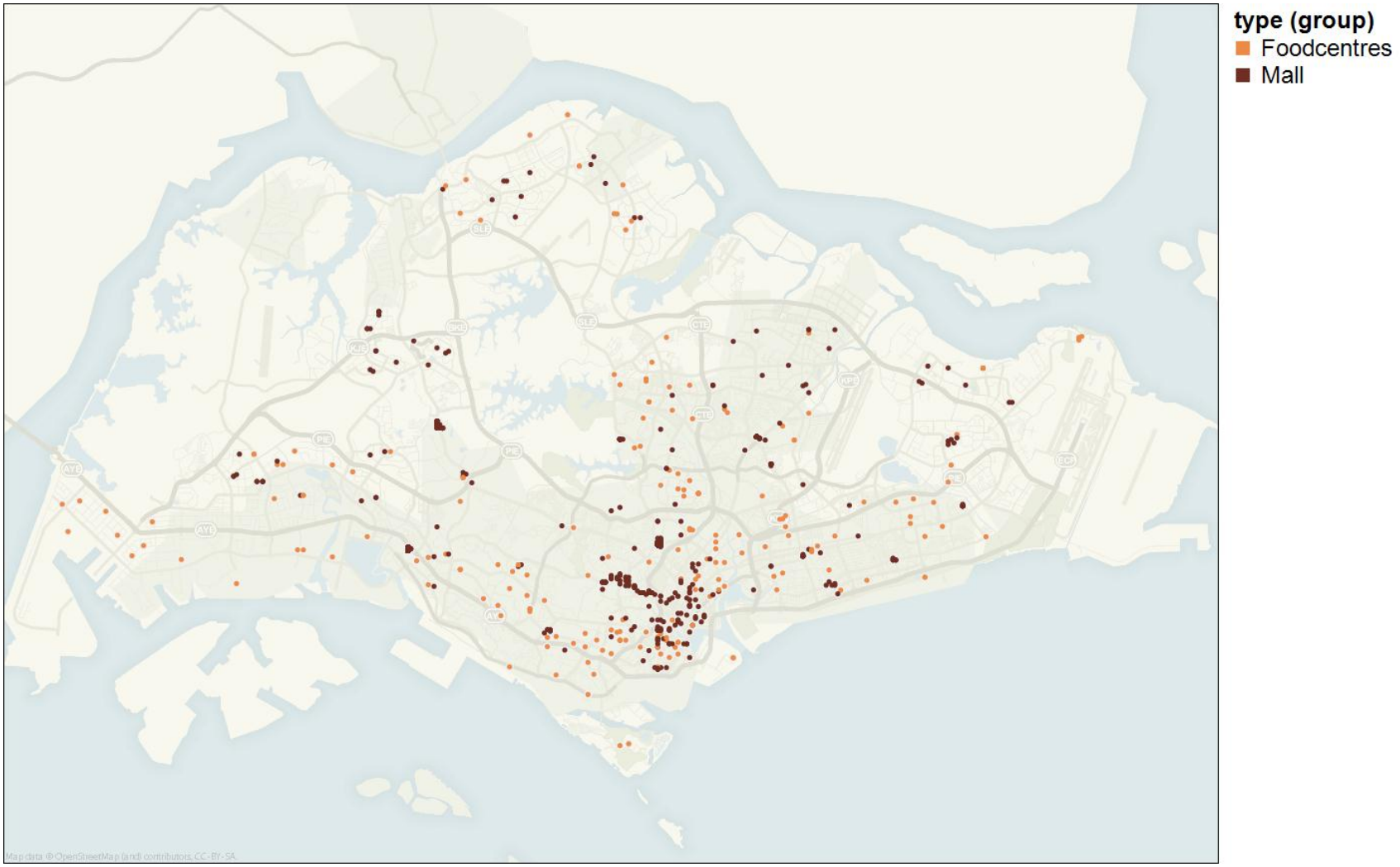
Locational variables – Supermarkets (source: several websites)



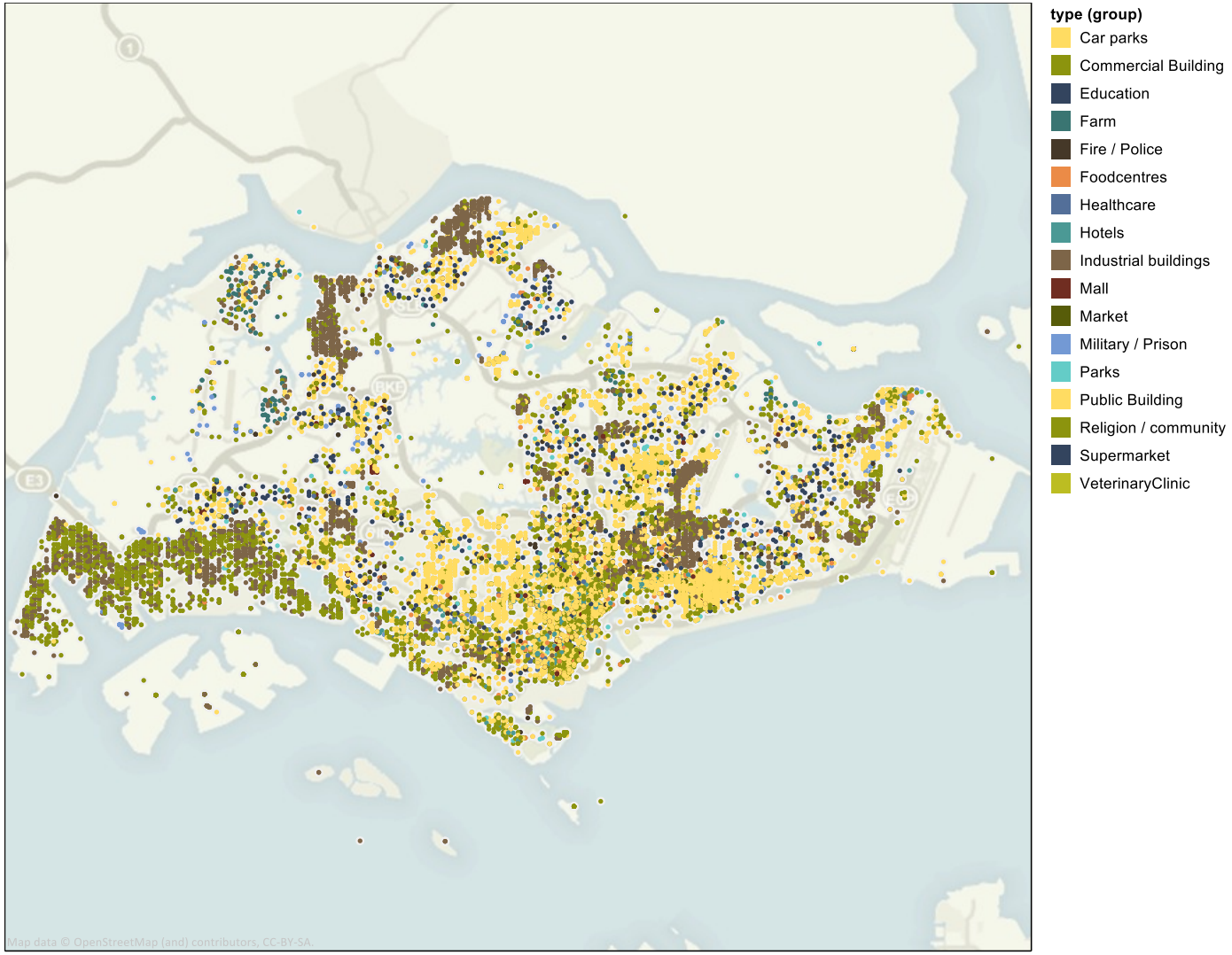
Locational variables – Education (source: Ministry of Education)



Locational variables - Foodcentres & Malls (source: Street Directory)



Collected variables



Model results

Expectations

- Existence of a clear market segmentation
- Expected impacts on flat prices:

Positive price impact

- Floor area
- Floor level
- Availability of amenities
- HDB upgrading
- Freehold tenure

Negative price impact

- Distance to the CBD
- Distance to MRT and bus stations
- Distance to car parks
- Distance to top schools
- Distance to shopping malls and food centres

Sources: Malpezzi (2003), Ong and Ho (2003), Sirmans et al. (2009), Sue and Wong (2010)

Overview of final models

Name	Market	Data	N=	Nvar=
Model A	Private sale	Asking and transaction	45'792	23
Model B	Private sale	Transaction	12'467	21
Model C	Private rental	Asking	22'444	19
Model D	HDB sale	Asking and transaction	34'873	13
Model E	HDB sale	Transactions	32'235	21
Model F	HDB rental	Asking	6'351	8

Hedonic regression: Modelling approaches

OLS model:

$$P = \beta X + \varepsilon$$

$$\varepsilon \sim N(0, \sigma^2 I_n)$$

OLS models → Problems with spatial autocorrelation

Spatial error model (SARerr)[1]:

$$P = \beta X + u$$

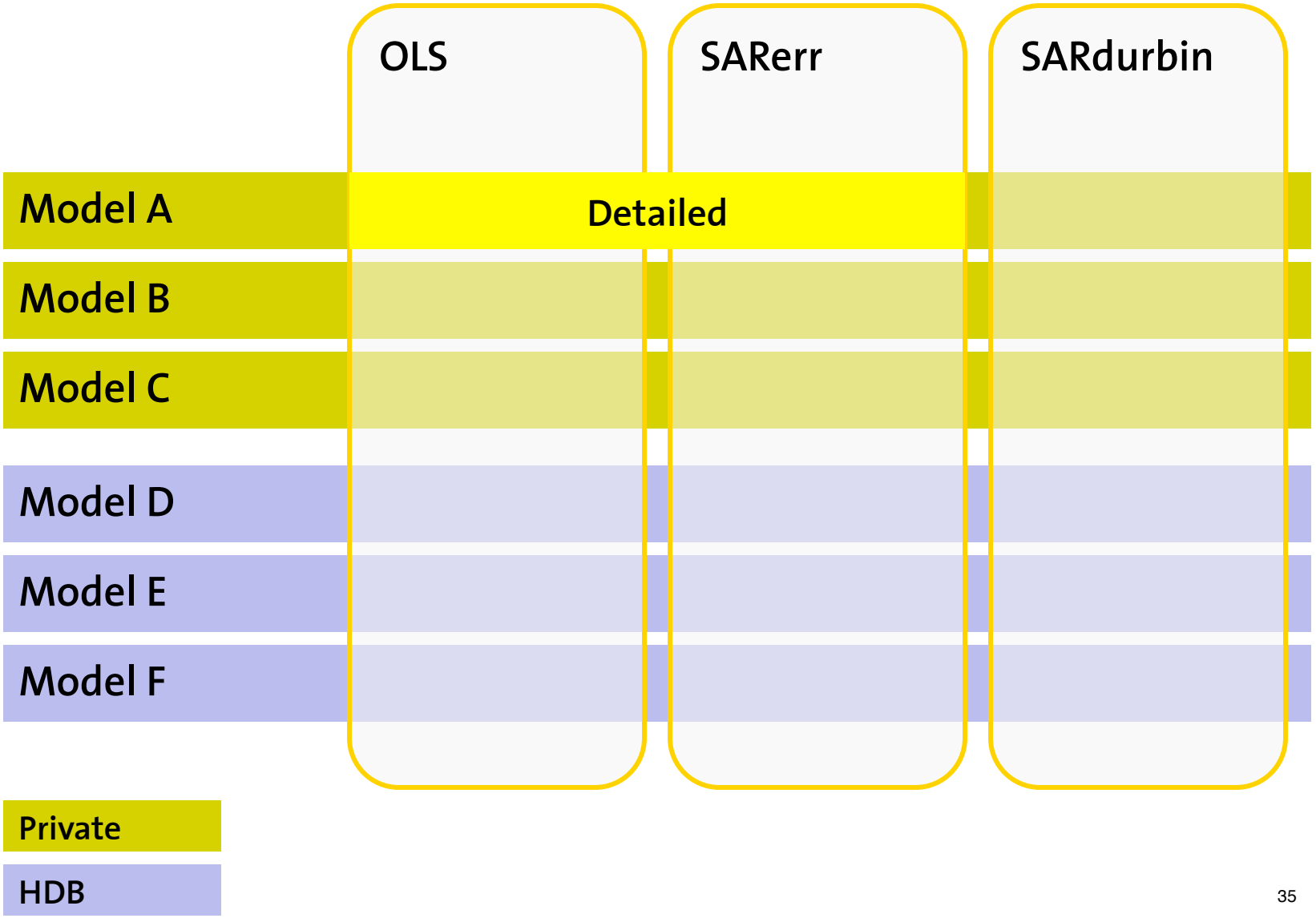
$$u = \lambda W u + \varepsilon$$

Spatial Durbin model (SARdurbin)[1]:

$$P = \rho W P + \beta X + W X \gamma + \varepsilon$$

[1]Source: Anselin (1988)

Overview of final models



Model A: Estimated coefficients (selection)

Dependent: log(Price)	OLS model		Spatial error model	
N=45'792	Estimate	Scaled	Estimate	Scaled
Constant	11.098		11.822	
Lambda			0.920	
log(Floor area)	0.970	0.712	0.894	0.657
Built between 1951 and 1960	-0.213		-0.233	
Built between 2001 and 2010	-0.059		-0.035	
Planned to be built after 2011	-0.014		0.028	
log(Dist. to the CBD)	-0.316	-0.414	-0.334	-0.438
log(Dist. to a industrial estate)	0.078	0.101	0.037	0.047
log (Dist. to a top primary)	-0.027	-0.033	-0.035	-0.043

Model A: Estimated coefficients (selection)

Dependent: log(Price)	OLS model		Spatial error model	
N=45'792	Estimate	Scaled	Estimate	Scaled
Constant	11.098		11.822	
Lambda			0.920	
log(Floor area)	0.970	0.712	0.894	0.657
Built between 1951 and 1960	-0.213		-0.233	
Built between 2001 and 2010	-0.059		-0.035	
Planned to be built after 2011	-0.014		0.028	
log(Dist. to the CBD)	-0.316	-0.414	-0.334	-0.438
log(Dist. to a industrial estate)	0.078	0.101	0.037	0.047
log (Dist. to a top primary)	-0.027	-0.033	-0.035	-0.043

Model A: Estimated coefficients (selection)

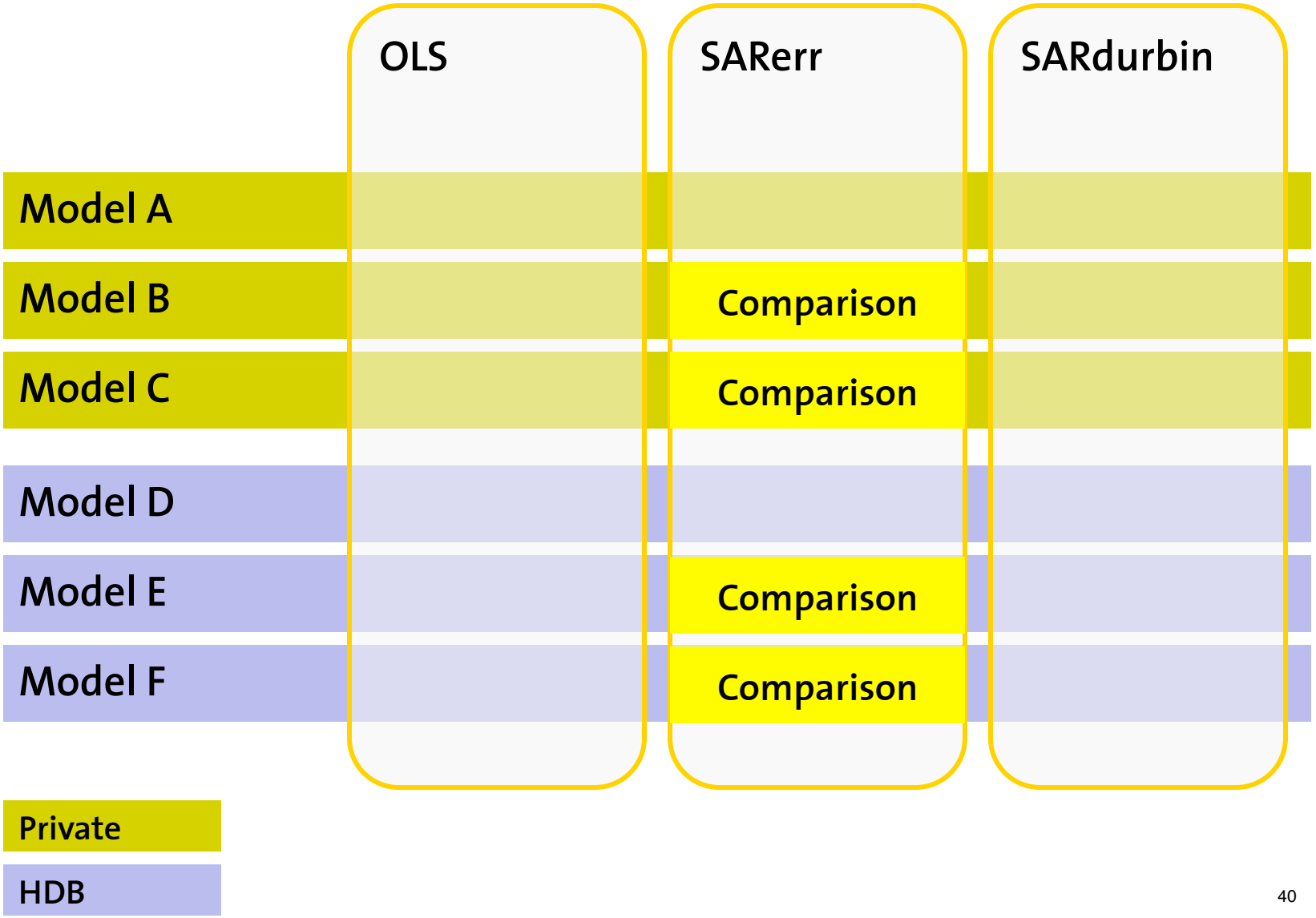
Dependent: log(Price)	OLS model		Spatial error model	
N=45'792	Estimate	Scaled	Estimate	Scaled
Constant	11.098		11.822	
Lambda			0.920	
log(Floor area)	0.970	0.712	0.894	0.657
Built between 1951 and 1960	-0.213		-0.233	
Built between 2001 and 2010	-0.059		-0.035	
Planned to be built after 2011	-0.014		0.028	
log(Dist. to the CBD)	-0.316	-0.414	-0.334	-0.438
log(Dist. to a industrial estate)	0.078	0.101	0.037	0.047
log (Dist. to a top primary)	-0.027	-0.033	-0.035	-0.043

Model A: Diagnostics

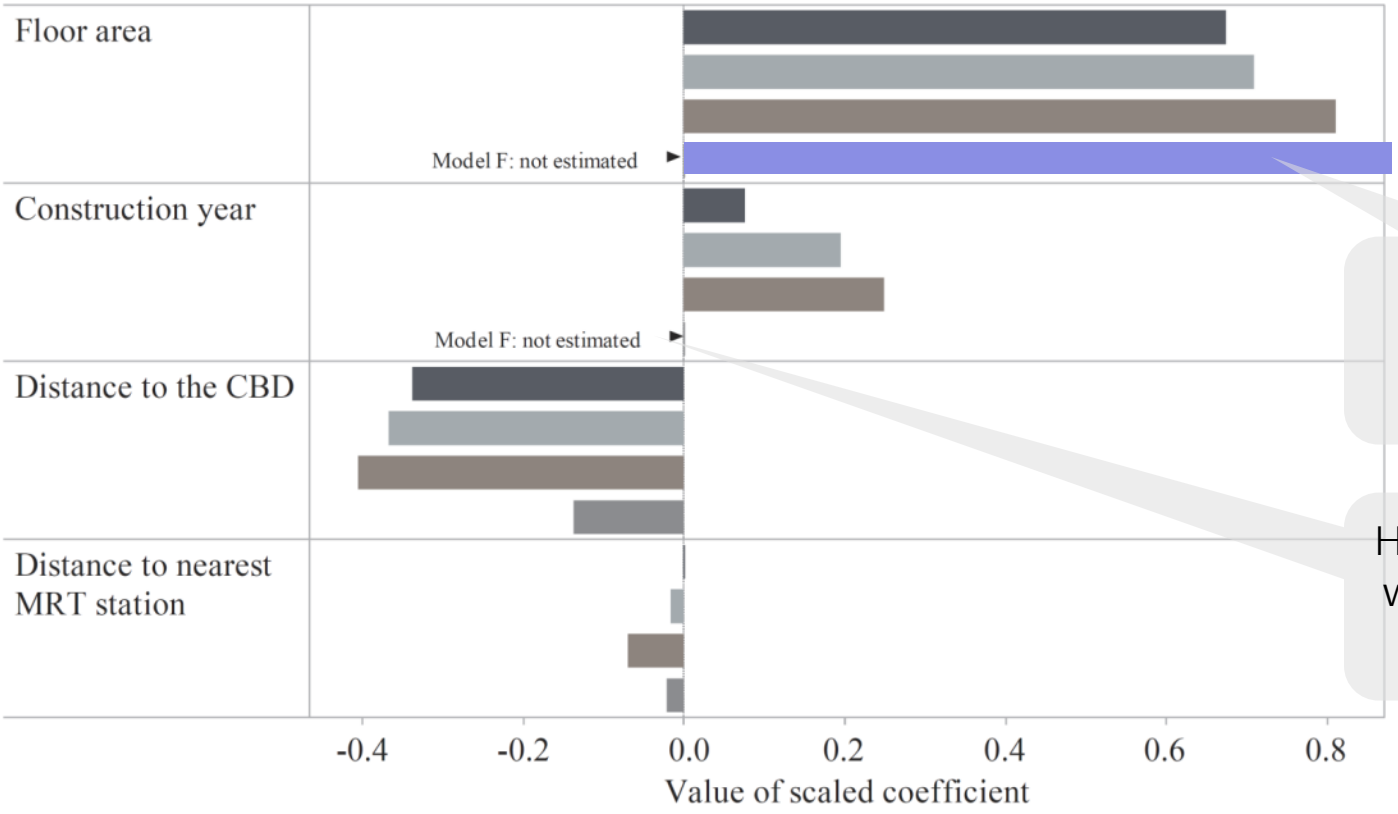
Dependent: log(Price)	OLS	SARerr
Adjusted R-square	0.890	
Akaike Information Criterion[1]	-12'743	-73'015
Sum of squared errors	2'027.1	492.6
Moran's I[2]	0.739	**-0.073**

Sources: [1]Sakamoto and Kitagawa (1987), [2]Cliff and Ord (1981)

Overview of final models



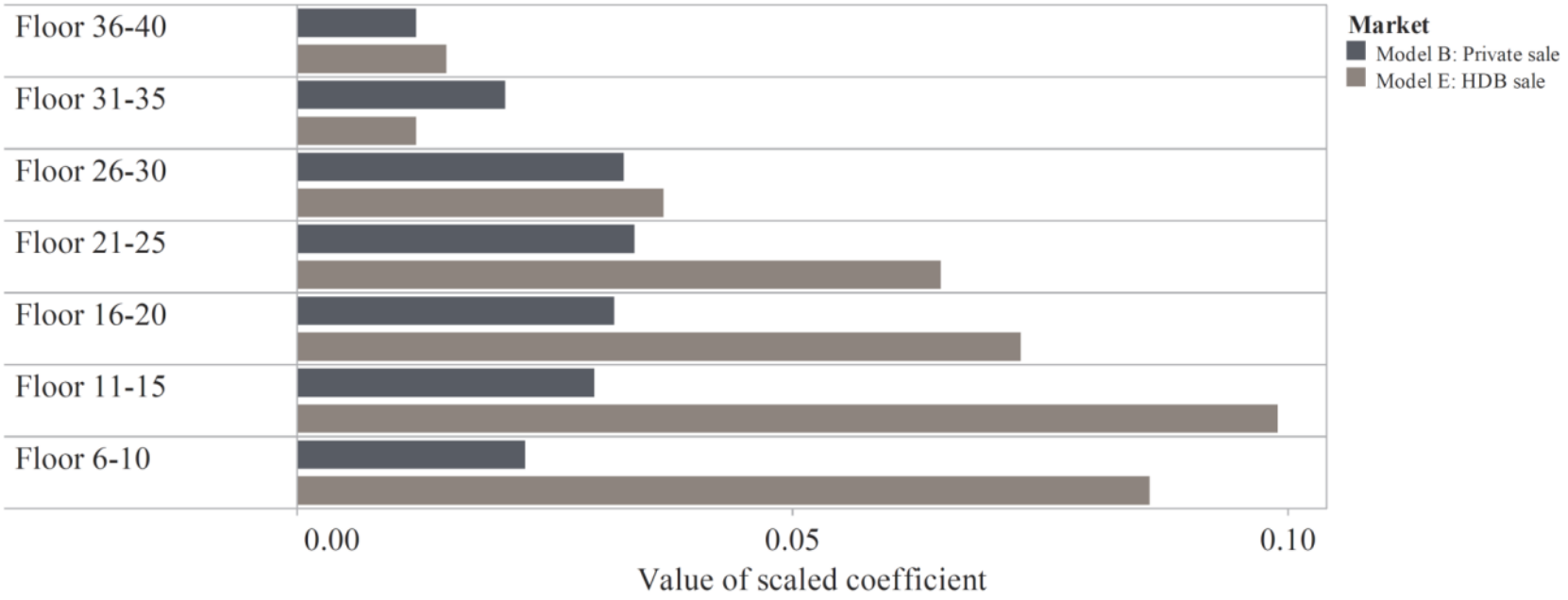
Comparison of housing preferences: Overview



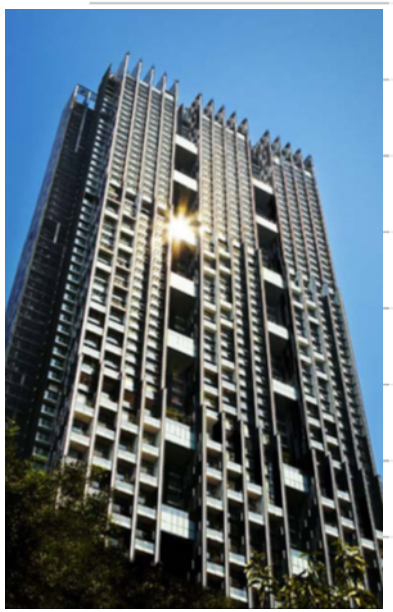
Number of bedrooms → 0.91

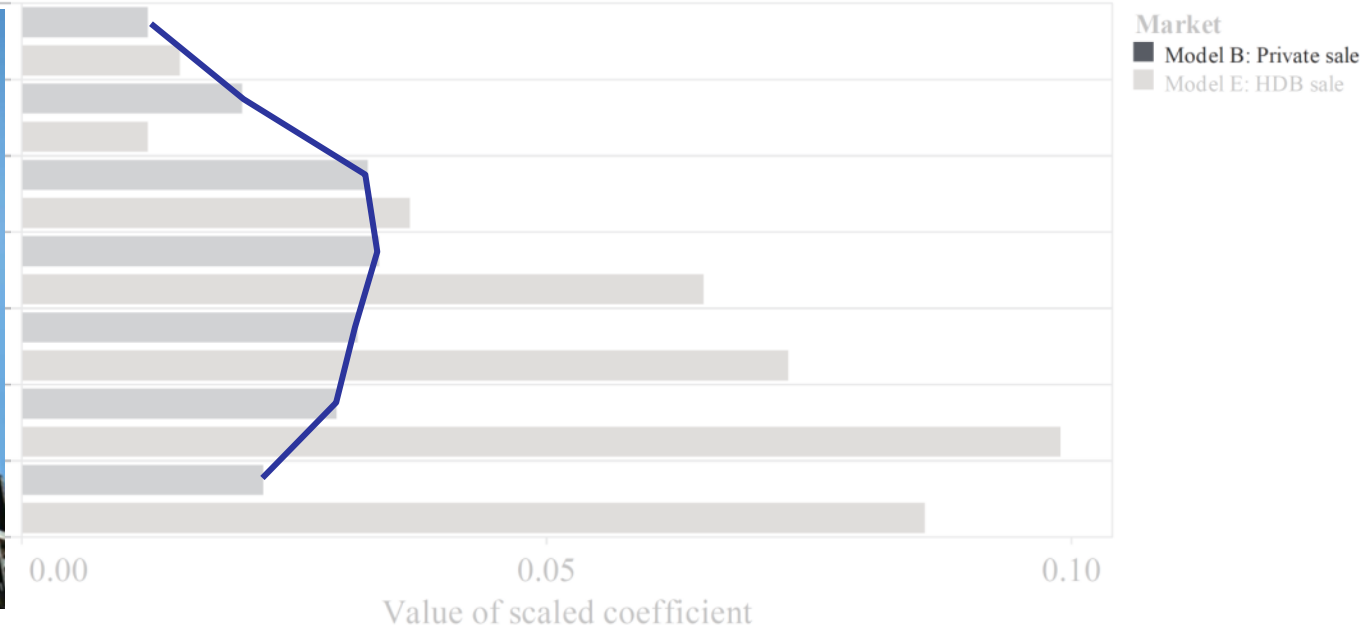
Highly correlated with distance to CBD

Comparison of housing preferences: Floor level

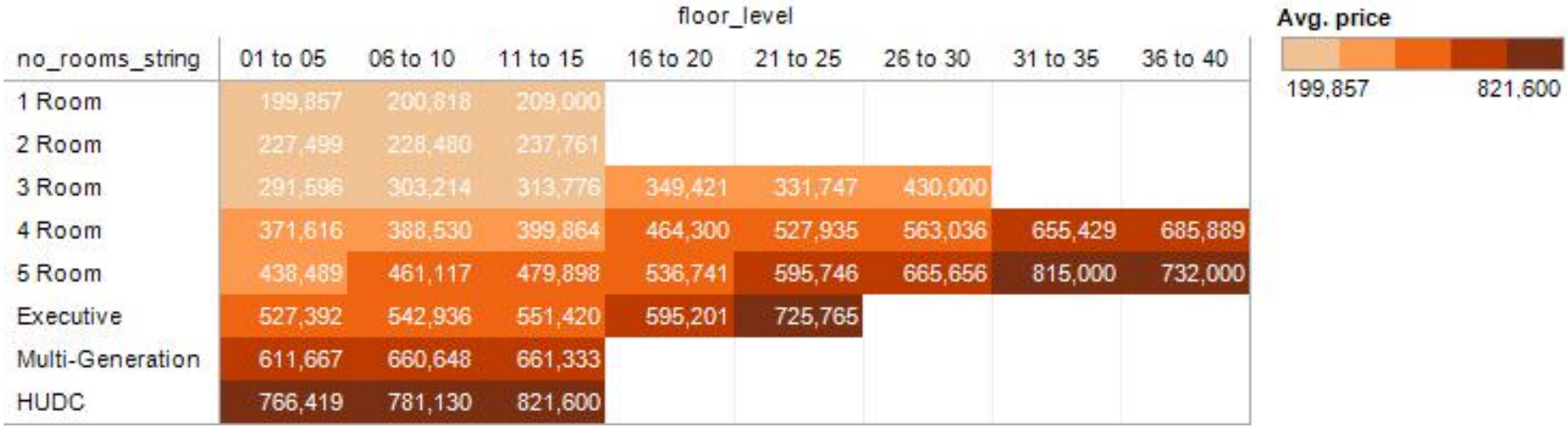


Comparison of housing preferences: Floor level PRIVATE



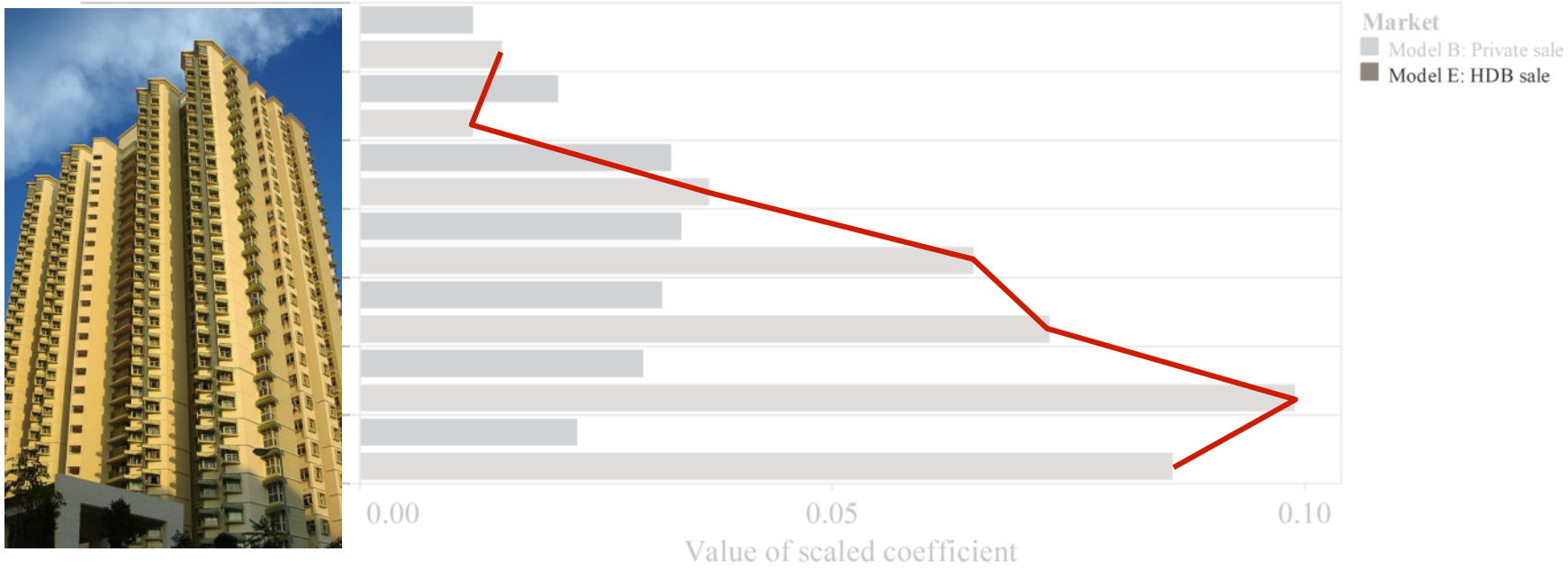


Revealed preferences – HDB floor level vs price



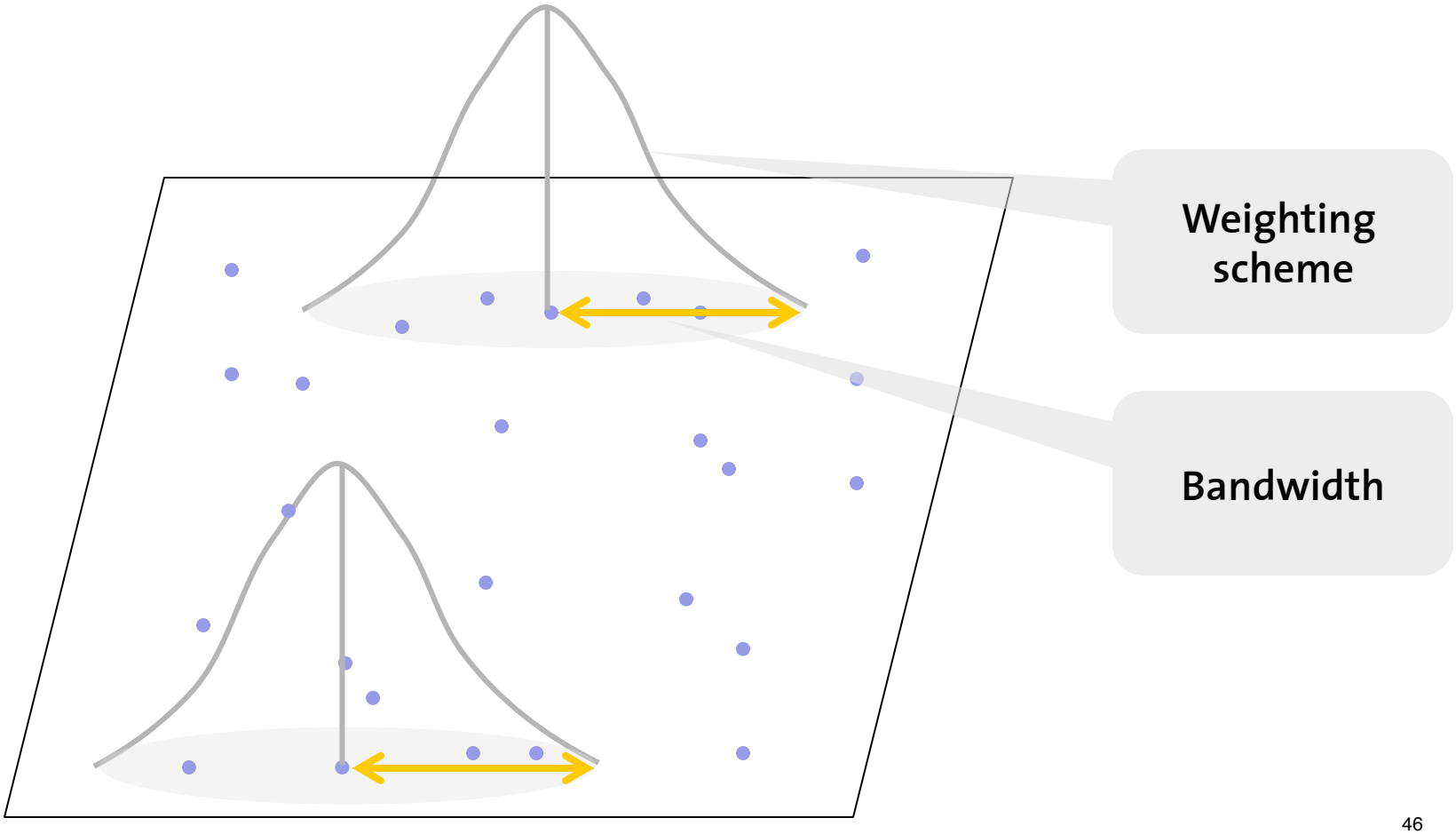
no_rooms_string	floor_level: 01 to 05	06 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40
1 Room	199,857	200,818	209,000					
2 Room	227,499	228,480	237,761					
3 Room	291,596	303,214	313,776	349,421	331,747	430,000		
4 Room	371,616	388,530	399,864	464,300	527,935	563,036	655,429	685,889
5 Room	438,489	461,117	479,898	536,741	595,746	665,656	815,000	732,000
Executive	527,392	542,936	551,420	595,201	725,765			
Multi-Generation	611,667	660,648	661,333					
HUDC	766,419	781,130	821,600					

Comparison of housing preferences: Floor level HDB

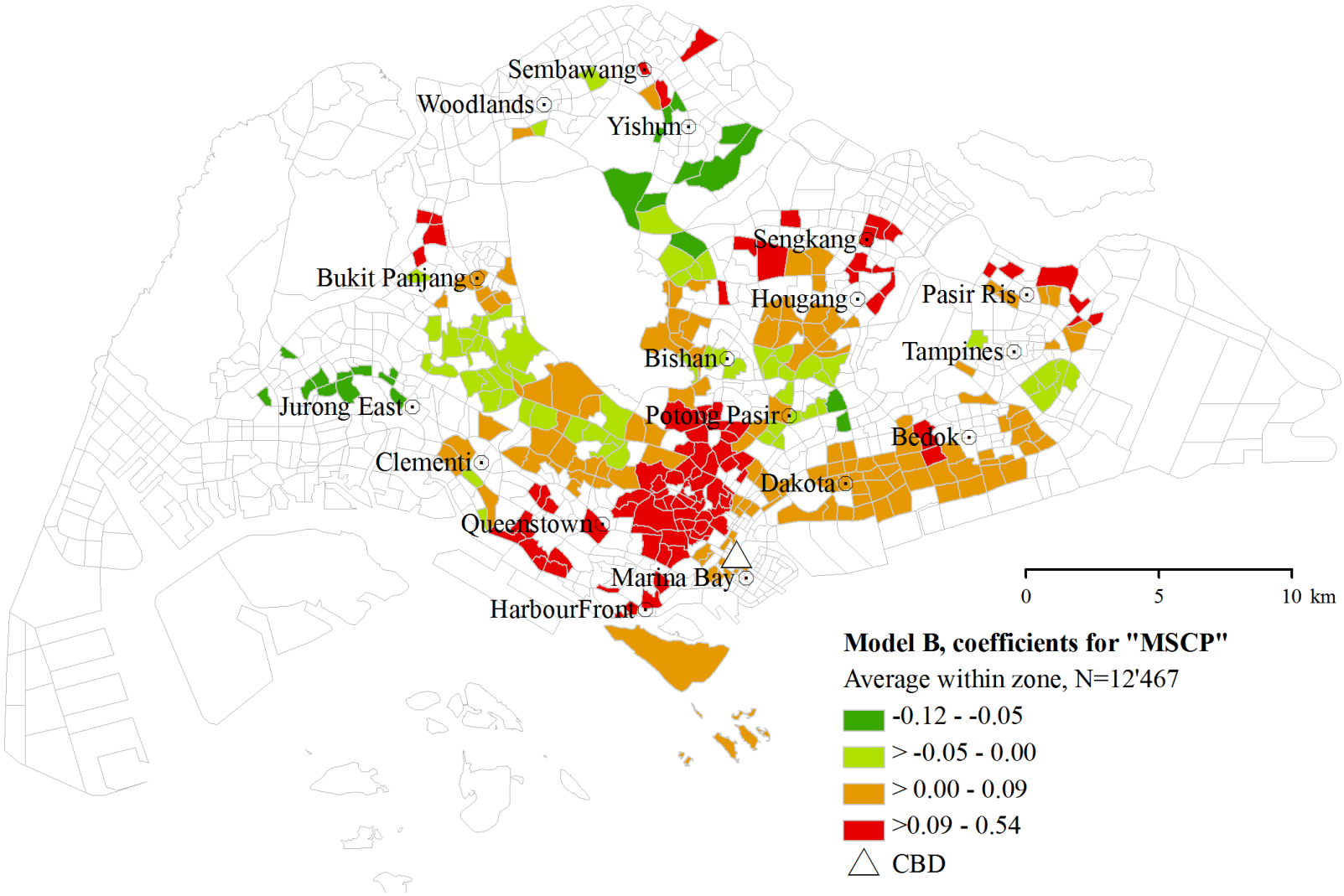


Exploring spatial variation of housing preferences

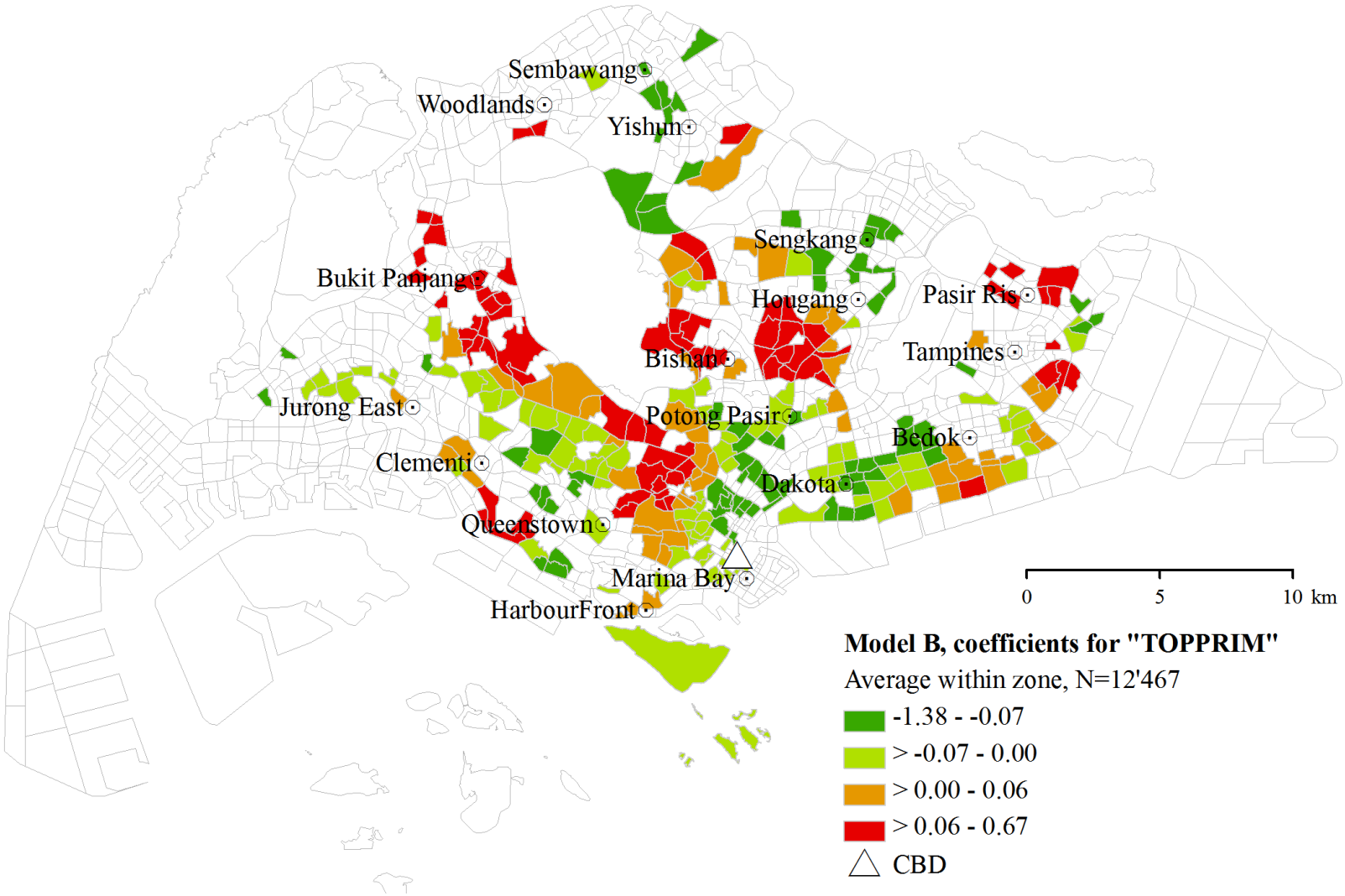
Applying geographically weighted regressions (GWR):



GWR model: Distance to nearest MSCP, PRIVATE SALE



GWR model: Distance to nearest top primary school



Research questions

- Understanding the role of the “developer” better
- Including it in formal land use models
- Testing their impact

General roles

Regulation	**Government**
Land assembly	**Government**, developer, owner
Platting	**Government**, developer, owner
Infrastructre providers	**Government**, developer, owner, network
Programming	**Owner**, **developer**
Building design	Architect
Funding	**Owner, developer**
Sales	**Developer**
Maintenance	**Owner**

Heterogeneity of real estate developers

Possible variables

- Legal status (Public, Private)
- Objective (Profit, non-profit)
- Strategy (Portfolio, object-oriented)
- Size
- Professionalism (Work oriented, non-work oriented)
- Purpose / Business plan (Promoter, self-owning)
- Organisation (Private person, company)

Stratified sampling of contacts from project records

DOUMEDIA data on building projects from 2000 – 2010

- Requests for proposals
- Projects with building permit
- Contact details
- Purpose (Sale, let, own use)
- Number of projects

Systematic sampling of 10 most active developers

Random sampling in three subpopulations

Sample

Code	Type	Purpose	Number of Projects	Number of Interviewees
O1	Unprofessional own use	Own use (letting)	1	2
Om	Professional with portfolio	Own use (letting)	m	3
Smc	Commercial developer	Sale	mc	6

Differences in criteria

Criterion	Own use, letting	Sale
Main criterion	Availability of affordable land Conservation of value Cost-benefit ratio positive Nb of housing unit > 100 Location and profitability	Net present value > 0 Profit opportunities Evaluation report positive Fit demand Gut feeling
Payoff time	10 – 21 years	1 – 10 years
Profitability	-20 – 5.3%	5 – 10%
Pre selling	N/A	30 – 70%

Differences in evaluation methods and information basis

	Unprofessional	Professional
Evaluation methods	Study advertisements Looking around Ask around Scouting expeditions Compare with neighbouring projects	GIS-Tools Price calculators Optimisation of budget and parcel Location analysis Market analysis Demographic analysis Consultation of ratings IFRS component approach Sustainability tool Portfolio review
Information basis	Press Personal situation Conditions of parcel Internet Local knowledge Opinion of trusted persons Professionals	Press Zoning Online markets Own market data Local knowledge Professional reports Prepared data Professional tools Statistical offices

Differences in task spectrum

Task	2	1	10	11	6	4	5	7	8	3	9
Financing	x	x	x	x	x				x	(x)	x
Search for location	x				x		(x)	x	x		x
(Buy property)								(x)	x	(x)	x
Programming	x	x	(x)	x	x			x	x		x
Design						x	x	x			
Construction management						x	x	x	x	x	x
Engineering										x	
Construction								x	x	x	
Marketing							x	(x)			x
Sell property				(x)				x	x	x	x
Sell service						x	x				
Own use let	x	x	x	x	x			x	x		
Own use	x	x									

Legend

Optional task (x)

Agent-based transport networks

Example: 5 mio agents (cars, public transport)

Video available at http://www.vimeo.com/24822377

See www.matsim.org@ (ETH) Zürich and TU Berlin

Dr. Michael Balmer
Dr. David Charypar
Dr. Nuhan Cetin
Yue Chen
Francesco Ciari
Christoph Dobler
Thibaut Dubernet
Dr. Matthias Feil
Dr. Gunnar Flötteröd
Dr. Christian Gloor
Dominik Grether
Dr. Jeremy K. Hackney
Andreas Horni
Johannes Illenberger
Gregor Lämmer
Nicolas Lefebvre
Konrad Meister
Manuel Moyo
Kirill Müller
Thomas Nicolai
Benjamin Kickhöfer
Dr. Brian Raney
Dr. Marcel Rieser
Dr. Nadine Schüssler
Dr. David Strippgen
Rashid Waraich
Michael Zilske

Transport (and social networks)

Acknowledgements: Social networks

- Andreas Frei
- Matthias Kowald
- Timo Ohnmacht
- Stephan Schönfelder

- Jonas Larsen, now Roskilde University
- John Urry, Lancaster University

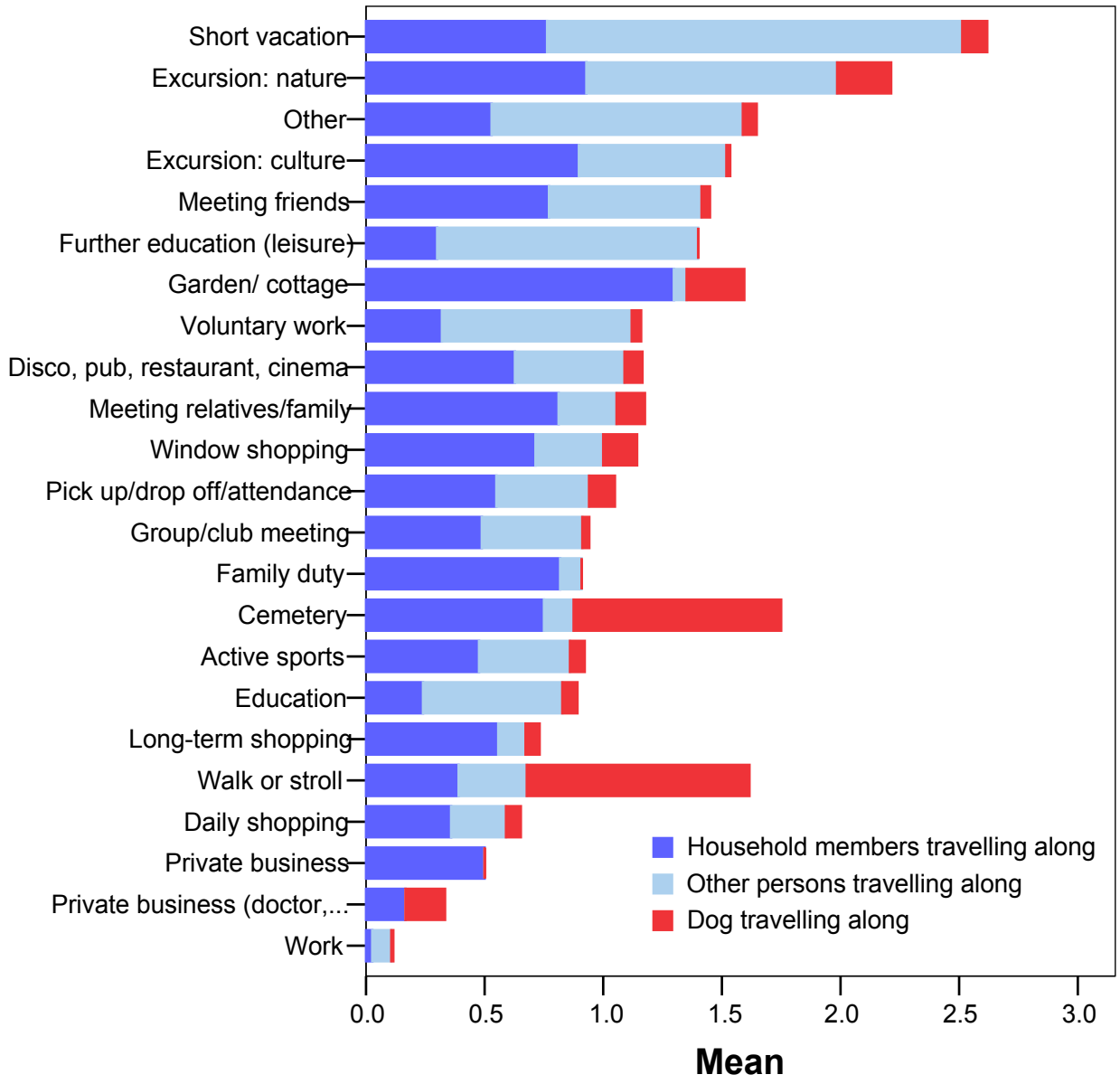
- Theo Arentze, TU Eindhoven

Sponsors

- ETH Zürich
- ifmo, Berlin
- UK Department of Transport, London
- VW Stiftung, Wolfsburg

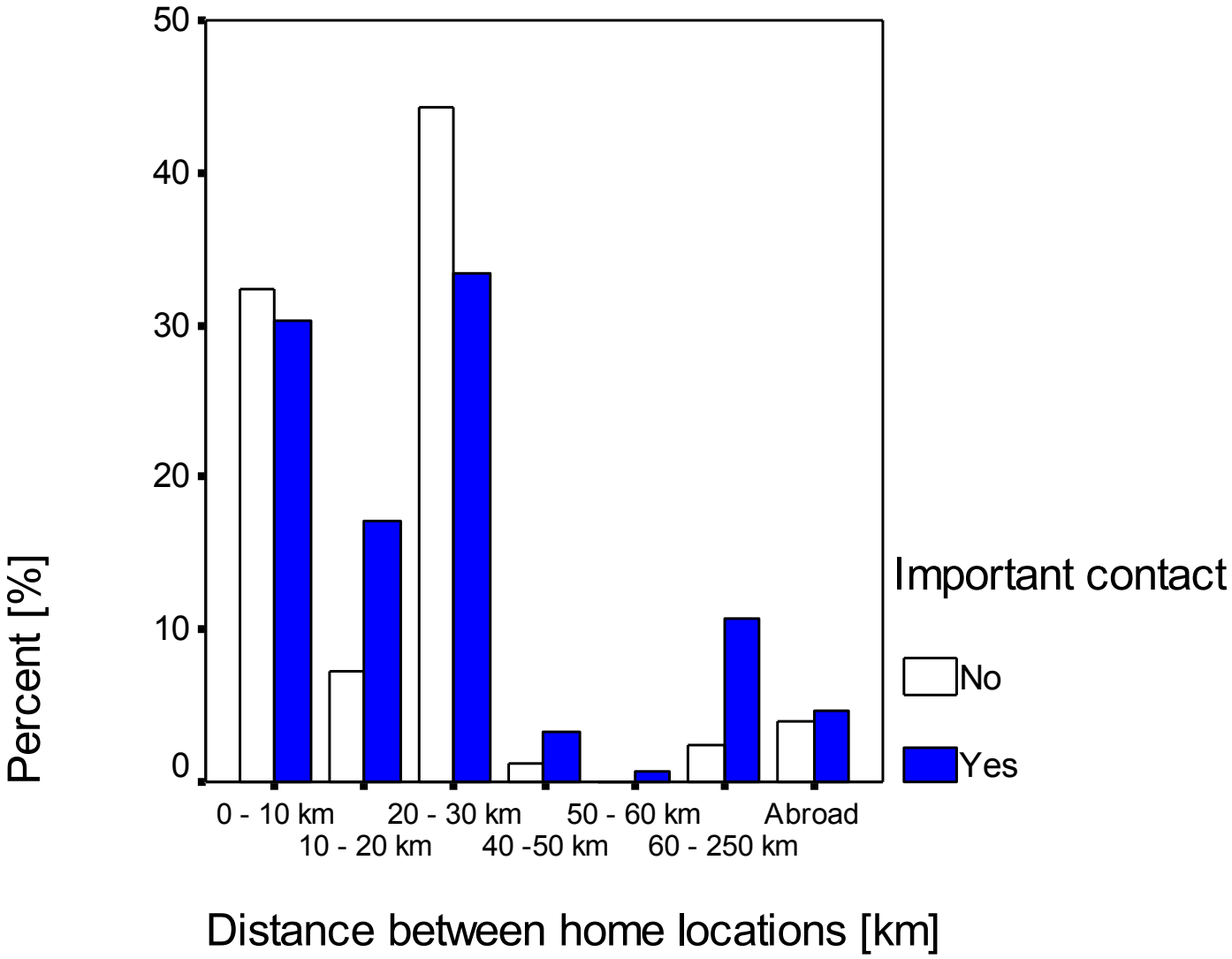
Why include social networks ?

e.g. number of accompanying persons



Axhausen et al., 2007

e.g. distance travelled by the guest

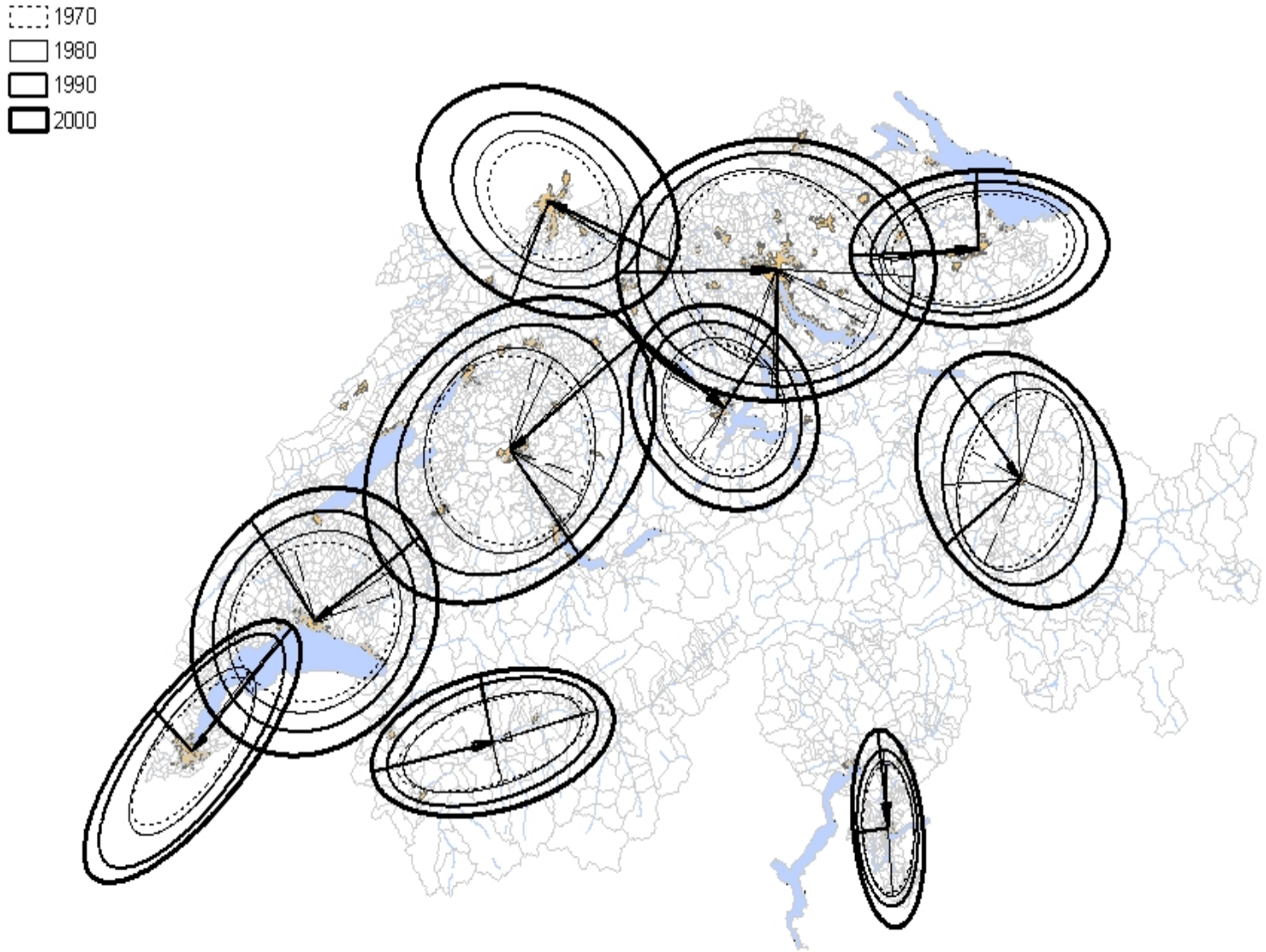


Schlich et al., 2002

e.g. residential home location choice

Variable	Beta	t-Test
Rent/Income	-5.51	***
log(m2/head)	0.98	***
Frequency weighted mean distance to friends	-8.16	*
Exponent (friends)	0.22	**
Mean distance to work/school	-1.59	**
Exponent (distance to work)	0.37	**
Travel time to Bürkliplatz	0.02	**
log(transit accessibility) * "No car"	0.41	**
log(car accessibility) * “Car"	-0.30	**
Share of equally sized HH within 1 km	0.02	*
Population density within 1 km	0.01	**
Share of empty flats in municipality	-0.11	
N= 683, rho² = 0.2128; * > 0.1; ** > 0.05; *** > 0.01		

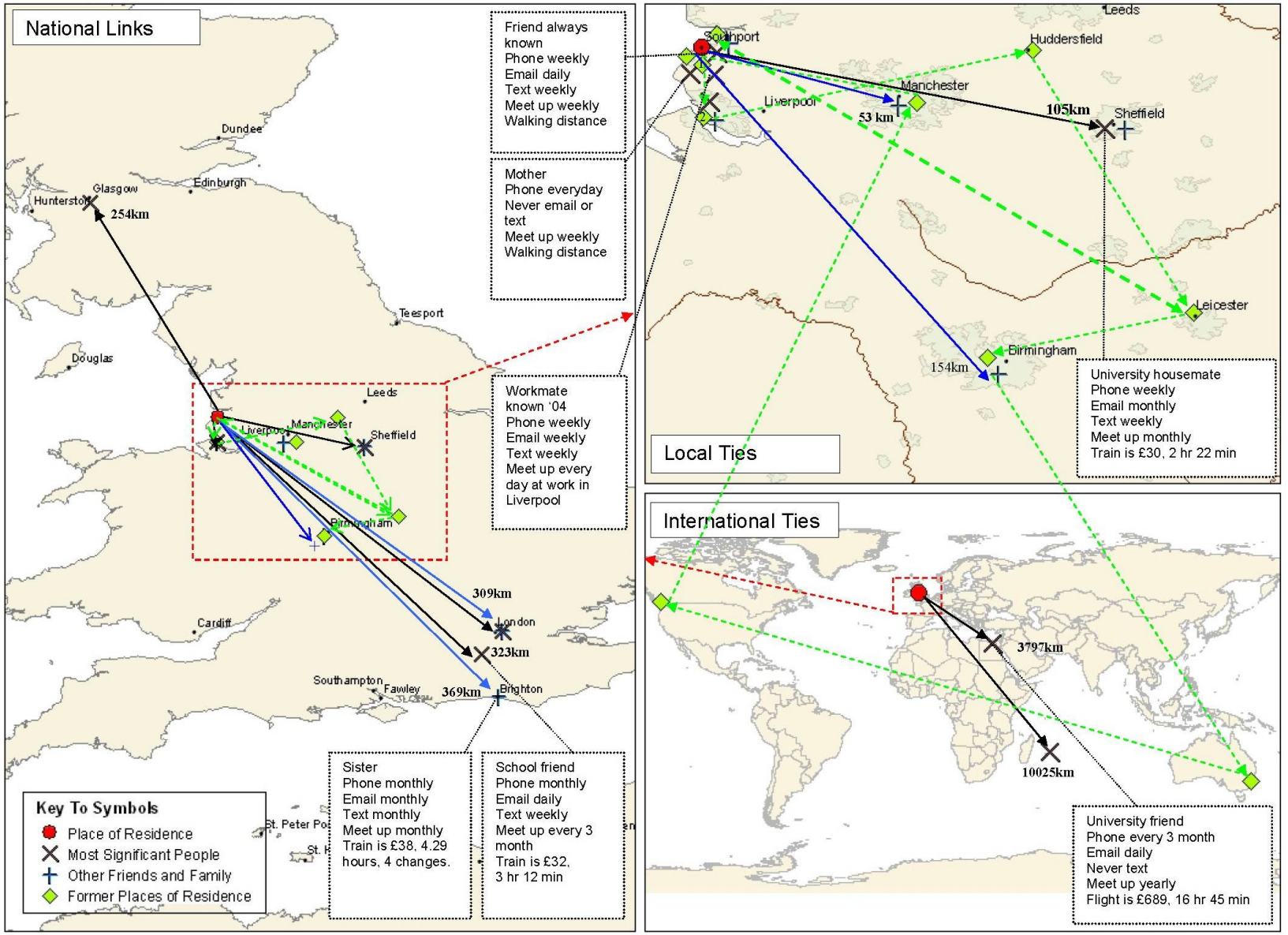
Commuter catchment areas of the 10 biggest Swiss cities



Nach Botte, 2003

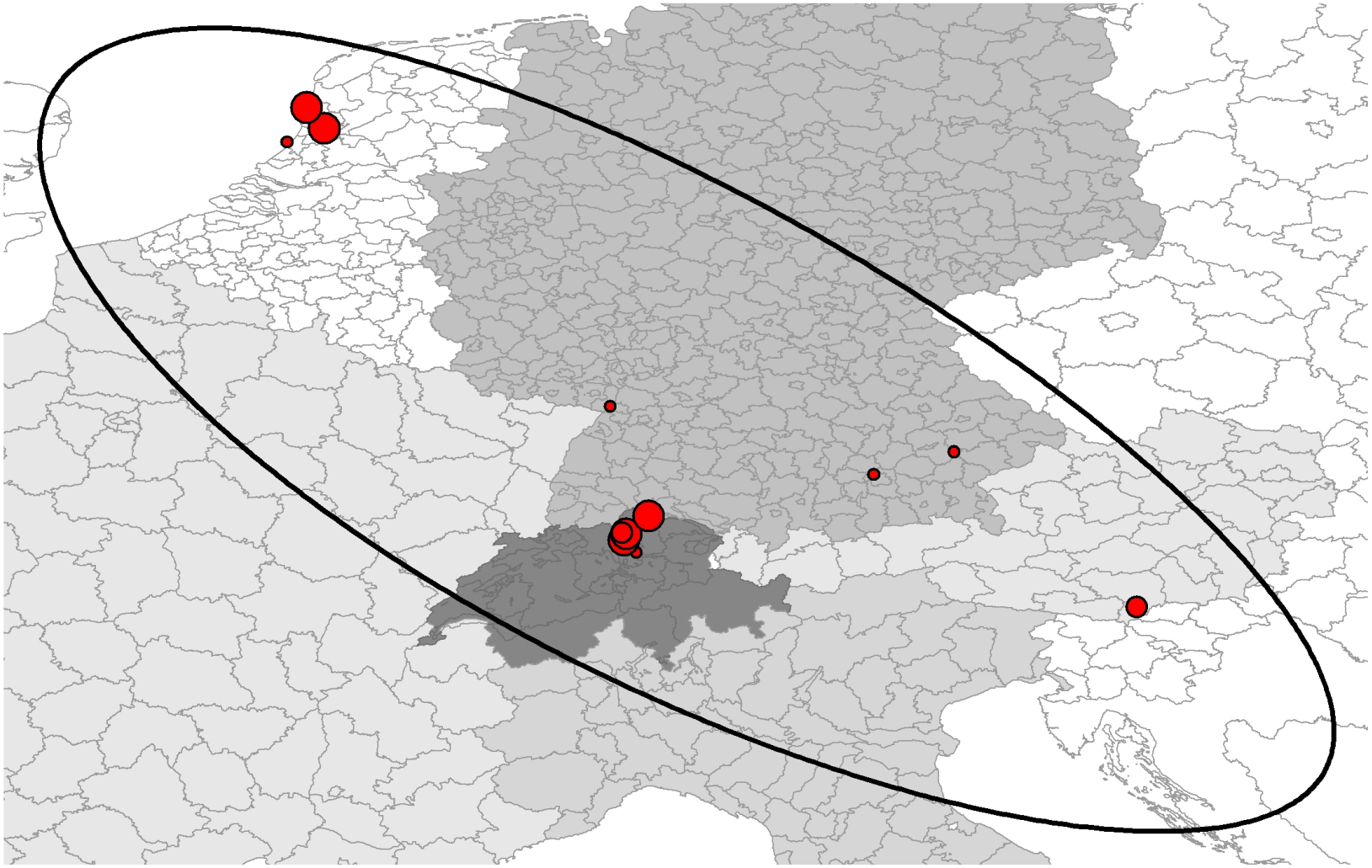
Transport and social networks

An example biography (UK architect)



Larsen, Urry and Axhausen, 2006

A social network geography

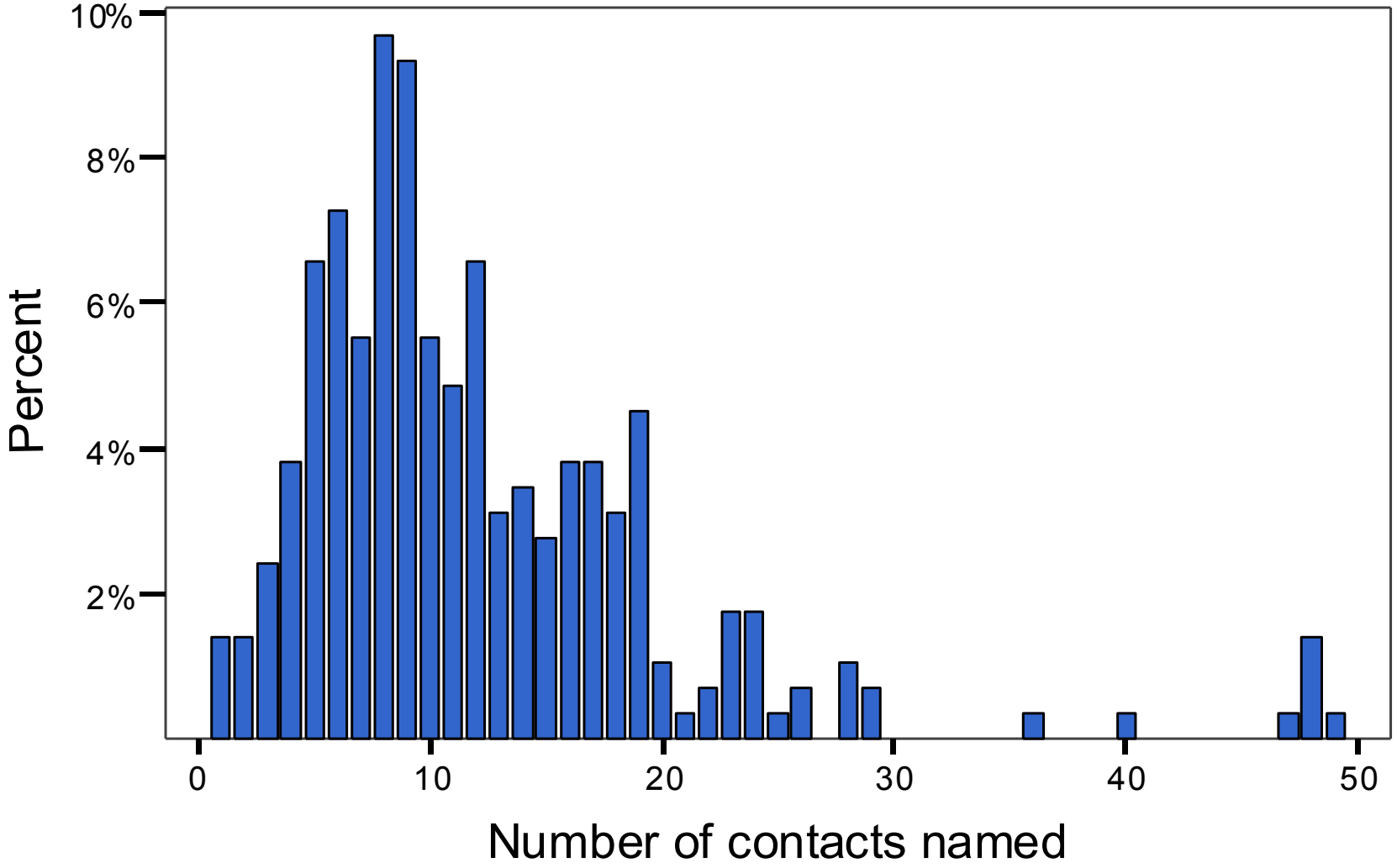


Reference conditions today

Social network surveys @ IVT

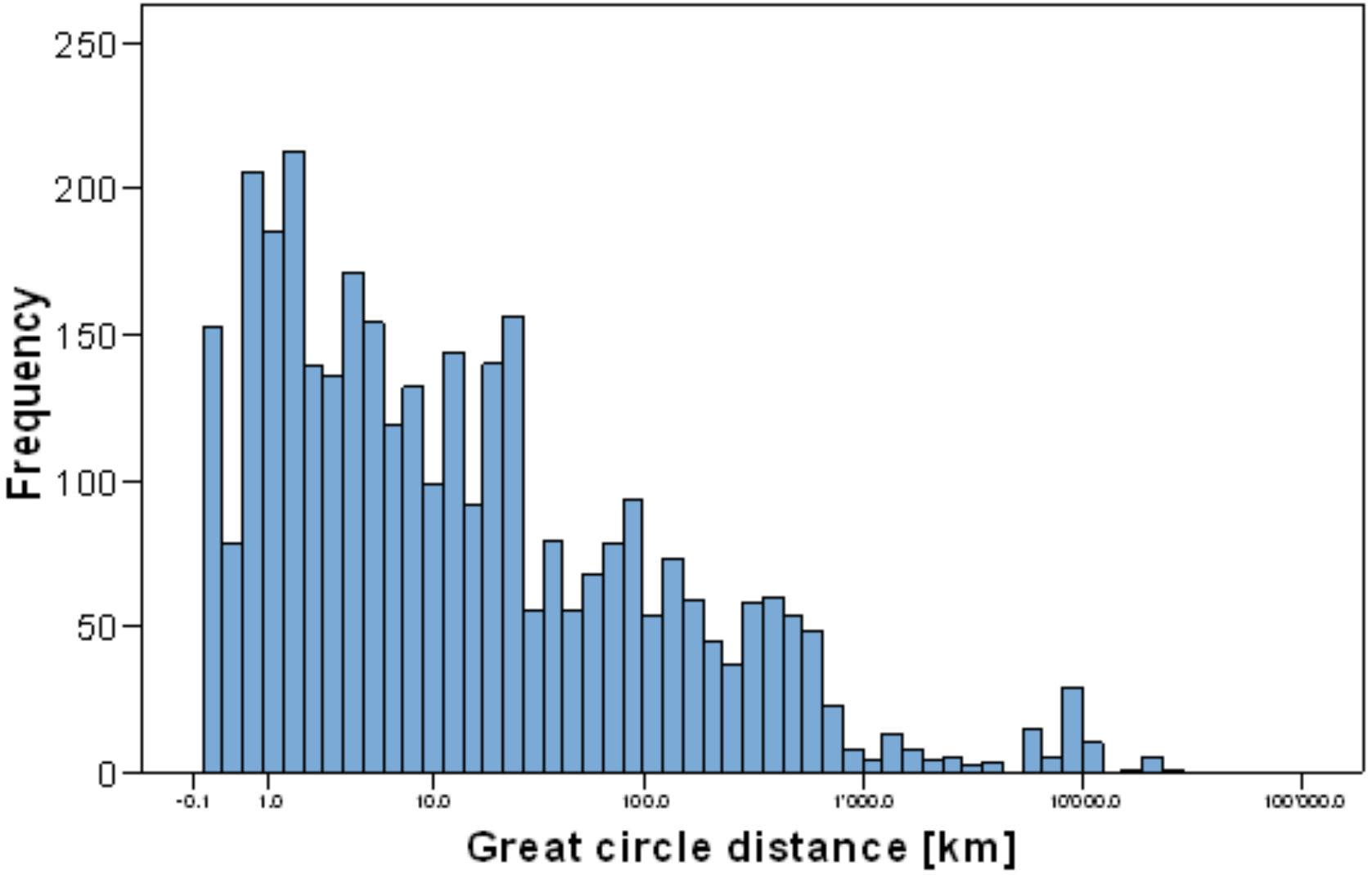
- Ohnmacht: 50 Egos Qualitative/Quantitative in Zürich
- Larsen/Urry: 24 Egos Qualitative/Quantitative in NE England
- Frei: 300 Egos Quantitative in Zürich
- Kowald: Schneeball; 750 Egos quantitative worldwide with starting person (ego) im Kanton Zürich

Degree distribution



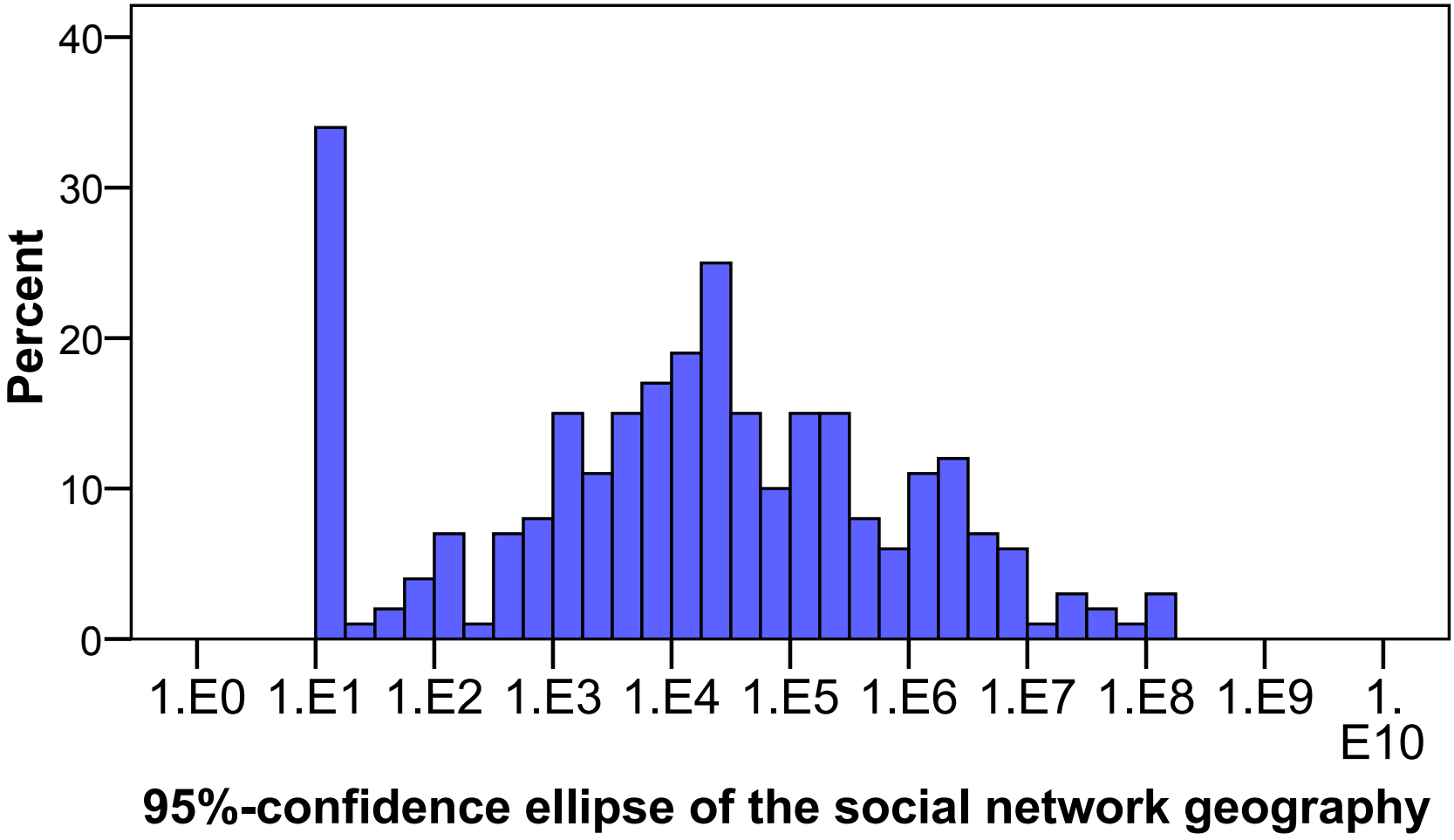
Frei and Axhausen, 2007

Distance distribution between home locations

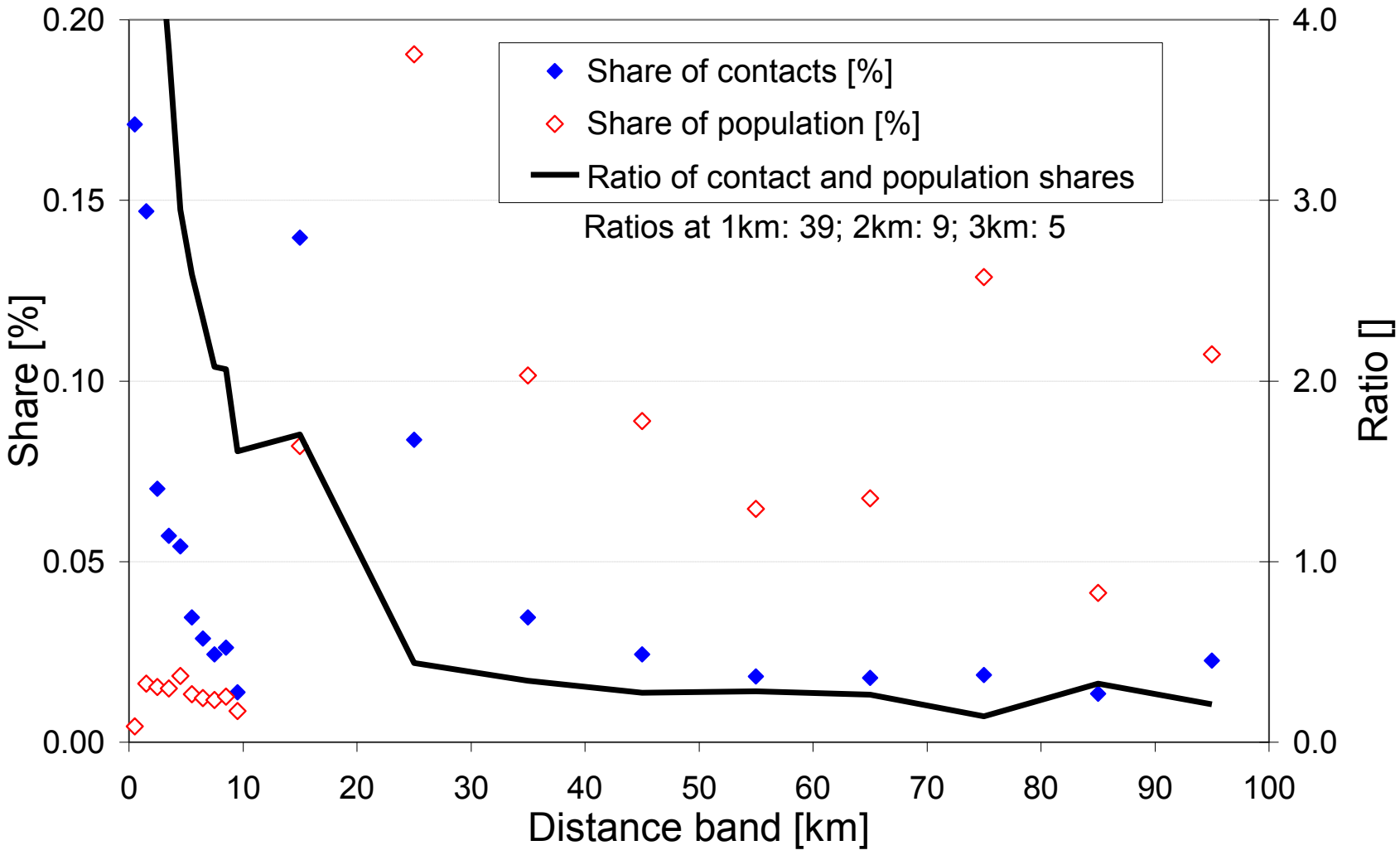


Frei and Axhausen, 2007

Distribution of the social network geographies

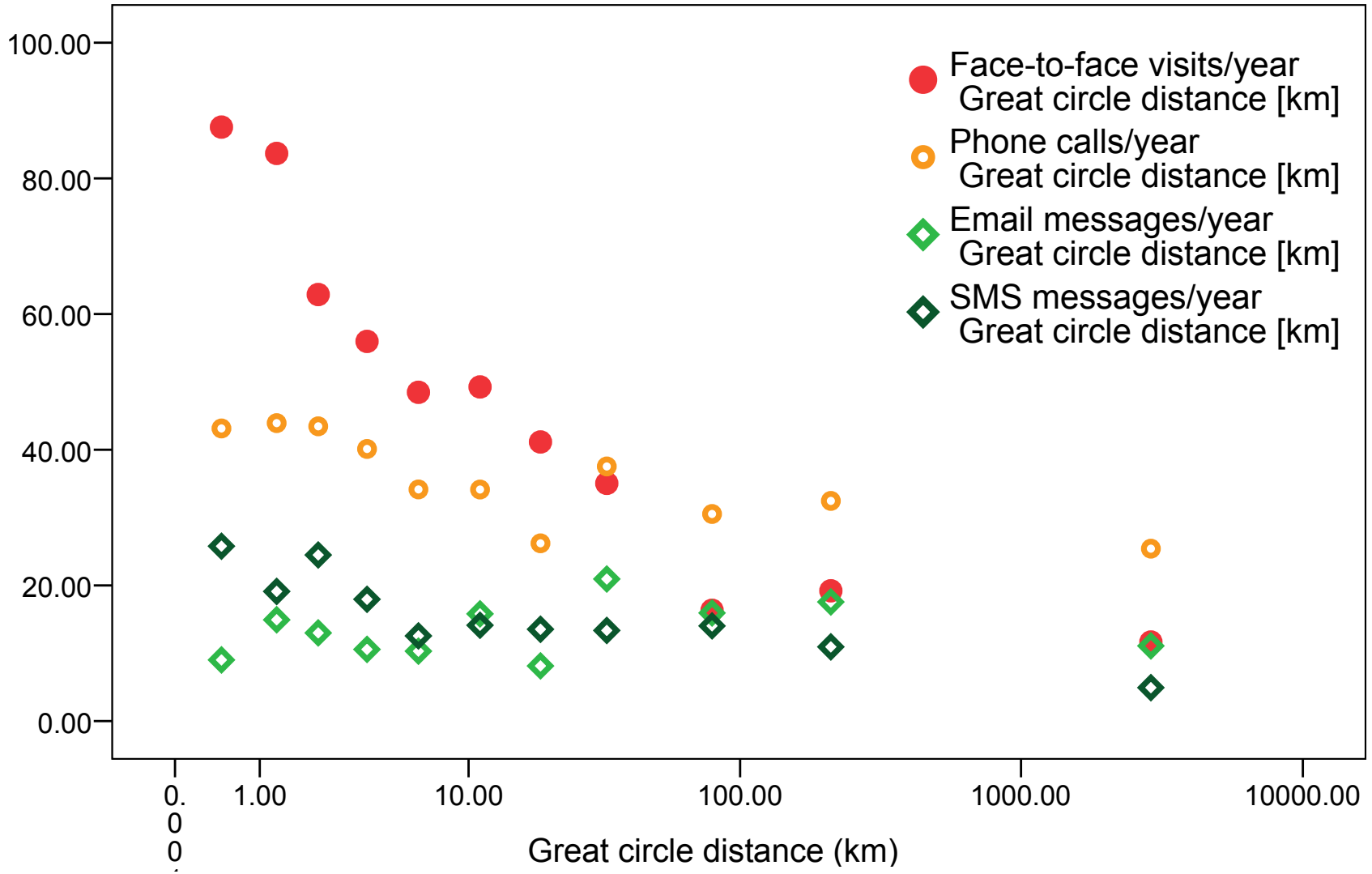


Contact to population ratio



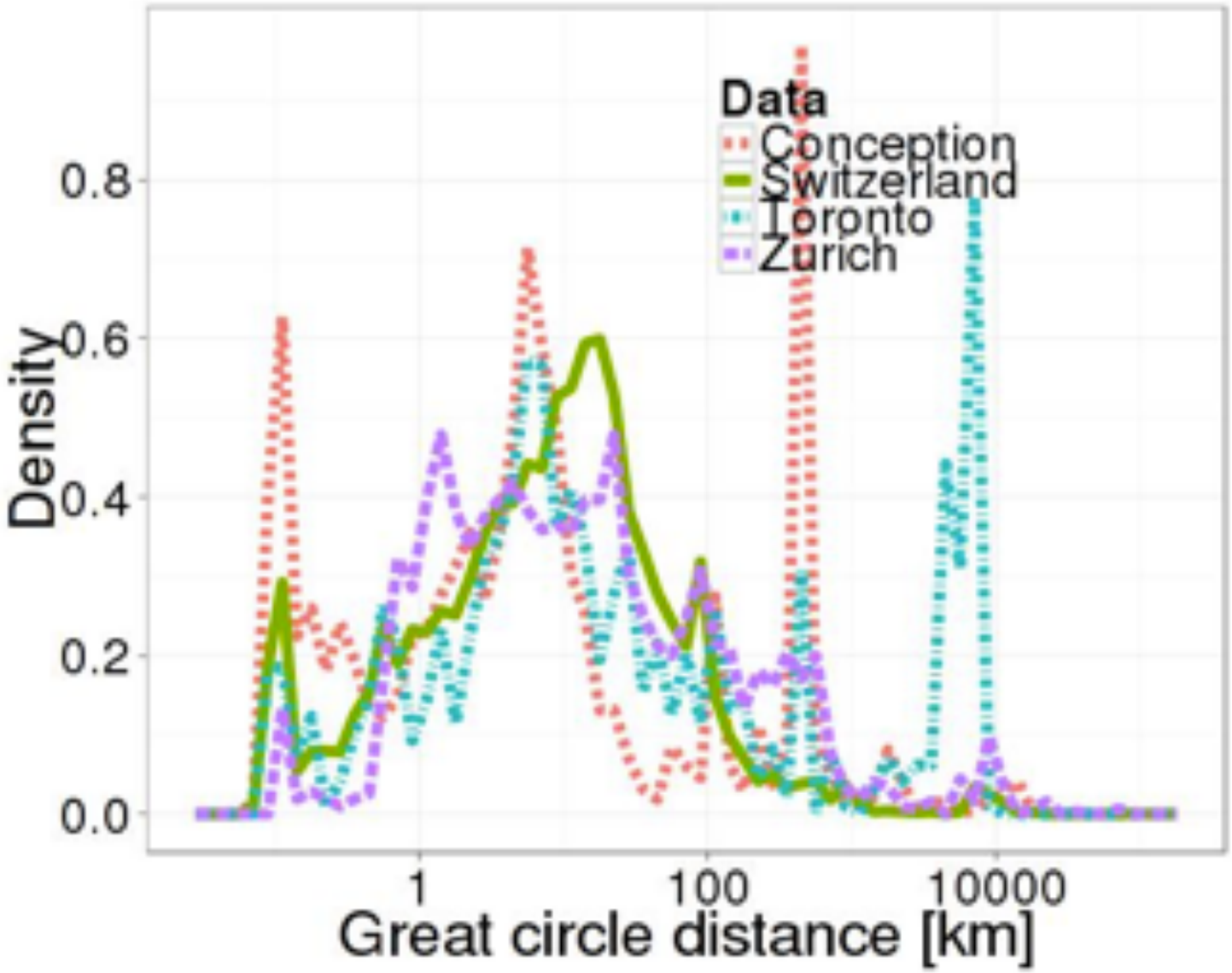
Frei and Axhausen, 2007

Channel choice

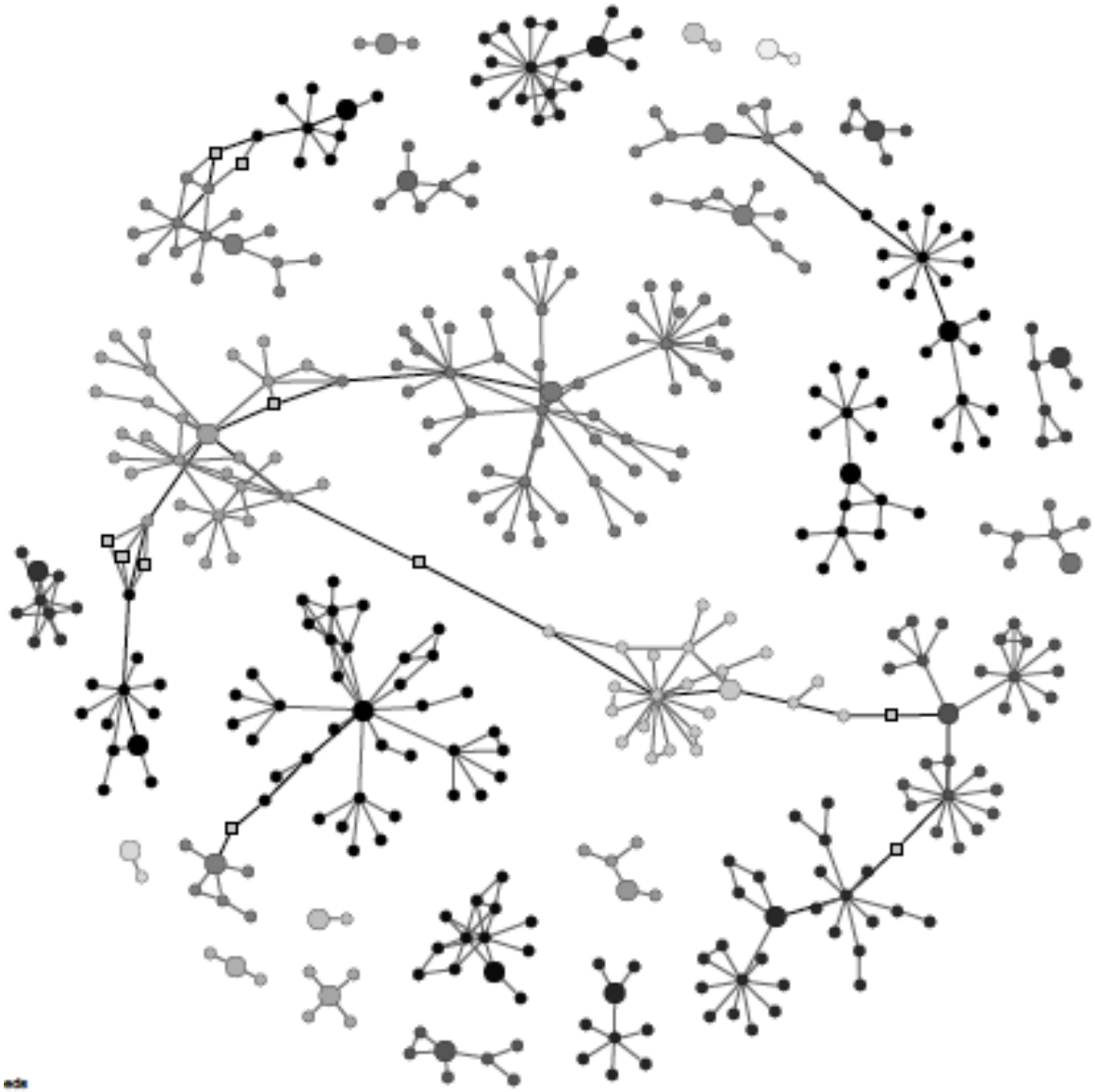


Frei and Axhausen, 2007

International comparison

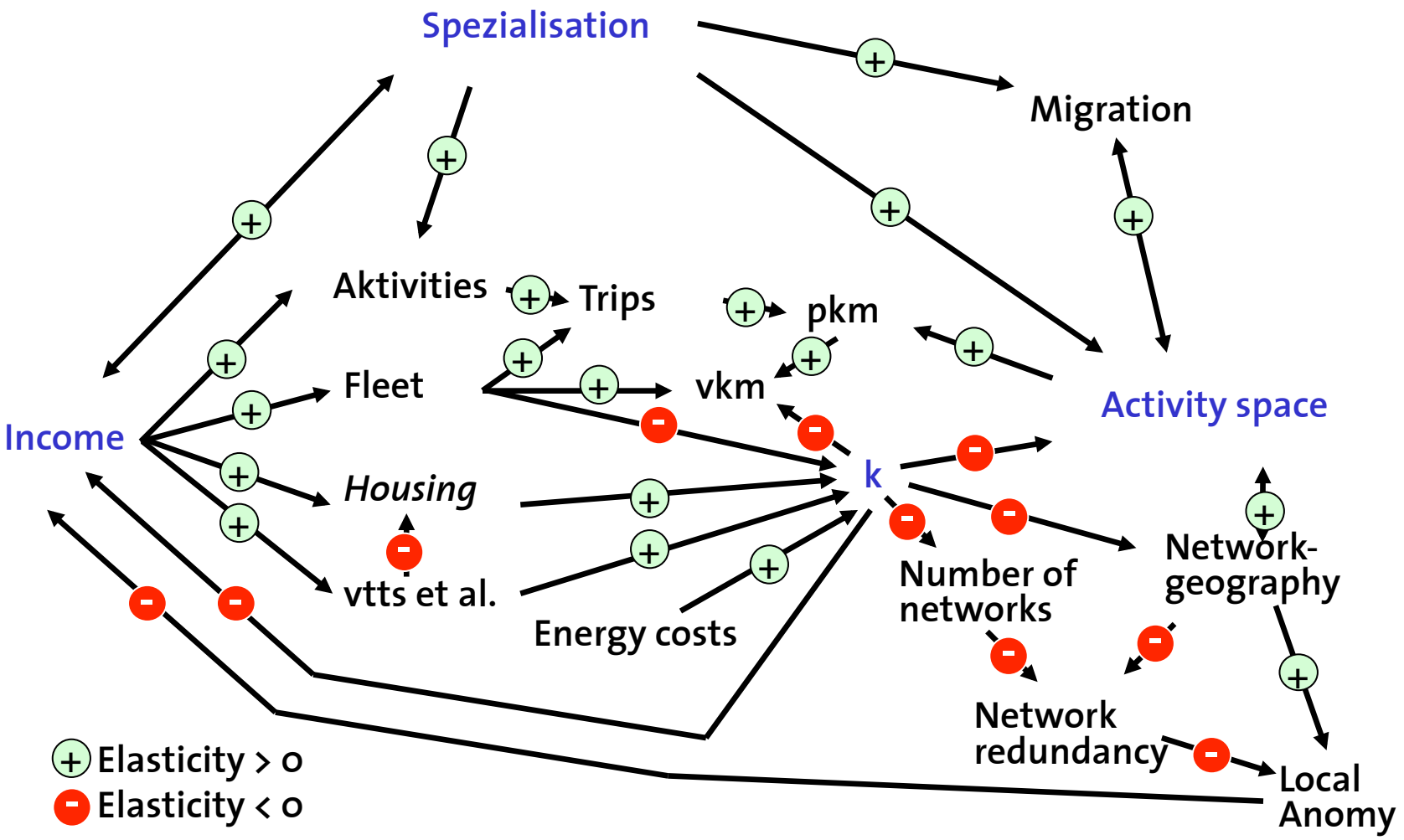


Social networks, e.g. Linked ego-centric networks



What next ?

Dynamics of activity spaces: A thought model



Questions ?

www.sustaincity.eu

www.matsim.org

www.ivt.ethz.ch

Literature

Arentze, T.A., M. Kowald and K.W. Axhausen (2012) A method to model population-wide social networks for large scale activity-travel micro-simulations, paper presented at the *91th Annual Meeting of the Transportation Research Board*, Washington, D.C., January 2012

Axhausen, K.W. (2000) Geographies of somewhere: A review of urban literature, *Urban Studies*, **37** (10) 1849-1864.

Axhausen, K.W. (2007) Activity spaces, biographies, social networks and their welfare gains and externalities: Some hypotheses and empirical results, *Mobilities*, **2** (1) 15-36.

Axhausen, K.W. (2008) Social networks, mobility biographies and travel: survey challenges, *Environment and Planning B*, **35** (6) 981-996.

Axhausen, K.W. and A. Frei (2007) Contacts in a shrunken world, *Arbeitsbericht Verkehrs- und Raumplanung*, **440**, IVT, ETH Zürich, Zürich.

Belart, B. (2011) Wohnstandortwahl im Grossraum Zürich, Master Thesis, , ETH Zurich, Zurich.

Bierlaire M., D. Bolduc and D. McFadden (2008) The estimation of generalized extreme value models from choice-based samples, *Transportation Research Part B*, **42** (4) 381-394.

Literature

Bierlaire, M., 2003. BIOGEME: a free package for the estimation of discrete choice models. In: Proceedings of the Third Swiss Transportation Research Conference, Ascona, Switzerland, www.strc.ch.

Bodenmann B.R. (2007) Modelle zur Standortwahl von Unternehmen, in T. Bieger, C. Lässer und R. Maggi (Hrsg.) Jahrbuch 2006/2007 Schweizerische Verkehrswirtschaft, SVWG, St. Gallen.

Bodenmann, B.R. (2011) Micro-simulation of firm's location choice, presentation at the *11th Swiss Transport Research Conference*, Ascona, May 2011.

Bodenmann, B.R. and K.W. Axhausen (2008) Schweizer Unternehmen - quo vaditis? Firmendemographische Trends am Beispiel des Wirtschaftsraums St. Gallen, *Raumforschung und Raumordnung RuR*, **66** (4) 15-28.

Botte, M. (2003) Strukturen des Pendelns in der Schweiz, Diplomarbeit, Fakultät für Bauingenieurwesen, TU Dresden, August 2003.

Dong, H. and J.P. Gliebe (2011) Forecasting the Location of New Housing in Integrated Land Use Models: Comparison of Three Approaches to the Developer's Perspective in the Portland Region, in *TRB 90th Annual Meeting Compendium of Papers DVD*, Transportation Research Board, paper presented at *Transportation Research Board 90th Annual Meeting*, Washington D.C, 2011.

Literature

Frei, A. and K.W. Axhausen (2007) Size and structure of social netowork geographies, *Arbeitsberichte Verkehrs- und Raumplanung*, **439**, IVT, ETH Zürich, Zürich.

Frei, A. and K.W. Axhausen (2011) Collective location choice model, paper presented *Arbeitsberichte Verkehrs- und Raumplanung*, **686**, IVT, ETH Zürich, Zürich

Gilbert, G.N. und K.G. Troitzsch (1999) Simulation as a method, in *Simulation for the social scientist*, Open University Press, Buckingham.

Grannis, R. (1998) The importance of trivial streets: Residential streets and residential segregation, *American Journal of Sociology,* **103 (**6) 1530-1564.

Gruber, R., R. Zbinden und W.A. Schmid (2000) Räumliche Effekte von Swissmetro, Modellsimulation der Auswirkungen von Verkehrsinfrastrukturänderungen, Teil ORL-ETHZ von Projekt F5, *Berichte des NFP 41 "Verkehr und Umwelt"*, BBL/EDMZ, Bern.

Illenberger, J., M. Kowald, K.W. Axhausen and K. Nagel (2011) Insights into a spatially embedded social network from a larger-scale snowball sample, *European Physical Journal B*, **84** (4) 549-563.

Kowald M. and K.W. Axhausen (2011) Surveying data on connected personal networks, Arbeitsberichte Verkehrs- und Raumplanung, 722, IVT, ETH Zürich, Zürich.

Literature

Larsen, J., J. Urry and K.W. Axhausen (2006) *Mobilities, Networks, Geographies*, Ashgate, Aldershot.

Löchl, M., M. Bürgle and K. W. Axhausen (2007a) Implementierung des integrierten Flächennutzungsmodells UrbanSim für den Grossraum Zürich – ein Erfahrungsbericht, *disP*, **168**, 13–25.

Löchl, M., M. Bürgle und K.W. Axhausen (2007): Implementierung des integrierten Flächennutzungsmodells UrbanSim für den Grossraum Zürich – ein Erfahrungsbericht, DISP, **168**, 13-25.

Maoh, H.F. and P.S. Kanaroglou (2005) Agent-Based Firmographic Models: A Simulation Framework for the City of Hamilton, *PROCESSUS 2nd International Colloquium on the Behavioural Foundations of Integrated Land-use and Transportation Models: Frameworks, Models and Applications*, Toronto, June 2005.

Putnam, R.D. (1999) *Bowling Alone: The collapse and revival of American community*, Schuster and Schuster, New York.

Schirmer, P., B. Belart and K. W. Axhausen (2011) Location choice in the greater Zurich area, paper presented at the *11th Swiss Transport Research Conference*, Ascona, May 2011.

Schirmer, P., C. Zöllig, B. Bodenmann, K. Müller and K.W. Axhausen (2011): Current works on UrbanSim at the IVT, *UrbanSim Workshop: Developing Common Data Structures for Urban Modeling and 3D-Visualisation,* Zurich, February 2011.

Literature

Schlich, R., B. Kluge, S. Lehmann und K.W. Axhausen (2002) Durchführung einer 12-wöchigen Langzeitbefragung, *Stadt Region Land,* **73**, 141-154.

Spiekermann, K. und M. Wegener (2008) Modelle in der Raumplanung I, präsentier in *Modelle in der Raumplanung*, Universität Dortmund, August 2008.

SustainCity (2011) The SustainCity project, www.sustaincity.org.