

Estimating the agglomeration effects of public transport improvements: the case of Switzerland

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Presentation's Outline

- Introduction – background
- Methodology
- Case study
- Estimation and comparison of models
- Conclusions
- Next steps

Introduction – background

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Introduction – background

“Throughout the evolution of human settlements, there is only one factor which defines their extent: the distance man wants to go or can go in the course of his daily life. The shortest of the two distances defines the extent of the real human settlement, through definition of a daily urban system” (Doxiadis 1970).

Introduction – background

Transportation aspect defines the spatial extent of human settlements

- *Different than the physical structure (built-up area)*
- *Different than the institutional frame*

Urban agglomeration: specify the extent of human settlements around main cities that major economic activities are concentrated

Spatial concentration of activities, externalities arise that can lead to positive effects on productivity.

Introduction – background

Three main mechanisms are responsible for agglomeration economy benefits (Duranton and Puga, 2004):

- Sharing
- Matching
- Learning

Public transport improvements are capable of having substantial external benefits (Chatman and Noland, 2011)

- increase the accessibility between firms
- Increase the accessibility among firms and labor force

Methodology

- Introduction – background
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Methodology

Dependent variable: Productivity

$$\text{productivity} = \beta X + \varepsilon$$

Two components of the model:

- 1) Employment data
- 2) Travel Accessibility

$$A_i = \sum O_j * e^{\beta * c_{ij}}$$

Methodology

Geographically Weighted Regression model (GWR), (Fotheringham et al. ,1998), non stationary spatial regression model

Unlike the "global" approach of the linear regression, GWR as a "local" model does not provide single statistical estimates, but spatial-aware distributions of these parameters

$$y_i = \beta_0(u_i, v_i) + \sum_{i=1}^k \beta_k(u_i, v_i) x_i + \varepsilon_i$$

with (u_i, v_i) the coordinates of the point i

$\beta_k(u_i, v_i)$ a known continuous function at the point i

Case study

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Case study

Objectives

- Identify and quantify of the agglomeration economy effects in Switzerland
- Understand how the impact of public transport improvements
 - Isolate the transport effects from other possible sources of productivity gains
 - Isolate the public transport effects from the private transport ones

Case study

Dependent variable: Productivity ~ Mean salary

Public transport improvements are capable of having substantial external benefits (Chatman and Noland, 2011)

- increase the accessibility between firms
- **Increase the accessibility among firms and labor force**

Case study

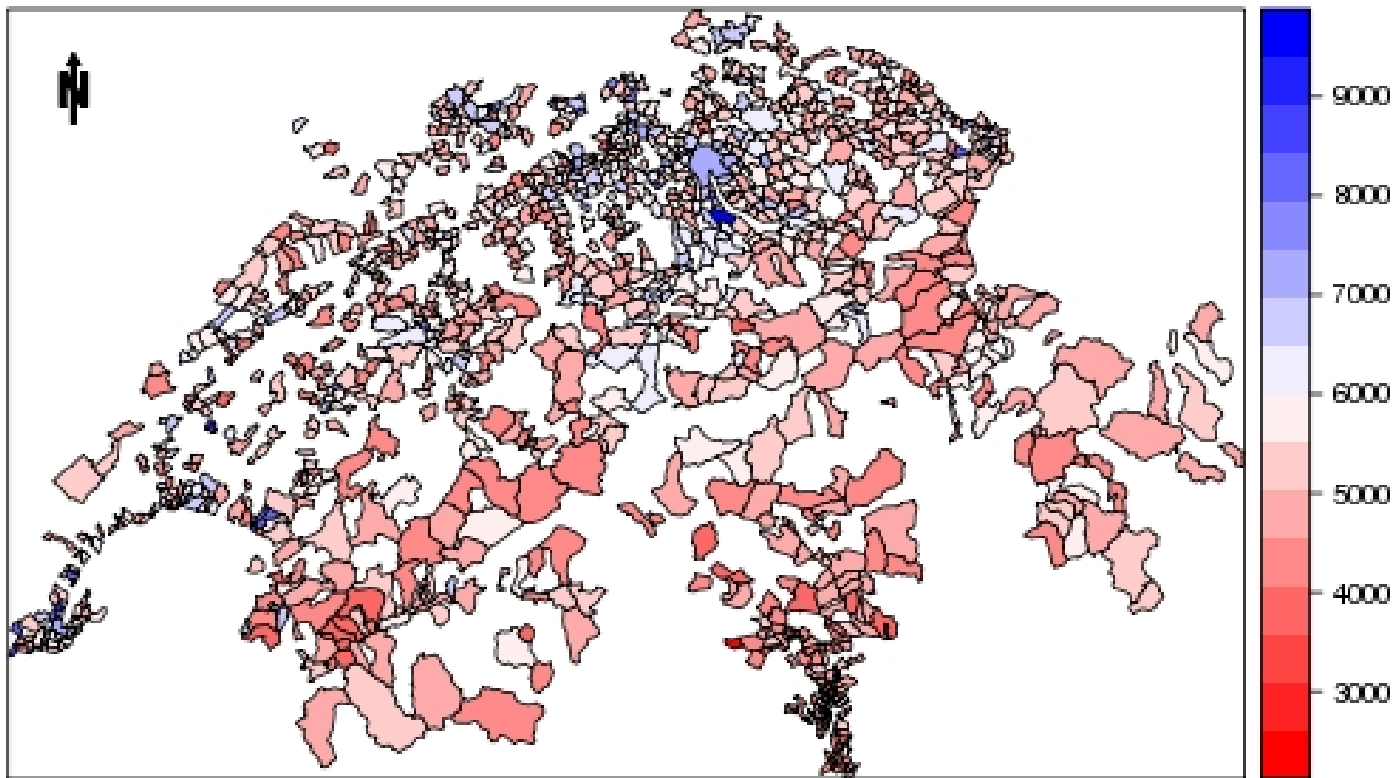
Data from Switzerland, 2000-2005-2010

Salary data per individual per post-code, aggregated per municipality

Calculation of population travel accessibilities for car and public transport (time corrected β estimates)

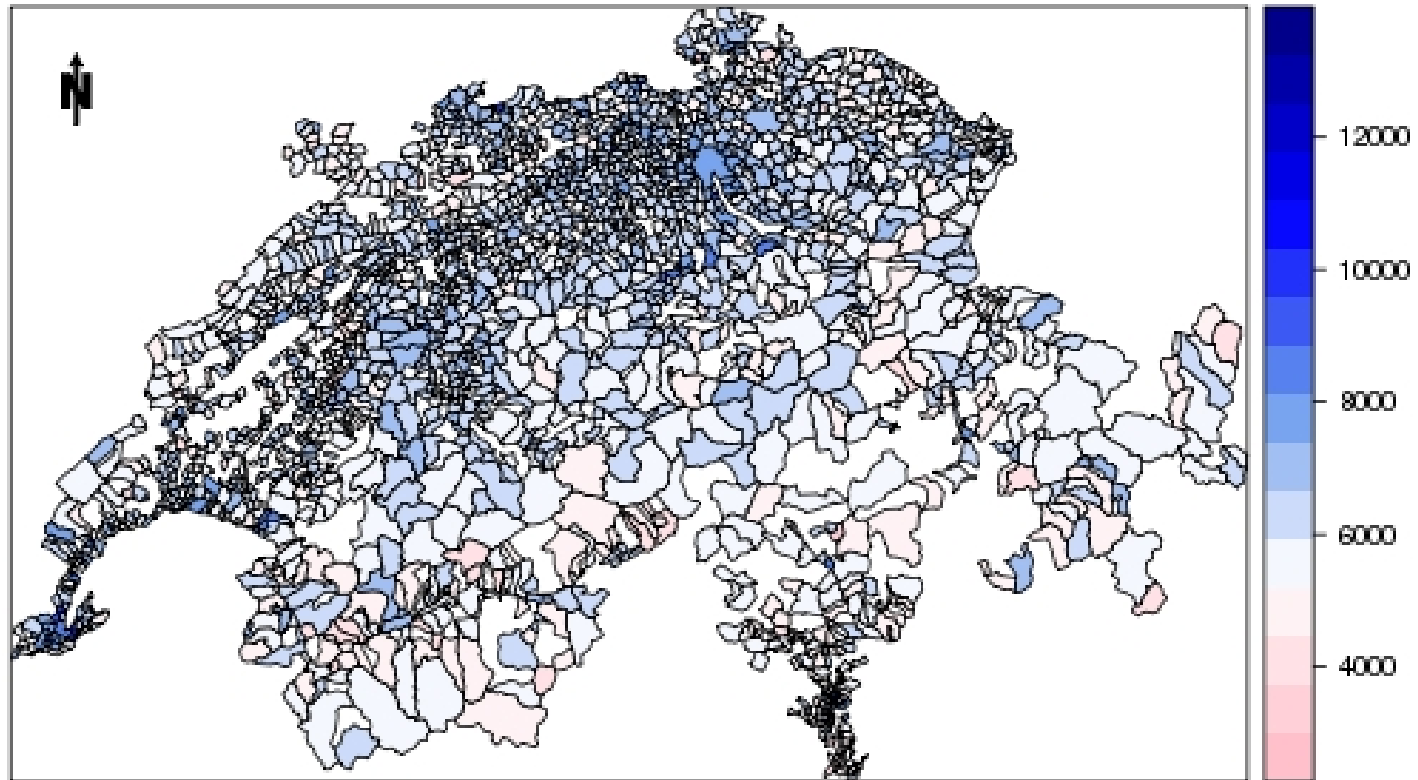
Case study

Mean salary per municipality, 2000



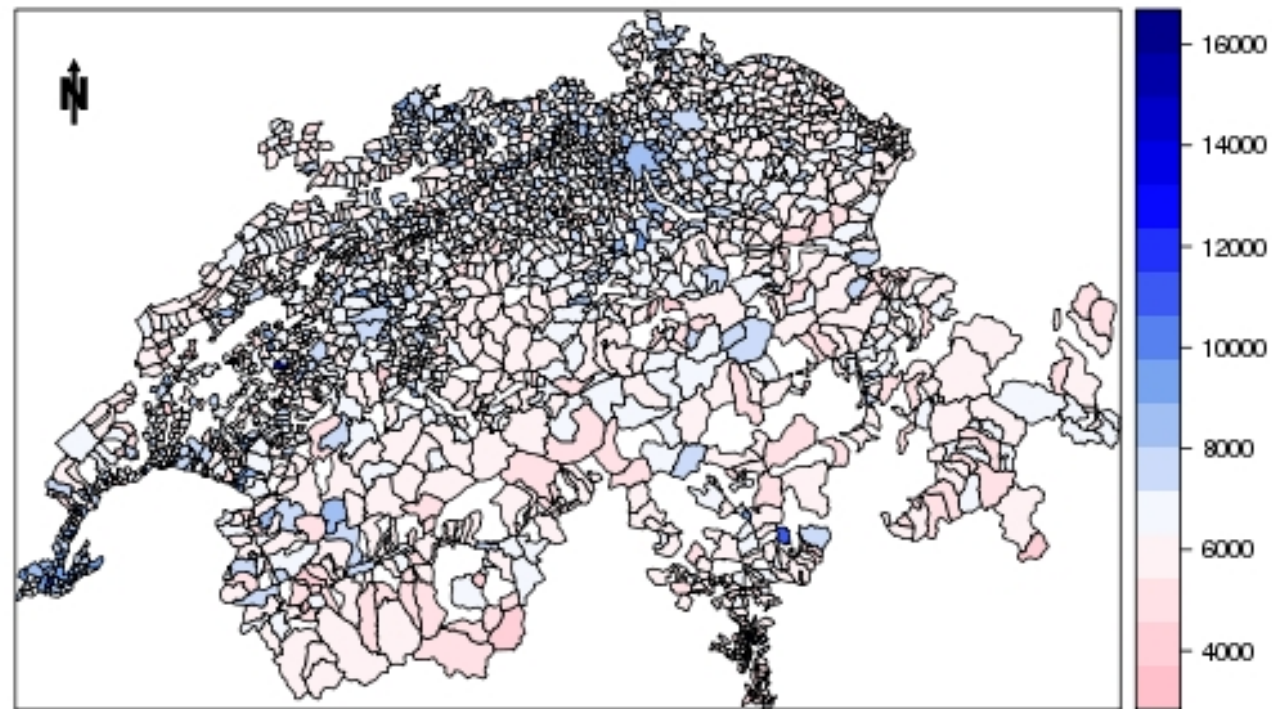
Case study

Mean salary per municipality, 2005

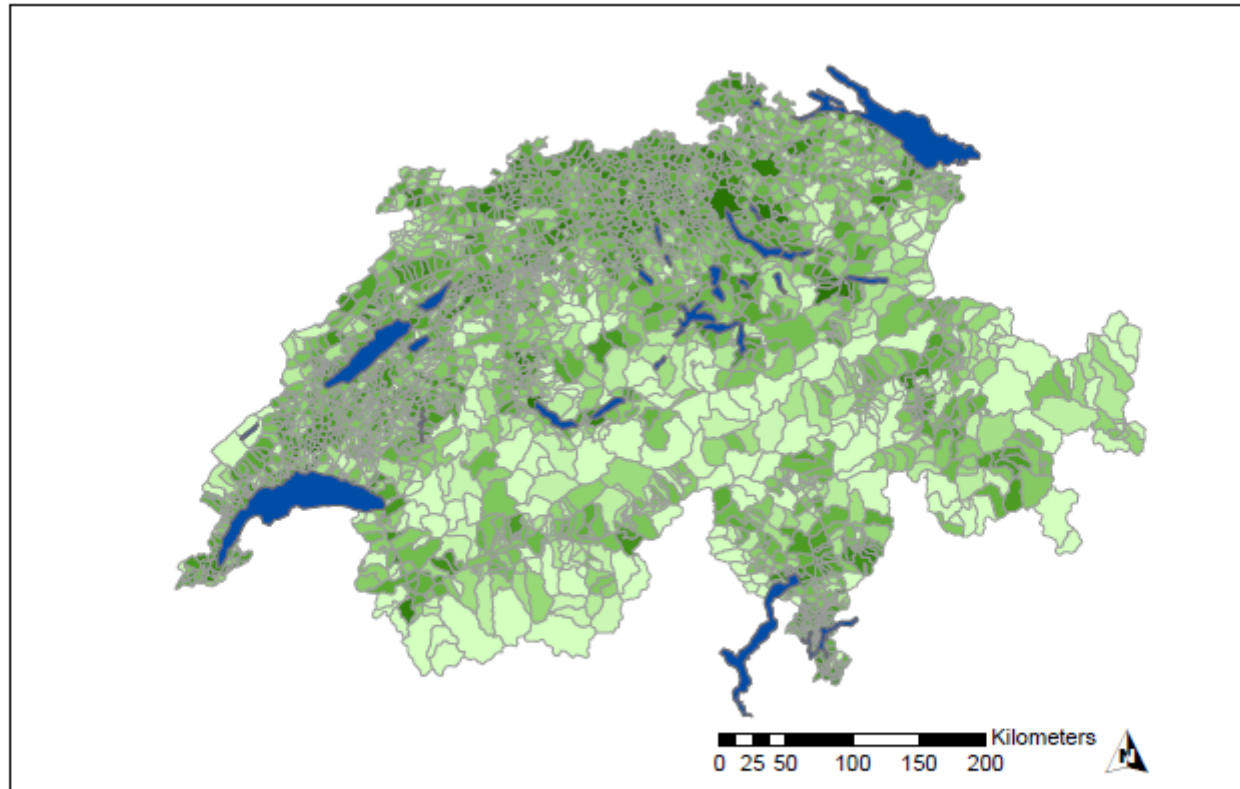


Case study

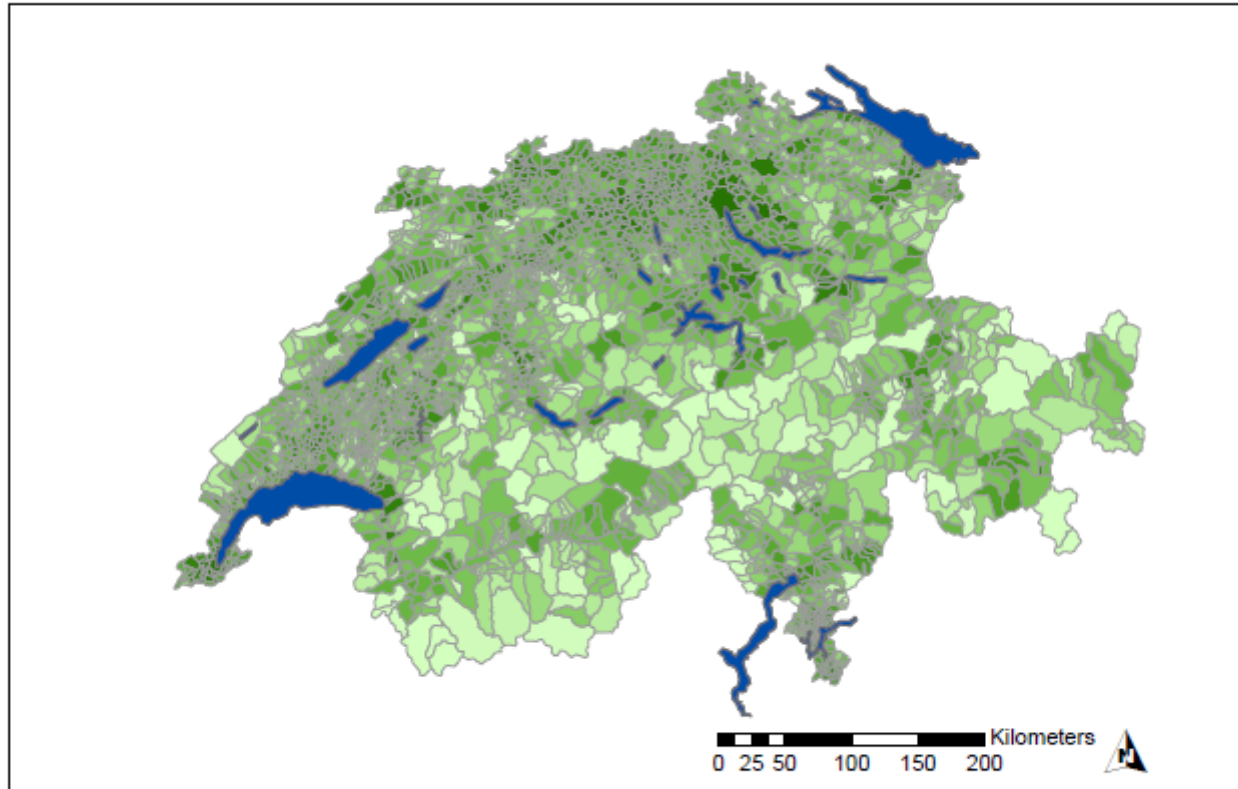
Mean salary per municipality, 2010



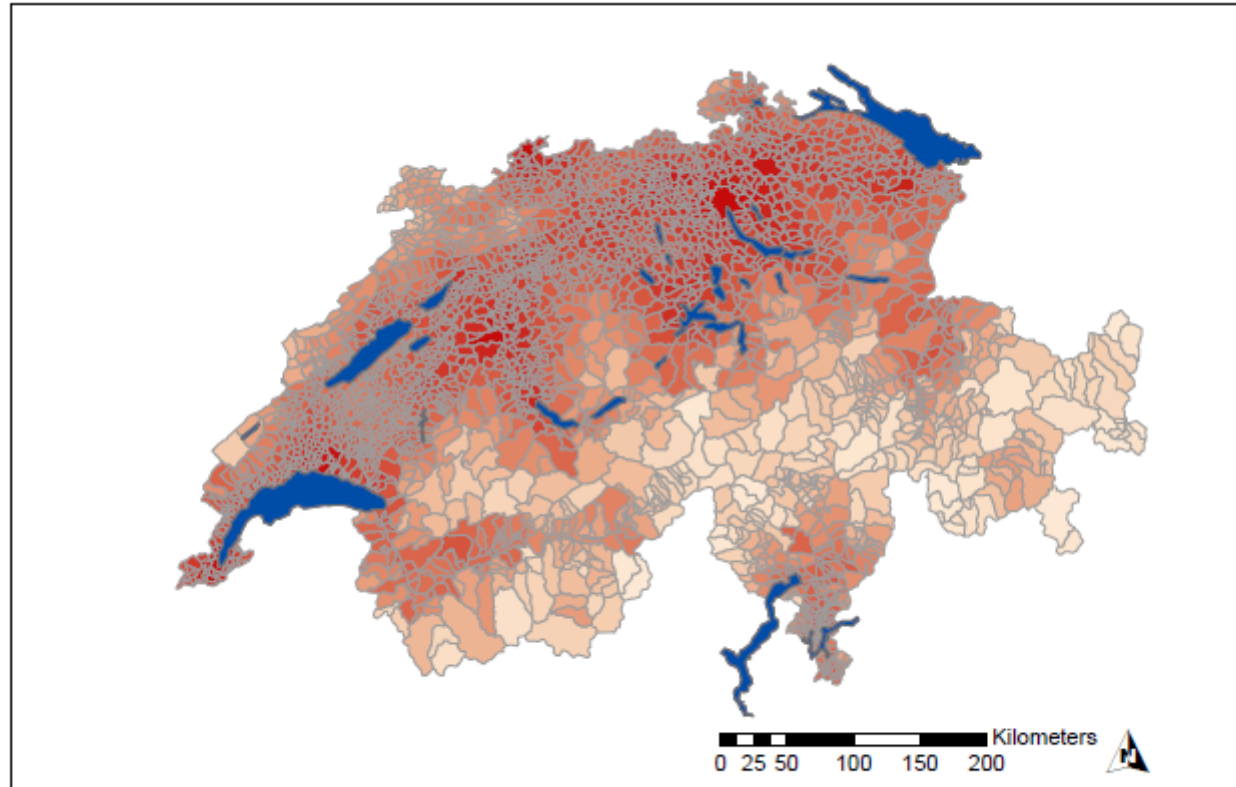
Population Travel accessibility by public transport: 2000



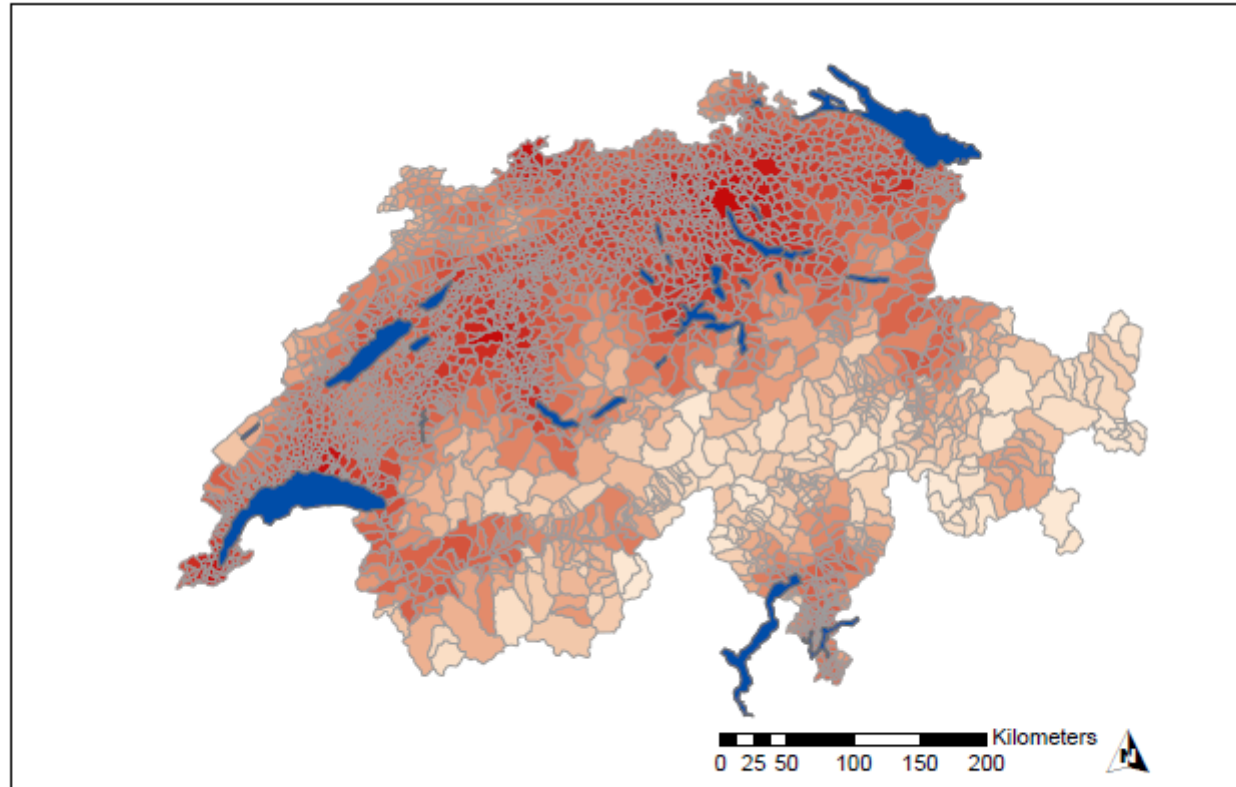
Population Travel accessibility by public transport: 2010



Population Travel accessibility by car: 2000



Population Travel accessibility by car: 2010



Estimation and comparison of models

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Estimation and comparison of models - 2000

Variable	Estimate	Std. Error	t-value	significance
(Intercept)	7.4604	0.0613	121.6330	***
education 1	1.0625	0.0648	16.3880	***
education 2	0.4334	0.0635	6.8210	***
education 3	0.2222	0.0566	3.9290	***
education 4	0.1460	0.0766	1.9050	.
education 5	0.4803	0.1231	3.9020	***
education 6	0.0598	0.0207	2.8900	**
log(PuT accessibility)	0.0015	0.0017	0.8740	
log(car accessibility)	0.0248	0.0034	7.3840	***
log(employment)	0.0155	0.0024	6.3980	***
swiss_5year_permit	0.0918	0.0242	3.7910	***
qualifications 1	0.4396	0.0901	4.8800	***
qualifications 2	0.2413	0.0315	7.6480	***
qualifications 3	0.1344	0.0213	6.3090	***
private sector	-0.1004	0.0174	-5.7750	***
empl. manufactory	-0.2023	0.0604	-3.3490	***
empl. banks and real estate	0.0854	0.0423	2.0190	*
employment years	0.0033	0.0012	2.6860	**
empl.hotels&rest	0.0089	0.0014	6.5110	***
men	-0.1420	0.0249	-5.6980	***
age	0.2436	0.0189	12.8710	***
Adjusted R	0.6646			
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Estimation and comparison of models - 2005

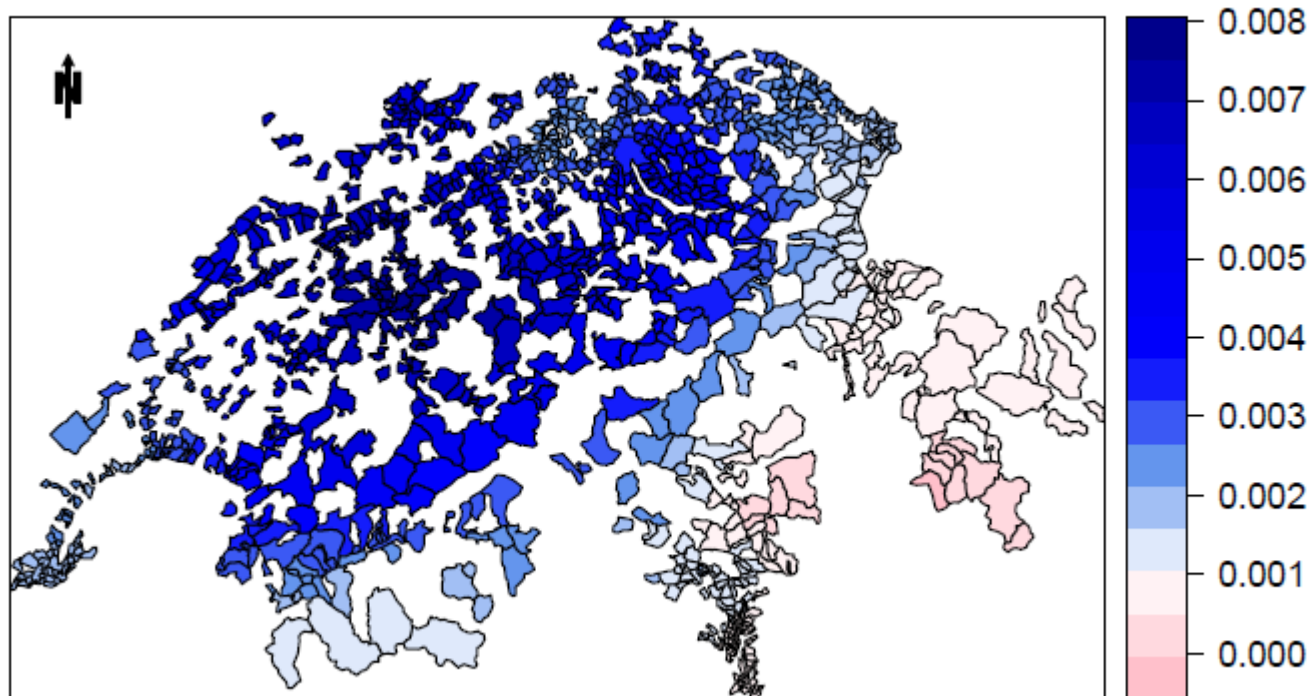
Variable	Estimate	Std. Error	t-value	significance
(Intercept)	7.6471	0.0490	156.0030	***
education 1	0.7881	0.0483	16.3130	***
education 2	0.2893	0.0285	10.1380	***
education 3	0.2552	0.0375	6.8010	***
education 4	0.1914	0.0380	5.0350	***
education 5	0.2545	0.0975	2.6110	**
education 6	0.0615	0.0187	3.2880	**
log(PuT accessibility)	0.0010	0.0013	0.7350	
log(car accessibility)	0.0278	0.0025	11.2490	***
log(employment)	0.0144	0.0016	9.2610	***
swiss_5year_permit	0.0152	0.0180	0.8440	
qualifications 1	0.4242	0.0504	8.4140	***
qualifications 2	0.2482	0.0219	11.3110	***
qualifications 3	0.1931	0.0195	9.8880	***
private sector	-0.0721	0.0124	-5.8180	***
empl. manufactory	-0.2169	0.0245	-8.8590	***
employment years	0.0072	0.0011	6.6530	***
age	0.0075	0.0010	7.2010	***
empl.hotels&rest	-0.1548	0.0217	-7.1230	***
men	0.1105	0.0149	7.3960	***
Adjusted R	0.6104			

Estimation and comparison of models - 2010

Variable	Estimate	Std. Error	t-value	significance
(Intercept)	7.8042	0.0548	142.5190	***
education 1	0.5862	0.0341	17.1910	***
education 2	0.2797	0.0276	10.1280	***
education 3	0.1814	0.0347	5.2270	***
education 4	0.2922	0.0277	10.5650	***
log(PuT accessibility)	-0.0003	0.0016	-0.1620	
log(car accessibility)	0.0222	0.0028	7.8590	***
log(employment)	0.0137	0.0017	7.9240	***
swiss_5year_permit	0.0320	0.0183	1.7490	.
qualifications 1	0.5775	0.0558	10.3490	***
qualifications 2	0.2666	0.0207	12.8660	***
qualifications 3	0.1716	0.0198	8.6770	***
private sector	-0.0625	0.0138	-4.5310	***
empl. manufactory	-0.1540	0.0343	-4.4870	***
empl. banks and real estate	0.1090	0.0500	2.1780	*
employment years	0.0040	0.0012	3.2680	**
age	0.0067	0.0011	5.9670	***
empl.hotels&rest	-0.1080	0.0221	-4.8940	***
men	0.1657	0.0164	10.1300	***
Adjusted R	0.5641			

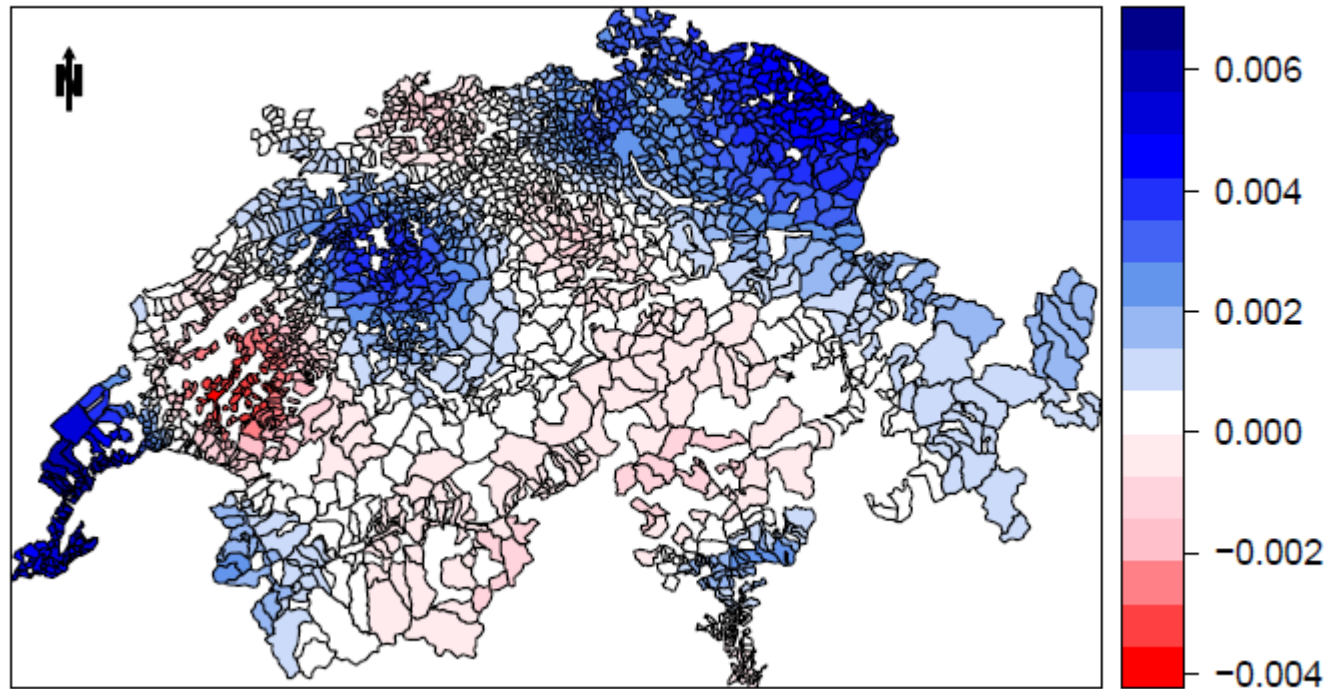
Estimation and comparison of models

GWR: Public transport accessibility co-efficient, 2000



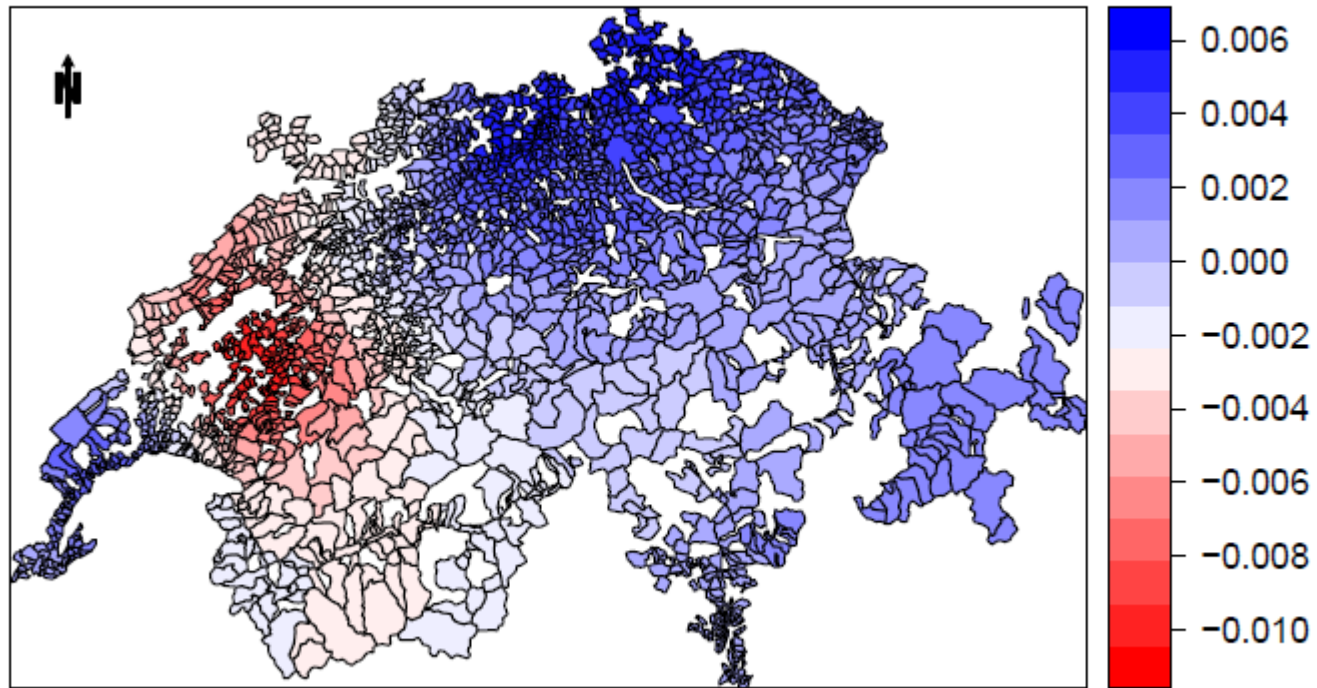
Estimation and comparison of models

GWR: Public transport accessibility co-efficient, 2005



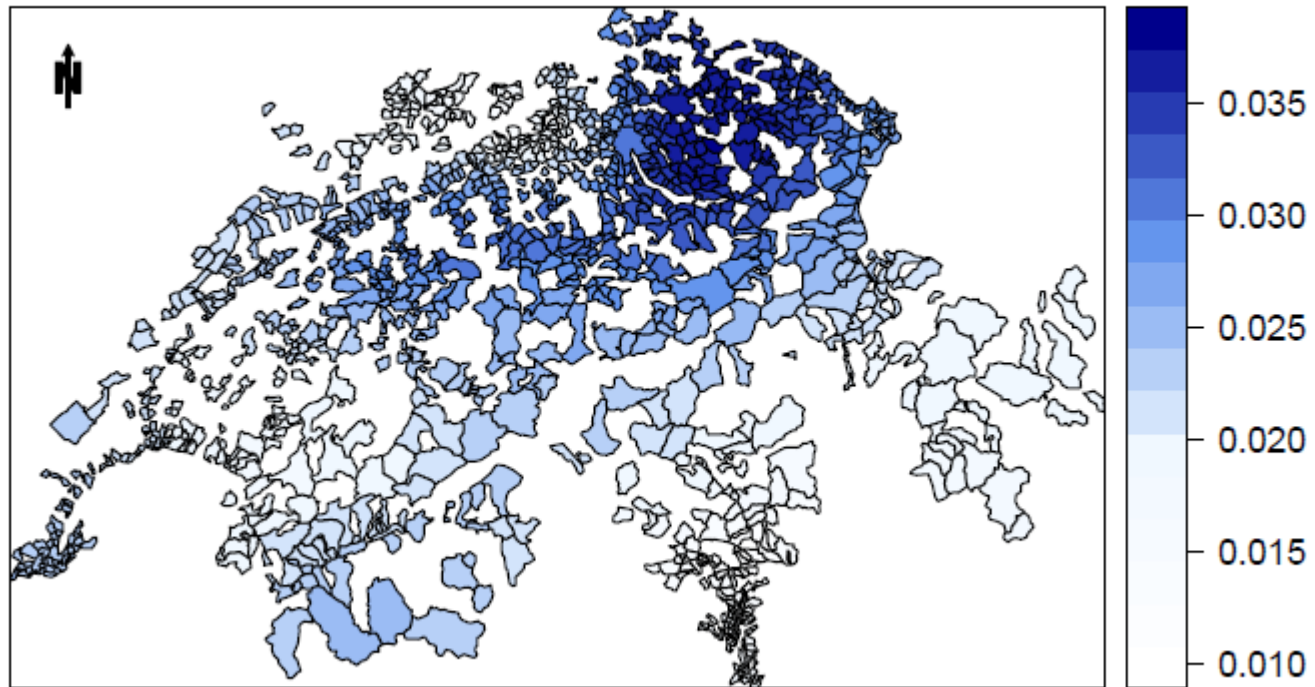
Estimation and comparison of models

GWR: Public transport accessibility co-efficient, 2010



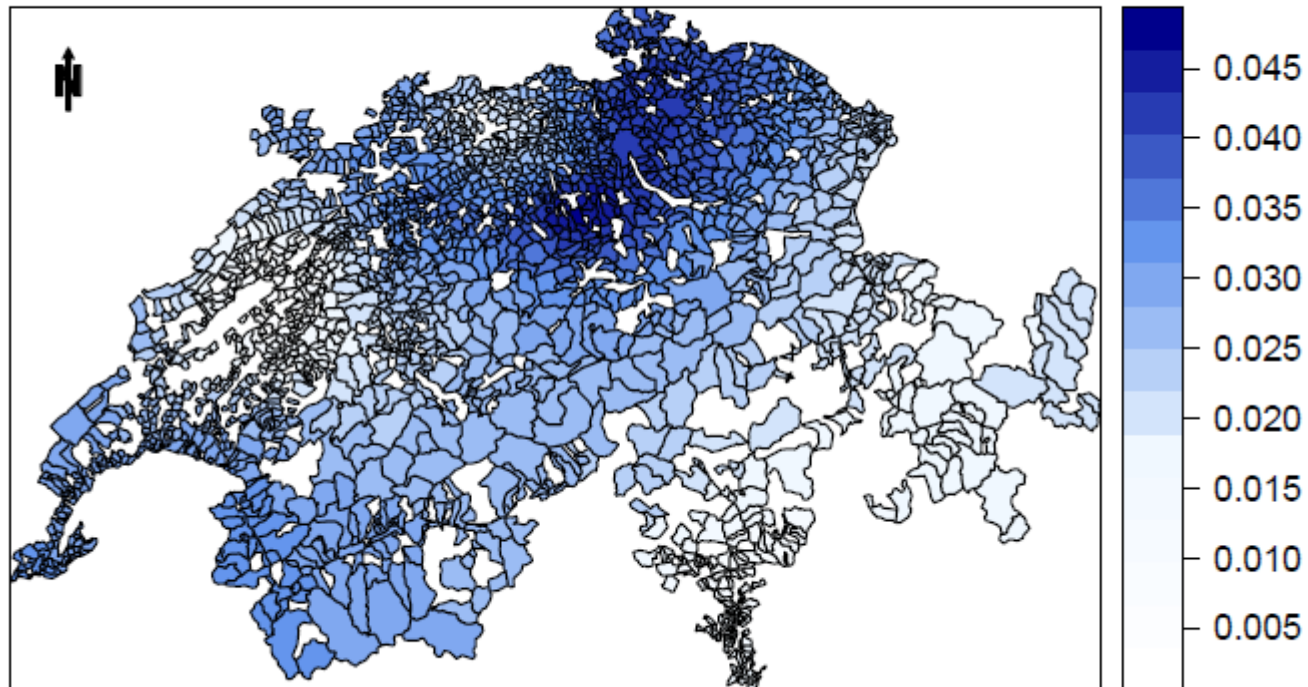
Estimation and comparison of models

GWR: Car accessibility co-efficient, 2000



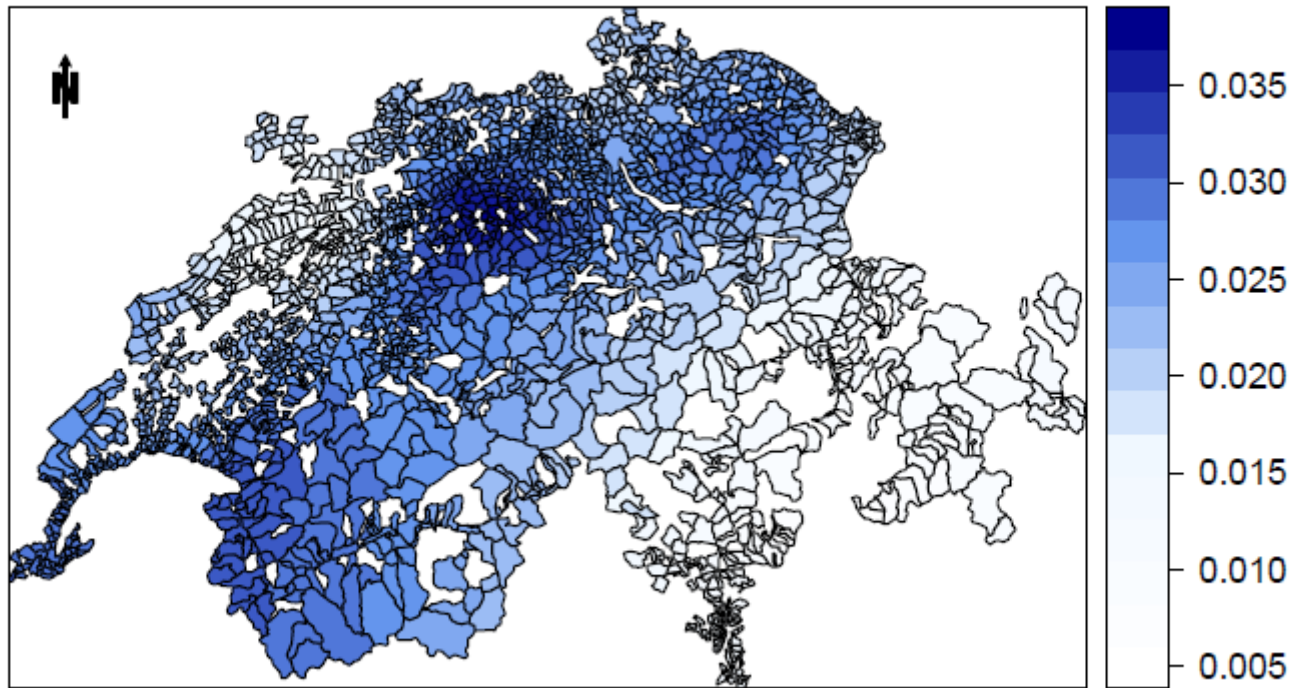
Estimation and comparison of models

GWR: Car accessibility co-efficient, 2005



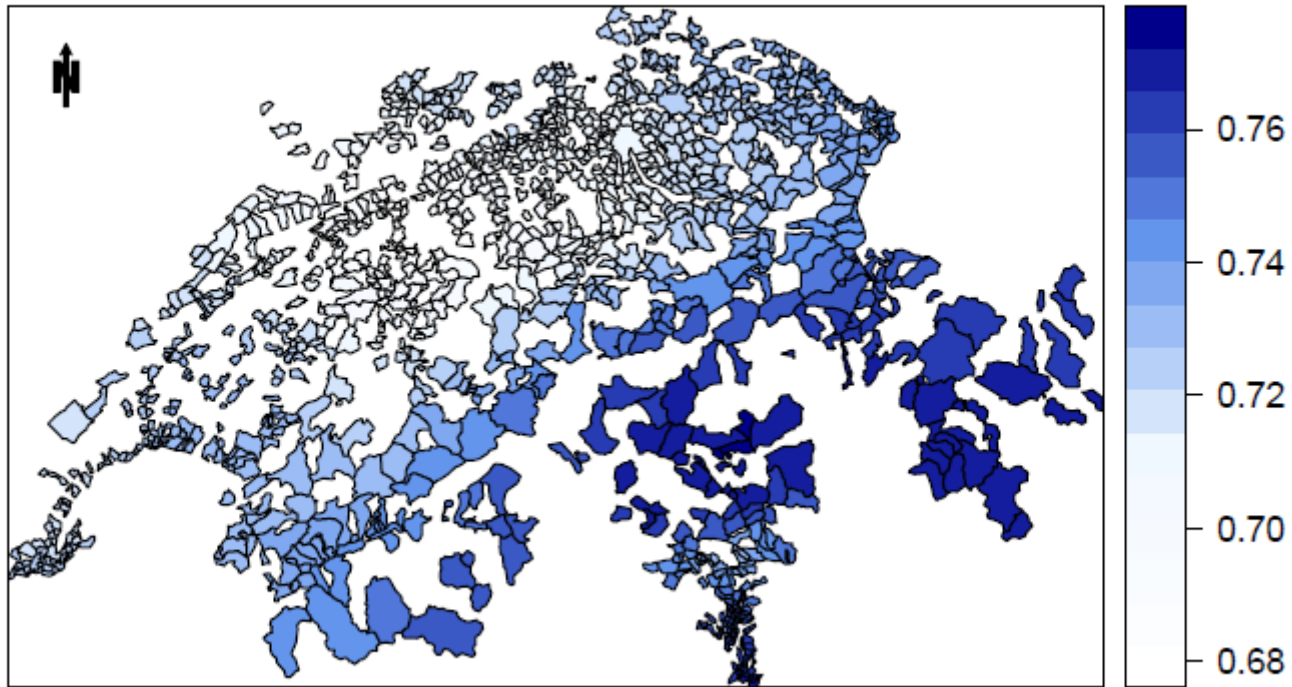
Estimation and comparison of models

GWR: Car accessibility co-efficient, 2010



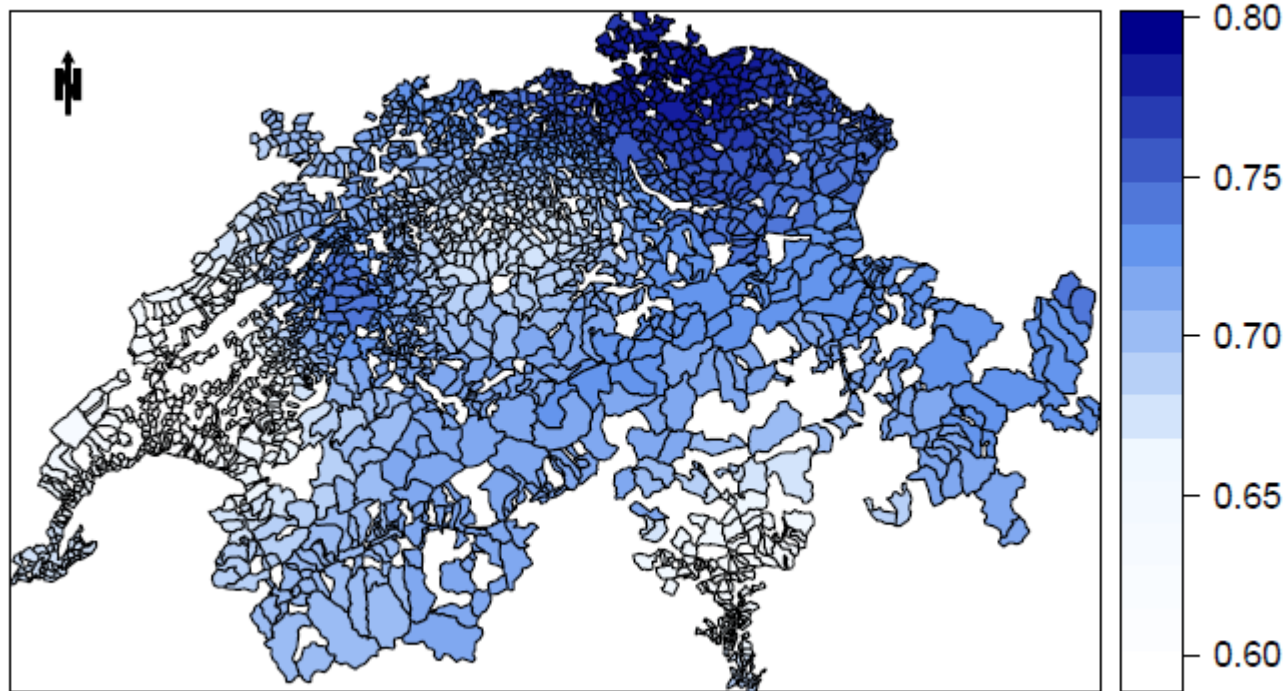
Estimation and comparison of models

GWR: Local R-square, 2000



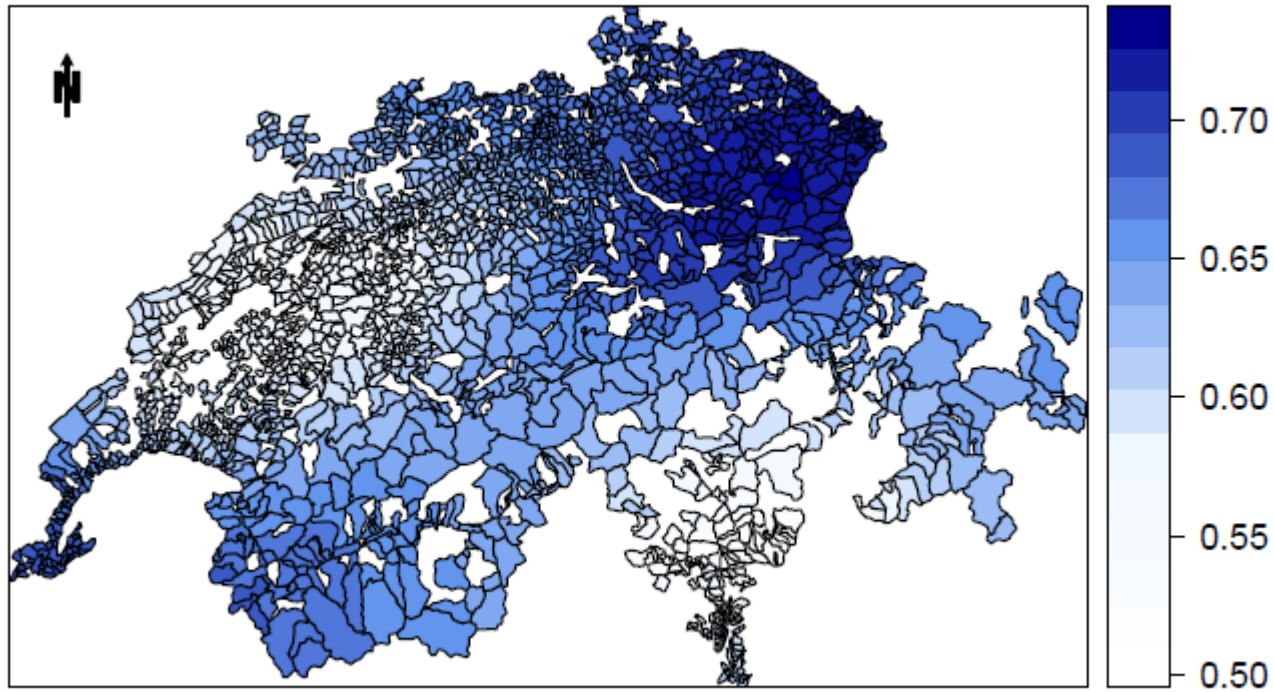
Estimation and comparison of models

GWR: Local R-square, 2005



Estimation and comparison of models

GWR: Local R-square, 2010



Estimation and comparison of models – GWR 2000

Variable	Min.	1st Quantile	Median	3rd Quantile	Max.	Global
(Intercept)	7.3240	7.4050	7.4860	7.6150	7.7850	7.4604
education 1	0.6896	0.8423	0.9041	1.1370	1.2680	1.0625
education 2	0.2319	0.3196	0.3825	0.5040	0.7217	0.4334
education 3	0.0680	0.1543	0.2133	0.2564	0.3687	0.2222
education 4	-0.2209	0.0899	0.2962	0.4886	0.8381	0.1460
education 5	0.2274	0.4574	0.5724	0.6905	0.8832	0.4803
education 6	0.0022	0.0199	0.0300	0.0450	0.1023	0.0598
log(PuT accessibility)	0.0000	0.0021	0.0032	0.0052	0.0075	0.0015
log(car accessibility)	0.0107	0.0194	0.0230	0.0291	0.0374	0.0248
log(employment)	0.0050	0.0118	0.0166	0.0197	0.0227	0.0155
swiss_5year_permit	-0.1329	-0.0536	-0.0073	0.0662	0.1788	0.0918
qualifications 1	0.2653	0.3958	0.5208	0.6414	1.0130	0.4396
qualifications 2	0.0791	0.1625	0.2288	0.2632	0.3695	0.2413
qualifications 3	0.0747	0.1097	0.1287	0.1525	0.1929	0.1344
private sector	-0.2138	-0.1216	-0.0996	-0.0726	-0.0515	-0.1004
empl. manufactory	-0.4115	-0.2857	-0.2131	-0.1792	-0.1018	-0.2023
empl. banks and real estate	-0.0227	0.0355	0.1082	0.1753	0.2462	0.0854
employment years	-0.0017	0.0010	0.0020	0.0035	0.0087	0.0033
age	0.0046	0.0077	0.0099	0.0114	0.0141	0.0089
empl.hotels&rest	-0.1840	-0.1215	-0.0998	-0.0845	-0.0547	-0.1420
men	0.1434	0.2512	0.2802	0.3081	0.3459	0.2436
Adjusted R square	0.6823	0.7108	0.7216	0.737	0.7724	0.6646

Estimation and comparison of models – GWR 2005

Variable	Min.	1st Quantile	Median	3rd Quantile	Max.	Global
(Intercept)	7.4190	7.5950	7.6730	7.7570	8.0440	7.6471
education 1	0.1553	0.6298	0.8121	0.9678	1.2120	0.7881
education 2	0.1885	0.2758	0.3349	0.3812	0.4513	0.2893
education 3	0.0892	0.2004	0.2403	0.2992	0.4897	0.2552
education 4	-0.1407	0.0599	0.2297	0.3278	0.4538	0.1914
education 5	-0.0193	0.1980	0.2986	0.4954	0.8041	0.2545
education 6	-0.0670	0.0029	0.0412	0.1164	0.2637	0.0615
log(PuT accessibility)	-0.0036	-0.0001	0.0010	0.0027	0.0064	0.0010
log(car accessibility)	0.0036	0.0214	0.0278	0.0327	0.0465	0.0278
log(employment)	0.0003	0.0110	0.0153	0.0178	0.0251	0.0144
swiss_5year_permit	-0.1614	-0.0584	0.0047	0.0579	0.1547	0.0152
qualifications 1	0.0413	0.2971	0.4093	0.5070	0.6980	0.4242
qualifications 2	0.0145	0.1724	0.2298	0.2847	0.3974	0.2482
qualifications 3	0.0728	0.1346	0.1785	0.2274	0.2783	0.1931
private sector	-0.1546	-0.1041	-0.0766	-0.0494	0.0718	-0.0721
empl. manufactory	-0.3479	-0.2683	-0.2299	-0.1893	-0.0712	-0.2169
employment years	-0.0007	0.0057	0.0078	0.0093	0.0159	0.0072
age	0.0036	0.0058	0.0070	0.0082	0.0105	0.0075
empl.hotels&rest	-0.2244	-0.1763	-0.1354	-0.1052	0.0392	-0.1548
men	0.0505	0.1200	0.1480	0.1595	0.1783	0.1105
Adjusted R square	0.6014	0.6778	0.7112	0.7319	0.7892	0.6104

Estimation and comparison of models – GWR 2010

Variable	Min.	1st Quantile	Median	3rd Quantile	Max.	Global
(Intercept)	7.5840	7.7500	7.8010	7.8440	7.9740	7.8042
education 1	0.2935	0.5291	0.5788	0.7364	0.9240	0.5862
education 2	0.1549	0.2345	0.2977	0.3609	0.5025	0.2797
education 3	-0.0084	0.1988	0.2505	0.2980	0.4019	0.1814
education 4	0.2055	0.2526	0.2945	0.3589	0.5671	0.2922
log(PuT accessibility)	-0.0105	-0.0022	0.0006	0.0026	0.0058	-0.0003
log(car accessibility)	0.0060	0.0206	0.0251	0.0279	0.0369	0.0222
log(employment)	0.0068	0.0111	0.0141	0.0164	0.0209	0.0137
swiss_5year_permit	-0.1906	-0.0614	-0.0196	0.0205	0.1986	0.0320
qualifications 1	0.3843	0.4984	0.5625	0.6060	0.7216	0.5775
qualifications 2	0.1003	0.2227	0.2708	0.2979	0.3486	0.2666
qualifications 3	0.0927	0.1294	0.1584	0.1890	0.3033	0.1716
private sector	-0.1206	-0.0917	-0.0789	-0.0511	0.0722	-0.0625
empl. manufactory	-0.3462	-0.2082	-0.1725	-0.1543	-0.1275	-0.1540
empl. banks and real estate	0.0388	0.0906	0.1679	0.2513	0.4323	0.1090
employment years	-0.0022	0.0018	0.0038	0.0062	0.0113	0.0040
age	0.0043	0.0062	0.0070	0.0083	0.0114	0.0067
empl.hotels&rest	-0.1989	-0.1326	-0.0875	-0.0312	0.0575	-0.1080
men	0.0872	0.1343	0.1714	0.2129	0.2550	0.1657
Adjusted R square	0.5106	0.5956	0.6394	0.6742	0.7261	0.5641

Conclusions

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Conclusions

- Car and public transport improvements seem to have a positive effect on productivity (vary in space), however underestimated by the model. Further investigation required.
- GWR exhibits the variance of coefficients in space

Next steps

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Next steps

- Different model formulation
- Employ more independent variables
- Break down accessibilities into their main components
- Different approximation of productivity

Questions?