Factors Explaining the Spatial Variations in the Results of the Swiss Popular Initiative "Against Mass Immigration"

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1 Introduction

The referendum on the Swiss popular initiative "Against Mass Immigration" was held in February 2014 and resulted in a narrow majority in favor of the initiative with 50.33% *Yes* versus 49.67% *No* votes. The initiative demanded limitation on migration through the introduction of quotas and contingents. It was initiated by the national conservative Swiss People's Party (SVP) and attracted a voter turnout of 56%. While media articles in the NZZ (Moser 2014) and Berner Zeitung (Hug 2014) highlight the change in voter behavior in the large agglomerates since the last referendum on the EU Bilaterals I [1] in 2000 from pro EU to EU critical as the main driver of the results, so far no analysis has been undertaken that explores a wider set of demographical factors on a cantonal level and their relationship with the vote outcome.
The strict implementation of the proposal would have resulted in the denunciation of the Agreement on the Free Movement of Persons which consequently would have led to the loss of many bilateral trade agreements that contain "guillotine clauses" between the EU and Switzerland. To avoid such a case the Swiss Government implemented a "light" version of the proposal in December 2016 that avoided strict quotas and only demanded national preference for Swiss nationals in sectors of the economy with an above average rate of unemployment. The light implementation has so far been viewed as conform with the Agreement on the Free Movement of Persons but has been dubbed as unconstitutional by the SVP. The party recently announced that it would put forward a second referendum that would ensure a "hard" implementation of immigration quotas. The following research questions are therefore relevant for the ongoing debate in Switzerland and their answers can provide insights to policy makers in Switzerland and other EU countries that face similar challenging discussions, such as the Brexit vote in the United Kingdom:

1. How does the level of support for the initiative vary by canton and municipality and are there distinct pattern?
2. Can we identify demographical factors that correlated with the vote outcome?
3. Are these factors homogeneous across Switzerland or are there geographic variations?
4. Do these factors provide evidence for populist ideas that associate foreigners with overcrowding, unemployment and higher crime rates (Figure 1).
5. Is the "light" implementation of the proposal an appropriate answer to the concerns and fears of those voting in favor of the initiative?

(a) SVP Poster for the popular initiative "Against Mass Immigration"

(b) SVP Poster for the popular initiative "For the expulsion of foreign criminals"

Figure 1: Posters by the national-conservative SVP

Additionally Switzerland's division into three main language regions, French, German and Italian plus a few small Romansh regions (Figure 2c) makes it an interesting case to study demographic and cultural differences and their effect on vote outcomes. Among Swiss the cultural boundaries have their own humorous terminology: The boundary between the French-speaking and German-speaking parts is referred to as "Röstigraben" [2], similarly the border between the Italian- and German-speaking parts is referred to as "Polentagraben" [3].

[1] The acceptance of free movement of people was center price of the Bilaterals I and was accepted by 67.2 % of the electorate.
[2] Rösti is a potato based dish that is popular in the German-speaking part. "Graben" is German for "ditch"
[3] Polenta is a popular cornmeal based dish in the Italian-speaking region.

1.1 Data

While data of the outcome of the referendum has been made available by the swiss Federal Statistical Office on a cantonal and municipality level, a wide range of demographic census data is only available on a cantonal level (*Regional comparison of selected indicators, (cantons) - 2011-2013* 2014) (*Resultate in den Kantonen* 2014). Cantonal and municipal shapefiles are provided by the swiss Federal Office of Topography (*swissBOUNDARIES3D* 2017).

2 Tasks and Approach

In order to answer the stated research questions we conduct the analytical tasks outlined in Table 1. The tasks combine visual techniques, such as divergent choropleth maps with diverging ColorBrewer (Harrower and Brewer 2003) schemes used in all tasks, and computational tasks that range from simple global correlation calculations to more complex geographically weighted regression (GWR) models, described in Appendix A , and geographically weighed summary statistics which are available in the GW Model package by Gollini et al. (2015). All geographically weighted calculations used in this paper require a kernel bandwidth parameter. The larger the bandwidth, the larger the smoothing effect, that is more surrounded areas are included in each local statistics. The optimal bandwidth for GWR models is derived by minimizing the corrected version of the Akaike Information Criterion (AIC_c) model fit measure. For the initial feature selection stage via a AIC_c forward search procedure, as proposed by Gollini et al. (ibid.) and outlined in Appendix B, an arbitrary initial bandwidth of 50 is used. The independent variables selected by the AIC_c forward search procedure are examined for correlation and collinearity via correlation matrices, global and GW correlation coefficients, VIF scores and BKW condition numbers. Additionally we identify potential outliers by exploration of scatter plots of independent variables vs the vote outcome. The set of variables resulting from the previous steps are used to build GWR models. The spatial related outcomes of the GWR models, coefficients and residuals, are visualized using choropleth maps.

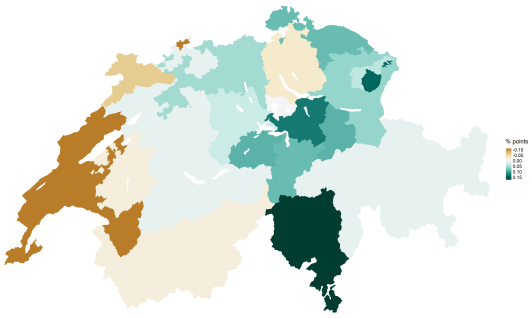
Table 1: Analytical Tasks

Analytical Task	Addresses Research Question	Visual Tools	Computational Tools	Interaction
1) Mapping of the outcome on cantonal and municipal level	1	- (Interactive) Divergent choropleth map	-	-
2) Selection of demographic variables based on theory and statistical methods	2,3	- Illustration of GWR model selection - Scatter plots - Correlation matrix	- GWR model selection (Appendix B) - Global Pearson's correlation coefficients - GW Pearson's correlation coefficients - VIF scores	- Selection of independent variables based on the visualization of AIC_c score vs model number - Visualization of global correlations coefficients and GW correlation coefficients
3) Creation of a geographically weighted regression models	-	- Divergent choropleth map - Boxplot of BKW condition numbers	- Calculation of GWR models - Estimation of the optimal bandwidth parameter for GW regression models	- Exploration of BKW condition numbers - Evaluation of model performance based on model performance measures and visualization of residuals and coefficients
4) Interpretation of GWR Model coefficients and GW Pearson's correlation coefficients	2,3,4,5	- (Interactive) Divergent choropleth map	- Results of task 3 and 2	- Visualization of results

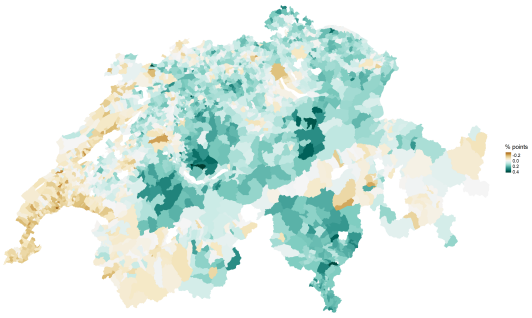
3 Analytical Steps

3.1 Mapping of the referendum outcome

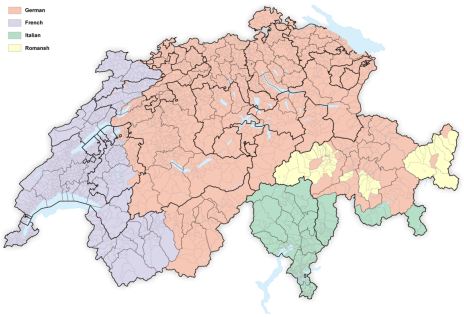
On a cantonal level a west-east divide is clearly visible (Figure 2a): The French speaking Romandy rejected the proposal whilst the German and Italian speaking east, with the exception of the cantons Zurich and Basel Stadt, voted in favor of it. Aside from the evident east-west cultural differences, the strong vote in favor (68.2 %) in the Italian-speaking Tessin is notable. These observations suggests that the aforementioned cultural differences, the "Röstigraben" and "Polentagraben", are evident in the referendum results.
A closer observation of the results on a municipality level additionally reveals that all major cities in the French-speaking and German-Speaking parts (Geneva, Lausanne, Zurich, Basel, Bern, Lucerne) rejected the proposal, whilst the two biggest cities in the Tessin, Locarno and Lugano, voted in favor of it (Figure 2b).



(a) Results on Cantonal Level



(b) Results on Municipality Level



(c) Dominant Language

Figure 2: Maps of cantons and municipalities that accepted or rejected the initiative by X percentage points. A map of dominant languages is displayed for comparison.

3.2 Selection of independent variables

The exploratory analysis conducted in the previous section resulted in some interesting findings, particularly the differences between the various language regions, between cities and rural areas, and the distinctiveness of the Tessin canton, where the two major cities voted in favor of the proposal whereas all other major cities voted against the proposal. This section tries to further explore factors that could explain these differences. We focus our analysis on the cantonal level as only a limited set of demographic factors are available on a municipal or district level.

Out of 40 available demographic features a subset of fifteen features were selected which we assumed to have some explanatory power for voter behavior between the cantons. In order to investigate whether the electorate was influenced by ideas outlined in research question 4, the variables *population change*

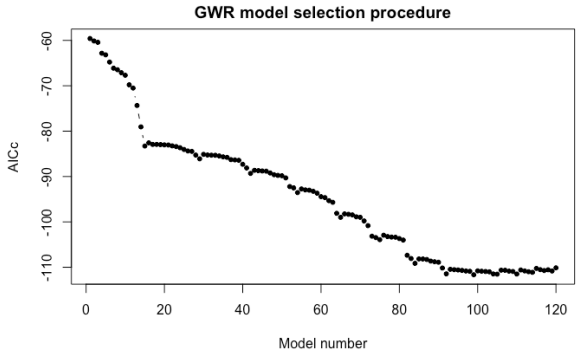


Figure 3: GWR model selection

and the percentage of *foreigners nationals*, *unemployed*, *social security beneficiary* and *criminal offenses* were chosen. The urban-rural and wealthy-poor differences are represented by the variables *population density*, *living in city*, *private transport to work*, *public transport to work*, *homeownership* and *change in gdp*. The percentage of *blue collar* workers and *degree educated* was included to account for differences in education and post-industrial success as proposed by Beecham, Slingsby, and Brunsdon (2017). The dataset only contained three age brackets, 0-19, 20-64 and older than 65, out of which the last bracket was selected.

A first investigation of scatter plots and correlation matrices, revealed that several variables had relatively high correlations amongst each other. As our goal was to create a model with interpretable coefficients with as few explanatory variables as possible, a GWModel forward stepwise feature selection procedure, outlined in Appendix B and Figure 3, was conducted with an arbitrary bandwidth of 50. This resulted in a subset of 9 features which are marked by a X in Table 2.

Table 2: GWR Feature selection

Initial independent variables	GWR Model Selection	VIF	Model 8
population change (2010 - 2013)			
population density (per km^2)			
living in city[3]			
blue collar workers[3]	X	9.06	
foreign nationals[3]	X	6.31	
unemployment rate[3]	X	12.69	X
change in gdp (2010-2011)	X	3.89	
homeownership[3]	X	8.19	
public transport to work[3]			
private transport to work[3]	X	4.80	X
social-security beneficiary[3]			
degree educated[3]	X	1.96	
criminal offences[3]	X	10.30	
age 65 plus[3]	X	1.64	

The correlation between the 9 selected features and the percentage point differences of the Yes and No votes from 50% is shown in Figure 4a. The Tessin stands out as a clear outlier in almost all plots. These plots also hint at similarities between *criminal offenses*, *foreign nationals* and *unemployment*, which is further exposed in the correlation matrix displayed in Figure 4b.

[3]in % of cantonal population

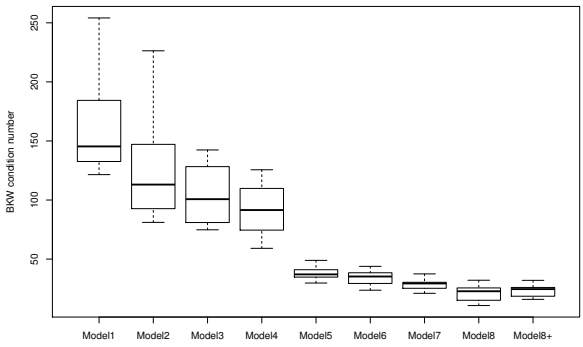
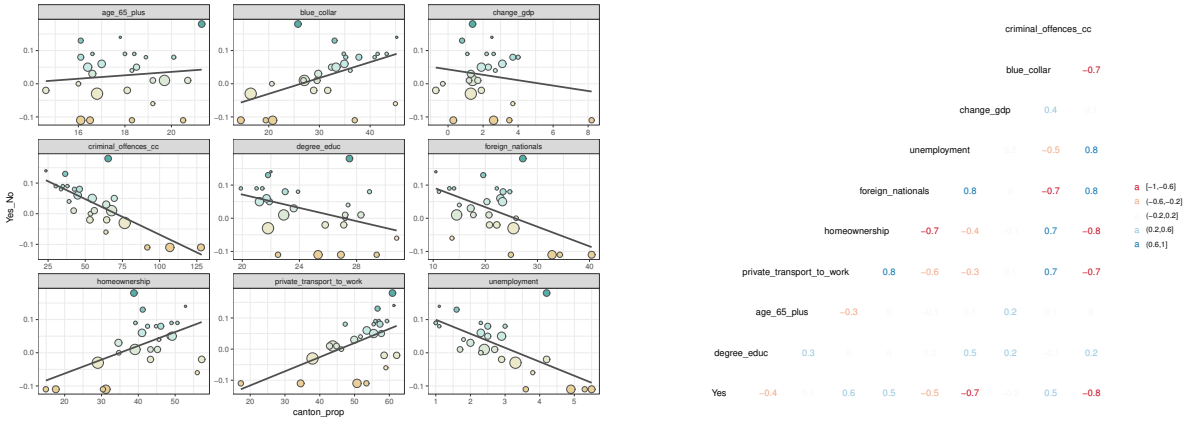


Figure 5: BKW condition numbers



(a) Correlation Plot

(b) Correlation Matrix

Figure 4: Global correlations between demographic factors and Yes:No vote outcome.

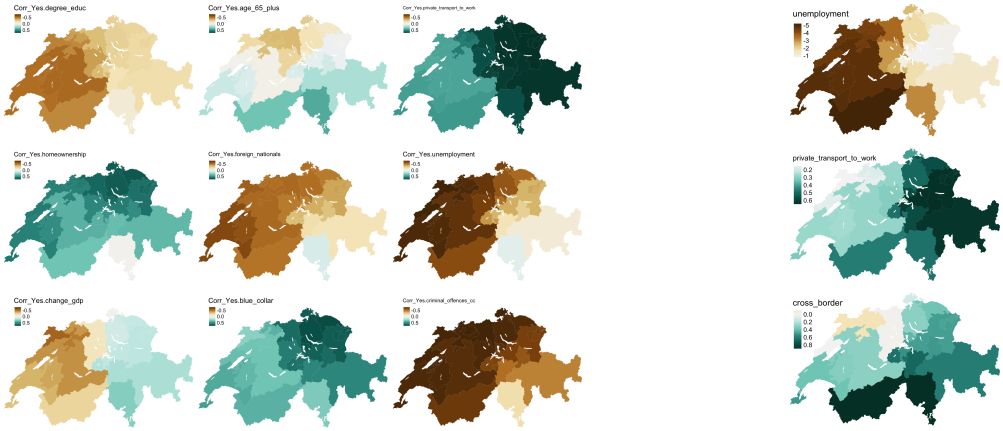
This suggested that collinearity among several independent variables could arise in a regression model, which is especially concerning as, according to Gollini et al. (2015), the issue of collinearity can be even more pronounced in GW regressions models. In order to further investigate the level of collinearity VIF scores (Table 2), geographically weighted Pearson's correlation coefficients (Figure 6a) and BKW condition numbers, as outlined in Belsley, Kuh, and Welsch (2005) were calculated. Figure 5 displays BKW condition number boxplots for eight models, with varying combinations of variables. Model 1 contained all variables that were selected in the previous step: *criminal offenses*, *blue collar*, *degree educ*, *age 65 plus*, *change gdp*, *homeownership*, *foreign nationals*, *unemployment*, *private transport to work*. *Criminal offenses* and *blue collar* were omitted in a first step (Model 3), as they showed a high correlation with five out of eight features, had high VIF scores (10.30 and 9.06) and homogeneous geographically weighted Pearson's correlation coefficients with a positive sign for all geographic regions. The recalculated VIF scores showed an improvement, however the relatively high VIF scores of *unemployment* (4.61) and *foreign nationals* (5.63), together with very high local and global condition numbers suggested that collinearity was still a problem. Further experimentation and assessment of models with a subset of variables resulted in Model 8 with *unemployment* and *private transport to work* as the only independent variables. It was selected due to it's low condition numbers, it's parsimoniousity, it's high significance of coefficients and it's relatively high R-squared and low AICc values as listed in Table 3. Besides the statistical properties, *unemployment* and *private transport to work* were found to be strong drivers of voter behavior in previous studies in similar domains like the Brexit referendum (Beecham, Slingsby, and Brunsdon 2017).

Table 3: GWR Model comparison

Results of GW Regression	Model 8	Model 8+ (including *cross border*)
AICc	-97.19	-98.68
Adjusted R-square value	0.8564	0.8922
Global condition number	14.3	16.27
Median local condition number	22.78	26.48

3.3 GW Pearson's correlation and GWR model coefficients and residuals

This section highlights key observations and findings that were drawn from the visualization of GW Pearson's correlation coefficients of the nine previously identified variables (Figure 6a), GWR model residuals and GWR model coefficients (Figure 6b and 7a) and how the inclusion of cross-border statistics further improved our model.



(a) GW Pearson's correlation coefficients

(b) GWR Model 8+ coefficients

Figure 6: GW Correlation and GWR Model 8+ coefficients.

- *Degree educated* and *criminal offenses* are negatively correlated with the *Yes* vote across Switzerland, with stronger correlation in the western parts compared to the east and almost no correlation in the canton of Tessin.
- The percentage of over 65 years old residents has a sign change from negative in the northern cantons of Jura, Basel, Solothurn, Aargau, Zurich, Thurgau and Schaffhausen to positive in the Romandy, the Tessin and Graubuenden.
- *Homeownership*, *blue collar* and *private transport to work* correlate positively with the *Yes* vote across Switzerland. *Private transport to work* and *blue collar* correlate more strongly in the eastern part of the country then in the west.
- *Change in gdp* is only weakly correlated with the vote outcome, but has a change in direction from negative to positive from west to east in the middle of the country.
- *Foreign nationals* and *unemployment* are negatively correlated with the acceptance of the initiative, with the notable exception of Tessin where a small positive correlation is present. This link gets weaker in the canton of Tessin once accounted for *private transport to work* in our GWR model 8.
- The size of the residuals of Model 8 is greatest in the canton of Tessin and Schaffhausen, were it significantly underestimated the Yes vote by a large margin of 6% (Figure 7a).

The above observations together with the residual map (Figure 7a) for GWR Model 8 stressed the distinctiveness of the Tessin. While the overall magnitude of residuals was reasonably low, the Tessin had a large positive residual - an indication of confounding variables which influenced the results but were not included in our model.

Intrigued by these findings we looked for other potential variables that could explain Tessin's special behavior. An article on swissinfo.ch by Gerhard Lob (2014) proposes cross-border commuters as a potential driver. Cross-border commuters are a controversial topic that is discussed within the population of Tessin and promoted as a problem for the region by the Ticino League, an extreme isolationist and national-conservative political party. Numbers of cross-border commuters are available in a separate dataset provided by the Federal Statistic Offices which was subsequently added to our existing dataset. The canton of Geneva and Tessin exhibited the largest flow of such commuters, in 2013 on average 71 and 58 thousand per quarter commuted from Italy and France. The ratio of cross-boarder commuters versus the total population is the highest in Tessin and Basel with roughly 17% percent.

The addition of the ratio of cross-boarder commuters to canton population (*cross border*) to Model 8, which we call Model8+, improved not only it's R-squared and AIC_c values whilst local and global condition numbers only increased slightly (Table 3 and Figure 5), but also substantially reduced the size of the residuals for Tessin and Geneva as shown in the residual plot in Figure 7b.

(a) GWR Model 8 (b) GWR Model 8+ including *cross-border*

Figure 7: GWR model residuals

4 Findings

This section summarizes the most important findings and relates them to the four original research questions in section 1.
In regard to question 1, we found that the level of support for the initiative varied substantially between the cantons. The cultural "ditches" were evident in the referendum outcome. Additionally we found evidence for the often cited rural-metropolitan division in the French- and German speaking parts but not in the Italian-speaking canton of Tessin. Tessin's distinctiveness became more evident in the analysis of demographic variables that correlated with the outcome. We successfully identified demographical factors that correlated with the vote outcome and observed geographic variations (questions 2 and 3): Our final Model 8+ highlighted interesting differences between the east and west and the Tessin and showed that three variables, *unemployment*, *private transport to work* and *cross border*, account for the majority of variation in the vote. Accounting for *unemployment* and *private transport to work*, cross-border commuters were found to be a strong driving factor in the canton of Tessin and Valais, cetris paribus, a one in percent increase in the ratio of cross-border commuters over the canton population in Tessin and Valais is associated with a 0.9 % increase in *Yes* votes. The similarly high cross-border number in the canton of Basel (17 %) paradoxically did not proof to be positively correlated, and even showed a slight negative effect on the *Yes* votes of –0.18 % . One reason for this could lie in the composition of cross-border workers: The higher importance of the tourism sector in the Tessin attracts more low-skilled workers compared to Basel, which attracts many high-skilled workers for it's pharmaceutical companies. The negative effect of the unemployment rate on the outcome is more pronounced in the west (e.g -5% in Geneva and Vaud) compared to the east (e.g. -0.8 % in St. Gallen and Appenzell). From a domain perspective two theories come to mind that could explain the relationship between unemployment and voter behavior. On the one hand, higher unemployment could be interpreted by voters as a sign of increased competition for jobs due to foreigners, in this case we would expect to see a positive relationship between the *Yes* vote and unemployment. On the other hand, voters might anticipate that the acceptance of the proposal could lead to a loss of access to the single market of the EU, which in turn could have severe negative effects on the swiss economy and unemployment rates. Whereas our analysis found strong evidence for the latter theory in the western part of Switzerland, the evidence

in the cantons of Zurich, Zug, Schaffhausen, Thurgau, St. Gallen Schwyz, Uri, Glarus Appenzell and Graubuenden is less strong. Conversely *private transport to work* is positively associated with the *Yes* vote to a greater degree in the aforementioned cantons compared to the eastern cantons. The presence of large cross-border commuter flows in the Tessin and Valais, and to lesser extend in Geneva, however adds further complexity to this theory. The positive effect of cross-border commuters on the Yes vote in these cantons, could be motivated by fear of unemployment, wage dumping and injustice as cross-boarder commuters have a far lower cost of living in their respective home countries compared to their swiss colleagues, while earning similar high salaries. These feelings seem to be exaggerated by the above average unemployment rates in the Tessin compared to Basel, which has similar high cross-border flows as a percentage of the population.
Our answer to research question 4 is therefore mixed. While we found no positive relationship between higher crime rates and the acceptance of the initiative, there is some evidence that cross-boarder commuters and *fear* of unemployment had a positive influence on the results in the canton of Tessin, Valais and Geneva. This leads to our last research question 5, that tries to answer the appropriateness of the "light" implementation of the proposal which demands preference for Swiss nationals in sectors of the economy with an above average rate of unemployment. We think that the "light" implementation is appropriate, as it will assure voters in regions where fear of unemployment due to cross-border commuters or inflow of new foreigners is strongest, such as in the Tessin, while not restricting companies in economically strong regions and sectors, like Basel, in their hiring decisions.

5 Critical reflection

Our findings suggest that if the motivation and implications of the "light" implementation are communicated effectively to the electorate, a potential referendum on a "hard" implementation is not likely to succeed. Our analysis also highlighted cross-border commuters as a key factor driving the results in the Tessin, that should be taken into account by policy makers in Switzerland and the EU.
Even though the aggregation of demographic factors on a cantonal level prevented a more granular investigation, it was detailed enough to answer our stated research questions. In future studies it would be nevertheless interesting to conduct a similar analysis on a local district or municipality level, in case more detailed demographic data becomes available. While our results are specific and unique to Switzerland and can be seen as a reflection of Switzerland's unique status within the European Union, as a landlocked, export focused country surrounded by EU members to which it exports two thirds of all exports and enjoys free movement of people, the computational and visual tools used in this paper can be applied to similar domains in which spatial variations of demographic factors are of interest. The recent rise of the right-winged AFD in the German federal election's of 2017 and the Catalan regional election of 2017 are two such examples.

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A Appendix GW Regression Model

The basic GWR form used in this paper is defined by Gollini et al. (2015) as:

$$y_i = \beta_{io} + \sum_{k=1}^{m} \beta_{ik} x_{ik} + \epsilon_i$$

with the dependent variable y_i, the intercept β_{i0}, the local regression coefficient β_{ik} and the kth independent variable x_{ik} at location i. The local regression coefficient is estimated by minimizing the weighted least squares defined in matrix form as :

$$\hat{\beta}_i = (X^T W(u_i, v_i) X)^{-1} X^T W(u_i, v_i) y$$

where y is a vector of dependent variables, $\hat{\beta}_i$ is a vector of the local regression coefficients and X and W_i are matrices, denoting the independent variables and the geographical weighting of each location (u_i, v_i).

B Appendix Feature Selection

Method for feature selection for GW regressions as outlined by Gollini et al. (ibid.):

1. "Start by calibrating all possible bivariate GW regressions by sequentially regressing a single independent variable against the dependent variable;
2. Find the best performing model which produces the minimum AIC_c, and permanently include the corresponding independent variable in subsequent models;
3. Sequentially introduce a variable from the remaining group of independent variables to construct new models with the permanently included independent variables, and determine the next permanently included variable from the best fitting model that has the minimum AIC_c;
4. Repeat step 3 until all independent variables are permanently included in the model."