Causes of ethnic segregation in a nineteenth century city

The case of Vyborg

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Introduction

Spatial segregation

- a classic theme of urban sociology
- implications both for individuals and society
- causes of spatial segregation studied using empirical data
- socio-economic segregation studied as a possible cause of ethnic segregation

Location of Vyborg

Vyborg

- Vyborg [1] castle founded in the late 13th century
- town privileges 1403
- conquered by Russians in the Great Northern War (1700–1721)

Population

- German and Swedish speaking Lutheran elites
- Finnish commoners
- large Russian garrison 1710–1917

The military units also brought civilians with them, not only families of soldiers and other camp followers, but also higher status persons, such as retired officers or wealthier merchants and artisans.

Segregation

Causes of segregation

Pre-modern causes:

(1)

(2)

Modern causes[2]:

(3)

(4)

(5)

(6)

(7)

[1] fi. Viipuri, sw. Viborg
[2] Dawkins (2004)

Discrimination

- lateral
- e.g. housing market discrimination

Prejudice

- horizontal and possibly reciprocal

Income differences

- socio-economic segregation creates ethnic segregation

Different preferences

- different groups value different things
- location of services, e.g. churches

Housing market information

- knowledge
- differences in perceived value

Segregation policies

- explicit policies of segregation
- attempts to segregate Russian and Finnish commoners into different suburbs

Guild-based differentiation

- in pre-industrial world, guild members were expected to live near one another
- most guilds in Vyborg tiny
- some attempts to created own areas for retired soldiers and cart drivers

There are still concentrations of the Russian minority in areas which were inhabited by Russians in the eighteenth century. Segregation based on membership of guilds was not significant based on previous research and distribution of masters. Most guilds in Vyborg were tiny, only having a few masters and journeymen as members. The remaining three potential causes of segregation, namely discrimination, prejudice, and differences in housing market information cannot be studied with the data available.

Data

Sources used

Table 1: Sources from the National archives of Finland

Signum	Original year	Digitization process
Town plan of Vyborg. Vyborg military engineer detachment's archive of plans for fortifications and buildings, 7, 11.	1878	Georeferenced using ground control points, vectorized manually into shapefile
Vyborg province poll tax registers	1880	Digitized manually into CSV
Financial office of the city of Vyborg, Municipal tax levies and payment registers	1880	Digitized manually into CSV

The spatial data are derived from historical maps and tax records. Digitised cadastral maps provide accurate location information. The religion of the inhabitants was recorded in the poll tax registers from 1880 onward. Since every household is tied to a cadastral plot, the density of populations can be tracked in high resolution, unlike censuses. In Vyborg, the Orthodox denomination can be used as a proxy for Russian speakers. The income level can be determined based on total income tax paid. This data is provided by municipal income tax records from 1880.

Poll tax records

Table 2: poll tax record columns in 1894

column	description
plot_number	Plot number
taxpayer_men	Men paying poll tax
taxpayer_women	Women paying poll tax
no_tax_men	Men exempt from poll tax
no_tax_women	Women exempt from poll tax
in_russia_men	Men legally residing in Russia proper
in_russia_women	Women legally residing in Russia proper
total_men	Total men
total_women	Total women
independent	Civil servants, entrepreneurs, and financially independent
white_collar	White collar workers
worker_industry	Workers in industry
worker_other	Other workers
servants	Servants
other	Other employment status
non_resident	Resident elsewhere
orthodox	Orthodox
other_christian	Non-Lutheran and non-Orthodox Christian
other_religion	Other religions
draftable	21-year-old males eligible for draft

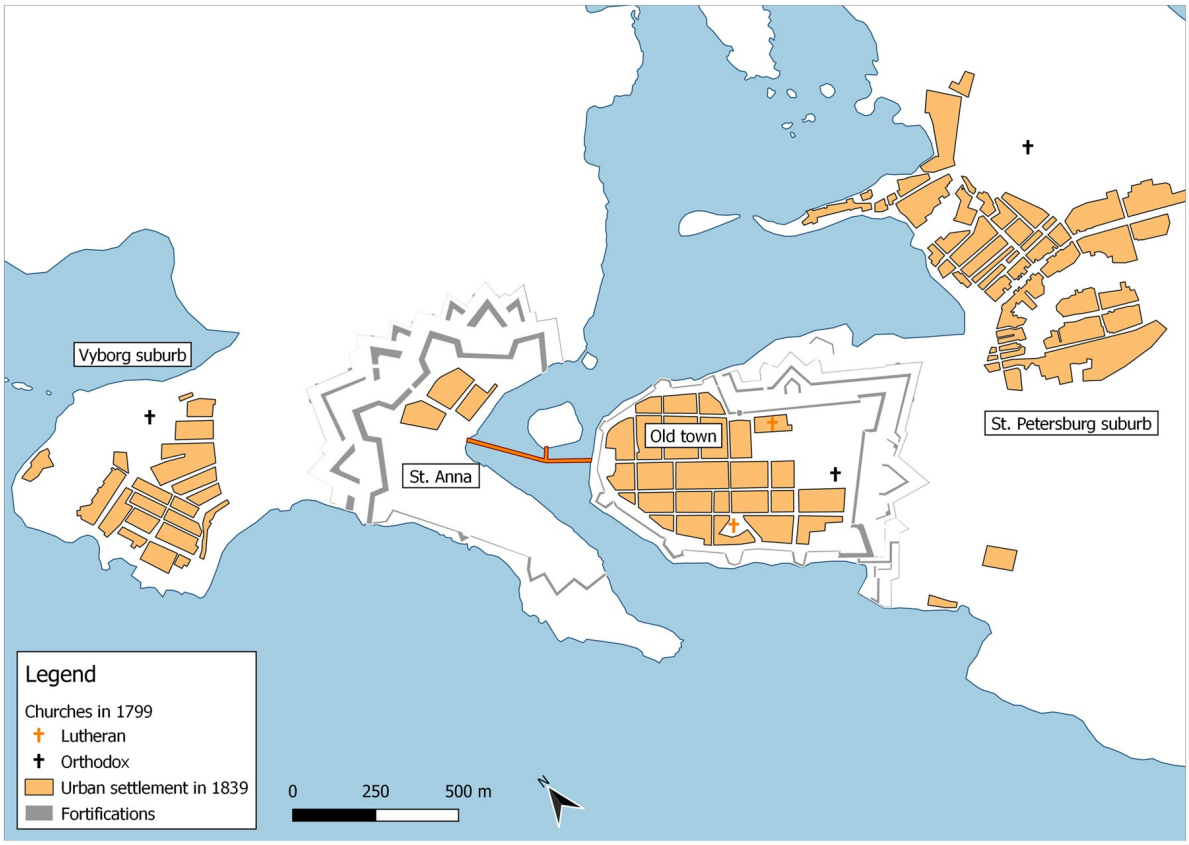
Estimating the size of Russian population

- over 90% of Orthodox in Vyborg Russian

Estimating the size of Lutheran population

$$P_{Lutheran} = (P_{total\_men} + P_{total\_women}) - (P_{Orthodox} + P_{other\_Christian} + P_{other\_religion})$$

Growth of Vyborg



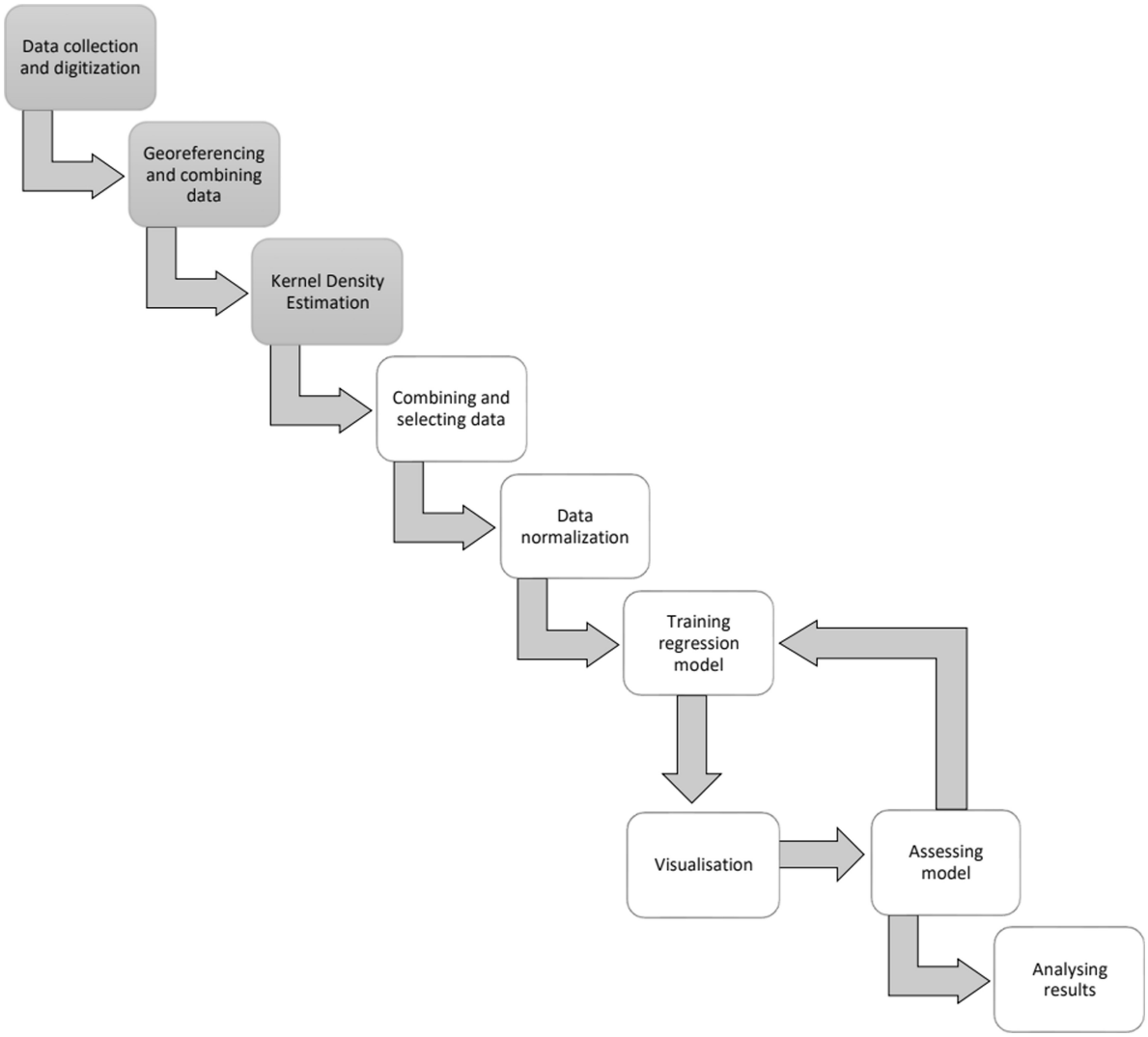
Population growth

Table 3: Population growth in key areas

District	1822	1880
Centre	1192	2506
St. Anna	244	117
Vyborg suburb	642	756
St Petersburg suburb	1512	2685

Spatial analyses

Work flow



Population surface model

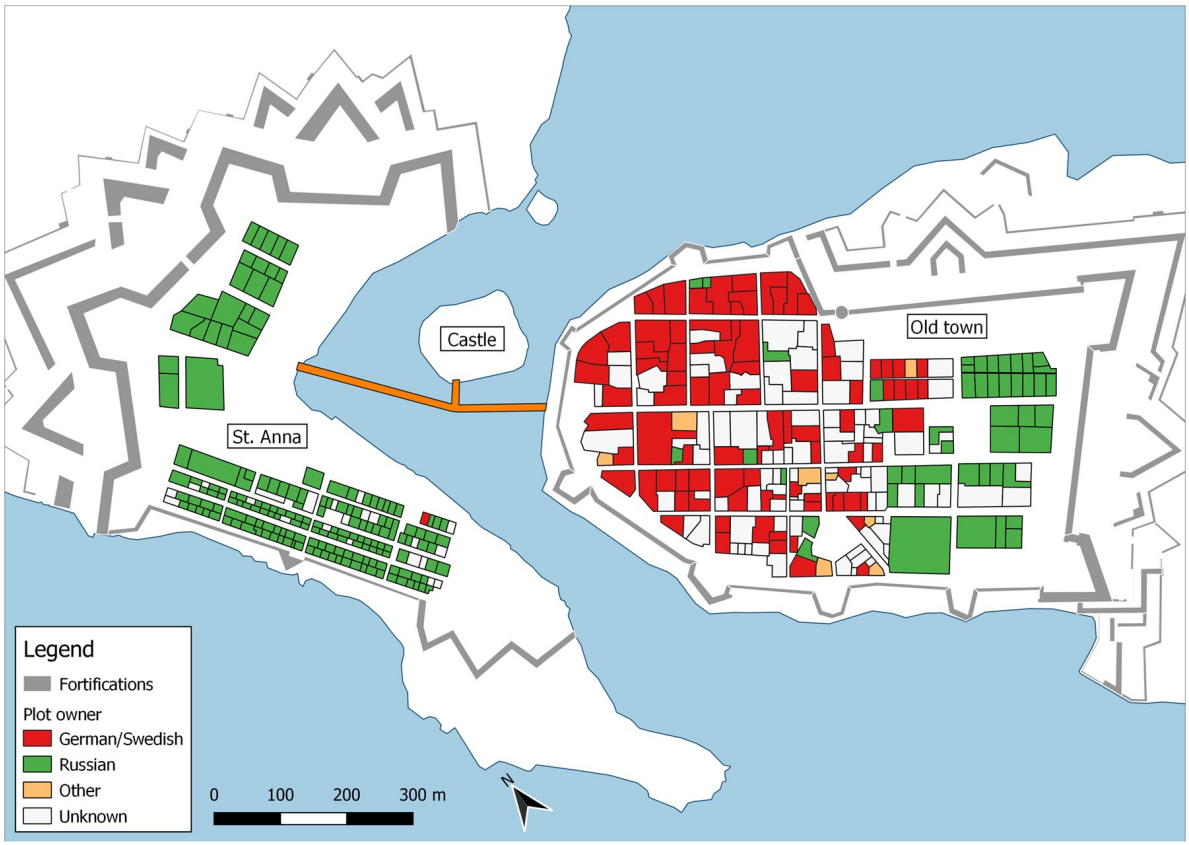
Population surface model

Based on Martin, Tate, and Langford (2000).

$$P_i = \sum_{j=1}^{N} P_j w_{ij}$$

$$w_{ij} = \begin{cases} \left(\frac{k^2 - d_{ij}^2}{k^2 + d_{ij}^2}\right)^{\alpha} & \text{if} \quad d_{ij<k} \\ 0 & \text{else} \end{cases}$$

Biweight kernel



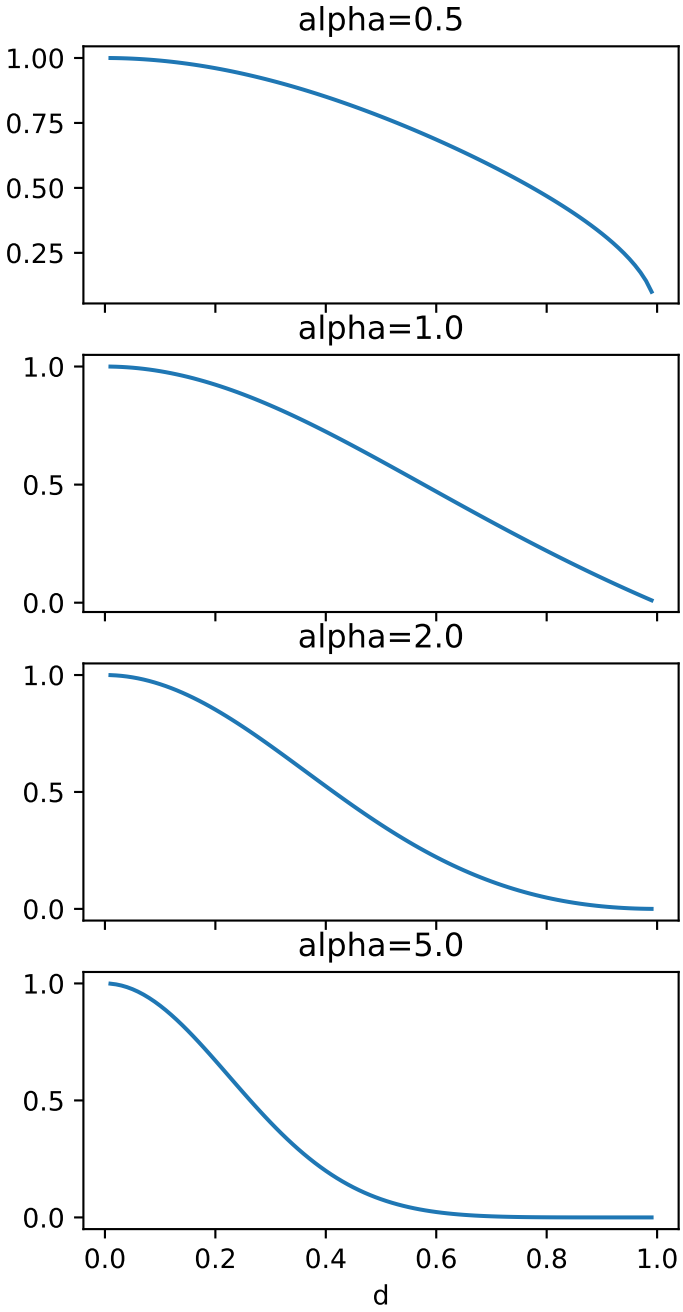


Figure 1: Kernel function


Vyborg suburb
St. Anna
Old town
Drivers' sloboda
Soldiers' sloboda
St. Petersburg suburb
Orthodox churches (1799)
Highways
Fortifications (1839)
Orthodox, % (1880)
> 35
30 - 35
25 - 30
20 - 25
15 - 20
10 - 15
5 - 10
< 5
0
250
500 m

Explaining segregation

Regression model

- Bayesian multilevel linear regression model with spatial correlation between observations (N=540)
- predictors are the natural logarithm of average local income and distance to nearest orthodox church
- predicted variable is the proportion of Russians in a location
- regression coefficients are different for each area of Vyborg

The coefficients of the linear regression are different for each of the three areas of Vyborg. These are the western suburb, the centre within the walls, and the eastern suburbs. This means that the effects of predictors on Russian population density can vary.

Partial pooling

- observations are partially pooled

There is also hyperparameter that acts as a restraint on the regression coefficients of the areas. In other words, the observations are partially pooled, which combines the flexibility of treating areas as separate (unpooled observations) with the robustness of using all observations (pooled observations).

Regression model (1)

$$O_i \sim MvNormal(\mu, \mathbf{K})$$

$$\mu_i = \beta_{0,k[i]} + \beta_{1,k[i]} ln(W) + \beta_{2,k[i]} C_i$$

$$k \in 1, 2, 3, 4 \qquad i, j \in 1, 2, 3, ... 539$$

$$\beta_k \sim MvNormal\left(\theta, \begin{bmatrix} 0.1 & 0 & 0 \\ 0 & 0.1 & 0 \\ 0 & 0 & 0.1 \end{bmatrix}\right)$$

$$\theta \sim MvNormal\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 0.1 & 0 & 0 \\ 0 & 0.1 & 0 \\ 0 & 0 & 0.1 \end{bmatrix}\right)$$

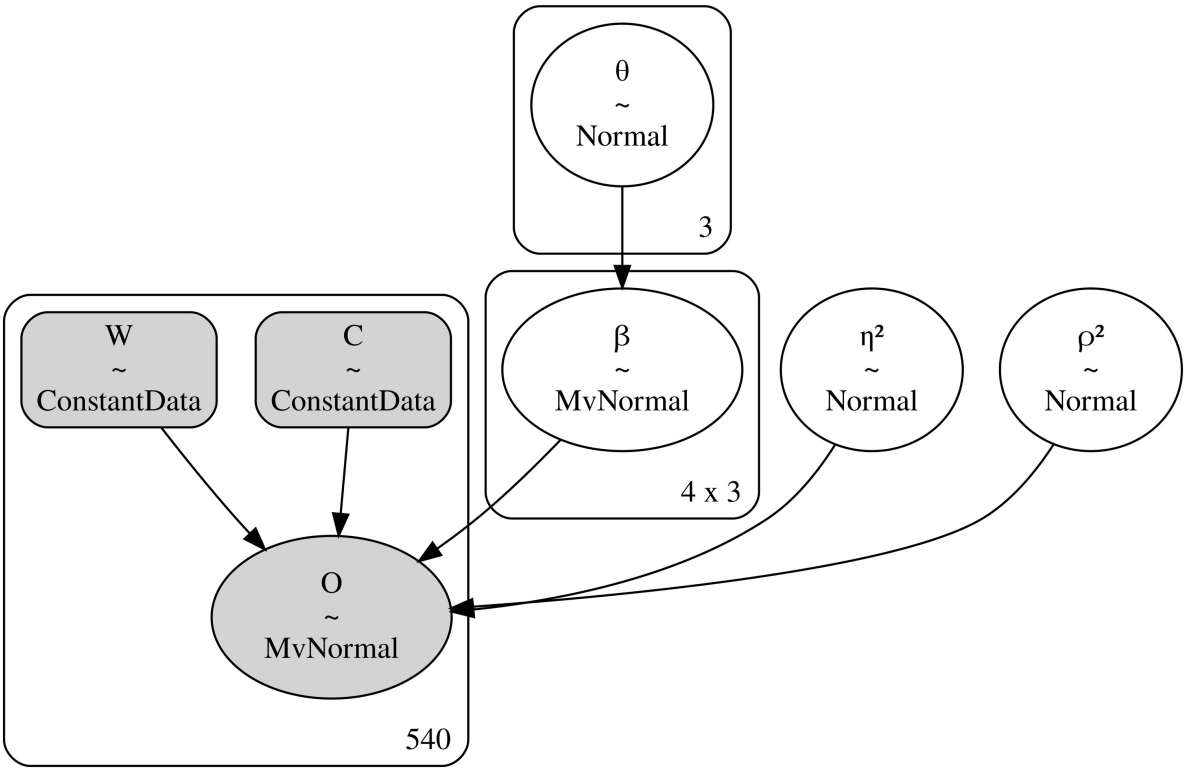
Regression model (2)

$$\mathbf{K}_{ij} = \eta^2 exp(-75\rho^2 d_{ij}^2) + 0.01 \times I_{540}$$

$$\eta^2 \sim Normal(1, 0.2)$$
$$\rho^2 \sim Normal(1, 0.2)$$

Multilevel Bayesian regression

Variable	Shape	Description
O	540	Normalized proportion of Russian Orthodox of the local population
W	540	Smoothed total income in a location in öre
C	540	Distance to nearest Orthodox church in 1799 in kilometres
d	540 x 540	Distance matrix holding pairwise distances between plots
	3	Hyperparameter for
	4 x 3	Linear regression coefficients for each district
2	1	Parameter for the covariance function
2	1	Parameter for the covariance function



Change of segregation

Surface-based segregation index

- index S works by comparing changes in population density surfaces

S

after O'Sullivan and Wong (2007)

$$S = 1 - \frac{\oiint_R min(p_L, p_O)\ \ dR}{\oiint_R max(p_L, p_O)\ \ dR}$$

where p_L and p_O are the normalised population densities of Lutheran and Orthodox populations respectively

Spline model (1)

$$S_{year} \sim Normal(\mu_{year}, \sigma)$$

$$\mu_{year} = \alpha + \sum_{k=1}^{K} w_k B_{k,year}$$

$$\alpha \sim Normal(0.45, 0.01)$$
$$\sigma \sim HalfNormal(0.05)$$

Spline model (2)

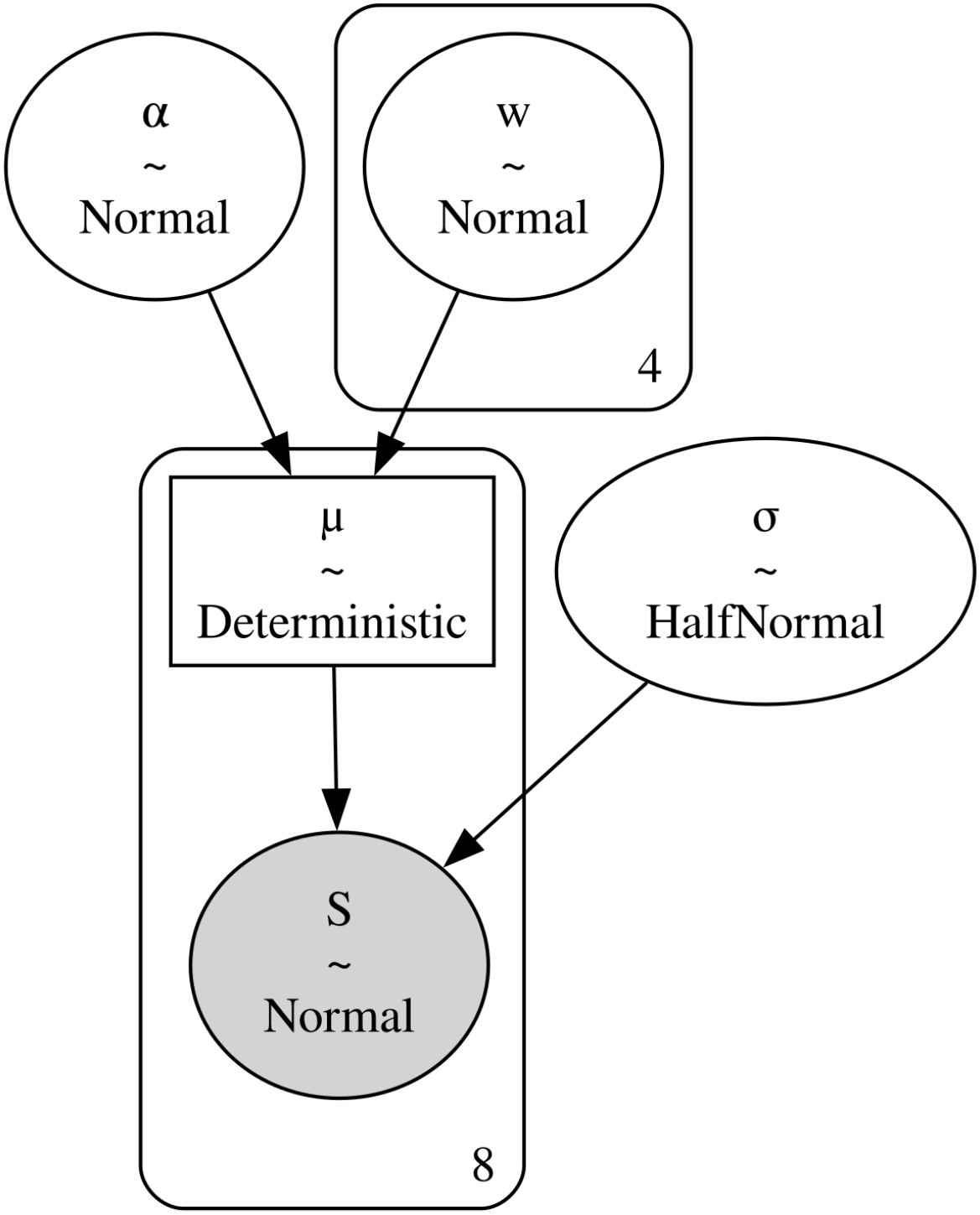
$$B = \begin{bmatrix} 1 & 0.687 & 0.295 & 0.02 & 0 & 0 & 0 & 0 \\ 0 & 0.299 & 0.601 & 0.612 & 0.367 & 0.276 & 0.007 & 0 \\ 0 & 0.015 & 0.104 & 0.367 & 0.612 & 0.658 & 0.209 & 0 \\ 0 & 0 & 0 & 0 & 0.02 & 0.066 & 0.784 & 1 \end{bmatrix}$$

$$w_k \sim Normal(0, 0.1)$$

Spline model code

```
import pymc as pm

with pm.Model() as model:
    a = pm.Normal(" ",  _a,  _a)
    w = pm.Normal("w", mu= _w, sigma= _w, shape=B.shape[1])
      = pm.Deterministic(
       " ", a + pm.math.dot(np.asarray(B, order="F"), w.T
    ))
      = pm.HalfNormal(' ',  _ )
    S = pm.Normal("S",  ,  , observed=regression_data['200'])
    idata = pm.sample(1000, tune=1000, chains=2)
```


α
~
Normal
w
~
Normal
4
μ
~
Deterministic
σ
~
HalfNormal
S
~
Normal
8

Results

Regression

- no evidence for income or preferences as causes of segregation

Change over time

- spatial segregation decreases 1880–1900 and increases 1900–1917
- exogamy rate of Russians declines constantly 1880–1917
- concentrations of Russians changes over time
- changes of urban space likely decreased segregation after 1860

One explanation for this may be the political battle between Finnish nationalists and the Imperial regime, which intensified after 1899. The disappearance of old segregation patterns may be related to the changes in the build environment, since the new concentrations of Russians were different than those in 19th century.

Variable	Mean	SD	HDI, 95%	
0	−0.027	0.096	−0.227	0.15
1	0.027	0.085	−0.142	0.193
2	−0.135	0.096	−0.309	0.067
0,0	−0.609	0.299	−1.162	−0.013
0,1	0.104	0.056	−0.009	0.209
0,2	−1.076	0.314	−1.702	−0.487
1,0	0.097	0.3	−0.46	0.743
1,1	0.142	0.14	−0.117	0.433
1,2	−0.037	0.316	−0.625	0.626
2,0	0.118	0.299	−0.509	0.677
2,1	0.119	0.074	−0.024	0.261
2,2	−0.287	0.312	−0.905	0.306
3,0	0.016	0.272	−0.54	0.515
3,1	0	0.069	−0.141	0.135
3,2	−0.496	0.248	−0.991	−0.024
scaled ^{2}	0.93	0.04	0.852	1.006
^{2}	1.0	0.099	0.812	1.194

Conclusions

Segregation

- no monocausal explanations work
- more complex causal system likely at work
- high quality spatial data allows rejection of overtly simplistic models

To conclude, segregation in Vyborg cannot be explained by any single cause. The explanations behind segregation are most likely a complex system of causal links that are hard to untangle with empirical research. However, the use of high-quality spatial data allows the rejection of overly simplistic explanations.

References

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