What causes the spatial pattern in Trumpism in Wisconsin?

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Introduction

Throughout this analysis we are studying the factors that influenced the support rates for Donald Trump in sub-counties of Wisconsin. The sample data comes from the 2016 presidential election. We are focusing on the spatial variations of the sample data, and we are also looking at some demographic factors such as rural-urban difference and racial differences.

Abstract

We are looking at the 2016 presidential election data from Wisconsin, and we are investigating how spatial effect, rural-urban difference and racial differences affect the proportion of Donald Trump voters in each sub-county in Wisconsin. We conducted a BYM model, and we found that there is evidence for strong spatial effect besides the individual sub-county noise. For the demographic factors, we find rural areas (sub-counties with lower population density) have a higher support rate for Trump comparing to urban areas. Sub-counties having more white population tends to have more Trump voters, whereas Indigenous people are more likely to vote against Trump.

Methods

The sample data contains 1853 records of the following information of each sub-county: population density (per km^2), proportion of white population, proportion of Indigenous population, total number of votes and the number of votes for Trump. An overview of the sample data is shown in Figure 1. We define areas with lower population density as rural areas, and areas with higher population density as urban areas.

We are using a BYM(Besaq, York and Mollié) model, which could be described as:

$$Y_i \sim Binomial(p_i, N_i) \qquad log(\frac{p_i}{1-p_i}) = \mu + \beta X_i + U_i$$
$$U_i \sim BYM(\sigma^2, \phi)$$

where Y_i, p_i, N_i represents the number of votes fro Trump, the total number of votes, and the proportion of people voted for Trump in i-th sub-county respectively. X_i is the covariates containing the following variables: log of population density (per km^2), proportion of white population and proportion of Indigenous population in the i-th sub-county. U_i represents the spatial random effect of i-th sub-county. The prior median of the spatial proportion ϕ is 0.5, and the prior median of the variability in residual variation σ is set to $log(2.5)$, so one standard deviation in independent random effect will times the odds ratio by 2.5.

The posterior quantiles of parameters are listed in Table 1. To help interpretation, Table 2 listed the posterior parameters after exponential. Notice that I converted the unit for population proportion of white and Indigenous to percentages, so we are looking at the effect of one percentage change in white/Indigenous population proportions, instead of one unit change in population proportions. The predicted random effects and proportion of Trump voters are shown in Figure 2. All parameters are significant as shown in Table 1. The fitted values of proportions of Trump voters(Figure 2b) are similar to the real data(Figure 1a), hence our model has a good fit on the sample data.

Results

In Table 1, we can see the predicted σ (propSpatial) is greater than ϕ (sd), which means the spatial variation is greater than the independent sub-county variation. Hence we have a smooth U as shown in Figure 2a, and the covariance decays slowly as distance between sub-counties increases.

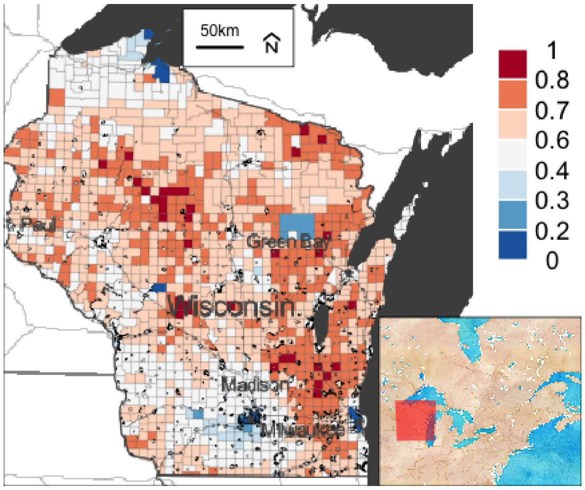
From Table 2, one unit increase in logged population density is correlated with about 7.8% decrease in the predicted odds ratios, hence the support rates for Trump would be slightly higher in rural areas than in urban areas. For example, the sub-county called Madison, which located at southern Wisconsin, has a high population density, and the support rate for Trump is low in Madison as shown in Figure 1.

For the racial differences, one percentage increase in white population proportion is correlated with 1.4% increase in predicted odds ratios, and one percentage increase in Indigenous population proportion is correlated with 0.8% decrease in predicted odds ratios. This demonstrates that white people are more likely to vote for Trump, whereas Indigenous people are less likely to vote for Trump. For example, Green Bay, the sub-county located at east-north Wisconsin, has a high Indigenous population proportion, and a low support rate for Trump as shown in Figure 1.

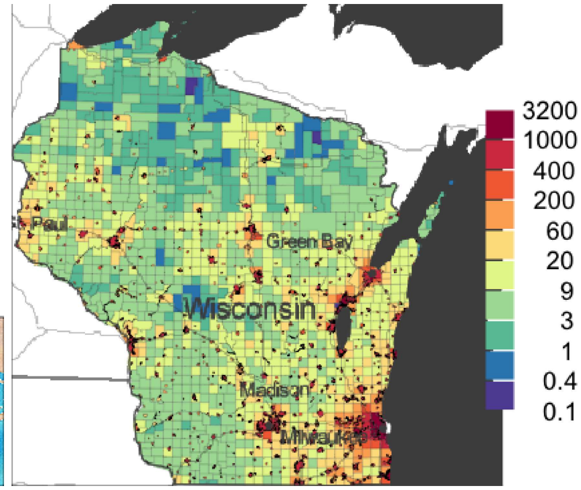
Discussion

The model proves that there is a strong spatial effect on the proportions of Trump voters in Wisconsin. There are some independent noise for individual sub-county, however, the spatial variation is larger than the independent noise.

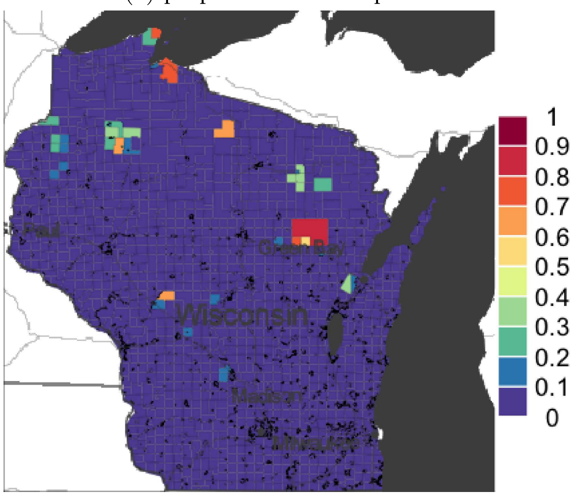
Besides the random effects, rural-urban difference and racial differences are significant factors as well. Rural areas have more Trump voters comparing to urban areas. White people are more likely to vote for Trump, while Indigenous people are more likely to vote against Trump.



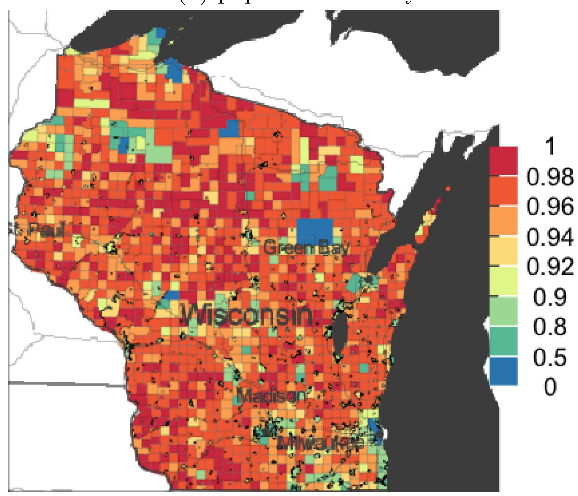
(a) proportion of Trump voters



(b) population density

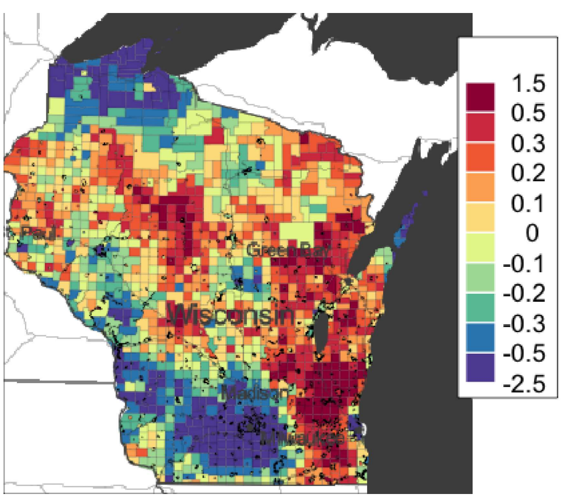


(c) proportion of Indigenous people

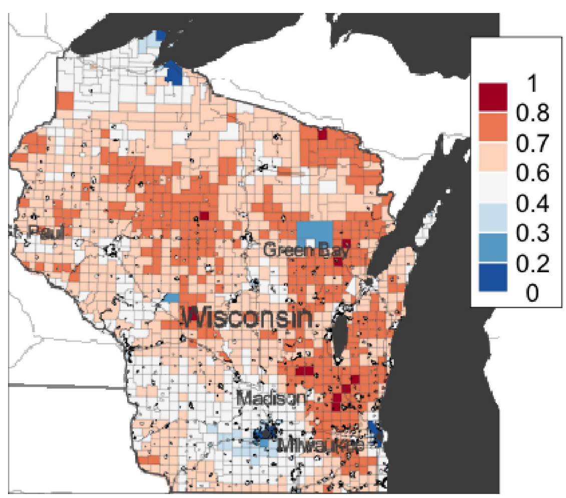


(d) proportion of white people

Figure 1: Overview of Sample Data



(a) random effects



(b) proportion of Trump voters

Figure 2: Fitted Values from Model

Table 1: Posterior Quantiles of Paramaters (logged odds ratios)

	0.5quant	0.025quant	0.975quant
(Intercept)	-0.563	-0.827	-0.297
log(population density)	-0.081	-0.090	-0.072
proportion of white in percent	0.014	0.012	0.017
proportion of Indigeous in percent	-0.008	-0.011	-0.004
sd	0.318	0.304	0.334
propSpatial	0.960	0.917	0.986

Table 2: Posterior Quantiles of Paramaters (odds ratios)

	0.5quant	0.025quant	0.975quant
(Intercept)	0.570	0.437	0.743
log(population density)	0.922	0.914	0.930
proportion of white in percent	1.014	1.012	1.017
proportion of Indigeous in percent	0.992	0.989	0.996
sd	1.375	1.356	1.397
propSpatial	2.612	2.502	2.680

Appendix: R codes

```r
(load("D:/E/wisconsin.RData"))
resTrump = diseasemapping::bym(trump ~ logPdens + propWhite +
propInd, data = wisconsinCsubm, prior = list(sd = c(log(2.5),
0.5), propSpatial = c(0.5, 0.5)), Ntrials = wisconsinCsubm$Total,
family = "binomial")
```

```r
# The tables
table1 = resTrump$parameters$summary[, paste0(c(0.5,
0.025, 0.975), "quant")]
table1[c(3, 4), ] = table1[c(3, 4), ]/100
rownames(table1)[2] = "log population density"
rownames(table1)[3] = "proportion of white in percent"
rownames(table1)[4] = "proportion of Indigeous in percent"
knitr::kable(table1, digits = 3,
caption = "Posterior Quantiles of Paramaters (logged odds ratios)", label = 'tab:atable')
knitr::kable(exp(table1), digits = 3,
caption = "Posterior Quantiles of Paramaters (odds ratios)", label = 'tab:atable')
```

```r
# The plots
theColTrump = mapmisc::colourScale(wisconsinCsubm$propTrump,
col = "RdBu", breaks = sort(unique(setdiff(c(0, 1, seq(0.2,
0.8, by = 0.1)), 0.5))), style = "fixed", rev = TRUE)
theColPop = mapmisc::colourScale(wisconsinCsubm$pdens, col = "Spectral",
breaks = 11, style = "equal", transform = "log", digits = 1,
rev = TRUE)
theColWhite = mapmisc::colourScale(wisconsinCsubm$propWhite,
col = "Spectral", breaks = c(0, 0.5, 0.8, 0.9, seq(0.9,
```

```
1, by = 0.02)), style = "fixed", rev = TRUE)
theColInd = mapmisc::colourScale(wisconsinCsubm$propInd,
col = "Spectral", breaks = seq(0, 1, by = 0.1), style = "fixed",
rev = TRUE)
theBg = mapmisc::tonerToTrans(mapmisc::openmap(wisconsinCm,
fact = 2, path = "stamen-toner"), col = "grey30")
theInset = mapmisc::openmap(wisconsinCm, zoom = 6, path = "stamen-watercolor",
crs = mapmisc::crsMerc, buffer = c(0, 1500, 100, 700) *
1000)
library("sp")
mapmisc::map.new(wisconsinCsubm, 0.85)
sp::plot(wisconsinCsubm, col = theColTrump$plot, add = TRUE,
lwd = 0.2)
raster::plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::insetMap(wisconsinCsubm, "bottomright", theInset,
outer = TRUE, width = 0.35)
mapmisc::scaleBar(wisconsinCsubm, "top", cex = 0.8)
mapmisc::legendBreaks("topright", theColTrump, bty = "n",
inset = 0)
mapmisc::map.new(wisconsinCsubm, 0.85)
plot(wisconsinCsubm, col = theColPop$plot, add = TRUE, lwd = 0.2)
plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::legendBreaks("right", theColPop, bty = "n", inset = 0)
mapmisc::map.new(wisconsinCsubm, 0.85)
plot(wisconsinCsubm, col = theColInd$plot, add = TRUE, lwd = 0.2)
plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::legendBreaks("right", theColInd, bty = "n", inset = 0)
mapmisc::map.new(wisconsinCsubm, 0.85)
plot(wisconsinCsubm, col = theColWhite$plot, add = TRUE,
lwd = 0.2)
plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::legendBreaks("right", theColWhite, bty = "n", inset = 0)
theColRandom = mapmisc::colourScale(resTrump$data$random.mean,
col = "Spectral", breaks = 11, style = "quantile", rev = TRUE,
dec = 1)
theColFit = mapmisc::colourScale(resTrump$data$fitted.invlogit,
col = "RdBu", rev = TRUE, breaks = sort(unique(setdiff(c(0,
1, seq(0.2, 0.8, by = 0.1)), 0.5))), style = "fixed")
mapmisc::map.new(wisconsinCsubm, 0.85)
plot(resTrump$data, col = theColRandom$plot, add = TRUE,
lwd = 0.2)
plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::legendBreaks("topright", theColRandom)
mapmisc::map.new(wisconsinCsubm, 0.85)
plot(resTrump$data, col = theColFit$plot, add = TRUE, lwd = 0.2)
plot(theBg, add = TRUE, maxpixels = 10^7)
mapmisc::legendBreaks("topright", theColFit)
```