The Standard Errors of Persistence

A Discussion of Kelly 2019

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Take Home Point

Failure to understand and account for spatial autocorrelation creates bias in regressions that could call into question major findings in economics and political science.

Only 25% of the studies in Kelly's sample have findings that are robust after taking into account possibility regressions are fitting spatial noise.

Goals of Kelly (2019)

1. Show the connection between high t-statistics and severe spatial autocorrelation of residuals

2. Apply that finding to the persistence literature

The setting for these findings

There is Large literature on persistence that suggest modern outcomes (incomes, social attitudes) are shaped by past characteristics

- Examples:
    - Medieval pograms and votes for Nazi parties Voigtlander and Voth
    - Slave trade and mistrust in African Societies (Nunn and Wantchekon 2011)
    - Slavery in the American South and contemporary differences in political attitudes (Acharya, Blackwell, Sen 2016)

The persistence variables have high explanatory power (e.g. big t-statistics)

The Problem with Space

Tobler's First Law of Geography: "Everything is related to everything else, but near things are more related than distant things."

- Persistence regressions are spatial regressions. Like time series, spatial regressions can have correlated values.
- Spatial Autocorrelation describes the degree to which observations in spatial locations are similar to each other

Kelly's Test

Kelly proposes a two step procedure for identification of persistence issues:

1. Compute a Moran Index. Large Moran Index are "reliable warnings that nominal significance levels differ substantially from true ones".
2. Generate synthetic spatial noise to match correlation structure of variables of interest. Use these as placebo tests.

What the paper is not doing

Checking for issues with data construction

- e.g. Acemoglu, Robinson, Johnson 2001 (Albouy 2012), La Porta et al 1997 (Spamann 2010)

Check plausibility of mechanism or quality of scholarship

Checking for econometric issues

Interested in disproving findings of original studies

Moran's Statistic

Moran's Statistic or Moran's *I* is a measure of spatial autocorrelation

$$I = \frac{N}{\sum_{i=1}^{n}\sum_{i=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

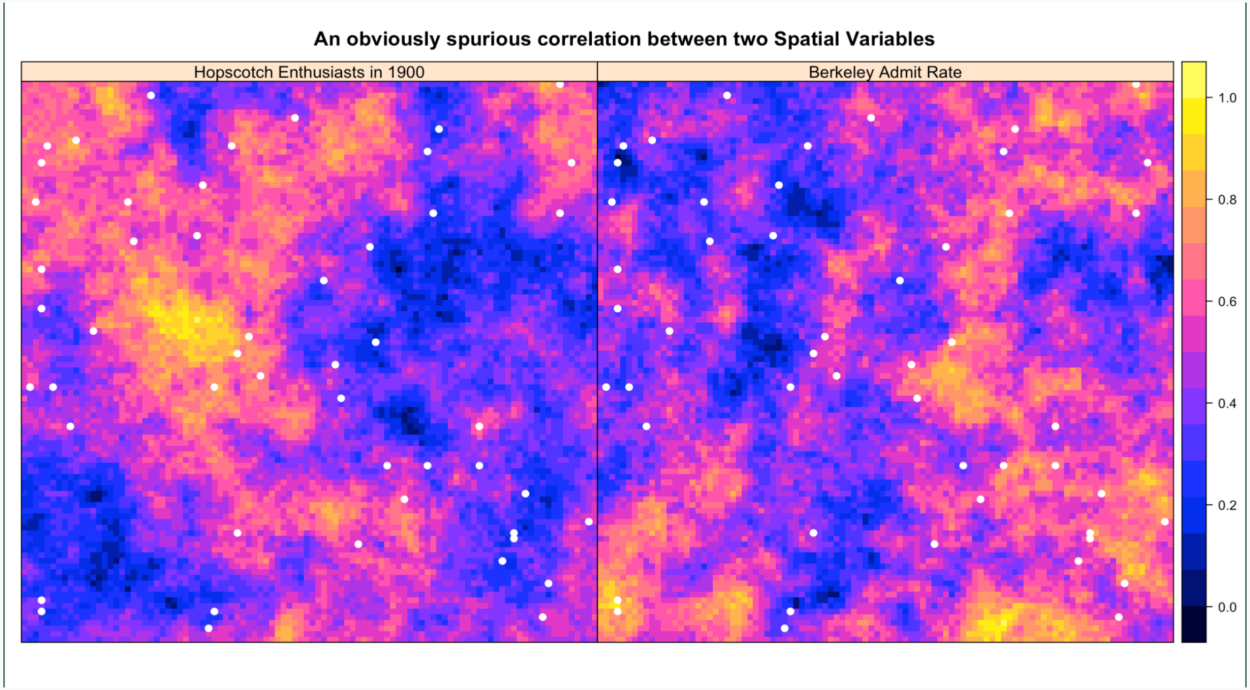
- N is the number of spatial weights indexed by *i* and *j*
- x is the variable of interest. $\bar{x}$ is the mean of x.
- w_{ij} is the spatial weights matrix with zeros on the diagonals

Think of this as the weighted sum of covariance between every pair of residuals with a weight scheme that follows Tobler's First Law of Geography

R Implementation

Full Code for R Simulation Setup

Two Independent Spatial Processes



Correlation in the Noise

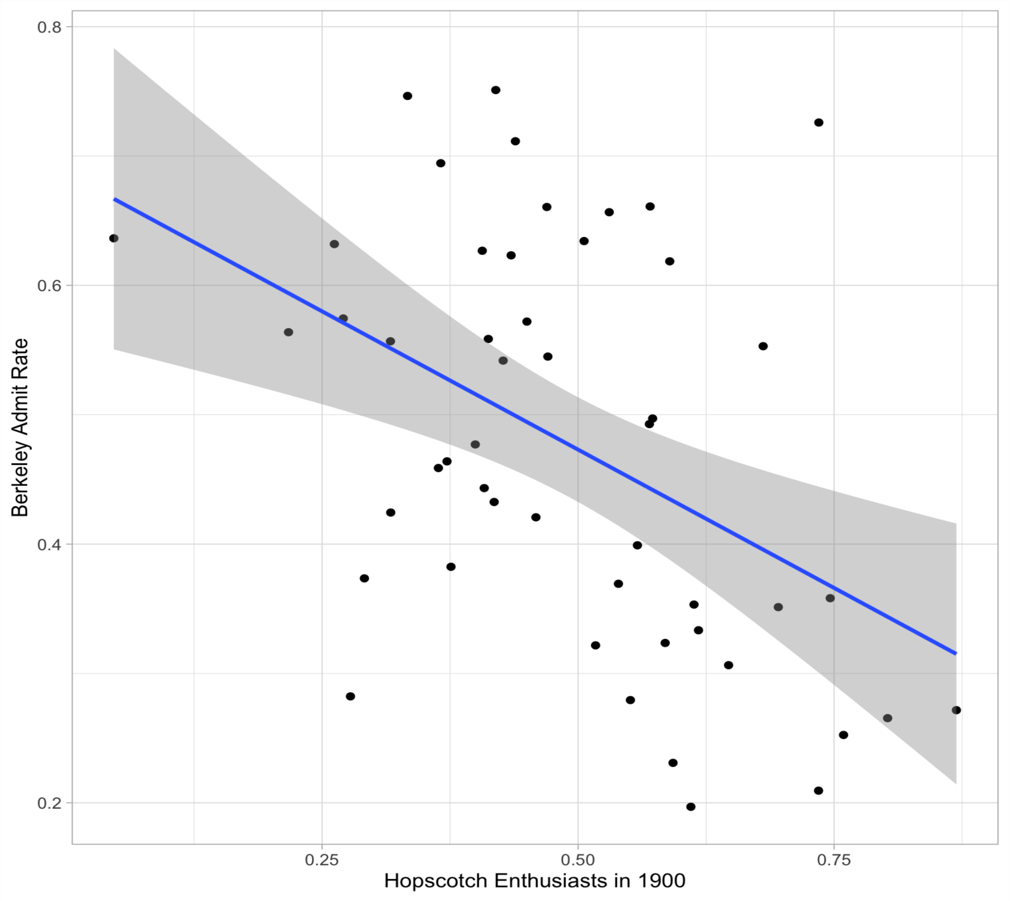
Even though by construction there is no relationship, a linear regression reports a negative and statistically significant coefficient

	Model 1
Intercept	0.69^{***}
	(0.06)
Hopscotch Enthusiasts in 1900	-0.43^{***}
	(0.11)
R^2	0.20
Adj. R^2	0.19
Num. obs.	50
RMSE	0.14
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$	

Statistical models

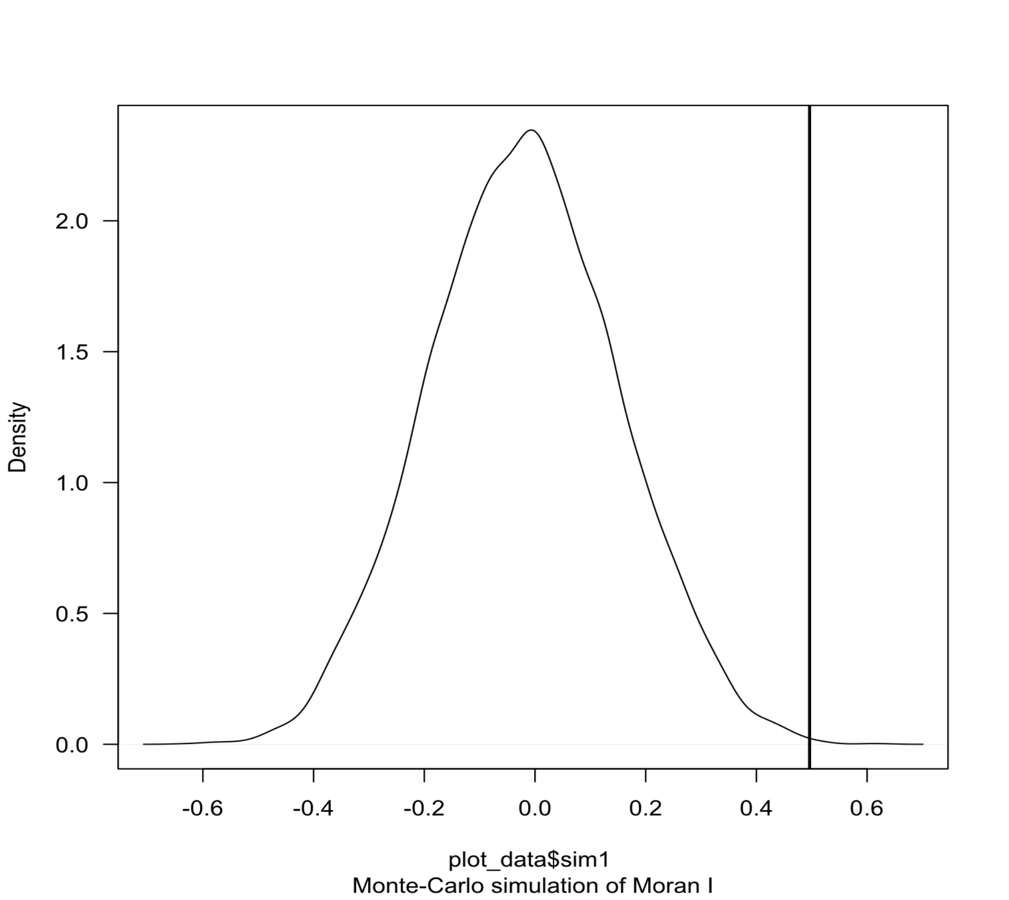
Visual Inspection of Correlation

The problem is that there is correlation in the residuals due to spatial autocorrelation.



Moran's Index for our simulated data

A Moran Monte Carlo test reveals that our observed Moran statistic is highly unlikely to occur if there was no spatial noise.



The real world is spatially correlated

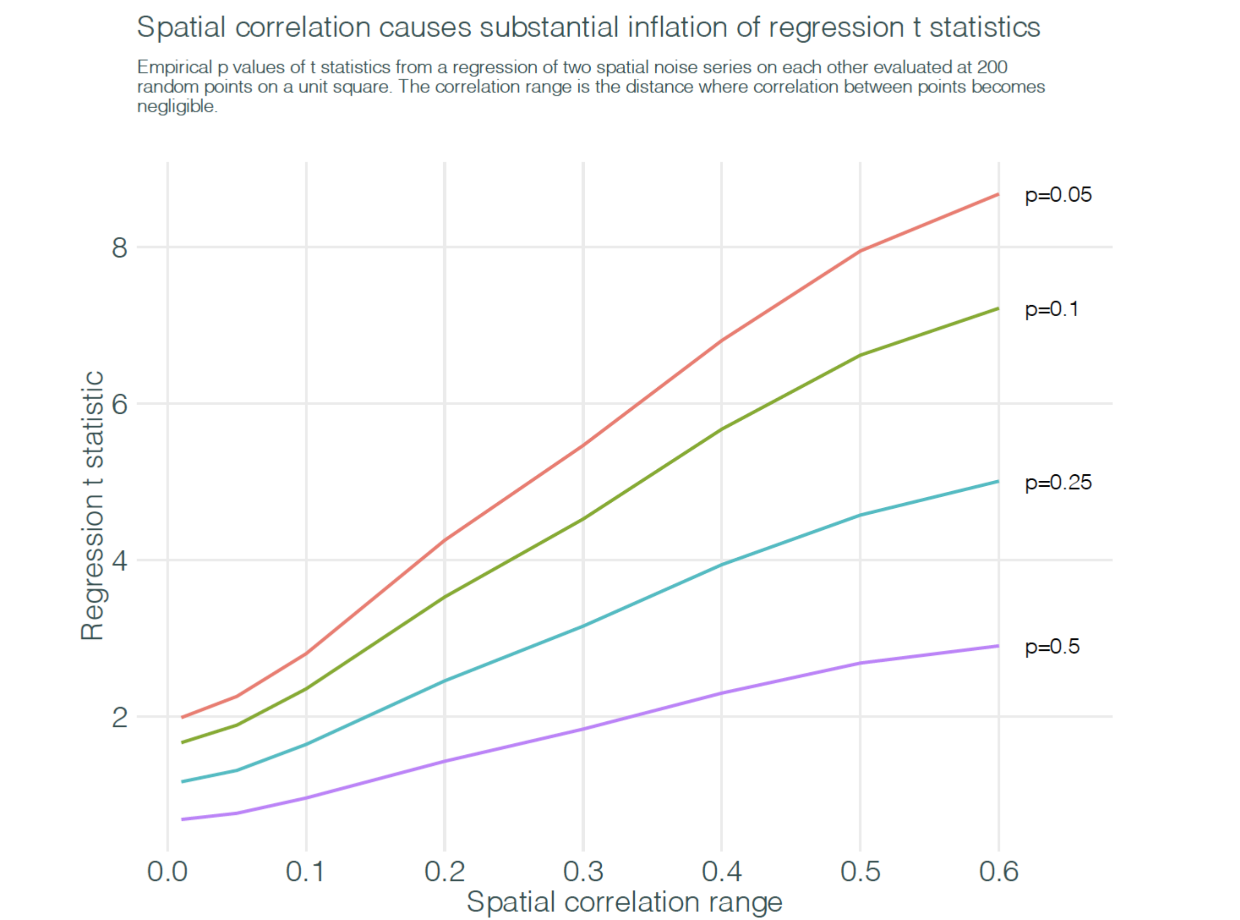


Figure 2: Empirical significance levels of t statistics from spatial noise regressions for different maximum ranges of spatial correlation. It can be seen that at a correlation range of 0.3, one quarter of regressions will return a t statistic above 3.3 (p=0.001), but that a regression requires a t statistic of 5.5 to be significant at 5 per cent.

The real world is spatially correlated

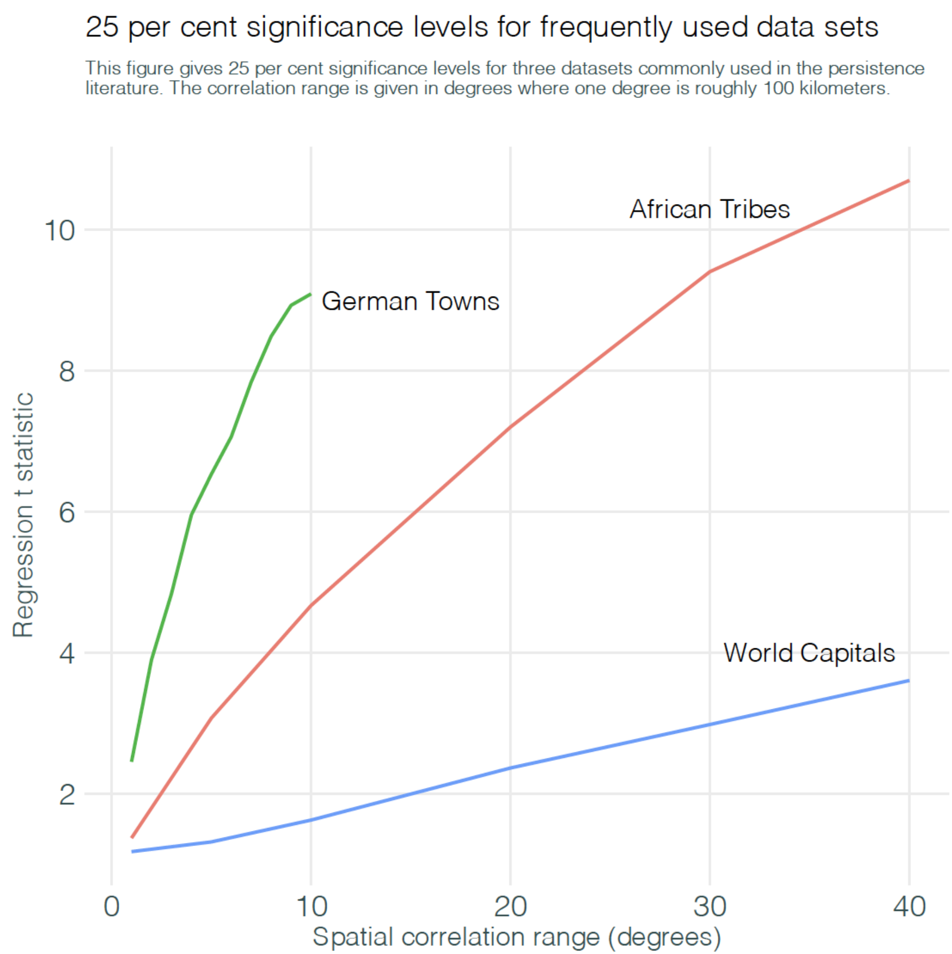


Figure 3: Empirical 25 per cent significance levels of t statistics of spatial noise regressions measured at 178 world capitals, 229 interwar German towns, and 225 African tribal areas. Correlation range is measured in degrees.

Kelly's Results

Replicates the leading regression in the paper exactly

- Applies two step procedure
- Implication: "Only about 1/4 of the persistence results we examine are robust after we take account of possibility that regressions might be fitting spatial noise"

Moran Index for Papers

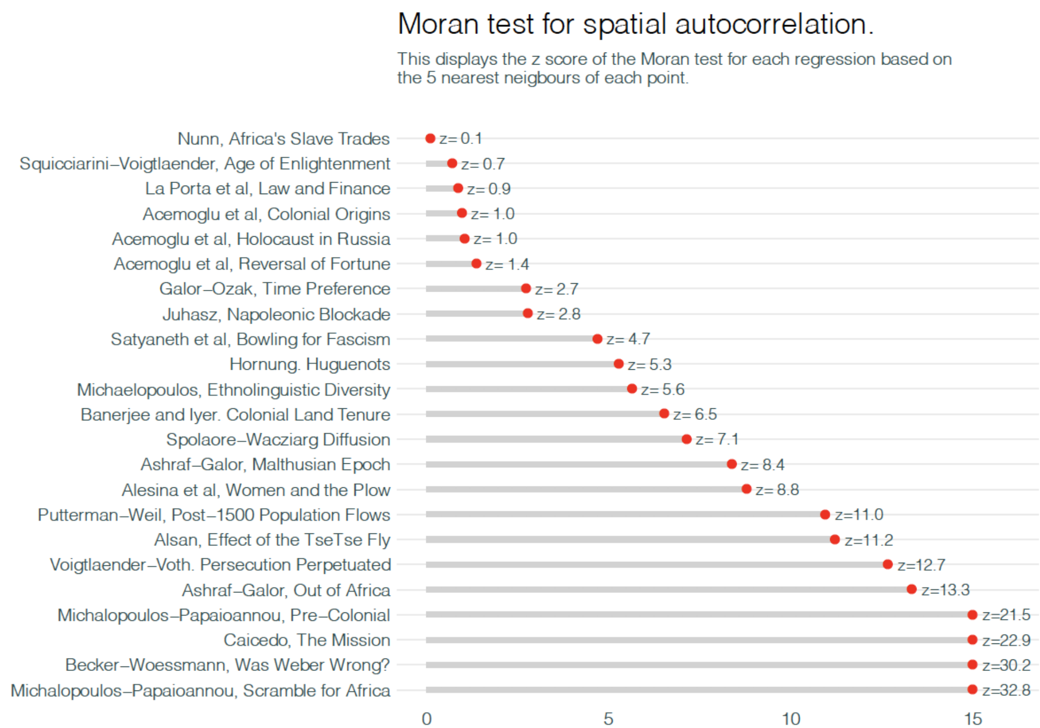
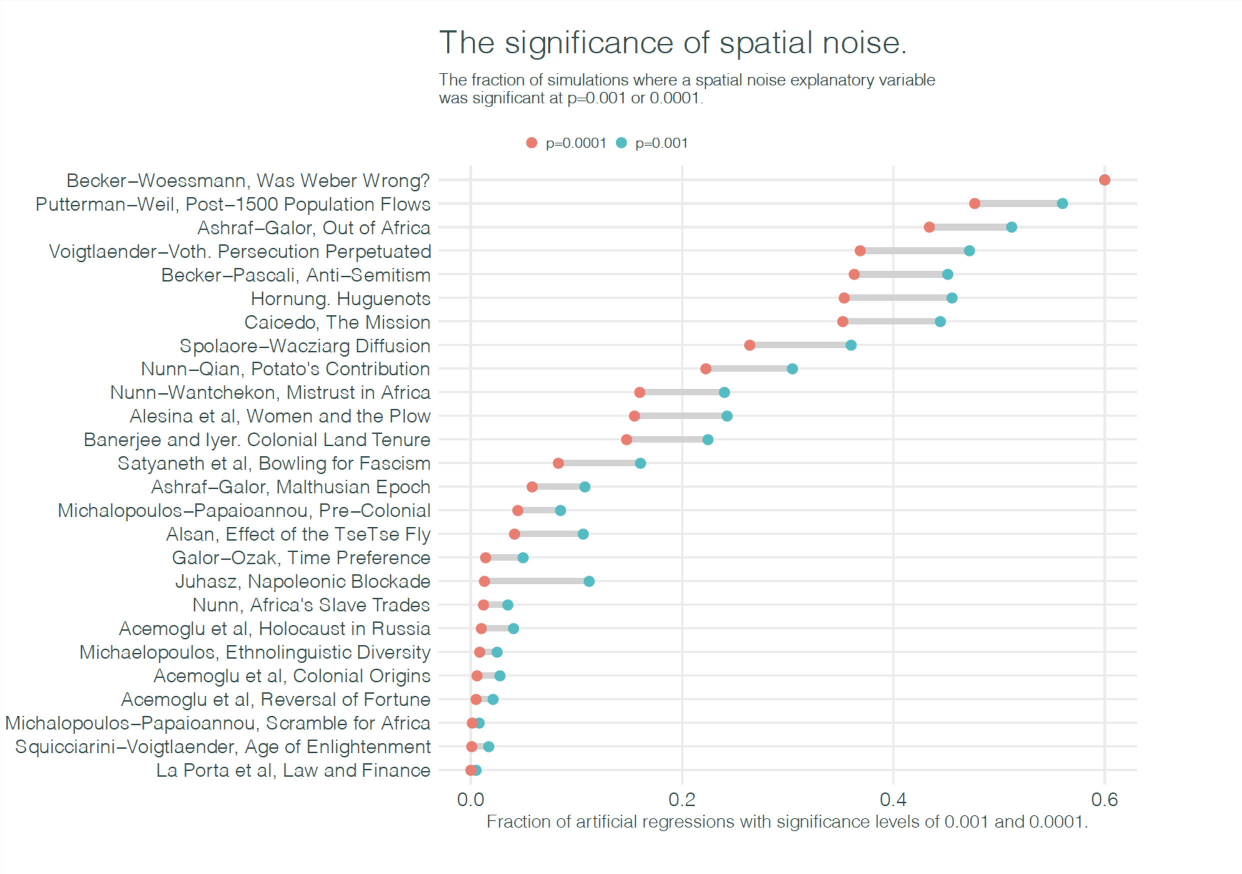
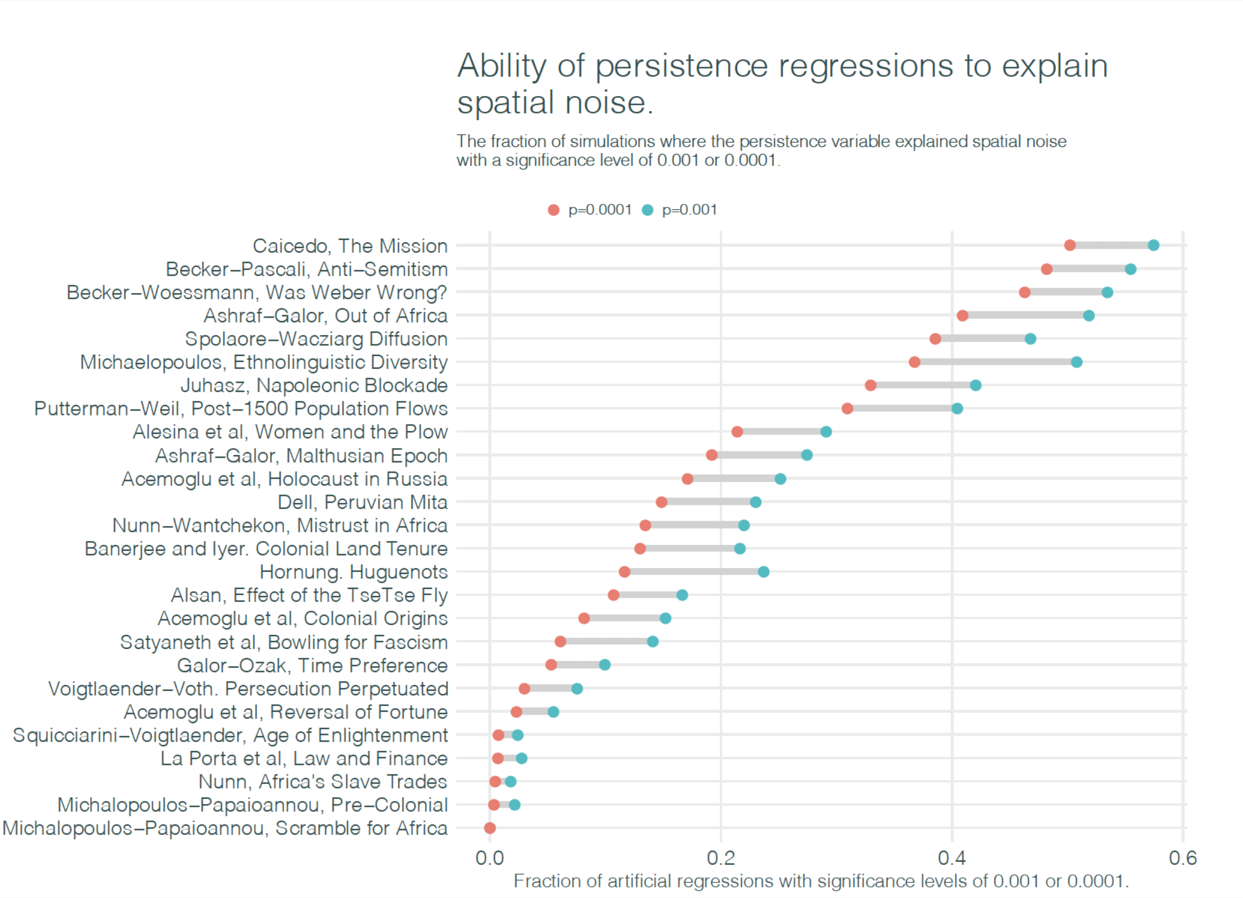


Figure 6: Z scores of Moran tests for spatial autocorrelation in regression residuals.

The explanatory power of noise



Actual predictors explain noise



Concluding remarks

From this sample of papers the papers that have low Moran statistics often use very weak instruments

Sample appears to trade off weak data with spatial correlation

Few if any actually estimate spatial regressions, even as a robustness check