Regional Disparities, Aggregation Effects and the Role of Space

Evidence from Homicide Rates in Colombia 2010-2018

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Motivation:

- Beyond GDP, social variables and their convergence are relevant for development studies (Royuela et al 2015)
- Persistent income differences, differences in health indicators and in "general" regional inequality in Colombia.
- Scarce academic literature on inequality (convergence approach) at the municipality level.

Research Objective:

- Study convergence/divergence of homicide rates across municipalities and departments in Colombia 2010-2018
- Analyze spatial autocorrelation and its robustness at different disaggregate levels

Methods:

- Classical convergence framework (Barro and Sala-i-Martin 1992)
- Distributional convergence framework (Quah 1996; Hyndman et. al 1996)
- Spatial autocorrelation (Moran's I)

Main Results:

1. **Sigma Convergence** for homicide rates at the state level, **Beta Convergence** at the municipality level
2. Regional disaggretation matters: **Local convergence clusters**
3. **Clustering dynamics**
    - State level: 4+? convergence clusters
    - Municipality level: 2+? convergence clusters
4. **Spatial Autocorrelation** robust only at the municipality level

Outline of this presentation

1. **Data description** Survival rates (not homicide rates)
2. **Global convergence:** Using classical summary measures
    - Beta convergence
    - Sigma convergence
3. **Regional disaggregation:**
    - Distribution dynamics framework
    - Distributional convergence
4. **Local convergence clusters**
5. **Global spatial autocorrelation:**
    - Disaggreagation effects
6. **Concluding Remarks**

Data:

- Total number of homicides in Colombia per year from 2010 until 2018 (data taken from the National police).
- Data is agreggated at the municipality and departament level.
- Population census and estimates for states and municipalitites.
- Raw rates computed

$$Hrate = homicides/population$$

- Survival rates (non- murder rates) computed

$$NMR = 10000 - raw\ rate * 10000$$

- **Survival rates** are chosen because positively defined variables are a **standard** in the convergence literature.

(2) Global convergence:

Using classical summary measures

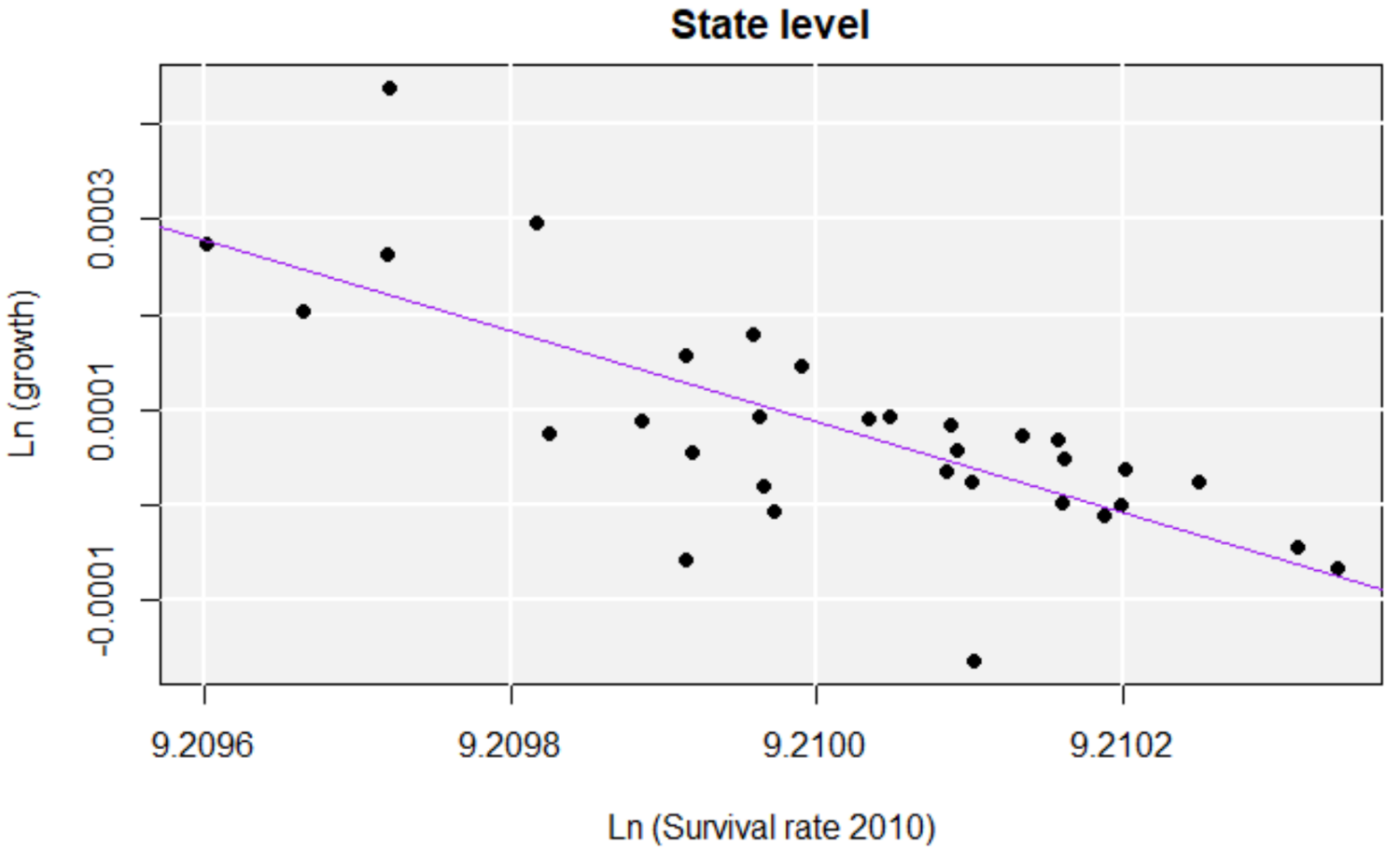
Beta convergence

Sigma convergence

States- Sigma and Beta convergence

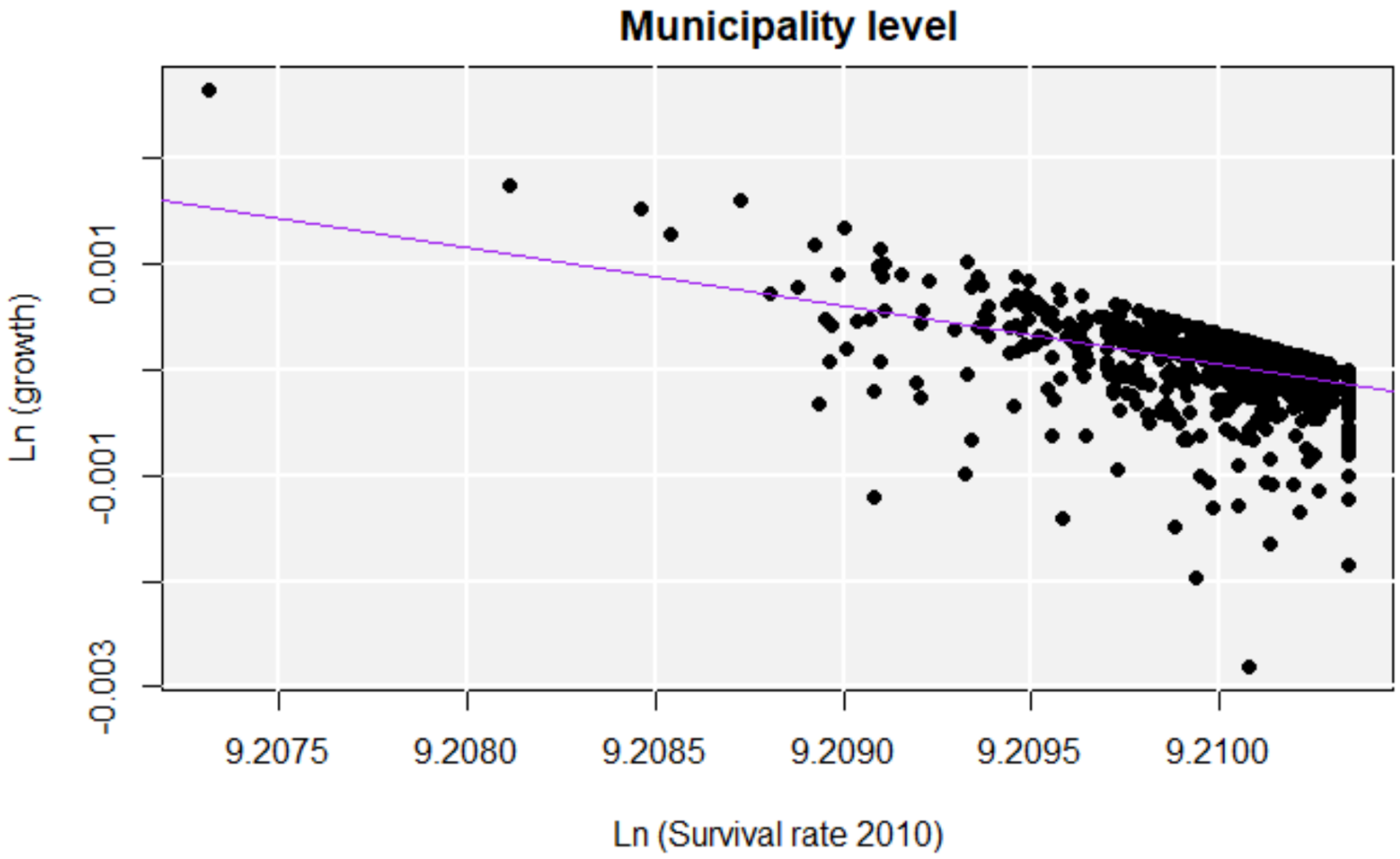
$$\sigma(Standard\ \ deviation)\ \sigma_{2010} = 1.84 \quad \sigma_{2018} = 1.26$$

$$log\frac{Y_t}{Y_0} = \alpha + \beta * logY_0 + \epsilon \quad \beta = -0.476^{***} \quad halflife = 8.59\ years$$



Municipalities - Beta convergence (only)

$$log\frac{Y_t}{Y_0} = \alpha + \beta * logY_0 + \epsilon \quad \beta = -0.551^{***} \quad halflife = 6.92\ years$$



(3) State and Municipality disaggregation:

Distribution dynamics framework

Distributional convergence class: middle

Regional heterogeneity matters

Dynamics of the **entire regional distribution**

conditional density estimation

The distribution dynamics framework

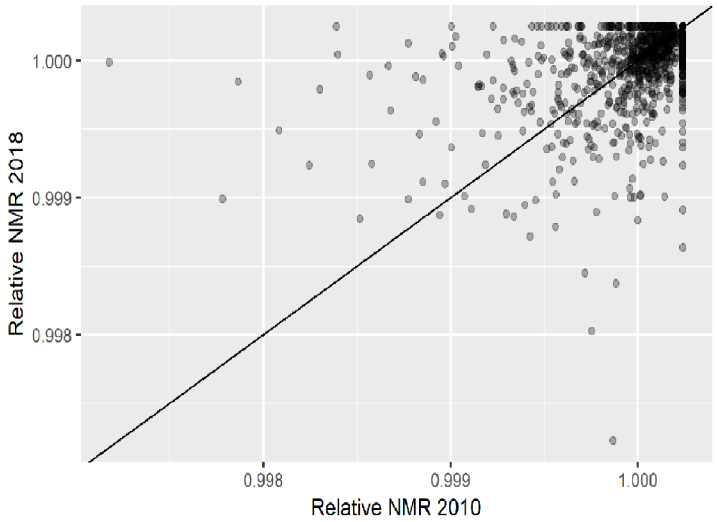
(4) Local convergence clusters

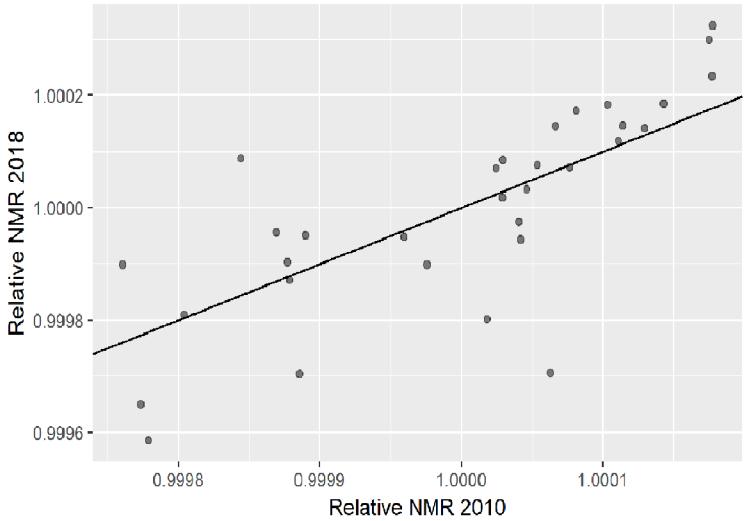
State level: 4+? convergence clusters

Municipality level: 2+? convergence clusters

Where are the clusters?

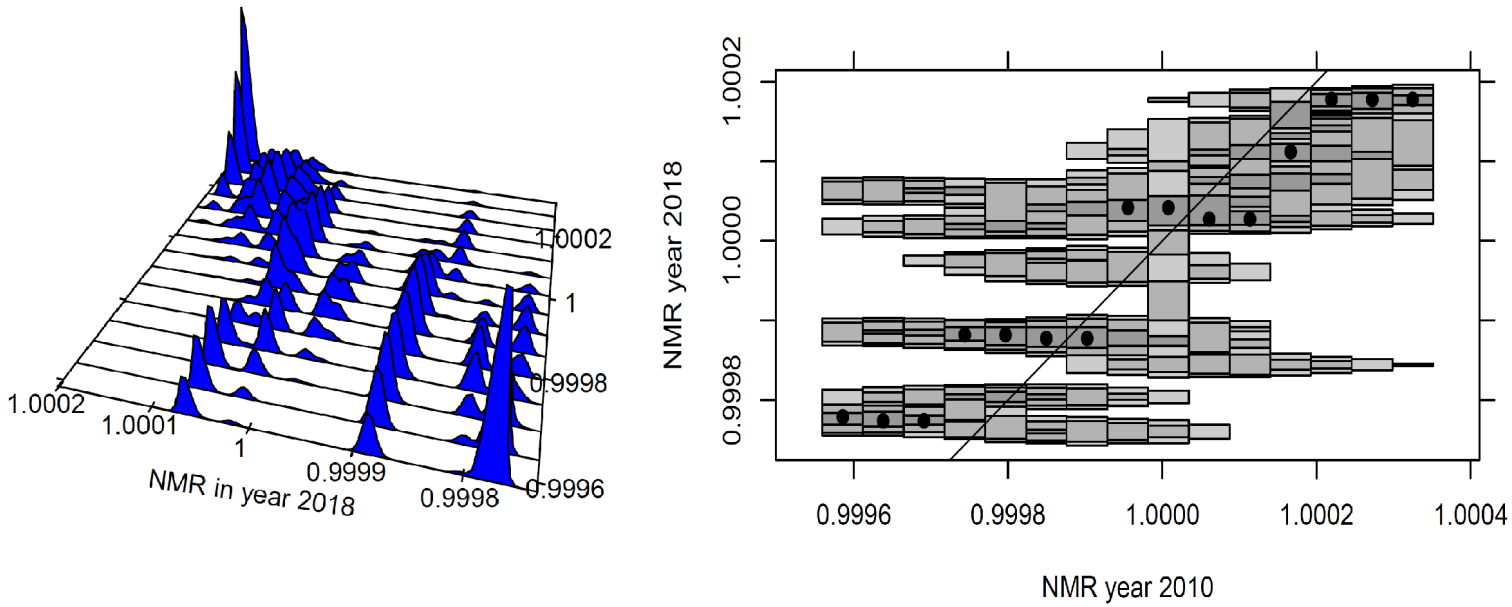
Municipality level - - - - - - - - - - - - - - Department Level





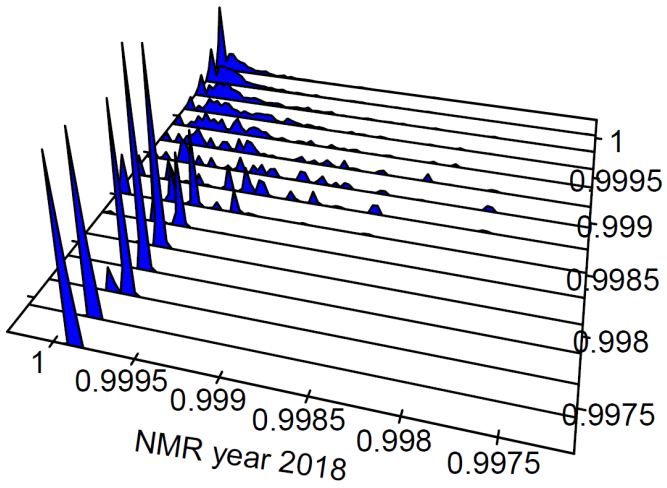
Those lines are not regression trends!

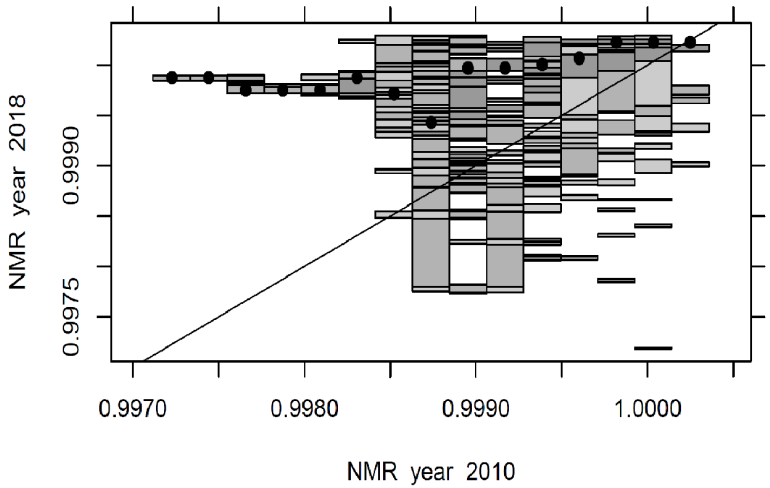
State level: 4+? convergence clusters



Multimodal distribution with sigma convergence

Municipality level: 2+? convergence clusters

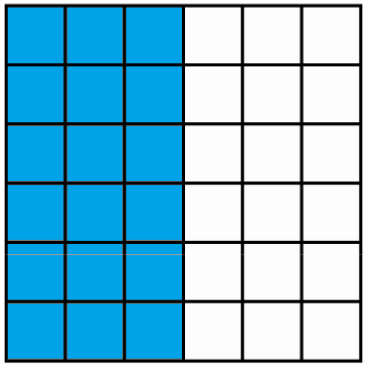




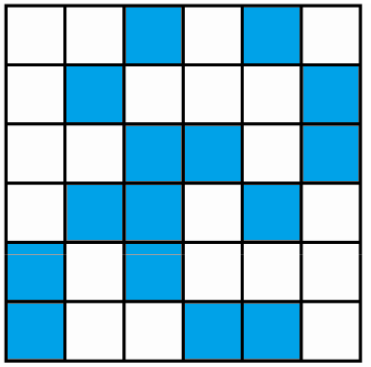
Interesting results; there are fewer clusters but sigma convergence is not present.

(4) Spatial Autocorrelation (moran I definition)

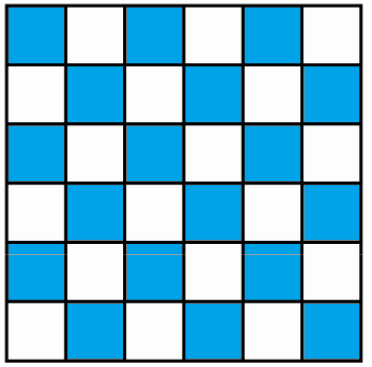
High Intuition Concept



Positive spatial autocorrelation



No spatial autocorrelation



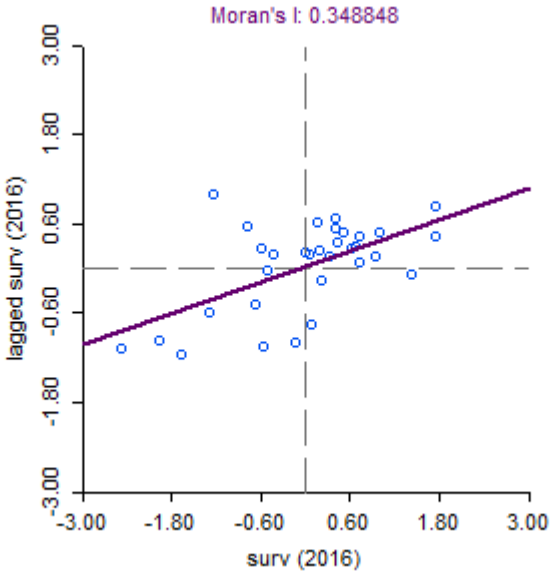
Negative spatial autocorrelation

Source: adapted from Radill (2011)

More Formal (less intuitive)

$$I = \frac{\sum_i \sum_j w_{ij} z_i . z_j}{\sum_i z_i^2} = \frac{\sum_i (z_i \times \sum_j w_{ij} z_j)}{\sum_i z_i^2}.$$

In the linear regression **y=α+βx** , the estimate for **β** is $\sum_i (x_i \times y_i) / \sum_i x_i^2$.In the Moran scatter plot shown below, **y** is the spatial lag variable $\sum_j w_{ij} z_j$



Differential Moran Scatter Plot ($y_{i,t} - y_{i,t-1}$)

Differencing the variable to control for the locational fixed effects: We computate the Moran's I for the variable $y_{i,t} - y_{i,t-1}$. If we consider there is a fixed effect μ_i related to location i, it is possible to present the value at each location for time t as the sum of some intrinsic value and the fixed effect. $y_{i,t} = y *_{i,t} + \mu_i$ (Geoda documentation 2019)

(4) Spatial autocorrelation

State level: Moran's I statistic significant from 2012, differntial Moran's I is not significan (**not robust**)

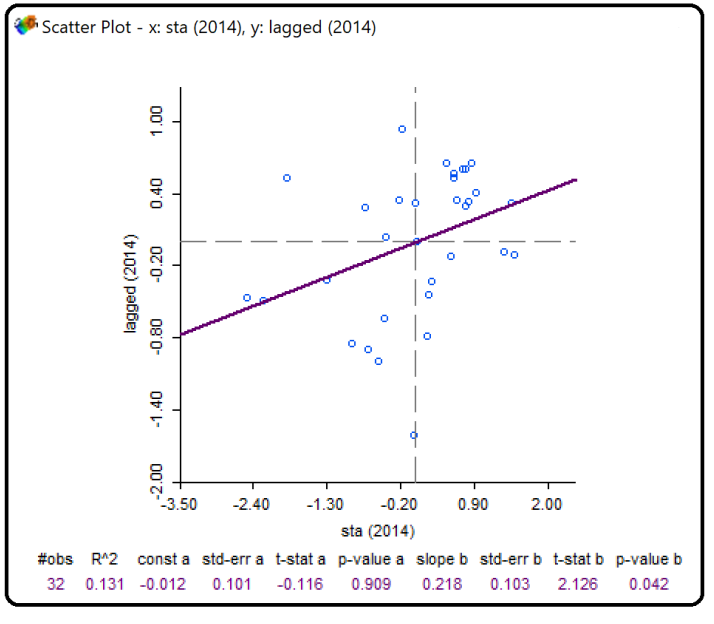
Municipality level: Differential Moran's I significant from 2010 (**robust**)

(4) Spatial autocorrelation

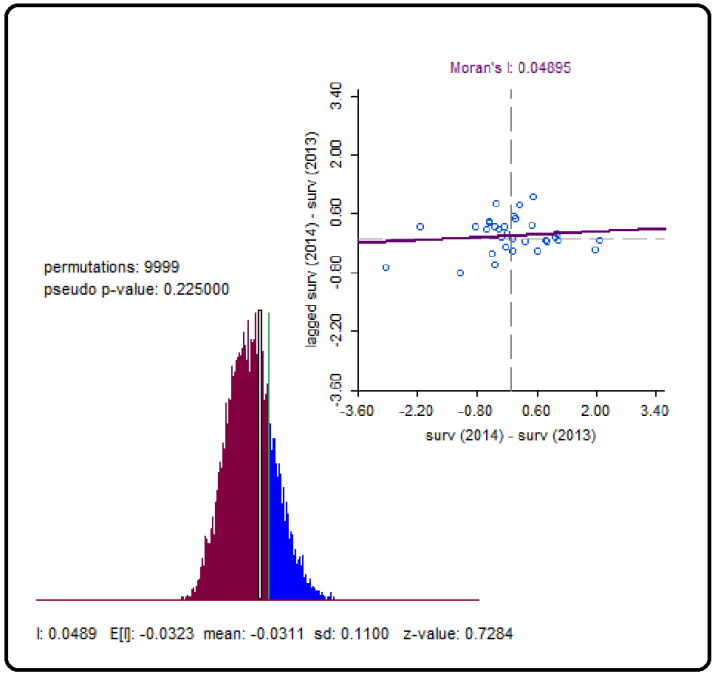
State level (not robust)

- Univatiate Moran's I is significant from 2012.
- But, **The differential moran statistic is not significant**. It is then considered that the significance of Spatial Autocorrelation is **not robust**.
- See plots for 2014 and 2014-2013, similar for other years (standarized variables)

Univariate Moran



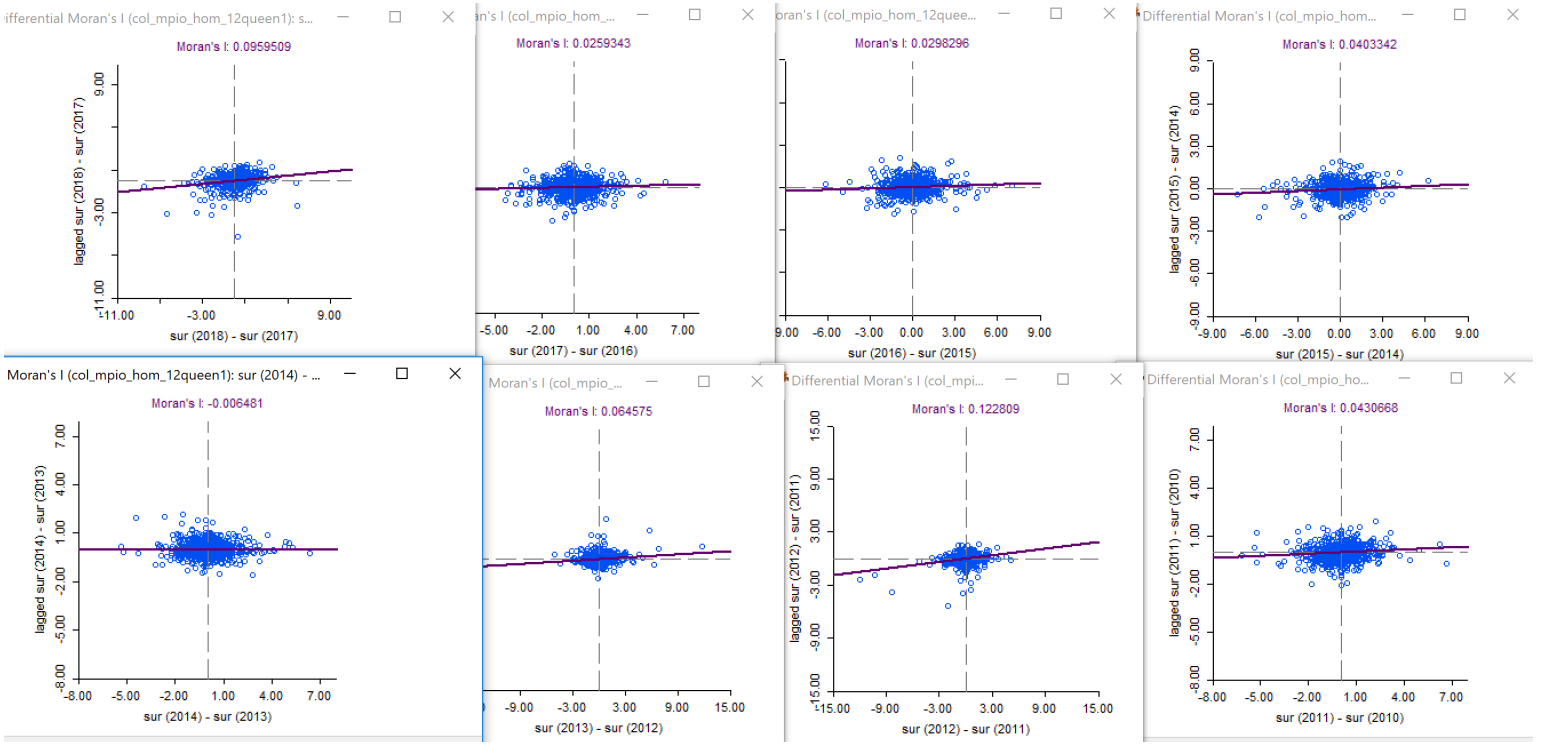
Differential Moran



(4) Spatial autocorrelation

Municipality level (Robust)

- The univariate Moran's I is not significant in 2010 and 2011. however, it is significant from 2012 to 2018; reaching a maximum value in 2016.
- Differential Moran's I ($sur_{2018} - sur_{2010}$) is **significant** $Moran's\ I = 0.22^{***}$
- Subsequent Differential Moran's I $sur_t - sur_{t-1}$ **statistically significant at the municipality level**. Except 2014-2013 (not statistically significant) see graphs



(5) Concluding Remarks

Uplifting results "on average" :

- Differences in overall raw rates at the state level **have decreased** and the means at both levels have increased (survival rate)
- **Global convergence on average at the state level**, while fast beta convergence at the municipality level.

Beyond classical convergence :

- Regional differences matter in **both disaggreagation levels**.
- **Multiple local convergence clubs**; with more clubs at the state level.

The Role of Space

- Subsequent Differential Moran's I are robust and significant at the **municipality level only**
- Results at the **state level** are not conlusive and similar to the ones reported by Royuela et al 2015.

(5) Concluding Remarks

Implications and further research

- Strong spatial autocorrelation suggest the posibility of applying the Getis filtering in order to filter the spatial component of homicide variables.
- Convergence clusters help us to find regions with similar outcomes, coordination among them can be promoted.
- Has crime followed a trajectory? can a speed and direction of contagious patterns be found?
- At the state or department level (including more variables) can a probit model help us to find the determinants for a conditional "jump" to the upper clusters.

Thank you very much for your attention

If you are interested in our research, please check Prof. Carlos Mendez website https://carlos-mendez.rbind.io

And the research semminar's website https://carlos-seminar.rbind.io/

Stay tuned for my Felipe's Master's thesis

Will the SGDs be Achieved in Colombia? A Study of National Convergence and Regional differences.

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