SPATIO-TEMPORAL METHODOLOGY TO ASSESS AND COMPARE THE DIFFERENCES OF LONGEVITY IN EUROPE.

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Main objective

In this study, there are **two objetives**:

- The first one is to present **a spatial-temporal methodology to test significant clusters (groups)** of 26 European countries over a period of 20 years with different behaviour.
- The second is to study the space-time dependence of significant clusters through a **spatial panel data model**.

Motivation

In general, all the countries of the European Union have suffered a decrease in mortality during the last century, but nevertheless **the gap between the mortality of Eastern and Western Europe countries is growing** (Leon, 2011; Vaupel et al., 2011).

Data

- This study is based on mortality data from **26 European countries** for the **period 1990-2009** and **an age range from zero to +110**.
- These data were obtained from the database *HMD (2014)* for a total of 26 European countries: Austria, Belarus, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK and Ukraine.
- In addition, for these 26 countries and 20 years, we collect information of seven covariates: ***Gross Domestic Product (GDP), Activity rate , Energy consumption and Birth rate***, from the database *The World Bank (2015)*.

Statistics

To study the spatio-temporal relationship of mortality in European countries, several statistics have been used:

- Standardised Mortality Ratio (SMR)
- Global Moran Index
- Local Moran Index
- Spatial Markov

Selected model

The typology of our data leads us to use a Fixed Effects Spatial Lag Model. The reasons are:

- Fixed Effects: The fixed effects model is generally more appropriate than the random effects model since spatial econometricians tend to work with space-time data of adjacent spatial units located in unbroken study areas (Elhorst, 2014).
- Spatial Lag: We confirm that the value of the SMR in a country depends on the value of SMR in another country adjacent.

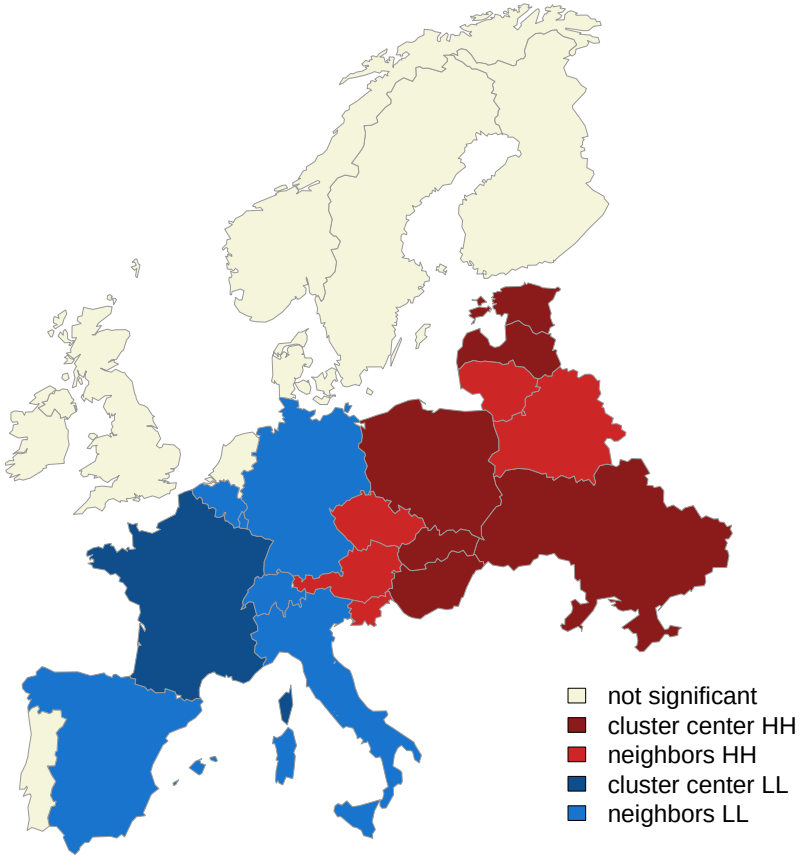
Mathematical formula

The Fixed Effects Spatial Lag Model is expressed as follows:

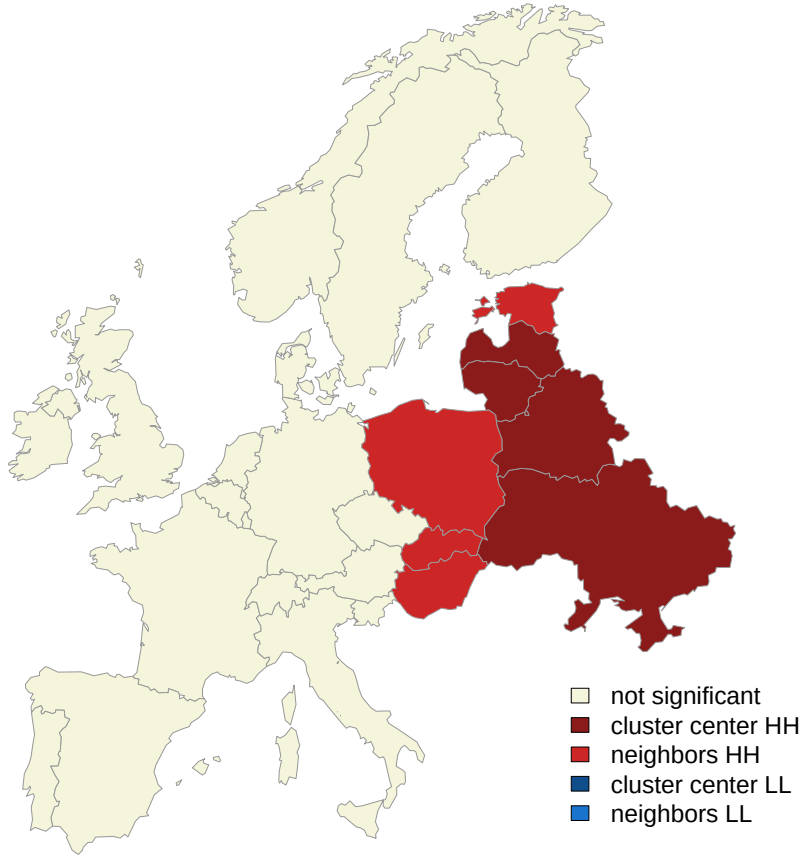
$$y_{it} = \lambda \sum_{j=1}^{N} W_{ij} y_{jt} + X_{it}\beta + \mu_i + \nu_t + \epsilon_{it}$$

where:
i represents the countries
t represents the years
y_{it} is an observation on the dependent variable at i and t
λ is the spatial parameter associated with the dependent variable
W_{ij} spatial weights matrix where i and j represent whichever two of the N countries
x_{it} vector of observations on the independent variables
β vector of fixed but unknown parameters
μ_s is the spatial fixed effect (not spatially autocorrelated)
ν_t is the temporal fixed effect (not temporal autocorrelation)
ϵ_{it} is the error model (not spatially autocorrelated)

Clusters Map for years 1990 and 2009 in Europe.



(a) Cluster Map Europe in 1990



(b) Cluster Map Europe in 2009

Parameter estimation of Fixed Effects Spatial Lag Model

```
> f <- (logSMR ~ GDP + activity rate  + energy consumption)
> model3cov<- spml(f,data,index=c("country","year"), listw = pesosmatl
w,lag=TRUE,model = "within", spatial.error="none", effect="twoways")
>
> summary(model3cov)
Spatial panel fixed effects lag model

Call:
spml(formula = f, data = data_imp2, index = c("country", "year"),
    listw = pesosmatlw, model = "within", effect = "twoways",
    lag = TRUE, spatial.error = "none")

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-0.216000 -0.018900 -0.000858  0.018000  0.143000

Coefficients:
                     Estimate  Std. Error t-value  Pr(>|t|)
lambda               0.34646104  0.03909351  8.8624 < 2.2e-16 ***
GDP                  0.00411959  0.00059531  6.9201 4.514e-12 ***
activity rate       -0.00329698  0.00087190 -3.7814  0.000156 ***
energy consumption  -0.00405517  0.00076275 -5.3165 1.058e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

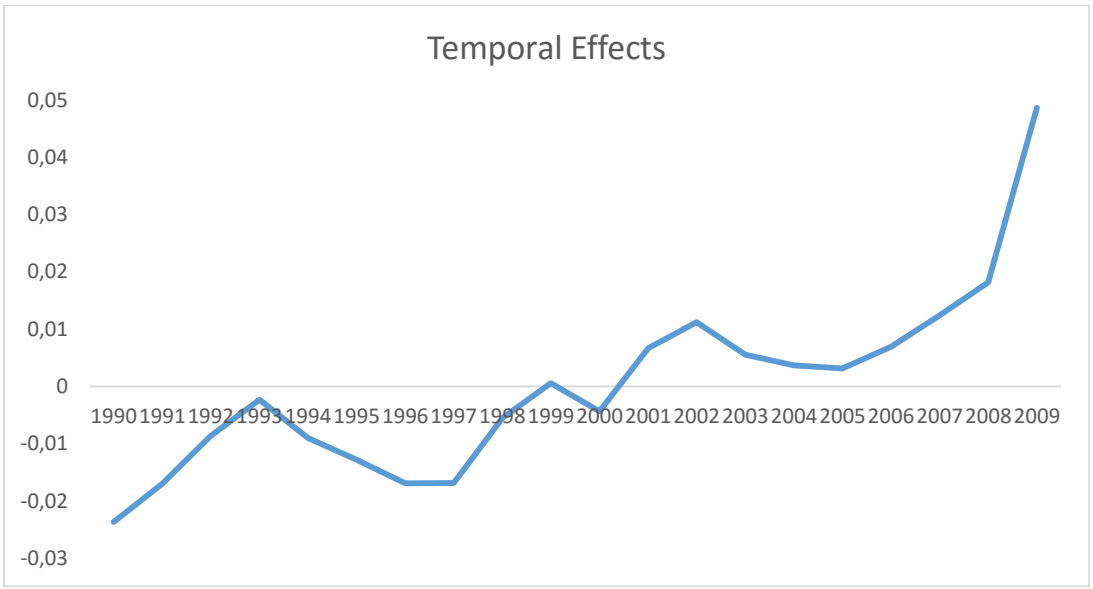
Parameter estimation of Fixed Effects Spatial Lag Model cont...

```
> effects(model3cov)

Intercept:
            Estimate Std. Error t-value  Pr(>|t|)
(Intercept) 0.289611   0.052336  5.5337 3.135e-08 ***

Spatial fixed effects:
     Estimate Std. Error t-value  Pr(>|t|)
austria        -0.1367964  0.0533695 -2.5632  0.010371 *
belgium        -0.1182289  0.0462476 -2.5564  0.010575 *
belarus         0.2724464  0.0529076  5.1495 2.612e-07 ***
switzerland    -0.1821221  0.0607600 -2.9974  0.002723 **
czech.republic  0.1167373  0.0531932  2.1946  0.028193 *
germany        -0.1025211  0.0522681 -1.9614  0.049827 *
denmark         0.0348714  0.0592428  0.5886  0.556117
estonia         0.1350265  0.0550526  2.4527  0.014180 *
spain          -0.1977822  0.0496440 -3.9840 6.776e-05 ***
finland        -0.0673335  0.0544749 -1.2360  0.216441
france         -0.2255814  0.0499580 -4.5154 6.319e-06 ***
hungary         0.2043721  0.0450712  4.5344 5.776e-06 ***
ireland        -0.0074169  0.0540874 -0.1371  0.890930
italy          -0.2122881  0.0452491 -4.6915 2.712e-06 ***
lithuania       0.1160925  0.0543955  2.1342  0.032824 *
luxembourg      0.0224167  0.0564338  0.3972  0.691204
latvia          0.2544437  0.0545260  4.6665 3.064e-06 ***
netherlands    -0.1217289  0.0550242 -2.2123  0.026947 *
norway         -0.1231497  0.0574568 -2.1433  0.032085 *
poland          0.0522064  0.0511289  1.0211  0.307219
portugal        0.0381412  0.0553676  0.6889  0.490903
sweden         -0.1727348  0.0563408 -3.0659  0.002170 **
slovenia        0.0213348  0.0527795  0.4042  0.686047
slovakia        0.1270905  0.0540766  2.3502  0.018764 *
ukraine         0.3611898  0.0512787  7.0437 1.873e-12 ***
uk             -0.0886855  0.0556644 -1.5932  0.111111
```

Graphical representation of temporal effect



Acknowledgements

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Thanks for your attention

Any question?

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