Econometria espacial com R - Aula 05

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Painel espacial

Pacotes

O pacote `plm` é responsável pelos painéis convencionais (não espaciais) que usaremos para comparação. O pacote `splm` é responsável pelos painéis espaciais. Os autores do pacote lançaram um artigo sobre ele neste link.

```
library(plm)
```

```
## Loading required package: Formula
```

```
library(splm)
```

```
## Loading required package: spdep
```

```
## Loading required package: sp
```

```
## Loading required package: Matrix
```

Shapefile

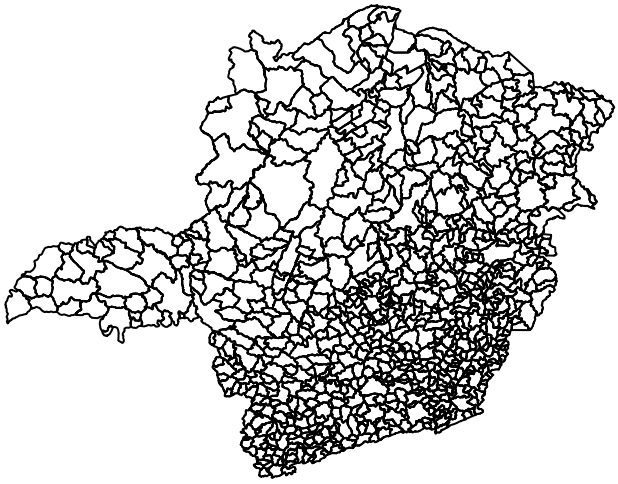
```
# Pacotes
library(rgdal)
```

```
## rgdal: version: 1.2-8, (SVN revision 663)
##  Geospatial Data Abstraction Library extensions to R successfully loaded
##  Loaded GDAL runtime: GDAL 1.11.3, released 2015/09/16
##  Path to GDAL shared files: /usr/share/gdal/1.11
##  Loaded PROJ.4 runtime: Rel. 4.9.2, 08 September 2015, [PJ_VERSION: 492]
##  Path to PROJ.4 shared files: (autodetected)
##  Linking to sp version: 1.2-5
```

```
guarda.shp <- readOGR("data", "guarda", encoding = "ISO-8859-1")
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "data", layer: "guarda"
## with 853 features
## It has 93 fields
```

```
# Plotar o mapa
plot(guarda.shp)
```



Dados

Uma olhada nos dados.

```
str(guarda.shp@data)
```

```
## 'data.frame':    853 obs. of  93 variables:
##  $ Z_         : Factor w/ 853 levels "ABADIA DOS DOURADOS",..: 159 442 697 389 828 121 330 715 358 387
##  $ SEM_ACENTO: Factor w/ 853 levels "ABADIA DOS DOURADOS",..: 159 442 697 389 828 121 330 715 358 387
##  $ ZEM_ACENTO: Factor w/ 853 levels "3100104","3100203",..: 158 443 697 389 827 120 330 715 358 387
##  $ UF         : Factor w/ 1 level "MG": 1 1 1 1 1 1 1 1 1 1 ...
##  $ UF_IBGE    : Factor w/ 1 level "31": 1 1 1 1 1 1 1 1 1 1 ...
##  $ ZF_IBGE    : Factor w/ 1 level "SE": 1 1 1 1 1 1 1 1 1 1 ...
##  $ MESO_IBGE  : Factor w/ 12 levels "CAMPO DAS VERTENTES",..: 9 9 9 9 9 9 9 9 9 9 ...
##  $ MESO_IBGO  : Factor w/ 13 levels "0","01","02",..: 6 6 6 6 6 6 6 6 6 6 ...
##  $ MICRO_IB1  : Factor w/ 66 levels "AIMORES","ALFENAS",..: 21 21 29 21 21 21 29 21 29 29 ...
##  $ MICRO_IB0  : Factor w/ 66 levels "001","002","003",..: 21 21 17 21 21 21 17 21 17 17 ...
##  $ MESO_IBG1  : Factor w/ 12 levels "3101","3102",..: 5 5 5 5 5 5 5 5 5 5 ...
##  $ MICRO_IBGE: Factor w/ 66 levels "310101","310102",..: 21 21 17 21 21 21 17 21 17 17 ...
##  $ AREA_97    : num  2057 1317 3013 1401 1161 ...
##  $ SEDE       : num  -50.7 -50.6 -50.1 -50.2 -50.3 ...
##  $ SEDE0      : num  -19.7 -19.6 -18.8 -19.7 -19.5 ...
##  $ CODCOMP    : Factor w/ 853 levels "310100104502",..: 221 227 188 226 231 220 185 230 186 187 ...
##  $ CODMUN6    : Factor w/ 853 levels "310010","310020",..: 158 443 697 389 827 120 330 715 358 387 ...
##  $ CODCOMP_1  : Factor w/ 853 levels "310100104502",..: 221 227 188 226 231 220 185 230 186 187 ...
##  $ MUNICIPIO0: Factor w/ 853 levels "ABADIA DOS DOURADOS",..: 159 442 697 389 828 121 330 715 358 387
##  $ GM         : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ AREA00     : num  2057 1317 3012 1401 1160 ...
##  $ AREA10     : num  2063 1319 3001 1405 1147 ...
##  $ EMP00      : num  16.5 10.5 17.1 21.3 9 12.2 12.9 19.7 14.4 19.9 ...
##  $ POLC00     : int  1 0 6 6 0 4 1 0 2 48 ...
##  $ POLM00     : int  20 9 42 104 5 31 11 6 9 221 ...
##  $ POLTPC00   : num  0.00236 0.00146 0.00293 0.00382 0.00108 ...
##  $ POLMPC00   : num  0.00224 0.00146 0.00256 0.00361 0.00108 ...
##  $ EMP09      : num  26.3 36.6 33.9 30.7 55.2 ...
##  $ BF09       : num  5.6 1.8 5.8 4.7 4 5.2 8.8 3.2 6 2.5 ...
##  $ POLMPC09   : num  0.002445 0.001027 0.002451 0.002924 0.000676 ...
##  $ POLM09     : int  23 7 44 99 3 34 11 6 9 199 ...
```

```
##  $ TANALF00  : num  21.5 19.2 16.8 13.2 17.3 ...
##  $ GINI00    : num  0.59 0.54 0.56 0.58 0.54 0.58 0.59 0.56 0.62 0.57 ...
##  $ EXTPOB00  : num  4.07 8.39 4.67 2.8 10.19 ...
##  $ X_POB00   : num  21.3 27.2 23 12 22.9 ...
##  $ VULPOB00  : num  51.9 59.8 49.5 36.2 57.6 ...
##  $ R20POB00  : num  3.69 3.7 3.78 3.45 3.09 3.53 3.31 3.63 3.14 3.58 ...
##  $ R20RIC00  : num  64.8 59.6 61.7 64 59.9 ...
##  $ RENDA00   : num  502 376 462 667 392 ...
##  $ RENPOB00  : num  92.6 69.4 87.4 115 60.6 ...
##  $ RENRIC00  : num  1626 1119 1424 2136 1175 ...
##  $ THEIL00   : num  0.62 0.48 0.54 0.6 0.44 0.59 0.61 0.54 0.71 0.57 ...
##  $ FORMAL00  : num  42.1 43.8 42.9 58 51.7 ...
##  $ THEILR00  : num  0.69 0.5 0.51 0.68 0.48 0.61 0.67 0.62 0.76 0.61 ...
##  $ CHEFA00   : num  6.21 4.39 10.16 12.35 5.61 ...
##  $ DESOCU00  : num  8.96 5.87 9.59 9.85 10.36 ...
##  $ NEMNEM00  : num  19.1 17.2 15 11.7 20.7 ...
##  $ X1519PM00 : int  465 344 774 1483 240 934 303 293 198 3890 ...
##  $ X2024PM00 : int  390 263 784 1373 220 780 302 238 156 3930 ...
##  $ POPRM     : int  4643 3212 8487 14498 2485 9711 3623 2754 2067 43641 ...
##  $ X1519PF00 : int  433 315 706 1391 200 880 281 285 168 3901 ...
##  $ X2024PF00 : int  368 267 738 1419 218 745 274 240 167 3946 ...
##  $ POPRF00   : int  4267 2958 7878 14316 2153 9389 3260 2520 1959 45450 ...
##  $ POPTOT00  : int  8910 6170 16365 28814 4638 19100 6883 5274 4026 89091 ...
##  $ POPURB00  : int  5515 3681 12544 26829 2272 13411 2834 3431 3511 83853 ...
##  $ IDH00     : num  0.607 0.586 0.565 0.669 0.533 0.621 0.587 0.612 0.625 0.653 ...
##  $ IDHE00    : num  0.421 0.406 0.352 0.528 0.327 0.427 0.401 0.433 0.463 0.508 ...
##  $ TANALF10  : num  12.31 13.57 12.95 9.23 14.82 ...
##  $ GINI10    : num  0.57 0.46 0.46 0.46 0.48 0.47 0.49 0.5 0.43 0.5 ...
##  $ EXTPOB10  : num  2.54 6.71 1.68 0.69 4.67 3.12 5.39 6.37 1.34 1.14 ...
##  $ X_POB10   : num  4.3 10.96 4.94 3.7 12.41 ...
##  $ VULPOB10  : num  20.3 27.7 20.2 17.3 29.7 ...
##  $ R20POB10  : num  4.12 3.7 5.21 5.07 4.15 4.53 3.85 3.61 5.83 4.68 ...
##  $ R20RIC10  : num  61.6 51.5 52.4 52.3 52.8 ...
##  $ RENDA10   : num  847 596 699 753 563 ...
##  $ RENPOB10  : num  175 110 182 191 117 ...
##  $ RENRIC10  : num  2631 1522 1827 1969 1478 ...
##  $ THEIL10   : num  0.59 0.35 0.38 0.37 0.42 0.4 0.41 0.44 0.34 0.44 ...
##  $ FORMAL10  : num  62.5 67.6 60.7 64.5 57.9 ...
##  $ DESOCU10  : num  4.65 9.59 4.21 4.85 7.71 4.65 3.6 5.16 4.2 5.55 ...
##  $ THEILR10  : num  0.35 0.24 0.43 0.36 0.26 0.37 0.38 0.38 0.32 0.45 ...
##  $ VULPOB100 : num  8.46 11.66 10.87 7.03 16.07 ...
##  $ CHEFA10   : num  10.31 15.03 7.7 6.58 21.42 ...
##  $ NEMNEM10  : num  3.87 7.75 8.03 3.6 12.24 ...
##  $ X1519PM10 : int  389 314 737 1523 182 782 237 223 158 4011 ...
##  $ X2024PM10 : int  429 318 784 1674 226 737 161 263 181 4211 ...
##  $ POPRM10   : int  4867 3532 9408 17297 2412 9804 3237 2972 2096 47862 ...
##  $ X1519PF10 : int  357 319 699 1502 170 756 196 231 180 3961 ...
##  $ X2024PF10 : int  355 313 677 1588 174 731 164 231 145 4074 ...
##  $ POPRF10   : int  4604 3358 8730 17159 2006 9520 2900 2804 2011 49309 ...
##  $ POPTOT10  : int  9471 6890 18138 34456 4418 19324 6137 5776 4107 97171 ...
##  $ POPURB10  : int  6975 5017 14926 32598 2726 14433 2692 4332 3741 93125 ...
##  $ IDH10     : num  0.741 0.71 0.71 0.747 0.672 0.704 0.68 0.688 0.696 0.739 ...
##  $ IDHE10    : num  0.622 0.62 0.576 0.674 0.534 0.562 0.525 0.528 0.61 0.644 ...
##  $ THOM0900  : num  10.93 14.72 6.33 9.03 20.1 ...
```

```
##  $ TCV00     : num  22.2 112.5 169.6 92.9 106.9 ...
##  $ TCV10     : num  63.4 101.6 93.7 136.4 249 ...
##  $ TCVPA00   : num  11.2 64.8 97.8 31.2 0 ...
##  $ TCVPA10   : num  31.7 43.5 66.2 78.4 135.8 ...
##  $ TCVPE00   : num  11.2 48.6 73.3 62.5 107.8 ...
##  $ TCVPE10   : num  31.7 58.1 27.6 58 113.2 ...
##  $ THOM00    : num  0 0 30.3 10.3 42.7 ...
##  $ THOM10    : num  10.56 14.51 5.51 5.8 22.63 ...
```

```
head(guarda.shp@data)
```

```
##                Z_       SEM_ACENTO ZEM_ACENTO UF UF_IBGE ZF_IBGE
## 0      CARNEIRINHO      CARNEIRINHO    3114550 MG      31      SE
## 1 LIMEIRA DO OESTE LIMEIRA DO OESTE    3138625 MG      31      SE
## 2    SANTA VITÓRIA    SANTA VITORIA    3159803 MG      31      SE
## 3          ITURAMA          ITURAMA    3134400 MG      31      SE
## 4   UNIÃO DE MINAS   UNIAO DE MINAS    3170438 MG      31      SE
## 5    CAMPINA VERDE    CAMPINA VERDE    3111101 MG      31      SE
##                          MESO_IBGE MESO_IBG0 MICRO_IB1 MICRO_IBO MESO_IBG1
## 0 TRIANGULO MINEIRO/ALTO PARANAIBA        05    FRUTAL       021      3105
## 1 TRIANGULO MINEIRO/ALTO PARANAIBA        05    FRUTAL       021      3105
## 2 TRIANGULO MINEIRO/ALTO PARANAIBA        05 ITUIUTABA       017      3105
## 3 TRIANGULO MINEIRO/ALTO PARANAIBA        05    FRUTAL       021      3105
## 4 TRIANGULO MINEIRO/ALTO PARANAIBA        05    FRUTAL       021      3105
## 5 TRIANGULO MINEIRO/ALTO PARANAIBA        05    FRUTAL       021      3105
##   MICRO_IBGE  AREA_97    SEDE   SEDE0      CODCOMP CODMUN6    CODCOMP_1
## 0     310521 2056.920 -50.688 -19.698 310502114550  311455 310502114550
## 1     310521 1317.386 -50.581 -19.551 310502138625  313862 310502138625
## 2     310517 3012.513 -50.121 -18.839 310501759803  315980 310501759803
## 3     310521 1401.303 -50.196 -19.728 310502134400  313440 310502134400
## 4     310521 1160.549 -50.336 -19.530 310502170438  317043 310502170438
## 5     310521 3659.177 -49.486 -19.536 310502111101  311110 310502111101
##         MUNICIPIO0 GM AREA00 AREA10 EMP00 POLC00 POLM00    POLTPC00
## 0      CARNEIRINHO  0 2056.9 2063.3  16.5      1     20 0.002358491
## 1 LIMEIRA DO OESTE  0 1317.4 1319.0  10.5      0      9 0.001457726
## 2    SANTA VITORIA  0 3012.5 3001.4  17.1      6     42 0.002932551
## 3          ITURAMA  0 1401.3 1404.7  21.3      6    104 0.003816794
## 4   UNIAO DE MINAS  0 1160.5 1147.4   9.0      0      5 0.001077586
## 5    CAMPINA VERDE  0 3659.2 3650.8  12.2      4     31 0.001831502
##      POLMPC00    EMP09 BF09     POLMPC09 POLM09 TANALF00 GINI00 EXTPOB00
## 0 0.002242152 26.32577  5.6 0.0024449878     23    21.50   0.59     4.07
## 1 0.001457726 36.58890  1.8 0.0010266940      7    19.19   0.54     8.39
## 2 0.002564103 33.88955  5.8 0.0024509804     44    16.77   0.56     4.67
## 3 0.003610108 30.72171  4.7 0.0029239766     99    13.24   0.58     2.80
## 4 0.001077586 55.18663  4.0 0.0006756757      3    17.31   0.54    10.19
## 5 0.001623377 17.63213  5.2 0.0017605634     34    12.40   0.58     4.37
##   X_POB00 VULPOB00 R20POB00 R20RIC00 RENDA00 RENPOB00 RENRIC00 THEIL00
## 0   21.32    51.93     3.69    64.76  502.07    92.63  1625.72    0.62
## 1   27.24    59.80     3.70    59.60  375.62    69.41  1119.35    0.48
## 2   22.96    49.50     3.78    61.67  461.96    87.38  1424.41    0.54
## 3   12.01    36.22     3.45    63.99  667.49   115.05  2135.72    0.60
## 4   22.95    57.58     3.09    59.93  391.96    60.60  1174.59    0.44
## 5   17.98    48.06     3.53    63.83  541.66    95.65  1728.65    0.59
##   FORMAL00 THEILR00 CHEFA00 DESOCU00 NEMNEM00 X1519PM00 X2024PM00 POPRM
## 0    42.11     0.69    6.21     8.96    19.11       465       390  4643
```

```
## 1    43.80     0.50    4.39     5.87    17.22       344       263  3212
## 2    42.94     0.51   10.16     9.59    14.99       774       784  8487
## 3    58.01     0.68   12.35     9.85    11.66      1483      1373 14498
## 4    51.68     0.48    5.61    10.36    20.71       240       220  2485
## 5    43.29     0.61    7.51    10.43    14.19       934       780  9711
##   X1519PF00 X2024PF00 POPRF00 POPTOT00 POPURB00 IDH00 IDHE00 TANALF10
## 0       433       368    4267     8910     5515 0.607  0.421    12.31
## 1       315       267    2958     6170     3681 0.586  0.406    13.57
## 2       706       738    7878    16365    12544 0.565  0.352    12.95
## 3      1391      1419   14316    28814    26829 0.669  0.528     9.23
## 4       200       218    2153     4638     2272 0.533  0.327    14.82
## 5       880       745    9389    19100    13411 0.621  0.427     8.50
##   GINI10 EXTPOB10 X_POB10 VULPOB10 R20POB10 R20RIC10 RENDA10 RENPOB10
## 0   0.57     2.54    4.30    20.27     4.12    61.59  847.07   174.63
## 1   0.46     6.71   10.96    27.68     3.70    51.54  595.92   110.36
## 2   0.46     1.68    4.94    20.18     5.21    52.38  698.70   182.17
## 3   0.46     0.69    3.70    17.30     5.07    52.28  753.23   191.00
## 4   0.48     4.67   12.41    29.67     4.15    52.81  562.84   116.74
## 5   0.47     3.12    7.10    22.39     4.53    52.51  681.73   154.33
##   RENRIC10 THEIL10 FORMAL10 DESOCU10 THEILR10 VULPOB100 CHEFA10 NEMNEM10
## 0  2631.48    0.59    62.45     4.65     0.35      8.46   10.31     3.87
## 1  1521.58    0.35    67.57     9.59     0.24     11.66   15.03     7.75
## 2  1827.27    0.38    60.67     4.21     0.43     10.87    7.70     8.03
## 3  1968.51    0.37    64.45     4.85     0.36      7.03    6.58     3.60
## 4  1477.66    0.42    57.88     7.71     0.26     16.07   21.42    12.24
## 5  1800.09    0.40    50.77     4.65     0.37     10.74   12.18     8.70
##   X1519PM10 X2024PM10 POPRM10 X1519PF10 X2024PF10 POPRF10 POPTOT10
## 0       389       429    4867       357       355    4604     9471
## 1       314       318    3532       319       313    3358     6890
## 2       737       784    9408       699       677    8730    18138
## 3      1523      1674   17297      1502      1588   17159    34456
## 4       182       226    2412       170       174    2006     4418
## 5       782       737    9804       756       731    9520    19324
##   POPURB10 IDH10 IDHE10  THOM0900  TCV00  TCV10 TCVPA00 TCVPA10 TCVPE00
## 0     6975 0.741  0.622 10.934937  22.25  63.35   11.22   31.68   11.22
## 1     5017 0.710  0.620 14.718870 112.47 101.60   64.83   43.54   48.62
## 2    14926 0.710  0.576  6.333523 169.61  93.73   97.77   66.16   73.33
## 3    32598 0.747  0.674  9.027987  92.89 136.41   31.23   78.36   62.47
## 4     2726 0.672  0.534 20.096463 106.86 248.98    0.00  135.81  107.81
## 5    14433 0.704  0.562 20.830079  88.23 108.67   47.12   82.80   41.88
##   TCVPE10 THOM00 THOM10
## 0   31.68   0.00  10.56
## 1   58.06   0.00  14.51
## 2   27.57  30.29   5.51
## 3   58.05  10.32   5.80
## 4  113.17  42.74  22.63
## 5   25.87   5.19   5.17
```

Filtrando dados

Vamos separar algumas variáveis para usarmos no modelo

```
dados <- guarda.shp@data
dados <- subset(dados, select=c("CODMUN6", "TCVPA00", "TCVPA10","RENDA00", "RENDA10", "THEIL00","THEIL1
```

Matriz de vizinhança

Para rodar os paineis espaciais, vamos precisar de uma matriz de vizinhança.

```
w1 <- nb2listw(poly2nb(guarda.shp, queen = TRUE))
summary(w1)
```

```
## Characteristics of weights list object:
## Neighbour list object:
## Number of regions: 853
## Number of nonzero links: 4860
## Percentage nonzero weights: 0.6679412
## Average number of links: 5.697538
## Link number distribution:
##
##   1   2   3   4   5   6   7   8   9  10  11  12  13  14  17  18
##   4  26  83 152 170 162 115  63  31  19   9  10   5   2   1   1
## 4 least connected regions:
## 17 49 50 809 with 1 link
## 1 most connected region:
## 851 with 18 links
##
## Weights style: W
## Weights constants summary:
##     n     nn  S0       S1       S2
## W 853 727609 853 323.6812 3596.946
```

Variáveis defasadas espacialmente

```
dados$LAGTCVPA00 <- lag.listw(w1, dados$TCVPA00)
dados$LAGTCVPA10 <- lag.listw(w1, dados$TCVPA10)
dados$LAGRENDA00 <- lag.listw(w1, dados$RENDA00)
dados$LAGRENDA10 <- lag.listw(w1, dados$RENDA10)
dados$LAGTHEIL00 <- lag.listw(w1, dados$THEIL00)
dados$LAGTHEIL10 <- lag.listw(w1, dados$THEIL10)
```

Empilhar dados

Para empilhar os dados de modo automático, vamos precisar que a base de dados tenha uma organização básica.

- O primeiro campo deve ser o de identificação;
- Os nomes das variáveis devem conter a especificação da variável e o ano, algo como “PIB2000” e “PIB2010”.
- Não devem existir outras variáveis além da identificação e dados do painel.

Vejamos a base de dados do exemplo.

```
names(dados)
```

```
##  [1] "CODMUN6"    "TCVPA00"    "TCVPA10"    "RENDA00"    "RENDA10"
##  [6] "THEIL00"    "THEIL10"    "LAGTCVPA00" "LAGTCVPA10" "LAGRENDA00"
## [11] "LAGRENDA10" "LAGTHEIL00" "LAGTHEIL10"
```

Para colocar os dados em painel, criamos uma função. Veja abaixo.

```
painel <- function(id, dados){
  require(reshape2)

  dadosp <- reshape2::melt(dados, id=id)
  dadosp$varname <- as.character(gsub("[[:digit:]]", "", dadosp$variable))
  dadosp$year <-  as.character(gsub("[[:alpha:]]", "", dadosp$variable))

  sp <- split(dadosp, f = dadosp$varname)

  dadosp <- data.frame(sp[[1]][,1], sp[[1]]$year)

  for(i in 1:length(sp)){
    dadosp <- cbind(dadosp, sp[[i]]$value)
  }

  names(dadosp) <- c("id","ano",names(sp))

  return(dadosp)
}
```

Depois de declarada, vamos colocar os dados em painel.

```
dadosp <- painel("CODMUN6", dados)
```

```
## Loading required package: reshape2
```

```
View(dadosp)
```

Especificação do modelo

```
esp <- TCVPA ~ RENDA + THEIL
```

Modelo não espacial de efeitos fixos

```
fe <- plm(esp, data=dadosp)
```

Modelo não espacial de efeitos aleatórios

```
re <- plm(esp, data=dadosp, model="random")
```

Teste de Hausman

```
ph <- phtest(fe, re) # H0: efeitos aleatórios
print(ph)
```

```
##
##  Hausman Test
##
## data:  esp
## chisq = 142, df = 2, p-value < 2.2e-16
## alternative hypothesis: one model is inconsistent
```

Teste Pesaran CD (cross-section dependence)

```
cd <- pcdtest(esp, data=dadosp) # H0: ausência de dependência CS
```

```
## Warning: Insufficient number of observations in time to estimate
## heterogeneous model: using within residuals
```

```
print(cd)
```

```
##
##  Pesaran CD test for cross-sectional dependence in panels
##
## data:  TCVPA ~ RENDA + THEIL
## z = 2.5478, p-value = 0.01084
## alternative hypothesis: cross-sectional dependence
```

Modelo OLS

```
modOLS <- plm(esp, data=dadosp)
summary(modOLS)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = esp, data = dadosp)
##
## Balanced Panel: n=853, T=2, N=1706
##
## Residuals :
##        Min.     1st Qu.      Median     3rd Qu.        Max.
## -3.4882e+02 -1.1524e+01 -2.2204e-16  1.1524e+01  3.4882e+02
##
## Coefficients :
##        Estimate Std. Error t-value Pr(>|t|)
## RENDA -0.003007   0.013132 -0.2290   0.8189
## THEIL -7.795720  13.330384 -0.5848   0.5588
##
## Total Sum of Squares:    1569500
## Residual Sum of Squares: 1568800
## R-Squared:      0.00040849
```

```
## Adj. R-Squared: -1.0027
## F-statistic: 0.173883 on 2 and 851 DF, p-value: 0.84042
```

SAR

```
modSAR <- spml(esp, data=dadosp, listw=w1, lag=TRUE, model="within", effect="individual", spatial.error=
summary(modSAR)
```

```
## Spatial panel fixed effects lag model
##
##
## Call:
## spml(formula = esp, data = dadosp, listw = w1, model = "within",
##     effect = "individual", lag = TRUE, spatial.error = "none")
##
## Residuals:
##        Min.     1st Qu.      Median     3rd Qu.        Max.
## -3.4879e+02 -1.1553e+01 -3.5805e-15  1.1553e+01  3.4879e+02
##
## Spatial autoregressive coefficient:
##         Estimate Std. Error t-value Pr(>|t|)
## lambda -0.011567   0.039438 -0.2933   0.7693
##
## Coefficients:
##         Estimate Std. Error t-value Pr(>|t|)
## RENDA -0.0029446  0.0092744 -0.3175   0.7509
## THEIL -7.7390993  9.4145971 -0.8220   0.4111
```

```
impSAR <- impacts(modSAR, listw=w1, time=2)
```

```
## Note: method with signature 'diagonalMatrix#Matrix' chosen for function 'kronecker',
##  target signature 'ddiMatrix#dgCMatrix'.
##  "ANY#sparseMatrix" would also be valid
```

```
## Note: method with signature 'dsparseMatrix#dsparseMatrix' chosen for function 'kronecker',
##  target signature 'dtTMatrix#dgCMatrix'.
##  "TsparseMatrix#sparseMatrix" would also be valid
```

```
summary(impSAR, zstats=TRUE, short=TRUE)
```

```
## Impact measures (lag, trace):
##             Direct     Indirect        Total
## RENDA -0.002944623 3.373934e-05 -0.002910883
## THEIL -7.739278454 8.867628e-02 -7.650602175
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated z-values:
##           Direct  Indirect      Total
## RENDA -0.3750402 0.1082324 -0.3731977
## THEIL -0.8086209 0.1564818 -0.8022101
##
## Simulated p-values:
##       Direct  Indirect Total
## RENDA 0.70763 0.91381  0.70900
```

```
## THEIL 0.41873 0.87565  0.42243
```

SEM

```
modSEM <- spml(esp, data=dadosp, listw=w1, lag=FALSE, model="within", effect="individual", spatial.erro
summary(modSEM)
```

```
## Spatial panel fixed effects error model
##
##
## Call:
## spml(formula = esp, data = dadosp, listw = w1, model = "within",
##     effect = "individual", lag = FALSE, spatial.error = "b")
##
## Residuals:
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -348.836  -11.535    0.000   11.535  348.836
##
## Spatial error parameter:
##      Estimate Std. Error t-value Pr(>|t|)
## rho -0.011445   0.039441 -0.2902   0.7717
##
## Coefficients:
##         Estimate Std. Error t-value Pr(>|t|)
## RENDA -0.0028973  0.0092175 -0.3143   0.7533
## THEIL -7.7269796  9.4015091 -0.8219   0.4111
```

SAC

```
modSAC <- spml(esp, data=dadosp, listw=w1, lag=TRUE, model="within", effect="individual", spatial.error=
```

```
## Note: method with signature 'sparseMatrix#ANY' chosen for function 'kronecker',
##  target signature 'dgCMatrix#dgeMatrix'.
##  "ANY#Matrix" would also be valid
```

```
## Note: method with signature 'dsparseMatrix#dsparseMatrix' chosen for function 'kronecker',
##  target signature 'dgCMatrix#dgTMatrix'.
##  "sparseMatrix#TsparseMatrix" would also be valid
```

```
## Note: method with signature 'sparseMatrix#matrix' chosen for function '%*%',
##  target signature 'dgTMatrix#matrix'.
##  "TsparseMatrix#ANY" would also be valid
```

```
summary(modSAC)
```

```
## Spatial panel fixed effects sarar model
##
##
## Call:
## spml(formula = esp, data = dadosp, listw = w1, model = "within",
##     effect = "individual", lag = TRUE, spatial.error = "b")
##
## Residuals:
```

```
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -346.983  -12.666    0.000   12.666  346.983
##
## Spatial error parameter:
##     Estimate Std. Error t-value  Pr(>|t|)
## rho 0.408063   0.091505  4.4595 8.217e-06 ***
##
## Spatial autoregressive coefficient:
##        Estimate Std. Error t-value Pr(>|t|)
## lambda -0.47593    0.12095  -3.935 8.32e-05 ***
##
## Coefficients:
##         Estimate Std. Error t-value Pr(>|t|)
## RENDA -0.0058008  0.0118834 -0.4881   0.6254
## THEIL -6.3975714  9.7120453 -0.6587   0.5101
```

```
impSAC <- impacts(modSAC, listw=w1, time=2)
summary(impSAC, zstats=TRUE, short=TRUE)
```

```
## Impact measures (lag, trace):
##             Direct    Indirect        Total
## RENDA -0.006012395 0.002082116 -0.003930279
## THEIL -6.630937153 2.296319733 -4.334617421
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated z-values:
##           Direct  Indirect      Total
## RENDA -0.5274515 0.5090099 -0.5259036
## THEIL -0.6730867 0.6727093 -0.6572707
##
## Simulated p-values:
##       Direct  Indirect Total
## RENDA 0.59788 0.61075  0.59896
## THEIL 0.50089 0.50113  0.51101
```

Especificação com lag

```
esp_lag <- TCVPA ~ LAGRENDA + LAGTHEIL
```

SDM

```
modSDM <- spml(esp_lag, data=dadosp, listw=w1, lag=TRUE, model="within", effect="individual", spatial.e
summary(modSDM)
```

```
## Spatial panel fixed effects lag model
##
##
## Call:
## spml(formula = esp_lag, data = dadosp, listw = w1, model = "within",
##     effect = "individual", lag = TRUE, spatial.error = "none")
##
```

```
## Residuals:
##        Min.     1st Qu.      Median     3rd Qu.        Max.
## -3.4389e+02 -1.1527e+01 -9.1038e-15  1.1527e+01  3.4389e+02
##
## Spatial autoregressive coefficient:
##         Estimate Std. Error t-value Pr(>|t|)
## lambda -0.014800   0.039435 -0.3753   0.7074
##
## Coefficients:
##            Estimate Std. Error t-value Pr(>|t|)
## LAGRENDA  -0.036158   0.014518 -2.4906  0.01275 *
## LAGTHEIL -47.156968  18.778729 -2.5112  0.01203 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
impSDM <- impacts(modSDM, listw=w1, time=12)
summary(impSDM, zstats=TRUE, short=TRUE)
```

```
## Impact measures (lag, trace):
##                Direct     Indirect        Total
## LAGRENDA  -0.03616626 0.0005355505  -0.03563071
## LAGTHEIL -47.16767709 0.6984595688 -46.46921752
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated z-values:
##             Direct  Indirect     Total
## LAGRENDA -2.713411 0.3323787 -2.665786
## LAGTHEIL -2.590048 0.3485351 -2.559851
##
## Simulated p-values:
##          Direct    Indirect Total
## LAGRENDA 0.0066594 0.73960  0.0076809
## LAGTHEIL 0.0095963 0.72744  0.0104717
```

SDEM

```
modSDEM <- spml(esp_lag, data=dadosp, listw=w1, lag=FALSE, model="within", effect="individual", spatial
summary(modSDEM)
```

```
## Spatial panel fixed effects error model
##
##
## Call:
## spml(formula = esp_lag, data = dadosp, listw = w1, model = "within",
##     effect = "individual", lag = FALSE, spatial.error = "b")
##
## Residuals:
##        Min.     1st Qu.      Median     3rd Qu.        Max.
## -3.4395e+02 -1.1484e+01 -1.7764e-15  1.1484e+01  3.4395e+02
##
## Spatial error parameter:
##      Estimate Std. Error t-value Pr(>|t|)
## rho -0.016058   0.039495 -0.4066   0.6843
```

```
##
## Coefficients:
##            Estimate Std. Error t-value Pr(>|t|)
## LAGRENDA  -0.036097   0.014463 -2.4958  0.01257 *
## LAGTHEIL -47.380779  18.755564 -2.5262  0.01153 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

SLX

```
modSLX <- plm(esp_lag, data=dadosp)
summary(modSLX)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = esp_lag, data = dadosp)
##
## Balanced Panel: n=853, T=2, N=1706
##
## Residuals :
##     Min.  1st Qu.   Median  3rd Qu.     Max.
## -343.961  -11.486    0.000   11.486  343.961
##
## Coefficients :
##            Estimate Std. Error t-value Pr(>|t|)
## LAGRENDA  -0.036022   0.020556 -1.7524  0.08006 .
## LAGTHEIL -46.960690  26.590099 -1.7661  0.07774 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    1569500
## Residual Sum of Squares: 1563000
## R-Squared:      0.0041527
## Adj. R-Squared: -0.99521
## F-statistic: 1.77434 on 2 and 851 DF, p-value: 0.17022
```