Testing spsurdev functions

Román Mínguez (UCLM)

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Archivo para realizar tests sobre las funciones del paquete **spsur** en la versión en desarrollo disponible en **spsurdev**.

Modelos uniecuacionales

Comparativa de resultados uniecuacionales con estimaciones de función `lm()` y funciones de estimación espaciales incluidas en `spatialreg`.

```
### Base de datos COL.OLD
data(oldcol, package="spdep")
listw <- spdep::nb2listw(COL.nb, style="W")
ev <- spatialreg::eigenw(listw)
W <- as(listw, "CsparseMatrix")
trMatc <- spatialreg::trW(W, type="mult")
Tformula <- CRIME ~ INC + HOVAL
```

Modelo uniecuacional no espacial. Comparativa con función `lm()`

```
#### OJO: HAY PEQUEÑAS DIFERENCIAS NUMÉRICAS EN LAS STANDARD DEVIATIONS...   ####

sim_col <- spsurml(formula = Tformula,
                   data = COL.OLD, type = "sim" )
```

```
## Initial point:
## log_lik:  -187.382
## Iteration:  1  log_lik:  -187.382
## Time to fit the model:  0.33  seconds
## Time to compute covariances:  0  seconds
```

```
summary(sim_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, type = "sim")
##
##
## Spatial SUR model type:  sim
##
## Equation  1
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 68.61896    4.63578 14.8020 < 2.2e-16 ***
## INC_1         -1.59731    0.32710 -4.8833 1.355e-05 ***
## HOVAL_1       -0.27393    0.10103 -2.7115   0.00945 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5524
##   Variance-Covariance Matrix of inter-equation residuals:
##  125.3103
## Correlation Matrix of inter-equation residuals:
```

```
##  1
##
##  R-sq. pooled: 0.5524
```

```
## Check with lm
lm_col <- lm(formula = Tformula, data = COL.OLD)
summary(lm_col)
```

```
##
## Call:
## lm(formula = Tformula, data = COL.OLD)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -34.418  -6.388  -1.580   9.052  28.649
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  68.6190     4.7355  14.490  < 2e-16 ***
## INC          -1.5973     0.3341  -4.780 1.83e-05 ***
## HOVAL        -0.2739     0.1032  -2.654   0.0109 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.43 on 46 degrees of freedom
## Multiple R-squared:  0.5524, Adjusted R-squared:  0.5329
## F-statistic: 28.39 on 2 and 46 DF,  p-value: 9.341e-09
```

Modelos uniecuacionales espaciales. Comparativa con funciones `spatialreg`

```
#### OJO: HAY PEQUEÑAS DIFERENCIAS NUMÉRICAS EN LAS STANDARD DEVIATIONS...   ####

system.time( slx_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "slx") )
```

```
## Initial point:
## log_lik:  -184.083
## Iteration:  1  log_lik:  -184.083
## Time to fit the model:  0.07  seconds
## Time to compute covariances:  0.03  seconds
```

```
##    user  system elapsed
##    0.32    0.06    0.38
```

```
summary(slx_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "slx")
##
##
## Spatial SUR model type:  slx
##
## Equation  1
```

```
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)_1 75.028748   6.343893 11.8269 4.18e-15 ***
## INC_1         -1.108929   0.357899 -3.0984 0.003423 **
## HOVAL_1       -0.289728   0.097052 -2.9853 0.004660 **
## lag.INC_1     -1.370972   0.537382 -2.5512 0.014375 *
## lag.HOVAL_1    0.191761   0.191805  0.9998 0.323014
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6088
##   Variance-Covariance Matrix of inter-equation residuals:
##  109.5233
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6088
```

```
system.time( lmslx_col <- spatialreg::lmSLX(
                            formula = Tformula,
                            data = COL.OLD,
                            listw = listw,
                            zero.policy = TRUE) )
```

```
##    user  system elapsed
##       0       0       0
```

```
summary(lmslx_col)
```

```
##
## Call:
## lm(formula = formula(paste("y ~ ", paste(colnames(x)[-1], collapse = "+"))),
##     data = as.data.frame(x), weights = weights)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -36.536  -7.835   0.474   8.349  25.594
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  75.0287     6.6260  11.323 1.26e-14 ***
## INC          -1.1089     0.3738  -2.967  0.00485 **
## HOVAL        -0.2897     0.1014  -2.858  0.00649 **
## lag.INC      -1.3710     0.5613  -2.443  0.01867 *
## lag.HOVAL     0.1918     0.2003   0.957  0.34369
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.93 on 44 degrees of freedom
## Multiple R-squared:  0.6088, Adjusted R-squared:  0.5732
## F-statistic: 17.12 on 4 and 44 DF,  p-value: 1.553e-08
```

```
## OJO: COVARIANZAS NUMÉRICAS... EN CUALQUIER CASO TARDA MUCHO
##      MÁS QUE LA FUNCIÓN spatialreg::lagsarlm() PARA DATOS ##      GRANDES. MIRAR EJEMPLO LUCAS COUNT
##      POR LA CONSTRUCCIÓN DE LA MATRIZ W A PARTIR DE listw

################### SLM MODEL ################################
```

```
system.time( slm_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "slm", method = "Matrix",
                        control = list(fdHess = TRUE)) )
```

```
## Initial point:   log_lik:  -183.2  rhos:  0.405
## Iteration:  1   log_lik:  -182.399  rhos:  0.429
## Iteration:  2   log_lik:  -182.396  rhos:  0.429
## Time to fit the model:  0.64  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.15  seconds
```

```
##    user  system elapsed
##    0.81    0.00    0.82
```

```
summary(slm_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "slm", method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 45.183694   4.089766 11.0480 2.828e-14 ***
## INC_1         -1.034126   0.288569 -3.5836 0.0008433 ***
## HOVAL_1       -0.265962   0.089127 -2.9841 0.0046285 **
## rho_1          0.429111   0.123248  3.4817 0.0011380 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6522
##   Variance-Covariance Matrix of inter-equation residuals:
##  97.52993
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6522
```

```
system.time( lagsarlm_slm_col <- spatialreg::lagsarlm(
                                formula = Tformula,
                                data = COL.OLD,
                                zero.policy = TRUE,
                                listw = listw,
                                method = "Matrix",
                                type = "lag") )
```

```
##    user  system elapsed
##    0.18    0.00    0.17
```

```
summary(lagsarlm_slm_col)
```

```
##
## Call:spatialreg::lagsarlm(formula = Tformula, data = COL.OLD, listw = listw,
```

```
##     type = "lag", method = "Matrix", zero.policy = TRUE)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -37.68585  -5.35636   0.05421   6.02013  23.20555
##
## Type: lag
## Coefficients: (asymptotic standard errors)
##              Estimate Std. Error z value  Pr(>|z|)
## (Intercept) 45.079249   7.177346  6.2808 3.369e-10
## INC         -1.031616   0.305143 -3.3808 0.0007229
## HOVAL       -0.265926   0.088499 -3.0049 0.0026570
##
## Rho: 0.43102, LR test value: 9.9736, p-value: 0.001588
## Asymptotic standard error: 0.11768
##     z-value: 3.6626, p-value: 0.00024962
## Wald statistic: 13.415, p-value: 0.00024962
##
## Log likelihood: -182.3904 for lag model
## ML residual variance (sigma squared): 95.494, (sigma: 9.7721)
## Number of observations: 49
## Number of parameters estimated: 5
## AIC: 374.78, (AIC for lm: 382.75)
## LM test for residual autocorrelation
## test value: 0.31954, p-value: 0.57188
```

```
################## SDM MODEL ################################

system.time( sdm_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "sdm", method = "Matrix",
                        control = list(fdHess = TRUE)) )
```

```
## Initial point:   log_lik:  -181.741  rhos:  0.398
## Iteration:  1   log_lik:  -181.402  rhos:  0.422
## Iteration:  2   log_lik:  -181.399  rhos:  0.423
## Time to fit the model:  0.66  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.12  seconds
```

```
##    user  system elapsed
##     0.8     0.0     0.8
```

```
summary(sdm_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "sdm", method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  sdm
##
## Equation  1
##                 Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 43.084010   5.870331  7.3393 4.774e-09 ***
```

```
## INC_1         -0.915805   0.331182 -2.7653  0.008415 **
## HOVAL_1       -0.293705   0.089807 -3.2704  0.002149 **
## lag.INC_1     -0.527193   0.497267 -1.0602  0.295121
## lag.HOVAL_1    0.245203   0.177487  1.3815  0.174423
## rho_1          0.422873   0.165466  2.5556  0.014308 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6655
##   Variance-Covariance Matrix of inter-equation residuals:
##  93.78215
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6655
```

```
system.time( lagsarlm_sdm_col <- spatialreg::lagsarlm(
                                  formula = Tformula,
                                  data = COL.OLD,
                                  zero.policy = TRUE,
                                  listw = listw,
                                  method = "Matrix",
                                  type = "mixed") )
```

```
##    user  system elapsed
##    0.18    0.00    0.17
```

```
summary(lagsarlm_sdm_col)
```

```
##
## Call:spatialreg::lagsarlm(formula = Tformula, data = COL.OLD, listw = listw,
##     type = "mixed", method = "Matrix", zero.policy = TRUE)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -37.47829  -6.46731  -0.33835   6.05200  22.62969
##
## Type: mixed
## Coefficients: (asymptotic standard errors)
##              Estimate Std. Error z value  Pr(>|z|)
## (Intercept) 42.822413  12.667204  3.3806 0.0007233
## INC         -0.914223   0.331094 -2.7612 0.0057586
## HOVAL       -0.293738   0.089212 -3.2926 0.0009927
## lag.INC     -0.520283   0.565129 -0.9206 0.3572355
## lag.HOVAL    0.245640   0.178917  1.3729 0.1697756
##
## Rho: 0.42634, LR test value: 5.3693, p-value: 0.020494
## Asymptotic standard error: 0.15623
##     z-value: 2.7288, p-value: 0.0063561
## Wald statistic: 7.4465, p-value: 0.0063561
##
## Log likelihood: -181.3935 for mixed model
## ML residual variance (sigma squared): 91.791, (sigma: 9.5808)
## Number of observations: 49
## Number of parameters estimated: 7
## AIC: 376.79, (AIC for lm: 380.16)
```

```
## LM test for residual autocorrelation
## test value: 0.28919, p-value: 0.59074
```

```
################## SEM MODEL ###############################

system.time( sem_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "sem", method = "Matrix",
                        control = list(fdHess = TRUE)) )
```

```
## Initial point:   log_lik:  -184.146  lambdas:  0.507
## Iteration:  1  log_lik:  -183.4  lambdas:  0.554
## Iteration:  2  log_lik:  -183.387  lambdas:  0.557
## Time to fit the model:  1.53  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.27  seconds
```

```
##    user  system elapsed
##    1.82    0.00    1.81
```

```
summary(sem_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "sem", method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  sem
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 59.966430   4.094002 14.6474 < 2.2e-16 ***
## INC_1         -0.946379   0.288868 -3.2762 0.0020571 **
## HOVAL_1       -0.302136   0.089219 -3.3864 0.0015003 **
## lambda_1       0.557173   0.148561  3.7505 0.0005123 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6579
##   Variance-Covariance Matrix of inter-equation residuals:
##  97.73207
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6579
```

```
system.time( errorsarlm_sem_col <-
               spatialreg::errorsarlm(formula = Tformula,
                                      data = COL.OLD,
                                      listw = listw,
                                      etype = "error",
                                      method = "Matrix") )
```

```
##    user  system elapsed
##    0.17    0.00    0.18
```

```r
summary(errorsarlm_sem_col)
```

```
##
## Call:spatialreg::errorsarlm(formula = Tformula, data = COL.OLD, listw = listw,
##     etype = "error", method = "Matrix")
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -34.81174  -6.44031  -0.72142   7.61476  23.33626
##
## Type: error
## Coefficients: (asymptotic standard errors)
##             Estimate Std. Error z value  Pr(>|z|)
## (Intercept) 59.893219   5.366163 11.1613 < 2.2e-16
## INC         -0.941312   0.330569 -2.8476 0.0044057
## HOVAL       -0.302250   0.090476 -3.3407 0.0008358
##
## Lambda: 0.56179, LR test value: 7.9935, p-value: 0.0046945
## Asymptotic standard error: 0.13387
##     z-value: 4.1966, p-value: 2.7098e-05
## Wald statistic: 17.611, p-value: 2.7098e-05
##
## Log likelihood: -183.3805 for error model
## ML residual variance (sigma squared): 95.575, (sigma: 9.7762)
## Number of observations: 49
## Number of parameters estimated: 5
## AIC: 376.76, (AIC for lm: 382.75)
```

```r
################### SDEM MODEL ###################################
system.time( sdem_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "sdem", method = "Matrix",
                        control = list(fdHess = TRUE)) )
```

```
## Initial point:   log_lik:  -181.901  lambdas:  0.396
## Iteration:  1  log_lik:  -181.594  lambdas:  0.421
## Iteration:  2  log_lik:  -181.59  lambdas:  0.422
## Time to fit the model:  1.38  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.26  seconds
```

```
##    user  system elapsed
##    1.64    0.00    1.64
```

```r
summary(sdem_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "sdem", method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  sdem
##
## Equation  1
##                Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)_1 73.569696   5.894109 12.4819 1.01e-15 ***
## INC_1         -1.052592   0.332523 -3.1655 0.002880 **
## HOVAL_1       -0.275616   0.090171 -3.0566 0.003883 **
## lag.INC_1     -1.159461   0.499281 -2.3223 0.025139 *
## lag.HOVAL_1    0.112476   0.178206  0.6312 0.531356
## lambda_1       0.421682   0.171424  2.4599 0.018096 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6629
##   Variance-Covariance Matrix of inter-equation residuals:
##  94.5434
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6629
```

```
system.time( errorsarlm_sdem_col <- spatialreg::errorsarlm(
                                    formula = Tformula,
                                    data = COL.OLD,
                                    listw = listw,
                                    etype = "emixed",
                                    method = "Matrix") )
```

```
##    user  system elapsed
##    0.17    0.00    0.17
```

```
summary(errorsarlm_sdem_col)
```

```
##
## Call:spatialreg::errorsarlm(formula = Tformula, data = COL.OLD, listw = listw,
##     etype = "emixed", method = "Matrix")
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -37.31635  -6.54376  -0.22212   6.44591  23.15801
##
## Type: error
## Coefficients: (asymptotic standard errors)
##              Estimate Std. Error z value  Pr(>|z|)
## (Intercept) 73.545133   8.783543  8.3731 < 2.2e-16
## INC         -1.051673   0.319514 -3.2915 0.0009966
## HOVAL       -0.275608   0.091151 -3.0236 0.0024976
## lag.INC     -1.156711   0.578629 -1.9991 0.0456023
## lag.HOVAL    0.111691   0.198993  0.5613 0.5746047
##
## Lambda: 0.4254, LR test value: 4.9871, p-value: 0.025537
## Asymptotic standard error: 0.15842
##     z-value: 2.6852, p-value: 0.0072485
## Wald statistic: 7.2103, p-value: 0.0072485
##
## Log likelihood: -181.5846 for error model
## ML residual variance (sigma squared): 92.531, (sigma: 9.6193)
## Number of observations: 49
## Number of parameters estimated: 7
## AIC: 377.17, (AIC for lm: 380.16)
```

```
################## SARAR MODEL ################################
system.time( sarar_col <- spsurml(formula = Tformula,
                        data = COL.OLD,
                        listw = listw, zero.policy = TRUE,
                        type = "sarar", method = "Matrix",
                        control = list(fdHess = TRUE)) )
```

```
## Initial point:   log_lik:  -183.042  rhos:  0.344  lambdas:  0.166
## Iteration:  1  log_lik:  -182.243  rhos:  0.366  lambdas:  0.167
## Iteration:  2  log_lik:  -182.24  rhos:  0.366  lambdas:  0.167
## Time to fit the model:  4.08  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.95  seconds
```

```
##    user  system elapsed
##    5.04    0.02    5.04
```

```
summary(sarar_col)
```

```
## Call:
## spsurml(formula = Tformula, data = COL.OLD, listw = listw, zero.policy = TRUE,
##     type = "sarar", method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  sarar
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 47.874411   4.091867 11.6999 5.971e-15 ***
## INC_1         -1.027723   0.288718 -3.5596 0.0009213 ***
## HOVAL_1       -0.281679   0.089173 -3.1588 0.0028970 **
## rho_1          0.366251   0.180801  2.0257 0.0490280 *
## lambda_1       0.166831   0.297746  0.5603 0.5781743
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.652
##   Variance-Covariance Matrix of inter-equation residuals:
##  97.63013
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.652
```

```
system.time( sacsarlm_sarar_col <-
               spatialreg::sacsarlm(formula = Tformula,
                                    data = COL.OLD,
                                    listw = listw,
                                    method = "Matrix") )
```

```
##    user  system elapsed
##    0.25    0.00    0.25
```

```
summary(sacsarlm_sarar_col)
```

```
##
## Call:spatialreg::sacsarlm(formula = Tformula, data = COL.OLD, listw = listw,
##     method = "Matrix")
```

```
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -37.32081  -5.33662  -0.20219   6.59672  23.25604
##
## Type: sac
## Coefficients: (numerical Hessian approximate standard errors)
##              Estimate Std. Error z value  Pr(>|z|)
## (Intercept) 47.783766   9.277915  5.1503 2.601e-07
## INC         -1.025894   0.334030 -3.0713  0.002132
## HOVAL       -0.281651   0.093373 -3.0164  0.002558
##
## Rho: 0.36807
## Approximate (numerical Hessian) standard error: 0.18115
##     z-value: 2.0319, p-value: 0.042167
## Lambda: 0.16668
## Approximate (numerical Hessian) standard error: 0.29796
##     z-value: 0.55941, p-value: 0.57588
##
## LR test value: 10.285, p-value: 0.0058432
##
## Log likelihood: -182.2348 for sac model
## ML residual variance (sigma squared): 95.604, (sigma: 9.7777)
## Number of observations: 49
## Number of parameters estimated: 6
## AIC: 376.47, (AIC for lm: 382.75)
```

Estimación 3sls

Estimación 3sls uniecuacional (modelos slm y sdm):

```
## Modelo SLM
slm_col_3sls <- spsur3sls(formula = Tformula,
                          data = COL.OLD,
                          type = "slm", listw = listw)
```

```
## Time to fit the model:  0.03  seconds
```

```
summary(slm_col_3sls)
```

```
## Call:
## spsur3sls(formula = Tformula, data = COL.OLD, listw = listw,
##     type = "slm")
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 43.793442  11.412490  3.8373 0.0003937 ***
## INC_1         -1.000716   0.399989 -2.5019 0.0161463 *
## HOVAL_1       -0.265489   0.095712 -2.7738 0.0080973 **
## rho_1          0.454567   0.192898  2.3565 0.0229645 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.654
```

```
##   Variance-Covariance Matrix of inter-equation residuals:
##  112.3163
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.654
```

```
## Comparación con spatialreg::stsls()
stsls_slm_col <- spatialreg::stsls(formula = Tformula,
                                   data = COL.OLD,
                                   listw = listw)
summary(stsls_slm_col)
```

```
##
## Call:spatialreg::stsls(formula = Tformula, data = COL.OLD, listw = listw)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -37.86437  -5.65096  -0.13669   6.23315  22.90823
##
## Coefficients:
##              Estimate Std. Error t value  Pr(>|t|)
## Rho          0.454567   0.185118  2.4555  0.014067
## (Intercept) 43.793442  10.952229  3.9986 6.372e-05
## INC         -1.000716   0.383858 -2.6070  0.009134
## HOVAL       -0.265489   0.091852 -2.8904  0.003847
##
## Residual variance (sigma squared): 103.44, (sigma: 10.171)
```

```
## Modelo SDM (spatialreg no lo incluye)
sdm_col_3sls <- spsur3sls(formula = Tformula,
                          data = COL.OLD,
                          type = "sdm", listw = listw)
```

```
## Time to fit the model:  0.07  seconds
```

```
summary(sdm_col_3sls)
```

```
## Call:
## spsur3sls(formula = Tformula, data = COL.OLD, listw = listw,
##     type = "sdm")
##
##
## Spatial SUR model type:  sdm
##
## Equation  1
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)_1 68.147495  49.531633  1.3758 0.176165
## INC_1         -1.067328   0.465014 -2.2953 0.026780 *
## HOVAL_1       -0.290585   0.097225 -2.9888 0.004665 **
## lag.INC_1     -1.189213   1.404379 -0.8468 0.401912
## lag.HOVAL_1    0.203273   0.208633  0.9743 0.335483
## rho_1          0.091091   0.650284  0.1401 0.889267
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.6247
```

```
##   Variance-Covariance Matrix of inter-equation residuals:
##  109.4786
## Correlation Matrix of inter-equation residuals:
##  1
##
##  R-sq. pooled: 0.6247
```

Modelos uniecuacionales espaciales. Comparativa de impactos con spatialreg

```
## OJO: LA FUNCIÓN impacts.spsur DEVUELVE UNA LISTA
## CON LOS IMPACTOS (EN FORMATO SPATIALREG) PARA CADA
## ECUACIÓN.

#### IMPACTOS SLM ########
## OJO: LOS IMPACTOS SON MUY SIMILARES PERO DIFIEREN LAS
## DESVIACIONES TÍPICAS ESTIMADAS. PROBAR CON COVARIANZAS
## ANALÍTICAS EN LUGAR DE NUMÉRICAS....

system.time( slm_col_imp <- impacts.spsur(slm_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.08    0.00    0.08
```

```
summary(slm_col_imp[[1]], zstats = TRUE, short = TRUE)
```

```
## Impact measures (lag, trace):
##             Direct   Indirect      Total
## INC_1   -1.0880864 -0.7233433 -1.8114296
## HOVAL_1 -0.2798397 -0.1860332 -0.4658728
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated standard errors
##             Direct  Indirect     Total
## INC_1   0.30617384 0.5294180 0.7448595
## HOVAL_1 0.09583216 0.1458789 0.2168748
##
## Simulated z-values:
##            Direct  Indirect     Total
## INC_1   -3.566024 -1.539074 -2.559726
## HOVAL_1 -2.938682 -1.441275 -2.267999
##
## Simulated p-values:
##         Direct     Indirect Total
## INC_1   0.00036244 0.12379  0.010475
## HOVAL_1 0.00329612 0.14951  0.023329
```

```
system.time( lagsarlm_slm_col_imp <- spatialreg::impacts(
                                    lagsarlm_slm_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.06    0.00    0.06
```

```r
summary(lagsarlm_slm_col_imp, zstats = TRUE, short = TRUE)
```

```
## Impact measures (lag, trace):
##           Direct   Indirect      Total
## INC   -1.0860220 -0.7270848 -1.8131068
## HOVAL -0.2799509 -0.1874254 -0.4673763
## ========================================================
## Simulation results (asymptotic variance matrix):
## ========================================================
## Simulated standard errors
##           Direct  Indirect     Total
## INC   0.31236366 0.4209369 0.6164575
## HOVAL 0.09526377 0.1280472 0.1985049
##
## Simulated z-values:
##          Direct  Indirect     Total
## INC   -3.514525 -1.855540 -3.047859
## HOVAL -2.920694 -1.588388 -2.426262
##
## Simulated p-values:
##       Direct     Indirect Total
## INC   0.00044054 0.063519 0.0023048
## HOVAL 0.00349252 0.112199 0.0152553
```

```r
#### IMPACTOS SDM ########
## OJO: LOS IMPACTOS SON MUY SIMILARES PERO DIFIEREN LAS
## DESVIACIONES TÍPICAS ESTIMADAS. PROBAR CON COVARIANZAS
## ANALÍTICAS EN LUGAR DE NUMÉRICAS....

system.time( sdm_col_imp <- impacts.spsur(sdm_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.17    0.00    0.17
```

```r
summary(sdm_col_imp[[1]], zstats = TRUE, short = TRUE)
```

```
## Impact measures (mixed, trace):
##             Direct  Indirect       Total
## INC_1   -1.0247658 -1.475545 -2.50031090
## HOVAL_1 -0.2792873  0.195246 -0.08404135
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated standard errors
##             Direct  Indirect     Total
## INC_1   0.35743778 1.5959632 1.7477384
## HOVAL_1 0.09816415 0.3981725 0.4433774
##
## Simulated z-values:
##            Direct   Indirect      Total
## INC_1   -2.959288 -1.1176897 -1.6258457
## HOVAL_1 -2.851967  0.4618067 -0.2167052
##
## Simulated p-values:
```

```
##         Direct    Indirect Total
## INC_1   0.0030835 0.26370  0.10398
## HOVAL_1 0.0043450 0.64422  0.82844
```

```r
system.time( lagsarlm_sdm_col_imp <- spatialreg::impacts(
                                    lagsarlm_sdm_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.10    0.00    0.09
```

```r
summary(lagsarlm_sdm_col_imp, zstats = TRUE, short = TRUE)
```

```
## Impact measures (mixed, trace):
##           Direct  Indirect       Total
## INC   -1.0238910 -1.476711 -2.50060224
## HOVAL -0.2792275  0.195385 -0.08384256
## ========================================================
## Simulation results (asymptotic variance matrix):
## ========================================================
## Simulated standard errors
##          Direct  Indirect     Total
## INC   0.3066446 0.8104043 0.8583202
## HOVAL 0.0900145 0.2977393 0.3319044
##
## Simulated z-values:
##          Direct   Indirect     Total
## INC   -3.399740 -1.8371418 -2.949178
## HOVAL -3.077276  0.6529572 -0.248832
##
## Simulated p-values:
##       Direct    Indirect Total
## INC   0.0006745 0.066189 0.0031862
## HOVAL 0.0020890 0.513784 0.8034908
```

```r
#### IMPACTOS SARAR ########

system.time( sarar_col_imp <- impacts.spsur(sarar_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.08    0.00    0.08
```

```r
summary(sarar_col_imp[[1]], zstats = TRUE, short = TRUE)
```

```
## Impact measures (sac, trace):
##             Direct   Indirect     Total
## INC_1   -1.0647456 -0.5569096 -1.621655
## HOVAL_1 -0.2918266 -0.1526384 -0.444465
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated standard errors
##            Direct  Indirect     Total
## INC_1   0.3142899 0.7822161 0.9684805
## HOVAL_1 0.0945478 0.2243872 0.2801476
##
```

```
## Simulated z-values:
##            Direct   Indirect     Total
## INC_1   -3.520264 -0.9334353 -1.896302
## HOVAL_1 -3.097680 -0.8577204 -1.732445
##
## Simulated p-values:
##         Direct     Indirect Total
## INC_1   0.00043112 0.35060  0.057920
## HOVAL_1 0.00195042 0.39105  0.083194
```

```
system.time( sacsarlm_sarar_col_imp <- spatialreg::impacts(
                                    sacsarlm_sarar_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##    0.07    0.00    0.08
```

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

```
## Impact measures (sac, trace):
##           Direct   Indirect      Total
## INC   -1.0632722 -0.5601501 -1.6234223
## HOVAL -0.2919129 -0.1537847 -0.4456977
## ========================================================
## Simulation results (numerical Hessian approximation variance matrix):
## ========================================================
## Simulated standard errors
##           Direct  Indirect     Total
## INC   0.34739956 0.7387055 0.9259750
## HOVAL 0.09693941 0.1739366 0.2271372
##
## Simulated z-values:
##          Direct   Indirect     Total
## INC   -3.148247 -0.9345242 -1.926659
## HOVAL -3.063003 -1.0621506 -2.120624
##
## Simulated p-values:
##       Direct    Indirect Total
## INC   0.0016425 0.35003  0.054022
## HOVAL 0.0021913 0.28817  0.033953
```

```
#### IMPACTOS SLX ########
## OJO: CAMBIA LA METODOLOGÍA, AQUÍ NO SE OBTIENEN POR SIMULACIÓN. VIP: TAMBIÉN SE OBTIENEN STANDARD DE

system.time( slx_col_imp <- impacts.spsur(slx_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##       0       0       0
```

```
summary(slx_col_imp[[1]], zstats = TRUE, short = TRUE)
```

```
## Impact measures (SLX, estimable, n-k):
##             Direct   Indirect       Total
## INC_1   -1.1089293 -1.3709725 -2.47990173
## HOVAL_1 -0.2897283  0.1917608 -0.09796753
## ========================================================
```

```
## Standard errors:
##             Direct  Indirect     Total
## INC_1   0.35789862 0.5373820 0.4965456
## HOVAL_1 0.09705184 0.1918047 0.2028016
## ========================================================
## Z-values:
##            Direct  Indirect      Total
## INC_1   -3.098445 -2.551207 -4.9943086
## HOVAL_1 -2.985294  0.999771 -0.4830709
##
## p-values:
##         Direct    Indirect Total
## INC_1   0.0019454 0.010735 5.9047e-07
## HOVAL_1 0.0028331 0.317421 0.62905
```

```
system.time( lmslx_col_imp <- spatialreg::impacts(
                                    lmslx_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##       0       0       0
```

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

```
## Impact measures (SLX, estimable, n-k):
##           Direct   Indirect       Total
## INC   -1.1089293 -1.3709725 -2.47990173
## HOVAL -0.2897283  0.1917608 -0.09796753
## ========================================================
## Standard errors:
##           Direct  Indirect     Total
## INC   0.3738129 0.5612771 0.4965456
## HOVAL 0.1013673 0.2003335 0.2028016
## ========================================================
## Z-values:
##          Direct   Indirect      Total
## INC   -2.966535 -2.4425945 -4.9943086
## HOVAL -2.858202  0.9572079 -0.4830709
##
## p-values:
##       Direct    Indirect Total
## INC   0.0030118 0.014582 5.9047e-07
## HOVAL 0.0042605 0.338462 0.62905
```

```
#### IMPACTOS SDEM ########
## OJO: IGUAL METODOLOGÍA QUE CASO SLX

system.time( sdem_col_imp <- impacts.spsur(sdem_col,
                                    tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##       0       0       0
```

```
summary(sdem_col_imp[[1]], zstats = TRUE, short = TRUE)
```

```
## Impact measures (SLX, estimable, n-k):
##             Direct   Indirect     Total
```

```
## INC_1   -1.0525923 -1.1594613 -2.212054
## HOVAL_1 -0.2756164  0.1124764 -0.163140
## ========================================================
## Standard errors:
##             Direct  Indirect     Total
## INC_1   0.33252348 0.4992814 0.4613403
## HOVAL_1 0.09017083 0.1782057 0.1884229
## ========================================================
## Z-values:
##            Direct   Indirect      Total
## INC_1   -3.165467 -2.3222602 -4.7948413
## HOVAL_1 -3.056603  0.6311607 -0.8658184
##
## p-values:
##         Direct    Indirect Total
## INC_1   0.0015483 0.020219 1.628e-06
## HOVAL_1 0.0022386 0.527935 0.38659
```

```
system.time( errorsarlm_sdem_col_imp <- spatialreg::impacts(
                                        errorsarlm_sdem_col,
                                        tr = trMatc, R = 1000) )
```

```
##    user  system elapsed
##       0       0       0
```

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

```
## Impact measures (SDEM, estimable, n):
##           Direct   Indirect      Total
## INC   -1.0516727 -1.1567109 -2.2083836
## HOVAL -0.2756084  0.1116912 -0.1639172
## ========================================================
## Standard errors:
##           Direct  Indirect     Total
## INC   0.31951388 0.5786287 0.6478635
## HOVAL 0.09115142 0.1989927 0.2346288
## ========================================================
## Z-values:
##          Direct   Indirect      Total
## INC   -3.291477 -1.9990555 -3.4087174
## HOVAL -3.023633  0.5612828 -0.6986235
##
## p-values:
##       Direct     Indirect Total
## INC   0.00099663 0.045602 0.00065269
## HOVAL 0.00249759 0.574605 0.48478732
```

Modelos multiecuacionales espaciales.

Ejemplo con archivo NAT (comparar con PySal)

```
############## EXAMPLE WITH NAT FILE ###############
ncovr <- sf::st_read("C:/Users/Roman.Minguez/OneDrive/spsurdev/notes/ncovr/NAT.shp")
```

```
## Reading layer `NAT' from data source `C:\Users\Roman.Minguez\OneDrive\spsurdev\notes\ncovr\NAT.shp' u
## Simple feature collection with 3085 features and 69 fields
## geometry type:  MULTIPOLYGON
```

```
## dimension:      XY
## bbox:           xmin: -124.7314 ymin: 24.95597 xmax: -66.96985 ymax: 49.37173
## epsg (SRID):    4326
## proj4string:    +proj=longlat +datum=WGS84 +no_defs
```

```
ncovr_nb <- spdep::poly2nb(ncovr, queen = TRUE)
ncovr_lw <- spdep::nb2listw(ncovr_nb, style = "W",
                            zero.policy = TRUE)
ncovrW <- as(ncovr_lw, "CsparseMatrix")
tr_ncovrW <- spatialreg::trW(ncovrW, type = "MC")
Tformula <- HR80  | HR90 ~ PS80 + UE80 | PS90 + UE90
```

Estimación de modelos multiecuacionales:

```
NCOVRSUR.sim <- spsurml(formula = Tformula, data = ncovr,
                        listw = ncovr_lw,
                        method = "Matrix", type = "sim")
```

```
## Initial point:
## log_lik:  -19864.14
## Iteration:  1  log_lik:  -19860.1
## Iteration:  2  log_lik:  -19860.1
## Time to fit the model:  0.04  seconds
## Time to compute covariances:  0.21  seconds
```

```
summary(NCOVRSUR.sim)
```

```
## Call:
## spsurml(formula = Tformula, data = ncovr, listw = ncovr_lw, type = "sim",
##     method = "Matrix")
##
##
## Spatial SUR model type:  sim
##
## Equation  1
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 5.179417   0.259455 19.9627 < 2.2e-16 ***
## PS80_1        0.677534   0.121932  5.5567 2.865e-08 ***
## UE80_1        0.257775   0.033814  7.6233 2.846e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.02502
##   Equation  2
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_2 3.781120   0.253129  14.938 < 2.2e-16 ***
## PS90_2        1.024287   0.113331   9.038 < 2.2e-16 ***
## UE90_2        0.361394   0.034047  10.614 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1099
##   Variance-Covariance Matrix of inter-equation residuals:
##  45.43619 21.56823
##  21.56823 39.72187
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.5076902
##  0.5076902 1.0000000
```

```
##
##  R-sq. pooled: 0.06654
```

```
NCOVRSUR.slx <- spsurml(formula = Tformula, data = ncovr,
                        listw = ncovr_lw,
                        method = "Matrix", type = "slx")
```

```
## Initial point:
## log_lik:  -19853.08
## Iteration:  1  log_lik:  -19848.24
## Iteration:  2  log_lik:  -19848.24
## Time to fit the model:  0.07  seconds
## Time to compute covariances:  0.01  seconds
```

```
summary(NCOVRSUR.slx)
```

```
## Call:
## spsurml(formula = Tformula, data = ncovr, listw = ncovr_lw, type = "slx",
##     method = "Matrix")
##
##
## Spatial SUR model type:  slx
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1  5.765899   0.310785 18.5527 < 2.2e-16 ***
## PS80_1         1.017972   0.188641  5.3963 7.055e-08 ***
## UE80_1         0.441356   0.054360  8.1191 5.626e-16 ***
## lag.PS80_1    -0.484846   0.243131 -1.9942   0.04618 *
## lag.UE80_1    -0.269530   0.067491 -3.9936 6.584e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.03815
##   Equation  2
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_2  3.652205   0.321510 11.3595 < 2.2e-16 ***
## PS90_2         1.130696   0.181267  6.2377 4.734e-10 ***
## UE90_2         0.350941   0.048033  7.3063 3.094e-13 ***
## lag.PS90_2    -0.176707   0.229653 -0.7695    0.4417
## lag.UE90_2     0.030246   0.063531  0.4761    0.6340
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1103
##   Variance-Covariance Matrix of inter-equation residuals:
##  44.82421 21.20675
##  21.20675 39.69023
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.5027778
##  0.5027778 1.0000000
##
##  R-sq. pooled: 0.07434
```

```
NCOVRSUR.slm <- spsurml(formula = Tformula, data = ncovr,
                        listw = ncovr_lw,
                        method = "Matrix", type = "slm",
                        con = list(fdHess = TRUE))
```

```
## Initial point:   log_lik:  -19474.51  rhos:  0.456 0.431
## Iteration:  1   log_lik:  -19385.35  rhos:  0.512 0.474
## Iteration:  2   log_lik:  -19384.25  rhos:  0.518 0.479
## Iteration:  3   log_lik:  -19384.24  rhos:  0.519 0.479
## Time to fit the model:  2.86  seconds
## Computing numerical covariances...
## Time to compute covariances:  0.62  seconds
```

```
summary(NCOVRSUR.slm)
```

```
## Call:
## spsurml(formula = Tformula, data = ncovr, listw = ncovr_lw, type = "slm",
##     method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1 1.778290   0.231667  7.6760 1.896e-14 ***
## PS80_1        0.499211   0.104689  4.7685 1.899e-06 ***
## UE80_1        0.227069   0.030523  7.4393 1.150e-13 ***
## rho_1         0.518593   0.017429 29.7544 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3097
##   Equation  2
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_2 0.996484   0.230179  4.3292 1.520e-05 ***
## PS90_2        0.766198   0.098939  7.7441 1.118e-14 ***
## UE90_2        0.332855   0.031271 10.6442 < 2.2e-16 ***
## rho_2         0.479386   0.017853 26.8526 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3384
##   Variance-Covariance Matrix of inter-equation residuals:
##  33.38092 10.92374
##  10.92374 30.21285
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.3439747
##  0.3439747 1.0000000
##
##  R-sq. pooled: 0.3252
```

```
NCOVRSUR.sdm <- spsurml(formula = Tformula, data = ncovr,
                        listw = ncovr_lw,
                        method = "Matrix", type = "sdm",
                        con = list(fdHess = TRUE))
```

```
## Initial point:   log_lik:  -19446.63  rhos:  0.464 0.444
## Iteration:  1   log_lik:  -19343.97  rhos:  0.525 0.497
## Iteration:  2   log_lik:  -19341.9  rhos:  0.533 0.505
## Iteration:  3   log_lik:  -19341.85  rhos:  0.534 0.506
## Iteration:  4   log_lik:  -19341.85  rhos:  0.534 0.506
## Time to fit the model:  3.84  seconds
```

```
## Computing numerical covariances...
## Time to compute covariances:  0.64  seconds
```

```
summary(NCOVRSUR.sdm)
```

```
## Call:
## spsurml(formula = Tformula, data = ncovr, listw = ncovr_lw, type = "sdm",
##     method = "Matrix", control = list(fdHess = TRUE))
##
##
## Spatial SUR model type:  sdm
##
## Equation  1
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1  2.778937   0.275231 10.0967 < 2.2e-16 ***
## PS80_1         1.048834   0.159990  6.5556 5.991e-11 ***
## UE80_1         0.536398   0.049142 10.9153 < 2.2e-16 ***
## lag.PS80_1    -0.768347   0.206394 -3.7227 0.0001988 ***
## lag.UE80_1    -0.472104   0.060878 -7.7549 1.028e-14 ***
## rho_1          0.534163   0.017214 31.0305 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3373
##   Equation  2
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_2  1.552468   0.290339  5.3471 9.260e-08 ***
## PS90_2         1.126484   0.156585  7.1941 7.036e-13 ***
## UE90_2         0.477148   0.044215 10.7916 < 2.2e-16 ***
## lag.PS90_2    -0.609042   0.198380 -3.0701  0.002149 **
## lag.UE90_2    -0.251527   0.058298 -4.3145 1.624e-05 ***
## rho_2          0.506099   0.018139 27.9016 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3564
##   Variance-Covariance Matrix of inter-equation residuals:
##  32.150833  9.625562
##   9.625562 29.526214
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.3124108
##  0.3124108 1.0000000
##
##  R-sq. pooled: 0.3481
```

Ejemplo impactos en modelos SLX y Durbin. El output da un objeto tipo `list` con los impactos de cada ecuación en cada elemento de la lista.

```
############  IMPACTOS SLX  #################
NCOVRSUR.slx.impacts <- impacts.spsur(NCOVRSUR.slx,
                                      tr = tr_ncovrW,
                                      R = 1000)
summary(NCOVRSUR.slx.impacts[[1]], zstats = TRUE,
        short = TRUE)
```

```
## Impact measures (SLX, estimable, n-k):
##           Direct   Indirect     Total
## PS80_1 1.0179721 -0.4848459 0.5331262
```

```
## UE80_1 0.4413564 -0.2695303 0.1718262
## ========================================================
## Standard errors:
##            Direct   Indirect      Total
## PS80_1 0.18864101 0.24313119 0.15801215
## UE80_1 0.05436033 0.06749068 0.04589114
## ========================================================
## Z-values:
##          Direct  Indirect    Total
## PS80_1 5.396346 -1.994174 3.373957
## UE80_1 8.119090 -3.993593 3.744212
##
## p-values:
##        Direct     Indirect  Total
## PS80_1 6.8012e-08 0.046133  0.00074096
## UE80_1 4.4409e-16 6.508e-05 0.00018096
```

```
summary(NCOVRSUR.slx.impacts[[2]], zstats = TRUE,
        short = TRUE)
```

```
## Impact measures (SLX, estimable, n-k):
##           Direct   Indirect     Total
## PS90_2 1.1306959 -0.1767070 0.9539888
## UE90_2 0.3509413  0.0302463 0.3811876
## ========================================================
## Standard errors:
##            Direct   Indirect      Total
## PS90_2 0.18126687 0.22965330 0.14386917
## UE90_2 0.04803284 0.06353141 0.04902705
## ========================================================
## Z-values:
##          Direct   Indirect    Total
## PS90_2 6.237741 -0.7694512 6.630947
## UE90_2 7.306279  0.4760842 7.775048
##
## p-values:
##        Direct     Indirect Total
## PS90_2 4.4393e-10 0.44163  3.3354e-11
## UE90_2 2.7467e-13 0.63401  7.5495e-15
```

```
###########  IMPACTOS DURBIN ####################
NCOVRSUR.sdm.impacts <- impacts.spsur(NCOVRSUR.sdm,
                                      tr = tr_ncovrW,
                                      R = 1000)
summary(NCOVRSUR.sdm.impacts[[1]], zstats = TRUE,
        short = TRUE)
```

```
## Impact measures (mixed, trace):
##          Direct   Indirect     Total
## PS80_1 1.022776 -0.4206627 0.6021134
## UE80_1 0.513160 -0.3751432 0.1380168
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated standard errors
##           Direct   Indirect      Total
```

```
## PS80_1 0.1528977 0.30670878 0.28414576
## UE80_1 0.0479570 0.08605742 0.07912782
##
## Simulated z-values:
##           Direct  Indirect    Total
## PS80_1  6.710763 -1.363043 2.139756
## UE80_1 10.708752 -4.353948 1.755009
##
## Simulated p-values:
##        Direct     Indirect   Total
## PS80_1 1.9361e-11 0.17287    0.032374
## UE80_1 < 2.22e-16 1.3371e-05 0.079258
```

```
summary(NCOVRSUR.sdm.impacts[[2]], zstats = TRUE,
        short = TRUE)
```

```
## Impact measures (mixed, trace):
##           Direct    Indirect     Total
## PS90_2 1.1219878 -0.07432361 1.0476641
## UE90_2 0.4759883 -0.01917293 0.4568154
## ========================================================
## Simulation results ( variance matrix):
## ========================================================
## Simulated standard errors
##            Direct   Indirect     Total
## PS90_2 0.15203440 0.28607064 0.2574203
## UE90_2 0.04200389 0.08916169 0.0868993
##
## Simulated z-values:
##           Direct   Indirect    Total
## PS90_2  7.366028 -0.2544341 4.067680
## UE90_2 11.284496 -0.1641286 5.286104
##
## Simulated p-values:
##        Direct     Indirect Total
## PS90_2 1.7586e-13 0.79916  4.7484e-05
## UE90_2 < 2.22e-16 0.86963  1.2495e-07
```