

## Spatial autoregressive (SAR) models

- Linear models for spatial data
  - Spatially autoregressive and heteroskedastic errors
  - Spatial lags of dependent variables
  - Spatial lags of independent variables
  - Spatial lags given by one or more spatial weighting matrices
  - Different types of spatial weighting matrices
  - Maximum likelihood and generalized method of moments (GS2SLS) estimators
- Estimate direct and indirect (spillover) effects
- Moran's test of spatial error correlation
- SAR models for longitudinal or panel data
- Instrumental-variables SAR models
- Create and manage spatial weighting matrices
- Import shapefiles

Viewer - view sp1.smcl

view sp1.smcl x

Dialog ▾ Also see ▾ Jump to ▾

```
. spregress y x, ml dvarlag(W) errorlag(W)
```

Spatial autoregressive model  
Maximum likelihood estimates

Log likelihood = -4656.3167

Number of obs = 1,412  
Wald chi2(2) = 25.76  
Prob > chi2 = 0.0000  
Pseudo R2 = 0.0020

	y	Coefficient	Std. err.	z	P> z	[95% conf. interval]
y	xtset	.762087	.1667529	4.57	0.000	.4352573 1.088917
	_cons	3.331143	1.748412	1.91	0.057	-.0956816 6.757968
W	y	-.5038401	.2096501	-2.40	0.016	-.9147468 -.0929335
	e.y	.8295794	.1026362	8.08	0.000	.6284162 1.030743
	var(e.y)	36.56831	2.830766			31.42049 42.55952

Wald test of spatial terms:           chi2(2) = 589.63   Prob > chi2 = 0.0000

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Stata's Sp suite of commands fits simultaneous autoregressive (SAR) models to spatial lattice data.

### Declare or import spatial lattice data

Use **spset** to declare your spatial data-recording coordinates

```
. spset spid, coord(longitude latitude) coordsys(latlong)
```

Or import your spatial data from a shapefile

```
. spshape2dta shapefilename
```

### Create spatial weighting matrices

Create a contiguity matrix based on nearest neighbors

```
. spmatrix create contiguity W
```

### Check for spatial dependence

Fit linear regression

```
. regress y x
```

Perform Moran's spatial test

```
. estat moran, errorlag(W)
```

### Fit your model

Spatial error model

```
. spregress y x, ml errorlag(W)
```

Spatial lag model

```
. spregress y x, ml dvarlag(W)
```

Simultaneous autoregressive model

```
. spregress y x, ml dvarlag(W) errorlag(W)
```

(See output at top of page.)

### Perform postestimation analysis

Estimate direct and indirect effects after fitting your model

```
. estat impact
```

And more.

## SAR models for cross-sectional data

SAR model using inverse-distance weighting matrix  $\mathbf{M}$  for errors and contiguity matrix  $\mathbf{W}$  for spatial lags of dependent and independent variables:

```
. spregress hrate ln_population ln_pdensity gini,
    gs2sls dvarlag(W) errorlag(M)
    ivarlag(W: ln_population ln_pdensity gini)
```

	hrate	Coefficient	Std. err.	z	P> z	[95% conf. interval]
hrate						
ln_populat-n		-.0475582	.3295548	-0.14	0.885	-.6934737 .5983573
ln_pdensity		.8989538	.3211524	2.80	0.005	.2695066 1.528401
gini		89.91969	6.409286	14.03	0.000	77.35772 102.4817
_cons		-32.21599	3.590014	-8.97	0.000	-39.25229 -25.17969
W						
ln_populat-n		2.679931	.5218152	5.14	0.000	1.657192 3.702669
ln_pdensity		-2.468953	.6209688	-3.98	0.000	-3.686029 -1.251876
gini		-57.38302	9.418108	-6.09	0.000	-75.84217 -38.92387
hrate		.6818566	.1141573	5.97	0.000	.4581125 .9056007
M						
e.hrate		.9533048	.1324392	7.20	0.000	.6937289 1.212881
Wald test of spatial terms:					chi2(5) = 169.23	Prob > chi2 = 0.0000

### Spatial data

- Data with shapefiles
- Data with spatial coordinates
- Nongeographic data such as networks
- Automatic translation of shapefiles
- Planar coordinates or longitude and latitude
- Calculate distances

## SAR models for longitudinal or panel data

Random-effects SAR model with inverse-distance weighting matrix  $\mathbf{M}$  for errors and spatial lags:

```
. spxtregress hrate ln_population ln_pdensity gini, re
    dvarlag(M) errorlag(M)
```

	hrate	Coefficient	Std. err.	z	P> z	[95% conf. interval]
hrate						
ln_populat-n		.6136447	.1777656	3.45	0.001	.2652305 .9620588
ln_pdensity		-.0951383	.1693845	-0.56	0.574	-.4271257 .2368492
gini		28.49245	2.571106	11.08	0.000	23.45317 33.53172
_cons		-13.04204	1.594928	-8.18	0.000	-16.16804 -9.916039
M						
hrate		.6354142	.041818	15.19	0.000	.5534524 .7173761
e.hrate		2.241958	.0486863	46.05	0.000	2.146535 2.337382
/sigma_u		2.778349	.1146385			2.562507 3.012372
/sigma_e		5.668232	.062084			5.547846 5.79123
Wald test of spatial terms:					chi2(2) = 2385.86	Prob > chi2 = 0.0000

`spxtregress` also supports a fixed-effects estimator.

### Spatial weighting matrices

- Nearest-neighbor, inverse-distance, and custom
- Normalization: spectral, min-max, or row
- Manage matrices: list, summarize, copy, save, and more
- Import and export matrices from text files
- Use and save matrices in Stata format

## Use commands or point and click

