

Appendix to accompany “Spatial Perspectives in Family Health Research”

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0. Data sources and description

0. Data come from CDC through 2 public sources:

0.i. Life expectancy at birth, from <https://www.cdc.gov/nchs/nvss/life-expectancy.htm>

0.ii. Social Vulnerability Index, by census tract, from

<https://www.atsdr.cdc.gov/placeandhealth/svi/index.html>

The CT extract combines the two UC census tract level datasets, and in addition contains spatially lagged variables for several original variables, generated after merging the CT dataset with a CT shape file, from https://magic.lib.uconn.edu/connecticut_data.html ; variables are labeled e.g.

lgincks = Census tract CDC income 1,000sdollars spatially lagged in Geoda using queen contiguity

ep_pcik = Census tract CDC income 1,000sdollars

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1. Correlations between the two main variables and their spatially lagged versions

```
reg trlfex1015 ep_minrty , beta
      trlfex1015 | Coefficient   Std. err.      t    P>|t|          Beta
-----+-----
      ep_minrty |    -0.067    0.004   -18.78   0.000          -0.558
           _cons |    81.933    0.156   523.96   0.000              .
```

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2. Spatial lag regression and spatial SEM results

```
reg trlfex1015 ep_minrty lglifeexp, beta
      trlfex1015 | Coefficient   Std. err.      t    P>|t|          Beta
-----+-----
      ep_minrty |    -0.030    0.004    -7.53   0.000          -0.251
      lglifeexp |     0.711    0.048   14.84   0.000           0.495
           _cons |    24.038    3.904     6.16   0.000              .
```

```
sem (trlfex1015 <- ep_minrty lglifeexp), method(mlmv)
      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
      trlfex1015
           ep_minrty |    -0.030    0.004   -7.55   0.000       -0.038       -0.022
           lglifeexp |     0.711    0.048   14.87   0.000        0.617        0.804
```

_cons		24.038	3.897	6.17	0.000	16.401	31.675
-----+							
mean(ep_minrty)		33.813	0.959	35.26	0.000	31.933	35.693
mean(lglifeexp)		79.735	0.079	1004.55	0.000	79.579	79.890
-----+							
var(e.trlfex1015)		5.905	0.298			5.348	6.520
var(ep_minrty)		764.436	37.499			694.362	841.582
var(lglifeexp)		5.248	0.257			4.768	5.777
-----+							
cov(ep_minrty,lglifeexp)		-39.190	2.582	-15.18	0.000	-44.250	-34.130

LR test of model vs. saturated: chi2(0) = 0.00 Prob > chi2 = .

```
sem (trlfex1015 <- ep_minrty lglifeexp), method(mlmv) standardized
STANDARDIZED
```

trlfex1015							
ep_minrty		-0.253	0.033	-7.68	0.000	-0.318	-0.189

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3. SEM Stata (likeIVREG) results %NonWhite -> LifeExpectancy, Census tracts, CT

Spatial SEM replicates the reg3 IV model

```
sem ( trlfex1015 <- ep_minrty lglifeexp) (ep_minrty <- lgpminor), cov(e.ep_minrty*e.trlfex1015)
```

		Coefficient	std. err.	z	P> z	[95% conf. interval]	
-----+							
Structural							
trlfex1015							
	ep_minrty	-.0202504	.0046445	-4.36	0.000	-.0293534 -.0111474	
	lglifeexp	.7714985	.0492773	15.66	0.000	.6749168 .8680803	
	_cons	18.83971	4.033104	4.67	0.000	10.93497 26.74445	
-----+							
ep_minrty							
	lgpminor	1.069713	.0187197	57.14	0.000	1.033023 1.106403	
	_cons	-2.227068	.7658847	-2.91	0.004	-3.728174 -.7259617	
-----+							
	var(e.trlfex1015)	5.953703	.3041497			5.386453 6.580691	
	var(e.ep_minrty)	146.1337	7.38558			132.3521 161.3504	
-----+							
	cov(e.trlfex1015,e.ep_minrty)	-5.225253	1.237159	-4.22	0.000	-7.65004 -2.800465	

LR test of model vs. saturated: chi2(1) = 6.82 Prob > chi2 = 0.0090

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4. IVREG results %NonWhite -> LifeExpectancy, Census tracts, CT

```
. ivregress gmm trlfex1015 lglifeexp (ep_minrty = lgpminor)
```

Instrumental variables GMM regression	Number of obs	=	783
	Wald chi2(2)	=	595.08
	Prob > chi2	=	0.0000
	R-squared	=	0.4570
GMM weight matrix: Robust	Root MSE	=	2.4429

		Robust				
trlfex1015		Coefficient	std. err.	z	P> z	[95% conf. interval]
-----+						
ep_minrty		-.0187841	.005318	-3.53	0.000	-.0292071 -.008361
lglifeexp		.7954585	.0527643	15.08	0.000	.6920425 .8988746
_cons		16.88003	4.336971	3.89	0.000	8.379719 25.38033

Instrumented: ep_minrty
Instruments: lglifeexp lgpminor

```
. ivregress 2sls trlfex1015 lglifeexp (ep_minrty = lgpminor)
```

```
Instrumental variables 2SLS regression      Number of obs   =      783
                                           Wald chi2(2)    =      625.76
                                           Prob > chi2     =      0.0000
                                           R-squared       =      0.4570
                                           Root MSE       =      2.4429
```

```
-----+-----
      trlfex1015 | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----
      ep_minrty |  -.0187841   .0048644    -3.86   0.000   - .0283182   - .0092499
      lglifeexp |   .7954585   .0520103    15.29   0.000    .6935201    .8973969
      _cons |   16.88003   4.261959     3.96   0.000    8.526739   25.23331
-----+-----
```

```
Instrumented: ep_minrty
Instruments: lglifeexp lgpminor
```

```
. reg3 (trlfex1015 = ep_minrty lglifeexp) (ep_minrty = lgpminor) , corr(u)
```

```
Three-stage least-squares regression
```

```
-----+-----
Equation          Obs    Params      RMSE    "R-squared"      chi2    P>chi2
-----+-----
trlfex1015         783         2     2.439943     0.4583     619.09    0.0000
ep_minrty          783         1    12.08858     0.8066    3265.41    0.0000
-----+-----
```

```
-----+-----
      | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----
trlfex1015 |
      ep_minrty |  -.0202973   .0048297    -4.20   0.000   - .0297632   - .0108313
      lglifeexp |   .7707324   .0511377    15.07   0.000    .6705043    .8709604
      _cons |   18.90238   4.190726     4.51   0.000    10.6887    27.11605
-----+-----
ep_minrty |
      lgpminor |   1.069713   .0187197    57.14   0.000    1.033023    1.106403
      _cons |  -2.227068   .7658847    -2.91   0.004   -3.728174   -.7259617
-----+-----
```

```
Endogenous variables: trlfex1015 ep_minrty
```

```
Exogenous variables: lglifeexp lgpminor
```

```
. reg3 (trlfex1015 = ep_minrty lglifeexp), endog(ep_minrty) exog(lgpminor)
```

```
Three-stage least-squares regression
```

```
-----+-----
Equation          Obs    Params      RMSE    "R-squared"      chi2    P>chi2
-----+-----
trlfex1015         783         2     2.442864     0.4570     625.76    0.0000
-----+-----
```

```
-----+-----
      trlfex1015 | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----
trlfex1015 |
      ep_minrty |  -.0187841   .0048644    -3.86   0.000   - .0283182   - .0092499
      lglifeexp |   .7954585   .0520103    15.29   0.000    .6935201    .8973969
      _cons |   16.88003   4.261959     3.96   0.000    8.526739   25.23331
-----+-----
```

```
Endogenous variables: trlfex1015 ep_minrty
```

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5. Co-variation between Life Expectancy and the FIPS census tract code: a-spatial and spatial

A-spatial/naive Pearson correlation, and beta regression coefficient:

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```
. pwcorr tractcel0 trlfex1015 , sig star(.05)
      | tract~10 trl~1015
```

tractcel0		1.0000
trlfex1015		-0.1401* 1.0000
		0.0001

```
. sem (trlfex1015 <- tractcel0), standardized
```

		OIM				
	Standardized	Coefficient	std. err.	z	P> z	[95% conf. interval]
Structural						
trlfex1015						
tractcel0		-0.140	0.035	-4.02	0.000	-0.208 -0.072
_cons		24.233	0.605	40.04	0.000	23.046 25.419
var(e.trlfex1015)		0.980	0.010			0.961 1.000
LR test of model vs. saturated: chi2(0) = 0.00 Prob > chi2 = .						

```
sem (trlfex1015 <- tractcel0 lglifeexp), standardized
```

	Standardized	Coefficient	std. err.	z	P> z	[95% conf. interval]
Structural						
trlfex1015						
tractcel0		-0.006	0.028	-0.22	0.829	-0.060 0.048
lglifeexp		0.650	0.019	33.83	0.000	0.612 0.687
_cons		1.631	0.994	1.64	0.101	-0.317 3.579
var(e.trlfex1015)		0.576	0.024			0.532 0.625
LR test of model vs. saturated: chi2(0) = 0.00 Prob > chi2 = .						

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6. Spatial nonrecursive Stata results: %NonWhite <-> LifeExpectancy, Census tracts, CT Indicates both SIG

```
. sem (trlfex1015 <- ep_minrty lglifeexp) (ep_minrty <- trlfex1015 lgpminor),
cov(e.ep_minrty*e.trlfex1015)
```

(50 observations with missing values excluded)

Endogenous variables

Observed: trlfex1015 ep_minrty

Exogenous variables

Observed: lglifeexp lgpminor

Fitting target model:

Iteration 0: log likelihood = -9973.6531

Iteration 1: log likelihood = -9973.6531

Structural equation model

Number of obs = 783

Estimation method: ml

Log likelihood = -9973.6531

		OIM				
		Coefficient	std. err.	z	P> z	[95% conf. interval]
Structural						
trlfex1015						
ep_minrty		-0.0187841	.0048644	-3.86	0.000	-.0283182 -.0092499
lglifeexp		.7954585	.0520103	15.29	0.000	.6935201 .8973969
_cons		16.88003	4.261959	3.96	0.000	8.526739 25.23331
ep_minrty						
trlfex1015		-.797088	.2949174	-2.70	0.007	-1.375116 -.2190606
lgpminor		1.012189	.0279078	36.27	0.000	.9574904 1.066887

_cons		63.20645	24.22124	2.61	0.009	15.7337	110.6792
-----+							
var(e.trlfex1015)		5.967585	.3061296			5.396759	6.598788
var(e.ep_minrty)		135.8843	7.115181			122.6306	150.5706
-----+							
cov(e.trlfex1015,e.ep_minrty)		-.5549152	2.15917	-0.26	0.797	-4.786811	3.676981

```
. sem (trlfex1015 <- ep_minrty lglifeexp) (ep_minrty <-trlfex1015 lgpminor)
```

LR test of model vs. saturated: chi2(0) = 0.00 Prob > chi2 = .

	Coefficient	std. err.	z	P> z	[95% conf. interval]	
-----+						
Structural						
trlfex1015						
ep_minrty	-.0191711	.0046214	-4.15	0.000	-.0282288	-.0101134
lglifeexp	.7926133	.050789	15.61	0.000	.6930688	.8921579
_cons	17.11996	4.15598	4.12	0.000	8.974384	25.26553
-----+						
ep_minrty						
trlfex1015	-.8595176	.1657878	-5.18	0.000	-1.184456	-.5345795
lgpminor	1.007683	.0216364	46.57	0.000	.9652767	1.05009
_cons	68.33134	13.62961	5.01	0.000	41.61779	95.04488
-----+						
var(e.trlfex1015)	5.96348	.3052185			5.394289	6.592731
var(e.ep_minrty)	135.5225	6.905068			122.6426	149.755

LR test of model vs. saturated: chi2(1) = 0.07 Prob > chi2 = 0.7975

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7. Spatial SEM mediation Stata results: %NonWhite -> Income -> LifeExpectancy, Census tracts, CT

7.i. SVI 1

```
. sem ( trlfex1015 <- ep_minrty spl_them1 lgpminor) ( spl_them1 <- ep_minrty lgsvi2) /*
DIR + NS!!! */
```

	Coefficient	std. err.	z	P> z	[95% conf. interval]	
-----+						
Structural						
trlfex1015						
spl_them1	-2.509098	.1565847	-16.02	0.000	-2.815998	-2.202197
ep_minrty	.013873	.0086564	1.60	0.109	-.0030933	.0308393
lgpminor	-.0039578	.0084102	-0.47	0.638	-.0204414	.0125258
_cons	83.40114	.1772532	470.52	0.000	83.05373	83.74855
-----+						
spl_them1						
ep_minrty	.0279425	.0007765	35.98	0.000	.0264205	.0294645
lgsvi2	.6440727	.0760071	8.47	0.000	.4951016	.7930439
_cons	-.4931223	.1291323	-3.82	0.000	-.7462169	-.2400277
-----+						
var(e.trlfex1015)	5.702271	.288192			5.1645	6.29604
var(e.spl_them1)	.2721899	.0137564			.2465201	.3005326

LR test of model vs. saturated: chi2(2) = 25.84 Prob > chi2 = 0.0000

```
. * IE into lifexp1015
. nlcom _b[trlfex1015:spl_them1] * _b[spl_them1:ep_minrty] /* SIG - */
```

_nl_1: _b[trlfex1015:spl_them1] * _b[spl_them1:ep_minrty]						
	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
-----+						
_nl_1	-.0701103	.0047896	-14.64	0.000	-.0794978	-.0607229

```
. * TE into lifexp1015
. nlcom _b[trlfex1015:ep_minrty] + _b[trlfex1015:spl_them1] * _b[spl_them1:ep_minrty] /* SIG - */
```

```

      _nl_1: _b[trlfex1015:ep_minrty] + _b[trlfex1015:spl_themel] * _b[spl_themel:ep_minrty]
-----+-----
      | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----
      _nl_1 |      -.0562373    .0073508    -7.65   0.000    -.0706446    -.0418301
-----+-----

```

One should compare with the 'controlling for SVI 1 approach now:

```

      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_minrty |      .013873    .0086564     1.60   0.109    -.0030933     .0308393
    spl_themel |    -2.509098    .1565847    -16.02   0.000    -2.815998    -2.202197
    lgpmminor |    -.0039578    .0084102     -0.47   0.638    -.0204414     .0125258
    _cons |     83.40114    .1772532    470.52   0.000     83.05373     83.74855
-----+-----
var(e.trlfex1015) |     5.702271    .288192                5.1645     6.29604
-----+-----

```

LR test of model vs. saturated: chi2(0) = 0.00 Prob > chi2 = .

```
sem ( trlfex1015 <- ep_minrty spl_themel lgpmminor) (ep_minrty <- lgpmminor) /* DIR + NS!!! */
```

```

      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_minrty |      .013873    .0086564     1.60   0.109    -.0030933     .0308393
    spl_themel |    -2.509098    .1565847    -16.02   0.000    -2.815998    -2.202197
    lgpmminor |    -.0039578    .0084102     -0.47   0.638    -.0204414     .0125258
    _cons |     83.40114    .1772532    470.52   0.000     83.05373     83.74855
-----+-----
  ep_minrty
    lgpmminor |     1.069713    .0187197    57.14   0.000     1.033023     1.106403
    _cons |    -2.227068    .7658847     -2.91   0.004    -3.728174    -.7259617
-----+-----
var(e.trlfex1015) |     5.702271    .288192                5.1645     6.29604
var(e.ep_minrty) |    146.1337     7.38558                132.3521    161.3504
-----+-----

```

LR test of model vs. saturated: chi2(1) = 319.37 Prob > chi2 = 0.0000

7.ii. Income

```
sem ( trlfex1015 <- ep_minrty ep_pci lgpmminor) ( ep_pci <- ep_minrty lgincm) /* DIR SIG!!! */
```

```

      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_pci |     .0000752    4.76e-06    15.81   0.000     .0000659     .0000845
    ep_minrty |    -.0235973    .0075827    -3.11   0.002    -.0384591    -.0087354
    lgpmminor |    -.0129206    .008469     -1.53   0.127    -.0295195     .0036784
    _cons |     77.65487    .3112215    249.52   0.000     77.04488     78.26485
-----+-----
  ep_pci
    ep_minrty |    -167.7719    17.6792     -9.49   0.000    -202.4225    -133.1213
    lgincm |     .8638757    .0266841    32.37   0.000     .8115759     .9161755
    _cons |    11428.18    1595.739     7.16   0.000     8300.585    14555.77
-----+-----
var(e.trlfex1015) |     5.740059    .2901018                5.198724     6.337763
var(e.ep_pci) |    1.40e+08    7055982                1.26e+08     1.54e+08
-----+-----

```

Note: The LR test of model vs. saturated is not reported because the fitted model is not full rank.

```

. *      IE into lifexp1015 same NS
. nlcom _b[trlfex1015:ep_pci] * _b[ep_pci:ep_minrty] /* SIG */

```

```

      _nl_1: _b[trlfex1015:ep_pci] * _b[ep_pci:ep_minrty]
-----+-----

```

```

      | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----

```

```

-----+-----
      _nl_1 |  -.0126168   .0015507   -8.14   0.000   -.0156561   -.0095776
-----+-----

. *      TE into lifexp1015 same SIG
. nlcom _b[trlfex1015:ep_minrty] + _b[trlfex1015:ep_pci] * _b[ep_pci:ep_minrty] /* SIG */

      _nl_1: _b[trlfex1015:ep_minrty] + _b[trlfex1015:ep_pci] * _b[ep_pci:ep_minrty]

-----+-----
      | Coefficient   Std. err.      z    P>|z|    [95% conf. interval]
-----+-----
      _nl_1 |  -.0362141   .0074552   -4.86   0.000   -.050826   -.0216022
-----+-----

. *      One should compare with the `controlling for income approach now:
. sem    ( trlfex1015 <- ep_minrty ep_pci lgpminor) /* DIR + NS!!! */
      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_minrty |  -.0235973   .0075827   -3.11   0.002   -.0384591   -.0087354
    ep_pci   |   .0000752   4.76e-06   15.81   0.000   .0000659   .0000845
    lgpminor  |  -.0129206   .008469    -1.53   0.127   -.0295195   .0036784
    _cons     |   77.65487   .3112215   249.52   0.000   77.04488   78.26485
-----+-----
var(e.trlfex1015) |   5.740059   .2901018                5.198724   6.337763
-----+-----
LR test of model vs. saturated: chi2(0) = 0.00                      Prob > chi2 = .

sem      ( trlfex1015 <- ep_minrty ep_pci lgpminor) (ep_pci <- lgincm) /* DIR + NS!!! */
      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_pci   |   .0000752   4.76e-06   15.81   0.000   .0000659   .0000845
    ep_minrty |  -.0235973   .0075827   -3.11   0.002   -.0384591   -.0087354
    lgpminor  |  -.0129206   .008469    -1.53   0.127   -.0295195   .0036784
    _cons     |   77.65487   .3112215   249.52   0.000   77.04488   78.26485
-----+-----
  ep_pci
    lgincm    |   .9892088   .0244835   40.40   0.000   .941222    1.037196
    _cons     |   331.3905   1146.575    0.29   0.773  -1915.856   2578.637
-----+-----
var(e.trlfex1015) |   5.740059   .2901018                5.198724   6.337763
var(e.ep_pci)    |   1.56e+08   7867520                1.41e+08   1.72e+08

```

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8. Spatial nonrecursive Stata results: %NonWhite <-> Income, Census tracts, CT
Indicates %NonWhite -> Income

```

sem      ( ep_minrty <- ep_pci lgpminor) ( ep_pci <- ep_minrty lgincm), method(mlmv)
cov(e.ep_pci*e.ep_minrty) /* NS SIG */

      | Coefficient   std. err.      z    P>|z|    [95% conf. interval]
-----+-----
Structural
  ep_minrty
    ep_pci   |  -.0000198   .0000277   -0.71   0.476   -.0000741   .0000345
    lgpminor  |   1.06598    .0221139   48.20   0.000   1.022638    1.109323
    _cons     |  -1.166516   1.777301   -0.66   0.512   -4.649962    2.316931
-----+-----
  ep_pci
    ep_minrty |  -44.204    21.13841   -2.09   0.037   -85.63454   -2.773473
    lgincm    |   .9842767   .0290087   33.93   0.000   .9274207    1.041133
    _cons     |   1791.197   1805.769    0.99   0.321  -1748.044   5330.439
-----+-----

```

```

var(e.ep_minrty)| 143.1497 8.182068 127.9787 160.119
var(e.ep_pci)| 1.59e+08 8394601 1.43e+08 1.76e+08
-----+-----
cov(e.ep_minrty,e.ep_pci)| -69231.92 7479.874 -9.26 0.000 -83892.21 -54571.64
-----+-----

```

[GO BACK UP](#)

9. Spatial nonrecursive Stata results: Income <-> LifeExpectancy, Census tracts, CT
Indicates BOTH SIG

```

sem ( trlfex1015 <- ep_pci lglifeexp) ( ep_pci <- trlfex1015 lgincm), method(mlmv)
cov(e.ep_pci*e.trlfex1015) /* SIG SIG */
      | Coefficient std. err.      z    P>|z|      [95% conf. interval]
-----+-----
Structural
  trlfex1015
    ep_pci | .0000477 8.75e-06 5.44 0.000 .0000305 .0000648
    lglifeexp | .6141344 .0703287 8.73 0.000 .4762927 .7519761
    _cons | 28.64333 5.290753 5.41 0.000 18.27364 39.01301
-----+-----
  ep_pci
    trlfex1015 | 1378.2 487.0726 2.83 0.005 423.5557 2332.845
    lgincm | .863201 .0593492 14.54 0.000 .7468787 .9795233
    _cons | -104264.4 36455.48 -2.86 0.004 -175715.8 -32812.93
-----+-----
      var(e.trlfex1015) | 5.577016 .2853919 5.044794 6.165387
      var(e.ep_pci) | 1.48e+08 7584246 1.34e+08 1.64e+08
-----+-----
cov(e.trlfex1015,e.ep_pci) | -5273.564 3410.942 -1.55 0.122 -11958.89 1411.759
-----+-----

```

[GO BACK UP](#)

10. XXXXXXXXXXXXXXXXXXXX

[GO BACK UP](#)

11. XXXXXXXXXXXXXXXXXXXX

[GO BACK UP](#)

12. XXXXXXXXXXXXXXXXXXXX

[GO BACK UP](#)