GVPT 722
Examples of Regression with Pooled Cross-Sectional-Time-Series Data

(1) The data - black percentage of registered voters and black percentage of state legislators in the South, 1970-1990 (first three states only):

```
. list if state<4
```

```
. list state year blkpctreg blkpctlegs if state<4
```

	state	year	blkpct~g	blkpct~s
1.	al	1970	19.37	0
2.	al	1971	19.37	1.43
3.	al	1972	19.37	1.43
4.	al	1973	19.37	1.43
5.	al	1974	19.37	2.14
6.	al	1975	19.37	10.71
7.	al	1976	17.21	10.71
8.	al	1977	17.21	10.71
9.	al	1978	17.21	10.71
10.	al	1979	17.21	11.43
11.	al	1980	17.07	10.71
12.	al	1981	17.07	11.43
13.	al	1982	20.87	11.43
14.	al	1983	20.87	11.43
15.	al	1984	22.01	17.14
16.	al	1985	22.01	17.14
17.	al	1986	21.98	17.14
18.	al	1987	21.98	17.14
19.	al	1988	21.98	17.14
20.	al	1989	21.98	17.14
21.	al	1990	21.98	17.14
22.	ar	1970	17.37	0
23.	ar	1971	17.37	0
24.	ar	1972	17.37	0
25.	ar	1973	17.37	2.96
26.	ar	1974	17.37	2.96
27.	ar	1975	17.37	2.96
28.	ar	1976	19.98	2.96
29.	ar	1977	19.98	2.96
30.	ar	1978	19.98	2.96
31.	ar	1979	19.98	2.96
32.	ar	1980	10.96	2.96
33.	ar	1981	10.96	3.7
34.	ar	1982	13.07	3.7
35.	ar	1983	13.07	3.7
36.	ar	1984	13.49	3.7
37.	ar	1985	13.49	3.7
38.	ar	1986	13.23	3.7
39.	ar	1987	13.23	3.7
40.	ar	1988	13.23	3.7
41.	ar	1989	13.23	3.7
42.	ar	1990	13.23	3.7
43.	fl	1970	10.8	.6
44.	fl	1971	10.8	1.2
45.	fl	1972	10.8	1.2
46.	fl	1973	10.8	1.9
47.	fl	1974	10.8	1.9
48.	fl	1975	10.8	1.9
49.	fl	1976	10.54	1.9
50.	fl	1977	10.54	1.9
51.	fl	1978	10.54	1.9
52.	fl	1979	10.54	2.5
53.	fl	1980	10.15	2.5
54.	fl	1981	10.15	2.5
55.	fl	1982	10.64	3.12
56.	fl	1983	10.64	3.12
57.	fl	1984	10.6	7.5
58.	fl	1985	10.6	7.5
59.	fl	1986	10.97	7.5
60.	fl	1987	10.97	7.5
61.	fl	1988	10.97	7.5
62.	fl	1989	10.97	7.5
63.	fl	1990	10.97	7.5

(2) Telling Stata we have cross-sectional-time-series data and which variables represent the cross-sectional and time units:

```
. tsset state year, yearly
       panel variable:  state, 1 to 11
        time variable:  year, 1970 to 1990
```

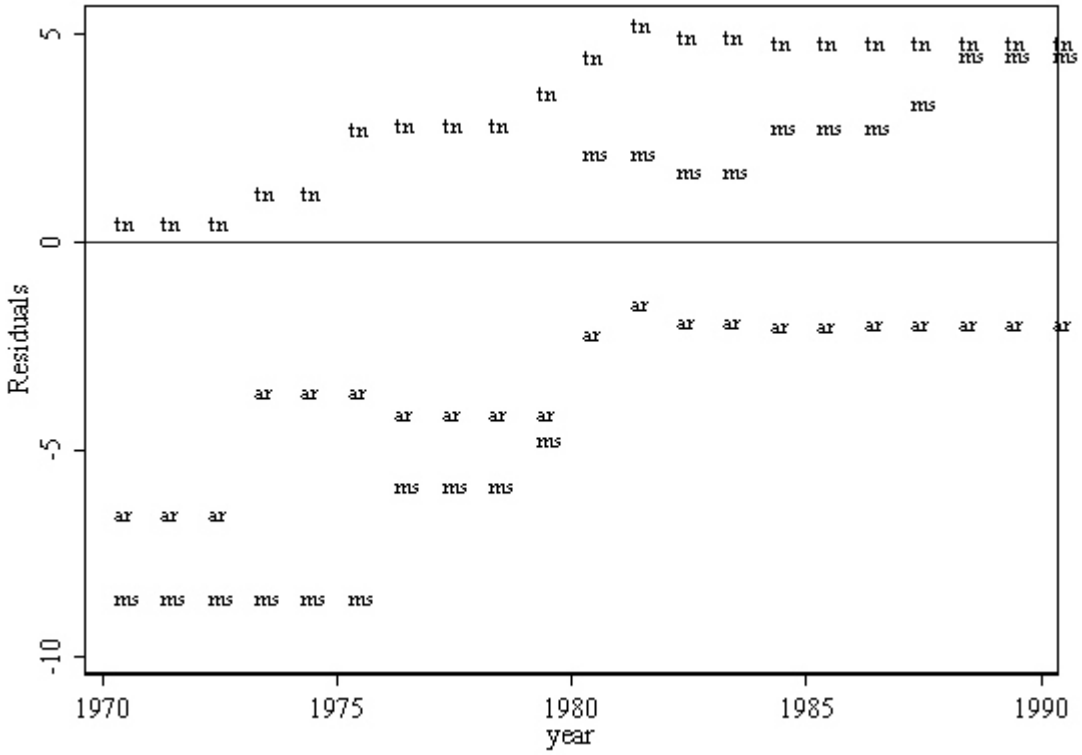
(3) Results of simple OLS model:

```
. reg blkpctlegs blkpctreg, beta

      Source |       SS       df       MS              Number of obs =     231
-------------+------------------------------           F(  1,   229) =   21.76
       Model |  352.665367     1  352.665367           Prob > F      =  0.0000
    Residual |  3711.68114   229  16.2082146           R-squared     =  0.0868
-------------+------------------------------           Adj R-squared =  0.0828
       Total |  4064.34651   230  17.6710718           Root MSE      =  4.0259

------------------------------------------------------------------------------
  blkpctlegs |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
   blkpctreg |    .216669   .0464497     4.66   0.000                 .2945683
       _cons |   2.731527    .893228     3.06   0.002                        .
------------------------------------------------------------------------------
```

(4) Do the residuals meet OLS assumptions (homoskedasticity across states, no autocorrelation within states)?

```
. predict error1, residuals

. tab state, summ(error1)

           |        Summary of Residuals
     state |        Mean   Std. Dev.       Freq.
-----------+------------------------------------
        al |   3.7347909   5.8786263          21
        ar |  -3.1986194   1.6678253          21
        fl |   -1.208751   2.6915652          21
        ga |   2.0395085   2.0029244          21
        la |   .37111553   3.4371618          21
        ms |  -1.8937252   5.4597566          21
        nc |  -1.8423611    3.072238          21
        sc |  -.82089942   3.5630554          21
        tn |   3.4525604   1.7343969          21
        tx |   1.5788585   2.4485623          21
        va |  -2.2124777   2.1169943          21
-----------+------------------------------------
     Total |   4.838e-09   4.0171811         231
```

```
. twoway (scatter error1 year if state==2 | state==6 | state==9, sort msymbol(none)
mlabel(state) mlabsize(small) mlabcolor(black)), yline(0) legend(off)
```




```
. gen error1_lag=error1[_n-1]
(1 missing value generated)

. list state year error1 error1_lag if state<3
```

	state	year	error1	error1_~g
1.	al	1970	-6.928407	.
2.	al	1971	-5.498406	-6.928407
3.	al	1972	-5.498406	-5.498406
4.	al	1973	-5.498406	-5.498406
5.	al	1974	-4.788406	-5.498406
6.	al	1975	3.781594	-4.788406
7.	al	1976	4.249599	3.781594
8.	al	1977	4.249599	4.249599
9.	al	1978	4.249599	4.249599
10.	al	1979	4.969599	4.249599
11.	al	1980	4.279932	4.969599
12.	al	1981	4.999933	4.279932
13.	al	1982	4.17659	4.999933
14.	al	1983	4.17659	4.17659
15.	al	1984	9.639586	4.17659
16.	al	1985	9.639586	9.639586
17.	al	1986	9.646087	9.639586
18.	al	1987	9.646087	9.646087
19.	al	1988	9.646087	9.646087
20.	al	1989	9.646087	9.646087
21.	al	1990	9.646087	9.646087
22.	ar	1970	-6.495069	9.646087
23.	ar	1971	-6.495069	-6.495069
24.	ar	1972	-6.495069	-6.495069
25.	ar	1973	-3.535069	-6.495069
26.	ar	1974	-3.535069	-3.535069
27.	ar	1975	-3.535069	-3.535069
28.	ar	1976	-4.100574	-3.535069
29.	ar	1977	-4.100574	-4.100574

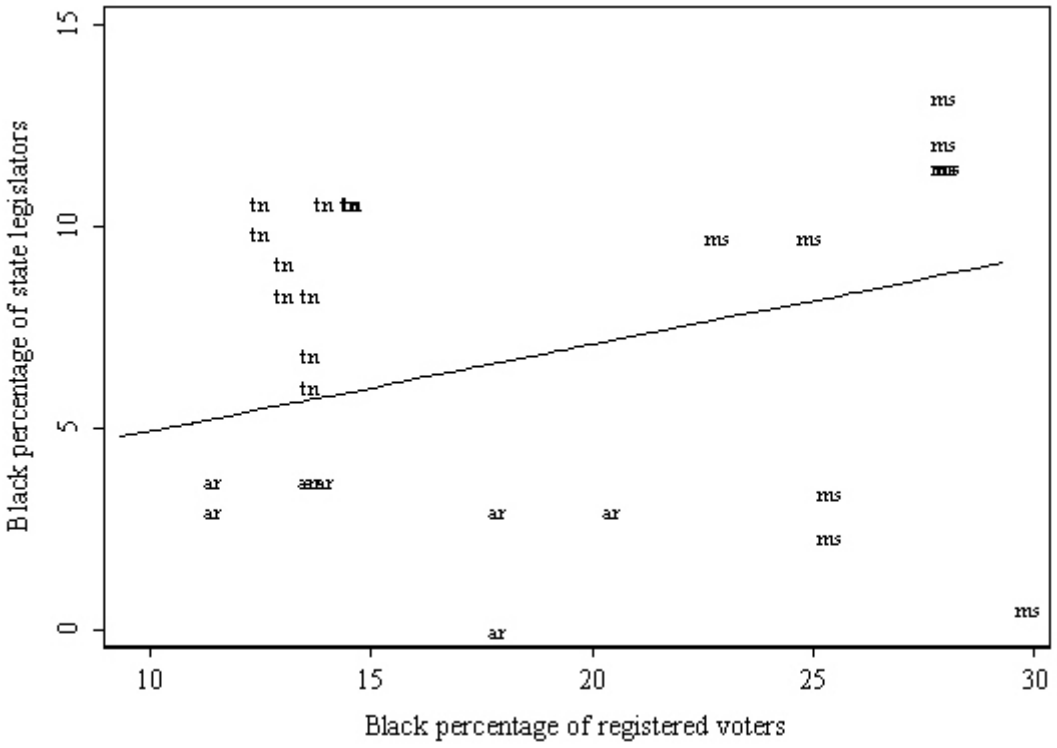
```
. replace error1_lag=. if year==1970
(10 real changes made, 10 to missing)
```

```
. sort state

. by state: reg error1 error1_lag, beta

-------------------------------------------------------------------------------
-> state = al

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  106.73
       Model |  489.259722     1  489.259722           Prob > F      =  0.0000
    Residual |  82.5162489    18  4.58423605           R-squared     =  0.8557
-------------+------------------------------           Adj R-squared =  0.8477
       Total |  571.775971    19  30.0934722           Root MSE      =  2.1411

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .8646163   .0836926    10.33   0.000                 .9250321
       _cons |    1.29434   .5586255     2.32   0.032                       .
------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-> state = ar

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =   59.17
       Model |  33.9078493     1  33.9078493           Prob > F      =  0.0000
    Residual |  10.3150678    18  .573059324           R-squared     =  0.7667
-------------+------------------------------           Adj R-squared =  0.7538
       Total |  44.2229171    19  2.32752195           Root MSE      =  .75701

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .7934689   .1031525     7.69   0.000                 .8756417
       _cons |  -.4441943   .3768134    -1.18   0.254                       .
------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-> state = fl

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  116.38
       Model |  115.801566     1  115.801566           Prob > F      =  0.0000
    Residual |   17.910726    18  .995040333           R-squared     =  0.8661
-------------+------------------------------           Adj R-squared =  0.8586
       Total |  133.712292    19  7.03748905           Root MSE      =  .99752

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9392007   .0870606    10.79   0.000                 .9306182
       _cons |   .2587222   .2537135     1.02   0.321                       .
------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-> state = ga

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  138.39
       Model |  59.9492019     1  59.9492019           Prob > F      =  0.0000
    Residual |  7.79756878    18  .433198266           R-squared     =  0.8849
-------------+------------------------------           Adj R-squared =  0.8785
       Total |  67.7467707    19  3.56561951           Root MSE      =  .65818

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9072446   .0771216    11.76   0.000                 .9406919
       _cons |   .4820296   .2080495     2.32   0.032                       .
------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-> state = la

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  102.52
       Model |  155.454665     1  155.454665           Prob > F      =  0.0000
    Residual |  27.2929714    18  1.51627619           R-squared     =  0.8507
-------------+------------------------------           Adj R-squared =  0.8424
       Total |  182.747636    19  9.61829664           Root MSE      =  1.2314

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .8501762   .0839646    10.13   0.000                  .922308
       _cons |   .6036672   .2756173     2.19   0.042                       .
------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-> state = ms

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  181.73
       Model |  500.629339     1  500.629339           Prob > F      =  0.0000
    Residual |  49.5866288    18  2.75481271           R-squared     =  0.9099
-------------+------------------------------           Adj R-squared =  0.9049
       Total |  550.215968    19  28.9587351           Root MSE      =  1.6598

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9518771   .0706104    13.48   0.000                 .9538752
       _cons |   .5465465   .4027738     1.36   0.192                       .
```

```
-------------------------------------------------------------------------------
-> state = nc

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  100.99
       Model |   148.02528     1   148.02528           Prob > F      =  0.0000
    Residual |  26.3832186    18  1.46573437           R-squared     =  0.8487
-------------+------------------------------           Adj R-squared =  0.8403
       Total |  174.408498    19  9.17939465           Root MSE      =  1.2107

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9366486   .0932044    10.05   0.000                  .921264
       _cons |   .2728513   .3319352     0.82   0.422                        .
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> state = sc

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =   73.32
       Model |  158.969514     1  158.969514           Prob > F      =  0.0000
    Residual |  39.028933    18  2.16827406           R-squared     =  0.8029
-------------+------------------------------           Adj R-squared =  0.7919
       Total |  197.998447    19  10.4209709           Root MSE      =  1.4725

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .8074763    .094304     8.56   0.000                 .8960372
       _cons |   .3319998   .3418832     0.97   0.344                        .
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> state = tn

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  249.12
       Model |  47.4642123     1  47.4642123           Prob > F      =  0.0000
    Residual |  3.42951677    18   .19052871           R-squared     =  0.9326
-------------+------------------------------           Adj R-squared =  0.9289
       Total |  50.8937291    19  2.67861732           Root MSE      =   .4365

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9032985   .0572306    15.78   0.000                 .9657195
       _cons |   .5446329   .2168572     2.51   0.022                        .
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> state = tx

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  143.04
       Model |   78.053442     1   78.053442           Prob > F      =  0.0000
    Residual |  9.82216218    18  .545675677           R-squared     =  0.8882
-------------+------------------------------           Adj R-squared =  0.8820
       Total |  87.8756042    19   4.6250318           Root MSE      =   .7387

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |    .823519   .0688565    11.96   0.000                 .9424577
       _cons |   .6430051   .1937877     3.32   0.004                        .
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> state = va

      Source |       SS       df       MS              Number of obs =      20
-------------+------------------------------           F(  1,    18) =  141.36
       Model |  76.8766622     1  76.8766622           Prob > F      =  0.0000
    Residual |  9.78928181    18   .54384899           R-squared     =  0.8870
-------------+------------------------------           Adj R-squared =  0.8808
       Total |   86.665944    19  4.56136547           Root MSE      =  .73746

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   1.004031    .084448    11.89   0.000                 .9418311
       _cons |   .2721298   .2606899     1.04   0.310                        .
------------------------------------------------------------------------------

. reg error1 error1_lag, beta

      Source |       SS       df       MS              Number of obs =     220
-------------+------------------------------           F(  1,   218) = 2124.51
       Model |  3028.86625     1  3028.86625           Prob > F      =  0.0000
    Residual |   310.79801   218  1.42567895           R-squared     =  0.9069
-------------+------------------------------           Adj R-squared =  0.9065
       Total |  3339.66426   219  15.2496085           Root MSE      =   1.194

------------------------------------------------------------------------------
      error1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
  error1_lag |   .9322143   .0202249    46.09   0.000                 .9523326
       _cons |   .4178396   .0805803     5.19   0.000                        .
------------------------------------------------------------------------------
```

(5) Graphing predicted and actual values (notice the problems of failing to model unit effects and panel heteroskedasticity):

```
. predict legshat1
(option xb assumed; fitted values)

. twoway (connected legshat1 blkpctreg, sort msymbol(none) clcolor(black)
clpat(solid)) (scatter blkpctlegs blkpctreg if state==2 | state==6 | state==9, sort
msymbol(none) mlabel(state) mlabsize(small) mlabcolor(black)), ytitle(Black percentage
of state legislators, size(medsmall) margin(medsmall)) xtitle(Black percentage of
registered voters, size(medsmall) margin(medsmall)) legend(off)
```



(6) Estimating a fixed effects model "by hand"

```
. reg blkpctlegs blkpctreg al ar fl ga la ms nc sc tn tx

      Source |       SS       df       MS              Number of obs =     231
-------------+------------------------------           F( 11,   219) =   13.16
       Model |  1617.32042    11  147.029129           Prob > F      =  0.0000
    Residual |  2447.02609   219  11.1736351           R-squared     =  0.3979
-------------+------------------------------           Adj R-squared =  0.3677
       Total |  4064.34651   230  17.6710718           Root MSE      =  3.3427

------------------------------------------------------------------------------
  blkpctlegs |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   blkpctreg |   .5310141    .125822     4.22   0.000     .2830372     .778991
          al |   4.757099   1.136265     4.19   0.000     2.517684    6.996513
          ar |  -.8361542   1.033325    -0.81   0.419    -2.872688    1.200379
          fl |   2.661672     1.2266     2.17   0.031     .2442202    5.079124
          ga |   2.423396   1.264859     1.92   0.057    -.0694585    4.916251
          la |   .2087915   1.402751     0.15   0.882    -2.555828    2.973411
          ms |  -3.04893    1.697406    -1.80   0.074    -6.394271    .2964106
          nc |    .058017   1.039116     0.06   0.956     -1.98993    2.105964
          sc |  -1.908446    1.67598    -1.14   0.256     -5.21156    1.394668
          tn |   6.517961   1.086604     6.00   0.000     4.376422      8.6595
          tx |   5.219211   1.179323     4.43   0.000     2.894935    7.543487
       _cons |  -4.500741   2.137567    -2.11   0.036    -8.713576   -.2879064
------------------------------------------------------------------------------
```

(7) F-test that all of the fixed effects are 0 (i.e. that all of the coefficients on the state dummies = 0)

```
. test al ar fl ga la ms nc sc tn tx

 ( 1)  al = 0
 ( 2)  ar = 0
 ( 3)  fl = 0
 ( 4)  ga = 0
 ( 5)  la = 0
 ( 6)  ms = 0
 ( 7)  nc = 0
 ( 8)  sc = 0
 ( 9)  tn = 0
 (10)  tx = 0

       F( 10,   219) =   11.32
            Prob > F =    0.0000
```

(8) Using Stata's fixed effects command:

```
. xtreg blkpctlegs blkpctreg, fe

Fixed-effects (within) regression               Number of obs      =       231
Group variable (i): state                       Number of groups   =        11

R-sq:  within  = 0.0752                         Obs per group: min =        21
       between = 0.1626                                        avg =      21.0
       overall = 0.0868                                        max =        21

                                                F(1,219)           =     17.81
corr(u_i, Xb)  = -0.6082                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  blkpctlegs |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   blkpctreg |   .5310141    .125822     4.22   0.000     .2830372     .778991
       _cons |  -3.041412   2.321161    -1.31   0.191    -7.616084     1.53326
-------------+----------------------------------------------------------------
     sigma_u |   3.091432
     sigma_e |  3.3426988
         rho |   .4610073   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(10, 219) =    11.32             Prob > F = 0.0000
```

(9) The random effects model:

```
. xtreg blkpctlegs blkpctreg, re

Random-effects GLS regression                   Number of obs      =       231
Group variable (i): state                       Number of groups   =        11

R-sq:  within  = 0.0752                         Obs per group: min =        21
       between = 0.1626                                        avg =      21.0
       overall = 0.0868                                        max =        21

Random effects u_i ~ Gaussian                   Wald chi2(1)       =     15.97
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0001

------------------------------------------------------------------------------
  blkpctlegs |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   blkpctreg |   .3750634   .0938458     4.00   0.000     .1911289    .5589978
       _cons |  -.1773811   1.883528    -0.09   0.925    -3.869028    3.514266
-------------+----------------------------------------------------------------
     sigma_u |  2.3983221
     sigma_e |  3.3426988
         rho |  .33983754   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

(10) Test for random effects:

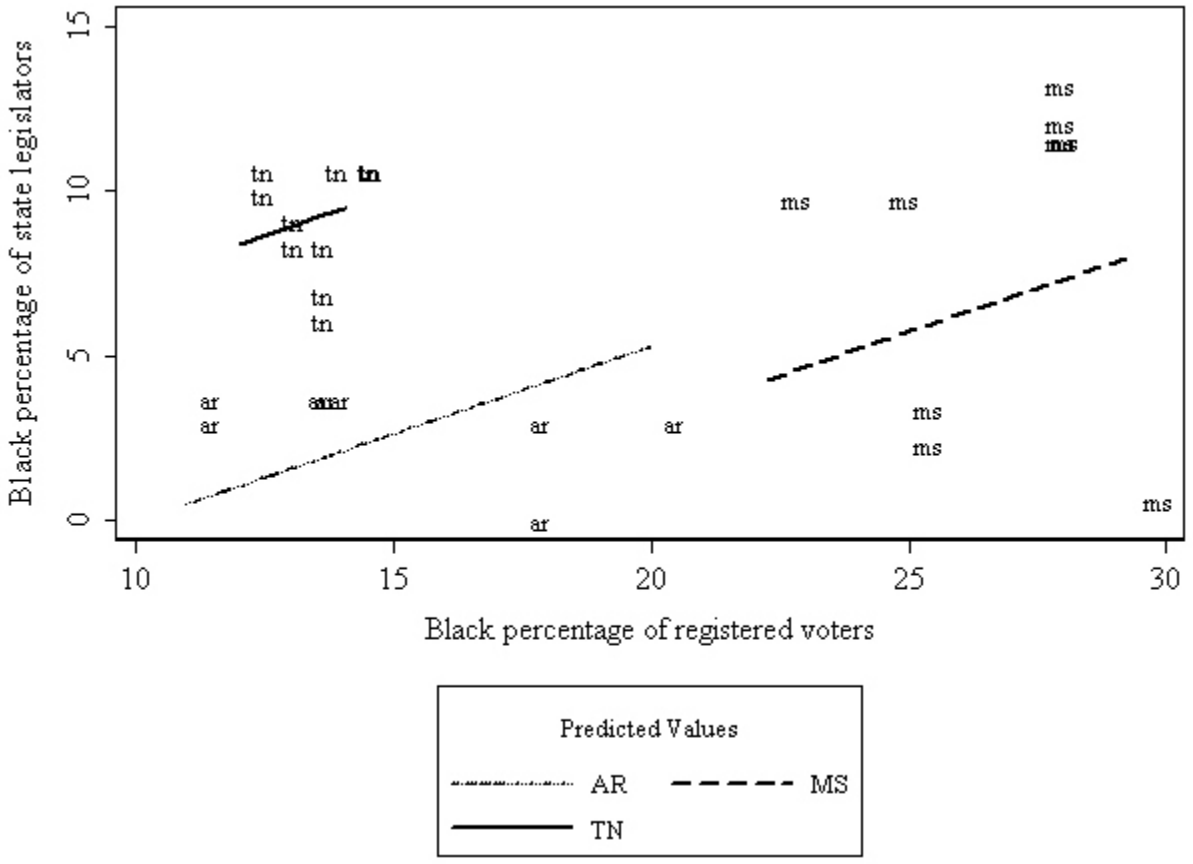
```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects:

        blkpctlegs[state,t] = Xb + u[state] + e[state,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                 ---------+-----------------------------
                blkpctl~s |   17.67107       4.203697
                        e |   11.17364       3.342699
                        u |   5.751949       2.398322

        Test:   Var(u) = 0
                                  chi2(1) =   191.64
                               Prob > chi2 =     0.0000
```

(11) Hausman test of no difference between fixed and random effects coefficients

```
. xtreg blkpctlegs blkpctreg, fe (results not shown)

. est store fixed

. xtreg blkpctlegs blkpctreg, re (results not shown)

. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
   blkpctreg |    .5310141     .3750634        .1559507        .0838101
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.46
                Prob>chi2 =      0.0628

.
```

(12) Graphing predicted and actual values from the fixed effects model (notice that assumption of homogeneity across units is gone, but panel heteroskedasticity remains):

```
. predict legshat2, xbu

. twoway (connected legshat2 blkpctreg if state==2, sort msymbol(none) clcolor(black)
clpat(tight_dot)) (scatter blkpctlegs blkpctreg if state==2 | state==6 | state==9,
sort msymbol(none) mlabel(state) mlabsize(small) mlabcolor(black)) (connected legshat2
blkpctreg if state==6, sort msymbol(none) clcolor(black) clpat(dash)) (connected
legshat2 blkpctreg if state==9, sort msymbol(none) clcolor(black) clpat(solid)),
ytitle(Black percentage of state legislators, size(medsmall) margin(medsmall))
xtitle(Black percentage of registered voters, size(medsmall) margin(medsmall))
legend(on order(1 "AR" 3 "MS" 4 "TN") size(small)) legend(title(Predicted Values,
size(small) margin(medsmall)))
```



(13) Further tests of panel heteroskedasticity and autocorrelation in fixed-effects residuals (notice that mean error within states now equals 0, but panel heteroskedasticity and autocorrelation remain):

```
. predict errorfe1, e

. tab state, summ(errorfe1)

           |        Summary of e[state,t]
     state |        Mean   Std. Dev.       Freq.
-----------+------------------------------------
        al |  -5.393e-08   5.6408917          21
        ar |  -1.419e-08   2.4680193          21
        fl |   1.135e-08    2.661925          21
        ga |   8.515e-09   1.9659608          21
        la |   1.419e-09   2.9920101          21
        ms |  -3.406e-08   5.7914268          21
        nc |  -1.561e-08   2.6085454          21
        sc |  -3.690e-08   3.1899351          21
        tn |           0   1.6806772          21
        tx |   1.135e-08    2.800138          21
        va |  -1.277e-08   1.8306524          21
-----------+------------------------------------
     Total |  -1.226e-08   3.2617854         231

. gen errorfe1_lag=errorfe1[_n-1]
(1 missing value generated)

. replace errorfe1_lag=. if year==1970
(10 real changes made, 10 to missing)

. reg errorfe1 errorfe1_lag, beta

      Source |       SS       df       MS              Number of obs =     220
-------------+------------------------------           F(  1,   218) = 1087.10
       Model |  1736.30723     1  1736.30723           Prob > F      =  0.0000
    Residual |  348.187953   218  1.59719245           R-squared     =  0.8330
-------------+------------------------------           Adj R-squared =  0.8322
       Total |  2084.49518   219  9.51824284           Root MSE      =  1.2638

------------------------------------------------------------------------------
    errorfe1 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
errorfe1_lag |   .8682921   .0263349    32.97   0.000                 .912668
       _cons |   .3919525   .0853133     4.59   0.000                       .
------------------------------------------------------------------------------
```

(14) Fixed effects model with a lagged dependent variable (leglag1)

```
. reg blkpctlegs leglag1 blkpctreg al ar fl ga la ms nc sc tn tx

      Source |       SS       df       MS              Number of obs =     220
-------------+------------------------------           F( 12,   207) =  209.80
       Model |  3435.68616    12   286.30718           Prob > F      =  0.0000
    Residual |  282.484645   207  1.36466012           R-squared     =  0.9240
-------------+------------------------------           Adj R-squared =  0.9196
       Total |  3718.17081   219  16.9779489           Root MSE      =  1.1682

------------------------------------------------------------------------------
  blkpctlegs |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     leglag1 |   .8970312   .0247103    36.30   0.000      .848315    .9457473
   blkpctreg |   .0296422   .0469364     0.63   0.528    -.0628925     .122177
          al |   1.143197   .4214053     2.71   0.007      .312401    1.973994
          ar |  -.1793712   .3707091    -0.48   0.629    -.9102206    .5514782
          fl |    .203398    .445273     0.46   0.648    -.6744535     1.08125
          ga |   .4481575    .457539     0.98   0.328    -.4538761    1.350191
          la |   .5429291   .5027628     1.08   0.281    -.4482629    1.534121
          ms |   .2917272   .6060169     0.48   0.631    -.9030293    1.486484
          nc |   .1800592    .372236     0.48   0.629    -.5538005    .9139189
          sc |   .3397975   .6025217     0.56   0.573    -.8480682    1.527663
          tn |   .5576069   .4233989     1.32   0.189      -.27712    1.392334
          tx |   .5098992   .4459904     1.14   0.254    -.3693666    1.389165
       _cons |   .2012985   .7745479     0.26   0.795    -1.325715    1.728312
------------------------------------------------------------------------------
```

(15) Beck's and Katz' test for first-order autocorrelation with PCSTS data (Nathaniel Beck and Jonathan Katz. 1996. "Nuisance vs. Substance: Specifying and Estimating Time-Series-Cross-Section Models." *Political Analysis* 6:1-36.)

```
. predict errorfe2, residuals
(11 missing values generated)

. gen errorfe2_lag=errorfe2[_n-1]
(12 missing values generated)

. replace errorfe2_lag=. if year==1970
(10 real changes made, 10 to missing)

. reg errorfe2 errorfe2_lag leglag1, nocons

      Source |       SS       df       MS              Number of obs =     209
-------------+------------------------------           F(  2,   207) =    0.71
       Model |  1.88364973     2  .941824864           Prob > F      =  0.4933
    Residual |  274.960133   207  1.32830982           R-squared     =  0.0068
-------------+------------------------------           Adj R-squared = -0.0028
       Total |  276.843782   209   1.3246114           Root MSE      =  1.1525

------------------------------------------------------------------------------
    errorfe2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
errorfe2_lag |  -.0825106   .0693999    -1.19   0.236    -.2193318    .0543107
     leglag1 |   .0025248   .0102034     0.25   0.805    -.0175911    .0226408
------------------------------------------------------------------------------
```

$(\chi^2 = N \times T \times R^2 = 21 \times 11 \times .0068 = 1.57 \text{ (df = 1)}; p > .10; \text{ accept } H_0: \rho = 0)$

(16) But panel heteroskedasticity remains:

```
. tab state, summ(errorfe2)

           |        Summary of Residuals
     state |        Mean   Std. Dev.       Freq.
-----------+------------------------------------
        al |   8.661e-09   2.1022586          20
        ar |   5.588e-10   .62568283          20
        fl |  -2.608e-09    .9790929          20
        ga |   2.515e-09   .56477677          20
        la |   4.843e-09   1.2024602          20
        ms |  -6.333e-09   1.5444691          20
        nc |   8.382e-10   1.2508111          20
        sc |   1.453e-08   1.4726759          20
        tn |  -7.451e-09   .41213957          20
        tx |  -7.451e-10   .67232041          20
        va |  -6.985e-09   .76978878          20
-----------+------------------------------------
     Total |   7.112e-10   1.1357307         220
```

(17) Estimating the model with Beck's and Katz' panel-corrected standard errors (Nathaniel Beck and Jonathan Katz. 1995. "What To Do (and Not To Do) with Times-Series-Cross-Section Data in Comparative Politics." *American Political Science Review* 89:634-647.)

- See next page

```
. xtpcse blkpctlegs leglag1 blkpctreg al ar fl ga la ms nc sc tn tx,
correlation(independent)

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:   state                           Number of obs      =       220
Time variable:    year                            Number of groups   =        11
Panels:           correlated (balanced)           Obs per group: min =        20
Autocorrelation:  no autocorrelation                                 avg =        20
                                                                     max =        20
Estimated covariances      =        66           R-squared          =    0.9240
Estimated autocorrelations =         0           Wald chi2(12)      =   6053.02
Estimated coefficients     =        13           Prob > chi2        =    0.0000

------------------------------------------------------------------------------
             |           Panel-corrected
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     leglag1 |   .8970312   .0427116    21.00   0.000      .813318    .9807443
   blkpctreg |   .0296422   .0498393     0.59   0.552     -.068041    .1273255
          al |   1.143197   .5848303     1.95   0.051    -.0030488    2.289444
          ar |  -.1793712   .2293989    -0.78   0.434    -.6289848    .2702424
          fl |    .203398   .3415431     0.60   0.551    -.4660141    .8728102
          ga |   .4481575   .4442188     1.01   0.313    -.4224954     1.31881
          la |   .5429291   .5390338     1.01   0.314    -.5135577    1.599416
          ms |   .2917272     .65226     0.45   0.655     -.986679    1.570133
          nc |   .1800592   .2797841     0.64   0.520    -.3683076    .7284259
          sc |   .3397975   .6594611     0.52   0.606    -.9527225    1.632317
          tn |   .5576069   .3178967     1.75   0.079    -.0654592    1.180673
          tx |   .5098992   .3398378     1.50   0.134    -.1561707    1.175969
       _cons |   .2012985   .8468056     0.24   0.812     -1.45841    1.861007
------------------------------------------------------------------------------
```

(18) Can the hypothesis that black legislative representation increases with black presence in the electorate be saved? (Maybe we don't need to specify separate intercepts for each state anymore):

```
. test al tn

 ( 1)  al = 0
 ( 2)  tn = 0

           chi2(  2) =    4.91
         Prob > chi2 =    0.0858

. test ar fl ga la ms nc sc tx

 ( 1)  ar = 0
 ( 2)  fl = 0
 ( 3)  ga = 0
 ( 4)  la = 0
 ( 5)  ms = 0
 ( 6)  nc = 0
 ( 7)  sc = 0
 ( 8)  tx = 0

           chi2(  8) =    7.21
         Prob > chi2 =    0.5143

. xtpcse blkpctlegs leglag1 blkpctreg al tn, correlation(independent)

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:   state                           Number of obs      =       220
Time variable:    year                            Number of groups   =        11
Panels:           correlated (balanced)           Obs per group: min =        20
Autocorrelation:  no autocorrelation                                 avg =        20
                                                                     max =        20
Estimated covariances      =        66           R-squared          =    0.9221
Estimated autocorrelations =         0           Wald chi2(4)       =   1446.35
Estimated coefficients     =         5           Prob > chi2        =    0.0000

------------------------------------------------------------------------------
             |           Panel-corrected
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     leglag1 |    .916428   .0367116    24.96   0.000     .8444746    .9883813
   blkpctreg |   .0359706   .0143659     2.50   0.012      .007814    .0641272
          al |   .7878913   .4331171     1.82   0.069    -.0610027    1.636785
          tn |   .2716138   .2125553     1.28   0.201     -.144987    .6882146
       _cons |   .2292132   .2387436     0.96   0.337    -.2387156     .697142
------------------------------------------------------------------------------
```