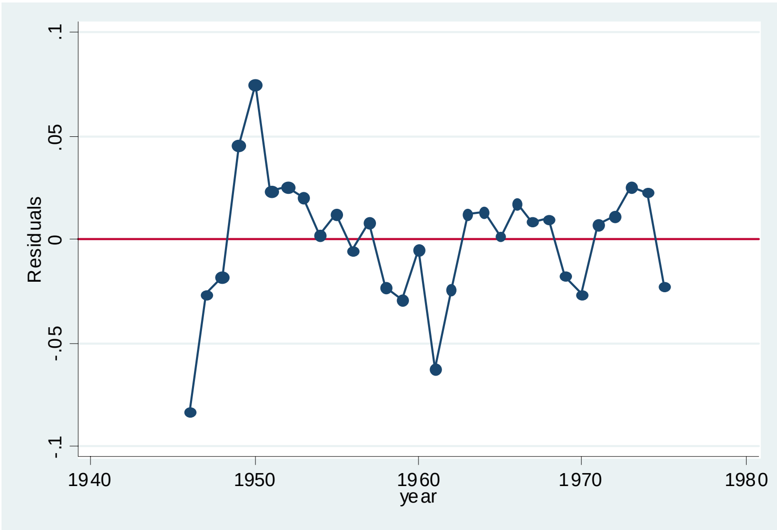
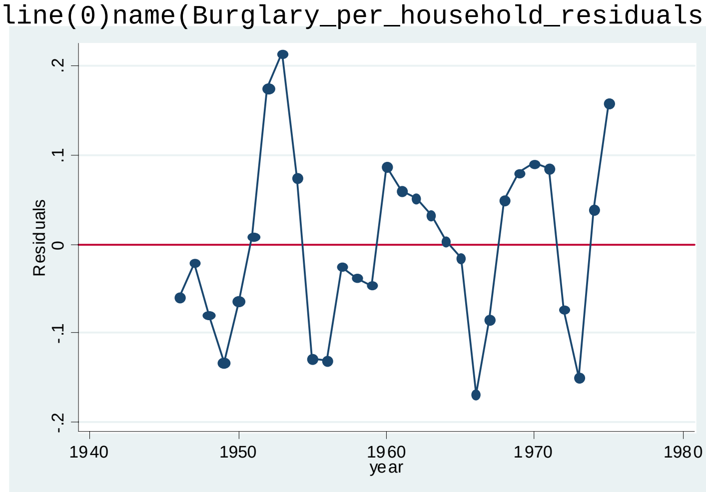
```
. infile year density unemp young burgper burghld durexp autocap ///
>      using "s:\703 Kaufman\tsexmp.dat"
(30 observations read)

. tsset year, yearly
        time variable:  year, 1946 to 1975
. global ivars = "young density"

. **  COMMENT Example 1: Autos/capita on age and density
. regress autocap $ivars

      Source |       SS       df       MS              Number of obs =      30
-------------+------------------------------           F(  2,    27) =  872.30
       Model |  1.76353759     2  .881768795           Prob > F      =  0.0000
    Residual |  .027293059    27  .001010854           R-squared     =  0.9848
-------------+------------------------------           Adj R-squared =  0.9836
       Total |  1.79083065    29  .061752781           Root MSE      =  .03179

------------------------------------------------------------------------------
     autocap |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       young |  -.2340718   .0588485    -3.98   0.000    -.3548189   -.1133248
     density |  -1.777278   .0512738   -34.66   0.000    -1.882483   -1.672073
       _cons |   6.639577   .0930228    71.38   0.000      6.44871    6.830444
------------------------------------------------------------------------------

. predict resols, res
. scatter resols year, connect(l) yline(0) name(Autos_per_capita_residuals)
. corrgram resols, lags(5)
```




```
                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial Autocor]
-------------------------------------------------------------------------------
1        0.4153   0.4210   5.7083  0.0169          |---               |---
2        0.1136  -0.1162   6.1505  0.0462          |                  |
3       -0.1204  -0.1602   6.6661  0.0833          |                 -|
4       -0.3141  -0.3721   10.309  0.0355        --|                --|
5       -0.1391   0.0607   11.052  0.0504         -|                  |
. estat dwatson

Durbin-Watson d-statistic(  3,    30) =  .8964546
```

```
. **  COMMENT  Estimate as AR(1)
. prais autocap $ivars, rho(dw)

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.5518
Iteration 2:  rho = 0.5589
Iteration 3:  rho = 0.5596
Iteration 4:  rho = 0.5596
Iteration 5:  rho = 0.5596
Iteration 6:  rho = 0.5597

Prais-Winsten AR(1) regression -- iterated estimates
      Source |       SS       df       MS              Number of obs =      30
-------------+------------------------------           F(  2,    27) = 2199.00
       Model |  3.37323417     2  1.68661708           Prob > F      =  0.0000
    Residual |  .020708836    27  .000766994           R-squared     =  0.9939
-------------+------------------------------           Adj R-squared =  0.9934
       Total |    3.393943    29  .117032517           Root MSE      =  .02769

------------------------------------------------------------------------------
     autocap |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       young |   -.240261   .0963593    -2.49   0.019    -.4379739   -.0425481
     density |  -1.776884   .0832976   -21.33   0.000    -1.947797   -1.605972
       _cons |   6.623522   .1562588    42.39   0.000     6.302905    6.944138
-------------+----------------------------------------------------------------
         rho |   .5596507
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.896455
Durbin-Watson statistic (transformed) 1.843319

. durbwats 1.567 year
Estimated exact D-W critical value = 1.5645765

. glsbeta autocap
beta[2,1]
         Standardized Coef
  young          -.1254883
density         -1.0651689

. busetime autocap year 1946
R-squared y, y-hat = .98475222    Buse R Squared = .95628534


. **  COMMENT Example 2: Burglary rate on durable expenditure  age  & density
. global ivars = "durexp young unemp"

. regress burghld  $ivars

      Source |       SS       df       MS              Number of obs =      30
-------------+------------------------------           F(  3,    26) =  369.52
       Model |  12.0236735     3  4.00789117           Prob > F      =  0.0000
    Residual |   .28200326    26  .010846279           R-squared     =  0.9771
-------------+------------------------------           Adj R-squared =  0.9744
       Total |  12.3056768    29  .424333682           Root MSE      =  .10415
------------------------------------------------------------------------------
     burghld |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      durexp |   1.751665   .1038058    16.87   0.000     1.538289     1.96504
       young |   .5384542   .2547497     2.11   0.044     .0148086      1.0621
       unemp |   .2867478   .0777662     3.69   0.001     .1268971    .4465986
       _cons |   1.013702   .8128022     1.25   0.223     -.657037    2.684441
```

```
------------------------------------------------------------------------------
. drop resols
. predict resols, res
. scatter resols year, connect(l) yline(0)name(Burglary_per_household_residuals)
```




```
. corrgram resols, lags(5)
                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial Autocor]
-------------------------------------------------------------------------------
1        0.4693   0.5190   7.2904  0.0069          |---               |----
2       -0.2206  -0.6625   8.9584  0.0113         -|             -----|
3       -0.4445  -0.0177   15.985  0.0011       ---|                  |
4       -0.4268  -0.4250   22.711  0.0001       ---|                ---|
5       -0.2648  -0.1605   25.404  0.0001        --|                  -|

. estat dwatson
Durbin-Watson d-statistic(  4,    30) =  .9587377

. **  COMMENT Estimate as AR(1).  Get ACF/PACF for transformed residuals
. prais burghld  $ivars, rho(dw)

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.5206
            ⋮
Iteration 9:  rho = 0.5497

Prais-Winsten AR(1) regression -- iterated estimates
      Source |       SS       df       MS              Number of obs =      30
-------------+------------------------------           F(  3,    26) =  274.11
       Model |  6.64760628     3  2.21586876           Prob > F      =  0.0000
    Residual |  .210176921    26  .008083728           R-squared     =  0.9694
-------------+------------------------------           Adj R-squared =  0.9658
       Total |   6.8577832    29  .236475283           Root MSE      =  .08991

------------------------------------------------------------------------------
     burghld |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      durexp |   1.666423   .1572079    10.60   0.000     1.343277    1.989568
       young |   .6839117   .3847096     1.78   0.087    -.1068703    1.474694
       unemp |   .3019254    .077212     3.91   0.001     .1432139    .4606369
       _cons |   1.575648    1.22314     1.29   0.209    -.9385518    4.089847
-------------+----------------------------------------------------------------
         rho |   .5497393
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.958738
```

```
Durbin-Watson statistic (transformed) 1.303719
. durbwats 1.650 year
      Estimated exact D-W critical value = 1.6063593
. predict resar1, res

. gen  res2=resar1-e(rho)*resar1[_n-1]
(1 missing value generated)
. replace  res2=(1-e(rho)^2)^.5*resar1 if year == 1946
(1 real change made)
. corrgram res2, lags(5)
                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial Autocor]
-------------------------------------------------------------------------------
1        0.2956   0.3218   2.8924  0.0890          |--                |--
2       -0.3180  -0.4889   6.3589  0.0416        --|               ---|
3       -0.3144  -0.0703   9.8738  0.0197        --|                  |
4       -0.2766  -0.4208   12.699  0.0128        --|               ---|
5       -0.1350  -0.2230   13.399  0.0199         -|                 -|

. **  COMMENT Try lagging all the X's (Excludes 1st year of data)
. gen unemp1=unemp[_n-1]
(1 missing value generated)
. gen young1=young[_n-1]
(1 missing value generated)
. gen durexp1=durexp[_n-1]
(1 missing value generated)

. drop if year==1946
(1 observation deleted)

. global ivars = "durexp1 young1 unemp1"

. prais burghld  $ivars, rho(dw)
Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.3031
            ⋮
Iteration 9:  rho = 0.3347

Prais-Winsten AR(1) regression -- iterated estimates
      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  3,    25) =  149.21
       Model |  6.42569808     3  2.14189936           Prob > F      =  0.0000
    Residual |  .358876958    25  .014355078           R-squared     =  0.9471
-------------+------------------------------           Adj R-squared =  0.9408
       Total |  6.78457504    28  .242306251           Root MSE      =  .11981

------------------------------------------------------------------------------
     burghld |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     durexp1 |   1.897276   .1635068    11.60   0.000     1.560527    2.234025
      young1 |   .2617262   .4112412     0.64   0.530     -.585241    1.108693
      unemp1 |    .130349   .1104428     1.18   0.249    -.0971123    .3578103
       _cons |   .2606844   1.288448     0.20   0.841    -2.392925    2.914294
-------------+----------------------------------------------------------------
         rho |   .3347332
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    1.393774
Durbin-Watson statistic (transformed) 1.876157

. durbwats 1.650 year
      Estimated exact D-W critical value = 1.6028531
```

```
. drop resar1 res2
. predict resar1, res

. gen  res2=resar1-e(rho)*resar1[_n-1]
(1 missing value generated)
. replace  res2=(1-e(rho)^2)^.5*resar1 if year == 1947
(1 real change made)
. corrgram res2, lags(5)
                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial Autocor]
-------------------------------------------------------------------------------
1        0.0301   0.0323   .02907  0.8646          |                  |
2       -0.0589  -0.0608   .14458  0.9303          |                  |
3       -0.2565  -0.2752   2.4188  0.4901        --|                --|
4       -0.0847  -0.0940   2.6765  0.6133          |                  |
5       -0.0927  -0.1372   2.9984  0.7002          |                 -|


. **  COMMENT Try lagging just Durexp
. global ivars = "durexp1 young unemp"

. prais burghld  $ivars, rho(dw)
Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.3567
Iteration 2:  rho = 0.4105
Iteration 3:  rho = 0.4297
            ⋮
Iteration 15:  rho = 0.4447
Iteration 16:  rho = 0.4447

Prais-Winsten AR(1) regression -- iterated estimates
      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  3,    25) =  181.82
       Model |  6.27595217     3  2.09198406           Prob > F      =  0.0000
    Residual |  .287650021    25  .011506001           R-squared     =  0.9562
-------------+------------------------------           Adj R-squared =  0.9509
       Total |  6.56360219    28  .234414364           Root MSE      =  .10727

------------------------------------------------------------------------------
     burghld |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     durexp1 |    1.71134   .1879971     9.10   0.000     1.324152    2.098527
       young |   .5855974   .4523562     1.29   0.207    -.3460477    1.517242
       unemp |   .2387035      .0922     2.59   0.016     .0488141     .428593
       _cons |   1.365519   1.465789     0.93   0.360     -1.65333    4.384367
-------------+----------------------------------------------------------------
         rho |   .4446824
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    1.286620
Durbin-Watson statistic (transformed) 2.051485

. durbwats 1.650 year
      Estimated exact D-W critical value = 1.6012119
. drop resar1 res2
. predict resar1, res

. gen  res2=resar1-e(rho)*resar1[_n-1]
(1 missing value generated)
. replace  res2=(1-e(rho)^2)^.5*resar1 if year == 1947
(1 real change made)
```

```
. corrgram res2, lags(5)
                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial Autocor]
-------------------------------------------------------------------------------
1       -0.0597  -0.0594   .11453  0.7350          |                  |
2        0.1311   0.1265   .68717  0.7092          |-                 |-
3       -0.1129  -0.0983   1.1278  0.7704          |                  |
4       -0.2232  -0.2684   2.9191  0.5714         -|                --|
5       -0.1815  -0.2231   4.1527  0.5277         -|                 -|


. **  COMMENT Calculate R square Y & Y_hat, Buse's R square, Standardized coefficients

. busetime burghld  year 1947
      R-squared y, y-hat = .97100882    Buse R Squared = .93278002
. glsbeta burghld

beta[3,1]
         Standardized Coef
durexp1          .83251221
  young          .11815422
  unemp          .09432825



. **  COMMENT Calculate Corrected OLS Var(B) & Display Corrected results
. sca rho=1-e(dw_0)/2
            ⋮
. ereturn post b varols

. display "OLS coefficients and Omega Corrected OLS Var(b)"
OLS coefficients and Omega Corrected OLS Var(b)

. ereturn display
------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     durexp1 |   1.868821   .1930041     9.68   0.000      1.49054    2.247102
       young |   .2970917   .4639358     0.64   0.522    -.6122057    1.206389
       unemp |   .2220424   .1073177     2.07   0.039     .0117035    .4323813
       _cons |   .2828694   1.511846     0.19   0.852    -2.680295    3.246034
------------------------------------------------------------------------------


. **  COMMENT  Calculate OLS Results using Newey-West Correction
. newey burghld $ivars, lag (2)

Regression with Newey-West standard errors          Number of obs  =        29
maximum lag: 2                                      F(  3,    25)  =    276.49
                                                    Prob > F       =    0.0000

------------------------------------------------------------------------------
             |             Newey-West
     burghld |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     durexp1 |   1.868821   .1896171     9.86   0.000     1.478298    2.259345
       young |   .2970917     .47809     0.62   0.540    -.6875531    1.281736
       unemp |   .2220424   .0808169     2.75   0.011     .0555969     .388488
       _cons |   .2828694   1.547651     0.18   0.856    -2.904578    3.470316
------------------------------------------------------------------------------
```

```
. **  COMMENT Try AR(2) model with lagging durexp


. arima burghld $ivars, ar(1 2)

(setting optimization to BHHH)
Iteration 0:   log likelihood =  25.393291
Iteration 1:   log likelihood =  25.541334
Iteration 2:   log likelihood =  25.697939
Iteration 3:   log likelihood =    25.7096
Iteration 4:   log likelihood =  25.713305
(switching optimization to BFGS)
Iteration 5:   log likelihood =  25.713938
Iteration 6:   log likelihood =  25.717909
Iteration 7:   log likelihood =  25.718266
Iteration 8:   log likelihood =   25.71831
Iteration 9:   log likelihood =  25.718328
Iteration 10:  log likelihood =  25.718335
Iteration 11:  log likelihood =  25.718336

ARIMA regression

Sample:  1947 - 1975                            Number of obs      =        29
                                                Wald chi2(5)       =    261.67
Log likelihood =  25.71834                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
             |                 OPG
     burghld |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
burghld      |
     durexp1 |   1.688202   .1994916     8.46   0.000     1.297205    2.079198
       young |   .6048715   .4419108     1.37   0.171    -.2612578    1.471001
       unemp |   .2427722   .0956355     2.54   0.011     .0553301    .4302143
       _cons |   1.476861   1.387936     1.06   0.287    -1.243444    4.197165
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |   .4093351   .1792871     2.28   0.022     .0579389    .7607313
         L2. |    .084903   .1951061     0.44   0.663    -.2974979     .467304
-------------+----------------------------------------------------------------
      /sigma |   .0992758   .0179125     5.54   0.000     .0641679    .1343837
------------------------------------------------------------------------------
```

```
. **  COMMENT Try AR(2) model without lagging durexp  --  read data in again to
get all cases
. clear

. infile year density unemp young burgper burghld durexp autocap ///
>       using "s:\703 Kaufman\tsexmp.dat"
(30 observations read)

. tsset year, yearly
        time variable:  year, 1946 to 1975
                delta:  1 year


. global ivars = "durexp young unemp"

. arima burghld $ivars, ar(1 2)

(setting optimization to BHHH)
Iteration 0:   log likelihood =  38.641482
Iteration 1:   log likelihood =  38.901665
Iteration 2:   log likelihood =  39.262779
Iteration 3:   log likelihood =   39.31656
Iteration 4:   log likelihood =  39.323132
(switching optimization to BFGS)
Iteration 5:   log likelihood =  39.324284
Iteration 6:   log likelihood =  39.326874
Iteration 7:   log likelihood =  39.327298
Iteration 8:   log likelihood =  39.327416
Iteration 9:   log likelihood =   39.32742

ARIMA regression

Sample:  1946 - 1975                            Number of obs      =        30
                                                Wald chi2(5)       =   1549.22
Log likelihood =  39.32742                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
             |                 OPG
     burghld |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
burghld      |
      durexp |   1.826069   .1138575    16.04   0.000     1.602913    2.049226
       young |   .3584466     .26977     1.33   0.184    -.1702928    .8871861
       unemp |   .3186917   .0753619     4.23   0.000      .170985    .4663984
       _cons |   .3545298   .8651929     0.41   0.682    -1.341217    2.050277
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |   .8384411   .1924377     4.36   0.000     .4612702    1.215612
         L2. |   -.652561   .2340379    -2.79   0.005    -1.111267   -.1938551
-------------+----------------------------------------------------------------
      /sigma |   .0637184   .0087042     7.32   0.000     .0466584    .0807784
------------------------------------------------------------------------------
```