EXAMPLE ABOUT DYNAMIC MODELS ESTIMATION:
ARELLANO AND BOND; BLUNDELL AND BOND ESTIMATORS

```
. ** Read the ata
. use "C:\Users\...\blundbondbalanc.dta", clear

. ** Declare Data as panel
. xtset id year, yearly

Panel variable: id (strongly balanced)
 Time variable: year, 1982 to 1989
         Delta: 1 year

. ** Describe panel
. xtdescribe

      id:  886, 1030, ..., 989349                             n =        492
    year:  1982, 1983, ..., 1989                             T =          8
           Delta(year) = 1 year
           Span(year)  = 8 periods
           (id*year uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%     95%     max
                         8       8       8         8         8       8       8

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+----------
       492    100.00  100.00 |  11111111
 ---------------------------+----------
       492    100.00         |  XXXXXXXX

.
. ** Descriptive statistics
. xtsum ly ln lk

Variable         |      Mean   Std. dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
ly       overall |  5.905447   1.991932   1.134937   11.67105 |     N =    3936
         between |             1.976804   1.408586   11.49127 |     n =     492
         within  |             .2588288   4.189762   7.355696 |     T =       8
                 |                                          |
ln       overall |  4.752687   2.283474  -2.253844   11.23016 |     N =    3936
         between |             2.270097  -.8955042   11.14857 |     n =     492
         within  |             .2647287   3.152142   6.033032 |     T =       8
                 |                                          |
lk       overall |  3.863383   2.081006  -1.295894   10.13477 |     N =    3936
         between |             2.065382  -.3310543   9.906047 |     n =     492
         within  |             .2690222   2.357184   5.506763 |     T =       8


. ** Pooled OLS
. reg ly l.ly ln l.ln lk l.lk D84-D89, vce(cluster id)
```

Equation 1

```
Linear regression                               Number of obs     =      3,444
                                                F(11, 491)        =   59731.41
                                                Prob > F          =     0.0000
                                                R-squared         =     0.9942
```

```
                                                Root MSE          =     .15155

                                    (Std. err. adjusted for 492 clusters in id)
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .9564256   .0062554   152.90   0.000     .9441351    .9687162
             |
          ln |
         --. |   .4153361    .023799    17.45   0.000     .3685757    .4620965
         L1. |  -.3915631   .0231784   -16.89   0.000    -.4371042    -.346022
             |
          lk |
         --. |   .2779901   .0392117     7.09   0.000     .2009466    .3550335
         L1. |  -.2653785   .0396475    -6.69   0.000    -.3432781   -.1874789
             |
         D84 |   .1058076   .0107729     9.82   0.000     .0846408    .1269743
         D85 |   .0374062   .0114001     3.28   0.001     .0150071    .0598052
         D86 |   .0560866   .0113762     4.93   0.000     .0337346    .0784386
         D87 |   .0993791    .010093     9.85   0.000     .0795484    .1192099
         D88 |   .0814873   .0101158     8.06   0.000     .0616117    .1013629
         D89 |   .0330753   .0105126     3.15   0.002     .0124199    .0537306
       _cons |   .0508464   .0147775     3.44   0.001     .0218115    .0798814
------------------------------------------------------------------------------

. estimates store POLS

.
. ** Fixed Effects
. xtreg ly l.ly ln l.ln lk l.lk D84-D89, fe vce(cluster id)
```

Equation 2

```
Fixed-effects (within) regression               Number of obs     =      3,444
Group variable: id                              Number of groups  =        492

R-squared:                                      Obs per group:
     Within  = 0.7081                                         min =          7
     Between = 0.9941                                         avg =        7.0
     Overall = 0.9897                                         max =          7

                                                F(11,491)         =     331.59
corr(u_i, Xb) = 0.9276                          Prob > F          =     0.0000

                                    (Std. err. adjusted for 492 clusters in id)
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    .550437   .0222981    24.69   0.000     .5066255    .5942485
             |
          ln |
         --. |   .3855652   .0249591    15.45   0.000     .3365254     .434605
         L1. |  -.2221847   .0245921    -9.03   0.000    -.2705035   -.1738659
             |
          lk |
```

```
         --. |    .423329   .0852401     4.97   0.000     .2558486    .5908093
         L1. |   -.356746   .0772825    -4.62   0.000    -.5085912   -.2049009
             |
         D84 |   .0971509   .0088385    10.99   0.000     .0797849    .1145168
         D85 |   .0657979   .0106529     6.18   0.000      .044867    .0867289
         D86 |   .0822508   .0118876     6.92   0.000      .058894    .1056076
         D87 |   .1294448   .0109197    11.85   0.000     .1079897    .1508999
         D88 |   .1460933   .0126098    11.59   0.000     .1213174    .1708692
         D89 |    .118153   .0133378     8.86   0.000     .0919468    .1443592
       _cons |   1.527745   .0968651    15.77   0.000     1.337424    1.718066
-------------+----------------------------------------------------------------
     sigma_u |  .42506735
     sigma_e |  .13408228
         rho |  .90950353   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store FE

. ** First Differences
. ** First Differences
. reg D.(ly l.ly ln l.ln lk l.lk D85-D89), nocons vce(cluster id)

Linear regression                               Number of obs     =      2,952
                                                F(10, 491)        =      92.65
                                                Prob > F          =     0.0000
                                                R-squared         =     0.3326
                                                Root MSE          =     .14912

                                   (Std. err. adjusted for 492 clusters in id)
------------------------------------------------------------------------------
             |               Robust
        D.ly | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         LD. |  -.0481349    .023618    -2.04   0.042    -.0945397   -.0017301
             |
          ln |
         D1. |   .3613453   .0269482    13.41   0.000     .3083974    .4142932
         LD. |   .0948679    .023779     3.99   0.000     .0481468     .141589
             |
          lk |
         D1. |   .6017026   .0937748     6.42   0.000     .4174531    .7859521
         LD. |  -.3178057   .0750133    -4.24   0.000    -.4651923   -.1704191
             |
         D85 |
         D1. |   .0072105     .00775     0.93   0.353    -.0080168    .0224378
             |
         D86 |
         D1. |   .0136521   .0123988     1.10   0.271    -.0107091    .0380133
             |
         D87 |
         D1. |   .0607204   .0152415     3.98   0.000     .0307738     .090667
             |
         D88 |
         D1. |   .1126837   .0176334     6.39   0.000     .0780376    .1473299
             |
         D89 |
         D1. |   .1019289   .0194654     5.24   0.000     .0636831    .1401748
------------------------------------------------------------------------------
```

```
. estimates store FD

. ** Estimates comparison
. estimates table POLS FE FD, star(.1 .05 .01)

-------------------------------------------------------------
    Variable |     POLS             FE               FD
-------------+-----------------------------------------------
          ly |
         L1. |  .95642564***    .55043701***
         LD. |                                   -.0481349**
             |
          ln |
         --. |  .41533612***    .38556523***
         L1. | -.39156312***   -.22218468***
         D1. |                                    .3613453***
         LD. |                                   .09486793***
             |
          lk |
         --. |  .27799009***    .42332897***
         L1. | -.26537853***   -.35674603***
         D1. |                                   .60170257***
         LD. |                                  -.31780568***
             |
         D84 |  .10580755***    .09715085***
         D85 |  .03740616***    .06579794***    .00721047
         D86 |  .05608661***    .08225079***    .0136521
         D87 |  .09937914***    .12944479***    .06072037***
         D88 |  .08148729***    .14609328***    .11268374***
         D89 |  .03307527***    .11815301***    .10192894***
       _cons |  .05084643***    1.5277449***
-------------------------------------------------------------
                           Legend: * p<.1; ** p<.05; *** p<.01
```

```
. ** Install xtabond2 for the first time
. ssc install xtabond2, replace
checking xtabond2 consistency and verifying not already installed...
all files already exist and are up to date.

.
. **Arellano & Bond
.
. ** one-step GMM, robust s.e., strictly exogenous variables

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(ln lk D85-D89) gmm(l.ly) noleveleq
robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 4

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2952
Time variable : year                            Number of groups   =       492
Number of instruments = 28                      Obs per group: min =         6
Wald chi2(0)  =         .                                      avg =      6.00
Prob > chi2   =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .3607257    .094404     3.82   0.000     .1756972    .5457542
             |
          ln |
         --. |   .3571752   .0363046     9.84   0.000     .2860196    .4283309
         L1. |  -.2724825   .1588374    -1.72   0.086     -.583798     .038833
             |
          lk |
         --. |   .2467726   .2049215     1.20   0.229    -.1548661    .6484114
         L1. |   .0348403   .2254312     0.15   0.877    -.4069967    .4766773
             |
         D85 |  -.0039102   .0143686    -0.27   0.786    -.0320722    .0242518
         D86 |   .0050872   .0170338     0.30   0.765    -.0282985    .0384729
         D87 |   .0463691   .0276202     1.68   0.093    -.0077656    .1005038
         D88 |   .0518713   .0416839     1.24   0.213    -.0298278    .1335703
         D89 |   .0257267   .0456622     0.56   0.573    -.0637696    .1152229
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(ln lk D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/7).L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.53  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.82  Pr > z =  0.410
------------------------------------------------------------------------------
```

```
Sargan test of overid. restrictions: chi2(18)   = 179.26  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(18)   = 111.55  Prob > chi2 =  0.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(ln lk D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(11)   =  60.07  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(7)    =  51.48  Prob > chi2 =  0.000

. estimates store AB1_SE
```

Equation 5

```
.
. ** one-step GMM, robust s.e., predetermined Variables

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly) gmm(ln lk)
noleveleq robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2952
Time variable : year                            Number of groups   =       492
Number of instruments = 80                      Obs per group: min =         6
Wald chi2(0)  =         .                                      avg =      6.00
Prob > chi2   =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .3762039   .0670725     5.61   0.000     .2447442    .5076636
             |
          ln |
         --. |   .3112212   .0869361     3.58   0.000     .1408297    .4816128
         L1. |  -.1165282   .0488476    -2.39   0.017    -.2122677   -.0207888
             |
          lk |
         --. |   .5298433   .3604296     1.47   0.142    -.1765858    1.236272
         L1. |  -.3537739    .265992    -1.33   0.184    -.8751086    .1675609
             |
         D85 |   .0134975   .0098068     1.38   0.169    -.0057236    .0327185
         D86 |   .0219259   .0145707     1.50   0.132    -.0066321    .0504838
         D87 |   .0643445   .0296498     2.17   0.030     .0062319    .1224571
         D88 |   .0913126   .0287797     3.17   0.002     .0349055    .1477197
         D89 |   .0688648    .031802     2.17   0.030      .006534    .1311956
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/7).(ln lk)
```

```
    L(1/7).L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.43  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.34  Pr > z =  0.180
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(70)   = 329.89  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(70)   = 189.84  Prob > chi2 =  0.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(L.ly, lag(1 .))
    Hansen test excluding group:     chi2(49)   = 143.76  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(21)   =  46.08  Prob > chi2 =  0.001
  gmm(ln lk, lag(1 .))
    Hansen test excluding group:     chi2(16)   =  81.91  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(54)   = 107.93  Prob > chi2 =  0.000
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(65)   = 165.94  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)    =  23.90  Prob > chi2 =  0.000

. estimates store AB1_PD

.
. ** one-step GMM, robust s.e., endogenous variables

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly) gmm(ln lk, lag(2
.)) noleveleq robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 6

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2952
Time variable : year                            Number of groups   =       492
Number of instruments = 68                      Obs per group: min =         6
Wald chi2(0)  =         .                                      avg =      6.00
Prob > chi2   =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4574448   .0699472     6.54   0.000     .3203508    .5945388
             |
          ln |
         --. |    .338695     .10256     3.30   0.001     .1376811    .5397089
         L1. |  -.1977893    .094012    -2.10   0.035    -.3820494   -.0135291
             |
          lk |
         --. |   .4064918   .3882054     1.05   0.295    -.3543768     1.16736
         L1. |  -.2048318   .2840822    -0.72   0.471    -.7616226    .3519591
```

```
            |
         D85 |   .0016435   .0099402     0.17   0.869    -.0178391     .021126
         D86 |   .0107268   .0142513     0.75   0.452    -.0172053    .0386588
         D87 |   .0519517   .0316544     1.64   0.101    -.0100898    .1139933
         D88 |   .0640769   .0320565     2.00   0.046     .0012474    .1269063
         D89 |   .0353323   .0357345     0.99   0.323    -.0347061    .1053707
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/7).(ln lk)
    L(1/7).L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.98  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.13  Pr > z =  0.260
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(58)   = 270.64  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(58)   = 165.51  Prob > chi2 =  0.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(L.ly, lag(1 .))
    Hansen test excluding group:     chi2(37)   = 121.69  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(21)   =  43.82  Prob > chi2 =  0.002
  gmm(ln lk, lag(2 .))
    Hansen test excluding group:     chi2(16)   =  82.50  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(42)   =  83.01  Prob > chi2 =  0.000
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(53)   = 149.88  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)    =  15.64  Prob > chi2 =  0.008

. estimates store AB1_End
```

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly, lag(4 .)) gmm(ln lk, lag(3 .)) noleveleq robust

```
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 7

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2952
Time variable : year                            Number of groups   =       492
Number of instruments = 41                      Obs per group: min =         6
Wald chi2(0)  =         .                                      avg =      6.00
Prob > chi2   =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
```

```
          ly |
        L1. |   .4825278     .12462     3.87   0.000     .2382771    .7267785
            |
          ln |
        --. |   .2764171   .1370197     2.02   0.044     .0078634    .5449707
        L1. |   -.116618   .1126548    -1.04   0.301    -.3374173    .1041813
            |
          lk |
        --. |   .3419936   .5800128     0.59   0.555    -.7948106    1.478798
        L1. |  -.1645263   .4650069    -0.35   0.723    -1.075923    .7468705
            |
        D85 |  -.0400568   .0151473    -2.64   0.008    -.0697449   -.0103687
        D86 |  -.0314324   .0191592    -1.64   0.101    -.0689838    .0061189
        D87 |   .0151856   .0416506     0.36   0.715    -.0664481    .0968194
        D88 |   .0281997   .0413091     0.68   0.495    -.0527647    .1091641
        D89 |  -.0009359   .0464686    -0.02   0.984    -.0920127    .0901409
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/7).(ln lk)
    L(4/7).L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.27  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =  -1.18  Pr > z =  0.236
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(31)   =  67.49  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(31)   =  42.61  Prob > chi2 =  0.080
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(L.ly, lag(4 .))
    Hansen test excluding group:     chi2(25)   =  31.82  Prob > chi2 =  0.163
    Difference (null H = exogenous): chi2(6)    =  10.79  Prob > chi2 =  0.095
  gmm(ln lk, lag(3 .))
    Hansen test excluding group:     chi2(1)    =   0.17  Prob > chi2 =  0.684
    Difference (null H = exogenous): chi2(30)   =  42.44  Prob > chi2 =  0.066
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(26)   =  39.25  Prob > chi2 =  0.046
    Difference (null H = exogenous): chi2(5)    =   3.36  Prob > chi2 =  0.645

. estimates store AB1_End_2
```

. ** Two-step GMM, endogenous variables, windmeijer correction

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly, lag(4 .)) gmm(ln lk, lag(3 .)) noleveleq twostep robust

```
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 8

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2952
Time variable : year                            Number of groups   =       492
Number of instruments = 41                      Obs per group: min =         6
Wald chi2(0)  =         .                                      avg =      6.00
Prob > chi2   =         .                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .4012062   .1551151     2.59   0.010     .0971863    .7052261
             |
          ln |
         --. |   .2976203   .1447838     2.06   0.040     .0138492    .5813913
         L1. |  -.0952081   .1271022    -0.75   0.454    -.3443237    .1539076
             |
          lk |
         --. |   .3614704   .4528362     0.80   0.425    -.5260724    1.249013
         L1. |  -.1972677   .3601123    -0.55   0.584    -.9030749    .5085394
             |
         D85 |  -.0354389   .0155798    -2.27   0.023    -.0659747    -.004903
         D86 |   -.018399   .0201085    -0.91   0.360    -.0578109     .021013
         D87 |   .0264229   .0376444     0.70   0.483    -.0473588    .1002045
         D88 |    .051239   .0426032     1.20   0.229    -.0322617    .1347398
         D89 |    .022516   .0499138     0.45   0.652    -.0753132    .1203453
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/7).(ln lk)
    L(4/7).L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.29  Pr > z =  0.022
Arellano-Bond test for AR(2) in first differences: z =  -1.29  Pr > z =  0.196
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(31)   =  67.49  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(31)   =  42.61  Prob > chi2 =  0.080
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  gmm(L.ly, lag(4 .))
    Hansen test excluding group:     chi2(25)   =  31.82  Prob > chi2 =  0.163
    Difference (null H = exogenous): chi2(6)    =  10.79  Prob > chi2 =  0.095
  gmm(ln lk, lag(3 .))

    Hansen test excluding group:     chi2(1)    =   0.17  Prob > chi2 =  0.684
    Difference (null H = exogenous): chi2(30)   =  42.44  Prob > chi2 =  0.066
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(26)   =  39.25  Prob > chi2 =  0.046
    Difference (null H = exogenous): chi2(5)    =   3.36  Prob > chi2 =  0.645

. estimates store AB2_End
```

```
.
. **Blundell & Bond
.
. ** one-step GMM, robust s.e., predetermined Variables

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly) gmm(ln lk) robust

Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 9

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3444
Time variable : year                            Number of groups   =       492
Number of instruments = 101                     Obs per group: min =         7
Wald chi2(10) =  3.94e+06                                      avg =      7.00
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .8929906   .0221431    40.33   0.000      .849591    .9363903
             |
          ln |
         --. |   .4235704   .0261299    16.21   0.000     .3723567     .474784
         L1. |  -.3513513   .0254912   -13.78   0.000    -.4013132   -.3013894
             |
          lk |
         --. |   .3056063   .0468686     6.52   0.000     .2137455    .3974671
         L1. |  -.2793262   .0479421    -5.83   0.000    -.3732911   -.1853614
             |
         D85 |  -.0145902   .0091882    -1.59   0.112    -.0325987    .0034182
         D86 |   .0044502   .0095962     0.46   0.643    -.0143581    .0232584
         D87 |   .0485603   .0084196     5.77   0.000     .0320582    .0650624
         D88 |    .035345   .0087457     4.04   0.000     .0182038    .0524861
         D89 |  -.0114121   .0096189    -1.19   0.235    -.0302647    .0074406
       _cons |   .1897415   .0434431     4.37   0.000     .1045947    .2748884
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/7).(ln lk)
    L(1/7).L.ly
Instruments for levels equation
  Standard
    D85 D86 D87 D88 D89
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(ln lk)
    D.L.ly
```

```
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -9.39  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.13  Pr > z =  0.260
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(90)   = 360.70  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(90)   = 216.10  Prob > chi2 =  0.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(70)   = 177.62  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(20)   =  38.48  Prob > chi2 =  0.008
  gmm(L.ly, lag(1 .))
    Hansen test excluding group:     chi2(63)   = 175.98  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(27)   =  40.12  Prob > chi2 =  0.050
  gmm(ln lk, lag(1 .))
    Hansen test excluding group:     chi2(22)   = 118.38  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(68)   =  97.72  Prob > chi2 =  0.011
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(85)   = 213.96  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)    =   2.14  Prob > chi2 =  0.830

. estimates store BB1_PD
```

. ** one-step GMM, robust s.e., endogenous Variables

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly, lag(5 .)) gmm(ln lk, lag(4 .)) robust

```
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate robust weighting matrix for Hansen test.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 10

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3444
Time variable : year                            Number of groups   =       492
Number of instruments = 39                      Obs per group: min =         7
Wald chi2(10) =  2.42e+06                                      avg =      7.00
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------


------------------------------------------------------------------------------
             |               Robust
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |   .8840458   .0725714    12.18   0.000     .7418084    1.026283
```

```
            |
         ln |
        --. |   .2073207   .1384582     1.50   0.134    -.0640524    .4786938
        L1. |  -.1583947   .1429606    -1.11   0.268    -.4385924    .1218029
            |
         lk |
        --. |   .0037101   .1185537     0.03   0.975    -.2286508     .236071
        L1. |   .0455812   .1285991     0.35   0.723    -.2064684    .2976308
            |
        D85 |  -.0603906   .0118666    -5.09   0.000    -.0836487   -.0371325
        D86 |   -.039142   .0162948    -2.40   0.016    -.0710793   -.0072047
        D87 |   .0212932   .0126795     1.68   0.093    -.0035583    .0461447
        D88 |   .0063014   .0114218     0.55   0.581    -.0160849    .0286877
        D89 |  -.0386234   .0126737    -3.05   0.002    -.0634633   -.0137835
      _cons |   .3186693   .1111699     2.87   0.004     .1007803    .5365584
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(4/7).(ln lk)
    L(5/7).L.ly
Instruments for levels equation
  Standard
    D85 D86 D87 D88 D89
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL3.(ln lk)
    DL4.L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -6.63  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.37  Pr > z =  0.172
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(28)   =  46.14  Prob > chi2 =  0.017
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(28)   =  38.68  Prob > chi2 =  0.086
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(17)   =  24.07  Prob > chi2 =  0.118
    Difference (null H = exogenous): chi2(11)   =  14.61  Prob > chi2 =  0.201
  gmm(L.ly, lag(5 .))
    Hansen test excluding group:     chi2(26)   =  35.18  Prob > chi2 =  0.108
    Difference (null H = exogenous): chi2(2)    =   3.50  Prob > chi2 =  0.174
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(23)   =  31.79  Prob > chi2 =  0.105
    Difference (null H = exogenous): chi2(5)    =   6.89  Prob > chi2 =  0.229

. estimates store BB1_End
```

. ** Two-step GMM, endogenous variables, windmeijer correction

. xtabond2 ly l.ly ln l.ln lk l.lk D85-D89, iv(D85-D89) gmm(l.ly, lag(5 .)) gmm(ln lk, lag(4 .)) twostep robust

```
Favoring space over speed. To switch, type or click on mata: mata set matafavor
speed, perm.
```

```
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.
```

Equation 11

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3444
Time variable : year                            Number of groups   =       492
Number of instruments = 39                      Obs per group: min =         7
Wald chi2(10) =  2.23e+06                                      avg =      7.00
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------
             |              Corrected
          ly | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          ly |
         L1. |    .912755   .0734558    12.43   0.000     .7687842    1.056726
             |
          ln |
         --. |   .2200791     .13108     1.68   0.093     -.036833    .4769912
         L1. |   -.179601   .1427809    -1.26   0.208    -.4594465    .1002445
             |
          lk |
         --. |   .0958246   .1132116     0.85   0.397     -.126066    .3177151
         L1. |  -.0606959   .1148837    -0.53   0.597    -.2858638    .1644721
             |
         D85 |  -.0560631   .0116184    -4.83   0.000    -.0788348   -.0332914
         D86 |   -.033387   .0152343    -2.19   0.028    -.0632457   -.0035283
         D87 |    .020081   .0122077     1.64   0.100    -.0038458    .0440077
         D88 |   .0098459    .011345     0.87   0.385      -.01239    .0320817
         D89 |  -.0406083   .0128852    -3.15   0.002    -.0658627   -.0153538
       _cons |   .2360994   .1099422     2.15   0.032     .0206166    .4515822
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D85 D86 D87 D88 D89)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(4/7).(ln lk)
    L(5/7).L.ly
Instruments for levels equation
  Standard
    D85 D86 D87 D88 D89
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL3.(ln lk)
    DL4.L.ly
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -6.73  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.39  Pr > z =  0.165
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(28)   =  46.14  Prob > chi2 =  0.017
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(28)   =  38.68  Prob > chi2 =  0.086
  (Robust, but weakened by many instruments.)
```

```
Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(17)   =  24.07  Prob > chi2 =  0.118
    Difference (null H = exogenous): chi2(11)   =  14.61  Prob > chi2 =  0.201
  gmm(L.ly, lag(5 .))
    Hansen test excluding group:     chi2(26)   =  35.18  Prob > chi2 =  0.108
    Difference (null H = exogenous): chi2(2)    =   3.50  Prob > chi2 =  0.174
  iv(D85 D86 D87 D88 D89)
    Hansen test excluding group:     chi2(23)   =  31.79  Prob > chi2 =  0.105
    Difference (null H = exogenous): chi2(5)    =   6.89  Prob > chi2 =  0.229

. estimates store BB2_End.

. ** Estimates comparison
. estimates table AB*, star(.1 .05 .01)
```

Table 1

Variable	AB1_SE	AB1_PD	AB1_End	AB1_End_2	AB2_End
ly					
L1.	.36072567***	.37620393***	.45744482***	.48252779***	.40120617***
ln					
--.	.35717523***	.31122124***	.33869502***	.27641705**	.29762027**
L1.	-.27248254*	-.11652824**	-.19778927**	-.11661799	-.09520806
lk					
--.	.24677264	.52984328	.40649179	.34199357	.36147036
L1.	.03484028	-.35377386	-.20483176	-.16452635	-.19726773
D85	-.00391024	.01349749	.00164346	-.04005683***	-.03543887**
D86	.00508719	.02192589	.01072679	-.03143241	-.01839897
D87	.04636913*	.06434452**	.05195174	.01518565	.02642286
D88	.05187125	.09131263***	.06407686**	.02819969	.05123904
D89	.02572667	.0688648**	.0353323	-.00093589	.02251603

Legend: * p<.1; ** p<.05; *** p<.01

```
.  estimates table BB* , star(.1 .05 .01)
```

Variable	BB1_PD	BB1_End	BB2_End
ly			
L1.	.89299064***	.8840458***	.91275498***
ln			
--.	.42357038***	.20732069	.22007909*
L1.	-.35135132***	-.15839474	-.17960099
lk			
--.	.3056063***	.00371006	.09582457
L1.	-.27932622***	.0455812	-.06069585
D85	-.01459023	-.06039058***	-.0560631***
D86	.00445017	-.03914205**	-.03338701**
D87	.04856031***	.0212932*	.02008098*
D88	.03534497***	.00630143	.00984586
D89	-.01141206	-.0386234***	-.04060828***
_cons	.18974151***	.31866932***	.23609938**

Legend: * p<.1; ** p<.05; *** p<.01

```
. estimates table POLS FE AB1_End_2 AB2_End BB1_End BB2_End, star(.1 .05 .01)

-------------------------------------------------------------------------------------------------------
    Variable |     POLS            FE          AB1_End_2        AB2_End         BB1_End         BB2_End
-------------+-----------------------------------------------------------------------------------------
          ly |
          L1. |  .95642564***    .55043701***    .48252779***    .40120617***     .8840458***    .91275498***
             |
          ln |
          --. |  .41533612***    .38556523***    .27641705**     .29762027**     .20732069       .22007909*
          L1. | -.39156312***   -.22218468***   -.11661799      -.09520806      -.15839474      -.17960099
             |
          lk |
          --. |  .27799009***    .42332897***    .34199357       .36147036       .00371006       .09582457
          L1. | -.26537853***   -.35674603***   -.16452635      -.19726773        .0455812      -.06069585
             |
          D84 |  .10580755***    .09715085***
          D85 |  .03740616***    .06579794***   -.04005683***   -.03543887**    -.06039058***    -.0560631***
          D86 |  .05608661***    .08225079***   -.03143241      -.01839897      -.03914205**    -.03338701**
          D87 |  .09937914***    .12944479***    .01518565       .02642286        .0212932*      .02008098*
          D88 |  .08148729***    .14609328***    .02819969       .05123904       .00630143       .00984586
          D89 |  .03307527***    .11815301***   -.00093589       .02251603      -.0386234***    -.04060828***
        _cons |  .05084643***    1.5277449***                                    .31866932***    .23609938**
-------------------------------------------------------------------------------------------------------
                                                                  Legend: * p<.1; ** p<.05; *** p<.01
```