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Trabajo Práctico N° 3:
Modelos de Paneles Dinámicos.

Ejercicio 1.

Considerar la base de datos "mod_abdata.dta" que fue utilizada por Arellano y Bond en su famoso paper de 1991. Se trata de un panel de 140 empresas británicas encuestadas, anualmente, entre 1976 y 1984. El panel original no es balanceado, pero la versión para este ejercicio se trata de un panel balanceado de empresas con observaciones para, exactamente, 6 años entre 1977 y 1982. La variable que identifica la empresa es id y la variable que identifica el tiempo es year. La variable n es el empleo de la empresa. Luego, considerar un modelo muy simplificado del siguiente tipo:

$ln\ n_{it} = \rho\ ln\ n_{it-1} + \varepsilon_{it}$,
$\varepsilon_{it} = c_i + \nu_{it}$,
$E(c_i) = E(\nu_{it}) = E(c_i \nu_{it}) = 0$,

donde n_{it} es el empleo de la empresa i en el año t.

(a) *Estimar el modelo por OLS. ¿Qué sesgo se esperaría encontrar y por qué?*

POLS:

```
      Source |       SS           df       MS      Number of obs   =       770
-------------+----------------------------------   F(1, 768)       =  76542.09
       Model |  1396.09073         1  1396.09073   Prob > F        =    0.0000
    Residual |  14.0079495       768  .018239518   R-squared       =    0.9901
-------------+----------------------------------   Adj R-squared   =    0.9901
       Total |  1410.09868       769  1.83367839   Root MSE        =    .13505

------------------------------------------------------------------------------
           n | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   .9967362   .0036027   276.66   0.000     .9896639    1.003809
       _cons |  -.0379493   .0063799    -5.95   0.000    -.0504734   -.0254252
------------------------------------------------------------------------------
```

El sesgo que se esperaría encontrar es el sesgo de paneles dinámicos, el cual se desprende que ln n_{it-1} está correlacionado con los efectos fijos, c_i, que se encuentran en el término de error. En general, bajo muchos supuestos, OLS sobrestima el valor real del parámetro ρ.

(b) *Estimar el modelo usando efectos fijos (FE). ¿Permite la transformación within eliminar el sesgo de paneles dinámicos?*

FE:

```
Fixed-effects (within) regression               Number of obs     =        770
Group variable: id                              Number of groups  =        138

R-squared:                                      Obs per group:
     Within  = 0.4926                                         min =          5
     Between = 0.9979                                         avg =        5.6
     Overall = 0.9901                                         max =          6

                                                F(1,631)          =     612.49
corr(u_i, Xb) = 0.9382                          Prob > F          =     0.0000

------------------------------------------------------------------------------
           n | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |    .869605   .0351375    24.75   0.000     .8006043    .9386056
       _cons |   .1076112   .0405095     2.66   0.008     .0280614    .1871609
-------------+----------------------------------------------------------------
     sigma_u |  .18358137
     sigma_e |   .1315487
         rho |  .66073284   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(137, 631) = 1.30                   Prob > F = 0.0194
```

La transformación *within* no permite eliminar el sesgo de paneles dinámicos, ya que, ahora, el problema se encuentra en que $\ln\widetilde{n_{it-1}}$= ln n_{it-1} - $\overline{\ln n_{\iota-1}}$ está correlacionado con $\tilde{\nu}_{it}$= ν_{it} - $\bar{\nu}_i$, aun cuando ν_{it} no tiene correlación serial. En particular, el término ln n_{it-1} correlaciona negativamente con $\frac{-1}{T-1}$ ν_{it-1} que se encuentra dentro de $\bar{\nu}_i$, mientras que, simétricamente, $\frac{-1}{T-1}$ ln n_{it} y ν_{it} también se encuentran correlacionados negativamente. Adicionalmente, hay otros pares de términos que correlacionan, pero su impacto es de segundo orden. Por último, cabe mencionar que Nickell mostró que, si $\rho >$ 0, este sesgo es siempre negativo.

(c) *Considerar una transformación de diferencias finitas de primer orden del modelo. ¿Continúa siendo la variable dependiente rezagada potencialmente endógena?*

Considerando una transformación de diferencias finitas de primer orden del modelo, la variable dependiente rezagada continúa siendo potencialmente endógena, ya que el término Δln n_{it-1}= ln n_{it-1} - ln n_{it-2} está correlacionado con ν_{it-1} en $\Delta\nu_{it}$= ν_{it} - ν_{it-1}.

(d) *Implementar el estimador de Anderson-Hsiao a partir del comando ivregress en Stata.*

IV (Anderson-Hsiao):

```
Instrumental variables 2SLS regression           Number of obs   =        632
                                                 Wald chi2(1)    =          .
                                                 Prob > chi2     =          .
                                                 R-squared       =          .
                                                 Root MSE        =     .25024

------------------------------------------------------------------------------
         D.n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |
         D1. |   2.015601   .4911953     4.10   0.000     1.052876    2.978327
------------------------------------------------------------------------------
Instrumented: D.nL1
 Instruments: nL2
```

(e) *Ahora, obtener la estimación GMM de ρ utilizando todos los instrumentos posibles en niveles para el modelo en primeras diferencias. Para ello, utilizar el comando xtabond2.*

GMM One-Step (Arellano-Bond):

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       632
Time variable : year                            Number of groups   =       138
Number of instruments = 10                      Obs per group: min =         4
Wald chi2(0)  =         .                                      avg =      4.58
Prob > chi2   =         .                                      max =         5
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.146045   .0865907    13.24   0.000     .9763309     1.31576
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.21  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.35  Pr > z =  0.019
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    = 122.88  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
```

<u>GMM Two-Step (Arellano-Bond):</u>

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       632
Time variable : year                            Number of groups   =       138
Number of instruments = 10                      Obs per group: min =         4
Wald chi2(0)  =         .                                      avg =      4.58
Prob > chi2   =         .                                      max =         5
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.176208   .0771686    15.24   0.000     1.024961    1.327456
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.97  Pr > z =  0.003
Arellano-Bond test for AR(2) in first differences: z =  -1.71  Pr > z =  0.087
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    = 122.88  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =  48.86  Prob > chi2 =  0.000
  (Robust, but weakened by many instruments.)
```

(f) *Obtener la estimación de GMM de ρ utilizando todos los instrumentos posibles en niveles para el modelo en primeras diferencias e Δy_{it-1} como instrumento para el modelo en niveles.*

SGMM One-Step (Blundell-Bond):

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       770
Time variable : year                            Number of groups   =       138
Number of instruments = 15                      Obs per group: min =         5
Wald chi2(1)  =  75831.06                                      avg =      5.58
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.107192   .0200965    55.09   0.000     1.067803     1.14658
       _cons |  -.1644167   .0233703    -7.04   0.000    -.2102216   -.1186118
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.47  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.27  Pr > z =  0.023
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)    = 168.40  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(9)     = 127.56  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(4)     =  40.84  Prob > chi2 =  0.000
```

<u>SGMM Two-Step (Blundell-Bond):</u>

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       770
Time variable : year                            Number of groups   =       138
Number of instruments = 15                      Obs per group: min =         5
Wald chi2(1)  =  23169.14                                      avg =      5.58
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.149856   .0316392    36.34   0.000     1.087845    1.211868
       _cons |  -.1738829   .0370401    -4.69   0.000    -.2464801   -.1012857
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.18  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =  -1.71  Pr > z =  0.087
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   = 168.40  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  56.19  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(9)    =  49.15  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(4)    =   7.04  Prob > chi2 =  0.134
```

(g) *Repetir las estimaciones de los incisos (e) y (f) incluyendo efectos fijos de tiempo.*

GMM One-Step (Arellano-Bond):

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       632
Time variable : year                            Number of groups   =       138
Number of instruments = 15                      Obs per group: min =         4
Wald chi2(0)  =         .                                      avg =      4.58
Prob > chi2   =         .                                      max =         5
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   .2667934   .1114731     2.39   0.017     .0483102    .4852767
      yr1977 |   .0072053   .0133804     0.54   0.590    -.0190198    .0334304
      yr1978 |   -.000092   .0101049    -0.01   0.993    -.0198972    .0197132
      yr1980 |  -.0390927    .010015    -3.90   0.000    -.0587218   -.0194636
      yr1981 |  -.1440582   .0107307   -13.42   0.000    -.1650901   -.1230264
      yr1982 |   -.214458   .0194763   -11.01   0.000    -.2526308   -.1762851
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =   0.30  Pr > z =  0.764
Arellano-Bond test for AR(2) in first differences: z =  -0.93  Pr > z =  0.351
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  36.01  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
```

GMM Two-Step (Arellano-Bond):

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       632
Time variable : year                            Number of groups   =       138
Number of instruments = 15                      Obs per group: min =         4
Wald chi2(0)  =         .                                      avg =      4.58
Prob > chi2   =         .                                      max =         5
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   .4092502   .0923988     4.43   0.000     .2281518    .5903486
      yr1977 |   .0090912   .0095385     0.95   0.341     -.009604    .0277864
      yr1978 |   .0020047   .0051366     0.39   0.696    -.0080629    .0120723
      yr1980 |  -.0313017   .0073163    -4.28   0.000    -.0456414   -.0169621
      yr1981 |  -.1342723   .0163176    -8.23   0.000    -.1662543   -.1022903
      yr1982 |  -.2001323   .0235447    -8.50   0.000    -.2462791   -.1539855
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.90  Pr > z =  0.370
Arellano-Bond test for AR(2) in first differences: z =  -1.22  Pr > z =  0.222
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  36.01  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =  11.00  Prob > chi2 =  0.276
  (Robust, but weakened by many instruments.)
```

SGMM One-Step (Blundell-Bond):

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       770
Time variable : year                            Number of groups   =       138
Number of instruments = 20                      Obs per group: min =         5
Wald chi2(6)  =  84467.08                                      avg =      5.58
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.070702   .0198077    54.05   0.000     1.031879    1.109524
      yr1977 |   .0438478   .0151864     2.89   0.004     .0140831    .0736126
      yr1978 |   .0518471   .0129701     4.00   0.000     .0264261    .0772681
      yr1979 |   .0418566   .0129664     3.23   0.001     .0164428    .0672704
      yr1981 |  -.0742759   .0129883    -5.72   0.000    -.0997325   -.0488193
      yr1982 |  -.0521052   .0133172    -3.91   0.000    -.0782065    -.026004
       _cons |  -.1213363   .0250374    -4.85   0.000    -.1704086    -.072264
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
Instruments for levels equation
  Standard
    yr1977 yr1978 yr1979 yr1980 yr1981 yr1982
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -6.30  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.36  Pr > z =  0.018
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)    =  79.17  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)

Difference-in-Sargan tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Sargan test excluding group:     chi2(9)     =  21.45  Prob > chi2 =  0.011
    Difference (null H = exogenous): chi2(4)     =  57.72  Prob > chi2 =  0.000
  iv(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982, eq(level))
    Sargan test excluding group:     chi2(8)     =  56.13  Prob > chi2 =  0.000
    Difference (null H = exogenous): chi2(5)     =  23.05  Prob > chi2 =  0.000
```

SGMM Two-Step (Blundell-Bond):

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       770
Time variable : year                            Number of groups   =       138
Number of instruments = 20                      Obs per group: min =         5
Wald chi2(6)  =  19554.89                                      avg =      5.58
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.115279   .0252032    44.25   0.000     1.065881    1.164676
      yr1977 |    .042046   .0187107     2.25   0.025     .0053737    .0787184
      yr1978 |   .0475315   .0087333     5.44   0.000     .0304146    .0646484
      yr1979 |   .0347642   .0075048     4.63   0.000     .0200551    .0494734
      yr1981 |  -.0766901   .0109072    -7.03   0.000    -.0980679   -.0553123
      yr1982 |  -.0535137   .0128686    -4.16   0.000    -.0787358   -.0282917
       _cons |  -.1778026   .0308186    -5.77   0.000     -.238206   -.1173993
------------------------------------------------------------------------------
Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
Instruments for levels equation
  Standard
    yr1977 yr1978 yr1979 yr1980 yr1981 yr1982
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.22  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =  -1.56  Pr > z =  0.118
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)    =  79.17  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)    =  28.91  Prob > chi2 =  0.007
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(9)     =   6.67  Prob > chi2 =  0.671
    Difference (null H = exogenous): chi2(4)     =  22.23  Prob > chi2 =  0.000
  iv(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982, eq(level))
    Hansen test excluding group:     chi2(8)     =  22.21  Prob > chi2 =  0.005
    Difference (null H = exogenous): chi2(5)     =   6.69  Prob > chi2 =  0.244
```

Ejercicio 2.

En este ejercicio, se ilustrará el hecho de que los estimadores de Arellano-Bond y de Blundell-Bond pueden extenderse, en forma directa, a modelos que incluyan regresores estrictamente exógenos y regresores secuencialmente exógenos.

En su paper original, Arellano y Bond modelaron el empleo de las empresas (n) utilizando un modelo de ajuste parcial para reflejar los costos de contratación y despido, incluyendo dos rezagos de la variable empleo. Otras variables incluidas fueron el nivel salarial actual y el rezagado (w), el stock de capital actual, rezagado una y dos veces (k), y la producción agregada actual, rezagada una y dos veces en el sector de la empresa (ys). Todas las variables se expresan en logaritmos. También se incluye un conjunto de variables dummy de tiempo.

(a) *Estimar el modelo por OLS. Computar los errores estándar robustos a heterocedasticidad y correlación serial.*

POLS:

```
Linear regression                               Number of obs     =        632
                                                F(14, 137)        =   15042.46
                                                Prob > F          =     0.0000
                                                R-squared         =     0.9948
                                                Root MSE          =     .09885

                                  (Std. err. adjusted for 138 clusters in id)
------------------------------------------------------------------------------
             |               Robust
           n | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |   1.083681   .0479746    22.59   0.000     .9888145    1.178548
         nL2 |  -.1204015   .0432502    -2.78   0.006    -.2059257   -.0348772
           w |  -.4314672   .1861579    -2.32   0.022    -.7995817   -.0633527
         wL1 |   .3933175   .1806983     2.18   0.031      .035999    .7506359
           k |   .3214569   .0546692     5.88   0.000     .2133524    .4295614
         kL1 |  -.2087172   .0674584    -3.09   0.002    -.3421117   -.0753228
         kL2 |  -.0811552    .030786    -2.64   0.009    -.1420324    -.020278
          ys |   .5156912   .1862924     2.77   0.006     .1473108    .8840716
        ysL1 |  -.7065917   .2745098    -2.57   0.011    -1.249416   -.1637674
        ysL2 |   .2489473   .1450994     1.72   0.088    -.0379767    .5358714
      yr1977 |          0  (omitted)
      yr1978 |          0  (omitted)
      yr1979 |   .0161153   .0087992     1.83   0.069    -.0012845    .0335151
      yr1980 |   .0267825   .0153105     1.75   0.082     -.003493     .057058
      yr1981 |  -.0111743   .0255106    -0.44   0.662    -.0616197    .0392712
      yr1982 |  -.0017447   .0217911    -0.08   0.936     -.044835    .0413456
       _cons |  -.1238146   .2952534    -0.42   0.676    -.7076579    .4600287
------------------------------------------------------------------------------
```

(b) *Estimar el modelo por FE. Computar los errores estándar robustos a heterocedasticidad y correlación serial.*

<u>FE:</u>

```
Fixed-effects (within) regression               Number of obs     =        632
Group variable: id                              Number of groups  =        138

R-squared:                                      Obs per group:
     Within  = 0.7708                                         min =          4
     Between = 0.9706                                         avg =        4.6
     Overall = 0.9674                                         max =          5

                                                F(14,137)         =     128.03
corr(u_i, Xb) = 0.6273                          Prob > F          =     0.0000

                                  (Std. err. adjusted for 138 clusters in id)
------------------------------------------------------------------------------
             |               Robust
           n | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |    .712259   .0546499    13.03   0.000     .6041925    .8203255
         nL2 |  -.2216269   .0557228    -3.98   0.000    -.3318149   -.1114389
           w |   -.504334   .1902322    -2.65   0.009    -.8805051   -.1281629
         wL1 |   .1750077   .1374862     1.27   0.205    -.0968619    .4468772
           k |   .3667223   .0660277     5.55   0.000     .2361571    .4972875
         kL1 |  -.0648159    .052492    -1.23   0.219    -.1686152    .0389834
         kL2 |   .0287852   .0412597     0.70   0.487    -.0528031    .1103735
          ys |   .5252203   .1803162     2.91   0.004     .1686574    .8817831
        ysL1 |  -.5622163   .2111979    -2.66   0.009    -.9798456   -.1445871
        ysL2 |   .1339081   .1695363     0.79   0.431    -.2013383    .4691544
      yr1977 |          0  (omitted)
      yr1978 |   .0218097   .0273806     0.80   0.427    -.0323336    .0759531
      yr1979 |   .0241949   .0257897     0.94   0.350    -.0268024    .0751922
      yr1980 |   .0319888   .0201233     1.59   0.114    -.0078037    .0717813
      yr1981 |  -.0005961   .0168409    -0.04   0.972    -.0338978    .0327056
      yr1982 |          0  (omitted)
       _cons |   1.248446   .8176095     1.53   0.129    -.3683202    2.865213
-------------+----------------------------------------------------------------
     sigma_u |  .29806935
     sigma_e |  .09040774
         rho |  .91575291   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

(c) *Implementar el estimador de Anderson-Hsiao usando* n_{it-2} *como instrumento.*

IV (Anderson-Hsiao):

```
Instrumental variables 2SLS regression          Number of obs   =        494
                                                Wald chi2(13)   =      14.10
                                                Prob > chi2     =     0.3669
                                                R-squared       =          .
                                                Root MSE        =     .53695

------------------------------------------------------------------------------
         D.n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         nL1 |
         D1. |   5.823993   14.07042     0.41   0.679    -21.75353    33.40152
             |
         nL2 |
         D1. |  -.9846567   2.216574    -0.44   0.657    -5.329062    3.359749
             |
           w |
         D1. |  -.3323156   .4888956    -0.68   0.497    -1.290533    .6259022
             |
         wL1 |
         D1. |   1.433551   3.563217     0.40   0.687    -5.550226    8.417328
             |
           k |
         D1. |   .0698672   .7653782     0.09   0.927    -1.430246    1.569981
             |
         kL1 |
         D1. |  -1.708326   4.482217    -0.38   0.703    -10.49331    7.076659
             |
         kL2 |
         D1. |  -.5052786   1.434586    -0.35   0.725    -3.317016    2.306459
             |
          ys |
         D1. |   1.344045   1.935232     0.69   0.487    -2.448939     5.13703
             |
        ysL1 |
         D1. |  -2.722142   6.196766    -0.44   0.660    -14.86758    9.423296
             |
        ysL2 |
         D1. |  -.1505585    .837905    -0.18   0.857    -1.792822    1.491705
             |
      yr1977 |
         D1. |          0  (omitted)
             |
      yr1978 |
         D1. |   .0677291    .381059     0.18   0.859    -.6791328     .814591
             |
      yr1979 |
         D1. |   .1150868   .3885855     0.30   0.767    -.6465268    .8767003
             |
      yr1980 |
         D1. |   .1093503   .2766837     0.40   0.693    -.4329398    .6516404
             |
      yr1981 |
         D1. |          0  (omitted)
             |
      yr1982 |
         D1. |          0  (omitted)
             |
       _cons |   .1190119    .350733     0.34   0.734    -.5684122     .806436
------------------------------------------------------------------------------
Instrumented: D.nL1
 Instruments: D.nL2 D.w D.wL1 D.k D.kL1 D.kL2 D.ys D.ysL1 D.ysL2 D.yr1978
              D.yr1979 D.yr1980 nL2
```

(d) *Estimar la ecuación de empleo usando el estimador de Arellano-Bond. Asumir que la única endogeneidad presente es en el rezago de la variable dependiente.*

<u>GMM One-Step (Arellano-Bond):</u>

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       414
Time variable : year                            Number of groups   =       138
Number of instruments = 20                      Obs per group: min =         3
Wald chi2(0)  =         .                                      avg =      3.00
Prob > chi2   =         .                                      max =         3
------------------------------------------------------------------------------
             |               Robust
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .5325962   .4060438     1.31   0.190    -.2632351    1.328428
         L2. |  -.1678165    .108895    -1.54   0.123    -.3812468    .0456137
             |
           w |
         --. |  -.5435347   .1878885    -2.89   0.004    -.9117894   -.1752799
         L1. |   .0465042   .2149028     0.22   0.829    -.3746976     .467706
             |
           k |
         --. |   .3597198   .0798932     4.50   0.000      .203132    .5163076
         L1. |  -.0203542   .1486021    -0.14   0.891     -.311609    .2709006
         L2. |   .0531949   .0564035     0.94   0.346    -.0573539    .1637438
             |
          ys |
         --. |   .6720783   .1618321     4.15   0.000     .3548932    .9892634
         L1. |  -.3962257   .2155005    -1.84   0.066     -.818599    .0261475
         L2. |   -.061621   .1883471    -0.33   0.744    -.4307746    .3075325
             |
      yr1979 |  -.0019098   .0289454    -0.07   0.947    -.0586417    .0548221
      yr1980 |   .0153498      .0194     0.79   0.429    -.0226734    .0533731
      yr1982 |  -.0047222   .0199879    -0.24   0.813    -.0438977    .0344534
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(w L.w k L.k L2.k ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981
    yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.93  Pr > z =  0.351
Arellano-Bond test for AR(2) in first differences: z =  -1.57  Pr > z =  0.117
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(7)    =  18.99  Prob > chi2 =  0.008
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(7)    =  12.33  Prob > chi2 =  0.090
  (Robust, but weakened by many instruments.)
```

<u>GMM Two-Step (Arellano-Bond):</u>

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       414
Time variable : year                            Number of groups   =       138
Number of instruments = 20                      Obs per group: min =         3
Wald chi2(0)  =         .                                      avg =      3.00
Prob > chi2   =         .                                      max =         3
------------------------------------------------------------------------------
             |              Corrected
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .6080291   .6739661     0.90   0.367    -.7129203    1.928978
         L2. |   -.137942   .1688863    -0.82   0.414     -.468953    .1930691
             |
           w |
         --. |  -.4912924   .2335444    -2.10   0.035     -.949031   -.0335539
         L1. |   .1263267   .2293468     0.55   0.582    -.3231847    .5758381
             |
           k |
         --. |   .2912765   .0889614     3.27   0.001     .1169154    .4656376
         L1. |  -.0170639    .219071    -0.08   0.938    -.4464351    .4123073
         L2. |   .0263268   .0736175     0.36   0.721    -.1179608    .1706145
             |
          ys |
         --. |   .5452599   .1895989     2.88   0.004     .1736528     .916867
         L1. |   -.307353   .2411337    -1.27   0.202    -.7799662    .1652603
         L2. |  -.1253987   .2036039    -0.62   0.538     -.524455    .2736577
             |
      yr1979 |    .008789   .0360821     0.24   0.808    -.0619306    .0795087
      yr1980 |   .0244669   .0224526     1.09   0.276    -.0195394    .0684731
      yr1982 |  -.0189478   .0283143    -0.67   0.503    -.0744428    .0365472
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(w L.w k L.k L2.k ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981
    yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).L.n
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.64  Pr > z =  0.523
Arellano-Bond test for AR(2) in first differences: z =  -1.41  Pr > z =  0.159
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(7)    =  18.99  Prob > chi2 =  0.008
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(7)    =  12.33  Prob > chi2 =  0.090
  (Robust, but weakened by many instruments.)
```

(e) *Ahora, considerar, como hicieron Blundell y Bond (1998), que los salarios y el stock de capital no deben tomarse como estrictamente exógenos en este contexto (como se hizo en los modelos anteriores). Reestimar el modelo usando el estimador de A-B y considerando a los salarios y al stock de capital como regresores secuencialmente exógenos.*

GMM One-Step (Arellano-Bond):

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       414
Time variable : year                            Number of groups   =       138
Number of instruments = 33                      Obs per group: min =         3
Wald chi2(0)  =         .                                      avg =      3.00
Prob > chi2   =         .                                      max =         3
------------------------------------------------------------------------------
             |               Robust
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .8328315   .1219725     6.83   0.000     .5937698    1.071893
         L2. |  -.1640736   .0770492    -2.13   0.033    -.3150873   -.0130599
             |
           w |
         --. |  -.5056556   .3148758    -1.61   0.108    -1.122801    .1114896
         L1. |   .2750362   .3347117     0.82   0.411    -.3809867     .931059
             |
           k |
         --. |   .3384097   .1810356     1.87   0.062    -.0164135    .6932329
         L1. |  -.2157422   .1197218    -1.80   0.072    -.4503925    .0189082
         L2. |  -.0006972   .0481602    -0.01   0.988    -.0950895    .0936951
             |
          ys |
         --. |   .7245478   .2528721     2.87   0.004     .2289276    1.220168
         L1. |  -.5540143   .4752081    -1.17   0.244    -1.485405    .3773765
         L2. |   .0545983   .2887007     0.19   0.850    -.5112447    .6204413
             |
      yr1979 |  -.0061002   .0303218    -0.20   0.841    -.0655299    .0533295
      yr1980 |   .0188299   .0214161     0.88   0.379    -.0231449    .0608046
      yr1982 |  -.0067336   .0217373    -0.31   0.757     -.049338    .0358708
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(L.n L.w L.k)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.83  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.12  Pr > z =  0.034
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(20)   =  38.36  Prob > chi2 =  0.008
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(20)   =  22.98  Prob > chi2 =  0.290
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
    Hansen test excluding group:     chi2(14)   =  14.84  Prob > chi2 =  0.389
    Difference (null H = exogenous): chi2(6)    =   8.14  Prob > chi2 =  0.228
```

<u>GMM Two-Step (Arellano-Bond):</u>

```
Dynamic panel-data estimation, two-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       414
Time variable : year                            Number of groups   =       138
Number of instruments = 33                      Obs per group: min =         3
Wald chi2(0)  =         .                                      avg =      3.00
Prob > chi2   =         .                                      max =         3
------------------------------------------------------------------------------
             |              Corrected
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .9403457   .1894156     4.96   0.000     .5690979    1.311593
         L2. |  -.1526986   .0928117    -1.65   0.100    -.3346062     .029209
             |
           w |
         --. |  -.4490707   .3993756    -1.12   0.261    -1.231833    .3336911
         L1. |   .3385343   .3136958     1.08   0.281    -.2762982    .9533668
             |
           k |
         --. |   .1701686   .2126183     0.80   0.424    -.2465556    .5868928
         L1. |  -.2258957   .1315513    -1.72   0.086    -.4837316    .0319401
         L2. |  -.0419358   .0564683    -0.74   0.458    -.1526117    .0687401
             |
          ys |
         --. |    .689388   .2434718     2.83   0.005     .2121921    1.166584
         L1. |  -.5276126   .4812107    -1.10   0.273    -1.470768    .4155429
         L2. |   .1320996   .2419835     0.55   0.585    -.3421794    .6063786
             |
      yr1979 |   .0193174   .0342941     0.56   0.573    -.0478977    .0865326
      yr1980 |   .0379698   .0228282     1.66   0.096    -.0067727    .0827124
      yr1982 |  -.0206929   .0242533    -0.85   0.394    -.0682285    .0268427
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(L.n L.w L.k)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.47  Pr > z =  0.014
Arellano-Bond test for AR(2) in first differences: z =  -1.74  Pr > z =  0.081
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(20)   =  38.36  Prob > chi2 =  0.008
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(20)   =  22.98  Prob > chi2 =  0.290
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  iv(ys L.ys L2.ys yr1977 yr1978 yr1979 yr1980 yr1981 yr1982)
    Hansen test excluding group:     chi2(14)   =  14.84  Prob > chi2 =  0.389
    Difference (null H = exogenous): chi2(6)    =   8.14  Prob > chi2 =  0.228
```

(f) *Adicionalmente, Blundell y Bond (1998) eliminan de su modelo los rezagos más largos (de dos períodos) del empleo y el capital y prescinden del nivel de producto agregado sectorial. Considerando esta cuestión, computar el estimador de Blundell-Bond.*

SGMM One-Step (Blundell-Bond):

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       690
Time variable : year                            Number of groups   =       138
Number of instruments = 47                      Obs per group: min =         5
Wald chi2(9)  =  37427.45                                      avg =      5.00
Prob > chi2   =     0.000                                      max =         5
------------------------------------------------------------------------------
             |              Robust
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .9025721   .0412484    21.88   0.000     .8217267    .9834175
             |
           w |
         --. |  -.5397871   .1984403    -2.72   0.007     -.928723   -.1508513
         L1. |   .3047706   .1800251     1.69   0.090    -.0480722    .6576134
             |
           k |
         --. |   .4734141   .0900715     5.26   0.000     .2968772    .6499511
         L1. |  -.3942878    .086912    -4.54   0.000    -.5646322   -.2239433
             |
      yr1978 |   .0347845   .0217776     1.60   0.110    -.0078988    .0774678
      yr1979 |    .044848   .0173516     2.58   0.010     .0108395    .0788565
      yr1980 |   .0291248   .0171671     1.70   0.090     -.004522    .0627716
      yr1982 |   .0333513   .0144621     2.31   0.021     .0050062    .0616964
       _cons |   .8194633   .3304982     2.48   0.013     .1716988    1.467228
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(L.n L.w L.k)
Instruments for levels equation
  Standard
    yr1977 yr1978 yr1979 yr1980 yr1981 yr1982
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L.n L.w L.k)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.61  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.18  Pr > z =  0.238
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(37)   =  86.05  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(37)   =  52.82  Prob > chi2 =  0.044
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(25)   =  35.67  Prob > chi2 =  0.077
    Difference (null H = exogenous): chi2(12)   =  17.15  Prob > chi2 =  0.144
  iv(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982, eq(level))
    Hansen test excluding group:     chi2(33)   =  44.68  Prob > chi2 =  0.084
    Difference (null H = exogenous): chi2(4)    =   8.14  Prob > chi2 =  0.087
```

SGMM Two-Step (Blundell-Bond):

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       690
Time variable : year                            Number of groups   =       138
Number of instruments = 47                      Obs per group: min =         5
Wald chi2(9)  =  30749.14                                      avg =      5.00
Prob > chi2   =     0.000                                      max =         5
------------------------------------------------------------------------------
             |              Corrected
           n | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |    .892057   .0524149    17.02   0.000     .7893258    .9947883
             |
           w |
         --. |  -.4138471   .2405795    -1.72   0.085    -.8853744    .0576801
         L1. |     .23221   .1663529     1.40   0.163    -.0938358    .5582558
             |
           k |
         --. |   .4563271   .1222931     3.73   0.000     .2166371    .6960171
         L1. |  -.3582417   .1210988    -2.96   0.003     -.595591   -.1208924
             |
      yr1978 |   .0405244   .0265643     1.53   0.127    -.0115406    .0925895
      yr1979 |   .0513874   .0198615     2.59   0.010     .0124596    .0903151
      yr1980 |   .0296077   .0200915     1.47   0.141    -.0097708    .0689863
      yr1982 |   .0290802    .014089     2.06   0.039     .0014662    .0566942
       _cons |   .6712912   .3744471     1.79   0.073    -.0626117    1.405194
------------------------------------------------------------------------------
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/5).(L.n L.w L.k)
Instruments for levels equation
  Standard
    yr1977 yr1978 yr1979 yr1980 yr1981 yr1982
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(L.n L.w L.k)
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.46  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.27  Pr > z =  0.203
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(37)   =  86.05  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(37)   =  52.82  Prob > chi2 =  0.044
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(25)   =  35.67  Prob > chi2 =  0.077
    Difference (null H = exogenous): chi2(12)   =  17.15  Prob > chi2 =  0.144
  iv(yr1977 yr1978 yr1979 yr1980 yr1981 yr1982, eq(level))
    Hansen test excluding group:     chi2(33)   =  44.68  Prob > chi2 =  0.084
    Difference (null H = exogenous): chi2(4)    =   8.14  Prob > chi2 =  0.087
```

Ejercicio 3.

Cuando hay muchos instrumentos, surgen dos problemas principales:

- *Sobreestimación (overfitting) de la variable endógena.*
- *Mala estimación de la matriz de pesos W.*

En estos casos, se proponen las siguientes soluciones:

- *Probar diferentes especificaciones de IV recortando el número de rezagos en la matriz de instrumentos Z.*
- *Colapsar/combinar instrumentos. Se modifica la matriz de instrumentos para el individuo i:*

$$Z_i = \begin{bmatrix} y_{i1} & 0 & 0 & \cdots \\ y_{i1} & y_{i2} & 0 & \cdots \\ y_{i3} & y_{i2} & y_{i1} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}.$$

Si el modelo funciona, debería dar resultados similares con distintos instrumentos. Retomar el Ejercicio 2.e para ver una aplicación de esta cuestión. Estimar el modelo de empleo restringiendo el máximo rezago a 3 y 4 períodos. Por último, estimar el modelo colapsando instrumentos. Analizar si los resultados obtenidos son robustos.

Tabla comparativa:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GMM (OS) 2	GMM (TS) 2	GMM (OS) 3	GMM (TS) 3	GMM (OS) 4	GMM (TS) 4	GMM (OS) 5	GMM (TS) 5
nL1	0.833***	0.940***	0.949***	0.900***	0.847***	0.930***	1.108***	0.877*
	(0.122)	(0.189)	(0.182)	(0.226)	(0.121)	(0.174)	(0.387)	(0.455)
N	414	414	414	414	414	414	414	414

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Ejercicio 4.

Considerar, nuevamente, el modelo del primer ejercicio. Obtener el estimador LSDVC propuesto por Kiviet (1995) a partir del comando xtlsdvc. Luego, estimar la matriz de varianzas y covarianzas de los coeficientes de Kiviet siguiendo el procedimiento explicado en clase.

LSDVC (Kiviet):

```
LSDVC dynamic regression
(SE not computed)
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .9890308          .        .       .            .           .
------------------------------------------------------------------------------
```

LSDVC (Kiviet):

```
LSDVC dynamic regression
(SE not computed)
------------------------------------------------------------------------------
           n | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .7863675          .        .       .            .           .
             |
      yr1978 |   .1430045          .        .       .            .           .
      yr1979 |   .1365801          .        .       .            .           .
      yr1980 |   .0957011          .        .       .            .           .
      yr1981 |   .0105706          .        .       .            .           .
------------------------------------------------------------------------------
```