2021 中级计量经济学作业 3 参考答案

1. (渐进一致的权重矩阵 $\widehat{\mathbf{W}}_{\mathbf{1}}$ 和 $\widehat{\mathbf{W}}_{\mathbf{2}}$) 假设 $\widehat{\mathbf{W}}_{\mathbf{1}} - \widehat{\mathbf{W}}_{\mathbf{2}} \xrightarrow{p} \mathbf{0}$. 证明 GMM 估计量

$$\sqrt{n}\hat{\boldsymbol{\beta}}(\widehat{\mathbf{W}}_1) - \sqrt{n}\hat{\boldsymbol{\beta}}(\widehat{\mathbf{W}}_2) \xrightarrow{p} \mathbf{0}$$

解:

$$\sqrt{n}\hat{\boldsymbol{\beta}}(\widehat{\mathbf{W}}_1) - \sqrt{n}\hat{\boldsymbol{\beta}}(\widehat{\mathbf{W}}_2) = \left[(\mathbf{S}'_{\mathbf{XZ}}\widehat{\mathbf{W}}_1\mathbf{S}_{\mathbf{XZ}})^{-1}\mathbf{S}'_{\mathbf{XZ}}\widehat{\mathbf{W}}_1 - (\mathbf{S}'_{\mathbf{XZ}}\widehat{\mathbf{W}}_2\mathbf{S}_{\mathbf{XZ}})^{-1}\mathbf{S}'_{\mathbf{XZ}}\widehat{\mathbf{W}}_2\right]\sqrt{n}\bar{\mathbf{g}} \tag{1}$$

其中，中括号部分依概率收敛于 0，$\sqrt{n}\bar{\mathbf{g}}$ 依分布收敛于正态分布，因此上式依概率收敛于 0.

2. 下列说法是否正确？为什么？

> 即使在过度识别时, 也可用如下方法找到方程 $\mathbf{g}_n(\hat{\boldsymbol{\beta}}) \equiv \frac{1}{n}\sum_{i=1}^n \mathbf{z}_i(y_i - \mathbf{x}'_i\hat{\boldsymbol{\beta}}) = \mathbf{0}$ 的解. 等式可写为
>
> $$\mathbf{S}_{ZX}\hat{\boldsymbol{\beta}} = \mathbf{S}_{Zy}, \tag{2}$$
>
> 其中 $\mathbf{S}_{ZX} = \frac{1}{n}\mathbf{z}_i\mathbf{x}'_i$, $\mathbf{S}_{Zy} = \frac{1}{n}\sum_{i=1}^n \mathbf{z}_i y_i$. 等式两边都乘以 $\mathbf{S}'_{XZ}$ 得到
>
> $$\mathbf{S}'_{ZX}\mathbf{S}_{ZX}\hat{\boldsymbol{\beta}} = \mathbf{S}'_{ZX}\mathbf{S}_{Zy}, \tag{3}$$
>
> 因为 $\mathbf{S}_{ZX}$ 满秩, $\mathbf{S}'_{ZX}\mathbf{S}_{ZX}$ 可逆, 因此得到
>
> $$\hat{\boldsymbol{\beta}} = (\mathbf{S}'_{ZX}\mathbf{S}_{ZX})^{-1}\mathbf{S}'_{ZX}\mathbf{S}_{Zy} \tag{4}$$

解: 有误。虽然 $\hat{\boldsymbol{\beta}} = (\mathbf{S}'_{ZX}\mathbf{S}_{ZX})^{-1}\mathbf{S}'_{ZX}\mathbf{S}_{Zy}$ 是(3)式的解，但 $\hat{\boldsymbol{\beta}}$ 并不是(2)式的解。

3. 课本 271 页习题 15.3

   1. 混合回归。

```
reg lwage exp exp2 wks ed, vce(cluster id)
```

```
. reg lwage exp exp2 wks ed, vce(cluster id)

Linear regression                               Number of obs     =      4,165
                                                F(4, 594)         =      72.58
                                                Prob > F          =     0.0000
                                                R-squared         =     0.2836
                                                Root MSE          =     .39082

                                   (Std. Err. adjusted for 595 clusters in id)
```

lwage	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
exp	.044675	.0054385	8.21	0.000	.0339941	.055356
exp2	-.0007156	.0001285	-5.57	0.000	-.0009679	-.0004633
wks	.005827	.0019284	3.02	0.003	.0020396	.0096144
ed	.0760407	.0052122	14.59	0.000	.0658042	.0862772
_cons	4.907961	.1399887	35.06	0.000	4.633028	5.182894

2. 随机效应模型的 FGLS 估计以及检验

```
xtreg lwage exp exp2 wks ed, re r
xttest0
```

```
. xtreg lwage exp exp2 wks ed, re r

Random-effects GLS regression                   Number of obs     =      4,165
Group variable: id                              Number of groups  =        595

R-sq:                                           Obs per group:
     within  = 0.6340                                         min =          7
     between = 0.1716                                         avg =        7.0
     overall = 0.1830                                         max =          7

                                                Wald chi2(4)      =    1598.50
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

                                   (Std. Err. adjusted for 595 clusters in id)
```

lwage	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
exp	.0888609	.0039992	22.22	0.000	.0810227	.0966992
exp2	-.0007726	.0000896	-8.62	0.000	-.0009481	-.000597
wks	.0009658	.0009259	1.04	0.297	-.000849	.0027806
ed	.1117099	.0083954	13.31	0.000	.0952552	.1281647
_cons	3.829366	.1333931	28.71	0.000	3.567921	4.090812
sigma_u	.31951859					
sigma_e	.15220316					
rho	.81505521	(fraction of variance due to u_i)				

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        lwage[id,t] = Xb + u[id] + e[id,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   lwage |   .2129935       .4615122
                       e |   .0231658       .1522032
                       u |   .1020921       .3195186

        Test:   Var(u) = 0
                             chibar2(01) =  5192.13
                          Prob > chibar2 =   0.0000
```

拒绝“不存在个体随机效应”的原假设。因此在 pooled OLS 和 RE 之间，应选择 RE。

3. 随机效应模型的 MLE 估计

```
xtreg lwage exp exp2 wks ed, mle
```

lwage	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
exp	.1079955	.0024806	43.54	0.000	.1031335	.1128574
exp2	-.0005202	.0000546	-9.53	0.000	-.0006272	-.0004132
wks	.0008365	.0006042	1.38	0.166	-.0003477	.0020208
ed	.1378558	.0125933	10.95	0.000	.1131735	.1625382
_cons	2.989859	.1720638	17.38	0.000	2.65262	3.327097
/sigma_u	.8509013	.0278622			.7980078	.9073006
/sigma_e	.1536109	.0018574			.1500132	.1572949
rho	.9684385	.002199			.9638788	.9725117

LR test of sigma_u=0: chibar2(01) = 4576.13   Prob >= chibar2 = 0.000

exp 参数估计的比上面的 FGLS 结果更大。其他的检验结果差不多。

4. 固定效应模型组内估计量。在 stata 中可看到个体虚拟变量大多数显著异于 0(未截图)，因此可以认为个体效应存在。

```
xtreg lwage exp exp2 wks ed, fe vce(cluster id)
```

```
Fixed-effects (within) regression               Number of obs     =      4,165
Group variable: id                              Number of groups  =        595

R-sq:                                           Obs per group:
     within  = 0.6566                                         min =          7
     between = 0.0276                                         avg =        7.0
     overall = 0.0476                                         max =          7

                                                F(3,594)          =    1059.72
corr(u_i, Xb)  = -0.9107                        Prob > F          =     0.0000

                                 (Std. Err. adjusted for 595 clusters in id)
------------------------------------------------------------------------------
             |               Robust
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         exp |   .1137879   .0040289    28.24   0.000     .1058753    .1217004
        exp2 |  -.0004244   .0000822    -5.16   0.000    -.0005858   -.0002629
         wks |   .0008359   .0008697     0.96   0.337    -.0008721    .0025439
          ed |          0  (omitted)
       _cons |   4.596396   .0600887    76.49   0.000     4.478384    4.714408
-------------+----------------------------------------------------------------
     sigma_u |  1.0362039
     sigma_e |  .15220316
         rho |  .97888036   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

5. LSDV

```
reg lwage exp exp2 wks ed i.id, vce(cluster id)
```

```
. reg lwage exp exp2 wks ed i.id, vce(cluster id)
note: 595.id omitted because of collinearity

Linear regression                               Number of obs     =      4,165
                                                F(2, 594)         =          .
                                                Prob > F          =          .
                                                R-squared         =     0.9068
                                                Root MSE          =      .1522

                                 (Std. Err. adjusted for 595 clusters in id)
------------------------------------------------------------------------------
             |               Robust
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         exp |   .1137879   .0043514    26.15   0.000     .1052418    .1223339
        exp2 |  -.0004244   .0000888    -4.78   0.000    -.0005988     -.00025
         wks |   .0008359   .0009393     0.89   0.374    -.0010089    .0026806
          ed |   .1022134   .0046744    21.87   0.000      .093033    .1113938
```

个体的虚拟变量大多数都是显著异于 0 的，因此可以认为存在个体效应。另外可以发现 LSDV 和 FE 的估计参数是一样的。标准差不一样是因为 FE 和 LSDV 估

计的夹心估计量的表达式中的数据矩阵 $\mathbf{X}$ 不一样，从而最终的对角线上的元素 (参数估计的方差) 不一样。一般在短面板中，个体的固定效应选择 FE。

6. 带时间效应的固定效应模型

```
xtreg lwage exp exp2 wks ed i.t, fe r
```

```
Fixed-effects (within) regression               Number of obs     =      4,165
Group variable: id                              Number of groups  =        595

R-sq:                                           Obs per group:
     within  = 0.6599                                         min =          7
     between = 0.0275                                         avg =        7.0
     overall = 0.0480                                         max =          7

                                                F(8,594)          =     412.33
corr(u_i, Xb)  = -0.9089                        Prob > F          =     0.0000

                                  (Std. Err. adjusted for 595 clusters in id)
```

lwage	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
exp	.1119927	.0041184	27.19	0.000	.1039043	.1200812
exp2	-.0004051	.0000834	-4.86	0.000	-.0005688	-.0002413
wks	.00068	.0008812	0.77	0.441	-.0010506	.0024105
ed	0	(omitted)				
t						
2	-.0083984	.0049321	-1.70	0.089	-.0180849	.0012881
3	.0259652	.0084359	3.08	0.002	.0093974	.0425329
4	.0289134	.0078093	3.70	0.000	.0135762	.0442506
5	.0239406	.0065275	3.67	0.000	.0111208	.0367604
6	.0069955	.0064617	1.08	0.279	-.0056949	.019686
7	0	(omitted)				
_cons	4.618339	.0599451	77.04	0.000	4.500609	4.736069
sigma_u	1.0268811					
sigma_e	.15159041					
rho	.97867247	(fraction of variance due to u_i)				

7. 一阶差分估计量。也可以用课本中提到的`xtserial`

```
reg d.(lwage exp exp2 wks ed), noconst vce(cluster id)
```

```
. reg d.(lwage exp exp2 wks ed), noconst vce(cluster id)
note: D.ed omitted because of collinearity

Linear regression                               Number of obs     =      3,570
                                                F(3, 594)         =    1035.19
                                                Prob > F          =     0.0000
                                                R-squared         =     0.2209
                                                Root MSE          =     .18156

                                  (Std. Err. adjusted for 595 clusters in id)
------------------------------------------------------------------------------
             |               Robust
     D.lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         exp |
         D1. |   .1170654   .0040974    28.57   0.000     .1090182    .1251126
             |
        exp2 |
         D1. |  -.0005321   .0000808    -6.58   0.000    -.0006908   -.0003734
             |
         wks |
         D1. |  -.0002683   .0011783    -0.23   0.820    -.0025824    .0020459
             |
          ed |
         D1. |          0  (omitted)
------------------------------------------------------------------------------
```

8. 组间估计量

```
xtreg lwage exp exp2 wks ed, be
```

```
. xtreg lwage exp exp2 wks ed, be

Between regression (regression on group means)  Number of obs      =      4,165
Group variable: id                               Number of groups   =        595

R-sq:                                            Obs per group:
     within  = 0.1357                                          min =          7
     between = 0.3264                                          avg =        7.0
     overall = 0.2723                                          max =          7

                                                 F(4,590)           =      71.48
sd(u_i + avg(e_i.))=   .324656                   Prob > F           =     0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         exp |    .038153   .0056967     6.70   0.000     .0269647    .0493412
        exp2 |  -.0006313   .0001257    -5.02   0.000    -.0008781   -.0003844
         wks |   .0130903   .0040659     3.22   0.001     .0051048    .0210757
          ed |   .0737838   .0048985    15.06   0.000     .0641632    .0834044
       _cons |   4.683039   .2100989    22.29   0.000     4.270407    5.095672
------------------------------------------------------------------------------
```

9. Hausman 检验。检验结果：拒绝 u_i 和 $\mathbf{x}_{it}$，$\mathbf{z}_i$ 不相关。应当选择固定效应模型。

```
xtreg lwage exp exp2 wks ed, fe
estimates store FE
xtreg lwage exp exp2 wks ed, re
estimates store RE
hausman FE RE, constant sigmamore
```

```
. hausman FE RE, constant sigmamore

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      FE           RE          Difference          S.E.
-------------+----------------------------------------------------------------
         exp |    .1137879     .0888609        .0249269        .0012778
        exp2 |   -.0004244    -.0007726        .0003482        .0000285
         wks |    .0008359     .0009658       -.0001299        .0001108
       _cons |    4.596396     3.829366        .7670299               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =     1374.55
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

10. 稳健 Hausman 检验

```
xtreg lwage exp exp2 wks ed, re r
xtoverid
```

```
. xtoverid

Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re  robust cluster(id)
Sargan-Hansen statistic 1792.412  Chi-sq(3)    P-value = 0.0000
```

4. 考察 Stata 的 abdata 数据 (在 Stata 中输入 webuse abdata 即可获得数据)。数据中 n 为企业雇员数，w 是企业工资水平，k 为公司总资本，ys 为公司所在行业的总产出。所有变量均取了 log。变量名称后缀 L1, L2 表示滞后 1 阶，2 阶。以 n 为因变量，$nL1$, $nL2$, w, $wL1$, k, $kL1$, $kL2$, ys, $ysL1$, $ysL2$, 以及时间虚拟变量 $yr1976, \ldots, yr1984$ 为自变量，做如下回归并比较和讨论结果：

    1. OLS 回归。注意 nL1 的系数估计大于 1，从理论上来讲，滞后项系数应当小于 1，否则 n 会越来越大，不符合常识。由于未考虑到 fixed effect，n 和 nL1 之间的相关性被放大了。也就是说，nL1 的系数估计偏大。

    ```
    reg n nL1 nL2 w wL1 k kL1 kL2 ys ysL1 ysL2 yr*
    ```

Source	SS	df	MS			
Model	1343.31797	16	83.9573732	Number of obs	=	751
Residual	7.57378164	734	.010318504	F(16, 734)	=	8136.58
				Prob > F	=	0.0000
Total	1350.89175	750	1.801189	R-squared	=	0.9944
				Adj R-squared	=	0.9943
				Root MSE	=	.10158

n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
nL1	1.044643	.0336647	31.03	0.000	.9785523	1.110734
nL2	-.0765426	.0328437	-2.33	0.020	-.1410214	-.0120639
w	-.5236727	.0487799	-10.74	0.000	-.6194374	-.427908
wL1	.4767538	.0486954	9.79	0.000	.381155	.5723527
k	.3433951	.0255185	13.46	0.000	.2932972	.3934931
kL1	-.2018991	.0400683	-5.04	0.000	-.2805613	-.123237
kL2	-.1156467	.0284922	-4.06	0.000	-.1715826	-.0597107
ys	.4328752	.1226806	3.53	0.000	.1920285	.673722
ysL1	-.7679125	.1658165	-4.63	0.000	-1.093444	-.4423813
ysL2	.3124721	.111457	2.80	0.005	.0936596	.5312846
yr1976	0	(omitted)				
yr1977	0	(omitted)				
yr1978	-.0153956	.0230101	-0.67	0.504	-.060569	.0297779
yr1979	.0004932	.0219057	0.02	0.982	-.0425121	.0434986
yr1980	.0065977	.0222523	0.30	0.767	-.0370881	.0502835
yr1981	-.0375487	.0231813	-1.62	0.106	-.0830582	.0079608
yr1982	-.0304299	.0218943	-1.39	0.165	-.0734128	.0125529
yr1983	-.0080024	.0214113	-0.37	0.709	-.0500371	.0340323
yr1984	0	(omitted)				
_cons	.2901212	.3418808	0.85	0.396	-.3810596	.9613019

2. 固定效应回归。固定效应把 u_i 去掉了，但此时 $y_{i,t-1} - \overline{Ly_i}$ 会和 $\varepsilon_{it} - \bar{\varepsilon}_i$ 相关。nL1 的系数此时小于 1。侧面印证之前 OLS 的估计过大。

```
xtreg n nL1 nL2 w wL1 k kL1 kL2 ys ysL1 ysL2 yr*, fe
```

```
Fixed-effects (within) regression               Number of obs     =        751
Group variable: id                              Number of groups  =        140

R-sq:                                           Obs per group:
     within  = 0.7973                                         min =          5
     between = 0.9809                                         avg =        5.4
     overall = 0.9758                                         max =          7

                                                F(16,595)         =     146.27
corr(u_i, Xb)  = 0.5459                         Prob > F          =     0.0000

------------------------------------------------------------------------------
           n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         nL1 |   .7329476    .039304    18.65   0.000     .6557563     .810139
         nL2 |  -.1394773    .040026    -3.48   0.001    -.2180867   -.0608678
           w |  -.5597445    .057033    -9.81   0.000    -.6717551   -.4477339
         wL1 |   .3149987   .0609756     5.17   0.000     .1952451    .4347522
           k |   .3884188   .0309544    12.55   0.000     .3276256    .4492119
         kL1 |  -.0805185   .0384648    -2.09   0.037    -.1560618   -.0049751
         kL2 |  -.0278013   .0328257    -0.85   0.397    -.0922695     .036667
          ys |    .468666   .1231278     3.81   0.000     .2268481    .7104839
        ysL1 |  -.6285587     .15796    -3.98   0.000    -.9387856   -.3183318
        ysL2 |   .0579764   .1345353     0.43   0.667    -.2062454    .3221982
      yr1976 |          0  (omitted)
      yr1977 |          0  (omitted)
      yr1978 |   .0119152   .0261724     0.46   0.649    -.0394862    .0633167
      yr1979 |   .0165714    .024721     0.67   0.503    -.0319795    .0651224
      yr1980 |   .0231479   .0249969     0.93   0.355    -.0259449    .0722408
      yr1981 |   -.013454   .0260231    -0.52   0.605    -.0645623    .0376542
      yr1982 |  -.0224821   .0229812    -0.98   0.328    -.0676163    .0226521
      yr1983 |  -.0161192   .0209498    -0.77   0.442    -.0572636    .0250253
      yr1984 |          0  (omitted)
       _cons |   1.780205   .5014522     3.55   0.000     .7953734    2.765036
-------------+----------------------------------------------------------------
     sigma_u |  .22568151
     sigma_e |  .09395847
         rho |  .85227336   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(139, 595) = 1.89                    Prob > F = 0.0000
```

3. Anderson-Hsiao 两阶段最小二乘法回归。AH 回归的结果理论上来说是 consistent，但滞后项的系数变为 2.3，远大于 1。结果仍然是很奇怪的。由此可以看出，模型设定是否和真实数据情况一样，是一个很难判断的问题。

```
ivregress 2sls d.n (d.nL1=nL2) d.(nL2 w wL1 k kL1 kL2 ys ///
  ysL1 ysL2 yr1979 yr1980 yr1981 yr1982 yr1983)
```

```
Instrumental variables (2SLS) regression          Number of obs   =        611
                                                   Wald chi2(15)   =      89.93
                                                   Prob > chi2     =     0.0000
                                                   R-squared       =          .
                                                   Root MSE        =       .247
```

D.n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
nL1						
D1.	2.307626	1.973193	1.17	0.242	-1.559762	6.175013
nL2						
D1.	-.2240271	.179043	-1.25	0.211	-.5749448	.1268907
w						
D1.	-.8103626	.261805	-3.10	0.002	-1.323491	-.2972342
wL1						
D1.	1.422246	1.179492	1.21	0.228	-.8895156	3.734007
k						
D1.	.2530975	.1447404	1.75	0.080	-.0305884	.5367835
kL1						
D1.	-.5524613	.6154929	-0.90	0.369	-1.758805	.6538825
kL2						
D1.	-.2126364	.2397909	-0.89	0.375	-.6826179	.2573451
ys						
D1.	.9905803	.4630105	2.14	0.032	.0830965	1.898064
ysL1						
D1.	-1.937912	1.438225	-1.35	0.178	-4.75678	.8809566
ysL2						
D1.	.4870838	.5099415	0.96	0.339	-.5123832	1.486551
yr1979						
D1.	.0467148	.0448599	1.04	0.298	-.0412089	.1346385
yr1980						
D1.	.0761344	.0624919	1.22	0.223	-.0463474	.1986163
yr1981						
D1.	.022623	.0557394	0.41	0.685	-.0866242	.1318701
yr1982						
D1.	.0127801	.0548402	0.23	0.816	-.0947048	.120265
yr1983						
D1.	.0099072	.0456113	0.22	0.828	-.0794894	.0993037
_cons	.0159337	.0273445	0.58	0.560	-.0376605	.0695279

4. 差分 GMM 回归。n 的滞后项为 GMM 形式工具变量，其他的工具（外生）变量为常规工具变量形式。注意 nL1 的系数估计较为合理。

```
xtabond2 n L.n L2.n w L.w L(0/2).(k ys) yr*, gmm(L.n) ///
  iv(w L.w L(0/2).(k ys) yr*) nolevel robust
```

```
Dynamic panel-data estimation, one-step difference GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       611
Time variable : year                            Number of groups   =       140
Number of instruments = 41                      Obs per group: min =         4
Wald chi2(19) =   1727.45                                      avg =      4.36
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |               Robust
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .6862261   .1445943     4.75   0.000     .4028266    .9696257
         L2. |  -.0853582   .0560155    -1.52   0.128    -.1951467    .0244302
             |
           w |
         --. |  -.6078208   .1782055    -3.41   0.001    -.9570972   -.2585445
         L1. |   .3926237   .1679931     2.34   0.019     .0633632    .7218842
             |
           k |
         --. |   .3568456   .0590203     6.05   0.000      .241168    .4725233
         L1. |  -.0580012   .0731797    -0.79   0.428    -.2014308    .0854284
         L2. |  -.0199475   .0327126    -0.61   0.542    -.0840631    .0441681
             |
          ys |
         --. |   .6085073   .1725313     3.53   0.000     .2703522    .9466624
         L1. |  -.7111651   .2317163    -3.07   0.002    -1.165321   -.2570095
         L2. |   .1057969   .1412021     0.75   0.454    -.1709542     .382548
             |
      yr1976 |          0  (omitted)
      yr1977 |          0  (omitted)
      yr1978 |          0  (omitted)
      yr1979 |   .0095545   .0102896     0.93   0.353    -.0106127    .0297217
      yr1980 |   .0220152   .0177104     1.24   0.214    -.0126966     .056727
      yr1981 |  -.0117743   .0295079    -0.40   0.690    -.0696086      .04606
      yr1982 |  -.0270588   .0292751    -0.92   0.355    -.0844369    .0303193
      yr1983 |  -.0213204   .0304599    -0.70   0.484    -.0810207    .0383798
      yr1984 |  -.0077033   .0314106    -0.25   0.806     -.069267    .0538604
------------------------------------------------------------------------------
```

需要注意扰动项是否存在 2 阶自相关。这里的结果认为不存在 2 阶自相关。符合差分 GMM 的假定。

```
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.60  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.52  Pr > z =  0.606
------------------------------------------------------------------------------
```

过度识别检验。Hansen test 认为可以在 5% 水平下接受所有工具变量外生。

```
Sargan test of overid. restrictions: chi2(22)    =  67.59  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(22)    =  31.38  Prob > chi2 =  0.089
  (Robust, but weakened by many instruments.)
```

5. 系统 GMM 回归。此时 nL1 系数符号又大于 1 了。

```
xtabond2 n L.n L2.n w L.w L(0/2).(k ys) yr*, gmm(L.n) ///
  iv(w L.w L(0/2).(k ys) yr*) robust twostep
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       751
Time variable : year                            Number of groups   =       140
Number of instruments = 49                      Obs per group: min =         5
Wald chi2(19) =  75477.28                                      avg =      5.36
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------
             |              Corrected
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   1.057271   .0572935    18.45   0.000     .9449778    1.169564
         L2. |   -.098028   .0368302    -2.66   0.008    -.1702138   -.0258421
             |
           w |
         --. |   -.537141   .1667007    -3.22   0.001    -.8638684   -.2104137
         L1. |   .5011521   .1765282     2.84   0.005     .1551631     .847141
             |
           k |
         --. |   .2996729   .0601121     4.99   0.000     .1818554    .4174904
         L1. |  -.1453414   .0788808    -1.84   0.065    -.2999449    .0092621
         L2. |  -.1194829   .0424068    -2.82   0.005    -.2025988   -.0363671
             |
          ys |
         --. |   .5180324   .1996673     2.59   0.009     .1266916    .9093731
         L1. |  -.7292613    .246855    -2.95   0.003    -1.213088   -.2454344
         L2. |    .255183   .1481775     1.72   0.085    -.0352395    .5456055
             |
      yr1976 |          0  (omitted)
      yr1977 |          0  (omitted)
      yr1978 |     .01419   .0312493     0.45   0.650    -.0470575    .0754374
      yr1979 |   .0290609   .0273843     1.06   0.289    -.0246113    .0827332
      yr1980 |   .0421484   .0197262     2.14   0.033     .0034857     .080811
      yr1981 |          0  (omitted)
      yr1982 |   .0075506   .0178061     0.42   0.672    -.0273487    .0424499
      yr1983 |   .0452061   .0240706     1.88   0.060    -.0019714    .0923835
      yr1984 |   .0275589   .0279575     0.99   0.324    -.0272369    .0823547
       _cons |  -.0701535   .3408083    -0.21   0.837    -.7381255    .5978186
------------------------------------------------------------------------------
```

6. 讨论：滞后项的系数估计可以提供估计是否合理的证据。如果模型是稳定的，那么滞后项的系数估计一般应当小于 1。另外，在这组数据中，工资 w 对 n 的影响是负的，尽管在不同的模型中估计的参数不一样。k，资本的影响是正的。动态面板估计的工具变量可以调整的空间很大，不同的工具变量设置有时会带来很不一样的估计结果。有兴趣的同学可以自行设置不同的工具变量，不同的滞后阶数来观察结果的异同。