Assignment 2
Simultaneous Equations Model

Imported-fruit Market

$$\ln S_t = \beta_{10} + \beta_{11} \ln P_{Dt} + \beta_{12} \ln P_{X2t} + \beta_{13} \ln P_{X3t} + \beta_{14} \ln P_{X4t} + \varepsilon_{1t} \quad (1)$$

$$\ln D_t = \beta_{20} + \beta_{21} \ln P_{Dt} + \beta_{22} \ln GNP_t + \varepsilon_{2t} \quad (2)$$

where: S_t = Domestic supply of Imported-fruit at time t

D_t = Domestic demand for Imported-fruit at time t

P_{Dt} = Domestic Price at time $t = P_{Mt} + T_t$

P_{Mt} = Import Price at time t

T_t = Tariff at time t

P_{X2t} = Price of Input 2 at time t

P_{X3t} = Price of Input 3 at time t

P_{X4t} = Price of Input 4 at time t

GNP_t = Gross National Product at time t

Endogenous variables in this system include S_t, D_t, and P_{Dt}
Exogenous variables in this system include P_{X2t}, P_{X3t}, P_{X4t}, and GNP_t

1. State reduce form model of these system models.
2. Estimate reduce form model using OLS and prediction of the endogenous variables.
3. Estimate structural form using predicted endogenous variables as independent variables in the structural form model.
4. Estimate the structural models of these system equations using OLS, 2SLS, 3SLS, and I3SLS. Concerning on the asymptotic property, which model is the most appropriated model? Why?
5. What does β21 mean?

1. State reduce form model of these system models.

$$\ln S_t = \pi_{10} + \pi_{11} \ln P_{X2t} + \pi_{12} \ln P_{X3t} + \pi_{13} \ln P_{X4t} + \pi_{14} \ln GNP_t + w_{1t}$$
$$\ln D_t = \pi_{20} + \pi_{21} \ln P_{X2t} + \pi_{22} \ln P_{X3t} + \pi_{23} \ln P_{X4t} + \pi_{24} \ln GNP_t + w_{2t}$$

2. Estimate reduce form model using OLS and prediction of the endogenous variables.

```
. tsset obs
       time variable:  obs, 1976 to 1996
               delta:  1 unit

. g lnst=ln(st)

. g lndt=ln(dt)

. g lnpd=ln(pd)

. g lnpx2=ln(px2)

. g lnpx3=ln(px3)

. g lnpx4=ln(px4)

. g lngnp=ln(gnp)

. reg lnst lnpx2 lnpx3 lnpx4 lngnp

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  4,    16) =   33.58
       Model |  4.37193167     4  1.09298292           Prob > F      =  0.0000
    Residual |  .520715895    16  .032544743           R-squared     =  0.8936
-------------+------------------------------           Adj R-squared =  0.8670
       Total |  4.89264757    20  .244632378           Root MSE      =   .1804

------------------------------------------------------------------------------
        lnst |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnpx2 |  -.4617077   .1566169    -2.95   0.009    -.7937207   -.1296946
       lnpx3 |  -.3563077   .4363607    -0.82   0.426    -1.281351    .5687357
       lnpx4 |  -.8948088    .290448    -3.08   0.007    -1.510531   -.2790865
       lngnp |   .3849467   .2117247     1.82   0.088    -.0638896    .8337831
       _cons |   23.81019   5.680262     4.19   0.001     11.76857     35.8518
------------------------------------------------------------------------------

. predict lnsthat, xb

. reg lndt lnpx2 lnpx3 lnpx4 lngnp

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  4,    16) =   23.05
       Model |   3.1536608     4  .788415201           Prob > F      =  0.0000
    Residual |   .54720881    16  .034200551           R-squared     =  0.8521
-------------+------------------------------           Adj R-squared =  0.8152
       Total |  3.70086961    20  .185043481           Root MSE      =  .18493

------------------------------------------------------------------------------
        lndt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnpx2 |  -.4883637   .1605517    -3.04   0.008     -.828718   -.1480093
       lnpx3 |  -.5789762   .4473236    -1.29   0.214     -1.52726    .3693075
       lnpx4 |  -.7252805   .2977451    -2.44   0.027    -1.356472   -.0940892
       lngnp |   .1252344    .217044     0.58   0.572    -.3348782    .5853471
       _cons |   27.21401   5.822969     4.67   0.000     14.86987    39.55815
------------------------------------------------------------------------------

. predict lndthat, xb

. reg lnpd lnpx2 lnpx3 lnpx4 lngnp

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  4,    16) =    7.73
       Model |  .252525093     4  .063131273           Prob > F      =  0.0011
    Residual |   .13071492    16  .008169683           R-squared     =  0.6589
-------------+------------------------------           Adj R-squared =  0.5737
       Total |  .383240013    20  .019162001           Root MSE      =  .09039

------------------------------------------------------------------------------
        lnpd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnpx2 |   .1444236   .0784695     1.84   0.084    -.0219243    .3107715
       lnpx3 |   .5507384    .218629     2.52   0.023     .0872655    1.014211
```

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       lnpx4 |    .079881   .1455227     0.55   0.591    -.2286133    .3883752
       lngnp |   .1294158   .1060801     1.22   0.240    -.0954638    .3542955
       _cons |   2.647434   2.845971     0.93   0.366    -3.385756    8.680623
------------------------------------------------------------------------------

. predict lnpdhat, xb
```

3. Estimate structural form using predicted endogenous variables as independent variables in the structural form model.

```
. reg lnst lnpdhat lnpx2 lnpx3 lnpx4

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  4,    16) =   33.58
       Model |  4.37193233     4  1.09298308           Prob > F      =  0.0000
    Residual |  .520715239    16  .032544702           R-squared     =  0.8936
-------------+------------------------------           Adj R-squared =  0.8670
       Total |  4.89264757    20  .244632378           Root MSE      =   .1804

------------------------------------------------------------------------------
        lnst |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lnpdhat |   2.974495   1.635997     1.82   0.088    -.4936645    6.442654
       lnpx2 |  -.8912952   .2562483    -3.48   0.003    -1.434517    -.348073
       lnpx3 |  -1.994472   .7318965    -2.73   0.015    -3.546023   -.4429207
       lnpx4 |  -1.132416   .2908942    -3.89   0.001    -1.749084   -.5157482
       _cons |   15.93539   9.859363     1.62   0.126    -4.965527    36.83631
------------------------------------------------------------------------------

. reg lndt lnpdhat lngnp

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  2,    18) =   38.01
       Model |  2.99229085     2  1.49614542           Prob > F      =  0.0000
    Residual |  .708578763    18  .039365487           R-squared     =  0.8085
-------------+------------------------------           Adj R-squared =  0.7873
       Total |  3.70086961    20  .185043481           Root MSE      =  .19841

------------------------------------------------------------------------------
        lndt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lnpdhat |  -2.340874   .5551117    -4.22   0.001    -3.507121   -1.174628
       lngnp |   .4195737   .1703314     2.46   0.024     .0617207    .7774266
       _cons |   34.27134    7.40287     4.63   0.000     18.71849    49.82419
------------------------------------------------------------------------------
```

4. Estimate the structural models of these system equations using OLS, 2SLS, 3SLS, and I3SLS. Concerning on the asymptotic property, which model is the most appropriated model? Why?

```
. reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngnp), ols inst(lnpx2 lnpx3 lnpx4 lngnp)

Multivariate regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"     F-Stat        P
----------------------------------------------------------------------
lnst               21      4    .1593477    0.9170      44.17   0.0000
lndt               21      2    .1424217    0.9013      82.23   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnst         |
        lnpd |  -1.246607    .421569    -2.96   0.006    -2.103338   -.3898756
       lnpx2 |  -.3618883   .1455299    -2.49   0.018    -.6576406    -.066136
       lnpx3 |  -.3377604   .3516223    -0.96   0.344    -1.052343    .3768221
       lnpx4 |  -.9612613   .2507584    -3.83   0.001    -1.470864   -.4516589
       _cons |   40.86618   3.032619    13.48   0.000     34.70316    47.02921
-------------+----------------------------------------------------------------
lndt         |
        lnpd |  -2.009299   .2801412    -7.17   0.000    -2.578614   -1.439983
       lngnp |   .4910902   .1058948     4.64   0.000     .2758859    .7062944
       _cons |    29.9116   3.788838     7.89   0.000     22.21176    37.61145
------------------------------------------------------------------------------

. reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngnp), 2sls inst(lnpx2 lnpx3 lnpx4 lngnp)

Two-stage least-squares regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"     F-Stat        P
----------------------------------------------------------------------
lnst               21      4    .4295316    0.3967       5.92   0.0010
```

```
lndt              21      2    .1478601    0.8937      68.43   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnst         |
        lnpd |   2.974495   3.895282     0.76   0.450    -4.941671    10.89066
       lnpx2 |   -.891295   .6101221    -1.46   0.153    -2.131212    .3486222
       lnpx3 |  -1.994476   1.742637    -1.14   0.260    -5.535941    1.546988
       lnpx4 |  -1.132414   .6926115    -1.63   0.111     -2.53997    .2751416
       _cons |   15.93541   23.47495     0.68   0.502    -31.77143    63.64225
-------------+----------------------------------------------------------------
lndt         |
        lnpd |  -2.340873   .4136886    -5.66   0.000     -3.18159   -1.500157
       lngnp |    .419573    .126937     3.31   0.002     .1616059      .67754
       _cons |   34.27133   5.516878     6.21   0.000     23.05969    45.48298
------------------------------------------------------------------------------
Endogenous variables:  lnst lnpd lndt
Exogenous variables:   lnpx2 lnpx3 lnpx4 lngnp
------------------------------------------------------------------------------

. reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngnp), 3sls inst(lnpx2 lnpx3 lnpx4 lngnp)

Three-stage least-squares regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
lnst               21      4    .3815188    0.3752      33.39   0.0000
lndt               21      2    .1368919    0.8937     159.68   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnst         |
        lnpd |   3.013987   3.395886     0.89   0.375    -3.641827      9.6698
       lnpx2 |  -.9862334   .5256922    -1.88   0.061    -2.016571    .0441045
       lnpx3 |  -1.594514   1.514324    -1.05   0.292    -4.562534    1.373506
       lnpx4 |  -1.455187   .5917524    -2.46   0.014       -2.615   -.2953733
       _cons |   15.32021   20.45472     0.75   0.454     -24.7703    55.41072
-------------+----------------------------------------------------------------
lndt         |
        lnpd |  -2.340873   .3830012    -6.11   0.000    -3.091542   -1.590205
       lngnp |    .419573   .1175208     3.57   0.000     .1892364    .6499096
       _cons |   34.27133   5.107637     6.71   0.000     24.26055    44.28212
------------------------------------------------------------------------------
Endogenous variables:  lnst lnpd lndt
Exogenous variables:   lnpx2 lnpx3 lnpx4 lngnp
------------------------------------------------------------------------------

. reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngnp), 3sls ireg3 inst(lnpx2 lnpx3 lnpx4
lngnp)

Iteration 1:   tolerance =   .1513648
Iteration 2:   tolerance =  .06544675
Iteration 3:   tolerance =  .02973097
Iteration 4:   tolerance =  .01300895
Iteration 5:   tolerance =  .00559569
Iteration 6:   tolerance =    .002389
Iteration 7:   tolerance =  .00101667
Iteration 8:   tolerance =  .00043206
Iteration 9:   tolerance =  .00018351
Iteration 10:   tolerance =  .00007792
Iteration 11:   tolerance =  .00003308
Iteration 12:   tolerance =  .00001405
Iteration 13:   tolerance =  5.963e-06
Iteration 14:   tolerance =  2.532e-06
Iteration 15:   tolerance =  1.075e-06
Iteration 16:   tolerance =  4.563e-07

Three-stage least-squares regression, iterated
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
lnst               21      4    .3907962    0.3445      33.28   0.0000
lndt               21      2    .1368919    0.8937     159.68   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnst         |
        lnpd |   3.043122   3.531834     0.86   0.389    -3.879146     9.96539
       lnpx2 |  -1.056275   .5349722    -1.97   0.048    -2.104801   -.0077486
       lnpx3 |  -1.299439   1.565779    -0.83   0.407    -4.368309    1.769431
       lnpx4 |  -1.693315   .5922992    -2.86   0.004      -2.8542   -.5324295
```

```
       _cons |   14.86634    21.2538     0.70   0.484    -26.79033    56.52302
-------------+----------------------------------------------------------------
lndt         |
        lnpd |  -2.340873   .3830012    -6.11   0.000    -3.091542   -1.590205
       lngnp |    .419573   .1175208     3.57   0.000     .1892364    .6499096
       _cons |   34.27133   5.107637     6.71   0.000     24.26055    44.28212
------------------------------------------------------------------------------
Endogenous variables:  lnst lnpd lndt
Exogenous variables:   lnpx2 lnpx3 lnpx4 lngnp
------------------------------------------------------------------------------
```

5. What does β21 mean?
   - Price elasticity of quantity demand.