Assignment 2
Simultaneous Equation Models

From the data set `assign2.dta`:

Demand and Supply Equations

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

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

Equilibrium condition can be achieved by $D_t = S_t$ through the price P_{Dt} mechanism.

where: S_t = Domestic Supply at time t

D_t = Domestic Demand at time t

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

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

GDP_t = Gross Domestic Product (Representing Income) 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 GDP_t

a. State reduce form models of this system. Estimate reduce form models using OLS and prediction of the endogenous variables.

b. Estimate structural form using predicted endogenous variables as independent variables in the structural form models.

c. Estimate this system equations model using OLS, 2SLS, 3SLS, and I3SLS. Determine whether there exists endogeneity bias in the estimated results. Concerning on the asymptotic property, which model is the most appropriated model? Why? What do β_{21} and β_{22} mean?

Additional Issue:

If equilibrium doesn't hold $D_t \neq S_t$, when $D_t > S_t$; then $Q_t = S_t$ but when $D_t < S_t$; then $Q_t = D_t$, where Q_t is transaction quantity at time t.

$$\ln Q_t = \beta_{10} + \beta_{11}\ln P_{Dt} + \beta_{12}\ln P_{X2t} + \beta_{13}\ln P_{X3t} + \beta_{14}\ln P_{X4t} + \varepsilon_{1t} \quad (3)$$

$$\ln Q_t = \beta_{20} + \beta_{21}\ln P_{Dt} + \beta_{22}\ln GDP_t + \varepsilon_{2t} \quad (4)$$

d. Generate lnQ_t and estimate the above system equations (model (3) and model (4)) using OLS, 2SLS, and 3SLS using Q_t, and P_{Dt} as endogenous variables and P_{X2t}, P_{X3t}, P_{X4t}, and GDP_t as exogenous variables.

e. What are the problems, in term of economic concept and econometric technique, of the estimated results in **d**?

a. State reduce form models of this system. Estimate reduce form models using OLS and prediction of the endogenous variables.

$$\ln S_t = \ln D_t$$

$$\beta_{10} + \beta_{11} \ln P_{Dt} + \beta_{12} \ln P_{x2t} + \beta_{13} \ln P_{x3t} + \beta_{14} \ln P_{x4t} + \varepsilon_{1t} = \beta_{20} + \beta_{21} \ln P_{Dt} + \beta_{22} \ln GDP_t + \varepsilon_{22t}$$

$$(\beta_{11} - \beta_{21}) \ln P_{Dt} = \beta_{20} + \beta_{22} \ln GDP_t + \varepsilon_{22t} - \beta_{10} - \beta_{12} \ln P_{x2t} - \beta_{13} \ln P_{x3t} - \beta_{14} \ln P_{x4t} - \varepsilon_{1t}$$

$$= \frac{\beta_{20} - \beta_{10}}{(\beta_{11} - \beta_{21})} + \frac{\beta_{22} \ln GDP_t}{(\beta_{11} - \beta_{21})} - \frac{\beta_{12} \ln P_{x2t}}{(\beta_{11} - \beta_{21})} - \frac{\beta_{13} \ln P_{x3t}}{(\beta_{11} - \beta_{21})} - \frac{\beta_{14} \ln P_{x4t}}{(\beta_{11} - \beta_{21})} - \frac{(\varepsilon_{1t} - \varepsilon_{22t})}{(\beta_{11} - \beta_{21})}$$

$$\ln P_{Dt} = \pi_0 + \pi_1 \ln GDP_t + \pi_2 \ln P_{x2t} + \pi_3 \ln P_{x3t} + \pi_4 \ln P_{x4t} + W$$

$$\widehat{\ln P_{Dt}} = 2.87652 + 0.1632779 \ln GDP_t + 0.1318015 \ln P_{x2t} + 0.0939842 \ln P_{x3t} + 0.4939641 \ln P_{x4t}$$

b. Estimate structural form using predicted endogenous variables as independent variables in the structural form models.

$$\ln S_t = 18.59912 + 2.106112 \ln \widehat{P_{Dt}} - 0.727963 \ln P_{x2t} - 1.122146 \ln P_{x3t} - 1.428722 \ln P_{x4t}$$

$$\ln D_t = 35.93498 - 2.574157 \ln \widehat{P_{dt}} + 0.5212927 \ln GDP_t$$

c. Estimate this system equations model using OLS, 2SLS, 3SLS, and I3SLS. Determine whether there exists endogeneity bias in the estimated results. Concerning on the asymptotic property, which model is the most appropriated model? Why? What do β_{21} and β_{22} mean?

OLS

```
. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), ols

Multivariate regression
```

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lst	22	4	.1652258	0.9103	43.14	0.0000
ldt	22	2	.1391259	0.9069	92.53	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lst						
lpd	-1.111835	.4515147	-2.46	0.019	-2.027549	-.1961207
lpx2	-.4189546	.1431634	-2.93	0.006	-.7093034	-.1286059
lpx3	-.9424196	.2585266	-3.65	0.001	-1.466736	-.4181034
lpx4	-.521346	.3441643	-1.51	0.139	-1.219344	.1766516
_cons	41.4946	3.661911	11.33	0.000	34.0679	48.9213
ldt						
lpd	-2.181329	.2946999	-7.40	0.000	-2.779008	-1.58365
lgdp	.5776586	.0887536	6.51	0.000	.397658	.7576593
_cons	31.03578	3.761201	8.25	0.000	23.40771	38.66385

2SLS

```
. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 2sls nodfk inst(lpx2 lpx3 lpx4 lgdp)

Two-stage least-squares regression
```

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lst	22	4	.329951	0.6424	13.81	0.0000
ldt	22	2	.1454858	0.8982	89.20	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lst						
lpd	2.10611	1.926677	1.09	0.282	-1.801371	6.013591
lpx2	-.7279628	.3026471	-2.41	0.021	-1.34176	-.114166
lpx3	-1.122146	.464304	-2.42	0.021	-2.063798	-.180494
lpx4	-1.428722	.7811544	-1.83	0.076	-3.012977	.1555325
_cons	18.59914	14.05113	1.32	0.194	-9.897873	47.09616
ldt						
lpd	-2.574157	.4046743	-6.36	0.000	-3.394875	-1.75344
lgdp	.5212921	.0955104	5.46	0.000	.327588	.7149961
_cons	35.93499	5.106302	7.04	0.000	25.57893	46.29105

```
Endogenous variables:  lst lpd ldt
Exogenous variables:   lpx2 lpx3 lpx4 lgdp
```

3SLS

```
. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 3sls inst(lpx2 lpx3 lpx4 lgdp)
```

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lst	22	4	.2963642	0.6266	57.47	0.0000
ldt	22	2	.135203	0.8982	178.41	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lst						
lpd	2.171576	1.926095	1.13	0.260	-1.603501	5.946652
lpx2	-.7990055	.2985983	-2.68	0.007	-1.384247	-.2137635
lpx3	-1.329743	.4560002	-2.92	0.004	-2.223487	-.4359989
lpx4	-1.171403	.775654	-1.51	0.131	-2.691657	.348851
_cons	17.84948	14.04122	1.27	0.204	-9.670808	45.36976
ldt						
lpd	-2.574157	.4046743	-6.36	0.000	-3.367304	-1.78101
lgdp	.5212921	.0955104	5.46	0.000	.3340951	.708489
_cons	35.93499	5.106302	7.04	0.000	25.92682	45.94316

Endogenous variables: lst lpd ldt
Exogenous variables: lpx2 lpx3 lpx4 lgdp

I3SLS

```
. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 3sls ireg3 inst(lpx2 lpx3 lpx4 lgdp)

Iteration 1:   tolerance =   .1059484
Iteration 2:   tolerance =  .04569793
Iteration 3:   tolerance =  .01846611
Iteration 4:   tolerance =  .00725496
Iteration 5:   tolerance =  .00281814
Iteration 6:   tolerance =  .00108981
Iteration 7:   tolerance =  .00042072
Iteration 8:   tolerance =  .00016231
Iteration 9:   tolerance =   .0000626
Iteration 10:  tolerance =  .00002414
Iteration 11:  tolerance =  9.310e-06
Iteration 12:  tolerance =  3.590e-06

Iteration 13:  tolerance =  1.384e-06
Iteration 14:  tolerance =  5.339e-07
```

Three-stage least-squares regression, iterated

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lst	22	4	.3022006	0.6117	54.83	0.0000
ldt	22	2	.135203	0.8982	178.41	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lst						
lpd	2.212666	2.005956	1.10	0.270	-1.718936	6.144268
lpx2	-.8435967	.3049354	-2.77	0.006	-1.441259	-.2459342
lpx3	-1.460044	.4623671	-3.16	0.002	-2.366267	-.5538216
lpx4	-1.009892	.7998393	-1.26	0.207	-2.577548	.557764
_cons	17.37893	14.61488	1.19	0.234	-11.26571	46.02357
ldt						
lpd	-2.574157	.4046743	-6.36	0.000	-3.367304	-1.78101
lgdp	.5212921	.0955104	5.46	0.000	.3340951	.708489
_cons	35.93499	5.106302	7.04	0.000	25.92682	45.94316

Endogenous variables: lst lpd ldt
Exogenous variables: lpx2 lpx3 lpx4 lgdp

Hausman test

For demand function p-value = 0.3667, there is an endogeneity problem that occurs in the model.

For supply function P-value = 0.5659, there is an endogeneity problem.

Concerning asymptotic property 2SLS should be used in this case because the system equation is simultaneous equation, using 2SLS will make the model asymptotically efficient. The reason that I do not recommend 3SLS is due to the risk of misspecification error which will make the model inconsistent.

β_{21} ; when P_{dt} increase by 1% D_t will increase by β_{21} %.

β_{22} : when GDP increase by 1% D_t will increase by β_{22} %.

d. Generate lnQ_t and estimate the above system equations (model (3) and model (4)) using OLS, 2SLS, and 3SLS using Q_t, and P_{Dt} as endogenous variables and P_{X2t}, P_{X3t}, P_{X4t}, and GDP_t as exogenous variables.

OLS

```
. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), ols
```

Multivariate regression

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lqt	22	4	.136235	0.9201	48.95	0.0000
2lqt	22	2	.1391259	0.9069	92.53	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lqt						
lpd	-1.353506	.3722912	-3.64	0.001	-2.108548	-.5984645
lpx2	-.3864994	.1180437	-3.27	0.002	-.6259031	-.1470957
lpx3	-.6782817	.2131651	-3.18	0.003	-1.110601	-.2459629
lpx4	-.3606189	.2837767	-1.27	0.212	-.9361448	.2149069
_cons	40.10218	3.019386	13.28	0.000	33.97858	46.22578
2lqt						
lpd	-2.181329	.2946999	-7.40	0.000	-2.779008	-1.58365
lgdp	.5776586	.0887536	6.51	0.000	.397658	.7576593
_cons	31.03578	3.761201	8.25	0.000	23.40771	38.66385

2SLS

Two-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lqt	22	4	.2329302	0.7665	20.29	0.0000
2lqt	22	2	.1454858	0.8982	89.20	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lqt						
lpd	.7752765	1.360145	0.57	0.572	-1.983225	3.533778
lpx2	-.5909191	.2136549	-2.77	0.009	-1.024231	-.1576068
lpx3	-.7971771	.3277773	-2.43	0.020	-1.46194	-.132414
lpx4	-.9608797	.551459	-1.74	0.090	-2.079291	.1575311
_cons	24.95604	9.919453	2.52	0.016	4.838457	45.07362
2lqt						
lpd	-2.574157	.4046743	-6.36	0.000	-3.394875	-1.75344
lgdp	.5212921	.0955104	5.46	0.000	.327588	.7149961

3SLS

```
. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), 3sls inst(lpx2 lpx3 lpx4 lgdp)
```

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lqt	22	4	.2056595	0.7644	81.74	0.0000
2lqt	22	2	.135203	0.8982	178.41	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lqt						
lpd	.7879239	1.360114	0.58	0.562	-1.877851	3.453699
lpx2	-.6046439	.2134422	-2.83	0.005	-1.022983	-.1863049
lpx3	-.8372831	.3273419	-2.56	0.011	-1.478861	-.1957047
lpx4	-.9111679	.5511692	-1.65	0.098	-1.99144	.1691039
_cons	24.81121	9.918929	2.50	0.012	5.370467	44.25195
2lqt						
lpd	-2.574157	.4046743	-6.36	0.000	-3.367304	-1.78101
lgdp	.5212921	.0955104	5.46	0.000	.3340951	.708489
_cons	35.93499	5.106302	7.04	0.000	25.92682	45.94316

Endogenous variables: lqt lpd
Exogenous variables: lpx2 lpx3 lpx4 lgdp

.

e. What are the problems, in term of economic concept and econometric technique, of the estimated results in **d**?

From the condition that $Q_t = D_t$ when $D_t > S_t$ and $Q_t = S_t$ when $S_t > D_t$, this will only give the quantity only left side of the equilibrium only, which makes the data not cover all the point on the demand and supply curve.

Another problem is that we do not know whether the equilibrium quantity come from the shift in the supply or demand curve. If we do not hold one function as fixed, we will not be able to create a demand nor supply function.

```
  ___  ____  ____  ____  ____ (R)
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Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  More than 2 billion observations are allowed; see help obs_advice.
      3.  Maximum number of variables is set to 5000; see help set_maxvar.

. use "C:\Users\User\Desktop\426\assign2.dta", clear

. g lst=ln(st)

. g ldt= ln(dt)

. g lpd=ln(pm+t)

. g lpx2= ln(px2)

. g lpx3= ln(px3)

. g lpx4=ln(px4)

. g lgdp= ln(gdp)

. tsset obs
        time variable:  obs, 1986 to 2007
                delta:  1 unit

. reg lpd lgdp lpx2 lpx3 lpx4

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(4, 17)        =      6.76
       Model |   .17707359         4  .044268398   Prob > F        =    0.0019
    Residual |  .111247189        17  .006543952   R-squared       =    0.6142
-------------+----------------------------------   Adj R-squared   =    0.5234
       Total |  .288320779        21  .013729561   Root MSE        =    .08089

------------------------------------------------------------------------------
         lpd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |   .1632779   .0877392     1.86   0.080    -.0218357    .3483914
        lpx2 |   .1318015   .0695123     1.90   0.075    -.0148567    .2784596
        lpx3 |   .0939842    .127627     0.74   0.472    -.1752851    .3632535
        lpx4 |   .4939641   .1936093     2.55   0.021     .0854842    .9024439
       _cons |    2.87652   2.434717     1.18   0.254    -2.260283    8.013322
------------------------------------------------------------------------------
```

```
. predict lpdhat
(option xb assumed; fitted values)

. reg lst lpdhat lpx2 lpx3 lpx4

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(4, 17)        =     37.32
       Model |  4.64569773         4  1.16142443   Prob > F        =    0.0000
    Residual |  .529104183        17  .031123775   R-squared       =    0.8978
-------------+----------------------------------   Adj R-squared   =    0.8737
       Total |  5.17480192        21  .246419139   Root MSE        =    .17642

------------------------------------------------------------------------------
         lst |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lpdhat |   2.106112   1.171903     1.80   0.090    -.3663879    4.578612
        lpx2 |   -.727963   .1840856    -3.95   0.001     -1.11635   -.3395762
        lpx3 |  -1.122146   .2824139    -3.97   0.001    -1.717988   -.5263052
        lpx4 |  -1.428722   .4751381    -3.01   0.008    -2.431176   -.4262679
       _cons |   18.59912   8.546622     2.18   0.044     .5673274    36.63092
------------------------------------------------------------------------------

. reg ldt lpdhat lgdp

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(2, 19)        =     44.99
       Model |  3.26129847         2  1.63064924   Prob > F        =    0.0000
    Residual |  .688574614        19  .036240769   R-squared       =    0.8257
-------------+----------------------------------   Adj R-squared   =    0.8073
       Total |  3.94987309        21  .188089195   Root MSE        =    .19037

------------------------------------------------------------------------------
         ldt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lpdhat |  -2.574157   .5697943    -4.52   0.000     -3.76675   -1.381563
        lgdp |   .5212927   .1344816     3.88   0.001     .2398194     .802766
       _cons |   35.93498   7.189835     5.00   0.000     20.88648    50.98347
------------------------------------------------------------------------------

. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), ols

Multivariate regression
----------------------------------------------------------------------
Equation             Obs   Parms        RMSE    "R-sq"       F-Stat        P
----------------------------------------------------------------------
lst                   22       4    .1652258    0.9103        43.14   0.0000
ldt                   22       2    .1391259    0.9069        92.53   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lst          |
         lpd |  -1.111835   .4515147    -2.46   0.019    -2.027549   -.1961207
        lpx2 |  -.4189546   .1431634    -2.93   0.006    -.7093034   -.1286059
        lpx3 |  -.9424196   .2585266    -3.65   0.001    -1.466736   -.4181034
        lpx4 |   -.521346   .3441643    -1.51   0.139    -1.219344    .1766516
       _cons |    41.4946   3.661911    11.33   0.000      34.0679     48.9213
-------------+----------------------------------------------------------------
ldt          |
         lpd |  -2.181329   .2946999    -7.40   0.000    -2.779008    -1.58365
        lgdp |   .5776586   .0887536     6.51   0.000      .397658    .7576593
       _cons |   31.03578   3.761201     8.25   0.000     23.40771    38.66385
------------------------------------------------------------------------------
```

```
. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 2sls nodfk inst(lpx2 lpx3 lpx4 lgdp)

Two-stage least-squares regression
----------------------------------------------------------------------
Equation          Obs   Parms        RMSE    "R-sq"     F-Stat        P
----------------------------------------------------------------------
lst                22       4     .329951    0.6424      13.81   0.0000
ldt                22       2    .1454858    0.8982      89.20   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lst          |
         lpd |    2.10611   1.926677     1.09   0.282    -1.801371    6.013591
        lpx2 |  -.7279628   .3026471    -2.41   0.021     -1.34176    -.114166
        lpx3 |  -1.122146    .464304    -2.42   0.021    -2.063798    -.180494
        lpx4 |  -1.428722   .7811544    -1.83   0.076    -3.012977    .1555325
       _cons |   18.59914   14.05113     1.32   0.194    -9.897873    47.09616
-------------+----------------------------------------------------------------
ldt          |
         lpd |  -2.574157   .4046743    -6.36   0.000    -3.394875    -1.75344
        lgdp |   .5212921   .0955104     5.46   0.000      .327588    .7149961
       _cons |   35.93499   5.106302     7.04   0.000     25.57893    46.29105
------------------------------------------------------------------------------
Endogenous variables:  lst lpd ldt
Exogenous variables:   lpx2 lpx3 lpx4 lgdp
------------------------------------------------------------------------------

. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 3sls inst(lpx2 lpx3 lpx4 lgdp)

Three-stage least-squares regression
----------------------------------------------------------------------
Equation          Obs   Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
lst                22       4    .2963642    0.6266      57.47   0.0000
ldt                22       2     .135203    0.8982     178.41   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lst          |
         lpd |   2.171576   1.926095     1.13   0.260    -1.603501    5.946652
        lpx2 |  -.7990055   .2985983    -2.68   0.007    -1.384247   -.2137635
        lpx3 |  -1.329743   .4560002    -2.92   0.004    -2.223487   -.4359989
        lpx4 |  -1.171403    .775654    -1.51   0.131    -2.691657     .348851
       _cons |   17.84948   14.04122     1.27   0.204    -9.670808    45.36976
-------------+----------------------------------------------------------------
ldt          |
         lpd |  -2.574157   .4046743    -6.36   0.000    -3.367304    -1.78101
        lgdp |   .5212921   .0955104     5.46   0.000     .3340951     .708489
       _cons |   35.93499   5.106302     7.04   0.000     25.92682    45.94316
------------------------------------------------------------------------------
Endogenous variables:  lst lpd ldt
Exogenous variables:   lpx2 lpx3 lpx4 lgdp
------------------------------------------------------------------------------

. reg3 (lst lpd lpx2 lpx3 lpx4) (ldt lpd lgdp), 3sls ireg3 inst(lpx2 lpx3 lpx4 lgdp)

Iteration 1:   tolerance =   .1059484
Iteration 2:   tolerance =  .04569793
Iteration 3:   tolerance =  .01846611
Iteration 4:   tolerance =  .00725496
Iteration 5:   tolerance =  .00281814
Iteration 6:   tolerance =  .00108981
Iteration 7:   tolerance =  .00042072
Iteration 8:   tolerance =  .00016231
Iteration 9:   tolerance =   .0000626
Iteration 10:   tolerance =  .00002414
Iteration 11:   tolerance =  9.310e-06
Iteration 12:   tolerance =  3.590e-06
```

```
Iteration 13:   tolerance =  1.384e-06
Iteration 14:   tolerance =  5.339e-07

Three-stage least-squares regression, iterated
```

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lst	**22**	**4**	**.3022006**	**0.6117**	**54.83**	**0.0000**
ldt	**22**	**2**	**.135203**	**0.8982**	**178.41**	**0.0000**

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lst						
lpd	**2.212666**	**2.005956**	**1.10**	**0.270**	**-1.718936**	**6.144268**
lpx2	**-.8435967**	**.3049354**	**-2.77**	**0.006**	**-1.441259**	**-.2459342**
lpx3	**-1.460044**	**.4623671**	**-3.16**	**0.002**	**-2.366267**	**-.5538216**
lpx4	**-1.009892**	**.7998393**	**-1.26**	**0.207**	**-2.577548**	**.557764**
_cons	**17.37893**	**14.61488**	**1.19**	**0.234**	**-11.26571**	**46.02357**
ldt						
lpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lgdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

```
Endogenous variables:  lst lpd ldt
Exogenous variables:   lpx2 lpx3 lpx4 lgdp

.
.
```

```
  ___  ____  ____  ____  ____ (R)
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Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  More than 2 billion observations are allowed; see help obs_advice.
      3.  Maximum number of variables is set to 5000; see help set_maxvar.

. use "C:\Users\User\Desktop\426\data ass2.dta", clear

. reg lst lpd lpx2 lpx3 lpx4

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(4, 17)        =     43.14
       Model |  4.71070935         4  1.17767734   Prob > F        =    0.0000
    Residual |  .464092568        17  .027299563   R-squared       =    0.9103
-------------+----------------------------------   Adj R-squared   =    0.8892
       Total |  5.17480192        21  .246419139   Root MSE        =    .16523

------------------------------------------------------------------------------
         lst |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lpd |  -1.111835   .4515147    -2.46   0.025    -2.064448   -.1592222
        lpx2 |  -.4189546   .1431634    -2.93   0.009    -.7210029   -.1169063
        lpx3 |  -.9424196   .2585266    -3.65   0.002    -1.487863   -.3969762
        lpx4 |   -.521346   .3441643    -1.51   0.148    -1.247469    .2047773
       _cons |    41.4946   3.661911    11.33   0.000     33.76865    49.22056
------------------------------------------------------------------------------

. est store olssupply

. ivregress 2sls lst lpx2 lpx3 lpx4 (lpd = lpx2 lpx3 lpx4 lgdp)

Instrumental variables (2SLS) regression          Number of obs   =         22
                                                  Wald chi2(4)    =      55.22
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.6424
                                                  Root MSE        =     .29004

------------------------------------------------------------------------------
         lst |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lpd |    2.10611   1.926677     1.09   0.274    -1.670107    5.882327
        lpx2 |  -.7279628   .3026471    -2.41   0.016     -1.32114   -.1347853
        lpx3 |  -1.122146    .464304    -2.42   0.016    -2.032165    -.212127
        lpx4 |  -1.428722   .7811544    -1.83   0.067    -2.959757    .1023125
       _cons |   18.59914   14.05113     1.32   0.186    -8.940569    46.13886
------------------------------------------------------------------------------
Instrumented:  lpd
Instruments:   lpx2 lpx3 lpx4 lgdp
```

```
. estimate store twostagesupply

. hausman twostagesupply olssupply

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             | twostagesu~y  olssupply       Difference          S.E.
-------------+----------------------------------------------------------------
         lpd |    2.10611    -1.111835        3.217945        1.873023
        lpx2 |  -.7279628    -.4189546       -.3090082         .266645
        lpx3 |  -1.122146    -.9424196       -.1797266        .3856712
        lpx4 |  -1.428722     -.521346        -.907376        .7012511
------------------------------------------------------------------------------
                         b = consistent under Ho and Ha; obtained from ivregress
          B = inconsistent under Ha, efficient under Ho; obtained from regress

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        2.95
                Prob>chi2 =      0.5659

. reg ldt lpd lgdp

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(2, 19)        =     92.53
       Model |  3.58210899         2  1.79105449   Prob > F        =    0.0000
    Residual |  .367764099        19  .019356005   R-squared       =    0.9069
-------------+----------------------------------   Adj R-squared   =    0.8971
       Total |  3.94987309        21  .188089195   Root MSE        =    .13913

------------------------------------------------------------------------------
         ldt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lpd |  -2.181329   .2946999    -7.40   0.000    -2.798143   -1.564515
        lgdp |   .5776586   .0887536     6.51   0.000     .3918952    .7634221
       _cons |   31.03578   3.761201     8.25   0.000      23.1635    38.90807
------------------------------------------------------------------------------

. estimate store olsdemand

. ivregress 2sls ldt lgdp ( lpd = lpx2 lpx3 lpx4 lgdp)

Instrumental variables (2SLS) regression          Number of obs   =         22
                                                  Wald chi2(2)    =     178.41
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.8982
                                                  Root MSE        =      .1352

------------------------------------------------------------------------------
         ldt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lpd |  -2.574157   .4046743    -6.36   0.000    -3.367304    -1.78101
        lgdp |   .5212921   .0955104     5.46   0.000     .3340951     .708489
       _cons |   35.93499   5.106302     7.04   0.000     25.92682    45.94316
------------------------------------------------------------------------------
Instrumented:  lpd
Instruments:   lgdp lpx2 lpx3 lpx4

. estimate store twostagedemand
```

```
. hausman twostagedemand olsdemand

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             | twostagede~d  olsdemand       Difference          S.E.
-------------+----------------------------------------------------------------
         lpd |   -2.574157    -2.181329        -.3928286        .2773324
        lgdp |    .5212921     .5776586        -.0563666         .035285
------------------------------------------------------------------------------
                         b = consistent under Ho and Ha; obtained from ivregress
          B = inconsistent under Ha, efficient under Ho; obtained from regress

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        2.01
                Prob>chi2 =      0.3667
                (V_b-V_B is not positive definite)

. gen qt = dt if st>dt

. gen lqt = ln(qt)

. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), ols

Multivariate regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       F-Stat        P
----------------------------------------------------------------------
lqt                22      4     .136235    0.9201        48.95   0.0000
2lqt               22      2    .1391259    0.9069        92.53   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lqt          |
         lpd |  -1.353506   .3722912    -3.64   0.001    -2.108548   -.5984645
        lpx2 |  -.3864994   .1180437    -3.27   0.002    -.6259031   -.1470957
        lpx3 |  -.6782817   .2131651    -3.18   0.003    -1.110601   -.2459629
        lpx4 |  -.3606189   .2837767    -1.27   0.212    -.9361448    .2149069
       _cons |   40.10218   3.019386    13.28   0.000     33.97858    46.22578
-------------+----------------------------------------------------------------
2lqt         |
         lpd |  -2.181329   .2946999    -7.40   0.000    -2.779008    -1.58365
        lgdp |   .5776586   .0887536     6.51   0.000      .397658    .7576593
       _cons |   31.03578   3.761201     8.25   0.000     23.40771    38.66385
------------------------------------------------------------------------------

. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), 2sls nodfk inst(lpx2 lpx3 lpx4 lgdp)

Two-stage least-squares regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       F-Stat        P
----------------------------------------------------------------------
lqt                22      4    .2329302    0.7665        20.29   0.0000
2lqt               22      2    .1454858    0.8982        89.20   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lqt          |
         lpd |   .7752765   1.360145     0.57   0.572    -1.983225    3.533778
        lpx2 |  -.5909191   .2136549    -2.77   0.009    -1.024231   -.1576068
        lpx3 |  -.7971771   .3277773    -2.43   0.020     -1.46194    -.132414
        lpx4 |  -.9608797    .551459    -1.74   0.090    -2.079291    .1575311
       _cons |   24.95604   9.919453     2.52   0.016     4.838457    45.07362
-------------+----------------------------------------------------------------
2lqt         |
         lpd |  -2.574157   .4046743    -6.36   0.000    -3.394875    -1.75344
        lgdp |   .5212921   .0955104     5.46   0.000      .327588    .7149961
```

```
       _cons |   35.93499   5.106302     7.04   0.000     25.57893    46.29105
------------------------------------------------------------------------------
Endogenous variables:  lqt lpd
Exogenous variables:   lpx2 lpx3 lpx4 lgdp
------------------------------------------------------------------------------

. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), 3sls ireg3(lpx2 lpx3 lpx4 lgdp)
option ireg3() not allowed
r(198);

. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), 3sls ireg3 inst(lpx2 lpx3 lpx4 lgdp)

Iteration 1:   tolerance =  .02535182
Iteration 2:   tolerance =  .01003058
Iteration 3:   tolerance =  .00390723
Iteration 4:   tolerance =  .00151264
Iteration 5:   tolerance =  .00058419
Iteration 6:   tolerance =  .00022541
Iteration 7:   tolerance =  .00008694
Iteration 8:   tolerance =  .00003353
Iteration 9:   tolerance =  .00001293
Iteration 10:   tolerance =  4.986e-06
Iteration 11:   tolerance =  1.923e-06
Iteration 12:   tolerance =  7.415e-07

Three-stage least-squares regression, iterated
----------------------------------------------------------------------
Equation             Obs   Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
lqt                   22       4    .2063295    0.7629      80.89   0.0000
2lqt                  22       2     .135203    0.8982     178.41   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lqt          |
         lpd |    .795862   1.370509     0.58   0.561    -1.890287    3.482011
        lpx2 |  -.6132584    .214736    -2.86   0.004    -1.034133   -.1923836
        lpx3 |  -.8624556   .3291486    -2.62   0.009    -1.507575   -.2173363
        lpx4 |  -.8799661   .5549316    -1.59   0.113    -1.967612    .2076798
       _cons |   24.72031   9.994251     2.47   0.013     5.131936    44.30868
-------------+----------------------------------------------------------------
2lqt         |
         lpd |  -2.574157   .4046743    -6.36   0.000    -3.367304    -1.78101
        lgdp |   .5212921   .0955104     5.46   0.000     .3340951     .708489
       _cons |   35.93499   5.106302     7.04   0.000     25.92682    45.94316
------------------------------------------------------------------------------
Endogenous variables:  lqt lpd
Exogenous variables:   lpx2 lpx3 lpx4 lgdp
------------------------------------------------------------------------------

. reg3 (lqt lpd lpx2 lpx3 lpx4) (lqt lpd lgdp), 3sls inst(lpx2 lpx3 lpx4 lgdp)

Three-stage least-squares regression
----------------------------------------------------------------------
Equation             Obs   Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
lqt                   22       4    .2056595    0.7644      81.74   0.0000
2lqt                  22       2     .135203    0.8982     178.41   0.0000
----------------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lqt						
lpd	**.7879239**	**1.360114**	**0.58**	**0.562**	**-1.877851**	**3.453699**
lpx2	**-.6046439**	**.2134422**	**-2.83**	**0.005**	**-1.022983**	**-.1863049**
lpx3	**-.8372831**	**.3273419**	**-2.56**	**0.011**	**-1.478861**	**-.1957047**
lpx4	**-.9111679**	**.5511692**	**-1.65**	**0.098**	**-1.99144**	**.1691039**
_cons	**24.81121**	**9.918929**	**2.50**	**0.012**	**5.370467**	**44.25195**
2lqt						
lpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lgdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

Endogenous variables: lqt lpd
Exogenous variables: lpx2 lpx3 lpx4 lgdp

.