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?

<u>Additional Issue</u>:

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**?

6204641218

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

$\ln S_t = \ln D_t$

$\beta_{10} + \beta_{11}\ln P_{Dt} + \beta_{12}\ln P_{X2t} + \beta_{13}\ln P_{X3t} + \beta_{14}\ln P_{X4t} + \varepsilon_{1t} = \beta_{20} + \beta_{21}\ln P_{Dt} + \beta_{22}\ln GDP_t + \varepsilon_{2t}$

$\beta_{11}\ln P_{Dt} - \beta_{21}\ln P_{Dt} = \beta_{20} + \beta_{22}\ln GDP_t + \varepsilon_{2t} - \beta_{10} - \beta_{12}\ln P_{X2t} - \beta_{13}\ln P_{X3t} - \beta_{14}\ln P_{X4t} - \varepsilon_{1t}$

$\ln P_{Dt}(\beta_{11} - \beta_{21}) = \beta_{20} + \beta_{22}\ln GDP_t + \varepsilon_{2t} - \beta_{10} - \beta_{12}\ln P_{X2t} - \beta_{13}\ln P_{X3t} - \beta_{14}\ln P_{X4t} - \varepsilon_{1t}$

$$\ln P_{Dt} = \frac{\beta_{20} - \beta_{10}}{(\beta_{11} - \beta_{21})} + \frac{\beta_{22}}{(\beta_{11} - \beta_{21})}\ln GDP_t - \frac{\beta_{12}}{(\beta_{11} - \beta_{21})}\ln P_{X2t} - \frac{\beta_{13}}{(\beta_{11} - \beta_{21})}\ln P_{X3t} - \frac{\beta_{14}}{(\beta_{11} - \beta_{21})}\ln P_{X4t} - \frac{\varepsilon_{1t} + \varepsilon_{2t}}{(\beta_{11} - \beta_{21})}$$

$\ln P_{Dt} = 2.87652 + .1318015 \ln P_{X2t} + .0939842 \ln P_{X3t} + .4939641 \ln P_{X4t}$
(2.434717) (.0695123) (.127627) (.1936093)
$+ .1632779 \ln gdp$
(.0877392)

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

$\ln st = 18.59912 + 2.106112 \ln pdhat - .727963 \ln P_{X2t} - 1.122146 \ln P_{X3t} - 1.428722 \ln P_{X4t}$
(8.546622) (1.171903) (.1840856) (.2824139) (.4751381)

$\ln dt = 35.93498 - 2.574157 \ln pdhat + .5212927 \ln gdp$
(7.189835) (.5697943) (.1344816)

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?

Hausman Test : prob > chi² = 0.5659 ∴ fail to reject H_0, there is no endogeneity bias
As there is no endogeneity bias, OLS method still be the most appropriated one.
Moreover, S.d. of OLS are the least as compared with 2SLS, 3SLS, I3SLS.
β_{12} = percentage change of domestic demand when domestic price changes for one unit at time t.
β_{22} = percentage change of domestic demand when GDP changes for one unit at time t.

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

$\ln qt = 40.10218 - 1.353506 \ln P_{Dt} - .3864994 \ln P_{X2t} - .6782817 \ln P_{X3t} - .3606189 \ln P_{X4t}$
(3.019386) (.3722912) (.1180437) (.2131651) (.2837767)

$\ln q_t = 31.03578 - 2.181329 \ln P_{Dt} + .5776586 \ln gdp$
(3.761201) (.2946999) (.0887536)

2SLS

$$\ln q_t = 24.95604 + .7752765 \ln P_{bt} - .5909191 \ln P_{x_2t} - .7971771 \ln P_{x_3t} - .9608797 \ln P_{x_4t}$$
$$(9.919453) \quad (1.360145) \quad (.2136549) \quad (.3277773) \quad (.551459)$$

$$\ln q_t = 35.93499 - 2.574157 \ln P_{bt} + .5212921 \ln gdp$$
$$(5.106302) \quad (.4046743) \quad (.0955104)$$

3SLS

$$\ln q_t = 24.81121 + .7879239 \ln P_{bt} - .6046439 \ln P_{x_2t} - .8372831 \ln P_{x_3t} - .9111679 \ln P_{x_4t}$$
$$(9.918929) \quad (1.360114) \quad (.2134422) \quad (.3273419) \quad (.5511692)$$

$$\ln q_t = 35.93499 - 2.574157 \ln P_{bt} + .5212921 \ln gdp$$
$$(5.106302) \quad (.4046743) \quad (.0955104)$$

I 3SLS

$$\ln q_t = 24.72031 + .795862 \ln P_{bt} - .6132584 \ln P_{x_2t} - .8624556 \ln P_{x_3t} - .8799661 \ln P_{x_4t}$$
$$(9.994251) \quad (1.370509) \quad (.214736) \quad (.3291487) \quad (.5549316)$$

$$\ln q_t = 35.93499 - 2.574157 \ln P_{bt} + .5212921 \ln gdp$$
$$(5.106302) \quad (.4046743) \quad (.0955104)$$

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

Once estimated, it is hardly recognized that whether it is demand or supply curve.

However, the result will always on the left side of equilibrium.

```
  ___  ____  ____  ____  ____(R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/
  Statistics/Data Analysis
```

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   16.0   Copyright 1985-2019 StataCorp LLC
  Statistics/Data Analysis            StataCorp
                                      4905 Lakeway Drive
     MP - Parallel Edition            College Station, Texas 77845 USA
                                      800-STATA-PC        http://www.stata.com
                                      979-696-4600        stata@stata.com
                                      979-696-4601 (fax)

20-student 2-core Stata lab perpetual license:
       Serial number:  501606222284
         Licensed to:  Faculty of economics
                       Thammasat University

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.

 1 . use "C:\Users\a\Downloads\assign2.dta"

 2 . log using "C:\Users\a\Desktop\426.a2.smcl"
--------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\a\Desktop\426.a2.smcl
  log type:  smcl
 opened on:   3 Feb 2021, 17:43:54

 3 . gen lnst=ln(st)

 4 . gen lndt=ln(dt)

 5 . gen lngdp=ln(gdp)

 6 . gen pd=pm+t

 7 . gen lnpd=ln(pd)

 8 . gen lnpx2=ln(px2)

 9 . gen lnpx3=ln(px3)

10 . gen lnpx4=ln(px4)

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

12 . reg lnpd lnpx2 lnpx3 lnpx4 lngdp    (d)

      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
```

lnpd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpx2	.1318015	.0695123	1.90	0.075	-.0148567	.2784596
lnpx3	.0939842	.127627	0.74	0.472	-.1752851	.3632535
lnpx4	.4939641	.1936093	2.55	0.021	.0854842	.9024439
lngdp	.1632779	.0877392	1.86	0.080	-.0218357	.3483914
_cons	2.87652	2.434717	1.18	0.254	-2.260283	8.013322

(a)

13 . predict lnpdhat
(option **xb** assumed; fitted values)

14 . reg lnst lnpdhat lnpx2 lnpx3 lnpx4 (b).

Source	SS	df	MS
Model	4.64569773	4	1.16142443
Residual	.529104183	17	.031123775
Total	5.17480192	21	.246419139

Number of obs	=	22
F(4, 17)	=	37.32
Prob > F	=	0.0000
R-squared	=	0.8978
Adj R-squared	=	0.8737
Root MSE	=	.17642

lnst	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpdhat	2.106112	1.171903	1.80	0.090	-.3663879	4.578612
lnpx2	-.727963	.1840856	-3.95	0.001	-1.11635	-.3395762
lnpx3	-1.122146	.2824139	-3.97	0.001	-1.717988	-.5263052
lnpx4	-1.428722	.4751381	-3.01	0.008	-2.431176	-.4262679
_cons	18.59912	8.546622	2.18	0.044	.5673274	36.63092

15 . reg lndt lnpdhat lngdp (b).

Source	SS	df	MS
Model	3.26129847	2	1.63064924
Residual	.688574614	19	.036240769
Total	3.94987309	21	.188089195

Number of obs	=	22
F(2, 19)	=	44.99
Prob > F	=	0.0000
R-squared	=	0.8257
Adj R-squared	=	0.8073
Root MSE	=	.19037

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

16 . reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngdp), ols

Multivariate regression

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

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnst						
lnpd	**-1.111835**	**.4515147**	**-2.46**	**0.019**	**-2.027549**	**-.1961207**
lnpx2	**-.4189546**	**.1431634**	**-2.93**	**0.006**	**-.7093034**	**-.1286059**
lnpx3	**-.9424196**	**.2585266**	**-3.65**	**0.001**	**-1.466736**	**-.4181034**
lnpx4	**-.521346**	**.3441643**	**-1.51**	**0.139**	**-1.219344**	**.1766516**
_cons	**41.4946**	**3.661911**	**11.33**	**0.000**	**34.0679**	**48.9213**
lndt						
lnpd	**-2.181329**	**.2946999**	**-7.40**	**0.000**	**-2.779008**	**-1.58365**
lngdp	**.5776586**	**.0887536**	**6.51**	**0.000**	**.397658**	**.7576593**
_cons	**31.03578**	**3.761201**	**8.25**	**0.000**	**23.40771**	**38.66385**

17 . est store ols

18 . reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngdp), 2sls nodfk inst(lnpx2 lnpx3 lnpx4 lngdp)

Two-stage least-squares regression

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

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnst						
lnpd	**2.10611**	**1.926677**	**1.09**	**0.282**	**-1.801371**	**6.013591**
lnpx2	**-.7279628**	**.3026471**	**-2.41**	**0.021**	**-1.34176**	**-.114166**
lnpx3	**-1.122146**	**.464304**	**-2.42**	**0.021**	**-2.063798**	**-.180494**
lnpx4	**-1.428722**	**.7811544**	**-1.83**	**0.076**	**-3.012977**	**.1555325**
_cons	**18.59914**	**14.05113**	**1.32**	**0.194**	**-9.897873**	**47.09616**
lndt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.394875**	**-1.75344**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.327588**	**.7149961**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.57893**	**46.29105**

Endogenous variables: lnst lnpd lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

19 . est store twostage

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

Three-stage least-squares regression

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

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnst						
lnpd	**2.171576**	**1.926095**	**1.13**	**0.260**	**-1.603501**	**5.946652**
lnpx2	**-.7990055**	**.2985983**	**-2.68**	**0.007**	**-1.384247**	**-.2137635**
lnpx3	**-1.329743**	**.4560002**	**-2.92**	**0.004**	**-2.223487**	**-.4359989**
lnpx4	**-1.171403**	**.775654**	**-1.51**	**0.131**	**-2.691657**	**.348851**
_cons	**17.84948**	**14.04122**	**1.27**	**0.204**	**-9.670808**	**45.36976**
lndt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

Endogenous variables: lnst lnpd lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
21 . reg3 (lnst lnpd lnpx2 lnpx3 lnpx4) (lndt lnpd lngdp), 3sls ireg3 inst(lnpx2 lnpx3 lnpx4 lngdp)

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
lnst	**22**	**4**	**.3022006**	**0.6117**	**54.83**	**0.0000**
lndt	**22**	**2**	**.135203**	**0.8982**	**178.41**	**0.0000**

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnst						
lnpd	**2.212666**	**2.005956**	**1.10**	**0.270**	**-1.718936**	**6.144268**
lnpx2	**-.8435967**	**.3049354**	**-2.77**	**0.006**	**-1.441259**	**-.2459342**
lnpx3	**-1.460044**	**.4623671**	**-3.16**	**0.002**	**-2.366267**	**-.5538216**
lnpx4	**-1.009892**	**.7998393**	**-1.26**	**0.207**	**-2.577548**	**.557764**
_cons	**17.37893**	**14.61488**	**1.19**	**0.234**	**-11.26571**	**46.02357**
lndt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

Endogenous variables: lnst lnpd lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

22 . hausman twostage ols

	(b) twostage	(B) ols	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	Coefficients			
lnpd	2.10611	-1.111835	3.217945	1.873023
lnpx2	-.7279628	-.4189546	-.3090082	.266645
lnpx3	-1.122146	-.9424196	-.1797266	.3856712
lnpx4	-1.428722	-.521346	-.907376	.7012511

b = consistent under Ho and Ha; obtained from reg3
B = inconsistent under Ha, efficient under Ho; obtained from reg3

Test: Ho: difference in coefficients not systematic

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

23 . gen qt=dt if st>dt

24 . gen lnqt=ln(qt)

25 . reg3 (lnqt lnpd lnpx2 lnpx3 lnpx4) (lnqt lnpd lngdp), ols

Multivariate regression

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

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnqt						
lnpd	-1.353506	.3722912	-3.64	0.001	-2.108548	-.5984645
lnpx2	-.3864994	.1180437	-3.27	0.002	-.6259031	-.1470957
lnpx3	-.6782817	.2131651	-3.18	0.003	-1.110601	-.2459629
lnpx4	-.3606189	.2837767	-1.27	0.212	-.9361448	.2149069
_cons	40.10218	3.019386	13.28	0.000	33.97858	46.22578
2lnqt						
lnpd	-2.181329	.2946999	-7.40	0.000	-2.779008	-1.58365
lngdp	.5776586	.0887536	6.51	0.000	.397658	.7576593
_cons	31.03578	3.761201	8.25	0.000	23.40771	38.66385

26 . reg3 (lnqt lnpd lnpx2 lnpx3 lnpx4) (lnqt lnpd lngdp), 2sls nodfk inst(lnpx2 lnpx3 lnpx4 lngdp)

Two-stage least-squares regression

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

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnqt						
lnpd	**.7752765**	**1.360145**	**0.57**	**0.572**	**-1.983225**	**3.533778**
lnpx2	**-.5909191**	**.2136549**	**-2.77**	**0.009**	**-1.024231**	**-.1576068**
lnpx3	**-.7971771**	**.3277773**	**-2.43**	**0.020**	**-1.46194**	**-.132414**
lnpx4	**-.9608797**	**.551459**	**-1.74**	**0.090**	**-2.079291**	**.1575311**
_cons	**24.95604**	**9.919453**	**2.52**	**0.016**	**4.838457**	**45.07362**
2lnqt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.394875**	**-1.75344**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.327588**	**.7149961**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.57893**	**46.29105**

Endogenous variables: lnqt lnpd
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

27 . reg3 (lnqt lnpd lnpx2 lnpx3 lnpx4) (lnqt lnpd lngdp), 3sls inst(lnpx2 lnpx3 lnpx4 lngdp)

Three-stage least-squares regression

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

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnqt						
lnpd	**.7879239**	**1.360114**	**0.58**	**0.562**	**-1.877851**	**3.453699**
lnpx2	**-.6046439**	**.2134422**	**-2.83**	**0.005**	**-1.022983**	**-.1863049**
lnpx3	**-.8372831**	**.3273419**	**-2.56**	**0.011**	**-1.478861**	**-.1957047**
lnpx4	**-.9111679**	**.5511692**	**-1.65**	**0.098**	**-1.99144**	**.1691039**
_cons	**24.81121**	**9.918929**	**2.50**	**0.012**	**5.370467**	**44.25195**
2lnqt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

Endogenous variables: lnqt lnpd
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

28 . reg3 (lnqt lnpd lnpx2 lnpx3 lnpx4) (lnqt lnpd lngdp), 3sls ireg3 inst(lnpx2 lnpx3 lnpx4 lngdp)

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
lnqt	**22**	**4**	**.2063295**	**0.7629**	**80.89**	**0.0000**
2lnqt	**22**	**2**	**.135203**	**0.8982**	**178.41**	**0.0000**

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnqt						
lnpd	**.795862**	**1.370509**	**0.58**	**0.561**	**-1.890287**	**3.482011**
lnpx2	**-.6132584**	**.214736**	**-2.86**	**0.004**	**-1.034133**	**-.1923836**
lnpx3	**-.8624556**	**.3291486**	**-2.62**	**0.009**	**-1.507575**	**-.2173363**
lnpx4	**-.8799661**	**.5549316**	**-1.59**	**0.113**	**-1.967612**	**.2076798**
_cons	**24.72031**	**9.994251**	**2.47**	**0.013**	**5.131936**	**44.30868**
2lnqt						
lnpd	**-2.574157**	**.4046743**	**-6.36**	**0.000**	**-3.367304**	**-1.78101**
lngdp	**.5212921**	**.0955104**	**5.46**	**0.000**	**.3340951**	**.708489**
_cons	**35.93499**	**5.106302**	**7.04**	**0.000**	**25.92682**	**45.94316**

Endogenous variables: lnqt lnpd
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
29 . log close
      name:  <unnamed>
       log:  C:\Users\a\Desktop\426.a2.smcl
  log type:  smcl
 closed on:   3 Feb 2021, 18:22:59

30 .
```