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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**?

Demand and Supply Equations

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

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

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

In equilibrium, $\ln S_t = \ln D_t$

$$\beta_{10} + \beta_{11}\ln P_{Dt} + \beta_{12}\ln P_{x2t} + \beta_{13}\ln P_{x3t} + \beta_{14}\ln P_{x4t} + \varepsilon_{1t} = \beta_{20} + \beta_{21}\ln P_{Dt} + \beta_{22}\ln GDP_t + \varepsilon_{2t}$$

$$\beta_{11}\ln P_{Dt} - \beta_{21}\ln P_{Dt} = (\beta_{20} - \beta_{10}) - \beta_{12}\ln P_{x2t} - \beta_{13}\ln P_{x3t} - \beta_{14}\ln P_{x4t} + \beta_{22}\ln GDP_t + (\varepsilon_{2t} - \varepsilon_{1t})$$

$$(\beta_{11} - \beta_{21})\ln P_{Dt} = (\beta_{20} - \beta_{10}) - \beta_{12}\ln P_{x2t} - \beta_{13}\ln P_{x3t} - \beta_{14}\ln P_{x4t} + \beta_{22}\ln GDP_t + (\varepsilon_{2t} - \varepsilon_{1t})$$

$$\ln P_{Dt} = \frac{(\beta_{20} - \beta_{10})}{(\beta_{11} - \beta_{21})} - \frac{\beta_{12}\ln P_{x2t}}{(\beta_{11} - \beta_{21})} - \frac{\beta_{13}\ln P_{x3t}}{(\beta_{11} - \beta_{21})} - \frac{\beta_{14}\ln P_{x4t}}{(\beta_{11} - \beta_{21})} + \frac{\beta_{22}\ln GDP_t}{(\beta_{11} - \beta_{21})} + \frac{(\varepsilon_{2t} - \varepsilon_{1t})}{(\beta_{11} - \beta_{21})}$$

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

where $\pi_0 = \frac{\beta_{20} - \beta_{10}}{\beta_{11} - \beta_{21}}$, $\pi_1 = \frac{\beta_{12}}{\beta_{11} - \beta_{21}}$, $\pi_2 = \frac{\beta_{13}}{\beta_{11} - \beta_{21}}$

$\pi_3 = \frac{\beta_{14}}{\beta_{11} - \beta_{21}}$, $\pi_4 = \frac{\beta_{22}}{\beta_{11} - \beta_{21}}$, $w = \frac{\varepsilon_{2t} - \varepsilon_{1t}}{\beta_{11} - \beta_{21}}$

Next, plug in $\ln P_{Dt}$ into the supply equation.

$$\ln S_t = \beta_{10} + \beta_{11}(\pi_0 + \pi_1\ln P_{x2t} + \pi_2\ln P_{x3t} + \pi_3\ln P_{x4t} + \pi_4\ln GDP_t + w)$$
$$+ \beta_{12}\ln P_{x2t} + \beta_{13}\ln P_{x3t} + \beta_{14}\ln P_{x4t} + \varepsilon_{1t}$$

$$\ln S_t = \beta_{10} + \beta_{11}\pi_0 + \beta_{11}\pi_1\ln P_{x2t} + \beta_{11}\pi_2\ln P_{x3t} + \beta_{11}\pi_3\ln P_{x4t} + \beta_{11}\pi_4\ln GDP_t + \beta_{11}w$$
$$+ \beta_{12}\ln P_{x2t} + \beta_{13}\ln P_{x3t} + \beta_{14}\ln P_{x4t} + \varepsilon_{1t}$$

$$\ln S_t = (\beta_{10} + \beta_{11}\pi_0) + (\beta_{11}\pi_1 + \beta_{12})\ln P_{x2t} + (\beta_{11}\pi_2 + \beta_{13})\ln P_{x3t} + (\beta_{11}\pi_3 + \beta_{14})\ln P_{x4t}$$
$$+ \beta_{11}\pi_4 \ln GDP_t + (\beta_{11} w + \varepsilon_{1t})$$

and plug in $\ln P_{Dt}$ in the demand equation

$$\ln D_t = \beta_{20} + \beta_{21}(\pi_0 + \pi_1 \ln P_{x2t} + \pi_2 \ln P_{x3t} + \pi_3 \ln P_{x4t} + \pi_4 \ln GDP_t + w) + \beta_{22} GDP_t + \varepsilon_{2t}$$
$$\ln D_t = (\beta_{20} + \beta_{21}\pi_0) + \beta_{21}\pi_1 \ln P_{x2t} + \beta_{21}\pi_2 \ln P_{x3t} + \beta_{21}\pi \ln P_{x4t} + (\beta_{21}\pi_4 + \beta_{22})\ln GDP_t + (w + \varepsilon_{2t})$$

At this stage, I run $\ln P_{Dt}$ on all exogeneous variables which are $\ln P_{x2t}$, $\ln P_{x3t}$, $\ln P_{x4t}$, and $\ln GDP_t$. So,

$$\widehat{\ln P_{Dt}} = \underset{(2.43)}{2.87} + \underset{(0.07)}{0.13}\ln P_{x2t} + \underset{(0.13)}{0.09}\ln P_{x3t} + \underset{(0.19)}{0.49}\ln P_{x4t} + \underset{(0.09)}{0.16}\ln GDP_t$$

Next, I use the command "predict" to obtain the fitted value $\widehat{\ln P_{Dt}}$.

I also run $\ln S_t$ and $\ln D_t$ on all exogeneous variables as well.

$$\widehat{\ln S_t} = \underset{(5.31)}{24.66} - \underset{(0.15)}{0.45}\ln P_{x2t} - \underset{(0.28)}{0.92}\ln P_{x3t} - \underset{(0.42)}{0.39}\ln P_{x4t} + \underset{(0.19)}{0.34}\ln GDP_t$$

$$\widehat{\ln D_t} = \underset{(5.40)}{27.18} - \underset{(0.15)}{0.49}\ln P_{x2t} - \underset{(0.28)}{0.72}\ln P_{x3t} - \underset{(0.43)}{0.58}\ln P_{x4t} + \underset{(0.19)}{0.13}\ln GDP_t$$

STATA : # 11 - 12

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

I use $\widehat{\ln P_{Dt}}$ instead of $\ln P_{Dt}$ for both demand and supply equation, and run them (individually) by using OLS method.

Supply : $\widehat{\ln S_t} = 18.60 + \underset{(1.17)}{2.11} \widehat{\ln P_{Dt}} - \underset{(0.18)}{0.73} \ln P_{x2t} - \underset{(0.28)}{1.12} \ln P_{x3t} - \underset{(0.48)}{1.43} \ln P_{x4t}$.

Demand : $\widehat{\ln D_t} = 35.93 - \underset{(0.57)}{2.57} \widehat{\ln P_{Dt}} + \underset{(0.13)}{0.52} \ln GDP_t$

Stata : #13

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?

Next, I estimate this system by different methods. The results are as follows,

- OLS

  Supply : $\widehat{\ln S_t} = \underset{(3.66)}{41.49} - \underset{(0.45)}{1.11} \ln P_{Dt} - \underset{(0.14)}{0.42} \ln P_{x2t} - \underset{(0.26)}{0.94} \ln P_{x3t} - \underset{(0.34)}{0.52} \ln P_{x4t}$

  Demand : $\widehat{\ln D_t} = 31.04 - \underset{(0.29)}{2.18} \ln P_{Dt} + \underset{(0.09)}{0.58} \ln GDP_t$

- 2SLS

  Supply : $\widehat{\ln S_t} = \underset{(14.05)}{18.60} + \underset{(1.93)}{2.11} \ln P_{Dt} - \underset{(0.30)}{0.73} \ln P_{x2t} - \underset{(0.46)}{1.12} \ln P_{x3t} - \underset{(0.78)}{1.43} \ln P_{x4t}$.

  Demand : $\widehat{\ln D_t} = \underset{(5.11)}{35.93} - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.10)}{0.52} \ln GDP_t$

- 3SLS

  Supply : $\widehat{\ln S_t} = \underset{(14.04)}{17.85} + \underset{(1.93)}{2.17} \ln P_{Dt} - \underset{(0.30)}{0.80} \ln P_{x2t} - \underset{(0.46)}{1.33} \ln P_{x3t} - \underset{(0.78)}{1.17} \ln P_{x4t}$.

  Demand : $\widehat{\ln D_t} = \underset{(5.11)}{35.93} - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.10)}{0.52} \ln GDP_t$

- I3sls Supply : $\widehat{\ln S_t} = \underset{(14.61)}{17.38} + \underset{(2.00)}{2.21} \ln P_{Dt} - \underset{(0.30)}{0.84} \ln P_{x2t} - \underset{(0.46)}{1.46} \ln P_{x3t} - \underset{(0.80)}{1.01} \ln P_{x4t}$.

  Demand : $\widehat{\ln D_t} = \underset{(5.11)}{35.93} - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.10)}{0.52} \ln GDP_t$

Next, I perform hausman test to see whether endogeneity problem really occurs. The outcome, surprisingly, suggests that there is no endogeneity problem. Therefore, OLS should be the best; nevertheless, the coefficients of OLS contradict the economic theory.

Concerning with the asymptotic properties, I prefer choosing 2SLS because it gives us consistentcy (but biased) no matter whether or not the endogeneity exists. Plus, I decide not to choose 3SLS nor I3SLS because these 2 methods run in a system, which means if at least one equation contain specification error, the problem will spread to all equations in the system.

β_{21} shows the elasticity between domestic demand and domestic price at time t. In other words, the domestic demand will change β_{21} % if domestic price alters by 1 % .

β_{22} shows the elasticity between domestic demand and GDP at time t. In other words, the domestic demand will change β_{22} % if GDP alters by 1 % .

STATA : # 15 - 21

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.

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

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

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.

From the data, $D_t < S_t$ for all t; thus, $Q_t = D_t$.

Runing model (3) and (4), the results are as follows.

OLS

Supply: $\widehat{\ln Q_t} = \underset{(3.02)}{40.10} - \underset{(0.37)}{1.35} \ln P_{Dt} - \underset{(0.12)}{0.39} \ln P_{x2t} - \underset{(0.21)}{0.68} \ln P_{x3t} - \underset{(0.28)}{0.36} \ln P_{x4t}$

Demand: $\widehat{\ln Q_t} = \underset{(3.76)}{91.04} - \underset{(0.29)}{2.18} \ln P_{Dt} + \underset{(0.09)}{0.58} \ln GDP_t$

2SLS

Supply: $\widehat{\ln Q_t} = \underset{(9.92)}{24.96} + \underset{(1.36)}{0.78} \ln P_{Dt} - \underset{(0.21)}{0.59} \ln P_{x2t} - \underset{(0.33)}{0.80} \ln P_{x3t} - \underset{(0.55)}{0.96} \ln P_{x4t}$

Demand: $\widehat{\ln Q_t} = \underset{(5.11)}{35.93} - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.09)}{0.52} \ln GDP_t$

3SLS

Supply: $\widehat{\ln Q_t} = \underset{(9.92)}{24.81} + \underset{(1.36)}{0.79} \ln P_{Dt} - \underset{(0.21)}{0.60} \ln P_{x2t} - \underset{(0.33)}{0.84} \ln P_{x3t} - \underset{(0.55)}{0.91} \ln P_{x4t}$

Demand: $\widehat{\ln Q_t} = 35.93 - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.10)}{0.52} \ln GDP_t$

I3SLS

Supply: $\widehat{\ln Q_t} = \underset{(10.00)}{24.72} + \underset{(1.37)}{0.80} \ln P_{Dt} - \underset{(0.21)}{0.61} \ln P_{x2t} - \underset{(0.33)}{0.86} \ln P_{x3t} - \underset{(0.55)}{0.88} \ln P_{x4t}$

Demand: $\widehat{\ln Q_t} = \underset{(5.10)}{35.93} - \underset{(0.40)}{2.57} \ln P_{Dt} + \underset{(0.96)}{0.52} \ln GDP_t$

STATA : #23-28

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

In term of economic concept, OLS result gives the contradiction.

1) The intercept term of Supply equation is higher than of demand equation.

2) The relationship between price and quantity suppied is negative.

In term of econometric technique, we use only $Q_t = D_t$ as a dependent variable for both supply and demand equations.

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

```
      name:  <unnamed>
       log:  C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 2\Assignment2_Simultaneous eq.smcl
  log type:  smcl
 opened on:   3 Feb 2021, 17:46:17

 1 . do "C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 2\Assignment 2.do"

 2 . set more off

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

 4 . gen lnst = ln(st)

 5 . gen lndt = ln(dt)

 6 . gen lnpdt = ln(pm+t)

 7 . gen lnpx2 = ln(px2)

 8 . gen lnpx3 = ln(px3)

 9 . gen lnpx4 = ln(px4)

10 . gen lngdp = ln(gdp)
```

(a)

```
11 . reg lnpdt lnpx2 lnpx3 lnpx4 lngdp
```

Source	SS	df	MS
Model	.17707359	4	.044268398
Residual	.111247189	17	.006543952
Total	.288320779	21	.013729561

Number of obs	=	22
F(4, 17)	=	6.76
Prob > F	=	0.0019
R-squared	=	0.6142
Adj R-squared	=	0.5234
Root MSE	=	.08089

lnpdt	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

```
12 . predict lnpdthat
   (option xb assumed; fitted values)
```

(b)

```
13 . reg3 (lnst lnpdthat lnpx2 lnpx3 lnpx4) (lndt lnpdthat lngdp), ols
```

Multivariate regression

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lnst	22	4	.1764193	0.8978	37.32	0.0000
lndt	22	2	.1903701	0.8257	44.99	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnst						
lnpdthat	2.106112	1.171903	1.80	0.081	-.2706182	4.482842
lnpx2	-.727963	.1840856	-3.95	0.000	-1.101306	-.35462
lnpx3	-1.122146	.2824139	-3.97	0.000	-1.694908	-.5493846
lnpx4	-1.428722	.4751381	-3.01	0.005	-2.392347	-.4650969
_cons	18.59912	8.546622	2.18	0.036	1.265771	35.93248
lndt						
lnpdthat	-2.574157	.5697943	-4.52	0.000	-3.729753	-1.41856
lngdp	.5212927	.1344816	3.88	0.000	.2485513	.7940341
_cons	35.93498	7.189835	5.00	0.000	21.35331	50.51664

(c)

```
14 .
15 . reg3 (lnst lnpdt lnpx2 lnpx3 lnpx4) (lndt lnpdt 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						
lnpdt	-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						
lnpdt	-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

```
16 . estimates store ols

17 . reg3 (lnst lnpdt lnpx2 lnpx3 lnpx4) (lndt lnpdt 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						
lnpdt	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						
lnpdt	-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 lnpdt lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
18 . estimates store twostage

19 . reg3 (lnst lnpdt lnpx2 lnpx3 lnpx4) (lndt lnpdt 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						
lnpdt	**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						
lnpdt	**-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 lnpdt lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
20 . reg3 (lnst lnpdt lnpx2 lnpx3 lnpx4) (lndt lnpdt 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						
lnpdt	**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						
lnpdt	**-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 lnpdt lndt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

21 . hausman twostage ols

	—— Coefficients ——			
	(b) twostage	(B) ols	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnpdt	**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
```

(d)

```
22 .
23 . gen qt = dt if st>dt

24 . gen lnqt = ln(qt)

25 . reg3 (lnqt lnpdt lnpx2 lnpx3 lnpx4) (lnqt lnpdt 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						
lnpdt	-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						
lnpdt	-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 lnpdt lnpx2 lnpx3 lnpx4) (lnqt lnpdt 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						
lnpdt	**.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						
lnpdt	**-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 lnpdt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
27 . reg3 (lnqt lnpdt lnpx2 lnpx3 lnpx4) (lnqt lnpdt 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						
lnpdt	.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						
lnpdt	-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 lnpdt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
28 . reg3 (lnqt lnpdt lnpx2 lnpx3 lnpx4) (lnqt lnpdt 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						
lnpdt	.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						
lnpdt	-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 lnpdt
Exogenous variables: lnpx2 lnpx3 lnpx4 lngdp

```
29 .
   end of do-file

30 . log off
         name:  <unnamed>
          log:  C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 2\Assignment2_Simultaneous eq.smcl
     log type:  smcl
    paused on:   3 Feb 2021, 17:46:35
```

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   16.0   Copyright 1985-2019 StataCorp LLC
  Statistics/Data Analysis            StataCorp
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     MP - Parallel Edition            College Station, Texas 77845 USA
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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.
      4.  New update available; type -update all-

1 . use "C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 2\assign2.dta"

2 . set more off

3 .
4 . tsset obs
        time variable:  obs, 1986 to 2007
                delta:  1 unit

5 .
6 . gen lnst = ln(st)

7 .
```

```
 8 . gen lndt = ln(dt)

 9 .
10 . gen lnpdt = ln(pm+t)

11 .
12 . gen lnpx2 = ln(px2)

13 .
14 . gen lnpx3 = ln(px3)

15 .
16 . gen lnpx4 = ln(px4)

17 .
18 . gen lngdp = ln(gdp)

19 . reg lnst lnpx2 lnpx3 lnpx4 lngdp
```

Source	SS	df	MS			
				Number of obs	=	22
				F(4, 17)	=	37.32
Model	4.64569724	4	1.16142431	Prob > F	=	0.0000
Residual	.529104674	17	.031123804	R-squared	=	0.8978
				Adj R-squared	=	0.8737
Total	5.17480192	21	.246419139	Root MSE	=	.17642

lnst	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpx2	-.4503744	.1515961	-2.97	0.009	-.7702142	-.1305347
lnpx3	-.9242052	.2783356	-3.32	0.004	-1.511442	-.3369685
lnpx4	-.3883793	.4222332	-0.92	0.371	-1.279214	.5024549
lngdp	.3438812	.1913463	1.80	0.090	-.0598242	.7475865
_cons	24.65741	5.309757	4.64	0.000	13.4548	35.86002

```
20 . reg lndt lnpx2 lnpx3 lnpx4 lngdp

      Source |       SS           df       MS      Number of obs   =        22
-------------+----------------------------------   F(4, 17)        =     26.43
       Model |   3.4026552         4  .850663799   Prob > F        =    0.0000
    Residual |   .54721789        17  .032189288   R-squared       =    0.8615
-------------+----------------------------------   Adj R-squared   =    0.8289
       Total |  3.94987309        21  .188089195   Root MSE        =    .17941

------------------------------------------------------------------------------
        lndt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnpx2 |  -.4887365   .1541691    -3.17   0.006    -.8140049   -.1634682
       lnpx3 |  -.7243134   .2830597    -2.56   0.020    -1.321517   -.1271097
       lnpx4 |   -.577921   .4293997    -1.35   0.196    -1.483875    .3280333
       lngdp |   .1265855    .194594     0.65   0.524    -.2839719    .5371429
       _cons |   27.18614   5.399879     5.03   0.000     15.79339    38.57889
------------------------------------------------------------------------------

21 .
```