

## Assignment 2 Solution Simultaneous Equations Model

### Demand and Supply Equations

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

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

- where:  $S_t$  = Domestic Supply at time  $t$   
 $D_t$  = Domestic Demand at time  $t$   
 $P_{Dt}$  = Domestic Price at time  $t = P_{Mt} + T_t$   
 $P_{Mt}$  = 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  $t$   
 $GDP_t$  = Gross Domestic 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  $GDP_t$

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  $\beta_{11}$  and  $\beta_{21}$  mean?

1. State reduce form model of these system models.

$$\ln S_t = \pi_{10} + \pi_{11} \ln P_{X2t} + \pi_{12} \ln P_{X3t} + \pi_{13} \ln P_{X4t} + \pi_{14} \ln GDP_t + w_{1t}$$

$$\ln D_t = \pi_{20} + \pi_{21} \ln P_{X2t} + \pi_{22} \ln P_{X3t} + \pi_{23} \ln P_{X4t} + \pi_{24} \ln GDP_t + w_{2t}$$

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

```
. tsset obs
      time variable: obs, 1986 to 2007
      delta: 1 unit
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```
. g lnst=ln(st)
. g lndt=ln(dt)
. g pd=pm+t
. g lnpd=ln(pd)
. g lnpx2=ln(px2)
. g lnpx3=ln(px3)
. g lnpx4=ln(px4)
. g lngdp=ln(gdp)
```

```
. reg lnst lnpx2 lnpx3 lnpx4 lngdp
```

Source	SS	df	MS			
Model	4.64569724	4	1.16142431	Number of obs =	22	
Residual	.529104674	17	.031123804	F( 4, 17) =	37.32	
Total	5.17480192	21	.246419139	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]	
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

```
. predict lnsthat, xb
```

```
. reg lndt lnpx2 lnpx3 lnpx4 lngdp
```

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

```
. predict lndthat, xb
```

```
. reg lnpd lnpx2 lnpx3 lnpx4 lngdp
```

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

. 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 = 22		
Model	4.64569773	4	1.16142443	F( 4, 17)	=	37.32
Residual	.529104183	17	.031123775	Prob > F	=	0.0000
Total	5.17480192	21	.246419139	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

. reg lndt lnpdhat lngdp

Source	SS	df	MS	Number of obs = 22		
Model	3.26129847	2	1.63064924	F( 2, 19)	=	44.99
Residual	.688574614	19	.036240769	Prob > F	=	0.0000
Total	3.94987309	21	.188089195	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

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 lngdp), ols lnst(lnpx2 lnpx3 lnpx4 lngdp)

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

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

Two-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	F-Stat	P
lnst	22	4	.329951	0.6424	10.67	0.0000
lndt	22	2	.1454858	0.8982	77.04	0.0000

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
lnst					
lnpd	2.10611	2.191774	0.96	0.343	-2.339013 6.551233
lnpx2	-.7279628	.3442892	-2.11	0.041	-1.426214 -.0297119
lnpx3	-1.122146	.528189	-2.12	0.041	-2.193363 -.0509293
lnpx4	-1.428722	.8886357	-1.61	0.117	-3.230959 .3735147
_cons	18.59914	15.98447	1.16	0.252	-13.81886 51.01715
lndt					
lnpd	-2.574157	.4354519	-5.91	0.000	-3.457295 -1.69102
lngdp	.5212921	.1027745	5.07	0.000	.3128558 .7297283
_cons	35.93499	5.494663	6.54	0.000	24.7913 47.07868

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

. 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"	chi 2	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

. 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"	chi 2	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
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Indt						
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
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Endogenous variables:	Inst	lnpd	Indt			
Exogenous variables:	lnpx2	lnpx3	lnpx4	lngdp		
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5. What does  $\beta_{11}$  and  $\beta_{21}$  mean?

$\beta_{11}$  represents price elasticity of quantity supply.

$\beta_{21}$  represents price elasticity of quantity demand.