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Assignment 3

From the data set `assign3.dta`:

The study of production function assumes the model follows CES production function:

$$y = \gamma\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{-\frac{\nu}{\rho}} + \varepsilon \tag{1}$$

where:

	y	= Output
	K	= Capital Input
	L	= Labor Input
gamma	γ	= Efficiency Parameter
delta	δ	= Distribution Parameter
nu	ν	= Parameter
rho	ρ	= Substitution Parameter
	ε	= Disturbance Term

Elasticity of Substitution can be computed from: $\sigma = \dfrac{1}{1-\rho}$

The model can then be transformed as:

$$\ln y = \ln\gamma - \frac{\nu}{\rho}\ln\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right] + \varepsilon \tag{2}$$

a. Estimate the model (1) using NLS estimation method using initial values of γ=4, δ=0, ρ= –1, ν=1. Determine the estimated value of efficiency parameter (γ), distribution parameter (δ), parameter (ν), and substitution parameter (ρ), and elasticity of substitution (σ). Perform F-test to test whether δ=0, ρ=0, and ν=0.

b. Estimate the model (2) using NLS estimation method initial values of lnγ=4, δ=0, ρ= –1, ν=1. Determine the estimated value of efficiency parameter (γ), distribution parameter (δ), parameter (ν), and substitution parameter (ρ), and elasticity of substitution (σ). Perform F-test to test whether δ=0, ρ=0, and ν=0.

c. From (a), if we change initial values to be γ=55, δ=0, ρ= –1, ν=1, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

d. From (a), if we change convergence value from default of 0.00001 or (1e-5) to (i) 0.1 or (1e-1) and (ii) (1e-15) with maximum iteration of 100, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

e. From (b), if we change initial values to be lnγ=55, δ=0, ρ= –1, ν=1, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

f. From (b), if we change convergence value from default of 0.00001 or (1e-5) to (i) 0.1 or (1e-1) and (ii) (1e-15) with maximum iteration of 100, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

g. Make comparison of the estimated results of model (1) and model (2). Which estimated result should be used in this case? Why?

a. Estimate the model (1) using NLS estimation method using initial values of γ=4, δ=0, ρ= –1, ν=1. Determine the estimated value of efficiency parameter (γ), distribution parameter (δ), parameter (ν), and substitution parameter (ρ), and elasticity of substitution (σ). Perform F-test to test whether δ=0, ρ=0, and ν=0.

```
3 . nl (y = {gamma}*(({delta}*k^(-{rho}))+((1-{delta})*l^(-{rho})))^(-{nu}/{rho})), init(gamma 4 delta 0 rho -1 nu 1) nolog
  (obs = 800)

      Source |      SS            df       MS
-------------+----------------------------------    Number of obs =        800
       Model |  2.363e+20          4  5.9080e+19    R-squared     =     0.9622
    Residual |  9.271e+18        796  1.1647e+16    Adj R-squared =     0.9621
-------------+----------------------------------    Root MSE      =   1.08e+08
       Total |  2.456e+20        800  3.0699e+17    Res. dev.     =   31861.36

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /gamma |   2.89e-17   6.45e-17     0.45   0.654    -9.77e-17    1.55e-16
      /delta |   .8017609   .0319332    25.11   0.000     .7390776    .8644443
        /rho |   -1.88296   .2889715    -6.52   0.000    -2.450197   -1.315724
         /nu |    3.39589   .1261608    26.92   0.000     3.148243    3.643537
------------------------------------------------------------------------------

4 . test (_b[/delta]=0) (_b[/rho]=0) (_b[/nu]=0)

 ( 1)  [delta]_cons = 0
 ( 2)  [rho]_cons = 0
 ( 3)  [nu]_cons = 0

       F(  3,   796) = 7383.35
            Prob > F =    0.0000
```

From the estimated result of model (1) by setting $\gamma = 4$, $\delta = 0$, $\rho = -1$, $\nu = 1$ as the initial values,

$$y = \gamma\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{-\frac{\nu}{\rho}} + \varepsilon \qquad \text{—— (1)}$$

- the efficiency parameter (γ) = 2.89e-17
- the distribution parameter (δ) = 0.8017
- parameter ν = 3.39589
- substituition parameter (ρ) = -1.88
- elasticity of subsituition (σ) $= \frac{1}{1-\rho} = 0.3469$

Next, testing whether $\delta = \rho = \nu = 0$ by using F-test, the result shows p-value = 0.00 which implies that δ, ρ, ν are jointly statistically significant.

b. Estimate the model (2) using NLS estimation method initial values of $\ln\gamma$=4, δ=0, ρ= −1, ν=1. Determine the estimated value of efficiency parameter (γ), distribution parameter (δ), parameter (ν), and substitution parameter (ρ), and elasticity of substitution (σ). Perform F-test to test whether δ=0, ρ=0, and ν=0.

```
7 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1)
  (obs = 800)

  Iteration 0:  residual SS =  1143.768
  Iteration 1:  residual SS =  1141.441
  Iteration 2:  residual SS =  1079.391
  Iteration 3:  residual SS =  1056.941
  Iteration 4:  residual SS =  1021.525
  Iteration 5:  residual SS =  983.1424
  Iteration 6:  residual SS =  899.3974
  Iteration 7:  residual SS =  828.0449
  Iteration 8:  residual SS =  820.0263
  Iteration 9:  residual SS =  819.9925
  Iteration 10:  residual SS =  819.9925
  Iteration 11:  residual SS =  819.9925
  Iteration 12:  residual SS =  819.9925
  Iteration 13:  residual SS =  819.9925
```

Source	SS	df	MS
Model	976.20485	3	325.401616
Residual	819.99246	796	1.03014129
Total	1796.1973	799	2.24805671

Number of obs =	800
R-squared =	0.5435
Adj R-squared =	0.5418
Root MSE =	1.014959
Res. dev. =	2290.048

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
/gamma	44.6476	18.90459	2.36	0.018	7.538852	81.75634
/nu	.9727292	.0317774	30.61	0.000	.9103518	1.035107
/rho	-.8079829	.2186236	-3.70	0.000	-1.23713	-.378836
/delta	.2351025	.0328464	7.16	0.000	.1706266	.2995783

Parameter gamma taken as constant term in model & ANOVA table

```
8 . test (_b[/delta]=0) (_b[/rho]=0) (_b[/nu]=0)

 ( 1)  [delta]_cons = 0
 ( 2)  [rho]_cons = 0
 ( 3)  [nu]_cons = 0

       F(  3,   796) =  366.55
            Prob > F =    0.0000
```

From the estimated result of model (2) by setting $\gamma = 4$, $\delta = 0$, $\rho = -1$, $\nu = 1$ as the initial values,

$$\ln y = \ln\gamma - \frac{\nu}{\rho}\ln\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right] + \varepsilon \quad \text{——— (2)}$$

- the efficiency parameter (γ) = 44.6476
- the distribution parameter (δ) = 0.2351
- parameter ν = 0.9727
- substituition parameter (ρ) = −0.8080
- elasticity of subsituition (σ) $= \frac{1}{1-\rho} = 0.5531$

Next, testing whether $\delta = \rho = \nu = 0$ by using F-test, the result shows p-value = 0.00 which implies that δ, ρ, ν are jointly statistically significant.

c. From (a), if we change initial values to be γ=55, δ=0, ρ= –1, ν=1, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

From model (1), when we change the initial values to be $\gamma = 55$, $\delta = 0$, $\rho = -1$, $\nu = -1$, the estimated result has significant changes as shown below.

```
7 . nl (y = {gamma}*( ({delta}*k^(-{rho})) + ((1-{delta})*l^(-{rho})) )^(-{nu}/{rho})), init(gamma 55 delta 0 rho -1 nu 1)
(obs = 800)

Iteration 0:  residual SS =  1.65e+20
Iteration 1:  residual SS =  1.62e+20
Iteration 2:  residual SS =  1.62e+20
Iteration 3:  residual SS =  1.62e+20
Iteration 4:  residual SS =  1.61e+20
Iteration 5:  residual SS =  1.42e+20
Iteration 6:  residual SS =  1.42e+20
Iteration 7:  residual SS =  1.42e+20
Iteration 8:  residual SS =  1.41e+20
Iteration 9:  residual SS =  1.41e+20
Iteration 10:  residual SS =  1.41e+20
Iteration 11:  residual SS =  1.38e+20
Iteration 12:  residual SS =  1.36e+20
Iteration 13:  residual SS =  1.35e+20
Iteration 14:  residual SS =  1.35e+20
Iteration 15:  residual SS =  1.35e+20
Iteration 16:  residual SS =  1.35e+20
Iteration 17:  residual SS =  1.35e+20
Iteration 18:  residual SS =  1.35e+20
Iteration 19:  residual SS =  1.35e+20
```

Source	SS	df	MS
Model	1.105e+20	4	2.7614e+19
Residual	1.351e+20	796	1.6977e+17
Total	2.456e+20	800	3.0699e+17

Number of obs =	800
R-squared =	0.4497
Adj R-squared =	0.4470
Root MSE =	4.12e+08
Res. dev. =	34004.87

y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	15.22065	9.365261	1.63	0.105	-3.162876	33.60418
/delta	.054846	2.020678	0.03	0.978	-3.911641	4.021333
/rho	-38.85703	533.4338	-0.07	0.942	-1085.96	1008.246
/nu	1.063579	.0348938	30.48	0.000	.9950845	1.132074

- the efficient parameter (γ) changes from 2.89e-17 to 15.22
- the distribution parameter (δ) changes from 0.8017 to 0.0548
- parameter ν changes from 3.39589 to 1.0636
- substituition parameter (ρ) changes from -1.88 to -38.8570
- elasticity of subsituition (σ) changes from 0.3469 to 0.0251

It is obvious that the initial values are vital. They affect the estimated result under non-linear least square (NLS), because it is "non-linear". So, we have to do the linear approximation, and the formula is $f(x_1) \cong f(x_0) + \left.\frac{\partial f(x)}{\partial x}\right|_{x=x_0} (x_1 - x_0) + 0$. Thus, the initial value is important. Moreover, R^2 significantly drops from 0.9622 to 0.4497.

d. From (a), if we change convergence value from default of 0.00001 or (1e-5) to (i) 0.1 or (1e-1) and (ii) (1e-15) with maximum iteration of 100, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

From the (1) model with the same set of initial values ($\gamma = 4$, $\delta = 0$, $\rho = -1$, $\nu = 1$),

(i) changes the convergence value to 0.1 (1e-1)

```
8 . nl (y = {gamma}*( ({delta}*k^(-{rho})) + ((1-{delta})*l^(-{rho})) )^(-{nu}/{rho})), init(gamma 4 delta 0 rho -1 nu 1) eps(1e-1)
  (obs = 800)

  Iteration 0:  residual SS =  2.35e+20
  Iteration 1:  residual SS =  2.35e+20
```

Source	SS	df	MS		
Model	1.043e+19	4	2.6070e+18	Number of obs =	800
Residual	2.352e+20	796	2.9543e+17	R-squared =	0.0425
				Adj R-squared =	0.0376
				Root MSE =	5.44e+08
Total	2.456e+20	800	3.0699e+17	Res. dev. =	34448.06

y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	4.000008	15.18698	0.26	0.792	-25.81125	33.81127
/delta	1.29e-07	.0001604	0.00	0.999	-.0003147	.000315
/rho	-29.02049	2408.079	-0.01	0.990	-4755.956	4697.915
/nu	1	.2149295	4.65	0.000	.5781045	1.421896

★ (Baseline) Estimated Result

y	Coef.
/gamma	2.89e-17
/delta	.8017609
/rho	-1.88296
/nu	3.39589

(ii) changes the convergence value to 1e-15 with 100 maximum iteration times.

```
convergence not achieved
r(430);
```

The estimated results differ from our baseline result because we change the convergence value. (Because NLS is an iterative process, the process keep repeating until one value converges to the convergence value). Thus, if we change our convergence value, the result may differ or we do not get the result as in case (ii).

e. From (b), if we change initial values to be $\ln\gamma$=55, δ=0, ρ= –1, ν=1, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

From model (2), if we change the initial values to be $\ln\gamma = 55$, $\delta = 0$, $\rho = -1$, $\nu = 1$, the estimated result will be as follows.

```
12 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(55) delta 0 rho -1 nu 1)
  (obs = 800)

Iteration 0:  residual SS =   2124794
Iteration 1:  residual SS =   2116579
Iteration 2:  residual SS =   2116571
Iteration 3:  residual SS =   2116504
Iteration 4:  residual SS =   2114468
Iteration 5:  residual SS =   2081538
Iteration 6:  residual SS =   1955293
Iteration 7:  residual SS =   1835355
Iteration 8:  residual SS =   1039523
Iteration 9:  residual SS =  611499.3
Iteration 10:  residual SS =    340404
Iteration 11:  residual SS =  98584.86
Iteration 12:  residual SS =  30130.18
Iteration 13:  residual SS =   16931.5
Iteration 14:  residual SS =  16871.05
Iteration 15:  residual SS =  16866.65
Iteration 16:  residual SS =  16866.63
Iteration 17:  residual SS =  16866.61
Iteration 18:  residual SS =  16866.61
Iteration 19:  residual SS =  16866.61
Iteration 20:  residual SS =  16866.61
Iteration 21:  residual SS =  16866.61
```

beginning model

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	44.6476	18.90459	2.36	0.018	7.538852	81.75634
/nu	.9727292	.0317774	30.61	0.000	.9103518	1.035107
/rho	-.8079829	.2186236	-3.70	0.000	-1.23713	-.378836
/delta	.2351025	.0328464	7.16	0.000	.1706266	.2995783

Parameter gamma taken as constant term in model & ANOVA table

$\neq$

Source	SS	df	MS
Model	-15070.41	2	-7535.20503
Residual	16866.607	797	21.162619
Total	1796.1973	799	2.24805671

```
Number of obs =        800
R-squared     =    -8.3902
Adj R-squared =    -8.4137
Root MSE      =   4.600285
Res. dev.     =   4709.085
```

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	7.69e+23	.	.	.	.	.
/nu	-2.769633	.0616376	-44.93	0.000	-2.890625	-2.648642
/rho	-38.85713	698.2575	-0.06	0.956	-1409.498	1331.784
/delta	.5869311	1.981458	0.30	0.767	-3.302562	4.476424

Parameter gamma taken as constant term in model & ANOVA table

The result is absolutely different from our begining model (with initial value $\ln\gamma = 4$). Noticeably, the R^2 and adj-R^2 of this model, given initial value $\ln\gamma = 55$, are negative. These occur because we change our initial values. According to what we have discussed, initial values are really important, we have to choose them carefully.

f. From (b), if we change convergence value from default of 0.00001 or (1e-5) to (i) 0.1 or (1e-1) and (ii) (1e-15) with maximum iteration of 100, what will happen to the estimated result? Interpret the estimated result and why do we get this kind of result? (Make comparison between previous result and the new result)

From the model (2) with the same set of initial values ($\ln\gamma = 4$, $\delta = 0$, $\rho = -1$, $\nu = 1$),

(i) change convergence value to 0.1 (1e-1)

```
14 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1) eps(1e-1)
  (obs = 800)

  Iteration 0:  residual SS =  1143.768
  Iteration 1:  residual SS =  1141.441
  Iteration 2:  residual SS =  1079.391
  Iteration 3:  residual SS =  1056.941
  Iteration 4:  residual SS =  1021.525
  Iteration 5:  residual SS =  983.1424
  Iteration 6:  residual SS =  899.3974
  Iteration 7:  residual SS =  828.0449
  Iteration 8:  residual SS =  820.0263
  Iteration 9:  residual SS =  819.9925


        Source |      SS            df       MS
  -------------+----------------------------------    Number of obs =        800
         Model |  976.20485          3  325.401616    R-squared     =     0.5435
      Residual |  819.99247        796  1.03014129    Adj R-squared =     0.5418
  -------------+----------------------------------    Root MSE      =   1.014959
         Total |  1796.1973        799  2.24805671    Res. dev.     =   2290.048

  ------------------------------------------------------------------------------
           lny |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
  -------------+----------------------------------------------------------------
        /gamma |   44.64812   18.77956     2.38   0.018     7.784805    81.51144
           /nu |   .9727292   .0317774    30.61   0.000     .9103518    1.035107
          /rho |  -.8077342   .2189572    -3.69   0.000    -1.237536   -.3779324
        /delta |   .2351088   .0328584     7.16   0.000     .1706095    .2996081
  ------------------------------------------------------------------------------
    Parameter nu taken as constant term in model & ANOVA table
```

=

(ii) change convergence value to 1e-15 (100 maximum iteration time)

```
16 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1) eps(1e-15) iterate(100)
  (obs = 800)

  Iteration 0:  residual SS =  1143.768
  Iteration 1:  residual SS =  1141.441
  Iteration 2:  residual SS =  1079.391
  Iteration 3:  residual SS =  1056.941
  Iteration 4:  residual SS =  1021.525
  Iteration 5:  residual SS =  983.1424
  Iteration 6:  residual SS =  899.3974
  Iteration 7:  residual SS =  828.0449
  Iteration 8:  residual SS =  820.0263
  Iteration 9:  residual SS =  819.9925
  Iteration 10:  residual SS =  819.9925
  Iteration 11:  residual SS =  819.9925
  Iteration 12:  residual SS =  819.9925
  Iteration 13:  residual SS =  819.9925
  Iteration 14:  residual SS =  819.9925
  Iteration 15:  residual SS =  819.9925
  Iteration 16:  residual SS =  819.9925
  Iteration 17:  residual SS =  819.9925
  Iteration 18:  residual SS =  819.9925
  Iteration 19:  residual SS =  819.9925

        Source |      SS            df       MS
  -------------+----------------------------------    Number of obs =        800
         Model |  222930.73          4  55732.6813    R-squared     =     0.9963
      Residual |  819.99246        796  1.03014129    Adj R-squared =     0.9963
  -------------+----------------------------------    Root MSE      =   1.014959
         Total |  223750.72        800  279.688397    Res. dev.     =   2290.048

  ------------------------------------------------------------------------------
           lny |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
  -------------+----------------------------------------------------------------
        /gamma |   44.64759   18.90461     2.36   0.018     7.538809    81.75637
           /nu |   .9727292   .0317774    30.61   0.000     .9103518    1.035107
          /rho |  -.8079839   .2186225    -3.70   0.000    -1.237129   -.3788391
        /delta |   .2351024   .0328463     7.16   0.000     .1706267    .2995781
  ------------------------------------------------------------------------------
```

=

★ beginning model

```
  ------------------------------------------------------------------------------
           lny |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
  -------------+----------------------------------------------------------------
        /gamma |    44.6476   18.90459     2.36   0.018     7.538852    81.75634
           /nu |   .9727292   .0317774    30.61   0.000     .9103518    1.035107
          /rho |  -.8079829   .2186236    -3.70   0.000     -1.23713    -.378836
        /delta |   .2351025   .0328464     7.16   0.000     .1706266    .2995783
  ------------------------------------------------------------------------------
    Parameter gamma taken as constant term in model & ANOVA table
```

Surprisingly, the estimated result of the model is almost the same even we keep changing the convergence value. However, what differs among these three cases is R^2 (and adj-R^2). When we change the convergence value to 1e-15 (smallest), we get the highest R^2.

This happens might be because our model is in the log-form.

g. Make comparison of the estimated results of model (1) and model (2). Which estimated result should be used in this case? Why?

As we have seen from a) to f), the estimated result of model (1) varies when we change either initial value or convergence value; also, we might not get the result as well. On the contrary, the estimated result of model (2) is much more stable when we change the convergence value; however, it changes when we change the initial value as well.

To conclude, the estimated result of model (2) should be used backing up by the reasons mentioned above. To be more precise, I think the estimated result from f)-(ii) should be employed because we set the convergence value to be very small (close to zero) and R^2 is extremely high (R^2 = 0.9963)

```
  ___  ____  ____  ____  ____(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
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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 . doedit "C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 3\Assignment 3.do"

2 . use "C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 3\assign3.dta"

3 . do "C:\Users\Chaiyapong M\Desktop\BE\EE426\Assignment 3\Assignment 3.do"

4 . set more off
```

(a)

```
5 . nl (y = {gamma}*(({delta}*k^(-{rho}))+((1-{delta})*l^(-{rho})))^(-{nu}/{rho}))
> , init(gamma 4 delta 0 rho -1 nu 1) nolog
(obs = 800)
```

Source	SS	df	MS			
				Number of obs	=	800
Model	2.363e+20	4	5.9080e+19	R-squared	=	0.9622
Residual	9.271e+18	796	1.1647e+16	Adj R-squared	=	0.9621
				Root MSE	=	1.08e+08
Total	2.456e+20	800	3.0699e+17	Res. dev.	=	31861.36

y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	2.89e-17	6.45e-17	0.45	0.654	-9.77e-17	1.55e-16
/delta	.8017609	.0319332	25.11	0.000	.7390776	.8644443
/rho	-1.88296	.2889715	-6.52	0.000	-2.450197	-1.315724
/nu	3.39589	.1261608	26.92	0.000	3.148243	3.643537

```
6 . test (_b[/delta]=0) (_b[/rho]=0) (_b[/nu]=0)

 ( 1)  [delta]_cons = 0
 ( 2)  [rho]_cons = 0
 ( 3)  [nu]_cons = 0

       F(  3,   796) = 7383.35
            Prob > F =    0.0000
```

(b)

```
7 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1)
  (obs = 800)

  Iteration 0:  residual SS =  1143.768
  Iteration 1:  residual SS =  1141.441
  Iteration 2:  residual SS =  1079.391
  Iteration 3:  residual SS =  1056.941
  Iteration 4:  residual SS =  1021.525
  Iteration 5:  residual SS =  983.1424
  Iteration 6:  residual SS =  899.3974
  Iteration 7:  residual SS =  828.0449
  Iteration 8:  residual SS =  820.0263
  Iteration 9:  residual SS =  819.9925
  Iteration 10:  residual SS =  819.9925
  Iteration 11:  residual SS =  819.9925
  Iteration 12:  residual SS =  819.9925
  Iteration 13:  residual SS =  819.9925
```

Source	SS	df	MS
Model	976.20485	3	325.401616
Residual	819.99246	796	1.03014129
Total	1796.1973	799	2.24805671

Number of obs =	800
R-squared =	0.5435
Adj R-squared =	0.5418
Root MSE =	1.014959
Res. dev. =	2290.048

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	44.6476	18.90459	2.36	0.018	7.538852	81.75634
/nu	.9727292	.0317774	30.61	0.000	.9103518	1.035107
/rho	-.8079829	.2186236	-3.70	0.000	-1.23713	-.378836
/delta	.2351025	.0328464	7.16	0.000	.1706266	.2995783

Parameter gamma taken as constant term in model & ANOVA table

```
8 . test (_b[/delta]=0) (_b[/rho]=0) (_b[/nu]=0)

 ( 1)  [delta]_cons = 0
 ( 2)  [rho]_cons = 0
 ( 3)  [nu]_cons = 0

       F(  3,   796) =  366.55
            Prob > F =    0.0000
```

(C)

```
9 . nl (y = {gamma}*( ({delta}*k^(-{rho})) + ((1-{delta})*l^(-{rho})) )^(-{nu}/{rho})), init(gamma 55 delta 0 rho -1 nu 1)
  (obs = 800)

  Iteration 0:  residual SS =  1.65e+20
  Iteration 1:  residual SS =  1.62e+20
  Iteration 2:  residual SS =  1.62e+20
  Iteration 3:  residual SS =  1.62e+20
  Iteration 4:  residual SS =  1.61e+20
  Iteration 5:  residual SS =  1.42e+20
  Iteration 6:  residual SS =  1.42e+20
  Iteration 7:  residual SS =  1.42e+20
  Iteration 8:  residual SS =  1.41e+20
  Iteration 9:  residual SS =  1.41e+20
  Iteration 10:  residual SS =  1.41e+20
  Iteration 11:  residual SS =  1.38e+20
  Iteration 12:  residual SS =  1.36e+20
  Iteration 13:  residual SS =  1.35e+20
  Iteration 14:  residual SS =  1.35e+20
  Iteration 15:  residual SS =  1.35e+20
  Iteration 16:  residual SS =  1.35e+20
  Iteration 17:  residual SS =  1.35e+20
  Iteration 18:  residual SS =  1.35e+20
  Iteration 19:  residual SS =  1.35e+20
```

```
      Source |       SS           df       MS
-------------+----------------------------------    Number of obs =        800
       Model |  1.105e+20          4  2.7614e+19    R-squared     =     0.4497
    Residual |  1.351e+20        796  1.6977e+17    Adj R-squared =     0.4470
-------------+----------------------------------    Root MSE      =   4.12e+08
       Total |  2.456e+20        800  3.0699e+17    Res. dev.     =   34004.87

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /gamma |   15.22065   9.365261     1.63   0.105    -3.162876    33.60418
      /delta |    .054846   2.020678     0.03   0.978    -3.911641    4.021333
        /rho |  -38.85703   533.4338    -0.07   0.942     -1085.96    1008.246
         /nu |   1.063579   .0348938    30.48   0.000     .9950845    1.132074
------------------------------------------------------------------------------
```

(d)

```
10 . nl (y = {gamma}*( ({delta}*k^(-{rho})) + ((1-{delta})*l^(-{rho})) )^(-{nu}/{rho})), init(gamma 4 delta 0 rho -1 nu 1) eps(1e-1)
   (obs = 800)

   Iteration 0:  residual SS =  2.35e+20
   Iteration 1:  residual SS =  2.35e+20


      Source |       SS           df       MS
-------------+----------------------------------    Number of obs =        800
       Model |  1.043e+19          4  2.6070e+18    R-squared     =     0.0425
    Residual |  2.352e+20        796  2.9543e+17    Adj R-squared =     0.0376
-------------+----------------------------------    Root MSE      =   5.44e+08
       Total |  2.456e+20        800  3.0699e+17    Res. dev.     =   34448.06

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /gamma |   4.000008   15.18698     0.26   0.792    -25.81125    33.81127
      /delta |   1.29e-07   .0001604     0.00   0.999    -.0003147     .000315
        /rho |  -29.02049   2408.079    -0.01   0.990    -4755.956    4697.915
         /nu |          1   .2149295     4.65   0.000     .5781045    1.421896
------------------------------------------------------------------------------
```

```
11 . nl (y = {gamma}*( ({delta}*k^(-{rho})) + ((1-{delta})*l^(-{rho})) )^(-{nu}/{rho})), init(gamma 4 delta 0 rho -1 nu 1) eps(1e-15) iterate(100)
   (obs = 800)

   Iteration 0:  residual SS =  2.35e+20
   Iteration 1:  residual SS =  2.35e+20
   Iteration 2:  residual SS =  2.35e+20
   Iteration 3:  residual SS =  2.35e+20
   Iteration 4:  residual SS =  2.35e+20
   Iteration 5:  residual SS =  2.35e+20
   Iteration 6:  residual SS =  2.35e+20
   Iteration 7:  residual SS =  2.35e+20
   Iteration 8:  residual SS =  2.35e+20
   Iteration 9:  residual SS =  2.35e+20
   Iteration 10:  residual SS =  2.35e+20
   Iteration 11:  residual SS =  2.35e+20
   Iteration 12:  residual SS =  2.35e+20
   Iteration 13:  residual SS =  2.35e+20
   Iteration 14:  residual SS =  2.35e+20
   Iteration 15:  residual SS =  2.35e+20
   Iteration 16:  residual SS =  2.35e+20
   Iteration 17:  residual SS =  2.35e+20
   Iteration 18:  residual SS =  2.35e+20
   Iteration 19:  residual SS =  2.35e+20
   Iteration 20:  residual SS =  2.35e+20
   Iteration 21:  residual SS =  2.35e+20
   Iteration 22:  residual SS =  2.35e+20
   Iteration 23:  residual SS =  2.35e+20
   Iteration 24:  residual SS =  2.35e+20
   Iteration 25:  residual SS =  2.35e+20
   Iteration 26:  residual SS =  2.35e+20
   Iteration 27:  residual SS =  2.35e+20
   Iteration 28:  residual SS =  2.35e+20
   Iteration 29:  residual SS =  2.35e+20
   Iteration 30:  residual SS =  2.35e+20
   Iteration 31:  residual SS =  2.35e+20
   Iteration 32:  residual SS =  2.35e+20
   Iteration 33:  residual SS =  2.35e+20
   Iteration 34:  residual SS =  2.35e+20
   Iteration 35:  residual SS =  2.35e+20
   Iteration 36:  residual SS =  2.35e+20
   Iteration 37:  residual SS =  2.35e+20
   Iteration 38:  residual SS =  2.35e+20
   Iteration 39:  residual SS =  2.35e+20
   Iteration 40:  residual SS =  2.35e+20
   Iteration 41:  residual SS =  2.35e+20
   Iteration 42:  residual SS =  2.35e+20
   Iteration 43:  residual SS =  2.35e+20
```

```
Iteration 44:  residual SS =  2.35e+20
Iteration 45:  residual SS =  2.35e+20
Iteration 46:  residual SS =  2.35e+20
Iteration 47:  residual SS =  2.35e+20
Iteration 48:  residual SS =  2.35e+20
Iteration 49:  residual SS =  2.35e+20
Iteration 50:  residual SS =  2.35e+20
Iteration 51:  residual SS =  2.35e+20
Iteration 52:  residual SS =  2.35e+20
Iteration 53:  residual SS =  2.35e+20
Iteration 54:  residual SS =  2.35e+20
Iteration 55:  residual SS =  2.35e+20
Iteration 56:  residual SS =  2.35e+20
Iteration 57:  residual SS =  2.35e+20
Iteration 58:  residual SS =  2.35e+20
Iteration 59:  residual SS =  2.35e+20
Iteration 60:  residual SS =  2.35e+20
Iteration 61:  residual SS =  2.35e+20
Iteration 62:  residual SS =  2.35e+20
Iteration 63:  residual SS =  2.35e+20
Iteration 64:  residual SS =  2.35e+20
Iteration 65:  residual SS =  2.35e+20
Iteration 66:  residual SS =  2.35e+20
Iteration 67:  residual SS =  2.35e+20
Iteration 68:  residual SS =  2.35e+20
Iteration 69:  residual SS =  2.35e+20
Iteration 70:  residual SS =  2.35e+20
Iteration 71:  residual SS =  2.35e+20
Iteration 72:  residual SS =  2.35e+20
Iteration 73:  residual SS =  2.35e+20
Iteration 74:  residual SS =  2.35e+20
Iteration 75:  residual SS =  2.35e+20
Iteration 76:  residual SS =  2.35e+20
Iteration 77:  residual SS =  2.35e+20
Iteration 78:  residual SS =  2.35e+20
Iteration 79:  residual SS =  2.35e+20
Iteration 80:  residual SS =  2.35e+20
Iteration 81:  residual SS =  2.35e+20
Iteration 82:  residual SS =  2.35e+20
Iteration 83:  residual SS =  2.35e+20
Iteration 84:  residual SS =  2.35e+20
Iteration 85:  residual SS =  2.35e+20
Iteration 86:  residual SS =  2.35e+20
Iteration 87:  residual SS =  2.35e+20
Iteration 88:  residual SS =  2.35e+20
Iteration 89:  residual SS =  2.35e+20
Iteration 90:  residual SS =  2.35e+20
```

```
Iteration 91:  residual SS =  2.35e+20
Iteration 92:  residual SS =  2.35e+20
Iteration 93:  residual SS =  2.35e+20
Iteration 94:  residual SS =  2.35e+20
Iteration 95:  residual SS =  2.35e+20
Iteration 96:  residual SS =  2.35e+20
Iteration 97:  residual SS =  2.35e+20
Iteration 98:  residual SS =  2.35e+20
Iteration 99:  residual SS =  2.35e+20


      Source |      SS            df       MS
-------------+----------------------------------    Number of obs =        800
       Model |  1.044e+19          4  2.6109e+18    R-squared     =     0.0425
    Residual |  2.351e+20        796  2.9541e+17    Adj R-squared =     0.0377
-------------+----------------------------------    Root MSE      =   5.44e+08
       Total |  2.456e+20        800  3.0699e+17    Res. dev.     =   34448.01

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /gamma |   4.002503   14.72497     0.27   0.786    -24.90186    32.90687
      /delta |   .0000247   .0071815     0.00   0.997    -.0140722    .0141217
        /rho |  -19.15934   594.7247    -0.03   0.974    -1186.573    1148.255
         /nu |   .9999954   .2082338     4.80   0.000     .5912432    1.408748
------------------------------------------------------------------------------

convergence not achieved
r(430);

end of do-file

r(430);
```

(e)

```
12 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(55) delta 0 rho -1 nu 1)
(obs = 800)
```

```
Iteration 0:  residual SS =   2124794
Iteration 1:  residual SS =   2116579
Iteration 2:  residual SS =   2116571
Iteration 3:  residual SS =   2116504
Iteration 4:  residual SS =   2114468
Iteration 5:  residual SS =   2081538
Iteration 6:  residual SS =   1955293
Iteration 7:  residual SS =   1835355
Iteration 8:  residual SS =   1039523
Iteration 9:  residual SS =  611499.3
Iteration 10:  residual SS =    340404
Iteration 11:  residual SS =  98584.86
Iteration 12:  residual SS =  30130.18
Iteration 13:  residual SS =   16931.5
Iteration 14:  residual SS =  16871.05
Iteration 15:  residual SS =  16866.65
Iteration 16:  residual SS =  16866.63
Iteration 17:  residual SS =  16866.61
Iteration 18:  residual SS =  16866.61
Iteration 19:  residual SS =  16866.61
Iteration 20:  residual SS =  16866.61
Iteration 21:  residual SS =  16866.61
```

Source	SS	df	MS
Model	-15070.41	2	-7535.20503
Residual	16866.607	797	21.162619
Total	1796.1973	799	2.24805671

Number of obs =	800
R-squared =	-8.3902
Adj R-squared =	-8.4137
Root MSE =	4.600285
Res. dev. =	4709.085

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	7.69e+23	.	.	.	.	.
/nu	-2.769633	.0616376	-44.93	0.000	-2.890625	-2.648642
/rho	-38.85713	698.2575	-0.06	0.956	-1409.498	1331.784
/delta	.5869311	1.981458	0.30	0.767	-3.302562	4.476424

Parameter gamma taken as constant term in model & ANOVA table

(f)

```
13 .
14 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1) eps(1e-1)
   (obs = 800)

   Iteration 0:  residual SS =  1143.768
   Iteration 1:  residual SS =  1141.441
   Iteration 2:  residual SS =  1079.391
   Iteration 3:  residual SS =  1056.941
   Iteration 4:  residual SS =  1021.525
   Iteration 5:  residual SS =  983.1424
   Iteration 6:  residual SS =  899.3974
   Iteration 7:  residual SS =  828.0449
   Iteration 8:  residual SS =  820.0263
   Iteration 9:  residual SS =  819.9925


         Source |      SS            df       MS
   -------------+----------------------------------    Number of obs =        800
          Model |  976.20485          3  325.401616    R-squared     =     0.5435
       Residual |  819.99247        796  1.03014129    Adj R-squared =     0.5418
   -------------+----------------------------------    Root MSE      =   1.014959
          Total |  1796.1973        799  2.24805671    Res. dev.     =   2290.048

   ------------------------------------------------------------------------------
            lny |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
   -------------+----------------------------------------------------------------
         /gamma |   44.64812   18.77956     2.38   0.018     7.784805    81.51144
            /nu |   .9727292   .0317774    30.61   0.000     .9103518    1.035107
           /rho |  -.8077342   .2189572    -3.69   0.000    -1.237536   -.3779324
         /delta |   .2351088   .0328584     7.16   0.000     .1706095    .2996081
   ------------------------------------------------------------------------------
     Parameter nu taken as constant term in model & ANOVA table

15 .
16 . nl (lny = ln({gamma})-({nu}/{rho})*ln(({delta}*k^(-{rho}))+(1-{delta})*l^(-{rho}))), init(gamma exp(4) delta 0 rho -1 nu 1) eps(1e-15) iterate(100)
   (obs = 800)
```

```
Iteration 0:  residual SS =  1143.768
Iteration 1:  residual SS =  1141.441
Iteration 2:  residual SS =  1079.391
Iteration 3:  residual SS =  1056.941
Iteration 4:  residual SS =  1021.525
Iteration 5:  residual SS =  983.1424
Iteration 6:  residual SS =  899.3974
Iteration 7:  residual SS =  828.0449
Iteration 8:  residual SS =  820.0263
Iteration 9:  residual SS =  819.9925
Iteration 10:  residual SS =  819.9925
Iteration 11:  residual SS =  819.9925
Iteration 12:  residual SS =  819.9925
Iteration 13:  residual SS =  819.9925
Iteration 14:  residual SS =  819.9925
Iteration 15:  residual SS =  819.9925
Iteration 16:  residual SS =  819.9925
Iteration 17:  residual SS =  819.9925
Iteration 18:  residual SS =  819.9925
Iteration 19:  residual SS =  819.9925
```

Source	SS	df	MS
Model	222930.73	4	55732.6813
Residual	819.99246	796	1.03014129
Total	223750.72	800	279.688397

Number of obs	=	800
R-squared	=	0.9963
Adj R-squared	=	0.9963
Root MSE	=	1.014959
Res. dev.	=	2290.048

lny	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
/gamma	44.64759	18.90461	2.36	0.018	7.538809	81.75637
/nu	.9727292	.0317774	30.61	0.000	.9103518	1.035107
/rho	-.8079839	.2186225	-3.70	0.000	-1.237129	-.3788391
/delta	.2351024	.0328463	7.16	0.000	.1706267	.2995781

17 .