EE 325 Section 2 HW 3
Due in class on ……………………..

Use 4 decimal places for numerical answers and test at the 5% significance level.

1. The variable RD_i is expenditures on research and development (R&D) as a percentage of sales. $sales_i$ are measured in millions of dollars. The variable $profit_i$ is profits as a percentage of sales. The following equation is estimated;

$$RD_i = 0.472 + 0.621 \ln sales_i + 0.095 \ln profit_i$$
$$se = \quad (1.369) \quad (0.216) \quad\quad (0.046)$$
$$R^2 = 0.900, n = 60$$

1.1. Interpret each of the coefficient estimates in regression equation.
1.2. Test the hypothesis that RD_i does increase with sales.
1.3. Does $profit_i$ have a statistically significant effect on RD_i ?
1.4. Test the hypothesis, $sales_i$ and $profit_i$ are the determining factors for expenditures on research and development.

2. From the data for 46 states in the United States for 1992, Baltagi obtained the following regression results:

$$\ln C_i = 4.30 - 1.34 \ln P_i + 0.17 \ln Y_i$$
$$se = \quad (0.91) \quad (0.32) \quad\quad (0.20)$$
$$\bar{R}^2 = 0.27$$

where C_i = cigarette consumption, packs per year
P_i = real price per pack, \$ per pack
Y_i = real disposable income per capita, \$ per week

2.1. Do the estimation results follow the law of demand?
2.2. What is the elasticity of demand for cigarettes with respect to price? Is it statistically significant? If so, is it statistically different from 1?
2.3. What is the income elasticity of demand for cigarettes? Is it statistically significant? If not, what might be the reasons for it?
2.4. Test the joint significance of all the slope coefficient estimates.

3. From the estimation of the regression equation of the variables as follows; headline consumer price index (in percent) and the money supply (in million baht) in Thailand during 1981-1997, the regression model can be estimated as follows.

Model 1

$$CPI_t = 38.9691 + 0.2609 MS_t$$
$$P-value \quad (0.000) \quad (0.001)$$
$$R^2 = 0.9423, F = 245.08, n = 17$$

Model 2

$$\ln CPI_t = 1.4041 + 0.5889 \ln MS_t$$
$$P-value \quad (0.007) \quad (0.000)$$
$$R^2 = 0.9642, F = 403.60, n = 17$$

Model 3

$$\ln CPI_t = 3.9315 + 0.0028 MS_t$$
$$P-value \quad (0.002) \quad (0.000)$$
$$R^2 = 0.9284, F = 194.59, n = 17$$

Model 4

$$CPI_t = -192.9661 + 54.2126 \ln MS_t$$
$$P-value \quad (0.000) \quad (0.003)$$
$$R^2 = 0.9543, F = 313.41, n = 17$$

3.1. Find the rate of change of CPI with respect to MS ($\Delta CPI/\Delta MS$) and the elasticity of CPI with respect to MS ($\%\Delta CPI/\%\Delta MS$), calculated when the money supply is 205 million baht and the consumer price index is 92%.

3.2. Explain the coefficient of determination $\left(R^2\right)$. Is it the criterion for selecting the appropriate regression model function? Why?

4. From estimating the regression equation on net financial wealth (nettfa), age of the survey respondent (age), and annual family income (inc) for people in the United States. The wealth and income variables are both recorded in thousands of dollars. The OLS estimation results for the model are given by; $nettfa_i = \beta_1 + \beta_2 inc_i + \beta_3 age_i + u_i$

```
reg nettfa inc age

      Source |       SS           df       MS      Number of obs   =     9,275
-------------+----------------------------------   F(2, 9272)      =    943.21
       Model |   6414618.8         2   3207309.4   Prob > F        =    0.0000
    Residual |  31528770.7     9,272  3400.42825   R-squared       =    0.1691
-------------+----------------------------------   Adj R-squared   =    0.1689
       Total |  37943389.5     9,274   4091.3726   Root MSE        =    58.313

------------------------------------------------------------------------------
      nettfa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         inc |   .9533566   .0252775    37.72   0.000     .9038072    1.002906
         age |   1.030777   .0591226    17.43   0.000     .9148838     1.14667
       _cons |  -60.69654   2.596333   -23.38   0.000    -65.78592   -55.60715
------------------------------------------------------------------------------

reg nettfa inc age agesq

      Source |       SS           df       MS      Number of obs   =     9,275
-------------+----------------------------------   F(3, 9271)      =    646.80
       Model |  6567017.15         3  2189005.72   Prob > F        =    0.0000
    Residual |  31376372.3     9,271  3384.35685   R-squared       =    0.1731
-------------+----------------------------------   Adj R-squared   =    0.1728
       Total |  37943389.5     9,274   4091.3726   Root MSE        =    58.175

------------------------------------------------------------------------------
      nettfa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         inc |   .9782522   .0254891    38.38   0.000      .928288    1.028216
         age |  -2.231489   .4897118    -4.56   0.000    -3.191432   -1.271547
       agesq |   .0377221   .0056214     6.71   0.000      .026703    .0487413
       _cons |   4.680388   10.08099     0.46   0.642    -15.08056    24.44134
------------------------------------------------------------------------------
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4.1. Test the coefficient $\beta_3 < 1$ or not?

4.2. Due to estimation result by adding the age^2 variable or agesq. Perform the test whether we should include the quadratic term of the age variable or not? [Test for both t-test and F-test]

5. You are conducting an empirical investigation into the median prices of houses in 506 communities of a large metropolitan area. The sample data consist of 506 observations on the following observable variables:

P_i : the median house price in community i, in dollars;

NOX_i : the level of nitrous oxide in the air of community i, in parts per 100 million;

$DIST_i$: the weighted distance of community i from municipal area, in miles;

$ROOM_i$: the average number of rooms per house in community i;

$STRAT_i$: the average student-teacher ratio of schools in community i.

Researcher estimates the following model of median house price. The OLS estimation results for the model are given by;

$$\ln(P_i) = 11.08 - 0.9535\ln(NOX_i) - 0.1343\ln(DIST_i) + 0.2545ROOM_i - 0.05245STRAT_i$$

$$se = \quad (0.3181) \quad (0.1167) \qquad (0.04310) \qquad (0.01853) \qquad (0.005897)$$

$RSS = 35.1835, TSS = 84.5822$

5.1. Interpret each of the coefficient estimates in regression equation.

5.2. Test the individual significance of each of the slope coefficient estimates for $\ln(NOX_i)$ and $ROOM_i$.

5.3. Test the joint significance of all the slope coefficient estimates.

5.4. If researcher would like to test the proposition that the marginal effect of $\ln(NOX_i)$ on $\ln(P_i)$ equals the marginal effect of $\ln(DIST_i)$ on $\ln(P_i)$. Perform the test given that OLS estimation of this restricted regression equation yields a Residual Sum of Squares value = 41.9532.

6. Production function (Y) of the industrial sector in Thailand. It depends on the capital factor (K) and labor factor (L) in the years 1980-2010 with the following estimation.

Model 1:

$$\ln Y_t = 18.27 + 0.536\ln L_t + 0.024\ln K_t$$

$$R^2 = 0.9389, RSS = 0.0124$$

Model 2:

$$\ln(Y/L)_t = 2.13 + 1.12\ln(K/L)_t$$

$$R^2 = 0.8087, RSS = 0.0153$$

6.1. Interpret the coefficients of the independent variables in models 1 and 2.

6.2. Test the hypothesis. Is the industrial production function characterized by constant return to scale?

6.3. Can we compare the R^2 value between the two regression models? Why?

7. Marc Nerlove has estimated the following cost function for electricity generation:

$$Y_i = AX_i^{\beta} P_{1i}^{\alpha_1} P_{2i}^{\alpha_2} P_{3i}^{\alpha_3} e^{u_i}$$

where Y = total cost of production
X = output in kilowatt hours
P_1 = price of labor input
P_2 = price of capital input
P_3 = price of fuel
and u = disturbance term

From data collection of 29 medium-sized firms to estimate the cost function of electricity generation. The estimate results are as follows:

Model 1:

$$\widehat{\ln Y_i} = -4.93 + 0.94\ln X_i + 0.31\ln P_{1i} - 0.26\ln P_{2i} + 0.44\ln P_{3i}$$

$$se = \quad (1.96) \quad (0.11) \qquad (0.23) \qquad (0.29) \qquad (0.07)$$

$$RSS = 0.336$$

Model 2:

$$\widehat{\ln\left(\frac{Y_i}{P_{3i}}\right)} = -6.55 + 0.91\ln X_i + 0.51\ln\left(\frac{P_{1i}}{P_{3i}}\right) - 0.09\ln\left(\frac{P_{2i}}{P_{3i}}\right)$$

$$se = \qquad (0.16) \quad (0.11) \qquad (0.19) \qquad (0.16)$$

$$RSS = 0.364$$

7.1. Interpret the coefficients of the independent variables in models 1 and 2.
7.2. Test the hypothesis that the sum of price elasticity is one.

8. To study the relationship of demand for roses, the variable of the analysis consisted of
Q_i = demand quantity of roses sold, dozens
P_{1i} = average wholesale price of roses, \$/dozen
P_{2i} = average wholesale price of carnations, \$/dozen
I_i = average weekly family disposable income, \$/week. By considering the following
$\ln Q_i = \beta_0 + \beta_1 \ln P_{1i} + \beta_2 \ln P_{2i} + \beta_3 \ln I_i + u_i$, $u_i \sim NIID\left(0, \sigma^2\right)$

Results from STATA:

```
gen lnQ=ln(Q)
gen lnP1=ln(P1)
gen lnP2=ln(P2)
gen lnI=ln(I)

reg lnQ lnP1 lnP2 lnI

      Source |       SS           df       MS      Number of obs   =        16
-------------+----------------------------------   F(3, 12)        =     11.22
       Model |  1.04144485         3  .347148283   Prob > F        =    0.0008
    Residual |  .371153994        12   .0309295    R-squared       =    0.7373
-------------+----------------------------------   Adj R-squared   =    0.6716
       Total |  1.41259884        15  .094173256   Root MSE        =    .17587

------------------------------------------------------------------------------
         lnQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnP1 |  -1.856237   .3437805    -5.40   0.000     -2.60527   -1.107204
        lnP2 |   1.454078   .5724105     2.54   0.026     .2069022    2.701253
         lnI |   .5595552   .9210802     0.61   0.555    -1.447306    2.566416
       _cons |   6.287681   4.874597     1.29   0.221    -4.333153    16.90852
------------------------------------------------------------------------------

estat vce

Covariance matrix of coefficients of regress model

        e(V) |       lnP1        lnP2         lnI       _cons
-------------+------------------------------------------------
        lnP1 |    .118185
        lnP2 | -.10984694    .3276538
         lnI | -.14482352   .17329678   .84838865
       _cons |  .75490579  -1.1797942  -4.4576995   23.761696

reg lnQ lnP1

      Source |       SS           df       MS      Number of obs   =        16
-------------+----------------------------------   F(1, 14)        =     20.54
       Model |  .840063506         1  .840063506   Prob > F        =    0.0005
    Residual |  .572535338        14  .040895381   R-squared       =    0.5947
-------------+----------------------------------   Adj R-squared   =    0.5657
       Total |  1.41259884        15  .094173256   Root MSE        =    .20223

------------------------------------------------------------------------------
         lnQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnP1 |  -1.392764   .3072972    -4.53   0.000    -2.051851    -.733677
       _cons |   10.46203   .3478488    30.08   0.000     9.715964    11.20809
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```

8.1. From $\ln Q_i = \beta_0 + \beta_1 \ln P_{1i} + \beta_2 \ln P_{2i} + \beta_3 \ln I_i + u_i$. Interpret each of the coefficient estimates in regression equation.

8.2. Forecast the average demand for roses when the wholesale price of roses is \$ 2 per dozen, the wholesale price of carnations is \$ 3 per dozen, and the weekly family disposable income is \$ 100 per week.

8.3. What is the estimated own-price elasticity of demand, cross price elasticity, and income elasticity?

8.4. At 95% confidence level. If the wholesale price of roses changes by 1%, how will it change the demand for roses?

8.5. Test the overall significance of the observed regression.

8.6. Test the hypothesis that β_0 is no different from zero.

8.7. What independent variables influence the demand for roses?

8.8. Do the estimation results follow the law of demand?

8.9. Test the hypothesis that rose is giffen goods.

8.10. Test the hypothesis that the relationship between carnations and rose is substitution goods.

8.11. Test the hypothesis that rose is luxury goods.

8.12. Test the hypothesis that rose is inferior goods.

8.13. Test this statement that "If rose shop discounts the price of roses, will increase the total revenue of the shop".

8.14. Test the hypothesis that the demand for rose is homogeneous of degree zero function. (Hint: Homogeneous of degree zero $\beta_1 + \beta_2 + \beta_3 = 0$)

8.15. Test the hypothesis that P_{2i} and I_i are statistically insignificant by F-test. If the coefficients of P_{2i} and I_i are statistically insignificant, what may be the reasons?

8.16. What percentage of the total variation in $\ln Q_i$ explained by the regression model?

9. From an estimation of the production function of the manufacturing sector of Thailand from 1977 - 2004. Define the production function as Cobb-Douglas production function as follows: $Q_t = AL_t^{\beta_2} K_t^{\beta_3} e^{u_t}$

Where Q is the output

L is the number of workers

K is the number of machines, and u is random error

To make the above function a linear regression model, so we take natural logarithm to get a model like this: $\ln Q_t = \beta_1 + \beta_2 \ln L_t + \beta_3 \ln K_t + u_t$ where $\ln A = \beta_1$. The estimate results are as follows:

```
gen lnL=ln(L)
gen lnK=ln(K)
reg lnQ lnL lnK

      Source |       SS           df       MS      Number of obs   =        28
-------------+----------------------------------   F(2, 25)        =    429.16
       Model |  5.53777363         2  2.76888682   Prob > F        =    0.0000
    Residual |  .161298649        25  .006451946   R-squared       =    0.9717
-------------+----------------------------------   Adj R-squared   =    0.9694
       Total |  5.69907228        27  .211076751   Root MSE        =    .08032

------------------------------------------------------------------------------
         lnQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnL |   2.432657   .5723547     4.25   0.000      1.25387    3.611443
         lnK |   .1073442   .1563223     0.69   0.499    -.2146076     .429296
       _cons |  -12.47529   3.073452    -4.06   0.000    -18.80518   -6.145393
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estat vce

Covariance matrix of coefficients of regress model

        e(V) |        lnL         lnK       _cons 
-------------+------------------------------------
         lnL |  .32758988                         
         lnK | -.08819668   .02443666             
       _cons | -1.7573674   .46956536   9.4461061 

gen y=ln(Q/K)
gen x=ln(L/K)

reg y x

      Source |       SS           df       MS      Number of obs   =        28
-------------+----------------------------------   F(1, 26)        =     58.26
       Model |  .556626413         1  .556626413   Prob > F        =    0.0000
    Residual |   .24842021        26  .009554623   R-squared       =    0.6914
-------------+----------------------------------   Adj R-squared   =    0.6796
       Total |  .805046623        27  .029816542   Root MSE        =    .09775

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   .3335901   .0437057     7.63   0.000     .2437517    .4234284
       _cons |  -1.183477   .0720469   -16.43   0.000    -1.331571   -1.035382
------------------------------------------------------------------------------
gen w=ln(Q/L)
gen v=ln(K/L)

reg w v

      Source |       SS           df       MS      Number of obs   =        28
-------------+----------------------------------   F(1, 26)        =    232.49
       Model |  2.22136773         1  2.22136773   Prob > F        =    0.0000
    Residual |  .248420242        26  .009554625   R-squared       =    0.8994
-------------+----------------------------------   Adj R-squared   =    0.8955
       Total |  2.46978797        27  .091473629   Root MSE        =    .09775

------------------------------------------------------------------------------
           w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           v |   .6664099   .0437057    15.25   0.000     .5765715    .7562482
       _cons |  -1.183477   .0720469   -16.43   0.000    -1.331572   -1.035382
------------------------------------------------------------------------------

reg lnQ lnL lnK if year>=1977&year<=1991

      Source |       SS           df       MS      Number of obs   =        15
-------------+----------------------------------   F(2, 12)        =    417.19
       Model |  2.23588558         2  1.11794279   Prob > F        =    0.0000
    Residual |  .032156437        12  .002679703   R-squared       =    0.9858
-------------+----------------------------------   Adj R-squared   =    0.9835
       Total |  2.26804202        14  .162003001   Root MSE        =    .05177

------------------------------------------------------------------------------
         lnQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnL |    2.62096   .9696654     2.70   0.019      .508241     4.73368
         lnK |   .2053099   .2802493     0.73   0.478    -.4053008    .8159206
       _cons |  -14.16664   5.123421    -2.77   0.017    -25.32962   -3.003667
------------------------------------------------------------------------------

reg lnQ lnL lnK if year>=1992&year<=2004

      Source |       SS           df       MS      Number of obs   =        13
```

```
-------------+----------------------------------   F(2, 10)        =     14.55
       Model |  .019537184         2  .009768592   Prob > F        =    0.0011
    Residual |  .006712637        10  .000671264   R-squared       =    0.7443
-------------+----------------------------------   Adj R-squared   =    0.6931
       Total |  .026249822        12  .002187485   Root MSE        =    .02591

------------------------------------------------------------------------------
         lnQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnL |   .8180791   .2438061     3.36   0.007     .2748454    1.361313
         lnK |   .0691826    .057894     1.19   0.260    -.0598133    .1981784
       _cons |   -1.14961   1.497085    -0.77   0.460    -4.485324    2.186105
------------------------------------------------------------------------------
```

9.1. From $\ln Q_t = \beta_1 + \beta_2 \ln L_t + \beta_3 \ln K_t + u_t$. Interpret each of the coefficient estimates in regression equation.

9.2. Can it be concluded that labor and capital factors influence the output? [Overall F-test]

9.3. What independent variables influence the output? [Individual t-test]

9.4. What percentage of the total variation in $\ln Q_t$ explained by the regression model?

9.5. Is the Cobb-Douglas production function in the constant returns to scale?

9.6. Is the Cobb-Douglas production function in the increasing returns to scale?

9.7. The Cold War ended in 1991. You think the Cold War that a factor in determining the output or not? [Chow test]

10. To find the relationship between aggregate consumption (C) and national income (Y) of Thailand between 1990 - 2017, the following models were determined.

$$\ln C_t = \beta_1 + \beta_2 \ln Y_t + u_t$$

The model estimate results using data between 1990 - 2017 are as follows:

Result of the first model estimation:

```
reg lnc lny

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  1,    26) = 4334.23
       Model |  2.37331993     1  2.37331993           Prob > F      =  0.0000
    Residual |  .014236981    26  .000547576           R-squared     =  0.9940
-------------+------------------------------           Adj R-squared =  0.9938
       Total |  2.38755691    27  .088428034           Root MSE      =   .0234

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .9354626   .0142092    65.83   0.000     .9062551      .96467
       _cons |   .3901666   .2225224     1.75   0.091    -.0672348     .847568
------------------------------------------------------------------------------
```

Since Thailand experienced the economic crisis in 1997, the model was estimated in two separate periods: 1) Using the data between 1990 - 1996 and 2) Using the data between 1997 - 2017, the relationship estimation is as follows.

Result of the second model estimation:

```
reg lnc lny if t<=2539

      Source |       SS       df       MS              Number of obs =       7
-------------+------------------------------           F(  1,     5) = 2201.60
       Model |  .156139595     1  .156139595           Prob > F      =  0.0000
    Residual |  .000354605     5  .000070921           R-squared     =  0.9977
-------------+------------------------------           Adj R-squared =  0.9973
       Total |    .1564942     6  .026082367           Root MSE      =  .00842

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .9490458   .0202264    46.92   0.000     .8970522    1.001039
```

```
       _cons |   .1728113   .3089612     0.56   0.600    -.6213987    .9670213
------------------------------------------------------------------------------
```

<u>Result of the third model estimation</u>:

```
reg lnc lny if t>=2540

      Source |       SS       df       MS              Number of obs =      21
-------------+------------------------------           F(  1,    19) = 1546.46
       Model |  .954434131     1  .954434131           Prob > F      =  0.0000
    Residual |  .011726329    19  .000617175           R-squared     =  0.9879
-------------+------------------------------           Adj R-squared =  0.9872
       Total |   .96616046    20  .048308023           Root MSE      =  .02484

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .9032613   .0229691    39.33   0.000     .8551863    .9513362
       _cons |   .9017561   .3626078     2.49   0.022     .1428092    1.660703
------------------------------------------------------------------------------
```

10.1. Interpret the first model estimation.

10.2. Test whether the economic crisis causes structural change between aggregate consumption and national income.