Assignment 9 Nattanicha Eiamwattanasin 6004641442

```
. dfuller y, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              1.000            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 1.0000

------------------------------------------------------------------------------
D.y          |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           y |
         L1. |   .0001178   .0001179     1.00   0.318    -.0001137    .0003494
         LD. |   .6997015   .0248993    28.10   0.000     .6507799    .7486231
      _trend |   2.897751   1.159296     2.50   0.013      .619992    5.175511
       _cons |   1811.233   147.0426    12.32   0.000     1522.327    2100.139
------------------------------------------------------------------------------

. dfuller y, lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             10.999            -3.440            -2.870            -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 1.0000

------------------------------------------------------------------------------
         D.y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           y |
         L1. |   .0003983   .0000362    11.00   0.000     .0003272    .0004695
         LD. |   .7218985   .0233849    30.87   0.000     .6759527    .7678444
             |
       _cons |    1773.23   147.0277    12.06   0.000     1484.355    2062.105
------------------------------------------------------------------------------

. dfuller y, nocon lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.347            -2.580            -1.950            -1.620

------------------------------------------------------------------------------
         D.y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           y |
         L1. |   6.29e-06   .0000181     0.35   0.729    -.0000293    .0000419
         LD. |   .9996004   .0046394   215.46   0.000     .9904852    1.008716
------------------------------------------------------------------------------

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```
. dfuller x, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.601            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9970

------------------------------------------------------------------------------
D.x          |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |
         L1. |   .0001061   .0001764     0.60   0.548    -.0002405    .0004526
         LD. |     .46018   .0349881    13.15   0.000     .3914361    .5289239
      _trend |   4.166909    1.14105     3.65   0.000     1.924999    6.408818
       _cons |   2128.626   140.0551    15.20   0.000     1853.449    2403.803
------------------------------------------------------------------------------

. dfuller d.x, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       497

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -10.657            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D2.x         |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         D.x |
         L1. |  -.4007114   .0376021   -10.66   0.000    -.4745915   -.3268312
         LD. |   -.414172   .0358603   -11.55   0.000    -.4846298   -.3437141
      _trend |   3.508317   .3506567    10.00   0.000     2.819351    4.197283
       _cons |   1596.429   147.0971    10.85   0.000     1307.415    1885.444
------------------------------------------------------------------------------

. dfuller d.y, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       497

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -10.554            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D2.y         |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         D.y |
         L1. |  -.2787856   .0264156   -10.55   0.000    -.3306866   -.2268845
         LD. |    -.32127   .0373756    -8.60   0.000    -.3947051   -.2478349
      _trend |   3.631984   .3708318     9.79   0.000     2.903379     4.36059
       _cons |   1678.082   154.4788    10.86   0.000     1374.564      1981.6
------------------------------------------------------------------------------

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```

The result shows the test statistic value(z(t))= .347 that less than 0.05 or 95% confident level. Therefore, the null hypothesis of unit root test is failed to reject, the Series are nonstationary. We can use differentiate to resolve unit root problem. So, they become stationary after first stationary.

2. From lag(1) linear trend suggest to have 1 rank. But the rest trend suggest to use 2 ranks to determine. Since, Johansen test and Maximum eigan test perform the same result.

```
. vecrank y x, trend(t) lag(1/1) max

                       Johansen tests for cointegration
Trend: trend                                            Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      4      -7387.4577           .    790.3357    18.17
    1      7      -6992.3441     0.79477      0.1085*    3.74
    2      8      -6992.2899     0.00022
-------------------------------------------------------------------------------
                                                         5%
maximum                                        max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      4      -7387.4577           .    790.2272    16.87
    1      7      -6992.3441     0.79477      0.1085     3.74
    2      8      -6992.2899     0.00022
-------------------------------------------------------------------------------

. vecrank y x, trend(rt) lag(1/1) max

                       Johansen tests for cointegration
Trend: rtrend                                           Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      2      -8050.4781           .   2116.3764    25.32
    1      6      -7075.2453     0.97993    165.9107    12.25
    2      8      -6992.2899     0.28286
-------------------------------------------------------------------------------
                                                         5%
maximum                                        max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      2      -8050.4781           .   1950.4657    18.96
    1      6      -7075.2453     0.97993    165.9107    12.52
    2      8      -6992.2899     0.28286
-------------------------------------------------------------------------------

. vecrank y x, trend(c) lag(1/1) max

                       Johansen tests for cointegration
Trend: constant                                         Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      2      -8050.4781           .   2086.8946    15.41
    1      5      -7083.8611     0.97923    153.6607     3.76
    2      6      -7007.0308     0.26504
-------------------------------------------------------------------------------
                                                         5%
maximum                                        max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      2      -8050.4781           .   1933.2339    14.07
    1      5      -7083.8611     0.97923    153.6607     3.76
    2      6      -7007.0308     0.26504
-------------------------------------------------------------------------------

. vecrank y x, trend(rc) lag(1/1) max

                       Johansen tests for cointegration
Trend: rconstant                                        Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      0      -8811.3759           .   3593.1922    19.96
    1      4      -7096.9792     0.99896    164.3988     9.42
    2      6      -7014.7798     0.28069
-------------------------------------------------------------------------------
                                                         5%
maximum                                        max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      0      -8811.3759           .   3428.7934    15.67
    1      4      -7096.9792     0.99896    164.3988     9.24
    2      6      -7014.7798     0.28069
-------------------------------------------------------------------------------

. vecrank y x, trend(n) lag(1/1) max

                       Johansen tests for cointegration
Trend: none                                             Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      0      -8811.3759           .   3204.1194    12.53
    1      3      -7211.7592     0.99836      4.8860     3.84
    2      4      -7209.3162     0.00974
-------------------------------------------------------------------------------
                                                         5%
maximum                                        max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      0      -8811.3759           .   3199.2334    11.44
    1      3      -7211.7592     0.99836      4.8860     3.84
    2      4      -7209.3162     0.00974
-------------------------------------------------------------------------------

.
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3.

```
. vecrank y x, trend(t) lag(1) max

                       Johansen tests for cointegration
Trend: trend                                            Number of obs =     499
Sample:  2 - 500                                                 Lags =       1
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0       4     -7387.4577        .       790.3357    18.17
    1       7     -6992.3441     0.79477      0.1085*    3.74
    2       8     -6992.2899     0.00022
-------------------------------------------------------------------------------
                                                         5%
maximum                                       max     critical
  rank    parms       LL       eigenvalue  statistic    value
    0       4     -7387.4577        .       790.2272    16.87
    1       7     -6992.3441     0.79477      0.1085     3.74
    2       8     -6992.2899     0.00022
-------------------------------------------------------------------------------

. vecrank y x, trend(t) lag(2) max

                       Johansen tests for cointegration
Trend: trend                                            Number of obs =     498
Sample:  3 - 500                                                 Lags =       2
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0       8     -6795.5337        .       187.5771    18.17
    1      11     -6703.3826     0.30932      3.2749*    3.74
    2      12     -6701.7451     0.00655
-------------------------------------------------------------------------------
                                                         5%
maximum                                       max     critical
  rank    parms       LL       eigenvalue  statistic    value
    0       8     -6795.5337        .       184.3022    16.87
    1      11     -6703.3826     0.30932      3.2749     3.74
    2      12     -6701.7451     0.00655
-------------------------------------------------------------------------------

.  vecrank y x, trend(t) lag(3) max

                       Johansen tests for cointegration
Trend: trend                                            Number of obs =     497
Sample:  4 - 500                                                 Lags =       3
-------------------------------------------------------------------------------
                                                         5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      12      -6756.658        .       140.0434    18.17
    1      15      -6688.113     0.24106      2.9534*    3.74
    2      16     -6686.6363     0.00592
-------------------------------------------------------------------------------
                                                         5%
maximum                                       max     critical
  rank    parms       LL       eigenvalue  statistic    value
    0      12      -6756.658        .       137.0900    16.87
    1      15      -6688.113     0.24106      2.9534     3.74
    2      16     -6686.6363     0.00592
-------------------------------------------------------------------------------

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```

4. With 1lag term 2 lag term 3 lag term . Ho : r=1 Ha :r>=1. This model with the linear trend is insignificant from the critical value. Then, they accept null hypothesis that rank should be rank1.

5.

```
. vec y x, lag(1)

Vector error-correction model

Sample:  2 - 500                                Number of obs     =        499
                                                AIC               =   28.41227
Log likelihood = -7083.861                      HQIC              =   28.42883
Det(Sigma_ml)  =  7.34e+09                      SBIC              =   28.45448

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_y                  2     331.479   0.9988   399343.6   0.0000
D_x                  2     430.726   0.9953   105050.2   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_y          |
        _ce1 |
         L1. |  -1.303404   .0095397  -136.63   0.000    -1.322102   -1.284707
             |
       _cons |   -107.843   69.40373    -1.55   0.120    -243.8718    28.18583
-------------+----------------------------------------------------------------
D_x          |
        _ce1 |
         L1. |  -.8364345   .0123959   -67.48   0.000    -.8607301    -.812139
             |
       _cons |   168.0502    90.1839     1.86   0.062    -8.706965    344.8074
------------------------------------------------------------------------------

Cointegrating equations

Equation           Parms    chi2     P>chi2
-------------------------------------------
_ce1                  1   1.71e+10   0.0000
-------------------------------------------

Identification:  beta is exactly identified

                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
           y |          1          .        .       .            .           .
           x |  -1.500508   .0000115 -1.3e+05   0.000    -1.500531   -1.500486
       _cons |  -1678.204          .        .       .            .           .
------------------------------------------------------------------------------

.  vec y x, lag(2)

Vector error-correction model

Sample:  3 - 500                                Number of obs     =        498
                                                AIC               =   27.18032
Log likelihood = -6758.899                      HQIC              =   27.21018
Det(Sigma_ml)  =  2.11e+09                      SBIC              =   27.25641

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_y                  4     213.415   0.9995   964110.3   0.0000
D_x                  4     263.876   0.9982   280728.2   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_y          |
        _ce1 |
         L1. |   -.427199   .0483639    -8.83   0.000    -.5219905   -.3324075
             |
           y |
         LD. |   .4022605   .0224005    17.96   0.000     .3583563    .4461646
             |
           x |
         LD. |   .4814843   .0598769     8.04   0.000     .3641276    .5988409
             |
       _cons |   171.4547   44.03061     3.89   0.000     85.15624    257.7531
-------------+----------------------------------------------------------------
D_x          |
        _ce1 |
         L1. |   .2903827   .0597995     4.86   0.000     .1731779    .4075875
             |
           y |
         LD. |   .5734396   .0276971    20.70   0.000     .5191544    .6277249
             |
           x |
         LD. |   .3676105   .0740347     4.97   0.000     .2225051    .5127159
             |
       _cons |    252.237   54.44157     4.63   0.000     145.5335    358.9405
------------------------------------------------------------------------------

Cointegrating equations

Equation           Parms    chi2     P>chi2
-------------------------------------------
_ce1                  1   8.09e+08   0.0000
-------------------------------------------

Identification:  beta is exactly identified

                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
           y |          1          .        .       .            .           .
           x |  -1.500176   .0000527 -2.8e+04   0.000     -1.50028   -1.500073
       _cons |  -577.9622          .        .       .            .           .
------------------------------------------------------------------------------
```

```
.  vec y x, lag(3)

Vector error-correction model

Sample:  4 - 500                                Number of obs     =        497
                                                AIC               =    27.1245
Log likelihood = -6727.439                      HQIC              =   27.16771
Det(Sigma_ml)  =  1.96e+09                      SBIC              =   27.23459

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_y                  6     211.673   0.9995   980003.4   0.0000
D_x                  6     253.098   0.9984   305162.2   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_y          |
        _ce1 |
         L1. |  -.3193909    .058155    -5.49   0.000    -.4333726   -.2054092
             |
           y |
         LD. |   .3553209   .0559202     6.35   0.000     .2457194    .4649225
        L2D. |   .0174858   .0312998     0.56   0.576    -.0438607    .0788323
             |
           x |
         LD. |   .6042668   .0763396     7.92   0.000     .4546439    .7538896
        L2D. |   .0521968   .0634683     0.82   0.411    -.0721988    .1765925
             |
       _cons |   181.5838   45.38519     4.00   0.000     92.63049    270.5372
-------------+----------------------------------------------------------------
D_x          |
        _ce1 |
         L1. |   .4434064   .0695359     6.38   0.000     .3071185    .5796943
             |
           y |
         LD. |   .4713427   .0668638     7.05   0.000     .3402922    .6023932
        L2D. |    .012763   .0374252     0.34   0.733     -.060589    .0861151
             |
           x |
         LD. |   .5220109   .0912792     5.72   0.000     .3431069     .700915
        L2D. |   .0911602   .0758891     1.20   0.230    -.0575797    .2399001
             |
       _cons |    130.797   54.26707     2.41   0.016     24.43548    237.1585
------------------------------------------------------------------------------

Cointegrating equations

Equation           Parms    chi2     P>chi2
-------------------------------------------
_ce1                 1   6.64e+08   0.0000
-------------------------------------------

Identification:  beta is exactly identified

                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
           y |          1          .        .       .            .           .
           x |  -1.500049   .0000582 -2.6e+04   0.000    -1.500163   -1.499935
       _cons |  -92.13439          .        .       .            .           .
------------------------------------------------------------------------------
```

The optimal lag determines by the SBIC which the lowest one is the best one. The Lag3 is the best one which have the lowest SBIC equal to 27.23459. So it is the most appropriate for VECM model of y and x. The cointegrate equation is y-1.5x-92.13439= 0, Rearrange to be y=92.13439+1.5x. The speed of adjustment parameter of y is -0.319 and x is 0.443.