Homework9

1.

```
. 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 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
------------------------------------------------------------------------------
```

From the table, p-value of both x and y are greater than 0.05 meaning that null hypothesizes of unit root are not rejected. So, x and y are non-stationary.

2.

```
. 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           .   3607.9616    19.96
    1       4      -7091.9244     0.99898    169.0586     9.42
    2       6      -7007.3951     0.28737
------------------------------------------------------------------------------
                                                        5%
maximum                                      max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0       0      -8811.3759           .   3438.9030    15.67
    1       4      -7091.9244     0.99898    169.0586     9.24
    2       6      -7007.3951     0.28737
------------------------------------------------------------------------------
```

```
. 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           .   3204.1196    12.53
    1       3      -7211.7591     0.99836      4.8860     3.84
    2       4      -7209.3161     0.00974
------------------------------------------------------------------------------
                                                              5%
maximum                                            max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0       0      -8811.3759           .   3199.2337    11.44
    1       3      -7211.7591     0.99836      4.8860     3.84
    2       4      -7209.3161     0.00974
------------------------------------------------------------------------------
```

3.

```
. 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(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           .   3204.1196    12.53
    1       3      -7211.7591     0.99836      4.8860     3.84
    2       4      -7209.3161     0.00974
------------------------------------------------------------------------------
                                                              5%
maximum                                            max    critical
  rank    parms       LL       eigenvalue  statistic    value
    0       0      -8811.3759           .   3199.2337    11.44
    1       3      -7211.7591     0.99836      4.8860     3.84
    2       4      -7209.3161     0.00974
------------------------------------------------------------------------------

. vecrank y x, trend(t) lag(3/3) 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
------------------------------------------------------------------------------
```

4. The model should be with trend that has maximum at rank1.

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

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    -8.706964    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          .        .       .            .           .
------------------------------------------------------------------------------
```

Cointegrating Equation : Yt = 1678.204+1.5005Xt

```
. vec y x, lag(2/2)

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 |   171.4546   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          .        .       .            .           .
------------------------------------------------------------------------------
```

Cointegrating Equation : Yt = 577.9622+1.500176Xt

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

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	.	.	.	.	.

Cointegrating Equation : Yt = 92.13439+1.500049Xt

The most appropriate model is the one that has lowest SBIC which is the model with lag3