Assignment 13

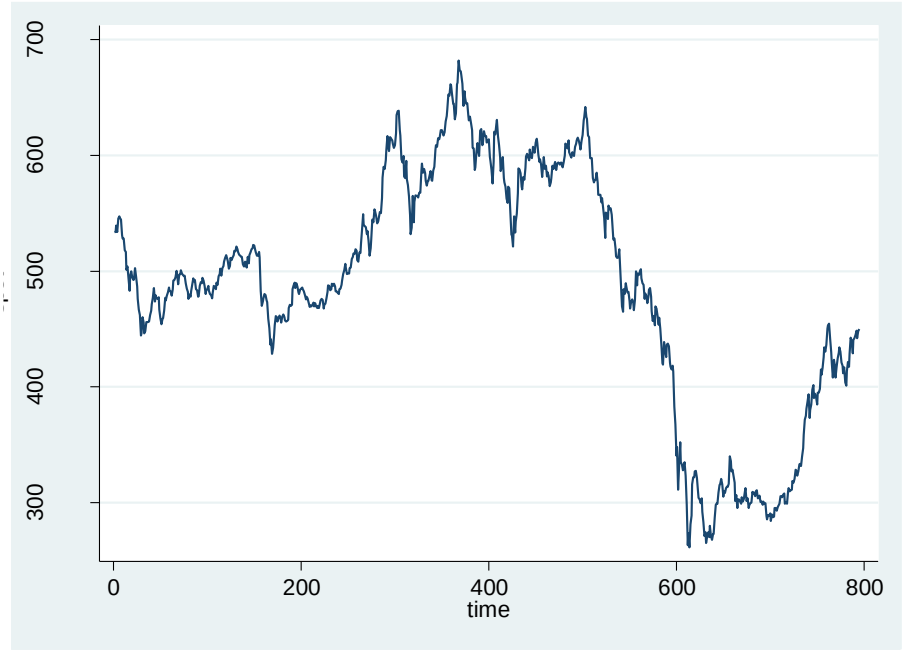
Properties Time Series – Unit Root Test

From the data set `assign_timeseries.dta`:

1. Test whether the series spot and future are stationary series.

Whether the series spot is stationary

```
. tsset t

        time variable:  time, 1 to 795

                delta:  1 unit

. line spot t
```



According to the graph above, the series spot might be nonstationary. However, the test is required to guarantee.

Augmented Dickey-Fuller Test

Test with all terms (intercept, trend, lags)

```
. dfuller spot, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.339            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.8780

------------------------------------------------------------------------------
D.spot       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |  -.0042396   .0031666    -1.34   0.181    -.0104556    .0019764
         LD. |   .0832853    .035481     2.35   0.019      .013637    .1529337
      _trend |   -.000739   .0014208    -0.52   0.603    -.0035281      .00205
       _cons |   2.253569   1.884627     1.20   0.232    -1.445907    5.953046
------------------------------------------------------------------------------
```

From the test result, it suggests that β = 1 since the MacKinnon p-value = 0.8780 > 0.05, i.e. the series is nonstationary. However, the time trend (α_1) is insignificant because p-value = 0.603 > 0.05. Therefore, the time trend must be removed first, then test again.

Test with intercept and lags

```
. dfuller spot, lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.238            -3.430            -2.860            -2.570
```

```
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.6570

------------------------------------------------------------------------------
      D.spot |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |  -.0034926    .002821    -1.24   0.216    -.0090301    .0020448
         LD. |   .0828543    .035455     2.34   0.020     .0132572    .1524514
             |
       _cons |   1.597051    1.39888     1.14   0.254    -1.14891    4.343012
------------------------------------------------------------------------------
```

From the test result, it suggests that β = 1 since the MacKinnon p-value = 0.6570 > 0.05, i.e. the series is nonstationary. However, the intercept (α_0) is insignificant because p-value = 0.254 > 0.05. Therefore, the intercept must be removed and test again.

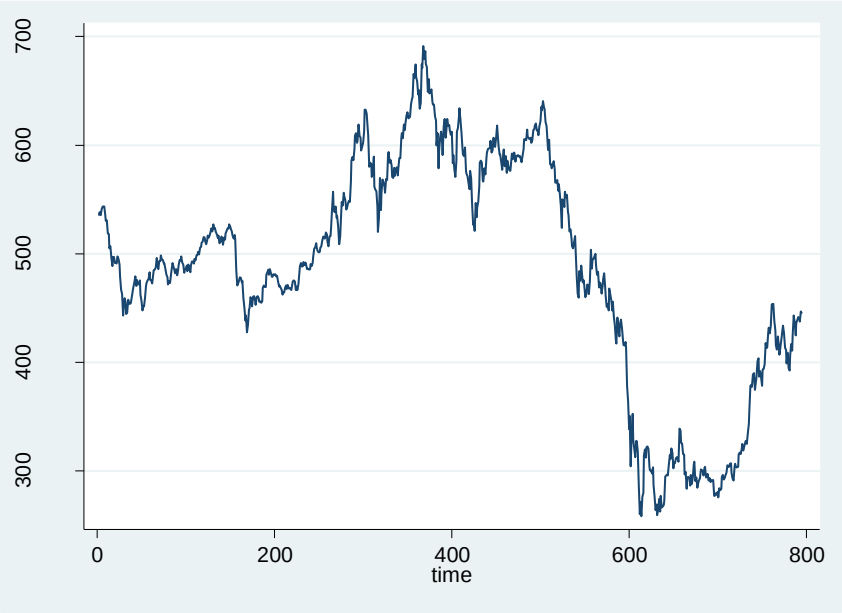
Test with only lags

```
. dfuller spot, nocon lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                             ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.585           -2.580            -1.950            -1.620
------------------------------------------------------------------------------
      D.spot |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |  -.0003419   .0005845    -0.58   0.559    -.0014892    .0008054
         LD. |   .0811979   .0354321     2.29   0.022      .011646    .1507499
------------------------------------------------------------------------------
```

Now, it can be concluded that the spot series is nonstationary since the t-statistic = -0.58 does not fall into the rejection region (\|t-statistic\|=0.58 < \|critical value\|=1.950). Thus, the null hypothesis that is β = 1 (nonstationary) cannot be rejected.

Whether the series future is stationary

```
. line future t
```



According to the graph above, the series future might be nonstationary. However, the test is required to guarantee.

Augmented Dickey-Fuller Test

Test with all terms (intercept, trend, lags)

```
. dfuller future, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.374            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.8685

------------------------------------------------------------------------------
D.future     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |  -.0050243   .0036579    -1.37   0.170    -.0122046     .002156
         LD. |  -.0335608   .0355846    -0.94   0.346    -.1034125     .036291
      _trend |  -.0009128   .0016705    -0.55   0.585    -.0041919    .0023663
       _cons |    2.67398   2.183399     1.22   0.221    -1.611978    6.959937
------------------------------------------------------------------------------
```

From the test result, it suggests that β = 1 since the MacKinnon p-value = 0.8685 > 0.05, i.e. the series is nonstationary. However, the time trend (α_1) is insignificant because p-value = 0.585 > 0.05. Therefore, the time trend must be removed first, then test again.

Test with intercept and lags

```
. dfuller future, lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
```

```
 Z(t)             -1.264            -3.430            -2.860            -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.6453

------------------------------------------------------------------------------
    D.future |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |  -.0041054   .0032469    -1.26   0.206    -.0104789    .0022682
         LD. |  -.0340903   .0355556    -0.96   0.338     -.103885    .0357044
             |
       _cons |   1.866323   1.606292     1.16   0.246    -1.286783    5.019429
------------------------------------------------------------------------------
```

From the test result, it suggests that β = 1 since the MacKinnon p-value = 0.6453 > 0.05, i.e. the series is nonstationary. However, the intercept (α_0) is insignificant because p-value = 0.246 > 0.05. Therefore, the intercept must be removed and test again.

Test with lags only

```
. dfuller future, nocon lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       793

                             ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.609            -2.580            -1.950            -1.620

------------------------------------------------------------------------------
    D.future |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |  -.0004181   .0006863    -0.61   0.543    -.0017653    .0009291
         LD. |  -.0360006   .0355254    -1.01   0.311    -.1057359    .0337347
------------------------------------------------------------------------------
```

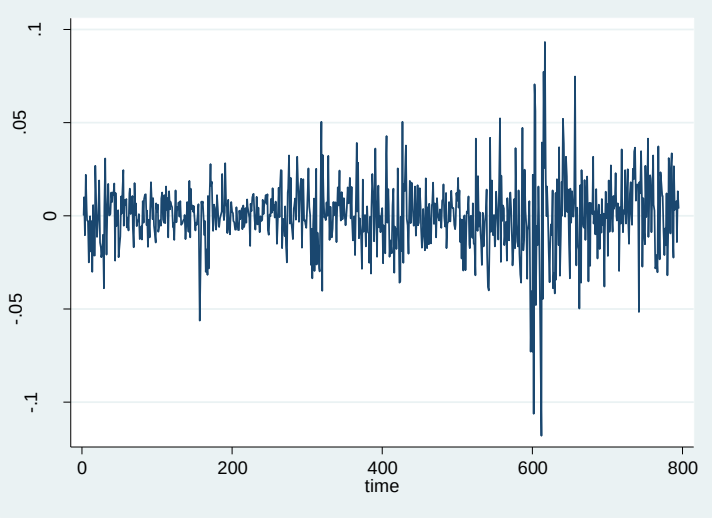
Now, it can be concluded that the future series is nonstationary since the t-statistic = -0.61 does not fall into the rejection region (\|t-statistic\|=0.61 < \|critical value\|=1.950). Thus, the null hypothesis that is β = 1 (nonstationary) cannot be rejected.

2. From spot and future, generate spot return (rspot) and future return (rfuture) and test whether they are stationary.

```
. gen rspot = (spot-l.spot)/l.spot
(1 missing value generated)

. gen rfuture = (future-l.future)/l.future
(1 missing value generated)
```

Whether the series rspot is stationary

```
. line rspot t
```



From the graph, rspot might be stationary; however, the test is required to guarantee.

Augmented Dickey-Fuller Test

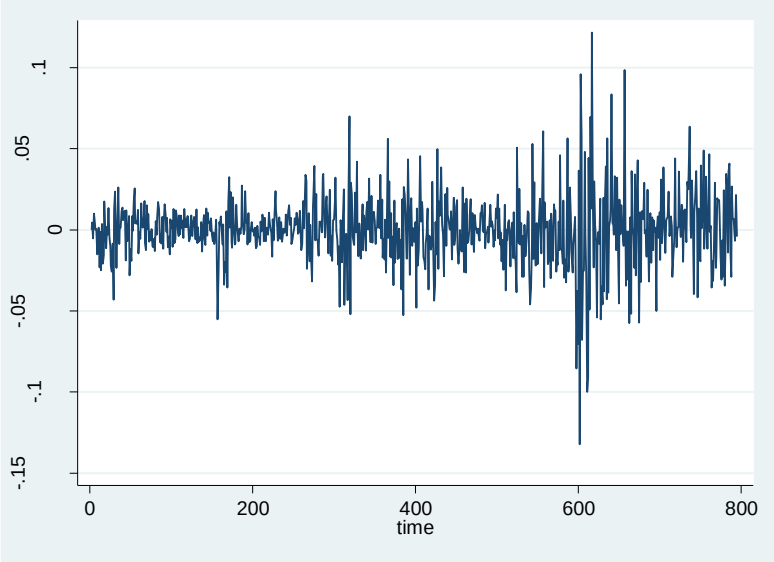
Test with all terms (intercept, trend, lags)

```
. dfuller rspot, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       792

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test            1% Critical       5% Critical      10% Critical
               Statistic            Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -17.710            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.rspot      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       rspot |
         L1. |  -.8597466    .048545   -17.71   0.000    -.9550394   -.7644539
         LD. |  -.0798976   .0355137    -2.25   0.025    -.1496103   -.0101849
      _trend |   1.03e-06   2.89e-06     0.36   0.721    -4.64e-06    6.71e-06
       _cons |  -.0004573   .0013254    -0.35   0.730    -.0030591    .0021445
------------------------------------------------------------------------------
```

From the test result, it indicates that rspot series is stationary since the MacKinnon p-value = 0.000 < 0.05, i.e. the null hypothesis that is β = 1 (nonstationary) is rejected.

Whether the series rfuture is stationary

```
. line rfuture t
```



From the graph, rfuture seems to be stationary; however, the test is required to guarantee.

Augmented Dickey-Fuller Test

Test with all terms (intercept, trend, lags)

```
. dfuller rfuture, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       792

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -19.613            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.rfuture    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rfuture |
         L1. |  -1.008595   .0514258   -19.61   0.000    -1.109543   -.9076473
         LD. |  -.0327739   .0356244    -0.92   0.358    -.1027038     .037156
      _trend |   1.36e-06   3.42e-06     0.40   0.690    -5.35e-06    8.07e-06
       _cons |   -.000539   .0015671    -0.34   0.731    -.0036152    .0025373
------------------------------------------------------------------------------
```

From the test result, it indicates that rfuture series is stationary since the MacKinnon p-value = 0.000 < 0.05, i.e. the null hypothesis that is β = 1 (nonstationary) is rejected.

Furthermore, it can be concluded that series spot and future are integrated series of order 1