

Assignment 13

Properties Time Series – Unit Root Test

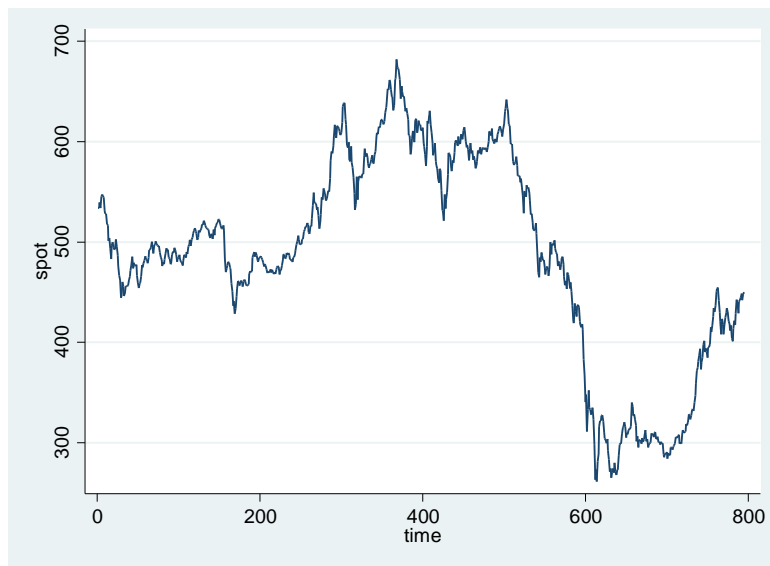
From the data set `assign_timeseries.dta`:

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

***Test whether the series `spot` is stationary.**

```
. tsset t
      time variable:  time, 1 to 795
              delta:  1 unit

. line spot t
```



According to this graph, it is possible that the series `spot` is nonstationary. 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, the MacKinnon p-value is 0.8780, which is more than 0.05. Thus, the beta equals to 1. The series is nonstationary.

However, the time trend is insignificant because its p-value equals to 0.603, which more than 0.05. Thus, we should remove the time trend and test again.

(test with all terms: 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, the Mackinnon p-value is 0.6570, which is more than 0.05. The series is nonstationary.

However, the intercept is insignificant as it has the p-value of 0.254, which is more than 0.05. Thus, 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
-----

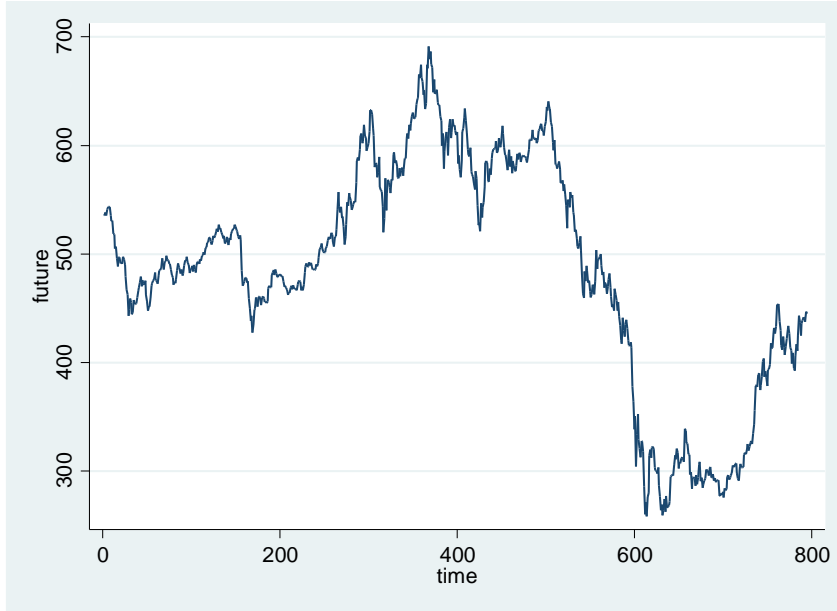
```

It can be concluded that the spot series is nonstationary because its t-statistic is -0.58. This number does not fall into the rejection region ($|t\text{-statistic}|=0.58 < |critical\ value|=1.950$).

Therefore, the null hypothesis that is $\beta = 1$ (nonstationary) cannot be rejected.

```
. *Test whether the series future is stationary series.
```

```
. line future t
```



From the graph above, the series future might be nonstationary. However, we should test 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)	-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   -0.0122046   .002156
      LD. |  -.0335608  .0355846   -0.94  0.346   -0.1034125   .036291
      _trend | -.0009128  .0016705   -0.55  0.585   -0.0041919   .0023663
      _cons |   2.67398  2.183399    1.22  0.221   -1.611978    6.959937
-----

```

According to the test, the MacKinnon p-value is 0.8685, which is more than 0.05. Thus, beta is equal to 1 and the series is nonstationary.

However, the time trend is insignificant (the p-value being 0.585 > 0.05). Therefore, we should remove the time trend and 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   -0.0104789   .0022682
      LD. |  -.0340903  .0355556   -0.96  0.338   -0.103885    .0357044
      |
      _cons |   1.866323  1.606292    1.16  0.246   -1.286783    5.019429
-----

```

 From the test result, it suggests that the beta equals to 1 since the MacKinnon p-value = 0.6453 > 0.05. The series is nonstationary.

However, the intercept is insignificant because p-value = 0.246 > 0.05. Thus, 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

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

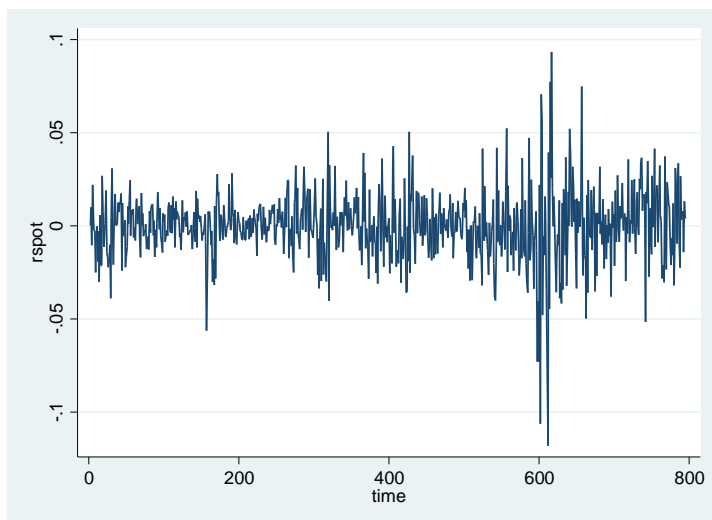
D.future	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
future						
L1.	-.0004181	.0006863	-0.61	0.543	-.0017653	.0009291
LD.	-.0360006	.0355254	-1.01	0.311	-.1057359	.0337347

 It can now be concluded that the future series is nonstationary t-statistic = -0.61 does not fall into the rejection region (|t-statistic|=0.61 < |critical value|=1.950).

In conclusion, the null hypothesis that is beta = 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)  
  
. *Test whether the series rspot is stationary.  
. line rspot t
```



According to the graph above, Rspot may be stationary. We need to test to guarantee.

***Augmented Dickey-Fuller Test**

(Test with all terms: intercept, trend, and lags)

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

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

----- Interpolated Dickey-Fuller -----

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-17.710	-3.960	-3.410	-3.120

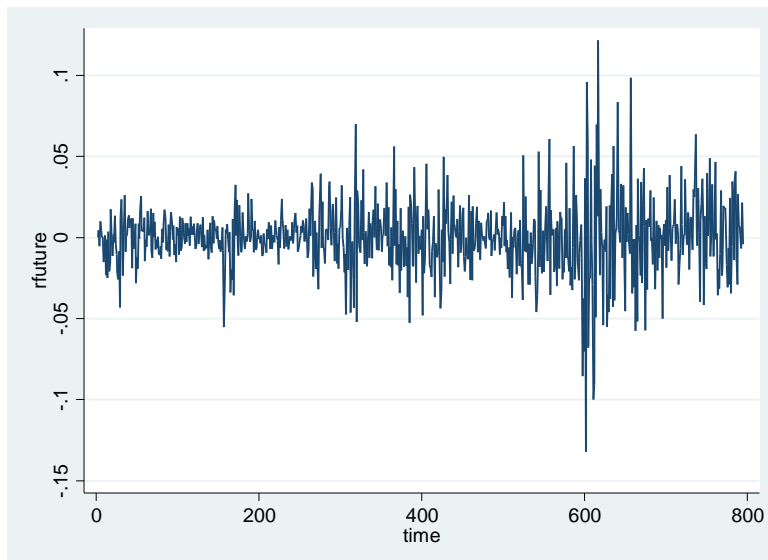
MacKinnon approximate p-value for Z(t) = 0.0000

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

Since the MacKinnon p-value = 0.000 < 0.05, the null hypothesis that is beta = 1 (nonstationary) is rejected. Thus, the rspot series is stationary.

*** Test whether the series rfuture is stationary**

. line rfuture t



According to the graph, rfuture might be stationary. We need to test to guarantee.

***Augmented Dickey-Fuller Test**

(Test with all terms: intercept, trend, and lags)

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

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

Test Statistic	----- Interpolated Dickey-Fuller -----		
	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-19.613	-3.960	-3.410

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

According to the test result, it indicates that rfuture series is stationary since the MacKinnon p-value = 0.000 < 0.05. The null hypothesis that beta = 1 (nonstationary) is rejected.

In addition, it can be concluded that series spot and future are integrated series of order 1.