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

For Spot Series,

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

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.438           -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.3597

------------------------------------------------------------------------------
D.spot       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |   -.001489   .0006108    -2.44   0.015    -.0026862   -.0002917
         LD. |   .0440347   .0114011     3.86   0.000     .0216855    .0663839
      _trend |   .0000171   8.32e-06     2.05   0.040     7.62e-07    .0000334
       _cons |   .7447753    .302873     2.46   0.014     .1510615    1.338489
------------------------------------------------------------------------------
```

The result shows p-value=0.3597>0.05, therefore we fail to reject null hypothesis of unit root. Then, the trend is not significant (p-value=0.040>0.05). Thus, there must be no trend.

- Test with intercept and lags

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.325           -3.430            -2.860            -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.6176

------------------------------------------------------------------------------
      D.spot |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |  -.0004809   .0003629    -1.33   0.185    -.0011923    .0002305
         LD. |   .0435503    .011401     3.82   0.000     .0212012    .0658993
             |
       _cons |   .2693479   .1950793     1.38   0.167    -.1130608    .6517565
------------------------------------------------------------------------------
```

The result shows p-value=0.6176>0.05, therefore we fail to reject null hypothesis of unit root. Then, the trend is not significant (p-value=0.167>0.05). Thus, there must be no constant term.

- Test with lags – no intercept

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.948           -2.580            -1.950            -1.620

------------------------------------------------------------------------------
      D.spot |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        spot |
         L1. |   .0000194   .0000204     0.95   0.343    -.0000206    .0000593
         LD. |   .0432884   .0114001     3.80   0.000     .0209412    .0656357
------------------------------------------------------------------------------
```

The result shows the test statistic value (Z(t)) = 0.948 that lies inside the 95% confident level (5% Critical Value = -1.950) range, therefore, the null hypothesis of Unit-root test is failed to reject, then, the series are non-stationary.

For Future Series,

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

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.563           -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.2971

------------------------------------------------------------------------------
D.future     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |   -.001768   .0006898    -2.56   0.010    -.0031202   -.0004159
         LD. |  -.0275938   .0114077    -2.42   0.016    -.0499561   -.0052315
      _trend |   .0000222     .00001     2.22   0.026     2.62e-06    .0000418
       _cons |     .86276   .3338726     2.58   0.010     .2082785    1.517241
------------------------------------------------------------------------------
```

The result shows p-value=0.2971>0.05, therefore we fail to reject null hypothesis of unit root. Then, the trend is not significant (p-value=0.026>0.05). Thus, there must be no trend.

- Test with intercept and lags

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

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

```
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.289           -3.430            -2.860            -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.6341

------------------------------------------------------------------------------
    D.future |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |  -.0004968   .0003854    -1.29   0.197    -.0012523    .0002587
         LD. |  -.0282081   .0114073    -2.47   0.013    -.0505696   -.0058467
             |
       _cons |   .2758156   .2042151     1.35   0.177    -.1245016    .6761329
------------------------------------------------------------------------------
```

The result shows p-value=0.6341>0.05, therefore we fail to reject null hypothesis of unit root. Then, the trend is not significant (p-value=0.177>0.05). Thus, there must be no constant term.

- Test with lags – no intercept

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7682

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.972           -2.580            -1.950            -1.620

------------------------------------------------------------------------------
    D.future |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      future |
         L1. |   .0000227   .0000234     0.97   0.331    -.0000231    .0000686
         LD. |  -.0284806   .0114061    -2.50   0.013    -.0508397   -.0061214
------------------------------------------------------------------------------
```

The result shows the test statistic value (Z(t)) = 0.972 that lies inside the 95% confident level (5% Critical Value = -1.950) range, therefore, the null hypothesis of Unit-root test is failed to reject, then, the series are non-stationary.

2. Determine order of integration of the series spot and future.

<u>For Spot Series,</u>

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

```
. dfuller d.spot, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

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

```
------------------------------------------------------------------------------
 Z(t)            -63.765            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D2.spot      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      D.spot |
         L1. |  -1.005364   .0157667   -63.77   0.000    -1.036271    -.974457
         LD. |   .0508571    .011398     4.46   0.000     .0285139    .0732003
      _trend |   7.82e-07   4.94e-06     0.16   0.874    -8.90e-06    .0000105
       _cons |   .0088178   .0219189     0.40   0.687    -.0341492    .0517848
------------------------------------------------------------------------------
```

The result shows p-value=0.0000<0.05, therefore we rejected null hypothesis of unit root. Then, the series are stationary at 1st difference.

For Future Series,

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

```
. dfuller d.future, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -65.269            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D2.future    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    D.future |
         L1. |  -1.067592   .0163567   -65.27   0.000    -1.099655   -1.035528
         LD. |    .038008   .0114045     3.33   0.001     .0156522    .0603639
      _trend |   1.01e-06   5.59e-06     0.18   0.856    -9.94e-06     .000012
       _cons |   .0096235   .0247823     0.39   0.698    -.0389566    .0582036
------------------------------------------------------------------------------
```

The result shows p-value=0.0000<0.05, therefore we rejected null hypothesis of unit root. Then, the series are stationary at 1st diffrence.

3. Generate series of the return of spot (rspot) and return of future (rfuture) and test whether they are stationary

For Spot Series,

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

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

```
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -63.787           -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. |  -1.005168   .0157581   -63.79   0.000    -1.036058   -.9742776
         LD. |   .0517018   .0113974     4.54   0.000     .0293598    .0740439
      _trend |   9.56e-10   9.19e-09     0.10   0.917    -1.71e-08    1.90e-08
       _cons |   .0000199   .0000408     0.49   0.626      -.00006    .0000998
------------------------------------------------------------------------------
```

The result shows p-value=0.0000<0.05, therefore we rejected null hypothesis of unit root. Then, the series are stationary.

For Future Series,

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

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

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

                                 ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -65.070           -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. |  -1.063572   .0163449   -65.07   0.000    -1.095612   -1.031531
         LD. |     .03575   .0114053     3.13   0.002     .0133924    .0581076
      _trend |   1.17e-09   1.06e-08     0.11   0.912    -1.96e-08    2.19e-08
       _cons |   .0000231    .000047     0.49   0.624    -.0000691    .0001152
------------------------------------------------------------------------------
```

The result shows p-value=0.0000<0.05, therefore we rejected null hypothesis of unit root. Then, the series are stationary.