Rolling-Hedge-OLS

March 24, 2020

0.1 Rolling Regression

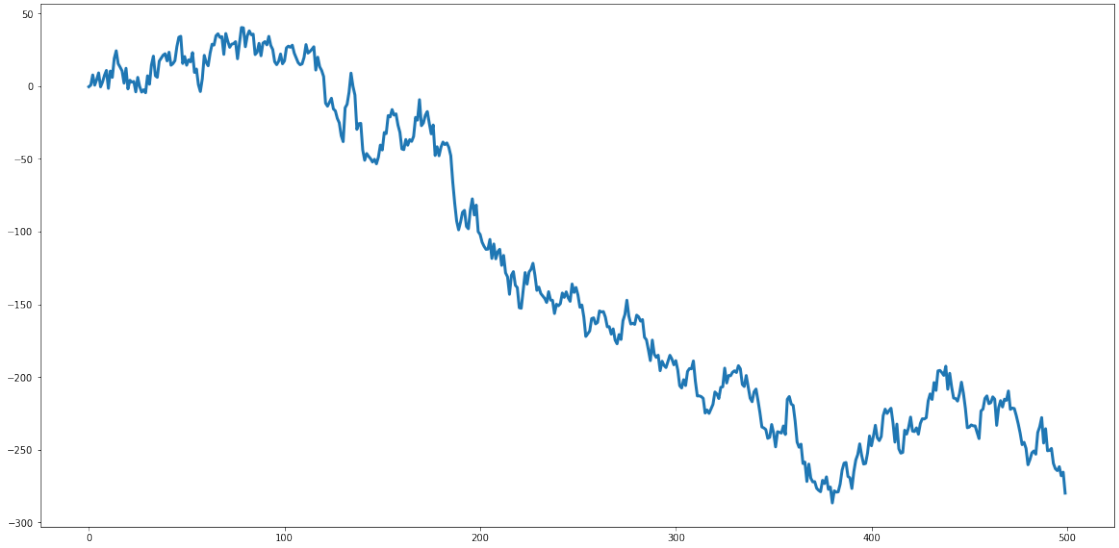
[6]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
plt.rcParams['figure.figsize'] = [20, 10]

## Function to calculate ols regressions
from scipy.stats import linregress
```

[7]:
```
# N = number of observations
N = 500

## x_t is a random walk
x = np.cumsum(np.random.normal(size=N))

## Derek's & Chris's parameter values
a = .22
b = 7.0

## Normal disturbances
z = np.random.normal(size=N,loc=0.0, scale=2.2)

## Y is cointegrated with x
y = a + b * x + z
```

[8]:
```
import matplotlib.pyplot as plt
```

[9]:
```
plt.plot(y, linewidth=3)
```

[9]:
```
[<matplotlib.lines.Line2D at 0x7f0a00feac88>]
```



[10]:
```
## First difference spot prices
dS = np.diff(y)

## First difference futures prices
dF = np.diff(x)
```

[11]:
```
dS[:10]
```

[11]:
```
array([  1.08218825,   7.01912312,  -7.03186555,   3.71625842,
         4.71503921,  -9.58191775,   3.27267058,   4.61398977,
         3.39842824, -12.34287124])
```

[12]:
```
dS[-10:]
```

[12]:
```
array([-15.14834492,   0.26609448,   1.34600253, -10.30557965,
        -3.67604018,  -1.2743138 ,   2.67336102,  -6.19360151,
         2.43568124, -14.39393888])
```

[13]:
```
dF[:10]
```

[13]:
```
array([ 0.34117558,  0.29366155, -0.60323595,  1.00546781,  0.1445845 ,
       -1.0599019 , -0.04789633,  0.7934035 ,  0.47032864, -1.44881429])
```

[14]:
```
dF[-10:]
```

[14]:
```
array([-2.27463395,  0.33439526, -0.08384676, -0.99054924, -0.77672123,
        0.024811  ,  1.13444121, -1.40867704,  0.09352651, -1.52450305])
```

[15]:
```
dS.shape
```

[15]:
```
(499,)
```

[16]:
```
dF.shape
```

[16]:
```
(499,)
```

[ ]:

[ ]:

[17]:
```
## Number of lookback observations in moving estimation window
M = 60

## The length of the sample for estimated hedge ratios (taking into account␣
 ↪that we require M initial observations for our first h)
L = N - M
```

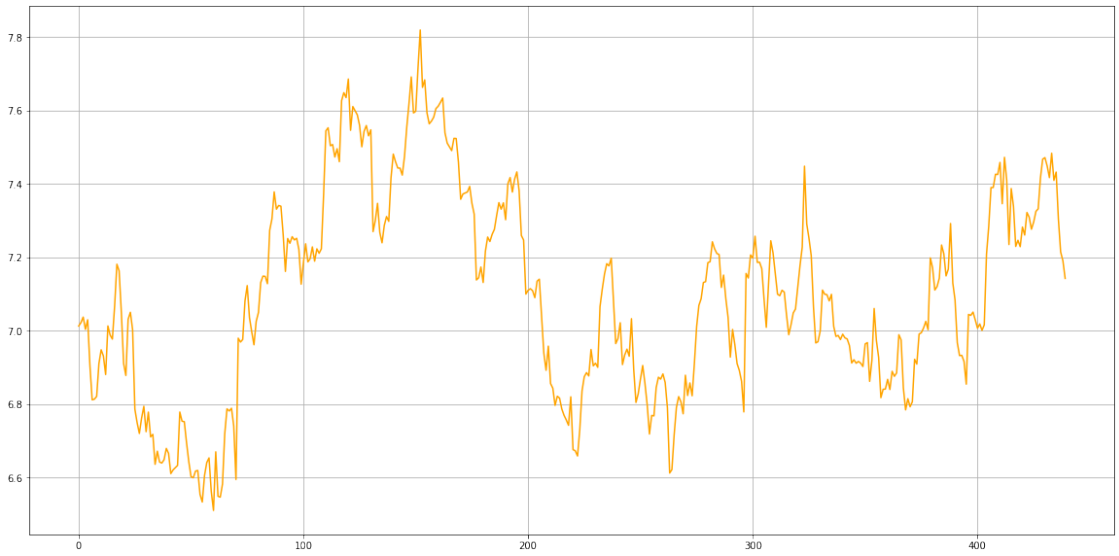
[18]:
```
## Empty storate array for estimated rolling hedge ratios
h = np.empty(L)
```

[19]:
```
## starting indices for 60-days rolling window
ibeg = 0
iend = 60

for i in range(L):
    reg = linregress(dF[ibeg:iend], dS[ibeg:iend])
    h[i] = reg.slope
    ibeg += 1
    iend += 1
```

[20]:
```
## Turn the estimated hedge ratios into a pandas series for convenience
ts = pd.Series(h)
```

[21]:
```
## ... such as plotting
ts.plot(grid=True, color="orange")
```

[21]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f0a00e64e80>
```



0.2 Tutorial on Reading Data into Pandas DataFrame from CSV File

[22]:
```
inFile = "./data/WTI-Prices-1992-to-1993.csv"
```

[23]:
```
df = pd.read_csv(inFile, parse_dates=True)
```

[24]:
```
whos
```

```
Variable     Type                Data/Info
-----------------------------------------
L            int                 440
M            int                 60
N            int                 500
a            float               0.22
ax           AxesSubplot         AxesSubplot(0.125,0.125;0.775x0.755)
b            float               7.0
dF           ndarray             499: 499 elems, type `float64`, 3992 bytes
dS           ndarray             499: 499 elems, type `float64`, 3992 bytes
df           DataFrame                     Date   Spot  F<…>n\n[500 rows x 3
columns]
fig          Figure              Figure(432x288)
h            ndarray             440: 440 elems, type `float64`, 3520 bytes
i            int                 439
ibeg         int                 440
iend         int                 500
inFile       str                 ./data/WTI-Prices-1992-to-1993.csv
linregress   function            <function linregress at 0x7f0a01456b70>
np           module              <module 'numpy' from
```

```
'/ho<…>kages/numpy/__init__.py'>
pd           module              <module 'pandas' from
'/h<…>ages/pandas/__init__.py'>
plt          module              <module
'matplotlib.pyplo<…>es/matplotlib/pyplot.py'>
reg          LinregressResult
LinregressResult(slope=7.<…>tderr=0.4065843162216528)
ts           Series              0      7.013042\n1      7<…>ngth: 440, dtype:
float64
x            ndarray             500: 500 elems, type `float64`, 4000 bytes
y            ndarray             500: 500 elems, type `float64`, 4000 bytes
z            ndarray             500: 500 elems, type `float64`, 4000 bytes
```

[25]:
```
df.head()
```

[25]:

	Date	Spot	Futures
0	1992-01-02	19.43	19.49
1	1992-01-03	19.22	19.23
2	1992-01-06	19.24	19.21
3	1992-01-07	18.72	18.69
4	1992-01-08	17.95	17.87

[26]:
```
df.tail()
```

[26]:

	Date	Spot	Futures
495	1993-12-23	14.48	14.48
496	1993-12-27	14.09	14.13
497	1993-12-28	14.11	14.11
498	1993-12-29	14.45	14.44
499	1993-12-30	14.19	14.17

[27]:
```
spot = df.Spot.values
futures = df.Futures.values
```

[28]:
```
whos
```

```
Variable     Type                Data/Info
-----------------------------------------
L            int                 440
M            int                 60
N            int                 500
a            float               0.22
ax           AxesSubplot         AxesSubplot(0.125,0.125;0.775x0.755)
b            float               7.0
dF           ndarray             499: 499 elems, type `float64`, 3992 bytes
dS           ndarray             499: 499 elems, type `float64`, 3992 bytes
df           DataFrame                   Date   Spot  F<…>n\n[500 rows x 3
columns]
```

```
fig          Figure              Figure(432x288)
futures      ndarray             500: 500 elems, type `float64`, 4000 bytes
h            ndarray             440: 440 elems, type `float64`, 3520 bytes
i            int                 439
ibeg         int                 440
iend         int                 500
inFile       str                 ./data/WTI-Prices-1992-to-1993.csv
linregress   function            <function linregress at 0x7f0a01456b70>
np           module              <module 'numpy' from
'/ho<…>kages/numpy/__init__.py'>
pd           module              <module 'pandas' from
'/h<…>ages/pandas/__init__.py'>
plt          module              <module
'matplotlib.pyplo<…>es/matplotlib/pyplot.py'>
reg          LinregressResult
LinregressResult(slope=7.<…>tderr=0.4065843162216528)
spot         ndarray             500: 500 elems, type `float64`, 4000 bytes
ts           Series              0      7.013042\n1      7<…>ngth: 440, dtype:
float64
x            ndarray             500: 500 elems, type `float64`, 4000 bytes
y            ndarray             500: 500 elems, type `float64`, 4000 bytes
z            ndarray             500: 500 elems, type `float64`, 4000 bytes
```

[29]:
```
dF = np.diff(futures)
dS = np.diff(spot)
```

[30]:
```
dF.shape
```

[30]: (499,)

[31]:
```
dS.shape
```

[31]: (499,)

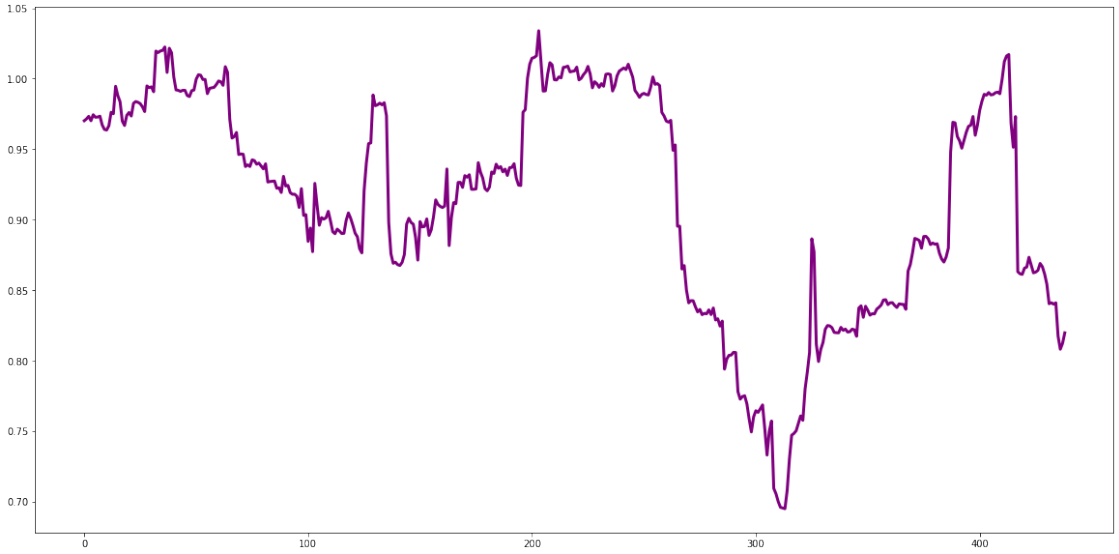
[32]:
```
M = 60
N = dS.shape[0]
L = N - M
```

[33]:
```
## starting indices for 60-days rolling window
ibeg = 0
iend = 60

h = np.empty(L)

for i in range(L):
    reg = linregress(dF[ibeg:iend], dS[ibeg:iend])
    h[i] = reg.slope
```

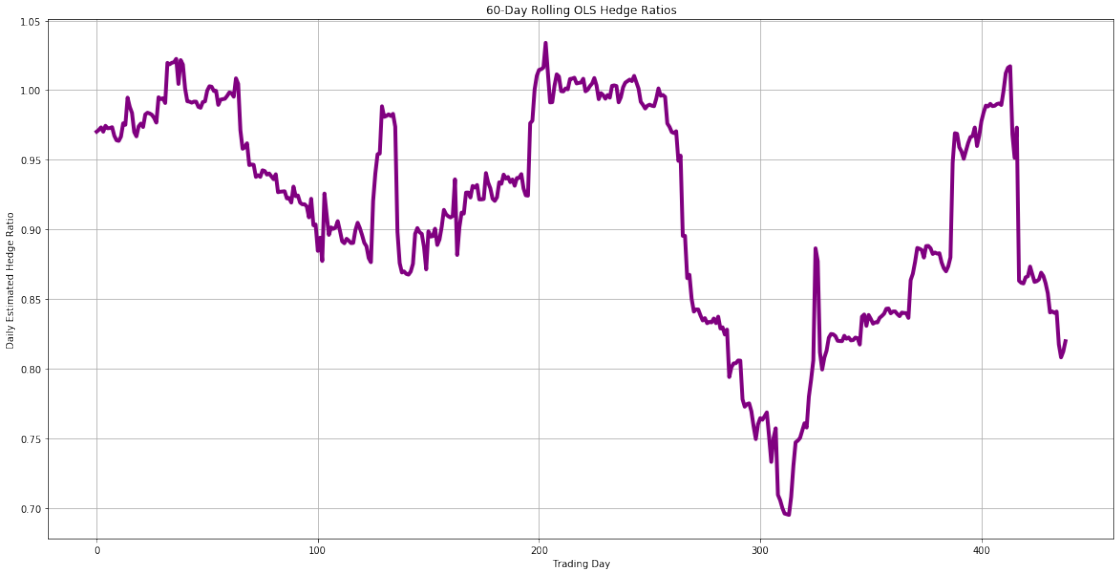
```
    ibeg += 1
    iend += 1
```

[34]:
```
plt.plot(h, linewidth=3, color="purple")
```

[34]:
```
[<matplotlib.lines.Line2D at 0x7f0a00d7c940>]
```



[37]:
```
fig, ax = plt.subplots()
ax.grid(True)
plt.title("60-Day Rolling OLS Hedge Ratios")
plt.ylabel("Daily Estimated Hedge Ratio")
plt.xlabel("Trading Day")
plt.plot(h, linestyle='-', linewidth=4, color="purple")
plt.savefig("SixtyDayRollingHedgeRatios.png")
```


60-Day Rolling OLS Hedge Ratios
Daily Estimated Hedge Ratio
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0
100
200
300
400
Trading Day

[ ]:

[ ]: