# Currency L-S Strategy

May 16, 2022

## 0.1 Learned

### 0.1.1 L-S strategy returns

- How to calculate returns of strategy == find NAV of portfolio at ALL times
- Compute returns from period-to-period
- Portfolio NAV == amount of money one will get if close out position == sell everything they own/ pay for everything they owe
- https://quant.stackexchange.com/questions/15530/calculation-of-returns-and-risk-metrics-for-l-s-portfolio
- https://quant.stackexchange.com/questions/44543/calculate-portfolio-return-with-one-long-position-and-one-short-position
- https://quant.stackexchange.com/questions/32513/calculating-the-returns-of-a-long-short-strategy

### 0.1.2 Plotting

- How to plot 2 graphs in one - https://cmdlinetips.com/2019/10/how-to-make-a-plot-with-two-different-y-axis-in-python-with-matplotlib/
- How to highlight specific values on a graph

https://stackoverflow.com/questions/8270981/in-a-matplotlib-plot-can-i-highlight-specific-x-value-ranges#8271438

https://stackoverflow.com/questions/55866957/using-axvspan-for-date-ranges-in-matplotlib

### 0.1.3 Other

- Dataframe.copy()
- Need for strings + converting strings to datetime format

[1]:

```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

[2]:

```python
def loadData():
    df = pd.read_csv("usdZarData.csv")
    # 2 different risk free data sets. One includes holidays, the other does not
    riskFree = pd.read_csv("3moTbill.csv")
    riskFree2 = pd.read_csv("3moDeptofTreasury.csv")

    return df, riskFree, riskFree2

df, riskFree, riskFree2 = loadData()
```

[3]:

```
def createDataTable(df):

    # create data table
    dataTable = df.merge(riskFree, left_on = 'Date', right_on= 'Date')
    zerosList = dataTable.shape[0]*[0]

    # Compute rolling window statistics

    movAvg = 15
    histVol = 90

    # def( movAvg, histVol):

    # create column titles
    maTitle = '{n}-day MA'.format(n = movAvg)
    volTitle = '{n}-day vol'.format(n = histVol)

    # add data to main table
    dataTable[maTitle] = dataTable.iloc[:,1].rolling(movAvg,min_periods =␣
 ↪movAvg).sum()/movAvg
    dataTable[volTitle] = dataTable.iloc[:,1].rolling(histVol,min_periods =␣
 ↪histVol).sum()/histVol

    return dataTable, zerosList

dataTable, zerosList = createDataTable(df)
```

[29]:

```
def computeBaselineStrategy(dataTable, buyNusd, sellMusd, zerosList):
## Compute strategy

    dataTable['Signal'] = dataTable['USDZAR'] - dataTable['15-day MA']

    dataTable['Signal/ Noise'] = zerosList
    for i in range(0, len(dataTable)):
        dataTable.loc[i,'Signal/ Noise'] = dataTable.loc[i,'Signal']/ dataTable.
 ↪loc[i,'90-day vol']

    dataTable['Baseline $ strategy'] = zerosList
    dataTable['Baseline ZAR strategy'] = zerosList
    for i in range(0, len(dataTable)):
            if dataTable['Signal'][i] > 0:
                # sell $, buy RAND
                dataTable.loc[i,'Baseline $ strategy'] = -buyNusd
                dataTable.loc[i,'Baseline ZAR strategy'] = sellMusd*dataTable.
 ↪loc[i,'USDZAR']

            elif dataTable['Signal'][i] < 0:
                dataTable.loc[i,'Baseline $ strategy'] = buyNusd
                dataTable.loc[i,'Baseline ZAR strategy'] = -sellMusd*dataTable.
 ↪loc[i,'USDZAR']

            else:
                dataTable.loc[i,'Baseline $ strategy'] = 0
                dataTable.loc[i,'Baseline ZAR strategy'] = 0

    return dataTable


# define baseline strategy - mod(amount of dollar to buy or sell based on␣
 ↪signal)
buyNusd = 1
sellMusd = 1

dataTable = computeBaselineStrategy(dataTable, buyNusd, sellMusd, zerosList)
dataTable.tail(20)
```

[29]:

```
            Date  USDZAR 3mo_Tbill  15-day MA  90-day vol    Signal  \
1262  07/04/2021   14.51      0.02  14.768667   14.897333 -0.258667
1263  08/04/2021   14.54      0.01  14.764000   14.889111 -0.224000
1264  09/04/2021   14.52      0.02  14.750000   14.881889 -0.230000
1265  12/04/2021   14.58      0.02  14.734667   14.874889 -0.154667
1266  13/04/2021   14.56      0.03  14.725333   14.868444 -0.165333
1267  14/04/2021   14.49      0.02  14.699333   14.863111 -0.209333
1268  15/04/2021   14.39      0.02  14.662000   14.856778 -0.272000
1269  16/04/2021   14.14      0.02  14.604667   14.847667 -0.464667
1270  19/04/2021   14.30      0.02  14.560000   14.839444 -0.260000
1271  20/04/2021   14.21      0.03  14.513333   14.830667 -0.303333
1272  21/04/2021   14.29      0.03  14.472667   14.824111 -0.182667
1273  22/04/2021   14.22      0.03  14.435333   14.817444 -0.215333
1274  23/04/2021   14.31      0.03  14.415333   14.813889 -0.105333
1275  26/04/2021   14.27      0.03  14.392000   14.808889 -0.122000
1276  27/04/2021   14.27      0.01  14.373333   14.805222 -0.103333
1277  28/04/2021   14.37      0.01  14.364000   14.801778  0.006000
1278  29/04/2021   14.20      0.01  14.341333   14.797444 -0.141333
1279  30/04/2021   14.28      0.01  14.325333   14.794556 -0.045333
```

```
1280  03/05/2021   14.46      0.04  14.317333   14.792889  0.142667
1281  04/05/2021   14.49      0.02  14.312667   14.791444  0.177333

      Signal/ Noise  Baseline $ strategy  Baseline ZAR strategy
1262      -0.017363                    1                 -14.51
1263      -0.015045                    1                 -14.54
1264      -0.015455                    1                 -14.52
1265      -0.010398                    1                 -14.58
1266      -0.011120                    1                 -14.56
1267      -0.014084                    1                 -14.49
1268      -0.018308                    1                 -14.39
1269      -0.031296                    1                 -14.14
1270      -0.017521                    1                 -14.30
1271      -0.020453                    1                 -14.21
1272      -0.012322                    1                 -14.29
1273      -0.014532                    1                 -14.22
1274      -0.007110                    1                 -14.31
1275      -0.008238                    1                 -14.27
1276      -0.006980                    1                 -14.27
1277       0.000405                   -1                  14.37
1278      -0.009551                    1                 -14.20
1279      -0.003064                    1                 -14.28
1280       0.009644                   -1                  14.46
1281       0.011989                   -1                  14.49
```

[5]:

```
## compute performance of strategy
# Compute performance of chosen strategy

def createEmptyDataFrame(colNames, width, zeroList):

    stats = []
    # initialise empty data frame

    for i in range(0,width):
        stats.append(zerosList)
        #colNames.append(str(i))

    # add column names
    stats = pd.DataFrame(stats).transpose()
    stats.columns = colNames

    return stats

def computeWeightedStrategy(weightingSchemes, selectedWeightingScheme):

    weightingScheme = weightingSchemes[selectedWeightingScheme - 1]
    # check for NaNs + reomve.
    droppedNAs = dataTable.dropna(axis = 0, how = 'any')
    droppedNAs.reset_index(inplace = True)

    # get weighted scheme + adjust if none
    if weightingScheme == 'None':
        weights = [1]*len(droppedNAs)
    else:
        weights = droppedNAs[weightingScheme]
    # get baseline strategy
    baselines = droppedNAs.loc[:,['Date','Baseline $ strategy', 'Baseline ZAR␣
 ↪strategy'], ]

    # scale the baseline strategy in accordance with weights
    for i in range(0,len(weights)):
        baselines.iloc[i,1] =  weights[i] * baselines.iloc[i,1]
        baselines.iloc[i,2] =  weights[i]  * baselines.iloc[i,2]

    return baselines, droppedNAs


weightingSchemes = ['None', 'Signal', '90-day vol', 'Signal/ Noise']
selectedWeightingScheme = 1

baselines = pd.DataFrame()
baselines, droppedNAs = computeWeightedStrategy(weightingSchemes,␣
 ↪selectedWeightingScheme)
baselines
```

[5]:

```
            Date  Baseline $ strategy  Baseline ZAR strategy
0     06/09/2016                   -1                  14.38
1     07/09/2016                    1                 -13.99
2     08/09/2016                    1                 -14.00
3     09/09/2016                    1                 -14.12
4     12/09/2016                   -1                  14.38
…            …                    …                     …
1188  28/04/2021                   -1                  14.37
1189  29/04/2021                    1                 -14.20
1190  30/04/2021                    1                 -14.28
1191  03/05/2021                   -1                  14.46
1192  04/05/2021                   -1                  14.49

[1193 rows x 3 columns]
```

[6]:

```
def computeCumulativeMetrics(baselines, droppedNAs):

    # compute cumulative metrics
    baselines['Cumulative $'] = baselines.iloc[:,1].cumsum()
    baselines['Cumulative ZAR'] = baselines.iloc[:,2].cumsum()
    baselines['USDZAR'] = droppedNAs.loc[:,'USDZAR']

    # series division - https://pandas.pydata.org/pandas-docs/stable/reference/
↪api/pandas.Series.divide.html
    baselines['Spot $ ZAR value'] = baselines['Cumulative ZAR'].
↪divide(baselines['USDZAR'])
    baselines['Portfolio NAV'] = baselines['Spot $ ZAR value'] +␣
↪baselines['Cumulative $']
    baselines['3mo_Tbill'] = droppedNAs.loc[:,'3mo_Tbill']

    return baselines

baselines = computeCumulativeMetrics(baselines, droppedNAs)
baselines
```

[6]:

```
            Date  Baseline $ strategy  Baseline ZAR strategy  Cumulative $  \
0     06/09/2016                   -1                  14.38            -1
1     07/09/2016                    1                 -13.99             0
2     08/09/2016                    1                 -14.00             1
3     09/09/2016                    1                 -14.12             2
4     12/09/2016                   -1                  14.38             1
…            …                    …                     …            …
1188  28/04/2021                   -1                  14.37            99
1189  29/04/2021                    1                 -14.20           100
1190  30/04/2021                    1                 -14.28           101
1191  03/05/2021                   -1                  14.46           100
1192  04/05/2021                   -1                  14.49            99

      Cumulative ZAR  USDZAR  Spot $ ZAR value  Portfolio NAV 3mo_Tbill
0              14.38   14.38          1.000000       0.000000      0.32
1               0.39   13.99          0.027877       0.027877      0.34
2             -13.61   14.00         -0.972143       0.027857      0.35
3             -27.73   14.12         -1.963881       0.036119      0.35
4             -13.35   14.38         -0.928373       0.071627      0.37
…                …      …                …             …         …
1188        -1253.71   14.37        -87.244955      11.755045      0.01
1189        -1267.91   14.20        -89.289437      10.710563      0.01
1190        -1282.19   14.28        -89.789216      11.210784      0.01
1191        -1267.73   14.46        -87.671508      12.328492      0.04
1192        -1253.24   14.49        -86.489993      12.510007      0.02

[1193 rows x 9 columns]
```

[7]:

```
def computePortfolioReturns(baselines):
    # compute portfolio returns
    returns = []

    for i,j in enumerate(baselines['Portfolio NAV']):
        if i == 0:
            returns.append('NaN')
        else:
            returns.append((j/baselines['Portfolio NAV'][i-1]) - 1)

    baselines['Portfolio returns'] = returns
    # baselines.columns
    return baselines

baselines = computePortfolioReturns(baselines)
baselines
```

```
<ipython-input-7-404281d39a9b>:9: RuntimeWarning: divide by zero encountered in
double_scalars
  returns.append((j/baselines['Portfolio NAV'][i-1]) - 1)
```

[7]:

```
            Date  Baseline $ strategy  Baseline ZAR strategy  Cumulative $  \
0     06/09/2016                   -1                  14.38            -1
1     07/09/2016                    1                 -13.99             0
2     08/09/2016                    1                 -14.00             1
3     09/09/2016                    1                 -14.12             2
4     12/09/2016                   -1                  14.38             1
…          …                  …                    …           …
1188  28/04/2021                   -1                  14.37            99
1189  29/04/2021                    1                 -14.20           100
1190  30/04/2021                    1                 -14.28           101
1191  03/05/2021                   -1                  14.46           100
1192  04/05/2021                   -1                  14.49            99

      Cumulative ZAR  USDZAR  Spot $ ZAR value  Portfolio NAV 3mo_Tbill  \
0              14.38   14.38          1.000000       0.000000      0.32
1               0.39   13.99          0.027877       0.027877      0.34
2             -13.61   14.00         -0.972143       0.027857      0.35
3             -27.73   14.12         -1.963881       0.036119      0.35
4             -13.35   14.38         -0.928373       0.071627      0.37
…              …     …               …            …       …
1188        -1253.71   14.37        -87.244955      11.755045      0.01
1189        -1267.91   14.20        -89.289437      10.710563      0.01
1190        -1282.19   14.28        -89.789216      11.210784      0.01
1191        -1267.73   14.46        -87.671508      12.328492      0.04
1192        -1253.24   14.49        -86.489993      12.510007      0.02

     Portfolio returns
0                  NaN
```

```
1                   inf
2          -0.000714286
3              0.296579
4              0.983092
…                     …
1188          0.0555279
1189         -0.0888539
1190          0.0467035
1191          0.0996994
1192          0.0147232

[1193 rows x 10 columns]
```

[8]:

```
def runStrategy(buyNusd, sellMusd, weightingSchemes,selectedWeightingScheme  ):

    df, riskFree, riskFree2 = loadData()

    # createDataTable
    dataTable, zerosList = createDataTable(df)

    # define baseline strategy - mod(amount of dollar to buy or sell based on␣
 ↪signal)
    #buyNusd = 1
    #sellMusd = 1
    dataTable = computeBaselineStrategy(dataTable, buyNusd, sellMusd, zerosList)

    # compute weighted strategy
    baselines = pd.DataFrame()
    baselines, droppedNAs = computeWeightedStrategy(weightingSchemes,␣
 ↪selectedWeightingScheme)

    # compute cumulative metrics
    baselines = computeCumulativeMetrics(baselines, droppedNAs)

    # compute portfolio returns
    baselines = computePortfolioReturns(baselines)

    return baselines

# Select portfolio weighting scheme
weightingSchemes = ['None', 'Signal', '90-day vol', 'Signal/ Noise']
selectedWeightingScheme = 1     # 1 == 'None'

#baselines = runStrategy()
#baselines.head(20)
```

## 0.2 Plotting strategy

- We now proceed to compute some return statistics
- We also proceed to plot

[9]:
```
def formatDate(baselines):

# Set date format
# https://stackoverflow.com/questions/37610983/how-set-column-as-date-index
    baselines['Date'] = pd.to_datetime(baselines['Date'], format = "%d/%m/%Y")
    baselines = baselines.set_index(['Date'])

    return baselines

baselines = formatDate(baselines)
print(baselines.head(5))
```

```
            Baseline $ strategy  Baseline ZAR strategy  Cumulative $  \
Date
2016-09-06                   -1                  14.38            -1
2016-09-07                    1                 -13.99             0
2016-09-08                    1                 -14.00             1
2016-09-09                    1                 -14.12             2
2016-09-12                   -1                  14.38             1

            Cumulative ZAR  USDZAR  Spot $ ZAR value  Portfolio NAV 3mo_Tbill  \
Date
2016-09-06           14.38   14.38          1.000000       0.000000      0.32
2016-09-07            0.39   13.99          0.027877       0.027877      0.34
2016-09-08          -13.61   14.00         -0.972143       0.027857      0.35
2016-09-09          -27.73   14.12         -1.963881       0.036119      0.35
2016-09-12          -13.35   14.38         -0.928373       0.071627      0.37

           Portfolio returns
Date
2016-09-06               NaN
2016-09-07               inf
2016-09-08      -0.000714286
2016-09-09          0.296579
2016-09-12          0.983092
```

[10]:
```
def getNAVData(baselines):
    droppedBaselineNAs = baselines.iloc[2:,:]
    portfolioNAV = droppedBaselineNAs.loc[:,'Portfolio NAV']
    portfolioDates = droppedBaselineNAs.index
    underlying = droppedBaselineNAs.loc[:,'USDZAR']

    return portfolioNAV, portfolioDates, underlying, droppedBaselineNAs
```

```
#y, x, z, droppedBaselineNAs = getNAVData(baselines)
portfolioNAV, portfolioDates, underlying, droppedBaselineNAs =␣
 ↪getNAVData(baselines)
portfolioNAV
```

[10]:

```
Date
2016-09-08     0.027857
2016-09-09     0.036119
2016-09-12     0.071627
2016-09-13     0.062500
2016-09-14     0.088011
                 …
2021-04-28    11.755045
2021-04-29    10.710563
2021-04-30    11.210784
2021-05-03    12.328492
2021-05-04    12.510007
Name: Portfolio NAV, Length: 1191, dtype: float64
```

[11]:

```
    droppedBaselineNAs = baselines.iloc[2:,:]
    y = droppedBaselineNAs.iloc[:,6]
    x = droppedBaselineNAs.index
    underlying = droppedBaselineNAs.loc[:,'USDZAR']
```

[12]:

```
def computeAllDrawdownStats(series):
    # compute drawdown duration


    storedDrawdowns = []
    sizeMaxDrawdownList = []
    maxDrawdownLocations = []
    drawDownStartList = []
    drawDownEndList = []
    # end

    for i in range(0, len(series)-1):
        #print(i)
        initialValue = series[i]
        comparison = series[i+1]
        count = 0

        drawdown = (comparison - initialValue)/ initialValue
        sizeMaxDrawdown = drawdown

        maxDrawdownLocation = 0
        if comparison > initialValue:
            sizeMaxDrawdown = 0
            maxDrawdownLocation = 0
        else:

        # stopping condition when sliding window hits end of series
            while initialValue > comparison and i+ count +1 < len(series)-1:

                    # compute new drawdown wrt start of window
                    drawdown = (comparison - initialValue)/ initialValue

                    #print('drawing down')
                    if drawdown < sizeMaxDrawdown:
                        #print()
                        sizeMaxDrawdown = drawdown
                        maxDrawdownLocation = i+1+count

                    count += 1

                    #print('i is ' + str(i))
                    #print(i + 1 + count)
                    #print('max len is ' + str(len(series)))
                    # add 1 to counter --> shift windw
                    comparison = series[i+1 + count]
            #print(count)

        #get dates
        dates = series.index
        #dates = list(dates)

        maxDrawdownLocations.append(dates[maxDrawdownLocation])
        sizeMaxDrawdownList.append(sizeMaxDrawdown)
        storedDrawdowns.append(count)
        drawDownStartList.append(dates[i])
        drawDownEndList.append(dates[i+1+count])

        output = {"maxDrawdownLocations":␣
↪maxDrawdownLocations,'sizeMaxDrawdownList': sizeMaxDrawdownList,
                 'storedDrawdowns': storedDrawdowns, 'drawDownStartIndex':␣
↪drawDownStartList, 'drawDownEndIndex': drawDownEndList}

        output = pd.DataFrame(output)
        #output = [maxDrawdownLocations,sizeMaxDrawdownList,
        #          storedDrawdowns,drawDownStartList,drawDownEndList]
        #outputFrame = pd.DataFrame(output, columns =␣
↪['maxDrawdownLocations','sizeMaxDrawdownList',␣
↪'storedDrawdowns','drawDownStartList','drawDownEndList'])
        #print(i)
    return output
```

[13]:

```
drawDownStats = computeAllDrawdownStats(portfolioNAV)
#type(portfolioNAV)
#y.index[0]
#y.iloc[0]
#y[0]
```

[14]:

```
drawDownStats.head(145)
```

[14]:

```
    maxDrawdownLocations  sizeMaxDrawdownList  storedDrawdowns  \
0             2016-09-08             0.000000                0
1             2016-09-08             0.000000                0
2             2016-09-08            -0.127427                1
3             2016-09-08             0.000000                0
4             2016-09-28            -4.373155               11
..                   …                    …              …
140           2016-09-08             0.153219                2
141           2016-09-08             0.081990                1
142           2016-09-08             0.000000                0
143           2016-09-08             0.000000                0
144           2016-09-08             0.000000                0

    drawDownStartIndex drawDownEndIndex
0           2016-09-08       2016-09-09
1           2016-09-09       2016-09-12
2           2016-09-12       2016-09-14
3           2016-09-13       2016-09-14
4           2016-09-14       2016-09-30
..                 …              …
140         2017-03-23       2017-03-28
141         2017-03-24       2017-03-28
142         2017-03-27       2017-03-28
143         2017-03-28       2017-03-29
144         2017-03-29       2017-03-30

[145 rows x 5 columns]
```

[15]:

```
def extractKeyDrawdownStats(drawDownStats):

    # compute drawdown statistics
    d = drawDownStats

    # findMaxDrawdown location
    maxDrawdown = max(d.iloc[:,2])
    maxDrawDownDetails = d.loc[d.iloc[:,2]== maxDrawdown,:]

    minDrawdown = min(d.iloc[:,1])
    minDrawDownDetails = d.loc[d.iloc[:,1]== minDrawdown,:]

    index1 = maxDrawDownDetails.index[0]
    index2 = minDrawDownDetails.index[0]

    finalDrawDowns = d.iloc[[index1,index2],:]

    return finalDrawDowns

finalDrawDowns = extractKeyDrawdownStats(drawDownStats)
finalDrawDowns
```

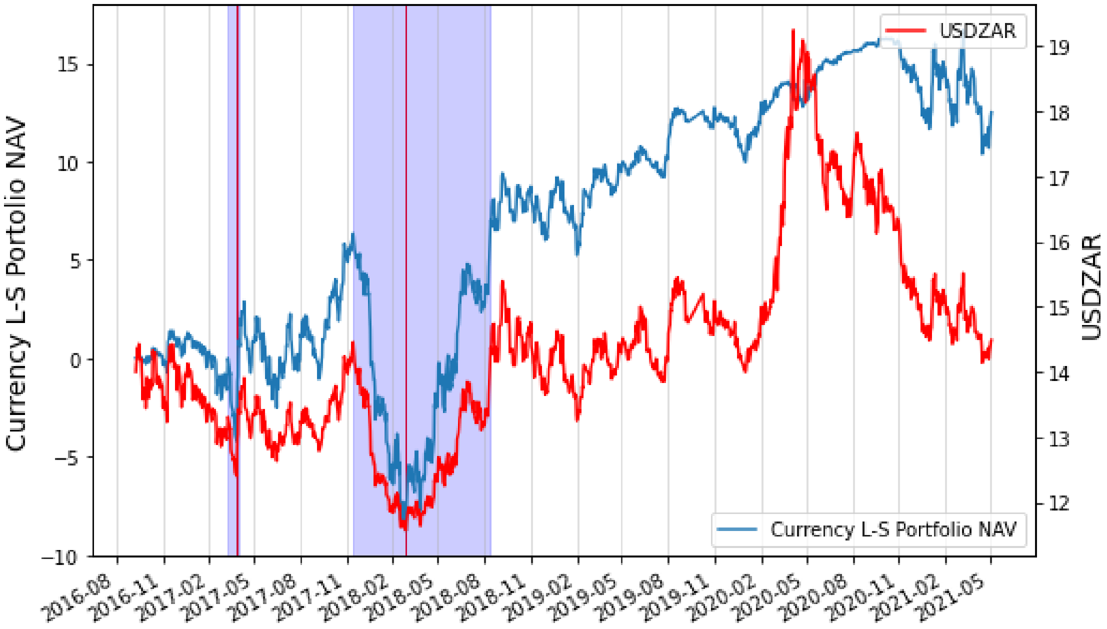
[15]:

```
    maxDrawdownLocations  sizeMaxDrawdownList  storedDrawdowns  \
307           2018-02-27            -2.376319              192
131           2017-03-27          -374.324032               14

    drawDownStartIndex drawDownEndIndex
307         2017-11-14       2018-08-13
131         2017-03-10       2017-03-31
```

[ ]:

[16]:

```
def plotGraphs(data, y, x, underlying):

    # convert date times to string for visualisation
    from datetime import datetime
    from matplotlib.dates import date2num
    import matplotlib.dates as mdates

    f, ax = plt.subplots(figsize=(9, 6))
    # https://stackoverflow.com/questions/8270981/
 ↪in-a-matplotlib-plot-can-i-highlight-specific-x-value-ranges#8271438
    # https://matplotlib.org/stable/gallery/text_labels_and_annotations/date.
 ↪html

    ax.plot(y)
    ax.grid(axis = 'x', alpha = 0.5)

    # Text in the x axis will be displayed in 'YYYY-mm' format.
    ax.xaxis.set_major_formatter(mdates.DateFormatter('%Y-%m'))
    ax.set_ylabel("Currency L-S Portolio NAV",fontsize=14)
    ax.legend(['Currency L-S Portfolio NAV'])

    for i in range(0,2):

        max2 = date2num(data.iloc[i,:][0])
        start2 = date2num(data.iloc[i,:][3])
        end2 = date2num(data.iloc[i,:][4])

        # plot max drawdown point and drawdown duration ranges
        ax.axvspan(max2, max2, color='red', alpha= 10)
        ax.axvspan(start2, end2, color='blue', alpha= 0.2)

    # Rotates and right aligns the x labels, and moves the bottom of the
    # axes up to make room for them.
    f.autofmt_xdate()

    # plot second axis - https://cmdlinetips.com/2019/10/
 ↪how-to-make-a-plot-with-two-different-y-axis-in-python-with-matplotlib/
    ax2 = ax.twinx()
    ax2.plot(underlying, color = "red")
    ax2.set_ylabel("USDZAR",fontsize=14)
    ax2.legend(['USDZAR'])

    fmt_half_year = mdates.MonthLocator(interval=3)
    ax2.xaxis.set_major_locator(fmt_half_year)

    # Minor ticks every month.
    fmt_month = mdates.MonthLocator(interval = 6)
    ax2.xaxis.set_minor_locator(fmt_month)

    plt.show()

plotGraphs(finalDrawDowns, portfolioNAV, portfolioDates, underlying)
```



[18]:

```
def computeGraphs(baselines):

    # formatDates
    baselines = formatDate(baselines)

    # getNAVData
    portfolioNAV, portfolioDates, underlying, droppedBaselineNAs =␣
 ↪getNAVData(baselines)

    # computeAllDrawdown Stats
    drawDownStats = computeAllDrawdownStats(portfolioNAV)

    # extract key drawdown stats
    finalDrawDowns = extractKeyDrawdownStats(drawDownStats)

    return finalDrawDowns, portfolioNAV, portfolioDates, underlying, baselines
    # plot graph

#finalDrawDowns, portfolioNAV, portfolioDates, underlying, baselines =␣
 ↪computeGraphs(baselines)
#plotGraphs(finalDrawDowns, portfolioNAV, portfolioDates, underlying)
```

### 0.3 Sharpe ratio

[19]:
```
def getTbillReturns(riskFree2):
    # Formatting the ates of risk free data.
    # Dates are fiddley

    from datetime import datetime

    s = riskFree2

    for i in range(0,len(s)):

        # try-except needed as there as inconsistencies in the dates
        # https://www.w3schools.com/python/python_try_except.asp
        try:
            s.loc[i,'Date'] = pd.to_datetime(s.loc[i,'Date'], format = "%m/%d/
 ↪%Y")
            #s.loc[i,'Date'] = datetime.strptime(s.loc[i,'Date'],"%m/%d/%Y")
        except:
            # https://docs.python.org/3/library/datetime.
 ↪html#strftime-and-strptime-behavior
            s.loc[i,'Date'] = pd.to_datetime(s.loc[i,'Date'], format = "%m/%d/
 ↪%y")
            #s.loc[i,'Date'] = datetime.strptime(s.loc[i,'Date'],"%m/%d/%y")


    s = s.set_index(['Date'])

    # add returns column
    s['3mo_Tbill_returns'] = s.loc[:,'3mo_Tbill'].diff(1)

    return s

riskFree2 = pd.read_csv("3moDeptofTreasury.csv")
tBillsReturns = getTbillReturns(riskFree2)

tBillsReturns
```

[19]:
```
            3mo_Tbill  3mo_Tbill_returns
Date
2016-04-04       0.23                NaN
2016-04-05       0.23               0.00
2016-04-06       0.23               0.00
2016-04-07       0.23               0.00
2016-04-08       0.23               0.00
…                 …                 …
2021-06-03       0.02               0.00
```

```
2021-06-04       0.02               0.00
2021-06-07       0.02               0.00
2021-06-08       0.02               0.00
2021-06-09       0.03               0.01

[1298 rows x 2 columns]
```

[20]:

```
droppedBaselineNAs
```

[20]:

```
            Baseline $ strategy  Baseline ZAR strategy  Cumulative $  \
Date
2016-09-08                    1                 -14.00             1
2016-09-09                    1                 -14.12             2
2016-09-12                   -1                  14.38             1
2016-09-13                    1                 -14.24             2
2016-09-14                   -1                  14.43             1
…                         …                    …           …
2021-04-28                   -1                  14.37            99
2021-04-29                    1                 -14.20           100
2021-04-30                    1                 -14.28           101
2021-05-03                   -1                  14.46           100
2021-05-04                   -1                  14.49            99

            Cumulative ZAR  USDZAR  Spot $ ZAR value  Portfolio NAV 3mo_Tbill  \
Date
2016-09-08          -13.61   14.00         -0.972143       0.027857      0.35
2016-09-09          -27.73   14.12         -1.963881       0.036119      0.35
2016-09-12          -13.35   14.38         -0.928373       0.071627      0.37
2016-09-13          -27.59   14.24         -1.937500       0.062500      0.36
2016-09-14          -13.16   14.43         -0.911989       0.088011      0.33
…                    …     …               …            …       …
2021-04-28        -1253.71   14.37        -87.244955      11.755045      0.01
2021-04-29        -1267.91   14.20        -89.289437      10.710563      0.01
2021-04-30        -1282.19   14.28        -89.789216      11.210784      0.01
2021-05-03        -1267.73   14.46        -87.671508      12.328492      0.04
2021-05-04        -1253.24   14.49        -86.489993      12.510007      0.02

           Portfolio returns
Date
2016-09-08      -0.000714286
2016-09-09          0.296579
2016-09-12          0.983092
2016-09-13         -0.127427
2016-09-14          0.408177
…                      …
2021-04-28         0.0555279
2021-04-29        -0.0888539
```

```
2021-04-30         0.0467035
2021-05-03         0.0996994
2021-05-04         0.0147232

[1191 rows x 9 columns]
```

[21]:

```
def computeSharpe(tBillsReturns, baselines):

# merge Tbills table with main data table
# and extract portfolio NAVs and Tbills

    droppedBaselineNAs = baselines.iloc[2:,:]

    s = tBillsReturns
    s['Date2'] = s.index
    test = droppedBaselineNAs.copy()
    test['Date2'] = test.index

        # merge tables
    merged = test.merge(s, how ='left', left_on = 'Date2', right_on = 'Date2')



    sharpeTable = merged.loc[:,['3mo_Tbill_y', '3mo_Tbill_returns','Portfolio␣
 ↪returns', 'Portfolio NAV','Date2']]
    sharpeTable['Portfolio - Tbill returns'] = sharpeTable.loc[:,'Portfolio␣
 ↪returns'] - sharpeTable.loc[:,'3mo_Tbill_returns']
    sharpeTable.head(5)

    # Using wiki definition - https://en.wikipedia.org/wiki/Sharpe_ratio
    meanPortfolioDailyReturn = sharpeTable['Portfolio - Tbill returns'].mean()
    portfolioDailyXsReturnStd = sharpeTable['Portfolio - Tbill returns'].std()

    dailySharpe = meanPortfolioDailyReturn/ portfolioDailyXsReturnStd
    annualisedSharpe = 365*dailySharpe/(252**0.5)

    print('Annualised sharpe ratio: ' + str(annualisedSharpe))
    print('Daily sharpe ratio: ' + str(dailySharpe))

    return merged

merged = computeSharpe(tBillsReturns, baselines)
```

```
Annualised sharpe ratio: 0.368222050995677
Daily sharpe ratio: 0.016014640671529398
```

[22]:

```
def computeTbillAndSharpe(baselines):

    riskFree2 = pd.read_csv("3moDeptofTreasury.csv")
    tBillsReturns = getTbillReturns(riskFree2)

    merged = computeSharpe(tBillsReturns, baselines)

    return merged

merged = computeTbillAndSharpe(baselines)
```

```
Annualised sharpe ratio: 0.368222050995677
Daily sharpe ratio: 0.016014640671529398
```

[23]:

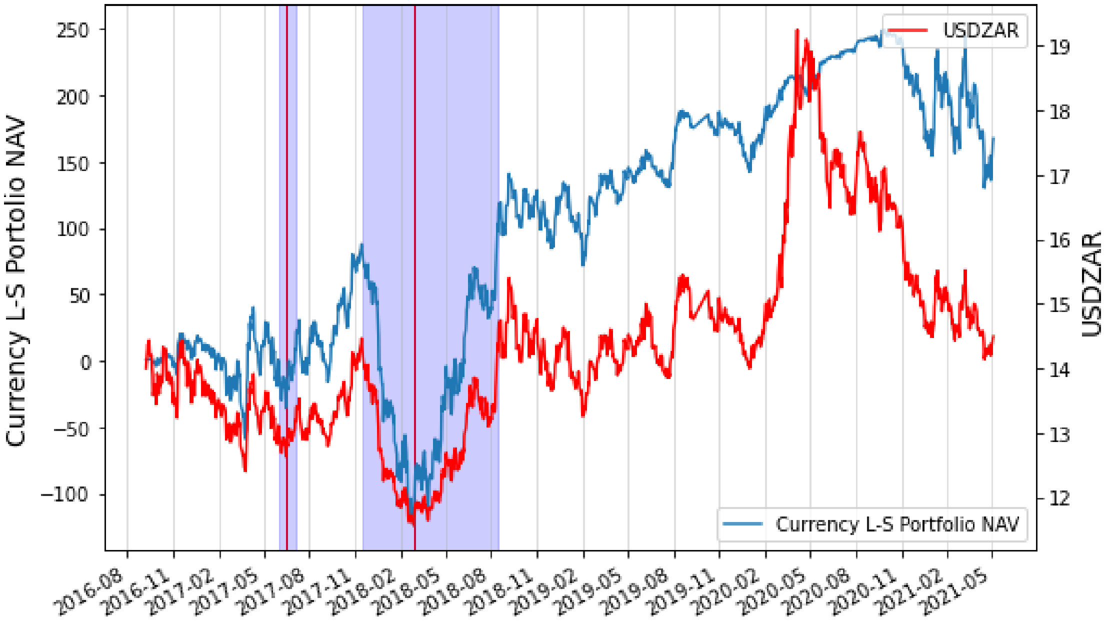
```
def plotTbill(merged):

    plt.plot(merged.loc[:,'Date2'], merged.loc[:,'3mo_Tbill_y'])
    plt.title('3mo Tbill Yield')
```

## 0.4 Main script

[35]:

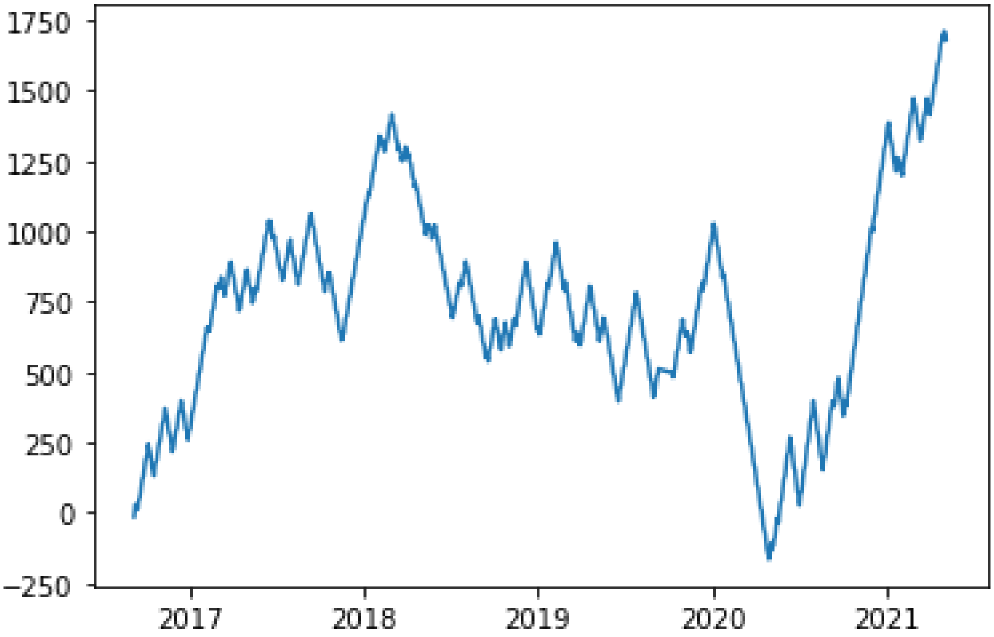
```
# Select portfolio weighting scheme
weightingSchemes = ['None', 'Signal', '90-day vol', 'Signal/ Noise']
selectedWeightingScheme = 3     # 1 == 'None'
buyNusd = 1
sellMusd = 1

baselines = runStrategy(buyNusd, sellMusd,␣
 ↪weightingSchemes,selectedWeightingScheme   )

finalDrawDowns, portfolioNAV, portfolioDates, underlying, baselines =␣
 ↪computeGraphs(baselines)

plotGraphs(finalDrawDowns, portfolioNAV, portfolioDates, underlying)

merged = computeTbillAndSharpe(baselines)

finalDrawDowns
plt.plot(baselines.iloc[:,2])
```

```
<ipython-input-7-404281d39a9b>:9: RuntimeWarning: divide by zero encountered in
double_scalars
  returns.append((j/baselines['Portfolio NAV'][i-1]) - 1)
```



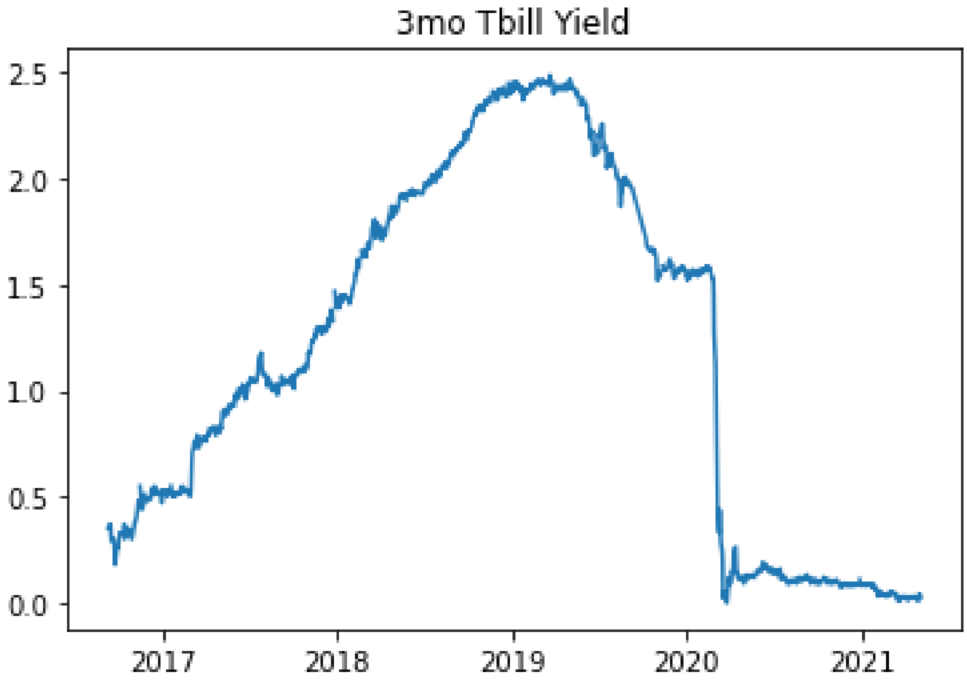
```
Annualised sharpe ratio: 0.8253438193094088
Daily sharpe ratio: 0.035895690279730275
```

```
[35]: [<matplotlib.lines.Line2D at 0xb4e23d0>]
```



[25]:

```
# plot Tbill yield

plotTbill(merged)
```



[31]:

```
baselines.head()
```

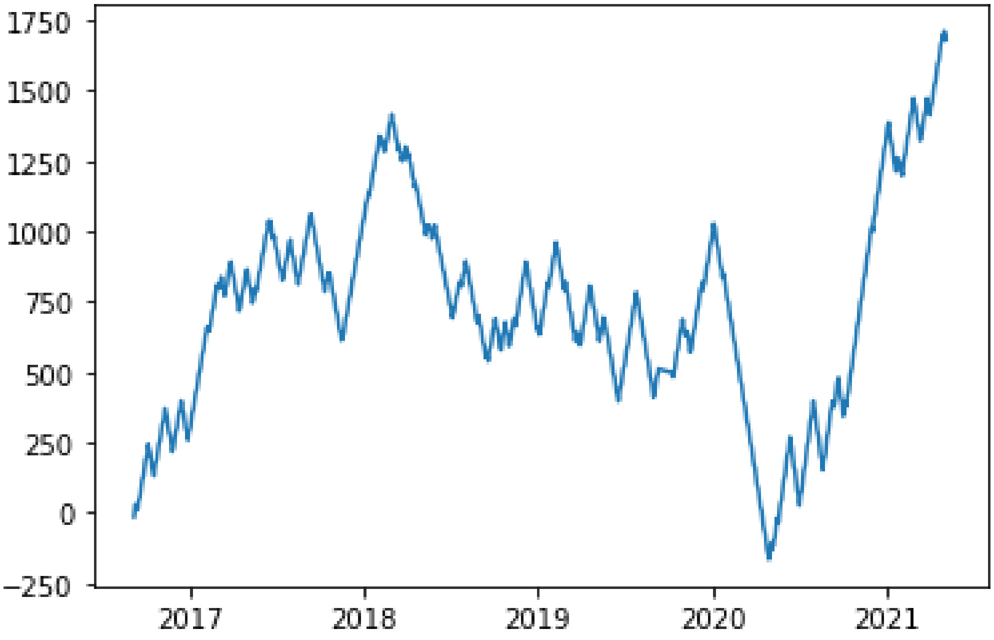
[31]:

```
            Baseline $ strategy  Baseline ZAR strategy  Cumulative $  \
Date
2016-09-06           -14.629333             210.369813    -14.629333
2016-09-07            14.622111            -204.563334     -0.007222
2016-09-08            14.611556            -204.561778     14.604333
2016-09-09            14.602333            -206.184947     29.206667
2016-09-12           -14.597444             209.911251     14.609222

            Cumulative ZAR  USDZAR  Spot $ ZAR value  Portfolio NAV 3mo_Tbill  \
Date
2016-09-06      210.369813   14.38         14.629333       0.000000      0.32
2016-09-07        5.806479   13.99          0.415045       0.407823      0.34
2016-09-08     -198.755299   14.00        -14.196807       0.407526      0.35
2016-09-09     -404.940246   14.12        -28.678488       0.528179      0.35
2016-09-12     -195.028994   14.38        -13.562517       1.046705      0.37

           Portfolio returns
Date
```

```
2016-09-06              NaN
2016-09-07              inf
2016-09-08     -0.000726935
2016-09-09         0.296061
2016-09-12         0.981724
```

```
[34]: #plt.plot(baselines.iloc[])
      plt.plot(baselines.iloc[:,2])
```

```
[34]: [<matplotlib.lines.Line2D at 0xb4d70d0>]
```



```
[ ]:
```

## 0.5 Important results

### 0.5.1 Point 1

- Very volatile strategy
- Large max drawdown window ~ 8 months. Maintaining a losing position for this long would be difficult

### 0.5.2 Assertion

- One would need to identify this change in regime and avoid trading into such events

### 0.5.3 Point 2

- Largest drawdown los of ~6x one's funds

## 0.6 Note on results

- We note that the strategy's E(ret) and Sharpe are greatly improved by scaling the position with volatility
- Using other schemes, such as scaling with signal strength worsen performance
- Scaling the signal with the inverse of volatility also worsens performance
- The result of this, is that scaling with using a signal/ noise metric also worsens performance

### 0.6.1 Additional observation

- We see oberve periods of appreciable underperformance when the USDZAR exhibits trending behaviour

### 0.6.2 Question

- Interestingly, the strategy did not lose much NAV when the USDZAR exhibited a strong upward trend in ~2020
- Why is this?

## 0.7 Conjecture

- Visual inspection of the graphs and of the USDZAR reveals that it most frequently trades in a range
- This may imply that it tends to be a mean-reverting signal
- Could it be the case that volatility increases the likelihood of mean-reversion, which is why scaling position size with volatility works
- It may well be the case that trading into volatility by scaling positions proportionally with volatility works well with range-bounded signals

If so, - Considering signals that exhibit strong trends - the complement of mean-reverting signals, it may be possible to assert that these signals favour low volatility environments, as volatility increases the likelihood of deviating from the desired trend

```
[ ]:
```