Bonds_Portfolio

September 29, 2021

1 Bonds Portfolio

http://www.buschinvestments.com/Types-of-Bonds.c71.htm

Treasury Securities
Municipal Bonds
Corporate Bonds
Zero-Coupon Bonds

[1]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.mlab as mlab
import seaborn as sns
from tabulate import tabulate
from scipy.stats import norm
import math

import warnings
warnings.filterwarnings("ignore")

# yfinance is used to fetch data
import yfinance as yf
yf.pdr_override()
```

[2]:
```python
# input
symbols = ['SPY','FIHBX','FBTAX','DBC']
start = '2014-01-01'
end = '2019-01-01'
title = "Bonds Portfolio"

# Read data
dataset = yf.download(symbols,start,end)['Adj Close']

# View Columns
dataset.head()
```

```
[*********************100%***********************]  4 of 4 completed
```

[2]:

Date	DBC	FBTAX	FIHBX	SPY
2014-01-02	24.572100	16.094238	6.968676	160.925400
2014-01-03	24.416641	16.017763	6.975503	160.898972
2014-01-06	24.445789	15.813823	6.975503	160.432693
2014-01-07	24.426357	16.068747	6.989153	161.418060
2014-01-08	24.193171	16.374655	6.989153	161.453278

[3]:

```
dataset.tail()
```

[3]:

Date	DBC	FBTAX	FIHBX	SPY
2018-12-24	14.163118	20.312393	8.344463	227.638824
2018-12-26	14.478073	21.567284	8.326165	239.140244
2018-12-27	14.340280	21.632837	8.335313	240.976212
2018-12-28	14.222172	21.632837	8.371911	240.665375
2018-12-31	14.261541	22.101082	8.426186	242.773315

1.0.1 Starting Cash with 100k to invest in Bonds

[4]:

```
Cash = 100000
print('Percentage of invest:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x in zip(dataset.columns, percent_invest):
    cost = x * Cash
    print('{}: {}'.format(i, cost))
```

```
Percentage of invest:
DBC: 25000.0
FBTAX: 25000.0
FIHBX: 25000.0
SPY: 25000.0
```

[5]:

```
print('Number of Shares:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(dataset.columns, percent_invest, dataset.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    print('{}: {}'.format(i, shares))
```

```
Number of Shares:
DBC: 1017
FBTAX: 1553
FIHBX: 3587
SPY: 155
```

[6]:
```python
print('Beginning Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(dataset.columns, percent_invest, dataset.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    Begin_Value = round(shares * y, 2)
    print('{}: ${}'.format(i, Begin_Value))
```

```
Beginning Value:
DBC: $24989.83
FBTAX: $24994.35
FIHBX: $24996.64
SPY: $24943.44
```

[7]:
```python
print('Current Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y, z in zip(dataset.columns, percent_invest, dataset.iloc[0], dataset.
 ↪iloc[-1]):
    cost = x * Cash
    shares = int(cost/y)
    Current_Value = round(shares * z, 2)
    print('{}: ${}'.format(i, Current_Value))
```

```
Current Value:
DBC: $14503.99
FBTAX: $34322.98
FIHBX: $30224.73
SPY: $37629.86
```

[8]:
```python
result = []
for i, x, y, z in zip(dataset.columns, percent_invest, dataset.iloc[0], dataset.
 ↪iloc[-1]):
    cost = x * Cash
    shares = int(cost/y)
    Current_Value = round(shares * z, 2)
    result.append(Current_Value)
print('Total Value: $%s' % round(sum(result),2))
```

```
Total Value: $116681.56
```

[9]:
```python
# Calculate Daily Returns
returns = dataset.pct_change()
returns = returns.dropna()
```

[10]:
```python
# Calculate mean returns
meanDailyReturns = returns.mean()
print(meanDailyReturns)
```

```
DBC     -0.000388
FBTAX    0.000403
FIHBX    0.000155
SPY      0.000362
dtype: float64
```

[11]:
```
# Calculate std returns
stdDailyReturns = returns.std()
print(stdDailyReturns)
```

```
DBC      0.009496
FBTAX    0.017337
FIHBX    0.002734
SPY      0.008306
dtype: float64
```

[12]:
```
# Define weights for the portfolio
weights = np.array([0.50, 0.10, 0.20, 0.20])
```

[13]:
```
# Calculate the covariance matrix on daily returns
cov_matrix = (returns.cov())*250
print (cov_matrix)
```

```
            DBC     FBTAX     FIHBX       SPY
DBC    0.022544  0.005441  0.001920  0.006348
FBTAX  0.005441  0.075140  0.003101  0.023501
FIHBX  0.001920  0.003101  0.001869  0.002384
SPY    0.006348  0.023501  0.002384  0.017247
```

[14]:
```
# Calculate expected portfolio performance
portReturn = np.sum(meanDailyReturns*weights)
```

[15]:
```
# Print the portfolio return
print(portReturn)
```

```
-5.022475164538252e-05
```

[16]:
```
# Create portfolio returns column
returns['Portfolio'] = returns.dot(weights)
```

[17]:
```
returns.head()
```

[17]:

Date	DBC	FBTAX	FIHBX	SPY	Portfolio
2014-01-03	-0.006327	-0.004752	0.000980	-0.000164	-0.003475
2014-01-06	0.001194	-0.012732	0.000000	-0.002898	-0.001256
2014-01-07	-0.000795	0.016120	0.001957	0.006142	0.002834
2014-01-08	-0.009547	0.019037	0.000000	0.000218	-0.002826

```
2014-01-09 -0.008032  0.047743  0.000000  0.000654   0.000889
```

[18]:

```
returns.tail()
```

[18]:

```
                  DBC     FBTAX     FIHBX       SPY  Portfolio
Date
2018-12-24 -0.011065 -0.010944 -0.003279 -0.026423  -0.012567
2018-12-26  0.022238  0.061780 -0.002193  0.050525   0.026963
2018-12-27 -0.009517  0.003039  0.001099  0.007677  -0.002700
2018-12-28 -0.008236  0.000000  0.004391 -0.001290  -0.003498
2018-12-31  0.002768  0.021645  0.006483  0.008759   0.006597
```

[19]:

```
# Calculate cumulative returns
daily_cum_ret=(1+returns).cumprod()
print(daily_cum_ret.tail())
```

```
                  DBC     FBTAX     FIHBX       SPY  Portfolio
Date
2018-12-24  0.576390  1.262091  1.197425  1.414561   0.889783
2018-12-26  0.589208  1.340062  1.194799  1.486032   0.913774
2018-12-27  0.583600  1.344136  1.196111  1.497441   0.911307
2018-12-28  0.578794  1.344136  1.201363  1.495509   0.908120
2018-12-31  0.580396  1.373229  1.209152  1.508608   0.914110
```

[20]:

```
# 99% confidence interval
# 0.01 empirical quantile of daily returns
var99 = round((returns['Portfolio']).quantile(0.01), 3)
```

[21]:

```
print('Value at Risk (99% confidence)')
print(var99)
```

```
Value at Risk (99% confidence)
-0.018
```

[22]:

```
# the percent value of the 5th quantile
print('Percent Value-at-Risk of the 5th quantile')
var_1_perc = round(np.quantile(var99, 0.01), 3)
print("{:.1f}%".format(-var_1_perc*100))
```

```
Percent Value-at-Risk of the 5th quantile
1.8%
```

[23]:

```
print('Value-at-Risk of 99% for 100,000 investment')
print("${}".format(round(-var99 * 100000),2))
```

```
Value-at-Risk of 99% for 100,000 investment
$1800.0
```

[24]:
```python
# 95% confidence interval
# 0.05 empirical quantile of daily returns
var95 = round((returns['Portfolio']).quantile(0.05), 3)
```

[25]:
```python
print('Value at Risk (95% confidence)')
print(var95)
```

```
Value at Risk (95% confidence)
-0.011
```

[26]:
```python
print('Percent Value-at-Risk of the 5th quantile')
print("{:.1f}%".format(-var95*100))
```

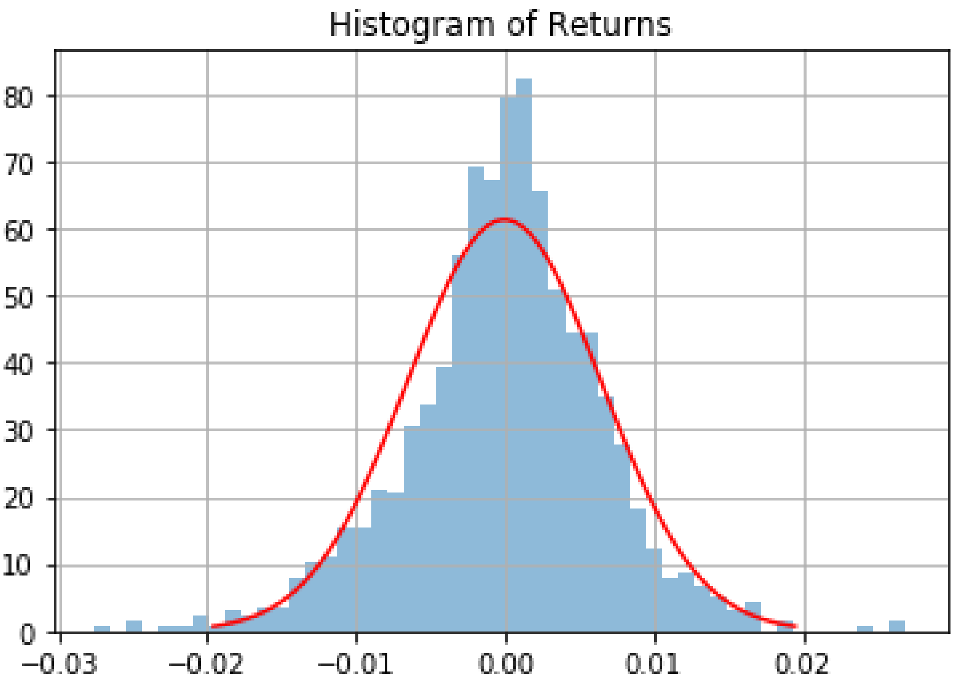
```
Percent Value-at-Risk of the 5th quantile
1.1%
```

[27]:
```python
# VaR for 100,000 investment
print('Value-at-Risk of 99% for 100,000 investment')
var_100k = "${}".format(int(-var95 * 100000))
print("${}".format(int(-var95 * 100000)))
```

```
Value-at-Risk of 99% for 100,000 investment
$1100
```

[28]:
```python
mean = np.mean(returns['Portfolio'])
std_dev = np.std(returns['Portfolio'])
```

[29]:
```python
returns['Portfolio'].hist(bins=50, normed=True, histtype='stepfilled', alpha=0.
↪5)
x = np.linspace(mean - 3*std_dev, mean + 3*std_dev, 100)
plt.plot(x, mlab.normpdf(x, mean, std_dev), "r")
plt.title('Histogram of Returns')
plt.show()
```

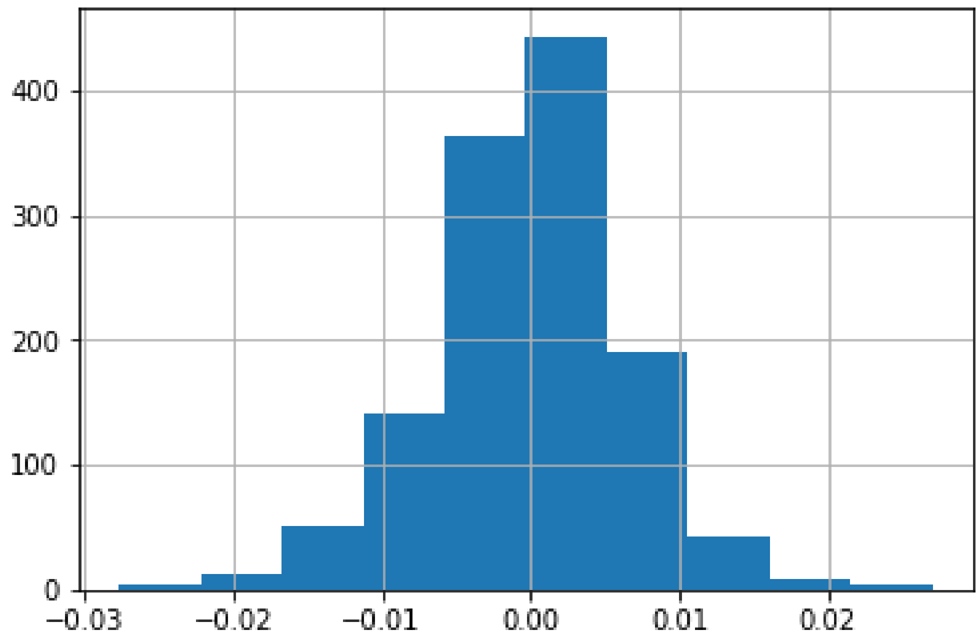


[30]:
```
VaR_90 = norm.ppf(1-0.9, mean, std_dev)
VaR_95 = norm.ppf(1-0.95, mean, std_dev)
VaR_99 = norm.ppf(1-0.99, mean, std_dev)
```

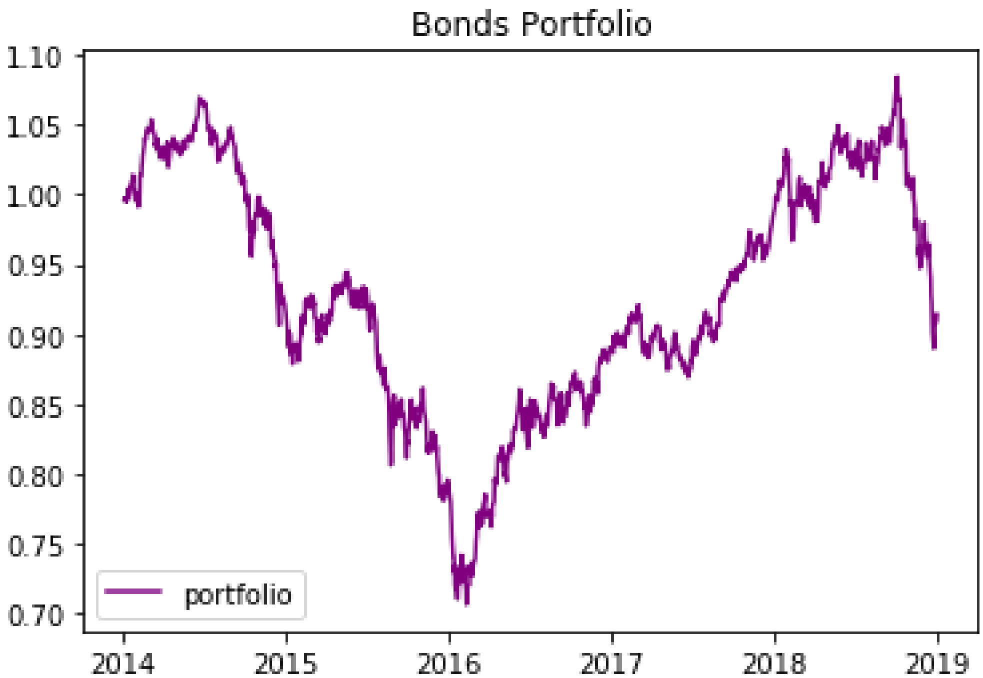
[31]:
```
print(tabulate([['90%', VaR_90], ['95%', VaR_95], ['99%', VaR_99]],
 ↪headers=['Confidence Level', 'Value at Risk']))
```

```
Confidence Level      Value at Risk
------------------  ---------------
90%                     -0.00839355
95%                     -0.0107588
99%                     -0.0151955
```

[32]:
```
returns['Portfolio'].hist()
plt.show()
```



[33]:
```
import matplotlib.dates

# Plot the portfolio cumulative returns only
fig, ax = plt.subplots()
ax.plot(daily_cum_ret.index, daily_cum_ret.Portfolio, color='purple',␣
 ↪label="portfolio")
ax.xaxis.set_major_locator(matplotlib.dates.YearLocator())
plt.title(title)
plt.legend()
plt.show()
```



[34]:
```
# Print the mean
print("mean : ", returns['Portfolio'].mean()*100)

# Print the standard deviation
print("Std. dev: ", returns['Portfolio'].std()*100)

# Print the skewness
print("skew: ", returns['Portfolio'].skew())

# Print the kurtosis
print("kurt: ", returns['Portfolio'].kurtosis())
```

```
mean :  -0.005022475164538249
Std. dev:  0.651291924442618
skew:  -0.2260558811935371
kurt:  1.2996237688067493
```

[35]:
```
# Calculate the standard deviation by taking the square root
port_standard_dev = np.sqrt(np.dot(weights.T, np.dot(weights, cov_matrix)))

# Print the results
print(str(np.round(port_standard_dev, 4) * 100) + '%')
```

```
10.299999999999999%
```

[36]:
```
# Calculate the portfolio variance
port_variance = np.dot(weights.T, np.dot(cov_matrix, weights))

# Print the result
print(str(np.round(port_variance, 4) * 100) + '%')
```

```
1.06%
```

[37]:
```
# Calculate total return and annualized return from price data
total_return = (returns['Portfolio'][-1] - returns['Portfolio'][0])

# Annualize the total return over 5 year
annualized_return = ((1 + total_return)**(1/5))-1
```

[38]:
```
# Calculate annualized volatility from the standard deviation
vol_port = returns['Portfolio'].std() * np.sqrt(250)
```

[39]:
```
# Calculate the Sharpe ratio
rf = 0.01
sharpe_ratio = ((annualized_return - rf) / vol_port)
print(sharpe_ratio)
```

```
-0.07762413406087283
```

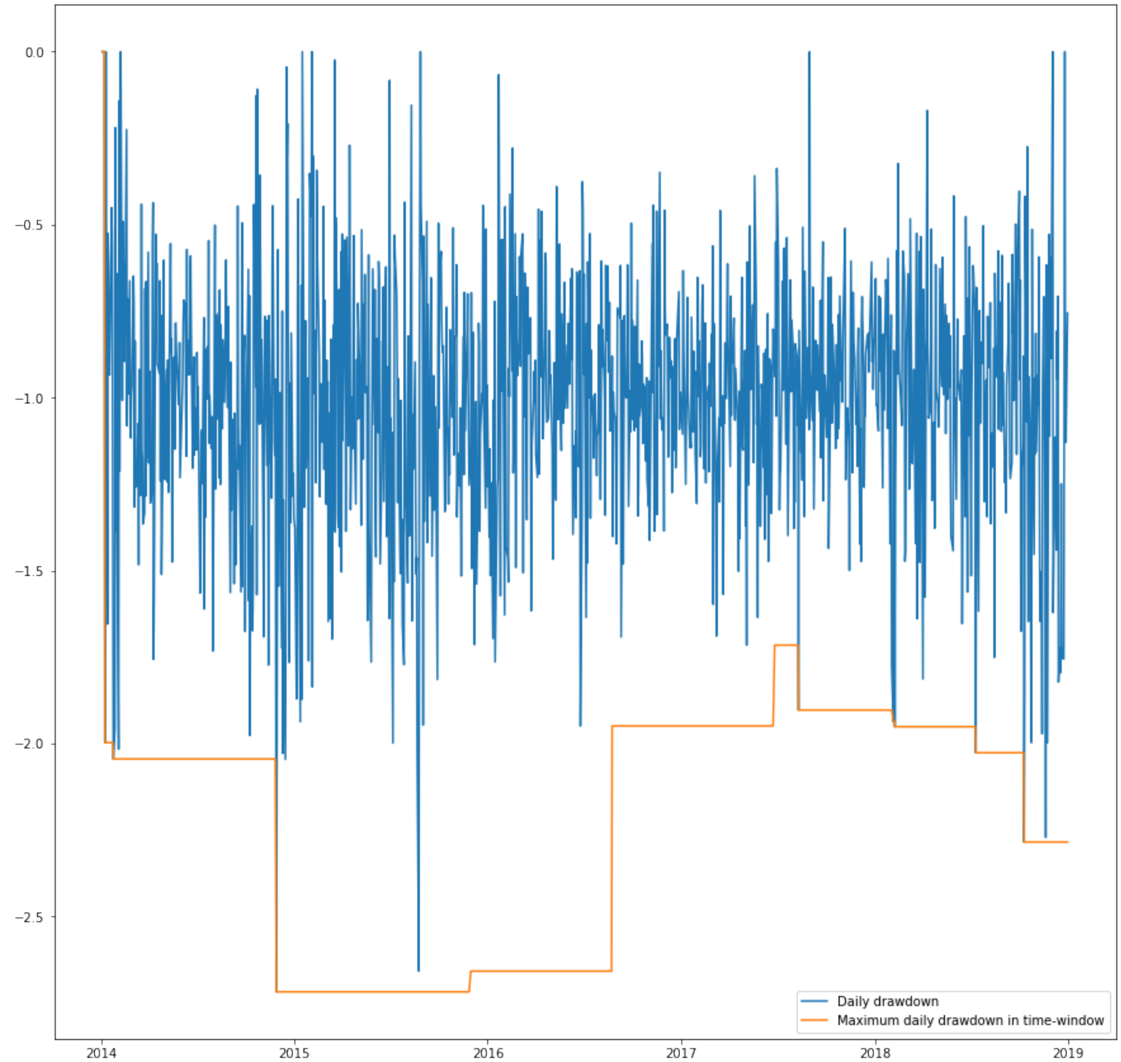
[40]:
```
# Create a downside return column with the negative returns only
target = 0
downside_returns = returns.loc[returns['Portfolio'] < target]

# Calculate expected return and std dev of downside
expected_return = returns['Portfolio'].mean()
down_stdev = downside_returns.std()

# Calculate the sortino ratio
rf = 0.01
sortino_ratio = (expected_return - rf)/down_stdev

# Print the results
print("Expected return: ", expected_return*100)
print('-' * 50)
print("Downside risk:")
print(down_stdev*100)
print('-' * 50)
print("Sortino ratio:")
print(sortino_ratio)
```

```
Expected return:  -0.005022475164538249
--------------------------------------------------
Downside risk:
```

```
DBC          0.717214
FBTAX        1.608918
FIHBX        0.269959
SPY          0.779532
Portfolio    0.459835
dtype: float64
--------------------------------------------------
Sortino ratio:
DBC         -1.401287
FBTAX       -0.624657
FIHBX       -3.722866
SPY         -1.289263
Portfolio   -2.185616
dtype: float64
```

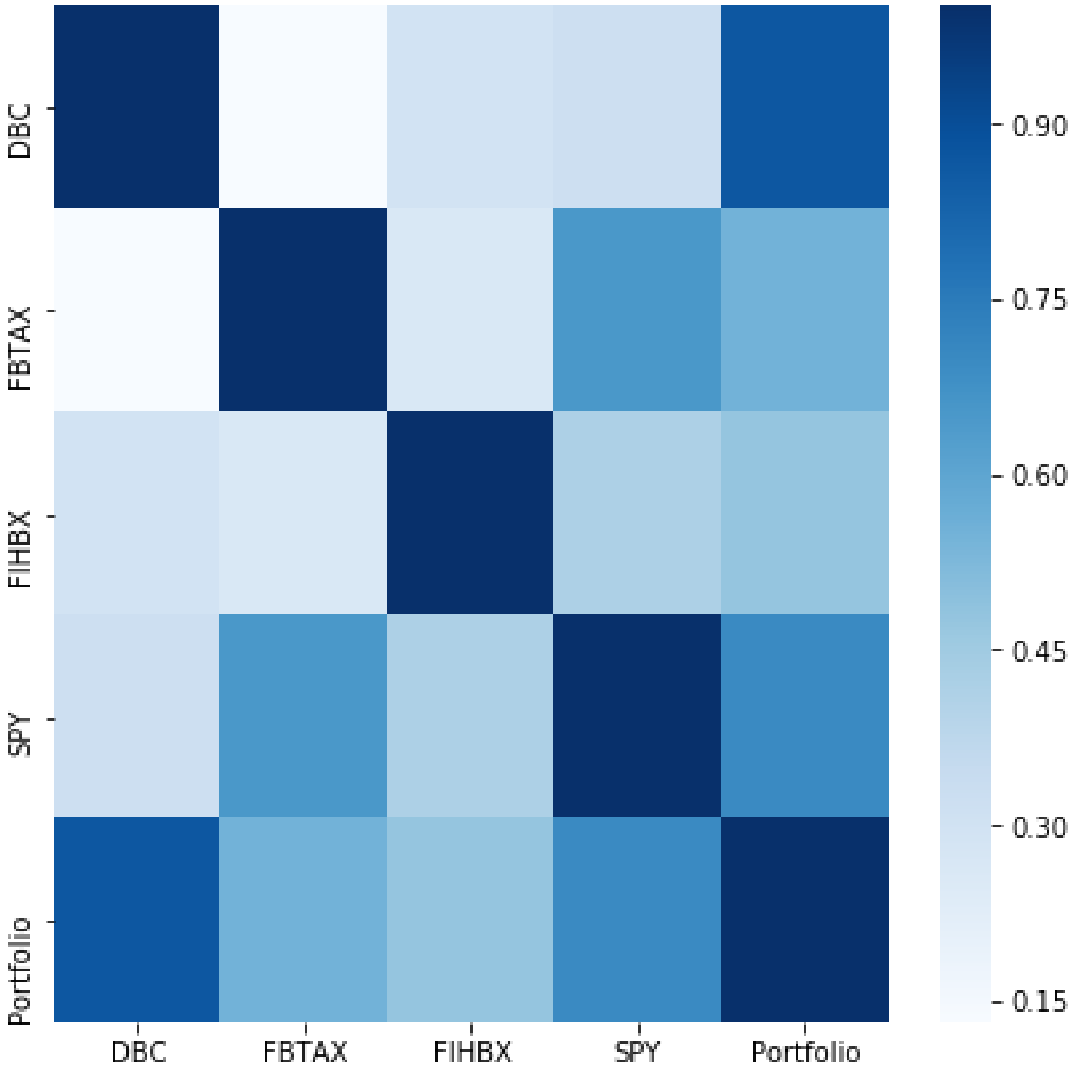
[41]:

```
# Calculate the max value
roll_max = returns['Portfolio'].rolling(center=False,min_periods=1,window=252).
 ↪max()

# Calculate the daily draw-down relative to the max
daily_draw_down = returns['Portfolio']/roll_max - 1.0

# Calculate the minimum (negative) daily draw-down
max_daily_draw_down = daily_draw_down.
 ↪rolling(center=False,min_periods=1,window=252).min()

# Plot the results
plt.figure(figsize=(15,15))
plt.plot(returns.index, daily_draw_down, label='Daily drawdown')
plt.plot(returns.index, max_daily_draw_down, label='Maximum daily drawdown in␣
 ↪time-window')
plt.legend()
plt.show()
```



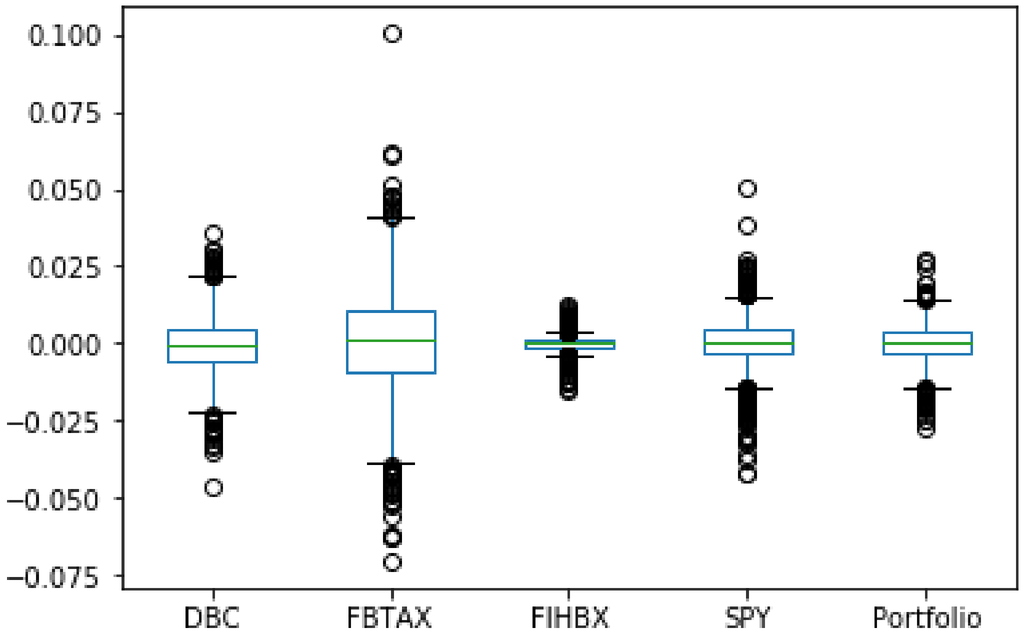
[42]:
```
plt.figure(figsize=(7,7))
corr = returns.corr()

# plot the heatmap
sns.heatmap(corr,
        xticklabels=corr.columns,
        yticklabels=corr.columns,
            cmap="Blues")
```

[42]: <matplotlib.axes._subplots.AxesSubplot at 0x1c50345d5c0>



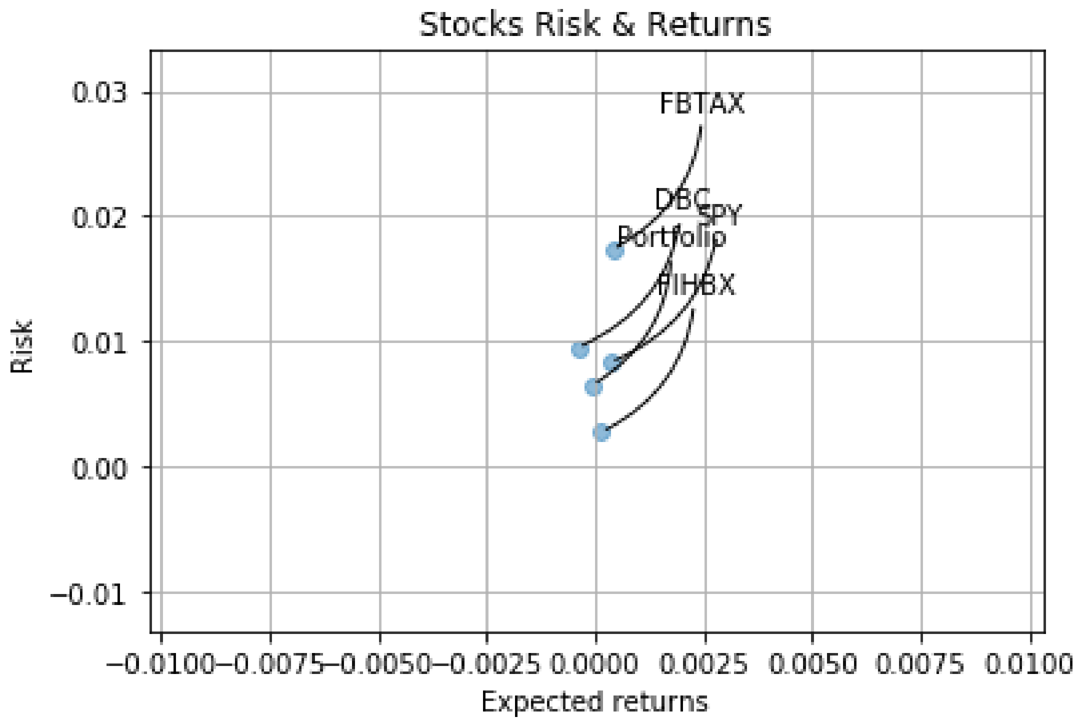
[43]:
```
# Box plot
returns.plot(kind='box')
```

[43]: <matplotlib.axes._subplots.AxesSubplot at 0x1c503414cf8>



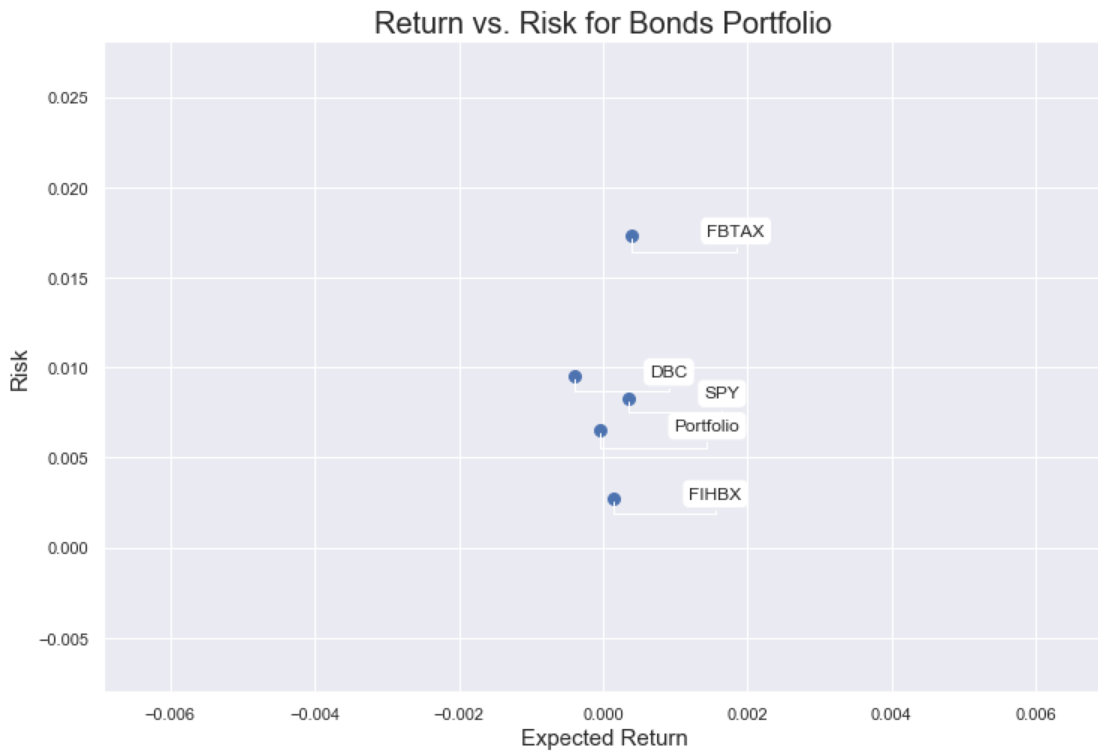
[44]:

```
rets = returns.dropna()

plt.scatter(rets.mean(), rets.std(),alpha = 0.5)

plt.title('Stocks Risk & Returns')
plt.xlabel('Expected returns')
plt.ylabel('Risk')
plt.grid(which='major')

for label, x, y in zip(rets.columns, rets.mean(), rets.std()):
    plt.annotate(
        label,
        xy = (x, y), xytext = (50, 50),
        textcoords = 'offset points', ha = 'right', va = 'bottom',
        arrowprops = dict(arrowstyle = '-', connectionstyle = 'arc3,rad=-0.3'))
```



[45]:

```
area = np.pi*20.0

sns.set(style='darkgrid')
plt.figure(figsize=(12,8))
plt.scatter(rets.mean(), rets.std(), s=area)
plt.xlabel("Expected Return", fontsize=15)
plt.ylabel("Risk", fontsize=15)
plt.title("Return vs. Risk for " + title, fontsize=20)

for label, x, y in zip(rets.columns, rets.mean(), rets.std()) :
    plt.annotate(label, xy=(x,y), xytext=(50, 0), textcoords='offset points',
                 arrowprops=dict(arrowstyle='-',␣
 ↪connectionstyle='bar,angle=180,fraction=-0.2'),
                 bbox=dict(boxstyle="round", fc="w"))
```



[46]:

```python
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risk:")
print(rets.std())
```

```
Stock returns:
DBC          -0.000388
FBTAX         0.000403
FIHBX         0.000155
SPY           0.000362
Portfolio    -0.000050
dtype: float64
--------------------------------------------------
Stock risk:
DBC           0.009496
FBTAX         0.017337
FIHBX         0.002734
SPY           0.008306
Portfolio     0.006513
dtype: float64
```

[47]:

```python
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[47]:

	Returns	Risk
DBC	-0.000388	0.009496
Portfolio	-0.000050	0.006513
FIHBX	0.000155	0.002734
SPY	0.000362	0.008306
FBTAX	0.000403	0.017337

[48]:

```python
table.sort_values(by='Risk')
```

[48]:

	Returns	Risk
FIHBX	0.000155	0.002734
Portfolio	-0.000050	0.006513
SPY	0.000362	0.008306
DBC	-0.000388	0.009496
FBTAX	0.000403	0.017337

[49]:

```python
rf = 0.01
table['Sharpe_Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[49]:

	Returns	Risk	Sharpe_Ratio
DBC	-0.000388	0.009496	-1.093885
FBTAX	0.000403	0.017337	-0.553582
FIHBX	0.000155	0.002734	-3.601055
SPY	0.000362	0.008306	-1.160409
Portfolio	-0.000050	0.006513	-1.543121