Government_Bonds_Portfolio

September 29, 2021

1 Bonds Porfolio (U.S Government Bonds ETFs)

https://www.investopedia.com/articles/investing/080515/top-4-us-government-bonds-etfs.asp

1.1 Government Bonds ETFs

[1]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import math

import warnings
warnings.filterwarnings("ignore")

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

[2]:
```python
# input
symbols = ['SHY','ITE','VGLT','SPIP']
start = '2011-01-01'
end = '2019-01-01'
title = "Bonds Porfolio (U.S Government Bonds ETFs)"

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

# View Columns
df.head()
```

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

[2]:
```
                  ITE        SHY       SPIP       VGLT
Date
2011-01-03  50.938450  77.158173  21.306452  46.152637
2011-01-04  50.964535  77.139748  21.382820  45.876617
2011-01-05  50.703655  77.001953  21.282339  45.316864
```

```
2011-01-06  50.790611  77.084633  21.330561  45.293865
2011-01-07  51.042774  77.194931  21.423006  45.554562
```

[3]:
```
df.tail()
```

[3]:
```
                  ITE        SHY       SPIP       VGLT
Date
2018-12-24  58.262810  81.224503  25.481457  72.159622
2018-12-26  58.095215  81.146645  25.424620  71.434258
2018-12-27  58.213520  81.234245  25.434093  71.434258
2018-12-28  58.430397  81.351013  25.500401  71.985535
2018-12-31  58.706436  81.380211  25.524086  72.256332
```

[4]:
```
df.min()
```

[4]:
```
ITE     50.397202
SHY     76.871162
SPIP    20.897419
VGLT    44.072567
dtype: float64
```

[5]:
```
df.max()
```

[5]:
```
ITE     58.706436
SHY     81.380211
SPIP    26.293741
VGLT    79.565544
dtype: float64
```

[6]:
```
from datetime import datetime
from dateutil import relativedelta

d1 = datetime.strptime(start, "%Y-%m-%d")
d2 = datetime.strptime(end, "%Y-%m-%d")
delta = relativedelta.relativedelta(d2,d1)
print('How many years of investing?')
print('%s years' % delta.years)
```

```
How many years of investing?
8 years
```

1.1.1 Starting Cash with 100k to invest in Bonds

[7]:
```
Cash = 100000
print('Percentage of invest:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x in zip(df.columns, percent_invest):
```

```
    cost = x * Cash
    print('{}: {}'.format(i, cost))
```

```
Percentage of invest:
ITE: 25000.0
SHY: 25000.0
SPIP: 25000.0
VGLT: 25000.0
```

[8]:
```
print('Number of Shares:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(df.columns, percent_invest, df.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    print('{}: {}'.format(i, shares))
```

```
Number of Shares:
ITE: 490
SHY: 324
SPIP: 1173
VGLT: 541
```

[9]:
```
print('Beginning Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(df.columns, percent_invest, df.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    Begin_Value = round(shares * y, 2)
    print('{}: ${}'.format(i, Begin_Value))
```

```
Beginning Value:
ITE: $24959.84
SHY: $24999.25
SPIP: $24992.47
VGLT: $24968.58
```

[10]:
```
print('Current Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y, z in zip(df.columns, percent_invest, df.iloc[0], df.iloc[-1]):
    cost = x * Cash
    shares = int(cost/y)
    Current_Value = round(shares * z, 2)
    print('{}: ${}'.format(i, Current_Value))
```

```
Current Value:
ITE: $28766.15
SHY: $26367.19
SPIP: $29939.75
```

```
VGLT: $39090.68
```

[11]:
```
result = []
for i, x, y, z in zip(df.columns, percent_invest, df.iloc[0], df.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: $124163.77
```

[12]:
```
# Calculate Daily Returns
returns = df.pct_change()
returns = returns.dropna()
```

[13]:
```
# Calculate mean returns
meanDailyReturns = returns.mean()
print(meanDailyReturns)
```

```
ITE     0.000072
SHY     0.000027
SPIP    0.000095
VGLT    0.000251
dtype: float64
```

[14]:
```
# Calculate std returns
stdDailyReturns = returns.std()
print(stdDailyReturns)
```

```
ITE     0.001601
SHY     0.000511
SPIP    0.003316
VGLT    0.007557
dtype: float64
```

[15]:
```
# Define weights for the portfolio
weights = np.array([0.50, 0.10, 0.20, 0.20])
```

[16]:
```
# Calculate the covariance matrix on daily returns
cov_matrix = (returns.cov())*250
print (cov_matrix)
```

```
           ITE       SHY      SPIP      VGLT
ITE   0.000640  0.000156  0.000973  0.002325
SHY   0.000156  0.000065  0.000252  0.000538
SPIP  0.000973  0.000252  0.002749  0.004889
VGLT  0.002325  0.000538  0.004889  0.014277
```

[17]:
```
# Calculate expected portfolio performance
portReturn = np.sum(meanDailyReturns*weights)
```

[18]:
```
# Print the portfolio return
print(portReturn)
```

```
0.00010795195908856735
```

[19]:
```
# Create portfolio returns column
returns['Portfolio'] = returns.dot(weights)
```

[20]:
```
returns.head()
```

[20]:
```
                 ITE       SHY      SPIP      VGLT  Portfolio
Date
2011-01-04  0.000512 -0.000239  0.003584 -0.005981  -0.000247
2011-01-05 -0.005119 -0.001786 -0.004699 -0.012201  -0.006118
2011-01-06  0.001715  0.001074  0.002266 -0.000508   0.001317
2011-01-07  0.004965  0.001431  0.004334  0.005756   0.004643
2011-01-10  0.001533  0.000477  0.002627  0.008248   0.002989
```

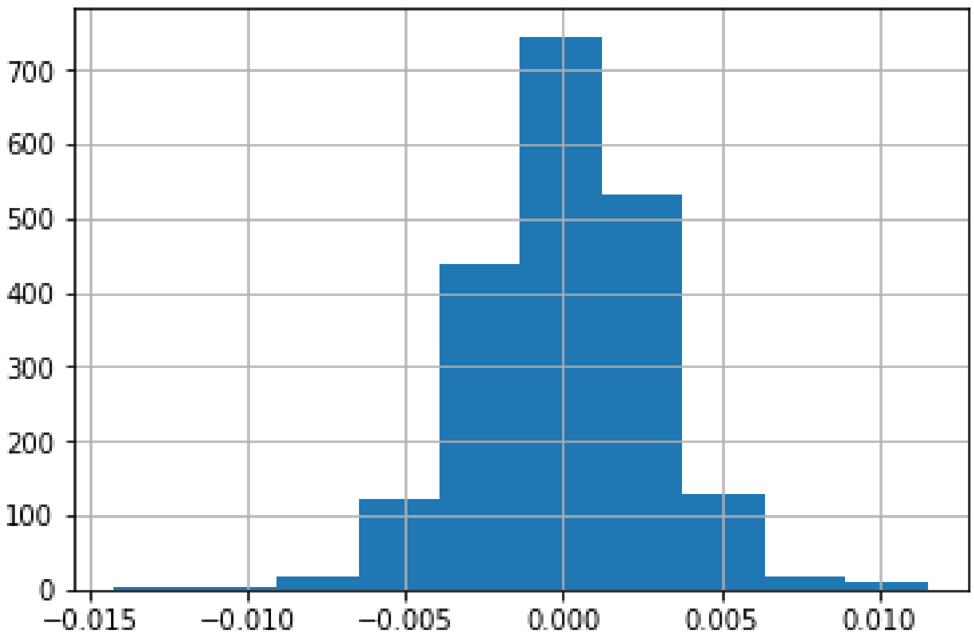
[21]:
```
returns.tail()
```

[21]:
```
                 ITE       SHY      SPIP      VGLT  Portfolio
Date
2018-12-24  0.002035  0.000839  0.001303  0.004524   0.002267
2018-12-26 -0.002877 -0.000959 -0.002231 -0.010052  -0.003991
2018-12-27  0.002036  0.001080  0.000373  0.000000   0.001201
2018-12-28  0.003726  0.001437  0.002607  0.007717   0.004071
2018-12-31  0.004724  0.000359  0.000929  0.003762   0.003336
```

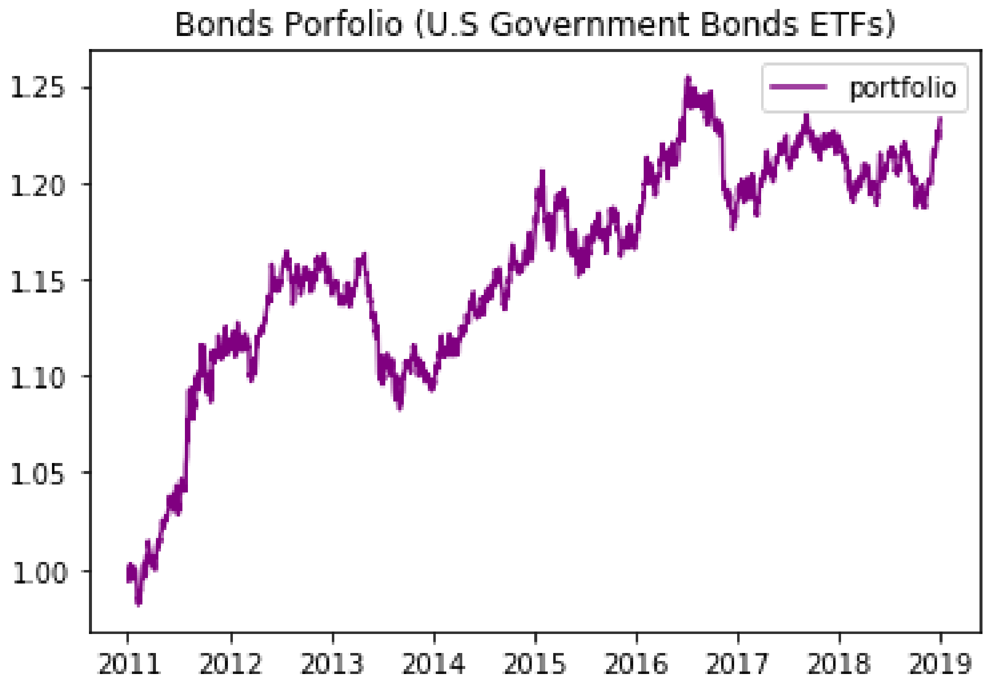
[22]:
```
# Calculate cumulative returns
daily_cum_ret=(1+returns).cumprod()
print(daily_cum_ret.tail())
```

```
                 ITE       SHY      SPIP      VGLT  Portfolio
Date
2018-12-24  1.143788  1.052701  1.195950  1.563499   1.227141
2018-12-26  1.140498  1.051692  1.193283  1.547783   1.222244
2018-12-27  1.142821  1.052827  1.193727  1.547783   1.223712
2018-12-28  1.147078  1.054341  1.196839  1.559727   1.228694
2018-12-31  1.152498  1.054719  1.197951  1.565595   1.232793
```

[23]:
```
returns['Portfolio'].hist()
plt.show()
```



[24]:
```
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()
```



[25]:

```
# 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 :  0.010795195908856739
Std. dev:  0.2785461006410433
skew:  -0.10169143705374066
kurt:  1.2837160493887936
```

[26]:

```
# 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) + '%')
```

```
4.3999999999999995%
```

[27]:
```
# 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) + '%')
```

```
0.19%
```

[28]:
```
# 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)**(1/8))-1
```

[29]:
```
# Calculate annualized volatility from the standard deviation
vol_port = returns['Portfolio'].std() * np.sqrt(250)
```

[30]:
```
# Calculate the Sharpe ratio
rf = 0.001
sharpe_ratio = (annualized_return - rf) / vol_port
print(sharpe_ratio)
```

```
-0.012551551993775178
```

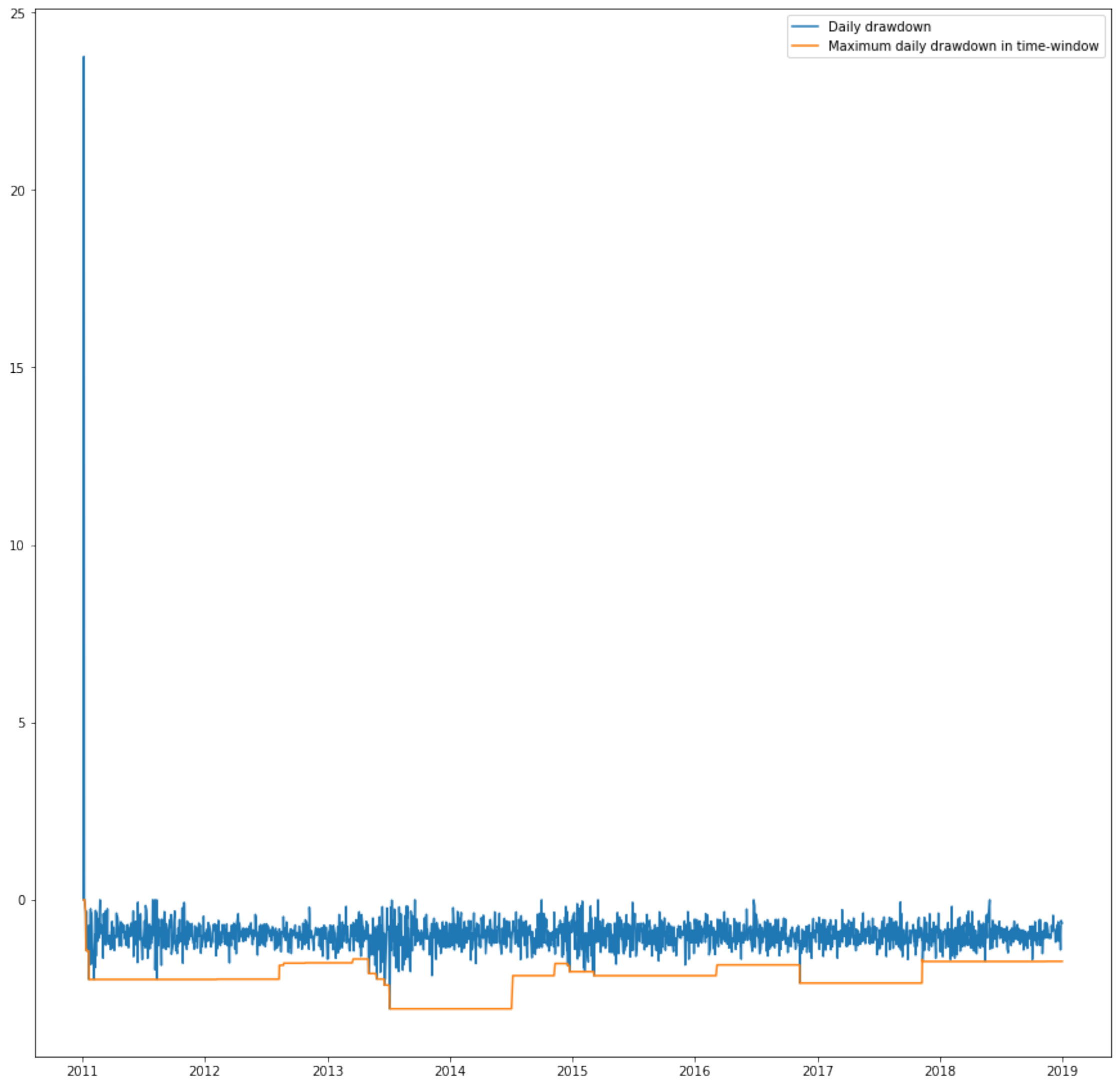
[31]:
```
# Create a downside return column with the negative returns only
target = 0
downside_returns = returns.loc[returns['Portfolio'] < target]

# 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:  0.010795195908856739
--------------------------------------------------
Downside risk:
```

```
ITE          0.114135
SHY          0.041096
SPIP         0.244470
VGLT         0.517763
Portfolio    0.180119
dtype: float64
--------------------------------------------------
Sortino ratio:
ITE           -8.666972
SHY          -24.070815
SPIP          -4.046329
VGLT          -1.910536
Portfolio     -5.491957
dtype: float64
```

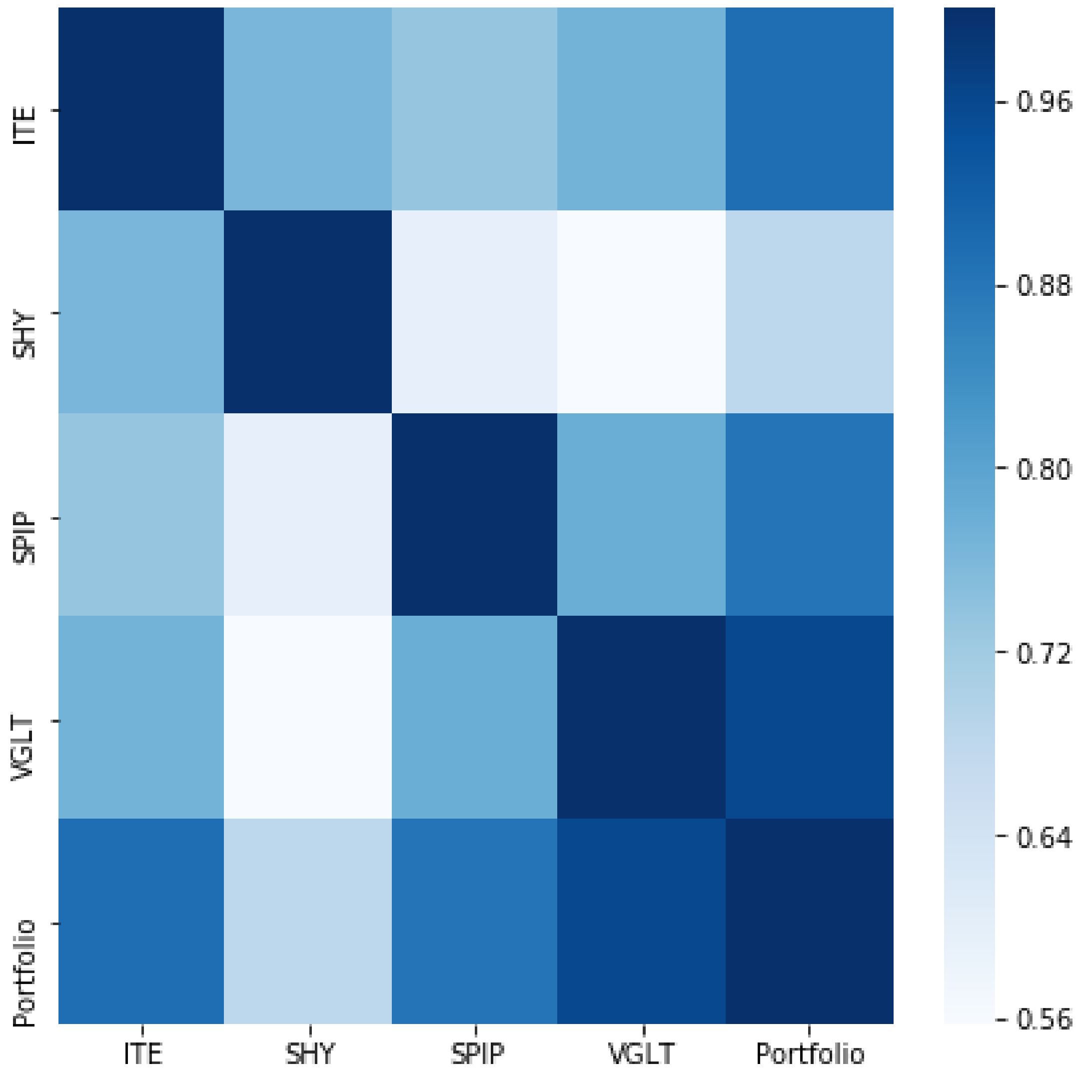
[32]:

```python
# 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()
```



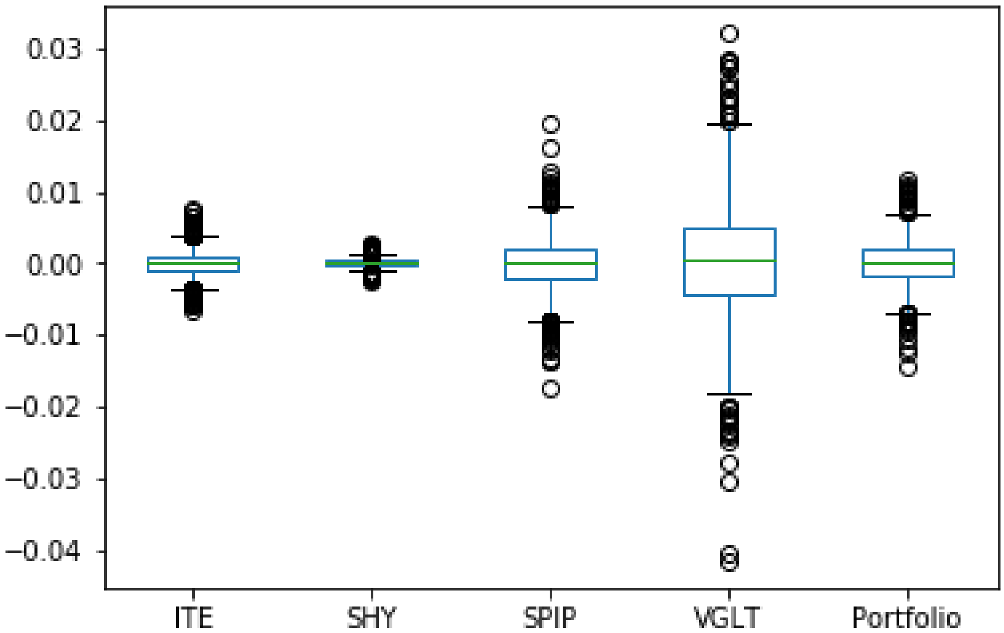
[33]:
```
plt.figure(figsize=(7,7))
corr = returns.corr()

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

[33]: <matplotlib.axes._subplots.AxesSubplot at 0x1e0a3457c18>



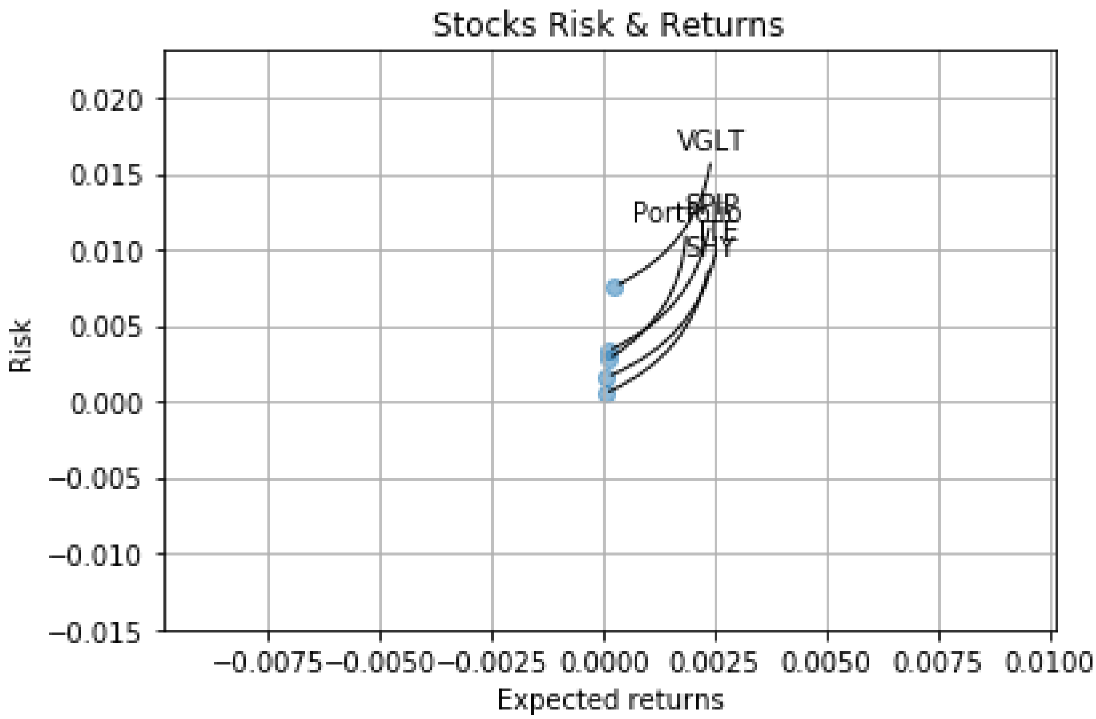
[34]:
```python
# Box plot
returns.plot(kind='box')
```

[34]: <matplotlib.axes._subplots.AxesSubplot at 0x1e0a55d16d8>

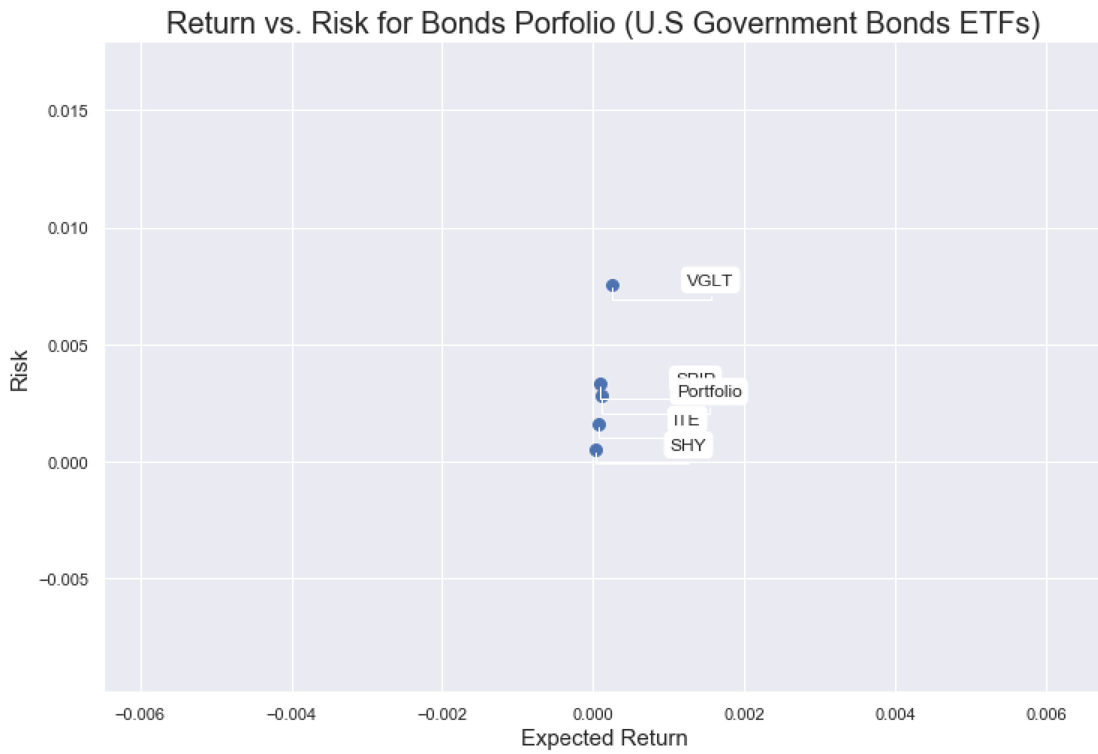


[35]:

```
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'))
```



[36]:
```
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"))
```



[37]:
```python
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risk:")
print(rets.std())
```

```
Stock returns:
ITE          0.000072
SHY          0.000027
SPIP         0.000095
VGLT         0.000251
Portfolio    0.000108
dtype: float64
--------------------------------------------------
Stock risk:
ITE          0.001601
SHY          0.000511
SPIP         0.003316
VGLT         0.007557
Portfolio    0.002785
dtype: float64
```

[38]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[38]:

	Returns	Risk
SHY	0.000027	0.000511
ITE	0.000072	0.001601
SPIP	0.000095	0.003316
Portfolio	0.000108	0.002785
VGLT	0.000251	0.007557

[39]:
```
table.sort_values(by='Risk')
```

[39]:

	Returns	Risk
SHY	0.000027	0.000511
ITE	0.000072	0.001601
Portfolio	0.000108	0.002785
SPIP	0.000095	0.003316
VGLT	0.000251	0.007557

[40]:
```
rf = 0.001
table['Sharpe_Ratio'] = ((table['Returns'] - rf) / table['Risk']) * np.sqrt(252)
table
```

[40]:

	Returns	Risk	Sharpe_Ratio
ITE	0.000072	0.001601	-9.205392
SHY	0.000027	0.000511	-30.249276
SPIP	0.000095	0.003316	-4.330842
VGLT	0.000251	0.007557	-1.572364
Portfolio	0.000108	0.002785	-5.083835