Corporate_Bonds_ETFs_Portfolio

September 29, 2021

1 Corporate Bonds ETFs Portfolio

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

Corporate Bonds

[1]:
```
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]:
```
# input
symbols = ['LQD','VCIT','VCSH','FLOT', 'IGIB']
start = '2012-01-01'
end = '2019-01-01'
title = "Corporate Bonds ETFs"

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

# View Columns
df.head()
```

```
[*********************100%***********************]  5 of 5 completed
```

[2]:

Date	FLOT	IGIB	LQD	VCIT	VCSH
2012-01-03	44.011772	42.293209	85.181641	61.755966	64.183327
2012-01-04	43.984859	42.226177	85.249100	61.598476	64.158577
2012-01-05	44.110458	42.170982	84.881905	61.545948	64.249367
2012-01-06	44.011772	42.245903	85.211617	61.710964	64.315376

```
2012-01-09  43.868217  42.198574  85.084213  61.815990  64.348389
```

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

[3]:
```
                 FLOT       IGIB         LQD       VCIT       VCSH
Date
2018-12-24  48.415710  49.632042  106.937920  78.497650  74.606453
2018-12-26  48.483200  49.555874  106.852036  78.278214  74.558395
2018-12-27  48.541039  49.613003  106.852036  78.516739  74.673714
2018-12-28  48.541039  49.832031  107.357758  78.802933  74.779388
2018-12-31  48.550682  49.917728  107.653564  79.050980  74.885086
```

[4]:
```
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?
7 years
```

1.0.1 Starting Cash with 100k to invest in Bonds

[5]:
```
Cash = 100000
print('Percentage of invest:')
percent_invest = [0.20, 0.20, 0.20, 0.20, 0.20]
for i, x in zip(df.columns, percent_invest):
    cost = x * Cash
    print('{}: {}'.format(i, cost))
```

```
Percentage of invest:
FLOT: 20000.0
IGIB: 20000.0
LQD: 20000.0
VCIT: 20000.0
VCSH: 20000.0
```

[6]:
```
print('Number of Shares:')
percent_invest = [0.20, 0.20, 0.20, 0.20, 0.20]
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:
```

```
FLOT: 454
IGIB: 472
LQD: 234
VCIT: 323
VCSH: 311
```

[7]:

```
print('Beginning Value:')
percent_invest = [0.20, 0.20, 0.20, 0.20, 0.20]
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:
FLOT: $19981.34
IGIB: $19962.39
LQD: $19932.5
VCIT: $19947.18
VCSH: $19961.01
```

[8]:

```
print('Current Value:')
percent_invest = [0.20, 0.20, 0.20, 0.20, 0.20]
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:
FLOT: $22042.01
IGIB: $23561.17
LQD: $25190.93
VCIT: $25533.47
VCSH: $23289.26
```

[9]:

```
result = []
percent_invest = [0.20, 0.20, 0.20, 0.20, 0.20]
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: $119616.84
```

[10]:
```
# Calculate Daily Returns
returns = df.pct_change()
returns = returns.dropna()
```

[11]:
```
# Calculate mean returns
meanDailyReturns = returns.mean()
print(meanDailyReturns)
```

```
FLOT    0.000056
IGIB    0.000095
LQD     0.000138
VCIT    0.000144
VCSH    0.000088
dtype: float64
```

[12]:
```
# Calculate std returns
stdDailyReturns = returns.std()
print(stdDailyReturns)
```

```
FLOT    0.000644
IGIB    0.001579
LQD     0.003103
VCIT    0.002503
VCSH    0.000993
dtype: float64
```

[13]:
```
# Define weights for the portfolio
weights = np.array([0.20, 0.20, 0.20, 0.20, 0.20])
```

[14]:
```
# Calculate the covariance matrix on daily returns
cov_matrix = (returns.cov())*250
print (cov_matrix)
```

```
          FLOT      IGIB       LQD      VCIT      VCSH
FLOT  0.000104  0.000007 -0.000013  0.000006  0.000005
IGIB  0.000007  0.000623  0.001011  0.000832  0.000283
LQD  -0.000013  0.001011  0.002407  0.001708  0.000519
VCIT  0.000006  0.000832  0.001708  0.001567  0.000450
VCSH  0.000005  0.000283  0.000519  0.000450  0.000246
```

[15]:
```
# Calculate expected portfolio performance
portReturn = np.sum(meanDailyReturns*weights)
```

[16]:
```
# Print the portfolio return
print(portReturn)
```

```
0.00010421818793216508
```

[17]:
```python
# Create portfolio returns column
returns['Portfolio'] = returns.dot(weights)
```

[18]:
```python
returns.head()
```

[18]:

Date	FLOT	IGIB	LQD	VCIT	VCSH	Portfolio
2012-01-04	-0.000611	-0.001585	0.000792	-0.002550	-0.000386	-0.000868
2012-01-05	0.002856	-0.001307	-0.004307	-0.000853	0.001415	-0.000439
2012-01-06	-0.002237	0.001777	0.003884	0.002681	0.001027	0.001426
2012-01-09	-0.003262	-0.001120	-0.001495	0.001702	0.000513	-0.000732
2012-01-10	0.002454	-0.000093	0.002818	0.000728	-0.000256	0.001130

[19]:
```python
returns.tail()
```

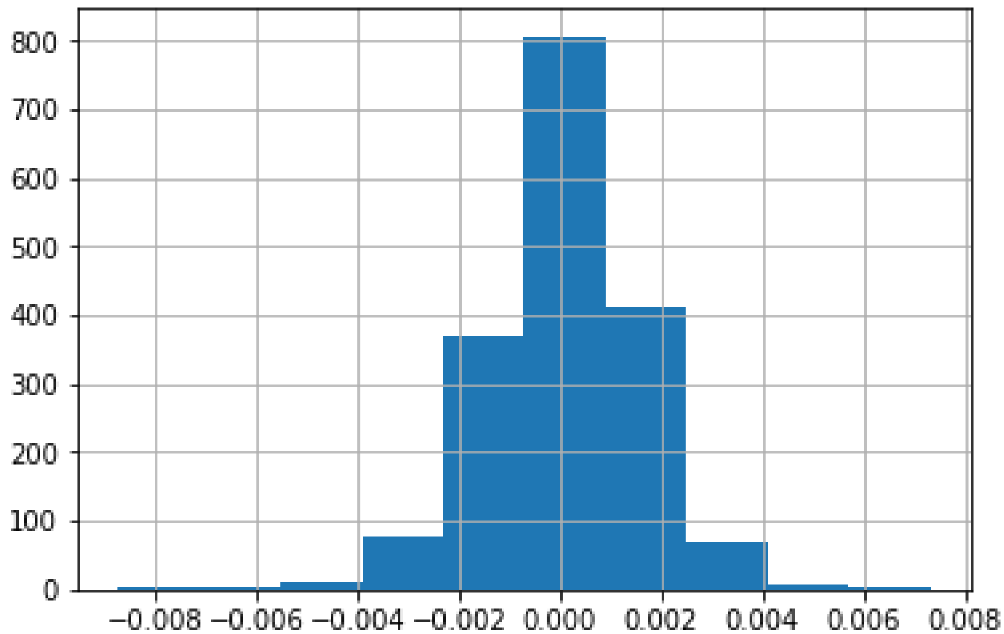
[19]:

Date	FLOT	IGIB	LQD	VCIT	VCSH	Portfolio
2018-12-24	-0.001193	-0.001341	-0.002315	-0.001517	-0.000193	-0.001312
2018-12-26	0.001394	-0.001535	-0.000803	-0.002795	-0.000644	-0.000877
2018-12-27	0.001193	0.001153	0.000000	0.003047	0.001547	0.001388
2018-12-28	0.000000	0.004415	0.004733	0.003645	0.001415	0.002842
2018-12-31	0.000199	0.001720	0.002755	0.003148	0.001413	0.001847

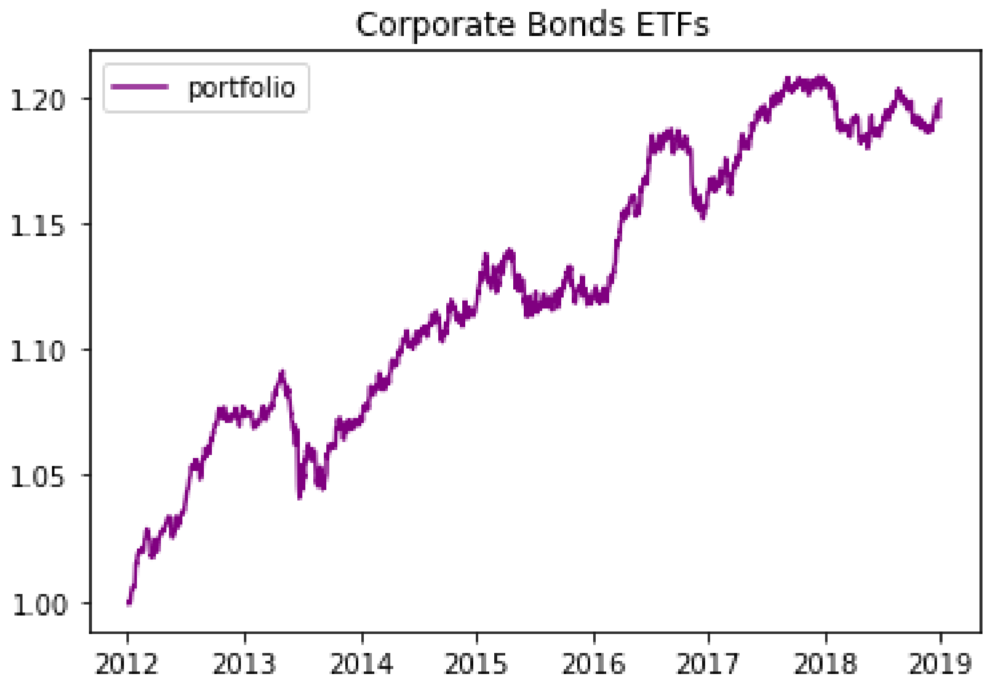
[20]:
```python
# Calculate cumulative returns
daily_cum_ret=(1+returns).cumprod()
print(daily_cum_ret.tail())
```

```
                FLOT      IGIB       LQD      VCIT      VCSH  Portfolio
Date
2018-12-24  1.100063  1.173523  1.255410  1.271094  1.162396   1.192521
2018-12-26  1.101596  1.171722  1.254402  1.267541  1.161647   1.191475
2018-12-27  1.102910  1.173073  1.254402  1.271403  1.163444   1.193129
2018-12-28  1.102910  1.178251  1.260339  1.276038  1.165091   1.196519
2018-12-31  1.103129  1.180278  1.263812  1.280054  1.166737   1.198729
```

[21]:
```python
returns['Portfolio'].hist()
plt.show()
```



[22]:
```
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()
```



[23]:
```
# 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 :  0.010421818793216513
Std. dev:  0.15264159451535508
skew:  -0.33950040471612913
kurt:  2.4579379805109496
```

[24]:
```
# 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) + '%')
```

```
2.41%
```

[25]:
```
# 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) + '%')
```

```
0.06%
```

[26]:
```
# Calculate total return and annualized return from price data
total_return = (returns['Portfolio'][-1] - returns['Portfolio'][0]) /␣
↪returns['Portfolio'][0]

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

[27]:
```
# Calculate annualized volatility from the standard deviation
vol_port = returns['Portfolio'].std() * np.sqrt(250)
```

[28]:
```
# Calculate the Sharpe ratio
rf = 0.01
sharpe_ratio = ((annualized_return - rf) / vol_port)
print(sharpe_ratio)
```

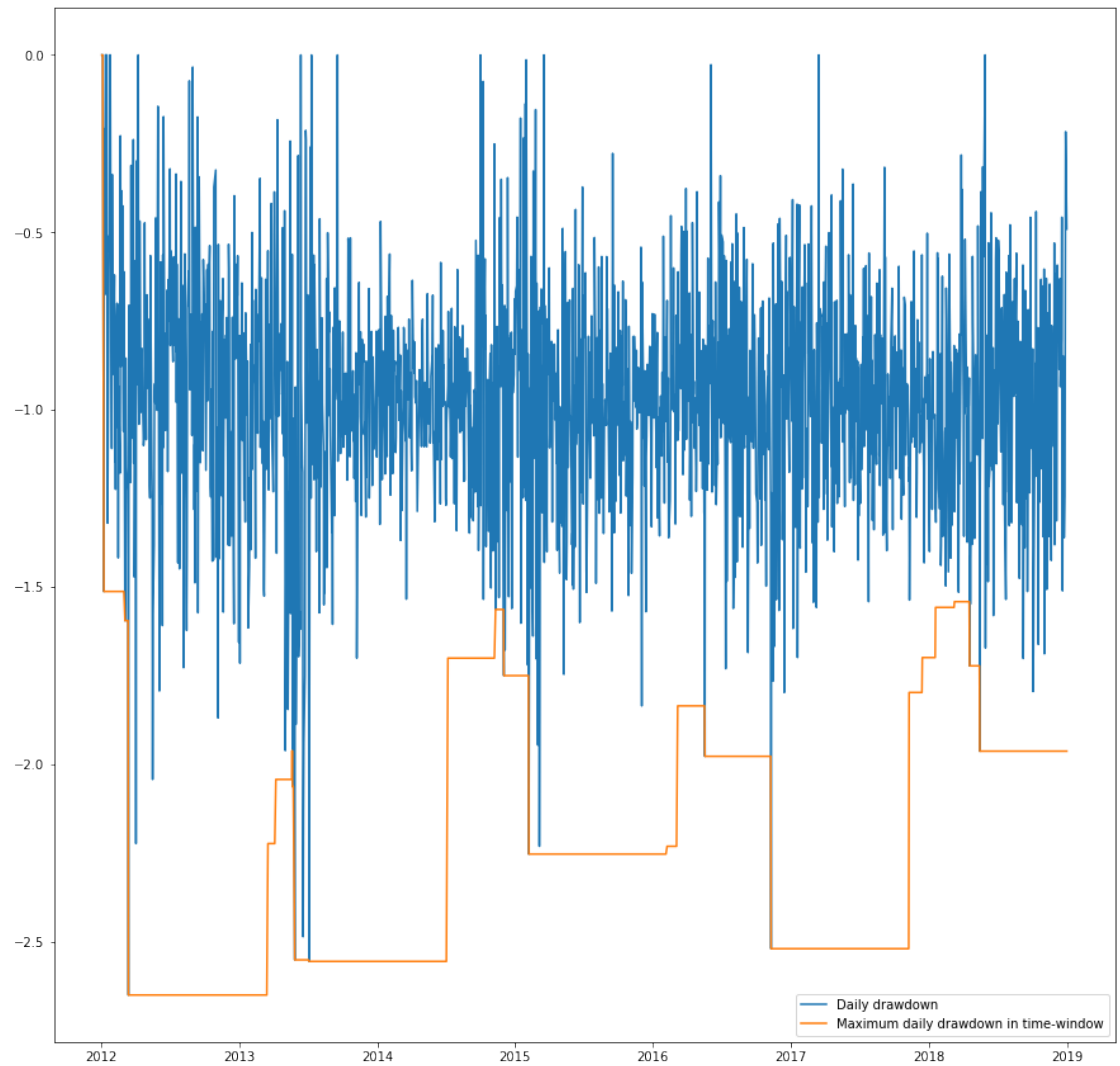
```
nan
```

[29]:
```
# 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:  0.010421818793216513
--------------------------------------------------
```

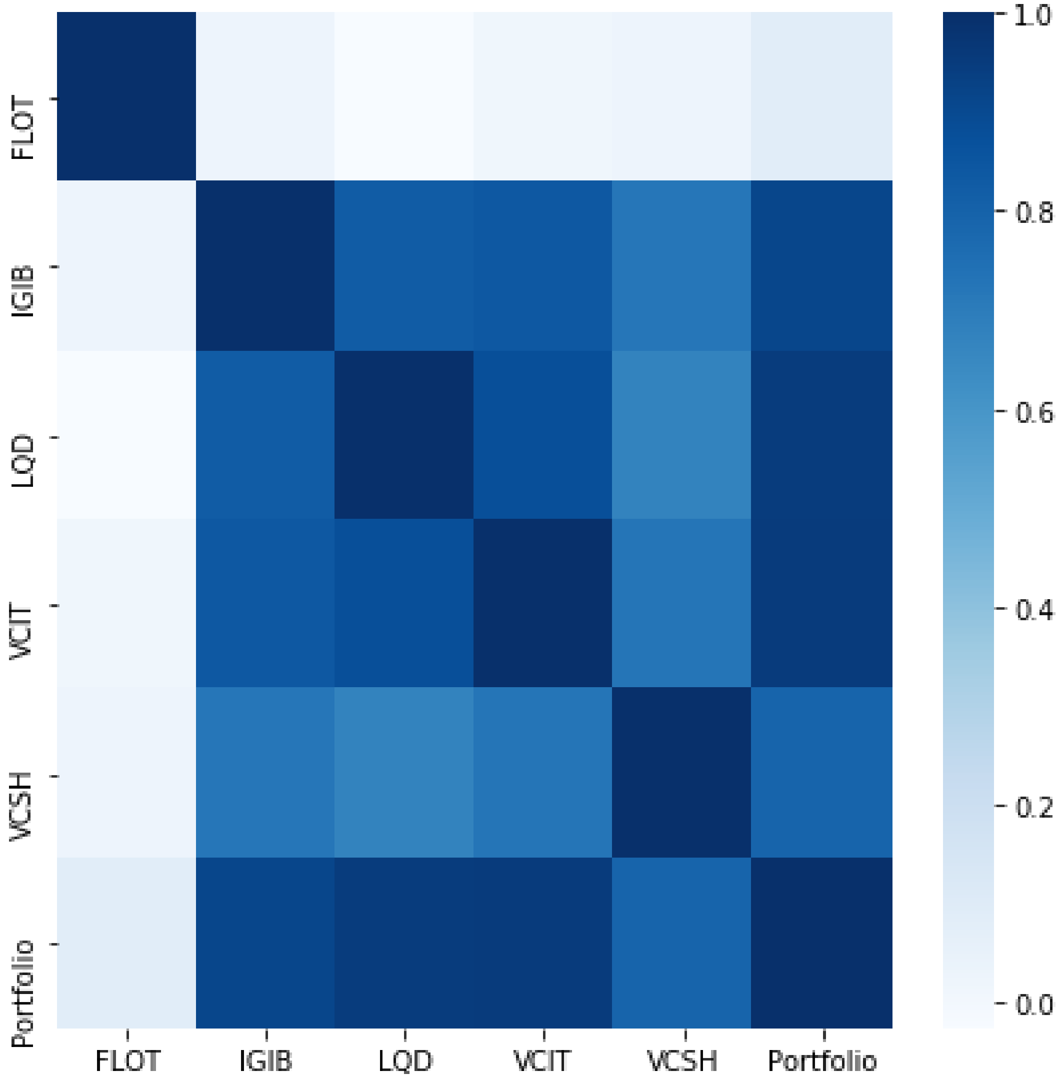
```
Downside risk:
FLOT         0.069584
IGIB         0.122583
LQD          0.233799
VCIT         0.184559
VCSH         0.080775
Portfolio    0.108096
dtype: float64
--------------------------------------------------
Sortino ratio:
FLOT        -14.221265
IGIB         -8.072688
LQD          -4.232594
VCIT         -5.361839
VCSH        -12.251011
Portfolio    -9.154592
dtype: float64
```

[30]:
```
# 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()
```



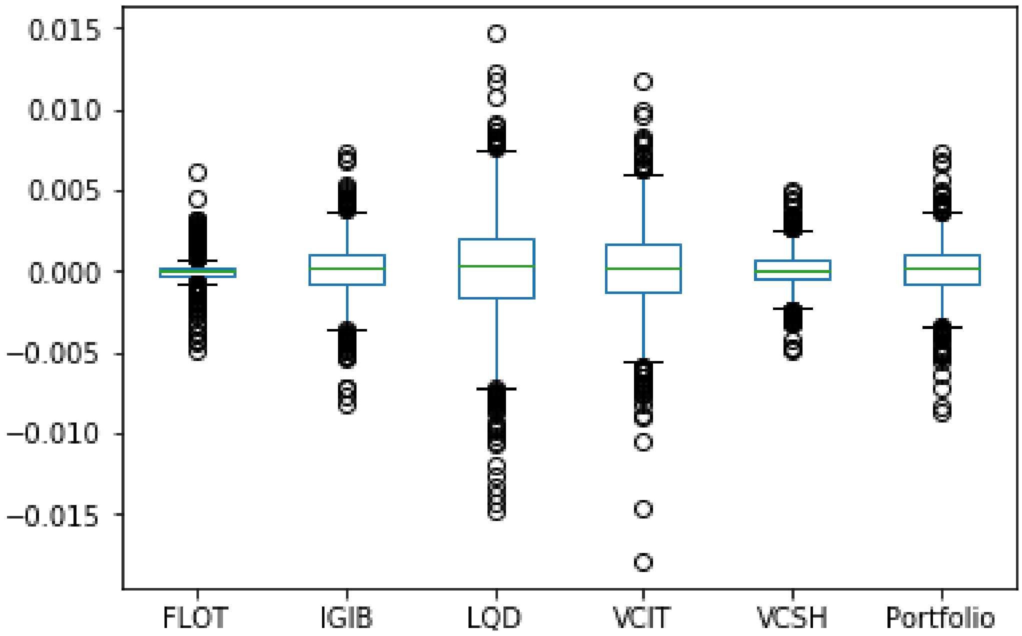
[31]:
```
plt.figure(figsize=(7,7))
corr = returns.corr()

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

[31]: <matplotlib.axes._subplots.AxesSubplot at 0x26927612940>

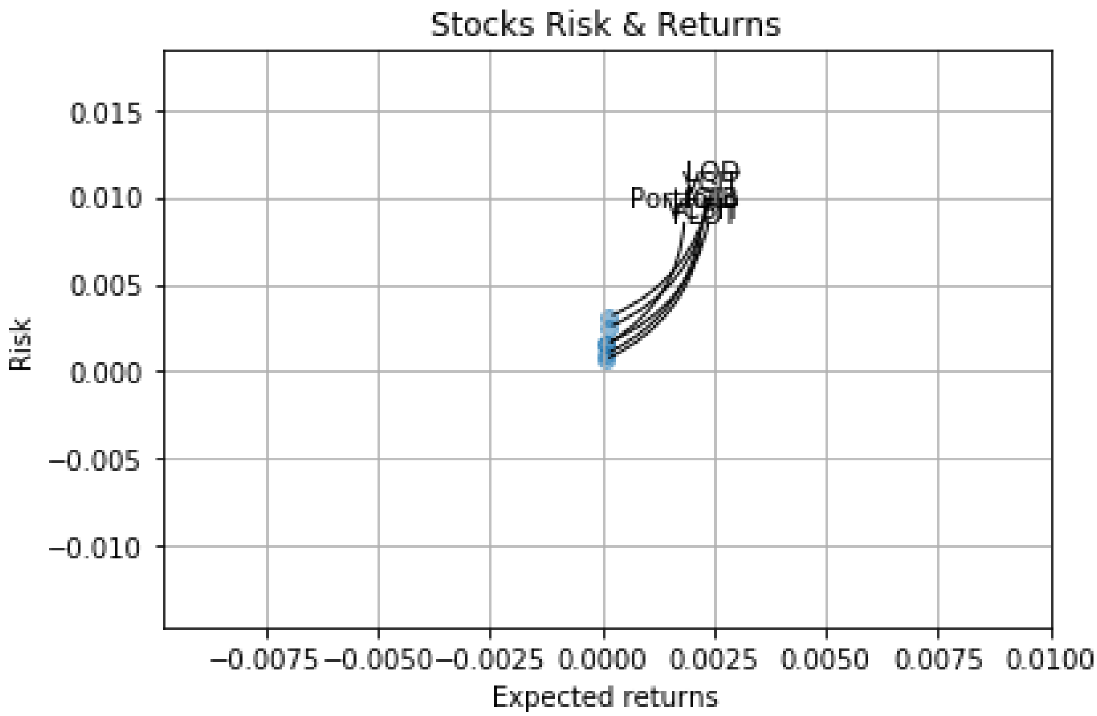


[32]:
```
# Box plot
returns.plot(kind='box')
```

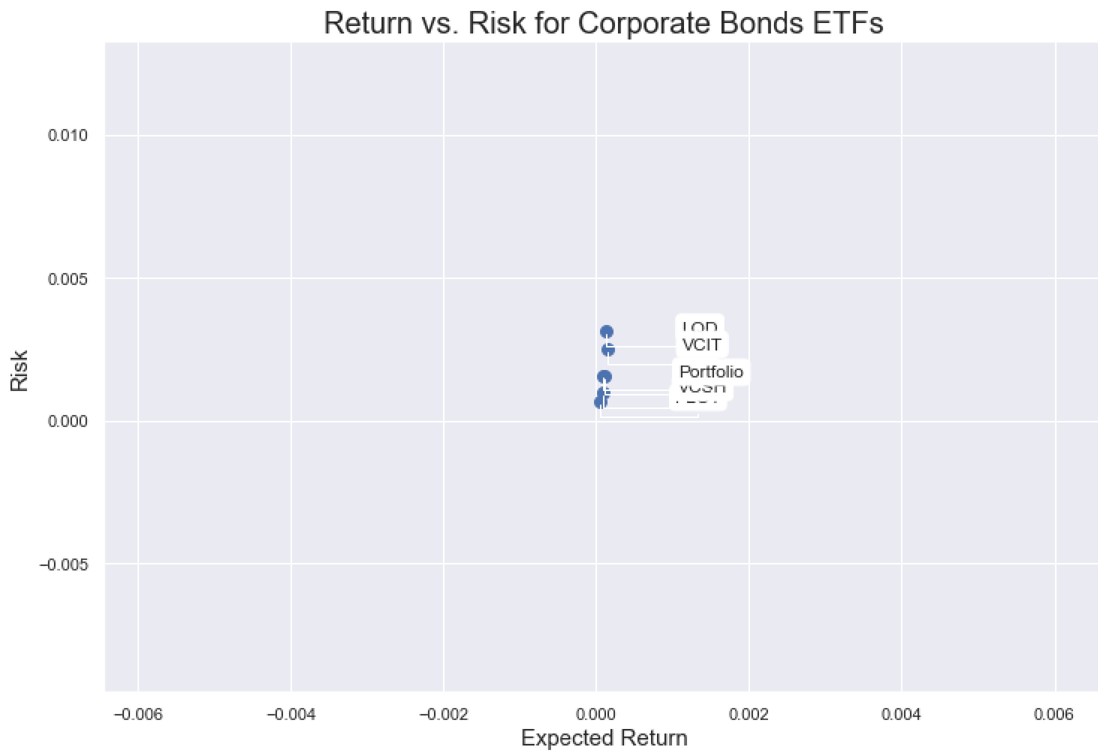
[32]: <matplotlib.axes._subplots.AxesSubplot at 0x26927635358>



[33]:
```
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'))
```



[34]:
```
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"))
```



[35]:
```
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risk:")
print(rets.std())
```

```
Stock returns:
FLOT         0.000056
IGIB         0.000095
LQD          0.000138
VCIT         0.000144
VCSH         0.000088
Portfolio    0.000104
dtype: float64
--------------------------------------------------
Stock risk:
FLOT         0.000644
IGIB         0.001579
LQD          0.003103
VCIT         0.002503
VCSH         0.000993
Portfolio    0.001526
dtype: float64
```

[36]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[36]:

	Returns	Risk
FLOT	0.000056	0.000644
VCSH	0.000088	0.000993
IGIB	0.000095	0.001579
Portfolio	0.000104	0.001526
LQD	0.000138	0.003103
VCIT	0.000144	0.002503

[37]:
```
table.sort_values(by='Risk')
```

[37]:

	Returns	Risk
FLOT	0.000056	0.000644
VCSH	0.000088	0.000993
Portfolio	0.000104	0.001526
IGIB	0.000095	0.001579
VCIT	0.000144	0.002503
LQD	0.000138	0.003103

[38]:
```
table['Sharpe_Ratio'] = (table['Returns'] / table['Risk']) * np.sqrt(252)
table
```

[38]:

	Returns	Risk	Sharpe_Ratio
FLOT	0.000056	0.000644	1.379759
IGIB	0.000095	0.001579	0.960191
LQD	0.000138	0.003103	0.705647
VCIT	0.000144	0.002503	0.910002
VCSH	0.000088	0.000993	1.409709
Portfolio	0.000104	0.001526	1.083854

[39]:
```
print('Sortino Ratio:')
for column in rets:
    returns = rets[column]
    numer = pow((1 + returns.mean()), 252) - 1
    annual_volatility = returns.std() * np.sqrt(252)
    denom = annual_volatility

    if denom > 0.0:
         sortino_ratio = numer / denom
    else:
        print('none')
    print(rets[column].name, sortino_ratio)
```

```
Sortino Ratio:
FLOT 1.3895030236690635
IGIB 0.9717889224701033
LQD 0.7180036103382496
VCIT 0.9265892010036217
VCSH 1.4254227713351055
Portfolio 1.0981543380109733
```

[40]:

```python
print('Kelly Value:')
for column in rets:
    returns = np.array(rets[column])
    wins = returns[returns > 0]
    losses = returns[returns <= 0]
    # W = Winning probability
    # R = Win/loss ratio
    W = len(wins) / len(returns)
    R = np.mean(wins) / np.abs(np.mean(losses))
    Kelly = W - ( (1 - W) / R )
    # Kelly value negative means the expected returns will be negative
    # Kelly value positive means the expected returns will be positive
    print(rets[column].name, round(Kelly, 4))
```

```
Kelly Value:
FLOT 0.1104
IGIB 0.0794
LQD 0.0591
VCIT 0.075
VCSH 0.107
Portfolio 0.0915
```