Core_and_Satellite

September 29, 2021

1 Core and Satellite

https://www.investopedia.com/articles/financial-theory/08/core-satellite-investing.asp

Portfolio Construction
Managed passively
Actively managed
High-yield bond

[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()
```

S&P 500 Index Fund
Actively Managed High-Yield Bond Fund
Actively Managed Biotechnology Fund
Actively Managed Commodities Fund

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

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

# View Columns
dataset.head()
```

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

[2]:

	DBC	FBTAX	FIHBX	SPY
Date				
2014-01-02	24.572100	16.094238	6.937886	160.925400
2014-01-03	24.416641	16.017763	6.944685	160.898972
2014-01-06	24.445789	15.813823	6.944685	160.432693
2014-01-07	24.426357	16.068747	6.958275	161.418060
2014-01-08	24.193171	16.374655	6.958275	161.453278

[3]:
```python
dataset.tail()
```

[3]:

	DBC	FBTAX	FIHBX	SPY
Date				
2018-12-24	14.163118	20.312393	8.307596	227.638824
2018-12-26	14.478073	21.567284	8.289378	239.140244
2018-12-27	14.340280	21.632837	8.298485	240.976212
2018-12-28	14.222172	21.632837	8.334924	240.665375
2018-12-31	14.261541	22.101082	8.388957	242.773315

[4]:
```python
from datetime import datetime


def calculate_years(start, end):
    date_format = "%Y-%m-%d"
    a = datetime.strptime(start, date_format).year
    b = datetime.strptime(end, date_format).year
    years = b - a

    return years
```

[5]:
```python
print(calculate_years(start, end), 'years')
```

```
5 years
```

[6]:
```python
# Calculate Daily Returns
returns = dataset.pct_change()
returns = returns.dropna()
```

[7]:
```python
# Calculate mean returns
meanDailyReturns = returns.mean()
print(meanDailyReturns)
```

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

[8]:
```
# Calculate std returns
stdDailyReturns = returns.std()
print(stdDailyReturns)
```

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

[9]:
```
# Define weights for the portfolio
weights = np.array([0.50, 0.10, 0.20, 0.20])
```

[10]:
```
# 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
```

[11]:
```
# Calculate expected portfolio performance
portReturn = np.sum(meanDailyReturns*weights)
```

[12]:
```
# Print the portfolio return
print(portReturn)
```

```
-5.022474207717689e-05
```

[13]:
```
# Create portfolio returns column
returns['Portfolio'] = returns.dot(weights)
```

[14]:
```
returns.head()
```

[14]:

```
                 DBC     FBTAX     FIHBX       SPY  Portfolio
Date
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
```

[15]:
```
returns.tail()
```

[15]:

```
                 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
```

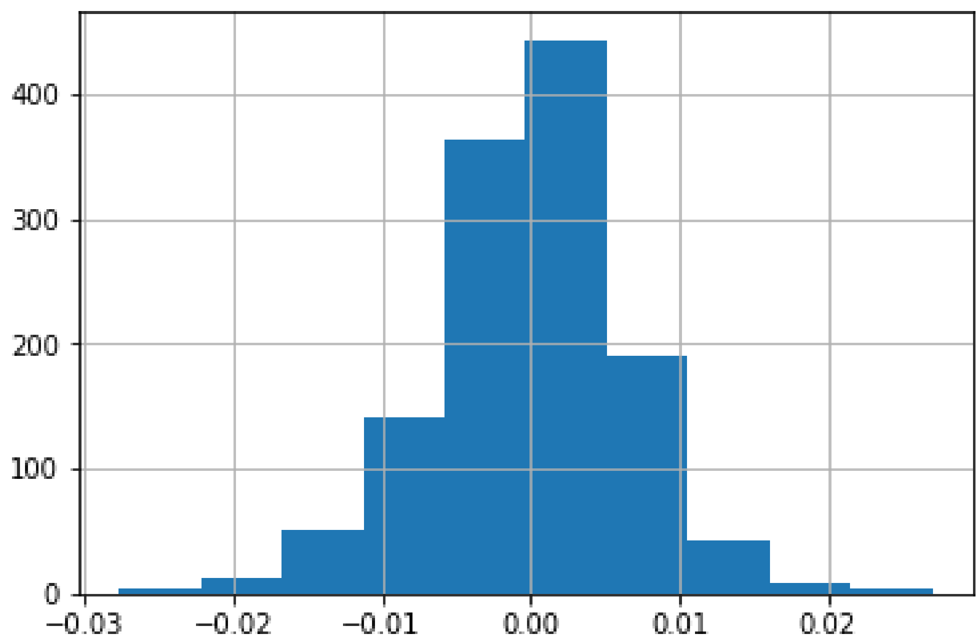
[16]:

```python
# 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  1.201364  1.495509   0.908120
2018-12-31  0.580396  1.373229  1.209152  1.508608   0.914110
```

[17]:

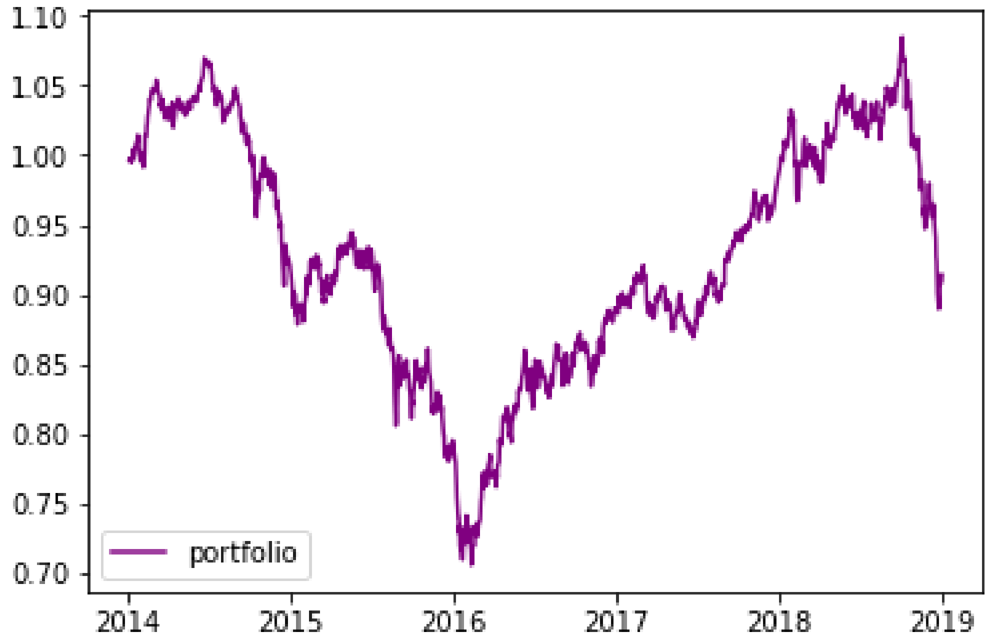
```python
returns['Portfolio'].hist()
plt.show()
```



[18]:

```python
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.legend()
plt.show()
```



[19]:
```
# 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 :  -0.005022474207717679
Std. dev:  0.6512920236657875
skew:  -0.22605463679872187
kurt:  1.299622507098448
```

[20]:
```python
# 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%
```

[21]:
```python
# 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%
```

[22]:
```python
# 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 = ((1+total_return)**(1/5))-1
```

[23]:
```python
# Calculate annualized volatility from the standard deviation
vol_port = returns['Portfolio'].std() * np.sqrt(250)
```

[24]:
```python
# Calculate the Sharpe ratio
rf = 0.01
sharpe_ratio = ((annualized_return - rf) / vol_port)
print(sharpe_ratio)
```

```
nan
```

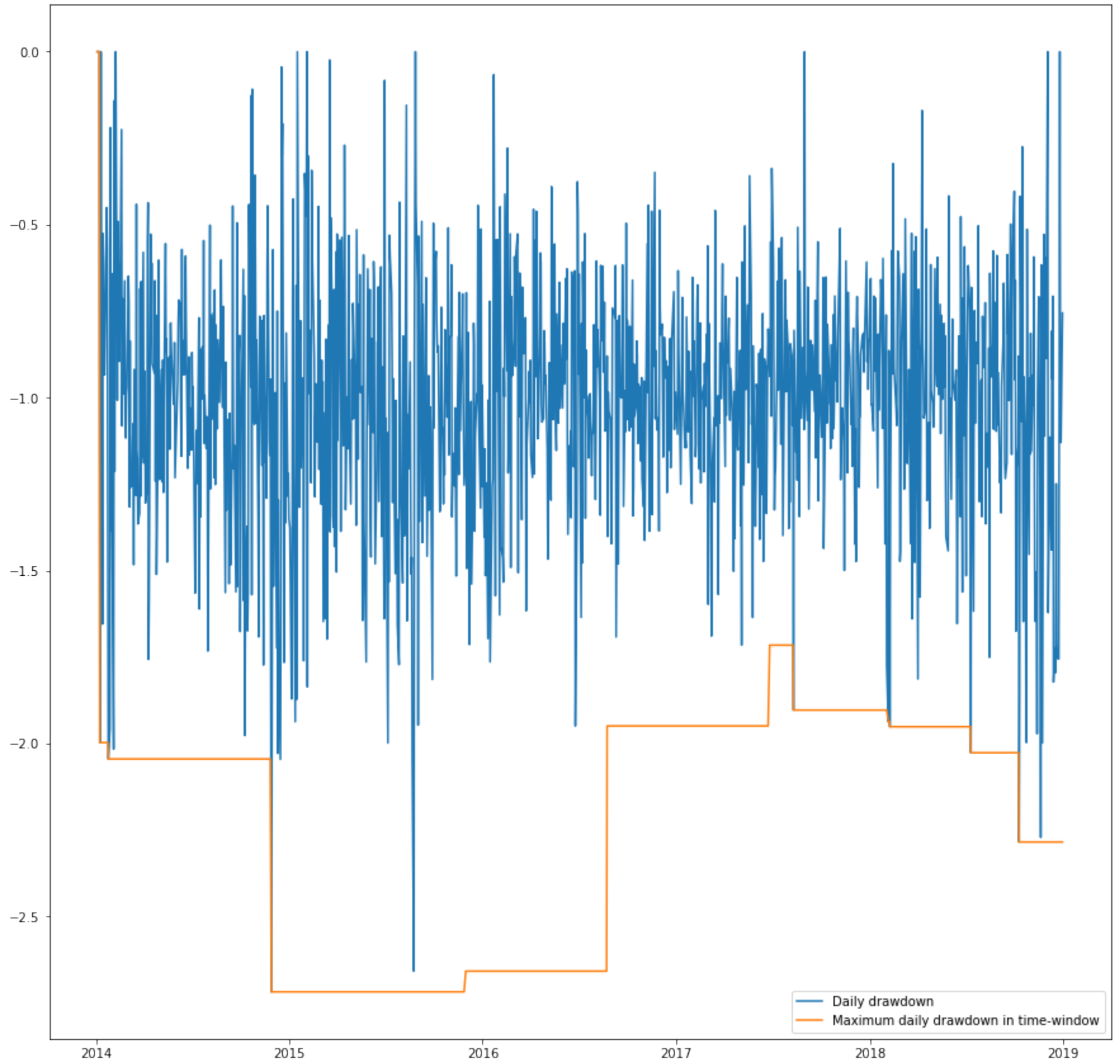
[25]:
```python
# Create a downside return column with the negative returns only
target = 0
downside_returns = returns.loc[returns['Portfolio'] < target]

# 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:  -0.005022474207717679
--------------------------------------------------
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       -3.722868
SPY         -1.289263
Portfolio   -2.185616
dtype: float64
```

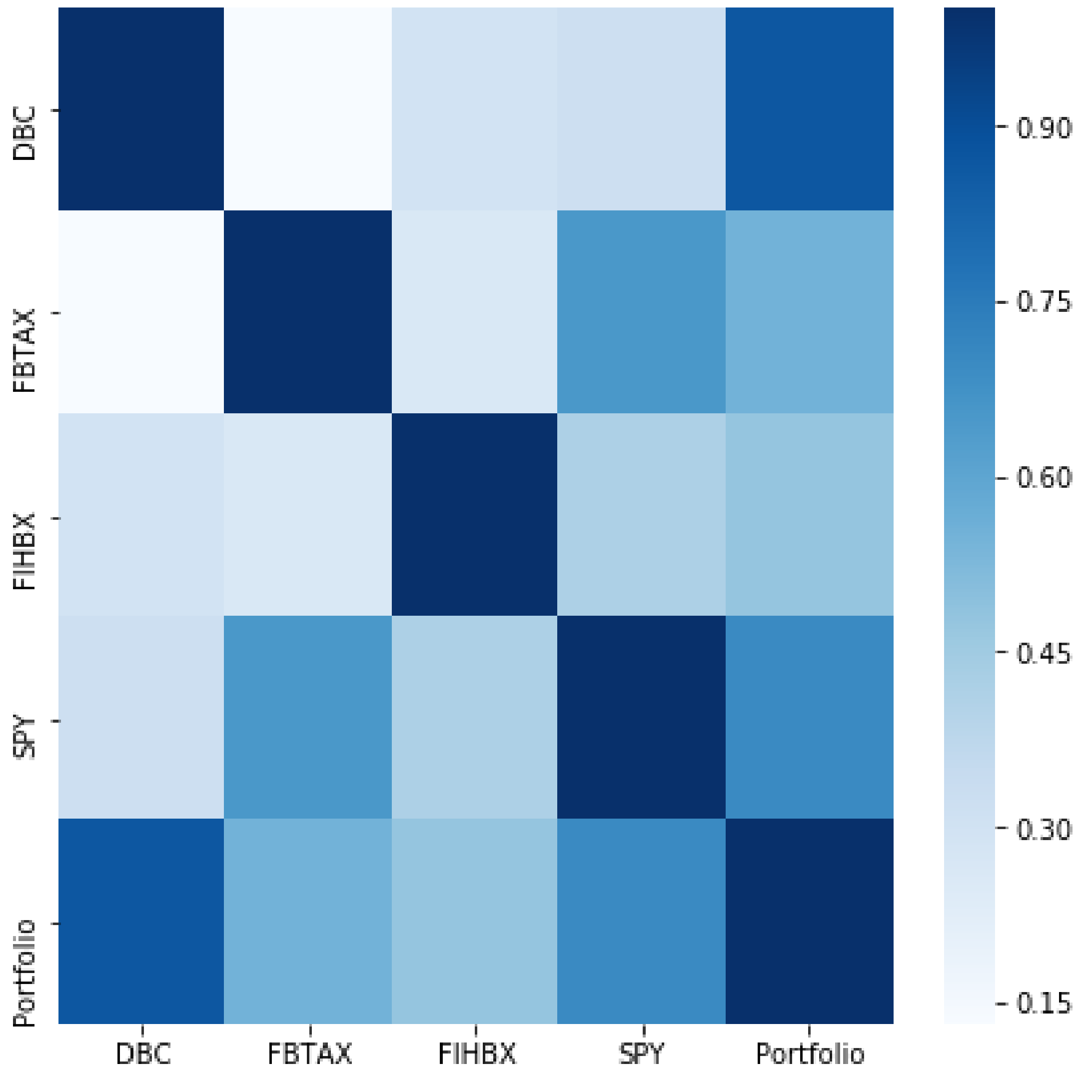
[26]:

```
# 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()
```



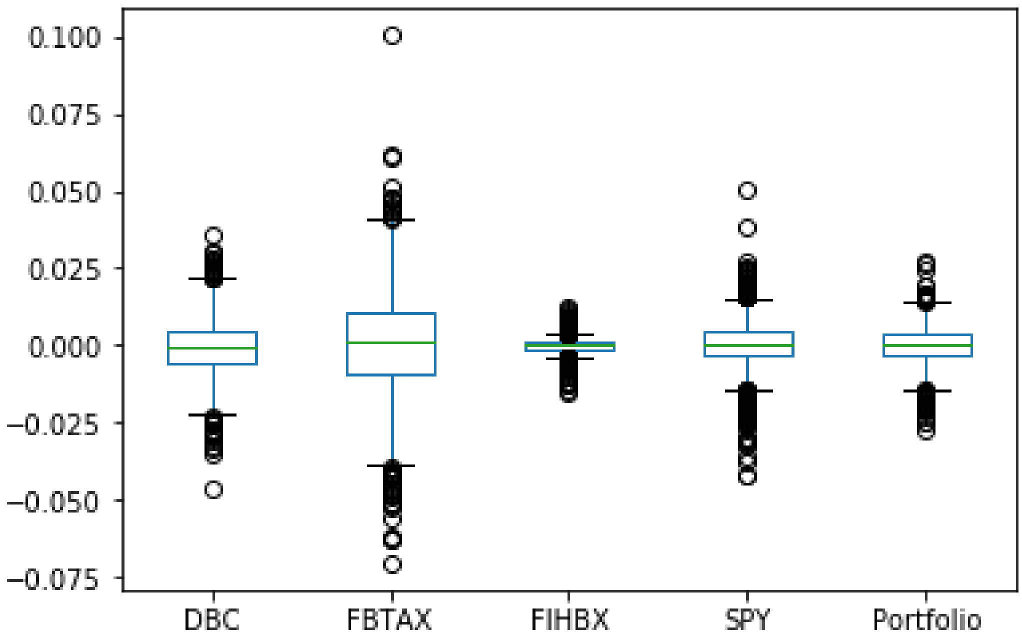
[27]:
```
plt.figure(figsize=(7,7))
corr = returns.corr()

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

[27]: <matplotlib.axes._subplots.AxesSubplot at 0x275d358c2b0>

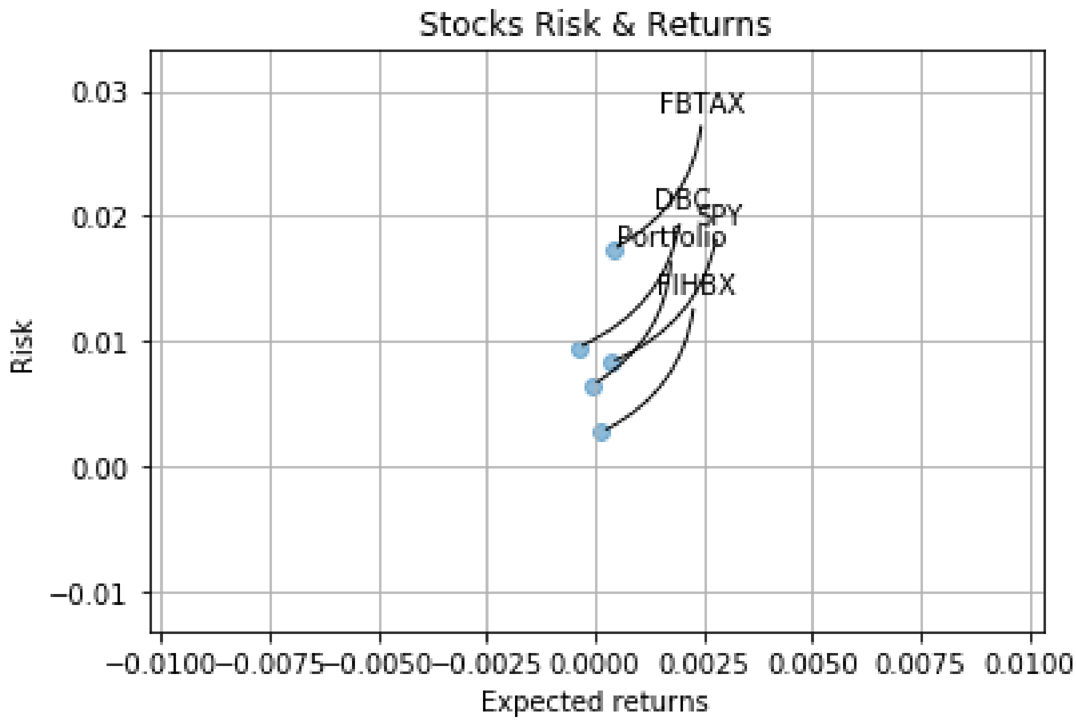


[28]:
```python
# Box plot
returns.plot(kind='box')
```

[28]: <matplotlib.axes._subplots.AxesSubplot at 0x275d35f83c8>

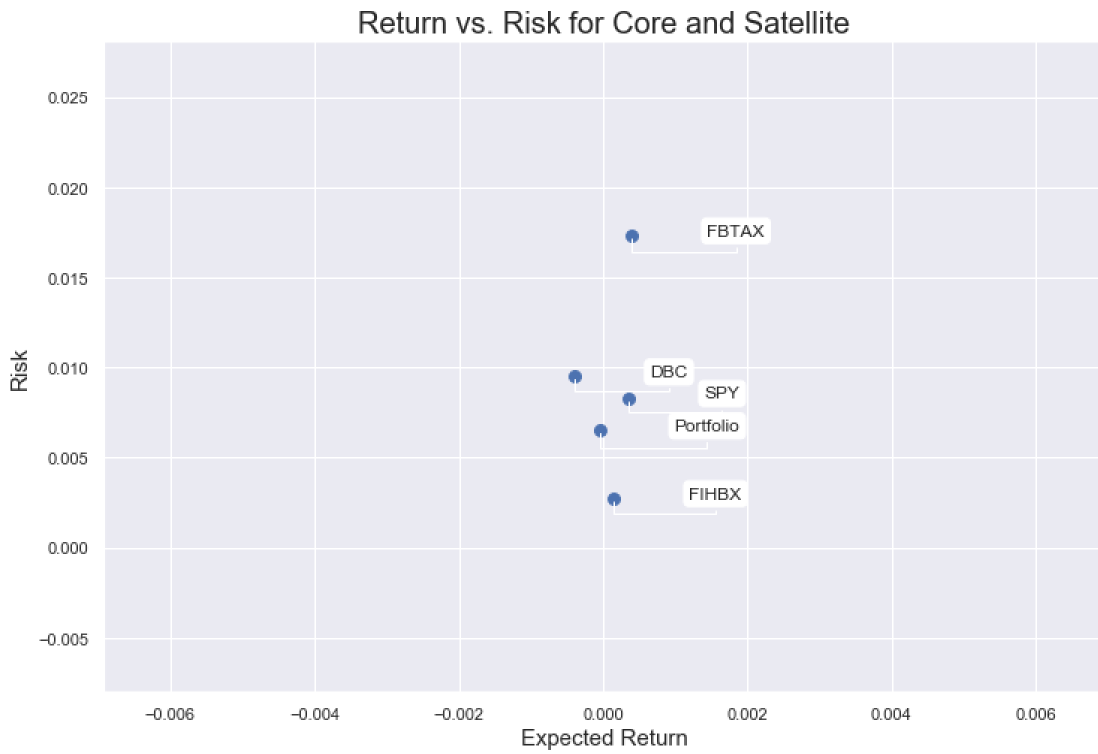


[29]:
```
rets = returns.dropna()

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'))
```



[30]:

```
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 Core and Satellite", 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"))
```



[31]:
```
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
```

[32]:
```python
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[32]:

	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

[33]:
```python
table.sort_values(by='Risk')
```

[33]:

	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

[34]:
```python
rf = 0.01
table['Sharpe_Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[34]:

	Returns	Risk	Sharpe_Ratio
DBC	-0.000388	0.009496	-1.093885
FBTAX	0.000403	0.017337	-0.553582
FIHBX	0.000155	0.002734	-3.601052
SPY	0.000362	0.008306	-1.160409
Portfolio	-0.000050	0.006513	-1.543121

[35]:
```python
days_per_year = 52 * 5
total_days_in_simulation = dataset.shape[0]
number_of_years = total_days_in_simulation / days_per_year
```

[36]:
```python
total_relative_returns = (np.exp(returns['Portfolio'].cumsum()) - 1)
total_portfolio_return = total_relative_returns[-1]

# Average portfolio return assuming compunding of returns
average_yearly_return = (1 + total_portfolio_return)**(1 / number_of_years) - 1
```

[37]:
```python
print('Total portfolio return is: ' +
      '{:5.2f}'.format(100 * total_portfolio_return) + '%')
print('Average yearly return is: ' +
      '{:5.2f}'.format(100 * average_yearly_return) + '%')
```

```
Total portfolio return is: -6.12%
Average yearly return is: -1.30%
```