Water_Stock_Portfolio

September 29, 2021

1 Water Stock Portfolio Risk and Returns

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import math
from sklearn.linear_model import LinearRegression

import warnings
warnings.filterwarnings("ignore")

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

[2]:
```
# input
# Water Stock
title = 'Water'
symbols = ['AQN','AWK','AWR','CWT', 'GWRS', 'YORW', 'XYL', 'WTRG']
start = '2021-01-01'
end = '2021-06-18'
```

[3]:
```
df = pd.DataFrame()
for s in symbols:
    df[s] = yf.download(s,start,end)['Adj Close']
```

```
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
```

[4]:
```python
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?
0 years
```

[5]:
```python
number_of_years = delta.years
```

[6]:
```python
months = (d2.year - d1.year) * 12 + (d2.month - d1.month)
months
```

[6]: 5

[7]:
```python
days = (df.index[-1] - df.index[0]).days
days
```

[7]: 164

[8]:
```python
df.head()
```

[8]:

Date	AQN	AWK	AWR	CWT	GWRS	YORW
2021-01-04	16.091688	149.145187	77.538078	53.019135	14.546535	45.562466
2021-01-05	16.180811	149.988983	77.835579	53.277039	14.457294	45.721775
2021-01-06	16.418472	151.249741	81.088226	56.490925	15.081991	47.991936
2021-01-07	16.646231	151.021408	79.422234	55.856083	16.708191	47.304913
2021-01-08	17.002724	155.836060	80.304817	55.350193	16.737936	47.633492

Date	XYL	WTRG
2021-01-04	99.169624	45.696087
2021-01-05	99.050247	46.309460
2021-01-06	103.228317	47.526310
2021-01-07	107.913742	46.972294
2021-01-08	106.819481	48.199036

[9]:
```python
df.tail()
```

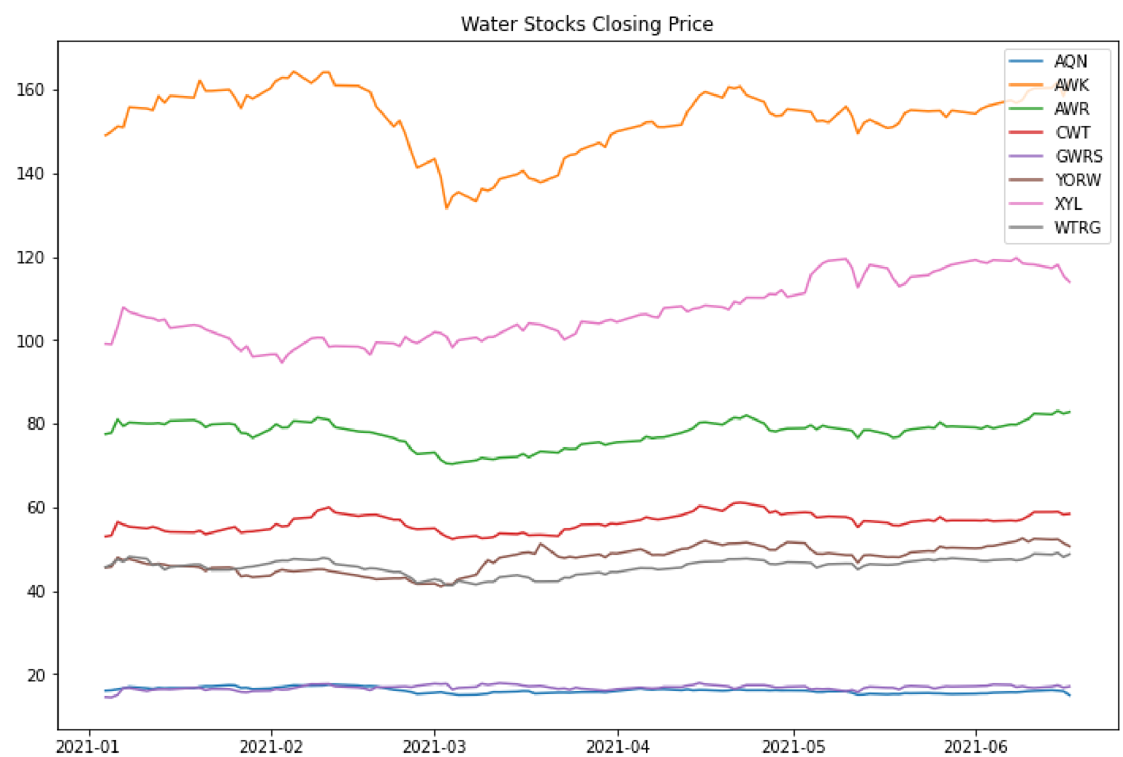
[9]:

Date	AQN	AWK	AWR	CWT	GWRS	YORW
2021-06-11	16.010000	160.360001	82.449997	58.830002	16.746450	52.470001

```
2021-06-14  16.200001  160.479996  82.230003  58.849998  17.066000  52.270000
2021-06-15  16.080000  161.789993  83.089996  58.910000  17.360001  52.330002
2021-06-16  15.950000  158.470001  82.430000  58.250000  16.809999  51.410000
2021-06-17  15.000000  162.199997  82.839996  58.430000  17.080000  50.660000

                   XYL       WTRG
Date
2021-06-11  118.160004  48.860001
2021-06-14  117.269997  48.660000
2021-06-15  118.089996  49.090000
2021-06-16  115.489998  48.070000
2021-06-17  113.940002  48.770000
```

[10]:
```python
plt.figure(figsize=(12,8))
plt.plot(df)
plt.title(title + ' Stocks Closing Price')
plt.legend(labels=df.columns)
```

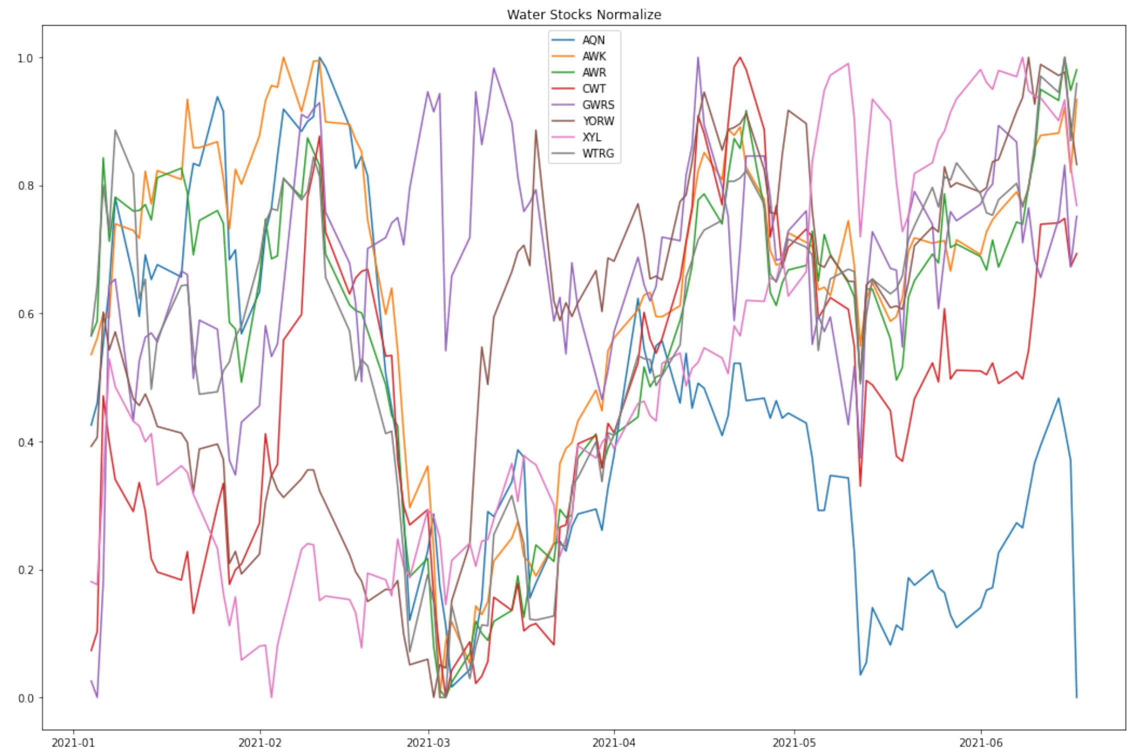
[10]:
```
<matplotlib.legend.Legend at 0x1325a351c18>
```



[11]:
```python
# Normalize the data
normalize = (df - df.min())/ (df.max() - df.min())
```

[12]:
```
plt.figure(figsize=(18,12))
plt.plot(normalize)
plt.title(title + ' Stocks Normalize')
plt.legend(labels=normalize.columns)
```

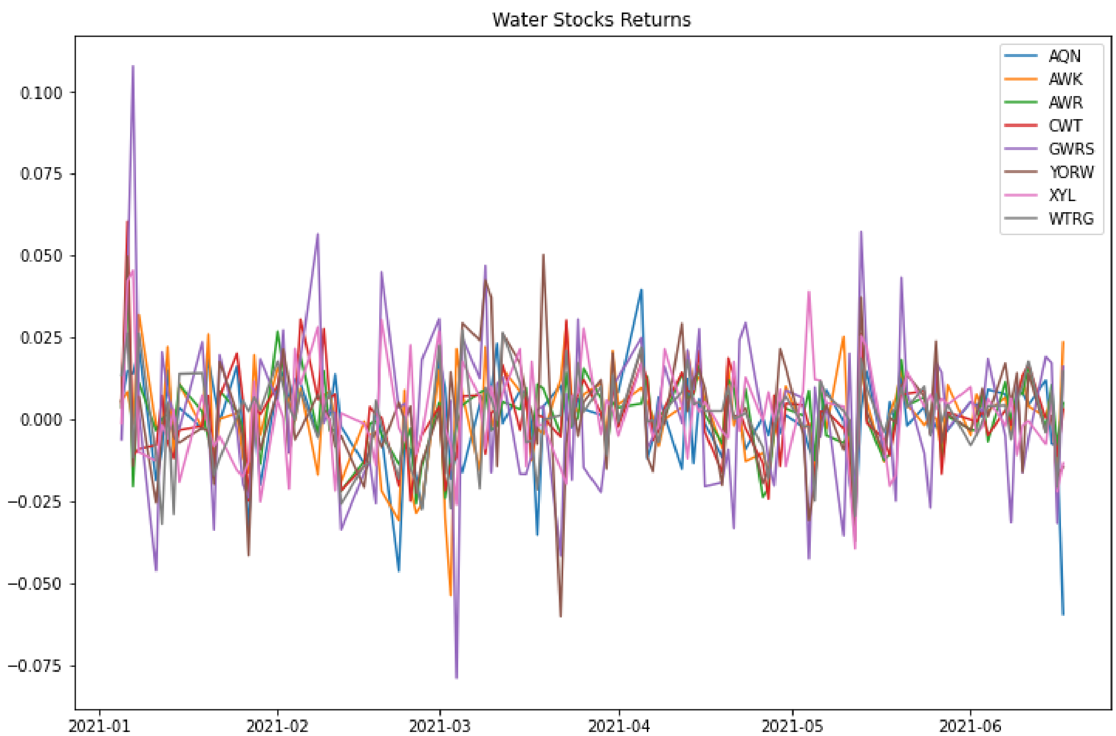
[12]: <matplotlib.legend.Legend at 0x1325a484da0>



[13]:
```
stock_rets = df.pct_change().dropna()
```

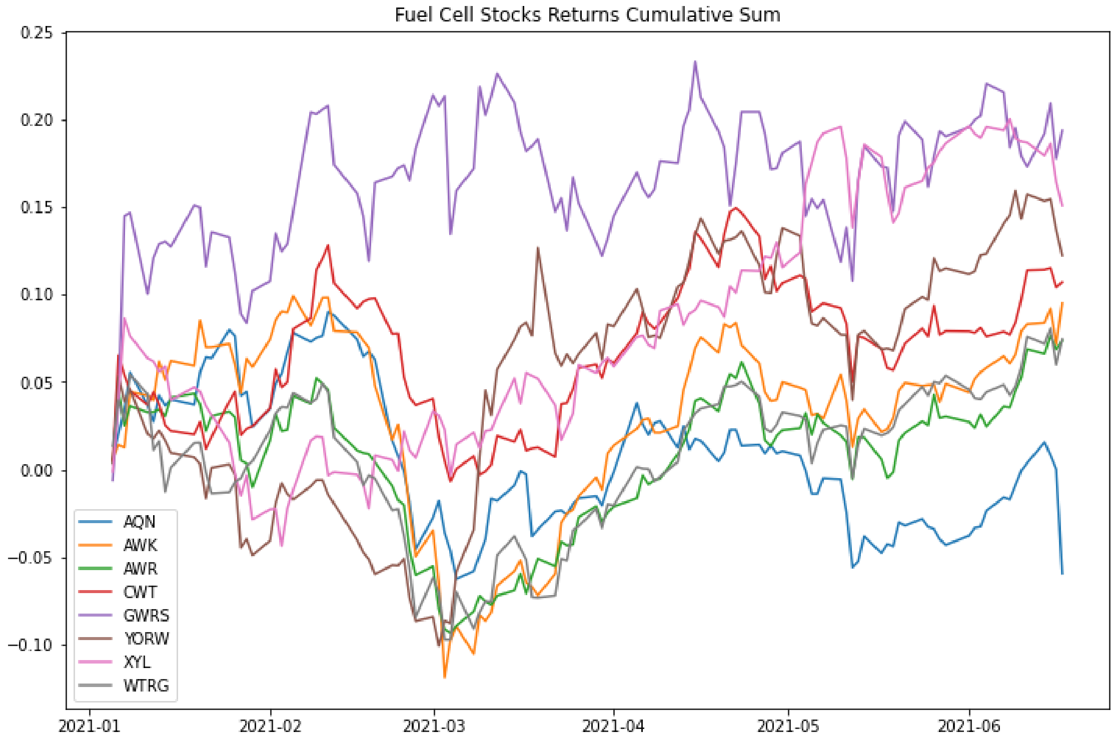
[14]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets)
plt.title(title +' Stocks Returns')
plt.legend(labels=stock_rets.columns)
```

[14]: <matplotlib.legend.Legend at 0x1325a52f2b0>



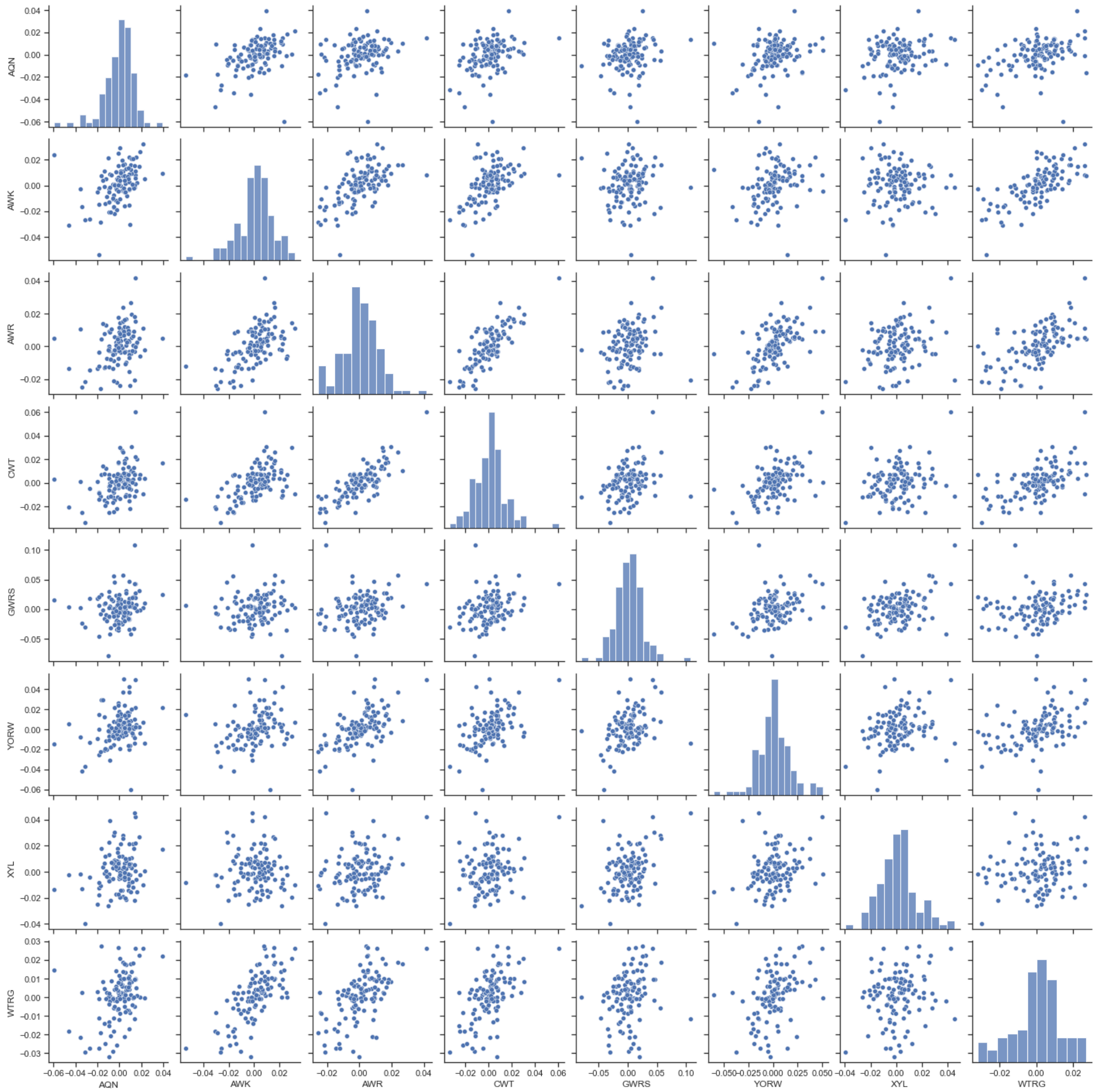
[15]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets.cumsum())
plt.title('Fuel Cell Stocks Returns Cumulative Sum')
plt.legend(labels=stock_rets.columns)
```

[15]: <matplotlib.legend.Legend at 0x1325a59b940>

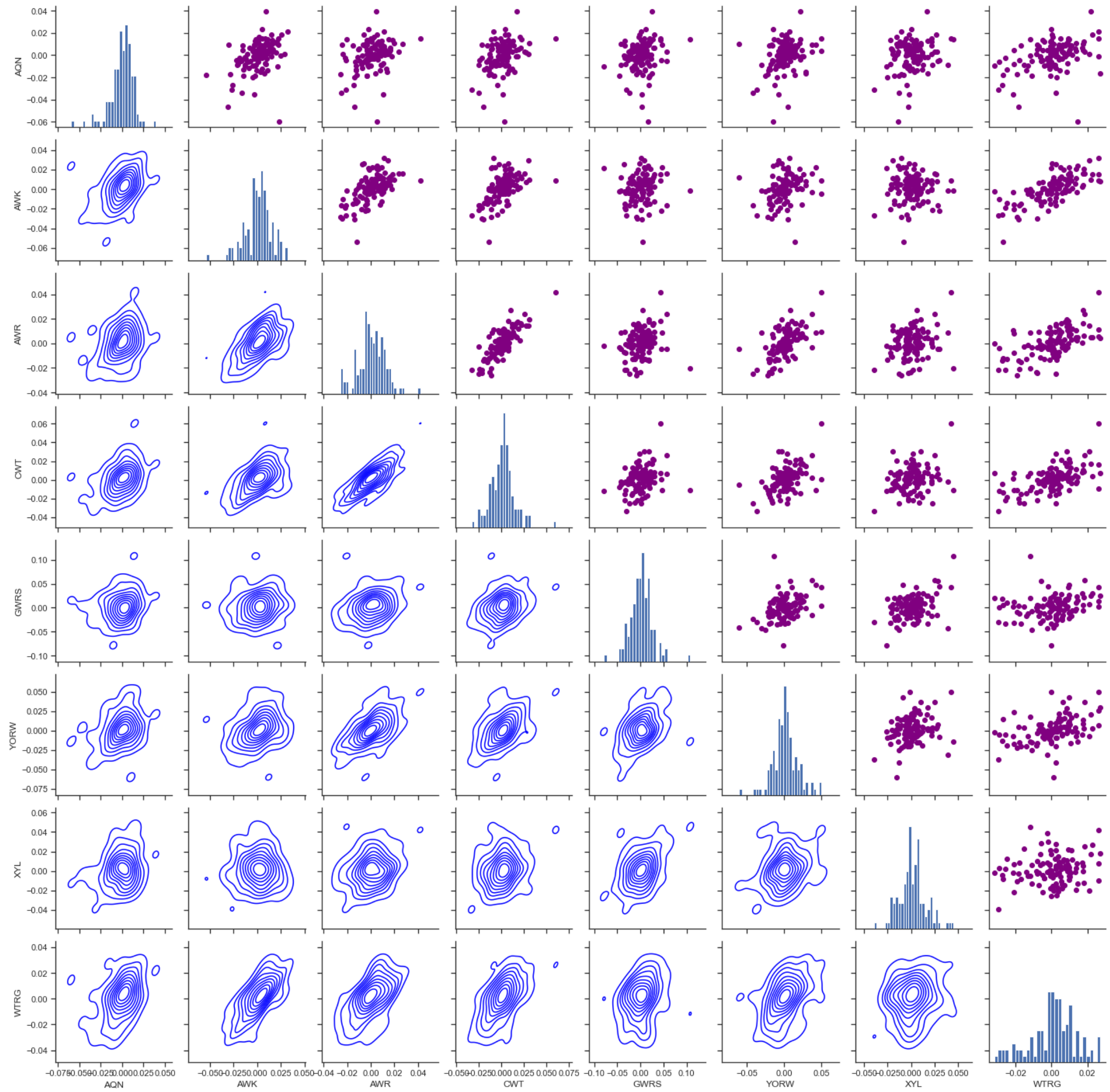


[16]:

```
sns.set(style='ticks')
ax = sns.pairplot(stock_rets, diag_kind='hist')

nplot = len(stock_rets.columns)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```



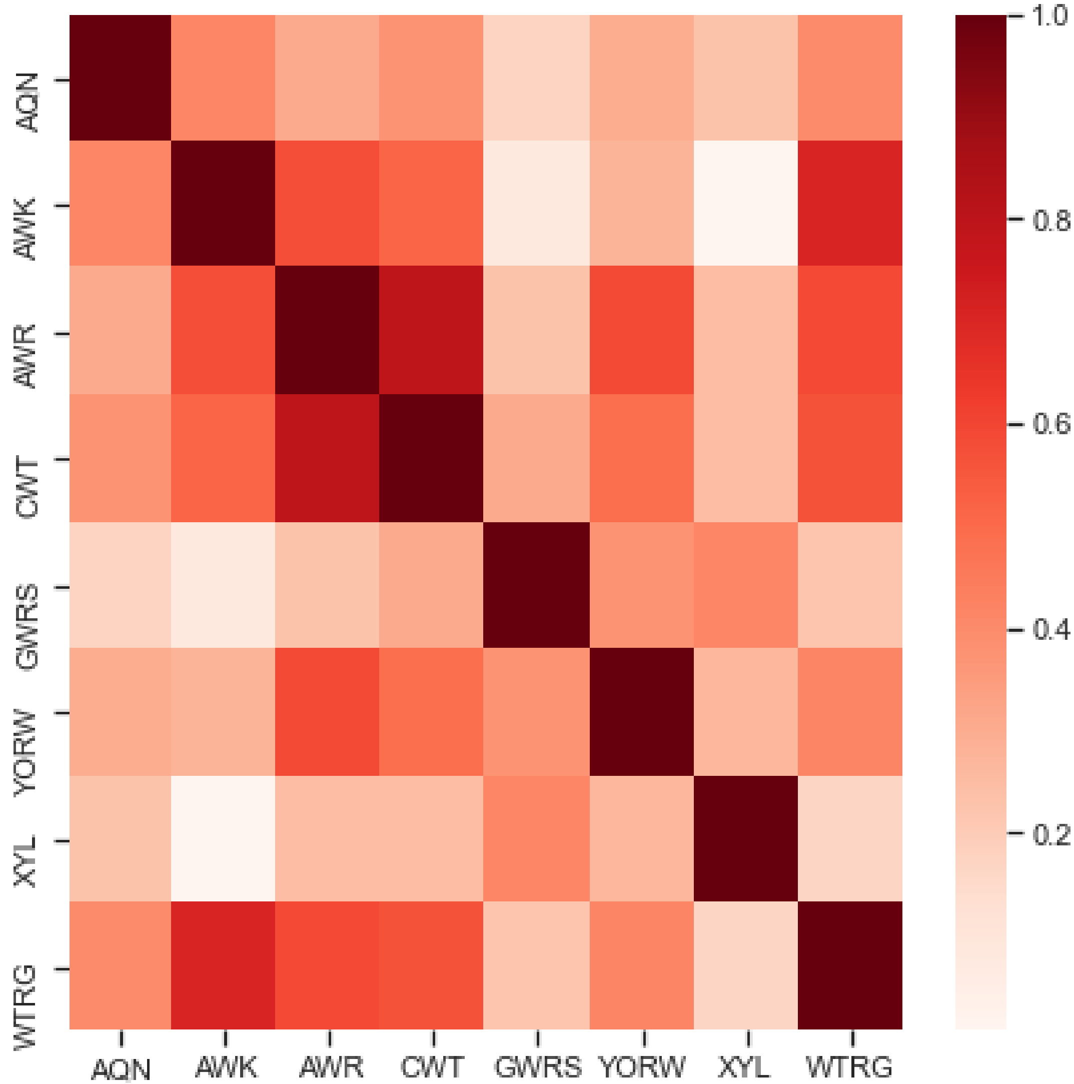
[17]:
```python
ax = sns.PairGrid(stock_rets)
ax.map_upper(plt.scatter, color='purple')
ax.map_lower(sns.kdeplot, color='blue')
ax.map_diag(plt.hist, bins=30)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```



[18]:

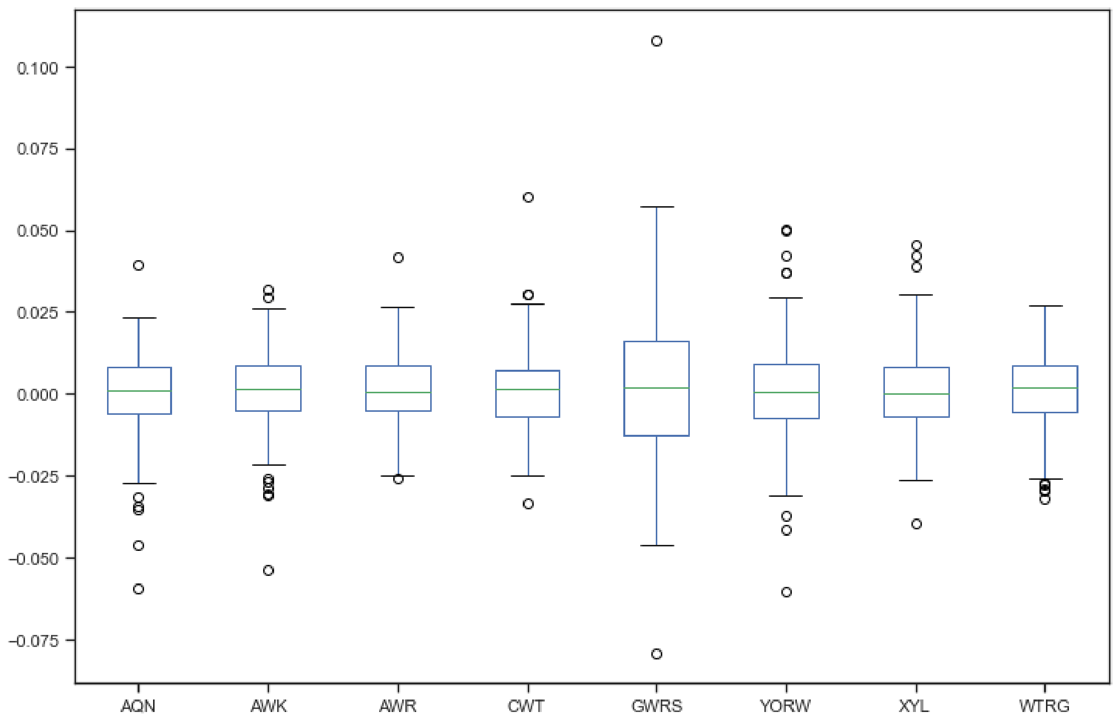
```
plt.figure(figsize=(7,7))
corr = stock_rets.corr()

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

[18]: <AxesSubplot:>



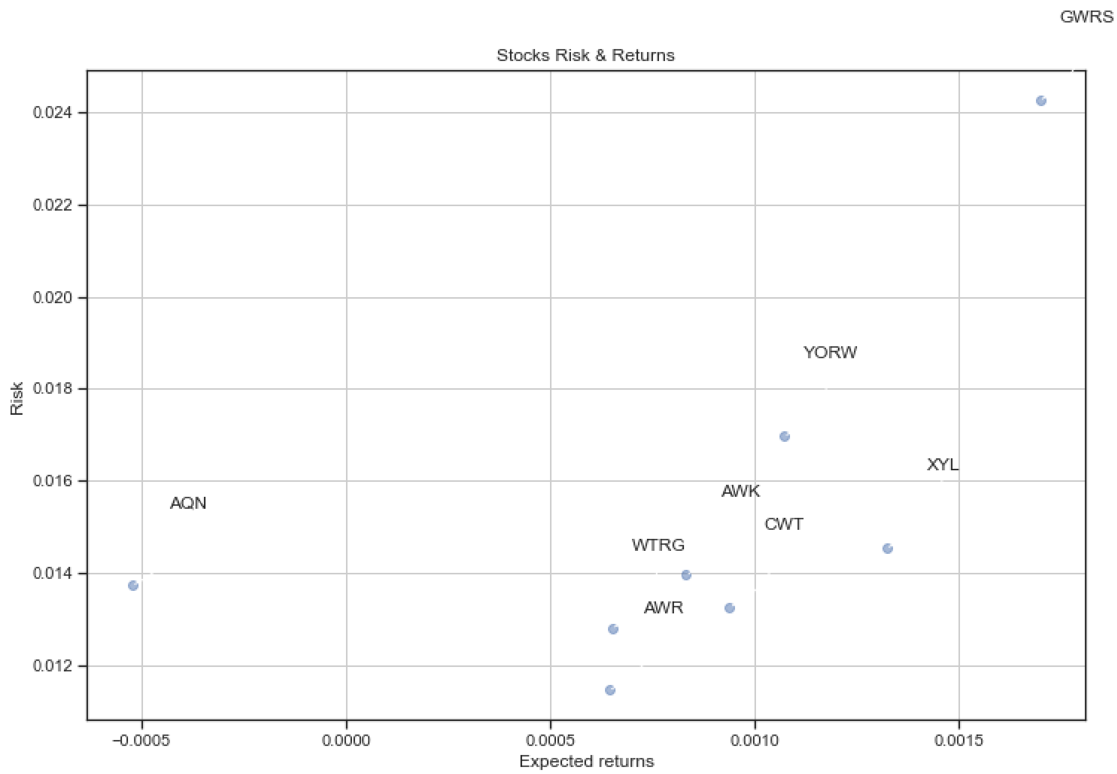
[19]:
```
# Box plot
stock_rets.plot(kind='box',figsize=(12,8))
```

[19]: <AxesSubplot:>

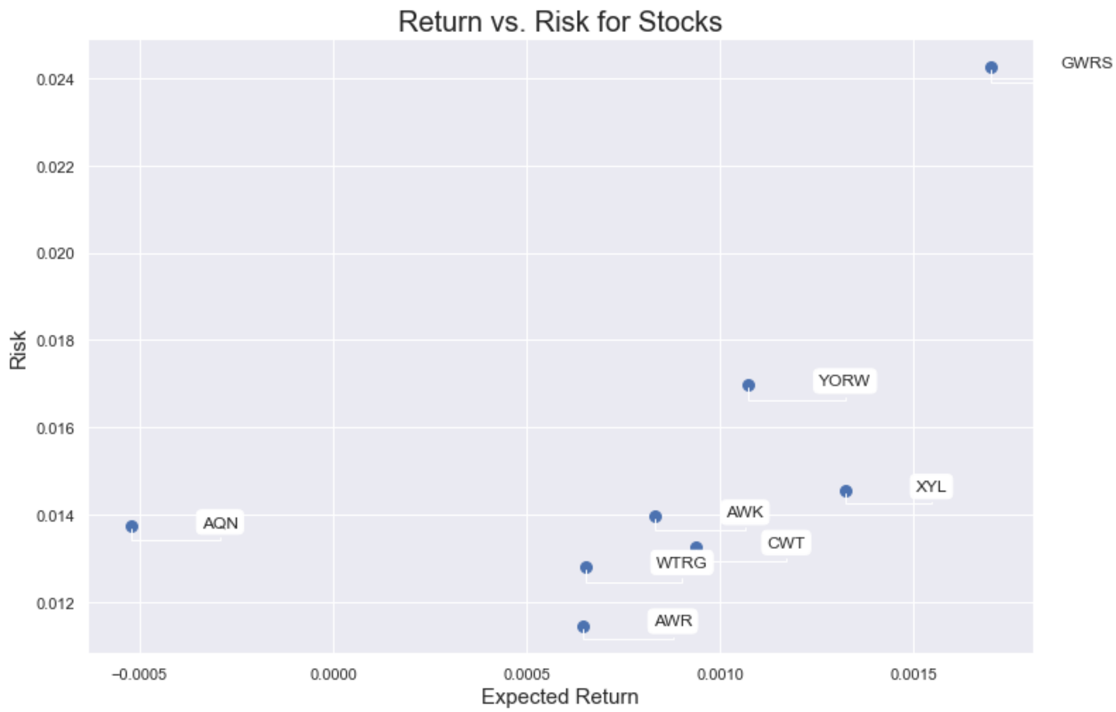


[20]:

```
rets = stock_rets.dropna()

plt.figure(figsize=(12,8))
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'))
```



[21]:
```
rets = stock_rets.dropna()
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 Stocks", 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"))
```



[22]:
```
rest_rets = rets.corr()
pair_value = rest_rets.abs().unstack()
pair_value.sort_values(ascending = False)
```

[22]:
```
WTRG  WTRG    1.000000
XYL   XYL     1.000000
AWK   AWK     1.000000
AWR   AWR     1.000000
CWT   CWT     1.000000
                …
WTRG  XYL     0.165724
AWK   GWRS    0.078229
GWRS  AWK     0.078229
AWK   XYL     0.006517
XYL   AWK     0.006517
Length: 64, dtype: float64
```

[23]:
```
# Normalized Returns Data
Normalized_Value = ((rets[:] - rets[:].min()) /(rets[:].max() - rets[:].min()))
Normalized_Value.head()
```

[23]:
```
                 AQN       AWK       AWR       CWT      GWRS      YORW  \
Date
2021-01-05  0.657504  0.693877  0.438203  0.407255  0.389993  0.577317
```

```
2021-01-06  0.749913  0.725958  1.000000  1.000000  0.654129  0.995270
2021-01-07  0.741674  0.610208  0.077275  0.235155  1.000000  0.416023
2021-01-08  0.817866  1.000000  0.545905  0.258465  0.432362  0.608553
2021-01-11  0.413332  0.602547  0.330224  0.270988  0.175484  0.314726

                 XYL      WTRG
Date
2021-01-05  0.451331  0.766759
2021-01-06  0.962227  0.983909
2021-01-07  1.000000  0.343059
2021-01-08  0.346098  0.981202
2021-01-11  0.316362  0.352744
```

[24]:
```python
Normalized_Value.corr()
```

[24]:
```
           AQN       AWK       AWR       CWT      GWRS      YORW       XYL  \
AQN   1.000000  0.414033  0.308962  0.377098  0.176483  0.300493  0.230793
AWK   0.414033  1.000000  0.580059  0.515210  0.078229  0.277962  0.006517
AWR   0.308962  0.580059  1.000000  0.792928  0.229248  0.586184  0.248382
CWT   0.377098  0.515210  0.792928  1.000000  0.307307  0.490191  0.248592
GWRS  0.176483  0.078229  0.229248  0.307307  1.000000  0.374658  0.414804
YORW  0.300493  0.277962  0.586184  0.490191  0.374658  1.000000  0.269311
XYL   0.230793  0.006517  0.248382  0.248592  0.414804  0.269311  1.000000
WTRG  0.400459  0.708625  0.592487  0.565928  0.221932  0.420316  0.165724

          WTRG
AQN   0.400459
AWK   0.708625
AWR   0.592487
CWT   0.565928
GWRS  0.221932
YORW  0.420316
XYL   0.165724
WTRG  1.000000
```

[25]:
```python
normalized_rets = Normalized_Value.corr()
normalized_pair_value = normalized_rets.abs().unstack()
normalized_pair_value.sort_values(ascending = False)
```

[25]:
```
WTRG  WTRG    1.000000
XYL   XYL     1.000000
AWK   AWK     1.000000
AWR   AWR     1.000000
CWT   CWT     1.000000
                …
WTRG  XYL     0.165724
AWK   GWRS    0.078229
```

```
GWRS  AWK     0.078229
AWK   XYL     0.006517
XYL   AWK     0.006517
Length: 64, dtype: float64
```

[26]:
```
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risks:")
print(rets.std())
```

```
Stock returns:
AQN    -0.000522
AWK     0.000833
AWR     0.000645
CWT     0.000939
GWRS    0.001699
YORW    0.001073
XYL     0.001323
WTRG    0.000653
dtype: float64
--------------------------------------------------
Stock risks:
AQN     0.013730
AWK     0.013953
AWR     0.011456
CWT     0.013260
GWRS    0.024254
YORW    0.016962
XYL     0.014544
WTRG    0.012803
dtype: float64
```

[27]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[27]:

	Returns	Risk
AQN	-0.000522	0.013730
AWR	0.000645	0.011456
WTRG	0.000653	0.012803
AWK	0.000833	0.013953
CWT	0.000939	0.013260
YORW	0.001073	0.016962
XYL	0.001323	0.014544
GWRS	0.001699	0.024254

[28]:
```
table.sort_values(by='Risk')
```

[28]:

	Returns	Risk
AWR	0.000645	0.011456
WTRG	0.000653	0.012803
CWT	0.000939	0.013260
AQN	-0.000522	0.013730
AWK	0.000833	0.013953
XYL	0.001323	0.014544
YORW	0.001073	0.016962
GWRS	0.001699	0.024254

[29]:
```
rf = 0.001
table['Sharpe Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[29]:

	Returns	Risk	Sharpe Ratio
AQN	-0.000522	0.013730	-0.110819
AWK	0.000833	0.013953	-0.011943
AWR	0.000645	0.011456	-0.030960
CWT	0.000939	0.013260	-0.004572
GWRS	0.001699	0.024254	0.028803
YORW	0.001073	0.016962	0.004315
XYL	0.001323	0.014544	0.022207
WTRG	0.000653	0.012803	-0.027123

[30]:
```
table['Max Returns'] = rets.max()
```

[31]:
```
table['Min Returns'] = rets.min()
```

[32]:
```
table['Median Returns'] = rets.median()
```

[33]:
```
total_return = stock_rets[-1:].transpose()
table['Total Return'] = 100 * total_return
table
```

[33]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns \
AQN	-0.000522	0.013730	-0.110819	0.039449	-0.059561
AWK	0.000833	0.013953	-0.011943	0.031881	-0.053781
AWR	0.000645	0.011456	-0.030960	0.041789	-0.025766
CWT	0.000939	0.013260	-0.004572	0.060324	-0.033240
GWRS	0.001699	0.024254	0.028803	0.107824	-0.078992
YORW	0.001073	0.016962	0.004315	0.050174	-0.060257
XYL	0.001323	0.014544	0.022207	0.045389	-0.039531
WTRG	0.000653	0.012803	-0.027123	0.027229	-0.031964

	Median Returns	Total Return

```
AQN          0.000896     -5.956112
AWK          0.001728      2.353755
AWR          0.000701      0.497387
CWT          0.001505      0.309013
GWRS         0.002117      1.606190
YORW         0.000784     -1.458860
XYL          0.000025     -1.342104
WTRG         0.002074      1.456211
```

[34]:
```python
table['Average Return Days'] = (1 + total_return)**(1 / days) - 1
table
```

[34]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
AQN  -0.000522  0.013730     -0.110819     0.039449    -0.059561
AWK   0.000833  0.013953     -0.011943     0.031881    -0.053781
AWR   0.000645  0.011456     -0.030960     0.041789    -0.025766
CWT   0.000939  0.013260     -0.004572     0.060324    -0.033240
GWRS  0.001699  0.024254      0.028803     0.107824    -0.078992
YORW  0.001073  0.016962      0.004315     0.050174    -0.060257
XYL   0.001323  0.014544      0.022207     0.045389    -0.039531
WTRG  0.000653  0.012803     -0.027123     0.027229    -0.031964

      Median Returns  Total Return  Average Return Days
AQN         0.000896     -5.956112            -0.000374
AWK         0.001728      2.353755             0.000142
AWR         0.000701      0.497387             0.000030
CWT         0.001505      0.309013             0.000019
GWRS        0.002117      1.606190             0.000097
YORW        0.000784     -1.458860            -0.000090
XYL         0.000025     -1.342104            -0.000082
WTRG        0.002074      1.456211             0.000088
```

[35]:
```python
initial_value = df.iloc[0]
ending_value = df.iloc[-1]
table['CAGR'] = ((ending_value / initial_value) ** (252.0 / days)) -1
table
```

[35]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
AQN  -0.000522  0.013730     -0.110819     0.039449    -0.059561
AWK   0.000833  0.013953     -0.011943     0.031881    -0.053781
AWR   0.000645  0.011456     -0.030960     0.041789    -0.025766
CWT   0.000939  0.013260     -0.004572     0.060324    -0.033240
GWRS  0.001699  0.024254      0.028803     0.107824    -0.078992
YORW  0.001073  0.016962      0.004315     0.050174    -0.060257
XYL   0.001323  0.014544      0.022207     0.045389    -0.039531
WTRG  0.000653  0.012803     -0.027123     0.027229    -0.031964
```

	Median Returns	Total Return	Average Return Days	CAGR
AQN	0.000896	-5.956112	-0.000374	-0.102327
AWK	0.001728	2.353755	0.000142	0.137616
AWR	0.000701	0.497387	0.000030	0.106977
CWT	0.001505	0.309013	0.000019	0.161045
GWRS	0.002117	1.606190	0.000097	0.279804
YORW	0.000784	-1.458860	-0.000090	0.176988
XYL	0.000025	-1.342104	-0.000082	0.237805
WTRG	0.002074	1.456211	0.000088	0.105211

[36]:
```
table.sort_values(by='Average Return Days')
```

[36]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	\
AQN	-0.000522	0.013730	-0.110819	0.039449	-0.059561	
YORW	0.001073	0.016962	0.004315	0.050174	-0.060257	
XYL	0.001323	0.014544	0.022207	0.045389	-0.039531	
CWT	0.000939	0.013260	-0.004572	0.060324	-0.033240	
AWR	0.000645	0.011456	-0.030960	0.041789	-0.025766	
WTRG	0.000653	0.012803	-0.027123	0.027229	-0.031964	
GWRS	0.001699	0.024254	0.028803	0.107824	-0.078992	
AWK	0.000833	0.013953	-0.011943	0.031881	-0.053781	

	Median Returns	Total Return	Average Return Days	CAGR
AQN	0.000896	-5.956112	-0.000374	-0.102327
YORW	0.000784	-1.458860	-0.000090	0.176988
XYL	0.000025	-1.342104	-0.000082	0.237805
CWT	0.001505	0.309013	0.000019	0.161045
AWR	0.000701	0.497387	0.000030	0.106977
WTRG	0.002074	1.456211	0.000088	0.105211
GWRS	0.002117	1.606190	0.000097	0.279804
AWK	0.001728	2.353755	0.000142	0.137616

[37]:
```
table['var_99'] = round((rets).quantile(0.01), 3)
table['var_95'] = round((rets).quantile(0.05), 3)
```

[38]:
```
table.sort_values(by='Returns')
```

[38]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	\
AQN	-0.000522	0.013730	-0.110819	0.039449	-0.059561	
AWR	0.000645	0.011456	-0.030960	0.041789	-0.025766	
WTRG	0.000653	0.012803	-0.027123	0.027229	-0.031964	
AWK	0.000833	0.013953	-0.011943	0.031881	-0.053781	
CWT	0.000939	0.013260	-0.004572	0.060324	-0.033240	
YORW	0.001073	0.016962	0.004315	0.050174	-0.060257	
XYL	0.001323	0.014544	0.022207	0.045389	-0.039531	
GWRS	0.001699	0.024254	0.028803	0.107824	-0.078992	

	Median Returns	Total Return	Average Return Days	CAGR	var_99
AQN	0.000896	-5.956112	-0.000374	-0.102327	-0.045
AWR	0.000701	0.497387	0.000030	0.106977	-0.025
WTRG	0.002074	1.456211	0.000088	0.105211	-0.029
AWK	0.001728	2.353755	0.000142	0.137616	-0.031
CWT	0.001505	0.309013	0.000019	0.161045	-0.025
YORW	0.000784	-1.458860	-0.000090	0.176988	-0.041
XYL	0.000025	-1.342104	-0.000082	0.237805	-0.026
GWRS	0.002117	1.606190	0.000097	0.279804	-0.046

	var_95
AQN	-0.023
AWR	-0.021
WTRG	-0.025
AWK	-0.023
CWT	-0.021
YORW	-0.021
XYL	-0.021
GWRS	-0.034

[39]:
```
# Pure Profit Score
df = df.dropna()
t = np.arange(0, df.shape[0]).reshape(-1, 1)
regression = LinearRegression().fit(t, df)
r_squared = regression.score(t, df)
table['PPS'] = table['CAGR'] * r_squared
```

[40]:
```
table
```

[40]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns
AQN	-0.000522	0.013730	-0.110819	0.039449	-0.059561
AWK	0.000833	0.013953	-0.011943	0.031881	-0.053781
AWR	0.000645	0.011456	-0.030960	0.041789	-0.025766
CWT	0.000939	0.013260	-0.004572	0.060324	-0.033240
GWRS	0.001699	0.024254	0.028803	0.107824	-0.078992
YORW	0.001073	0.016962	0.004315	0.050174	-0.060257
XYL	0.001323	0.014544	0.022207	0.045389	-0.039531
WTRG	0.000653	0.012803	-0.027123	0.027229	-0.031964

	Median Returns	Total Return	Average Return Days	CAGR	var_99
AQN	0.000896	-5.956112	-0.000374	-0.102327	-0.045
AWK	0.001728	2.353755	0.000142	0.137616	-0.031
AWR	0.000701	0.497387	0.000030	0.106977	-0.025
CWT	0.001505	0.309013	0.000019	0.161045	-0.025
GWRS	0.002117	1.606190	0.000097	0.279804	-0.046
YORW	0.000784	-1.458860	-0.000090	0.176988	-0.041
XYL	0.000025	-1.342104	-0.000082	0.237805	-0.026

WTRG	0.002074	1.456211	0.000088	0.105211	-0.029

	var_95	PPS
AQN	-0.023	-0.027934
AWK	-0.023	0.037567
AWR	-0.021	0.029203
CWT	-0.021	0.043963
GWRS	-0.034	0.076382
YORW	-0.021	0.048315
XYL	-0.021	0.064917
WTRG	-0.025	0.028721