Vaccine_Portfolio

September 29, 2021

1 Pharmaceutical Companies Racing for Vaccine Portfolio Risk and Returns (Coronavirus)

[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")

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

[2]:
```
# input
# Pharmaceutical Companie Vanccine
symbols = ['MRNA','INO','NVAX','GILD','JNJ','PFE','SNY','GSK']
start = '2019-12-01'
end = '2020-04-20'
```

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

```
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```

[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?
0 years
```

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

[6]:
```
days = (df.index[-1] - df.index[0]).days
days
```

[6]:
```
137
```

[7]:
```
df.head()
```

[7]:

Date	MRNA	INO	NVAX	GILD	JNJ	PFE	SNY	GSK
2019-12-02	19.760000	2.51	5.22	64.901039	136.489655	37.902821	45.820000	44.344246
2019-12-03	21.280001	2.55	4.77	64.851959	136.290924	37.665249	45.549999	44.067894
2019-12-04	21.270000	2.47	4.88	65.519424	138.496857	37.754337	46.610001	44.482418
2019-12-05	20.639999	2.33	4.55	64.714546	138.675705	37.645451	46.080002	44.620594
2019-12-06	18.940001	2.38	4.35	65.843346	139.490524	37.902821	46.029999	44.916679

[8]:
```
df.tail()
```

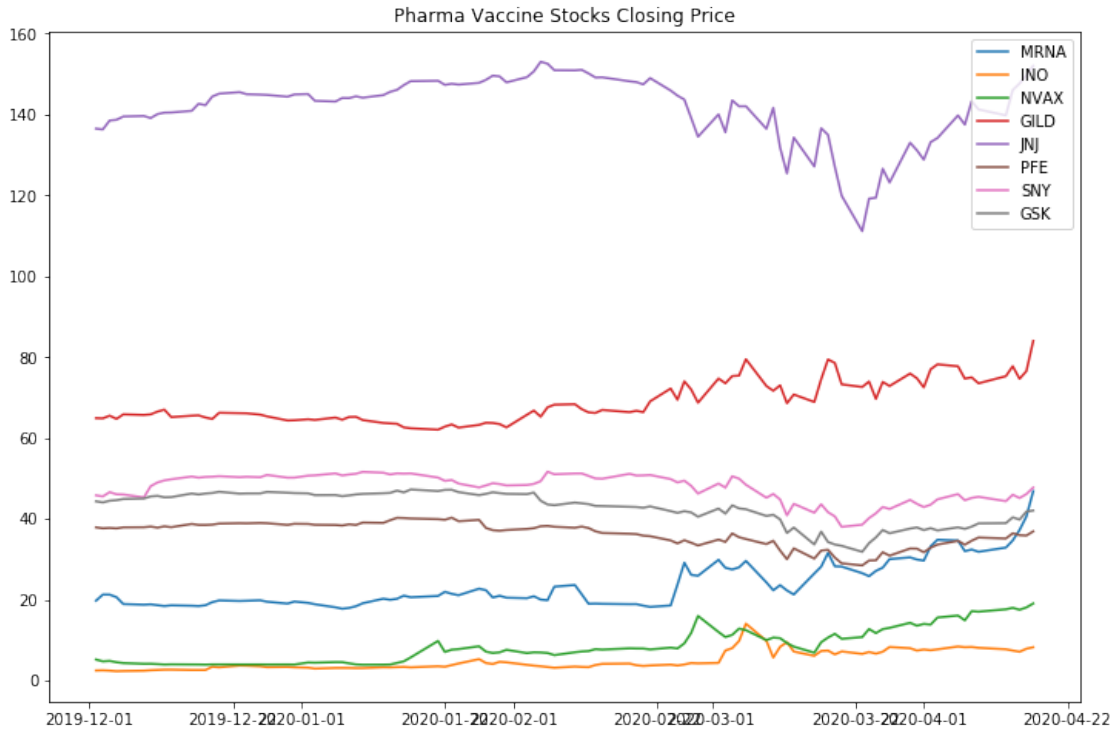
[8]:

Date	MRNA	INO	NVAX	GILD	JNJ	PFE	SNY	GSK
2020-04-13	32.900002	7.76	17.639999	75.279999	139.770004	35.139999		
2020-04-14	34.660000	7.44	18.000000	77.750000	146.029999	36.439999		
2020-04-15	37.250000	7.14	17.530001	74.629997	147.660004	35.970001		
2020-04-16	40.599998	7.89	18.100000	76.540001	149.669998	35.880001		
2020-04-17	46.849998	8.26	19.080000	83.989998	152.020004	36.910000		

```
2020-04-13   44.380001   38.939999
2020-04-14   45.970001   40.380001
2020-04-15   45.150002   39.820000
2020-04-16   46.130001   41.799999
2020-04-17   47.750000   42.070000
```

[9]:
```
plt.figure(figsize=(12,8))
plt.plot(df)
plt.title('Pharma Vaccine Stocks Closing Price')
plt.legend(labels=df.columns)
```

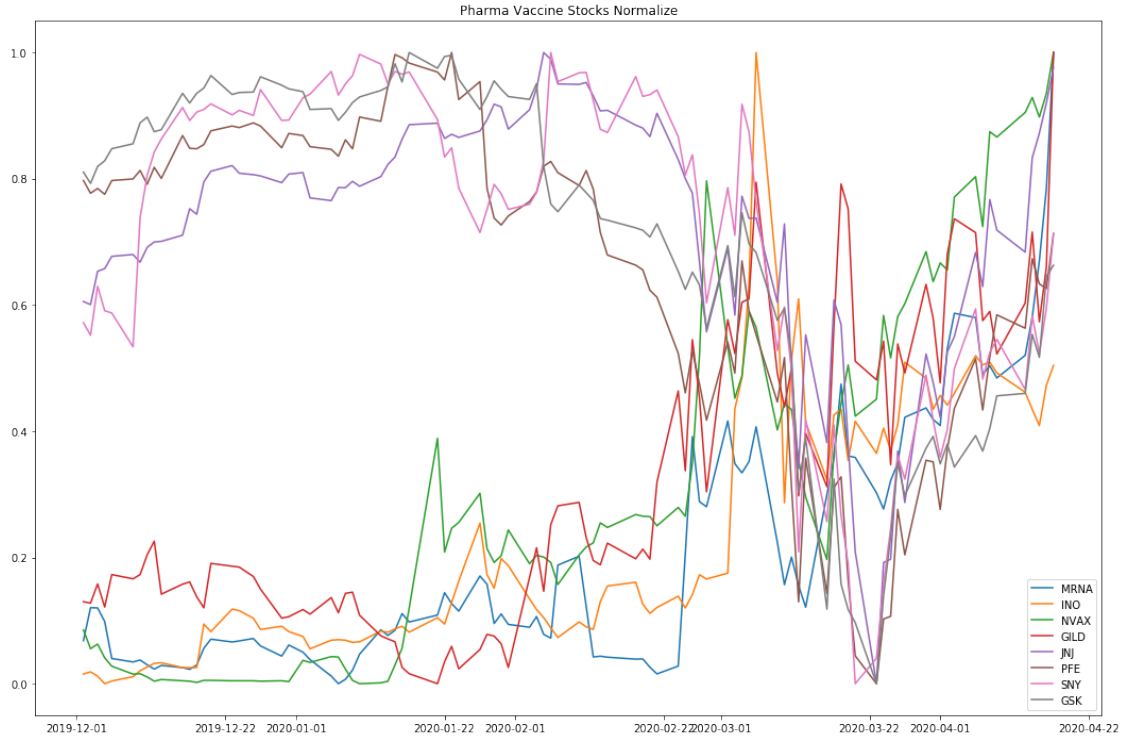
[9]: <matplotlib.legend.Legend at 0x29458c66ef0>



[10]:
```
# Normalize the data
normalize = (df - df.min())/ (df.max() - df.min())
```

[11]:
```
plt.figure(figsize=(18,12))
plt.plot(normalize)
plt.title('Pharma Vaccine Stocks Normalize')
plt.legend(labels=normalize.columns)
```

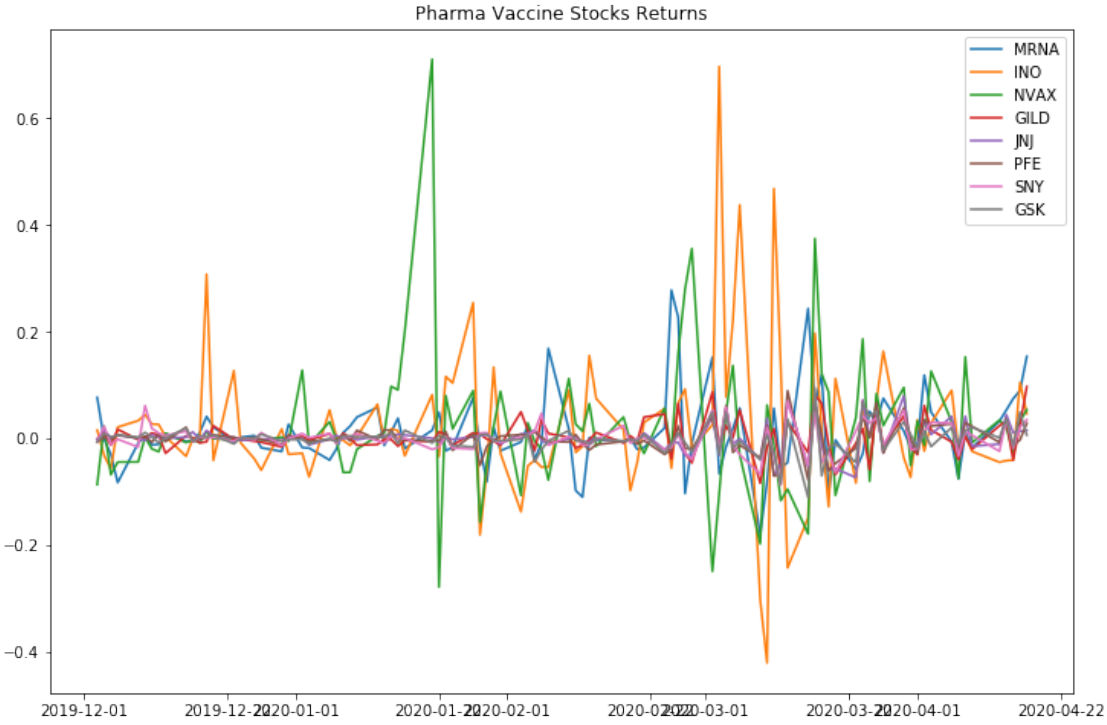
[11]: <matplotlib.legend.Legend at 0x29458cdffd0>



[12]:
```
stock_rets = df.pct_change().dropna()
```

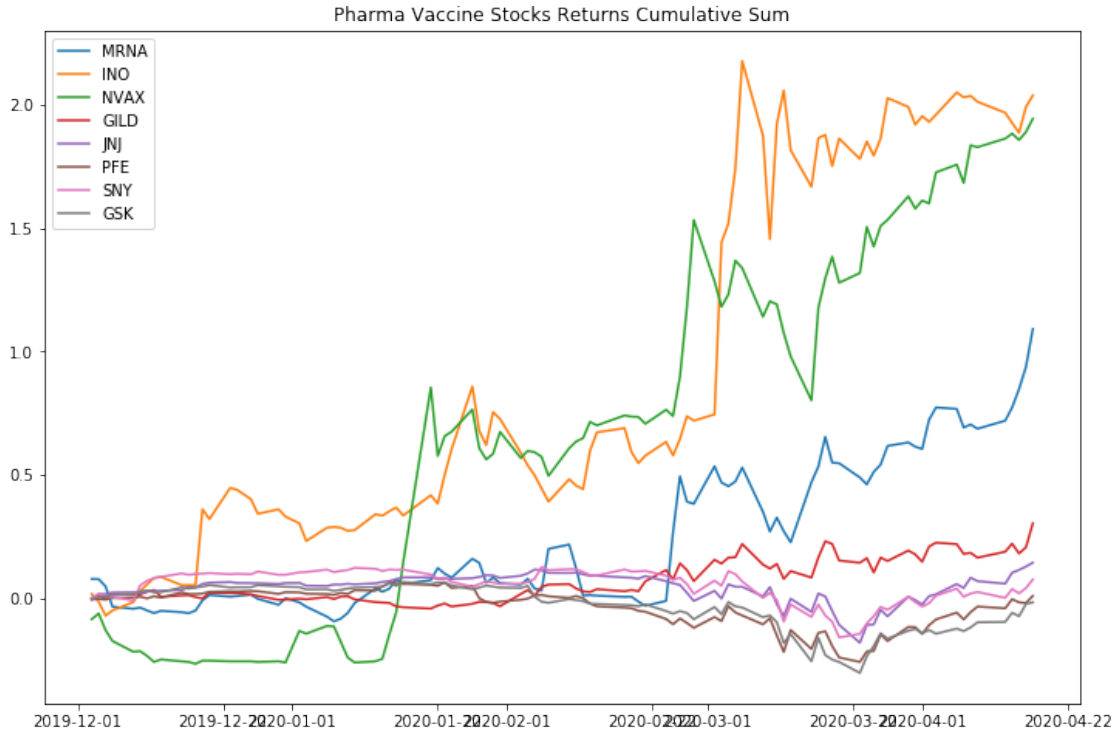
[13]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets)
plt.title('Pharma Vaccine Stocks Returns')
plt.legend(labels=stock_rets.columns)
```

[13]: <matplotlib.legend.Legend at 0x29458d3fbe0>

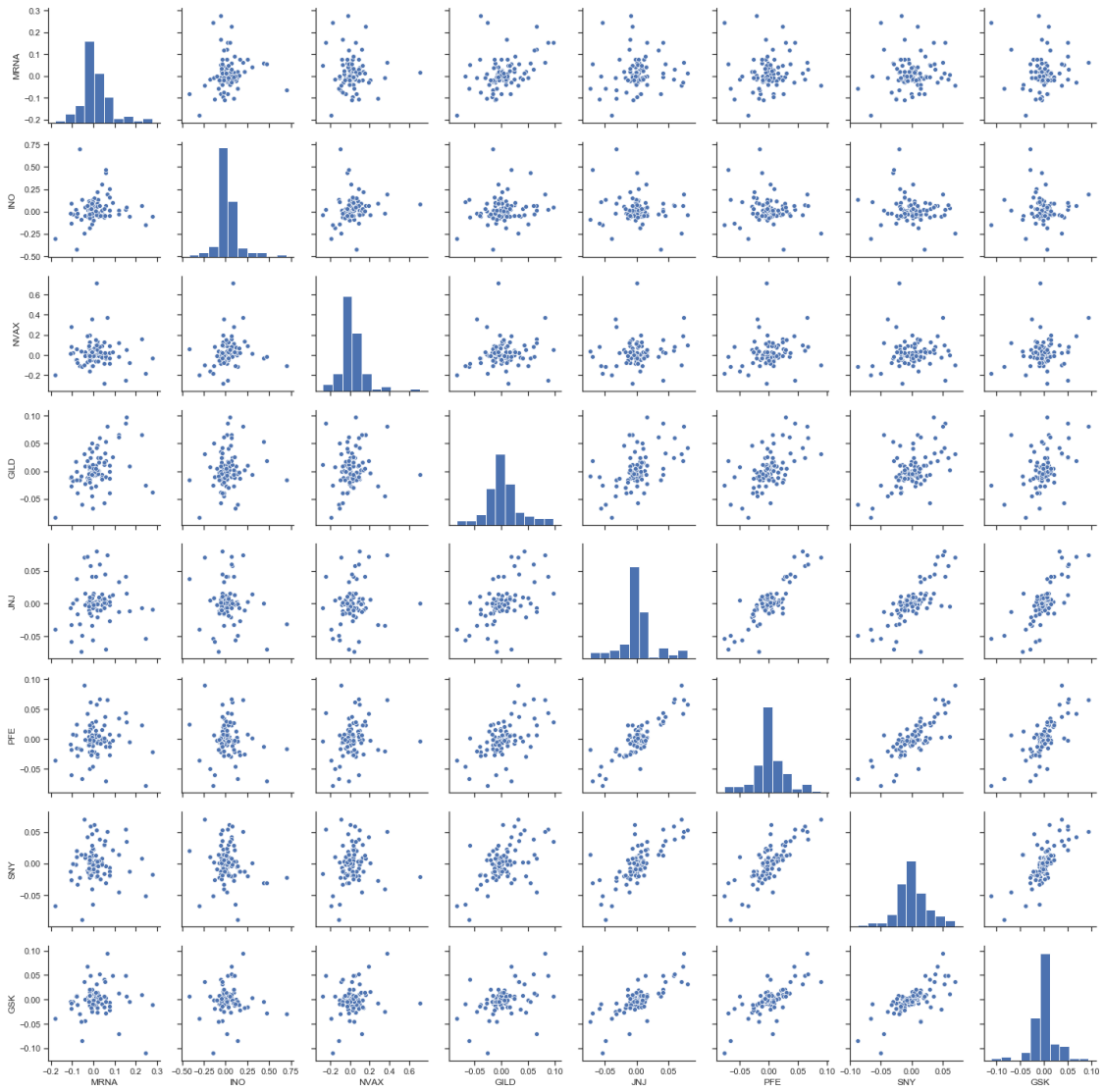


[14]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets.cumsum())
plt.title('Pharma Vaccine Stocks Returns Cumulative Sum')
plt.legend(labels=stock_rets.columns)
```

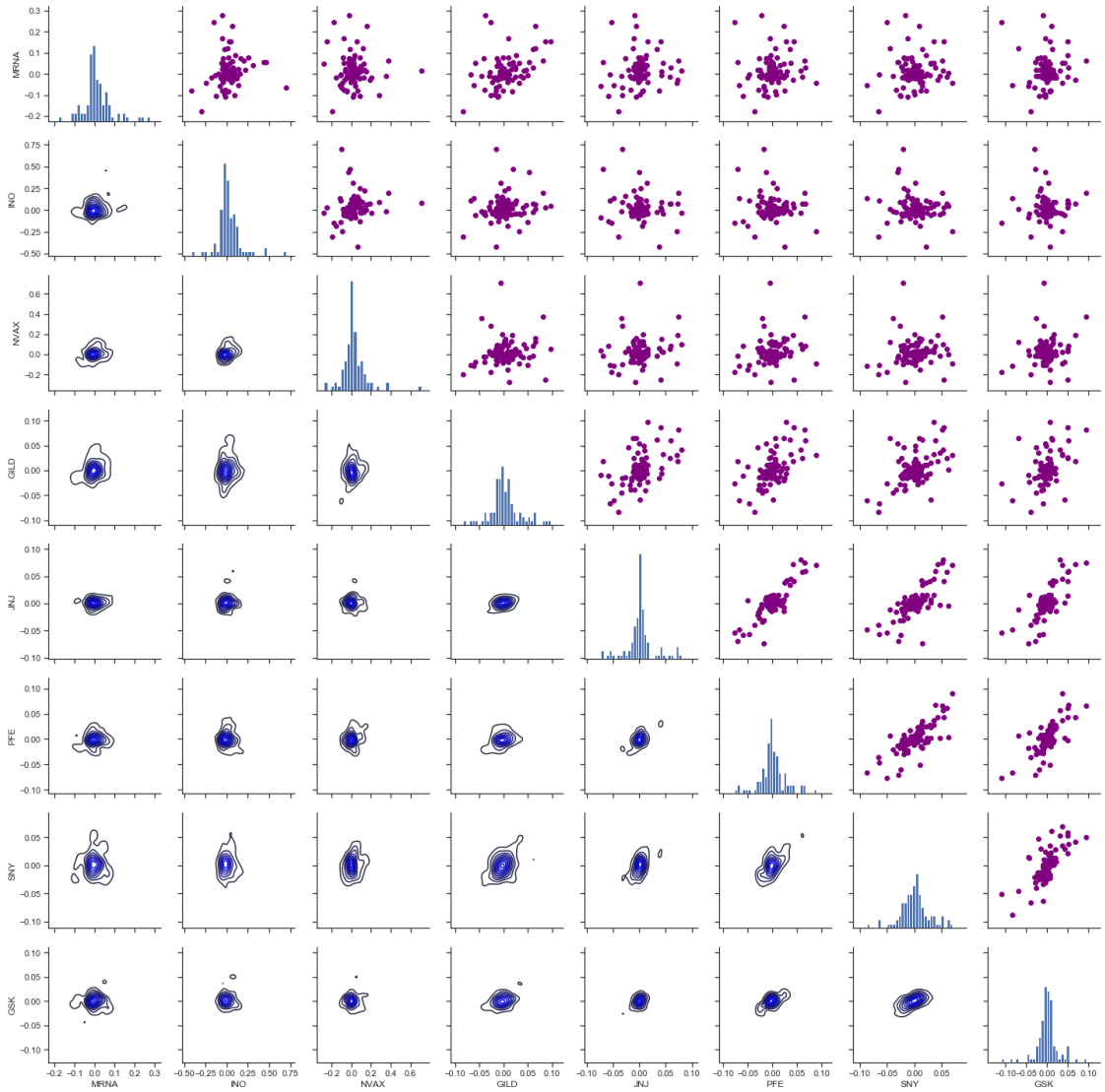
[14]: <matplotlib.legend.Legend at 0x29458da27f0>



[15]:
```
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)
```

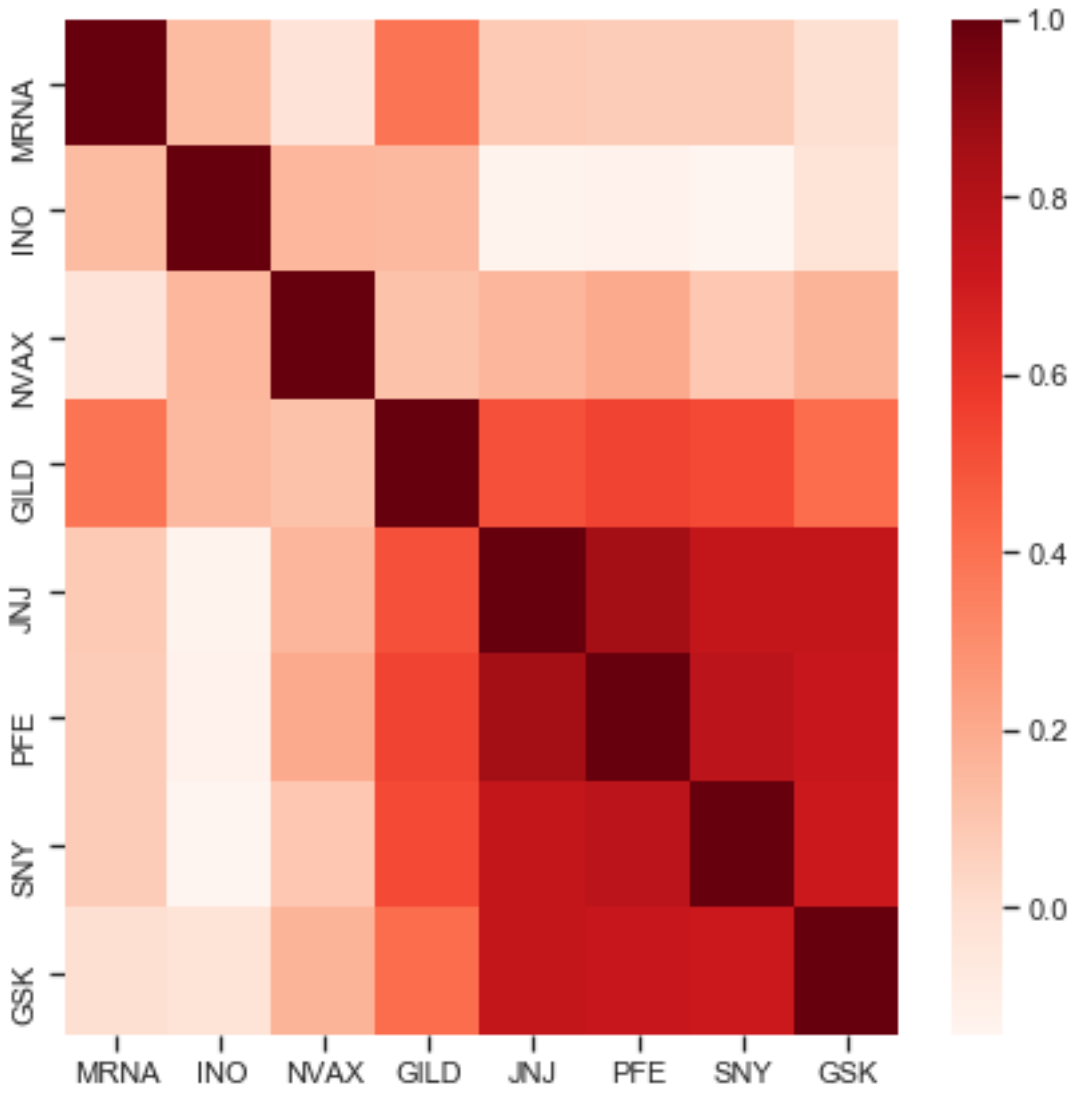


[16]:
```
ax = sns.PairGrid(stock_rets)
ax.map_upper(plt.scatter, color='purple')
ax.map_lower(sns.kdeplot, color='blue')
ax.map_diag(plt.hist, bins=30)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```



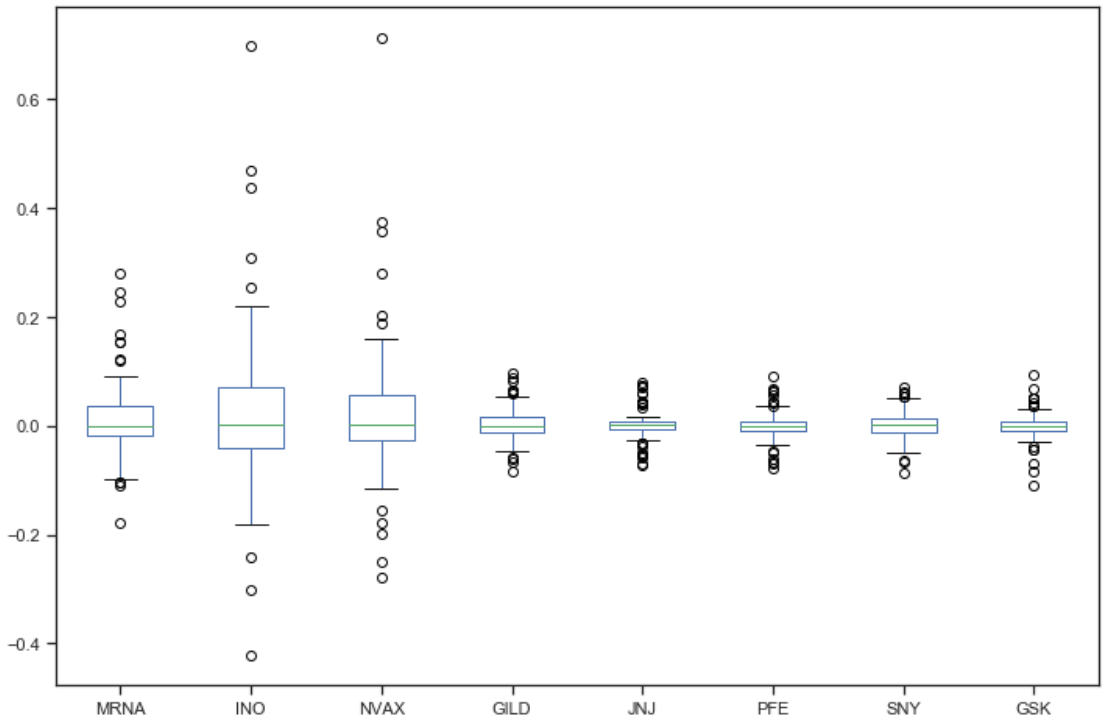
[17]:
```
plt.figure(figsize=(7,7))
corr = stock_rets.corr()

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

[17]: <matplotlib.axes._subplots.AxesSubplot at 0x2945c523668>

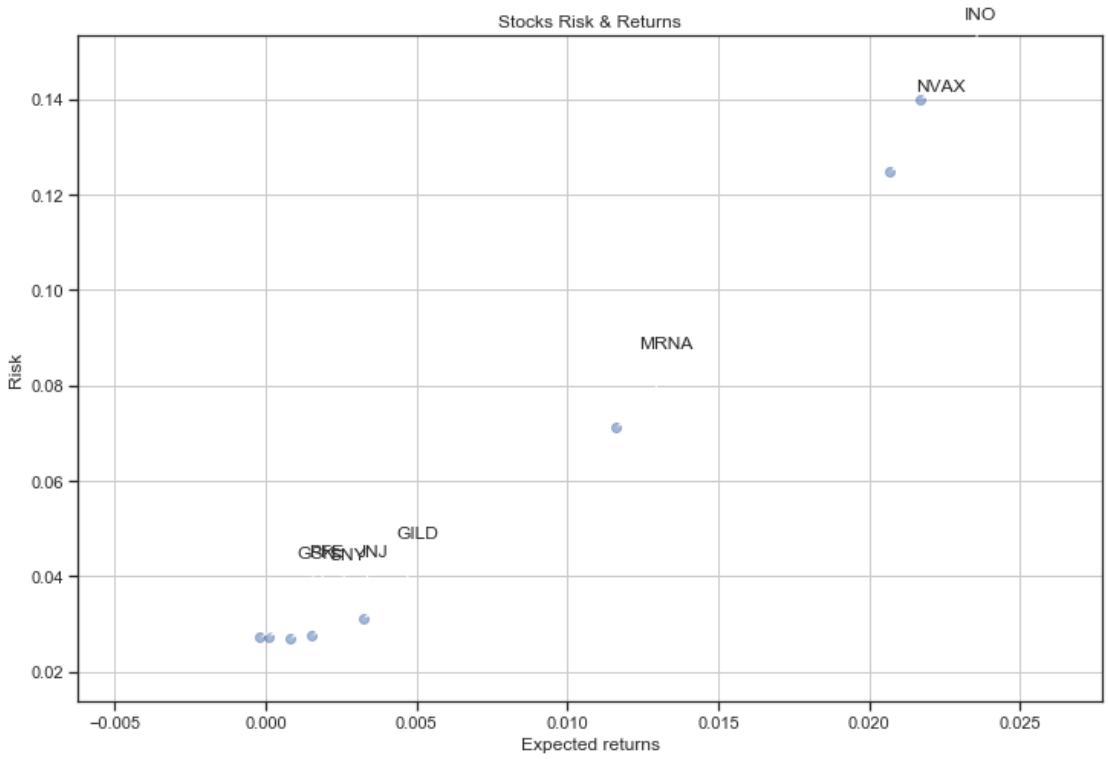


[18]:
```
# Box plot
stock_rets.plot(kind='box',figsize=(12,8))
```

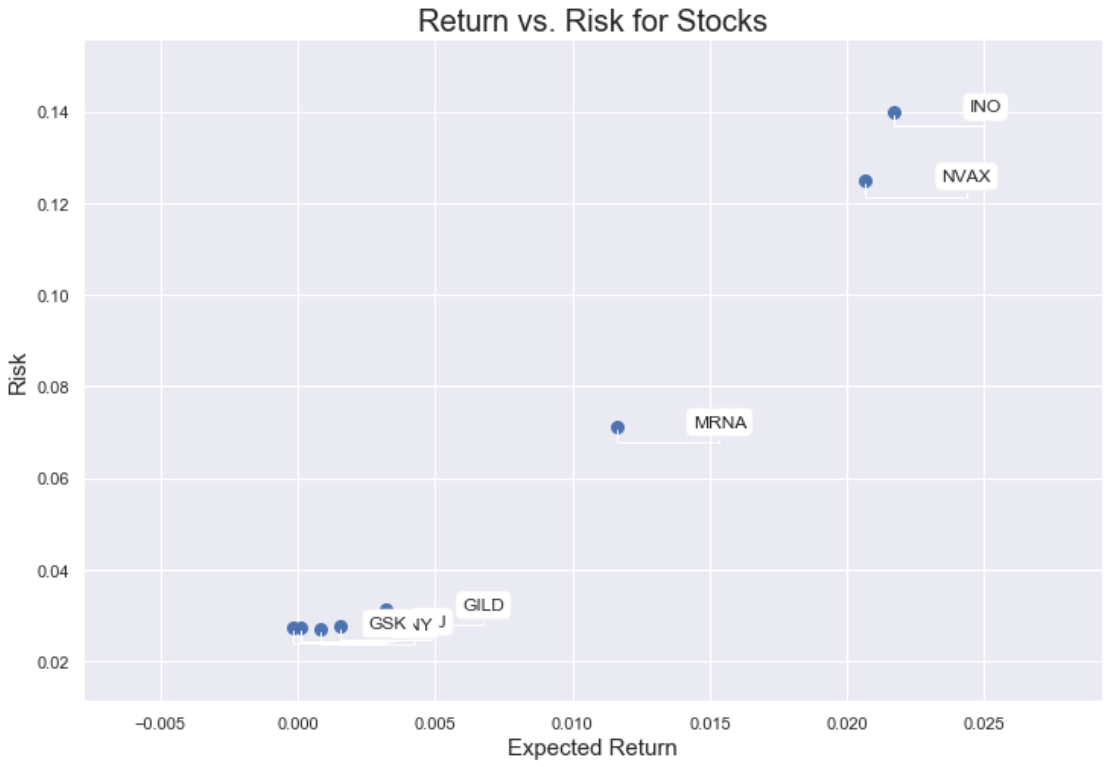
[18]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x294606bb2b0>
```



[19]:
```
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'))
```



[20]:
```
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"))
```



[21]:
```
rest_rets = rets.corr()
pair_value = rest_rets.abs().unstack()
pair_value.sort_values(ascending = False)
```

[21]:
```
GSK   GSK     1.000000
SNY   SNY     1.000000
INO   INO     1.000000
NVAX  NVAX    1.000000
GILD  GILD    1.000000
JNJ   JNJ     1.000000
PFE   PFE     1.000000
MRNA  MRNA    1.000000
PFE   JNJ     0.861104
JNJ   PFE     0.861104
PFE   SNY     0.773973
SNY   PFE     0.773973
GSK   JNJ     0.748842
JNJ   GSK     0.748842
      SNY     0.741214
SNY   JNJ     0.741214
PFE   GSK     0.724004
GSK   PFE     0.724004
      SNY     0.718149
```

```
SNY   GSK     0.718149
GILD  PFE     0.548195
PFE   GILD    0.548195
SNY   GILD    0.530566
GILD  SNY     0.530566
      JNJ     0.508266
JNJ   GILD    0.508266
GSK   GILD    0.415257
GILD  GSK     0.415257
MRNA  GILD    0.388209
GILD  MRNA    0.388209
                 …
NVAX  JNJ     0.161689
JNJ   NVAX    0.161689
INO   NVAX    0.158875
NVAX  INO     0.158875
GILD  INO     0.148613
INO   GILD    0.148613
      SNY     0.143877
SNY   INO     0.143877
MRNA  INO     0.138433
INO   MRNA    0.138433
JNJ   INO     0.128131
INO   JNJ     0.128131
      PFE     0.121590
PFE   INO     0.121590
GILD  NVAX    0.119585
NVAX  GILD    0.119585
      SNY     0.095427
SNY   NVAX    0.095427
JNJ   MRNA    0.084960
MRNA  JNJ     0.084960
PFE   MRNA    0.076733
MRNA  PFE     0.076733
SNY   MRNA    0.075363
MRNA  SNY     0.075363
NVAX  MRNA    0.025567
MRNA  NVAX    0.025567
INO   GSK     0.022506
GSK   INO     0.022506
MRNA  GSK     0.000692
GSK   MRNA    0.000692
Length: 64, dtype: float64
```

[22]:
```
# Normalized Returns Data
Normalized_Value = ((rets[:] - rets[:].min()) /(rets[:].max() - rets[:].min()))
Normalized_Value.head()
```

[22]:
```
                MRNA       INO      NVAX      GILD       JNJ       PFE  \
Date
2019-12-03  0.560520  0.390338  0.193969  0.457627  0.467620  0.425739
2019-12-04  0.391456  0.347992  0.304473  0.518717  0.582954  0.477449
2019-12-05  0.327780  0.325339  0.212763  0.393884  0.485582  0.446007
2019-12-06  0.212560  0.395282  0.236698  0.558254  0.515552  0.504231
2019-12-09  0.374029  0.406161  0.236979  0.449443  0.482727  0.467975

                SNY       GSK
Date
2019-12-03  0.519081  0.508605
2019-12-04  0.704538  0.584934
2019-12-05  0.484243  0.554183
2019-12-06  0.549652  0.571410
2019-12-09  0.455701  0.551892
```

[23]:
```
Normalized_Value.corr()
```

[23]:
```
           MRNA       INO      NVAX      GILD       JNJ       PFE       SNY  \
MRNA   1.000000  0.138433 -0.025567  0.388209  0.084960  0.076733  0.075363
INO    0.138433  1.000000  0.158875  0.148613 -0.128131 -0.121590 -0.143877
NVAX -0.025567  0.158875  1.000000  0.119585  0.161689  0.201658  0.095427
GILD   0.388209  0.148613  0.119585  1.000000  0.508266  0.548195  0.530566
JNJ    0.084960 -0.128131  0.161689  0.508266  1.000000  0.861104  0.741214
PFE    0.076733 -0.121590  0.201658  0.548195  0.861104  1.000000  0.773973
SNY    0.075363 -0.143877  0.095427  0.530566  0.741214  0.773973  1.000000
GSK   -0.000692 -0.022506  0.168451  0.415257  0.748842  0.724004  0.718149

            GSK
MRNA -0.000692
INO  -0.022506
NVAX  0.168451
GILD  0.415257
JNJ   0.748842
PFE   0.724004
SNY   0.718149
GSK   1.000000
```

[24]:
```
normalized_rets = Normalized_Value.corr()
normalized_pair_value = normalized_rets.abs().unstack()
normalized_pair_value.sort_values(ascending = False)
```

[24]:
```
GSK   GSK     1.000000
SNY   SNY     1.000000
INO   INO     1.000000
NVAX  NVAX    1.000000
GILD  GILD    1.000000
```

```
JNJ   JNJ     1.000000
PFE   PFE     1.000000
MRNA  MRNA    1.000000
PFE   JNJ     0.861104
JNJ   PFE     0.861104
PFE   SNY     0.773973
SNY   PFE     0.773973
GSK   JNJ     0.748842
JNJ   GSK     0.748842
      SNY     0.741214
SNY   JNJ     0.741214
PFE   GSK     0.724004
GSK   PFE     0.724004
      SNY     0.718149
SNY   GSK     0.718149
GILD  PFE     0.548195
PFE   GILD    0.548195
SNY   GILD    0.530566
GILD  SNY     0.530566
      JNJ     0.508266
JNJ   GILD    0.508266
GSK   GILD    0.415257
GILD  GSK     0.415257
MRNA  GILD    0.388209
GILD  MRNA    0.388209
                …
NVAX  JNJ     0.161689
JNJ   NVAX    0.161689
INO   NVAX    0.158875
NVAX  INO     0.158875
GILD  INO     0.148613
INO   GILD    0.148613
      SNY     0.143877
SNY   INO     0.143877
MRNA  INO     0.138433
INO   MRNA    0.138433
JNJ   INO     0.128131
INO   JNJ     0.128131
      PFE     0.121590
PFE   INO     0.121590
GILD  NVAX    0.119585
NVAX  GILD    0.119585
      SNY     0.095427
SNY   NVAX    0.095427
JNJ   MRNA    0.084960
MRNA  JNJ     0.084960
PFE   MRNA    0.076733
```

```
MRNA  PFE     0.076733
SNY   MRNA    0.075363
MRNA  SNY     0.075363
NVAX  MRNA    0.025567
MRNA  NVAX    0.025567
INO   GSK     0.022506
GSK   INO     0.022506
MRNA  GSK     0.000692
GSK   MRNA    0.000692
Length: 64, dtype: float64
```

[25]:
```
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risks:")
print(rets.std())
```

```
Stock returns:
MRNA    0.011607
INO     0.021686
NVAX    0.020682
GILD    0.003224
JNJ     0.001522
PFE     0.000088
SNY     0.000800
GSK    -0.000191
dtype: float64
--------------------------------------------------
Stock risks:
MRNA    0.071217
INO     0.139997
NVAX    0.124842
GILD    0.031218
JNJ     0.027595
PFE     0.027393
SNY     0.026974
GSK     0.027188
dtype: float64
```

[26]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[26]:

	Returns	Risk
GSK	-0.000191	0.027188
PFE	0.000088	0.027393

```
SNY   0.000800  0.026974
JNJ   0.001522  0.027595
GILD  0.003224  0.031218
MRNA  0.011607  0.071217
NVAX  0.020682  0.124842
INO   0.021686  0.139997
```

[27]:
```
table.sort_values(by='Risk')
```

[27]:
```
       Returns      Risk
SNY   0.000800  0.026974
GSK  -0.000191  0.027188
PFE   0.000088  0.027393
JNJ   0.001522  0.027595
GILD  0.003224  0.031218
MRNA  0.011607  0.071217
NVAX  0.020682  0.124842
INO   0.021686  0.139997
```

[28]:
```
rf = 0.01
table['Sharpe Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[28]:
```
       Returns      Risk  Sharpe Ratio
MRNA  0.011607  0.071217      0.022566
INO   0.021686  0.139997      0.083475
NVAX  0.020682  0.124842      0.085561
GILD  0.003224  0.031218     -0.217069
JNJ   0.001522  0.027595     -0.307241
PFE   0.000088  0.027393     -0.361833
SNY   0.000800  0.026974     -0.341075
GSK  -0.000191  0.027188     -0.374827
```

[29]:
```
table['Max Returns'] = rets.max()
```

[30]:
```
table['Min Returns'] = rets.min()
```

[31]:
```
table['Median Returns'] = rets.median()
```

[32]:
```
total_return = stock_rets[-1:].transpose()
table['Total Return'] = 100 * total_return
table
```

[32]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
```

```
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436

      Median Returns  Total Return
MRNA       -0.001416     15.394089
INO         0.003205      4.689485
NVAX        0.001202      5.414362
GILD       -0.000844      9.733469
JNJ         0.000477      1.570125
PFE        -0.001499      2.870677
SNY         0.001084      3.511812
GSK         0.000322      0.645934
```

[33]:
```
table['Average Return Days'] = (1 + total_return)**(1 / days) - 1
table
```

[33]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436

      Median Returns  Total Return  Average Return Days
MRNA       -0.001416     15.394089             0.001046
INO         0.003205      4.689485             0.000335
NVAX        0.001202      5.414362             0.000385
GILD       -0.000844      9.733469             0.000678
JNJ         0.000477      1.570125             0.000114
PFE        -0.001499      2.870677             0.000207
SNY         0.001084      3.511812             0.000252
GSK         0.000322      0.645934             0.000047
```

[34]:
```
initial_value = df.iloc[0]
ending_value = df.iloc[-1]
table['CAGR'] = ((ending_value / initial_value) ** (252.0 / days)) -1
table
```

[34]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
```

```
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436

      Median Returns  Total Return  Average Return Days      CAGR
MRNA       -0.001416     15.394089              0.001046  3.893715
INO         0.003205      4.689485              0.000335  7.944202
NVAX        0.001202      5.414362              0.000385  9.849802
GILD       -0.000844      9.733469              0.000678  0.606831
JNJ         0.000477      1.570125              0.000114  0.219232
PFE        -0.001499      2.870677              0.000207 -0.047651
SNY         0.001084      3.511812              0.000252  0.078845
GSK         0.000322      0.645934              0.000047 -0.092300
```

[35]:
```
table.sort_values(by='Average Return Days')
```

[35]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669

      Median Returns  Total Return  Average Return Days      CAGR
GSK         0.000322      0.645934              0.000047 -0.092300
JNJ         0.000477      1.570125              0.000114  0.219232
PFE        -0.001499      2.870677              0.000207 -0.047651
SNY         0.001084      3.511812              0.000252  0.078845
INO         0.003205      4.689485              0.000335  7.944202
NVAX        0.001202      5.414362              0.000385  9.849802
GILD       -0.000844      9.733469              0.000678  0.606831
MRNA       -0.001416     15.394089              0.001046  3.893715
```