TP1 - Chloe Constantineau, Augustin Commun

March 8, 2019

In [158]:
```
# Download Data from Yahoo Finance
import datetime
import matplotlib.pyplot as plt
from pandas_datareader import data as pdr
import pandas as pd
import fix_yahoo_finance as yf # This is a fix for getting series from Yahoo

yf.pdr_override() # This fix the problem
start_sp = datetime.datetime(2008,12,31)
end_sp = datetime.datetime(2018,12,31)

# Dow Jones index
# 1st Dow Jones Index + 30 components
dow30 = ['^DJI','AXP', 'AAPL', 'BA', 'CAT', 'CSCO', 'CVX', 'DWDP', 'XOM',
         'GE', 'GS', 'HD', 'IBM', 'INTC', 'JNJ', 'KO', 'JPM',
         'MCD', 'MMM', 'MRK', 'MSFT', 'NKE', 'PFE', 'PG',
         'TRV', 'UNH', 'UTX', 'VZ', 'V', 'WMT', 'DIS']

dow30 = sorted(dow30)

adj_close = pdr.get_data_yahoo(dow30, start_sp, end_sp)['Adj Close']
```

```
[*********************100%***********************]  31 of 31 downloaded
```

In [145]:
```
# 1.1 a) Rendements quotidiens

# Comme il n'y a pas eu de dividende versé pour ces stocks pour la période selection
# le rendement quotidien n'a pas été ajuste en fonction du dividende

stock_returns = dict()

for ticker in dow30:
    stock_returns[ticker] = adj_close[ticker].pct_change(1)
    print(stock_returns[ticker])
```

```
Date
2008-12-31          NaN
```

2009-01-02	0.063269
2009-01-05	0.042204
2009-01-06	-0.016494
2009-01-07	-0.021608
2009-01-08	0.018570
2009-01-09	-0.022870
2009-01-12	-0.021197
2009-01-13	-0.010715
2009-01-14	-0.027135
2009-01-15	-0.022853
2009-01-16	-0.012592
2009-01-20	-0.050164
2009-01-21	0.059207
2009-01-22	0.066763
2009-01-23	0.000000
2009-01-26	0.014486
2009-01-27	0.012160
2009-01-28	0.038246
2009-01-29	-0.012739
2009-01-30	-0.030860
2009-02-02	0.015311
2009-02-03	0.016064
2009-02-04	0.006130
2009-02-05	0.031106
2009-02-06	0.033797
2009-02-09	0.027978
2009-02-10	-0.045654
2009-02-11	-0.010324
2009-02-12	0.025305
	...
2018-11-15	0.024679
2018-11-16	0.011076
2018-11-19	-0.039632
2018-11-20	-0.047778
2018-11-21	-0.001130
2018-11-23	-0.025399
2018-11-26	0.013524
2018-11-27	-0.002176
2018-11-28	0.038453
2018-11-29	-0.007682
2018-11-30	-0.005402
2018-12-03	0.034942
2018-12-04	-0.043989
2018-12-06	-0.011150
2018-12-07	-0.035657
2018-12-10	0.006588
2018-12-11	-0.005719
2018-12-12	0.002787

```
2018-12-13    0.010940
2018-12-14   -0.031998
2018-12-17   -0.009306
2018-12-18    0.012993
2018-12-19   -0.031192
2018-12-20   -0.025235
2018-12-21   -0.038896
2018-12-24   -0.025874
2018-12-26    0.070422
2018-12-27   -0.006490
2018-12-28    0.000512
2018-12-31    0.009665
Name: AAPL, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.042049
2009-01-05    0.032075
2009-01-06    0.056140
2009-01-07   -0.042125
2009-01-08    0.001499
2009-01-09   -0.040419
2009-01-12   -0.020801
2009-01-13    0.008497
2009-01-14   -0.061085
2009-01-15   -0.028603
2009-01-16   -0.017898
2009-01-20   -0.082892
2009-01-21    0.081410
2009-01-22   -0.048014
2009-01-23   -0.003736
2009-01-26   -0.050000
2009-01-27    0.097368
2009-01-28    0.070144
2009-01-29   -0.063866
2009-01-30    0.001197
2009-02-02    0.014943
2009-02-03   -0.052415
2009-02-04    0.016781
2009-02-05    0.040953
2009-02-06    0.052848
2009-02-09   -0.010039
2009-02-10   -0.100281
2009-02-11    0.024421
2009-02-12   -0.010391
                 ...
2018-11-15    0.016981
2018-11-16   -0.001277
2018-11-19   -0.011054
```

```
2018-11-20   -0.019954
2018-11-21    0.003865
2018-11-23   -0.007136
2018-11-26    0.037261
2018-11-27    0.003920
2018-11-28    0.025247
2018-11-29   -0.013996
2018-11-30    0.008625
2018-12-03    0.000802
2018-12-04   -0.042008
2018-12-06    0.005667
2018-12-07   -0.014504
2018-12-10   -0.008343
2018-12-11   -0.003687
2018-12-12    0.019734
2018-12-13   -0.007257
2018-12-14   -0.009372
2018-12-17   -0.042762
2018-12-18   -0.001581
2018-12-19   -0.022273
2018-12-20   -0.030374
2018-12-21   -0.046361
2018-12-24   -0.020037
2018-12-26    0.048492
2018-12-27    0.008951
2018-12-28   -0.002746
2018-12-31    0.009532
Name: AXP, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.060464
2009-01-05    0.020331
2009-01-06    0.003033
2009-01-07   -0.033470
2009-01-08    0.000670
2009-01-09   -0.007591
2009-01-12   -0.015973
2009-01-13   -0.029263
2009-01-14   -0.029675
2009-01-15   -0.005825
2009-01-16    0.036621
2009-01-20   -0.049459
2009-01-21    0.047325
2009-01-22   -0.000237
2009-01-23   -0.006626
2009-01-26    0.024536
2009-01-27    0.004882
2009-01-28    0.000463
```

```
2009-01-29   -0.058511
2009-01-30    0.039303
2009-02-02   -0.035689
2009-02-03    0.031618
2009-02-04    0.007200
2009-02-05    0.017870
2009-02-06    0.004682
2009-02-09   -0.002796
2009-02-10   -0.060514
2009-02-11    0.002985
2009-02-12   -0.011654
                 ...
2018-11-15   -0.009138
2018-11-16   -0.016453
2018-11-19   -0.044679
2018-11-20   -0.010095
2018-11-21   -0.001196
2018-11-23   -0.015757
2018-11-26    0.012935
2018-11-27    0.005279
2018-11-28    0.048643
2018-11-29    0.027166
2018-11-30    0.012261
2018-12-03    0.038067
2018-12-04   -0.048505
2018-12-06   -0.030949
2018-12-07   -0.026152
2018-12-10    0.009684
2018-12-11   -0.013237
2018-12-12    0.014471
2018-12-13   -0.003734
2018-12-14   -0.020647
2018-12-17   -0.008220
2018-12-18    0.037738
2018-12-19   -0.025940
2018-12-20   -0.020341
2018-12-21   -0.027152
2018-12-24   -0.034116
2018-12-26    0.067208
2018-12-27    0.010225
2018-12-28   -0.002396
2018-12-31    0.019344
Name: BA, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.050146
2009-01-05   -0.017694
2009-01-06   -0.006076
```

```
2009-01-07   -0.046507
2009-01-08    0.008015
2009-01-09   -0.018628
2009-01-12   -0.046528
2009-01-13    0.005099
2009-01-14   -0.049517
2009-01-15    0.011816
2009-01-16    0.004062
2009-01-20   -0.031100
2009-01-21    0.032098
2009-01-22   -0.058660
2009-01-23   -0.042170
2009-01-26   -0.083848
2009-01-27   -0.010713
2009-01-28    0.021040
2009-01-29   -0.034849
2009-01-30   -0.031397
2009-02-02   -0.018152
2009-02-03   -0.009904
2009-02-04    0.020341
2009-02-05    0.033006
2009-02-06    0.052831
2009-02-09   -0.016827
2009-02-10   -0.055012
2009-02-11    0.006792
2009-02-12   -0.003534
                 ...
2018-11-15    0.034532
2018-11-16    0.004172
2018-11-19   -0.030625
2018-11-20   -0.029449
2018-11-21    0.013086
2018-11-23   -0.012513
2018-11-26    0.020275
2018-11-27   -0.001603
2018-11-28    0.049518
2018-11-29   -0.004129
2018-11-30    0.041772
2018-12-03    0.024176
2018-12-04   -0.069305
2018-12-06   -0.007346
2018-12-07   -0.037548
2018-12-10   -0.001295
2018-12-11   -0.001216
2018-12-12    0.017283
2018-12-13    0.004227
2018-12-14    0.006910
2018-12-17   -0.018143
```

```
2018-12-18   -0.001607
2018-12-19   -0.015611
2018-12-20   -0.006376
2018-12-21   -0.012176
2018-12-24   -0.025985
2018-12-26    0.066781
2018-12-27    0.015309
2018-12-28   -0.008368
2018-12-31    0.011623
Name: CAT, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.040491
2009-01-05    0.008845
2009-01-06    0.039743
2009-01-07   -0.026419
2009-01-08    0.012702
2009-01-09   -0.047891
2009-01-12   -0.017964
2009-01-13    0.003049
2009-01-14   -0.043161
2009-01-15    0.004447
2009-01-16    0.000632
2009-01-20   -0.051201
2009-01-21    0.045970
2009-01-22   -0.021019
2009-01-23    0.033832
2009-01-26    0.025802
2009-01-27    0.026380
2009-01-28    0.008966
2009-01-29   -0.056280
2009-01-30   -0.060264
2009-02-02    0.022712
2009-02-03    0.020248
2009-02-04    0.014084
2009-02-05    0.032197
2009-02-06    0.042202
2009-02-09   -0.011150
2009-02-10   -0.047477
2009-02-11    0.007477
2009-02-12    0.001855
                 ...
2018-11-15    0.055042
2018-11-16   -0.008980
2018-11-19   -0.012945
2018-11-20   -0.027541
2018-11-21    0.008991
2018-11-23   -0.007797
```

```
2018-11-26    0.023125
2018-11-27    0.012069
2018-11-28    0.025369
2018-11-29    0.001057
2018-11-30    0.011196
2018-12-03    0.018174
2018-12-04   -0.028519
2018-12-06    0.021964
2018-12-07   -0.040298
2018-12-10    0.009044
2018-12-11    0.004908
2018-12-12    0.007008
2018-12-13    0.001055
2018-12-14   -0.034759
2018-12-17   -0.035356
2018-12-18   -0.003167
2018-12-19   -0.020881
2018-12-20   -0.015067
2018-12-21   -0.015062
2018-12-24   -0.037515
2018-12-26    0.054369
2018-12-27    0.010360
2018-12-28   -0.003263
2018-12-31    0.013093
Name: CSCO, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.034474
2009-01-05    0.001829
2009-01-06    0.009000
2009-01-07   -0.043827
2009-01-08    0.003786
2009-01-09   -0.019127
2009-01-12   -0.027465
2009-01-13    0.014120
2009-01-14   -0.029657
2009-01-15    0.015497
2009-01-16    0.013706
2009-01-20   -0.047811
2009-01-21    0.042746
2009-01-22   -0.017970
2009-01-23    0.012437
2009-01-26    0.006636
2009-01-27    0.011222
2009-01-28    0.023582
2009-01-29   -0.042960
2009-01-30   -0.001416
2009-02-02   -0.003261
```

```
2009-02-03    0.019206
2009-02-04   -0.000559
2009-02-05    0.023045
2009-02-06    0.022526
2009-02-09   -0.006409
2009-02-10   -0.044343
2009-02-11    0.001968
2009-02-12   -0.010622
                 ...
2018-11-15    0.020506
2018-11-16    0.018042
2018-11-19    0.003024
2018-11-20   -0.027801
2018-11-21    0.012662
2018-11-23   -0.033767
2018-11-26    0.012148
2018-11-27    0.002000
2018-11-28    0.025432
2018-11-29    0.006010
2018-11-30    0.000757
2018-12-03    0.014545
2018-12-04   -0.028425
2018-12-06   -0.011344
2018-12-07   -0.003624
2018-12-10   -0.004762
2018-12-11    0.004611
2018-12-12    0.001299
2018-12-13    0.002768
2018-12-14   -0.018199
2018-12-17   -0.012123
2018-12-18   -0.024100
2018-12-19   -0.017405
2018-12-20   -0.026430
2018-12-21   -0.007335
2018-12-24   -0.030899
2018-12-26    0.063373
2018-12-27    0.017972
2018-12-28   -0.006129
2018-12-31    0.001289
Name: CVX, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.054209
2009-01-05   -0.017558
2009-01-06    0.034468
2009-01-07   -0.046483
2009-01-08   -0.012079
2009-01-09   -0.025764
```

```
2009-01-12   -0.020170
2009-01-13   -0.030192
2009-01-14   -0.018868
2009-01-15    0.026923
2009-01-16    0.004682
2009-01-20   -0.056850
2009-01-21    0.048913
2009-01-22   -0.012247
2009-01-23   -0.017167
2009-01-26    0.012130
2009-01-27    0.018696
2009-01-28    0.048470
2009-01-29   -0.046230
2009-01-30   -0.026824
2009-02-02   -0.023211
2009-02-03    0.020792
2009-02-04   -0.078565
2009-02-05   -0.015263
2009-02-06    0.039551
2009-02-09   -0.000514
2009-02-10   -0.034979
2009-02-11   -0.013859
2009-02-12    0.017838
                 ...
2018-11-15   -0.000085
2018-11-16   -0.007856
2018-11-19   -0.006627
2018-11-20   -0.030757
2018-11-21    0.010369
2018-11-23   -0.008405
2018-11-26    0.004193
2018-11-27    0.011995
2018-11-28    0.019315
2018-11-29    0.004393
2018-11-30   -0.009605
2018-12-03    0.002165
2018-12-04   -0.024797
2018-12-06    0.012935
2018-12-07   -0.012957
2018-12-10   -0.001072
2018-12-11    0.000983
2018-12-12    0.002143
2018-12-13    0.010516
2018-12-14   -0.010495
2018-12-17   -0.014082
2018-12-18   -0.010577
2018-12-19   -0.002101
2018-12-20   -0.020326
```

```
2018-12-21   -0.025981
2018-12-24   -0.037133
2018-12-26    0.054609
2018-12-27    0.006520
2018-12-28    0.007323
2018-12-31    0.021901
Name: DIS, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.021206
2009-01-05   -0.023361
2009-01-06    0.066445
2009-01-07    0.001869
2009-01-08   -0.016791
2009-01-09    0.000000
2009-01-12   -0.003163
2009-01-13   -0.013325
2009-01-14   -0.028296
2009-01-15    0.005957
2009-01-16   -0.011184
2009-01-20   -0.075848
2009-01-21    0.066955
2009-01-22   -0.029690
2009-01-23   -0.003477
2009-01-26   -0.076064
2009-01-27   -0.003776
2009-01-28    0.018954
2009-01-29   -0.084077
2009-01-30   -0.058489
2009-02-02   -0.046592
2009-02-03    0.027149
2009-02-04   -0.051102
2009-02-05    0.012999
2009-02-06   -0.002750
2009-02-09   -0.021140
2009-02-10   -0.028169
2009-02-11   -0.029952
2009-02-12    0.000000
                 ...
2018-11-15    0.012935
2018-11-16    0.007832
2018-11-19   -0.023484
2018-11-20   -0.024740
2018-11-21    0.010644
2018-11-23   -0.009479
2018-11-26    0.021797
2018-11-27   -0.008325
2018-11-28    0.000700
```

```
2018-11-29    0.007037
2018-11-30    0.010657
2018-12-03    0.022645
2018-12-04   -0.045132
2018-12-06   -0.010090
2018-12-07   -0.038805
2018-12-10    0.000930
2018-12-11   -0.010037
2018-12-12    0.020466
2018-12-13   -0.010488
2018-12-14   -0.018594
2018-12-17   -0.020841
2018-12-18    0.011803
2018-12-19   -0.002486
2018-12-20   -0.021472
2018-12-21   -0.008817
2018-12-24   -0.029650
2018-12-26    0.063964
2018-12-27    0.021061
2018-12-28   -0.005813
2018-12-31    0.008676
Name: DWDP, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.053704
2009-01-05   -0.025776
2009-01-06    0.013830
2009-01-07   -0.044484
2009-01-08    0.001862
2009-01-09   -0.008674
2009-01-12   -0.010625
2009-01-13   -0.056222
2009-01-14   -0.055556
2009-01-15   -0.024096
2009-01-16    0.013798
2009-01-20   -0.073782
2009-01-21    0.007734
2009-01-22    0.034535
2009-01-23   -0.107567
2009-01-26    0.032419
2009-01-27    0.051530
2009-01-28    0.033691
2009-01-29   -0.057778
2009-01-30   -0.046384
2009-02-02   -0.042045
2009-02-03   -0.021514
2009-02-04   -0.009675
2009-02-05   -0.036412
```

```
2009-02-06    0.023041
2009-02-09    0.138739
2009-02-10   -0.080696
2009-02-11    0.027539
2009-02-12   -0.021776
                ...
2018-11-15   -0.018029
2018-11-16   -0.018360
2018-11-19   -0.022444
2018-11-20   -0.024235
2018-11-21    0.020915
2018-11-23   -0.030730
2018-11-26    0.001321
2018-11-27   -0.018470
2018-11-28    0.040322
2018-11-29    0.025840
2018-11-30   -0.055416
2018-12-03    0.041333
2018-12-04   -0.067862
2018-12-06    0.009615
2018-12-07   -0.046259
2018-12-10   -0.011412
2018-12-11   -0.024531
2018-12-12   -0.007397
2018-12-13    0.073025
2018-12-14   -0.013889
2018-12-17    0.007042
2018-12-18    0.018182
2018-12-19    0.053703
2018-12-20   -0.028721
2018-12-21   -0.038978
2018-12-24   -0.032168
2018-12-26    0.067919
2018-12-27   -0.016238
2018-12-28    0.033012
2018-12-31    0.007989
Name: GE, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.028084
2009-01-05    0.023282
2009-01-06   -0.000788
2009-01-07   -0.047458
2009-01-08    0.010769
2009-01-09   -0.017445
2009-01-12   -0.074475
2009-01-13    0.003218
2009-01-14   -0.028619
```

```
2009-01-15   -0.024574
2009-01-16   -0.010565
2009-01-20   -0.189596
2009-01-21    0.180743
2009-01-22    0.016166
2009-01-23    0.054625
2009-01-26   -0.009478
2009-01-27    0.054717
2009-01-28    0.120624
2009-01-29   -0.056784
2009-01-30   -0.024057
2009-02-02    0.035179
2009-02-03   -0.009094
2009-02-04    0.062311
2009-02-05    0.055473
2009-02-06    0.040064
2009-02-09    0.013669
2009-02-10   -0.076514
2009-02-11    0.047677
2009-02-12    0.009186
                 ...
2018-11-15    0.006173
2018-11-16   -0.007951
2018-11-19   -0.019295
2018-11-20   -0.034709
2018-11-21    0.006585
2018-11-23   -0.018172
2018-11-26    0.027710
2018-11-27   -0.003550
2018-11-28    0.024271
2018-11-29   -0.013667
2018-11-30   -0.021350
2018-12-03    0.004930
2018-12-04   -0.038199
2018-12-06   -0.001194
2018-12-07   -0.024010
2018-12-10   -0.004675
2018-12-11   -0.011352
2018-12-12   -0.000566
2018-12-13   -0.004414
2018-12-14   -0.017906
2018-12-17   -0.027551
2018-12-18    0.020773
2018-12-19   -0.013120
2018-12-20   -0.004963
2018-12-21   -0.049641
2018-12-24   -0.023118
2018-12-26    0.042085
```

```
2018-12-27    0.015221
2018-12-28   -0.014389
2018-12-31    0.024658
Name: GS, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.048219
2009-01-05    0.024036
2009-01-06    0.022258
2009-01-07   -0.027316
2009-01-08   -0.007326
2009-01-09   -0.021730
2009-01-12   -0.037301
2009-01-13   -0.020026
2009-01-14   -0.026655
2009-01-15    0.041077
2009-01-16    0.017098
2009-01-20   -0.052155
2009-01-21    0.013188
2009-01-22   -0.013914
2009-01-23   -0.011379
2009-01-26    0.046501
2009-01-27   -0.026837
2009-01-28    0.039783
2009-01-29   -0.043478
2009-01-30   -0.021363
2009-02-02    0.001858
2009-02-03    0.016226
2009-02-04   -0.008667
2009-02-05    0.030833
2009-02-06    0.050447
2009-02-09   -0.018699
2009-02-10   -0.038112
2009-02-11   -0.003152
2009-02-12   -0.007227
                 ...
2018-11-15   -0.014119
2018-11-16   -0.001917
2018-11-19   -0.019376
2018-11-20   -0.026153
2018-11-21    0.001479
2018-11-23   -0.002658
2018-11-26    0.005745
2018-11-27    0.020021
2018-11-28    0.030431
2018-11-29   -0.009976
2018-11-30    0.026529
2018-12-03    0.007875
```

```
2018-12-04   -0.035435
2018-12-06    0.003765
2018-12-07   -0.018016
2018-12-10   -0.006366
2018-12-11    0.003029
2018-12-12    0.011614
2018-12-13   -0.001952
2018-12-14   -0.009087
2018-12-17   -0.025074
2018-12-18    0.012324
2018-12-19   -0.014585
2018-12-20   -0.020291
2018-12-21   -0.022417
2018-12-24   -0.014581
2018-12-26    0.064120
2018-12-27    0.012123
2018-12-28   -0.000587
2018-12-31    0.009400
Name: HD, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.038142
2009-01-05   -0.006295
2009-01-06    0.027758
2009-01-07   -0.016138
2009-01-08   -0.006948
2009-01-09   -0.028447
2009-01-12    0.011924
2009-01-13   -0.004316
2009-01-14   -0.025194
2009-01-15    0.011179
2009-01-16    0.009510
2009-01-20   -0.034621
2009-01-21    0.115150
2009-01-22   -0.014767
2009-01-23   -0.006440
2009-01-26    0.023578
2009-01-27    0.000655
2009-01-28    0.034475
2009-01-29   -0.024361
2009-01-30   -0.009296
2009-02-02   -0.007856
2009-02-03    0.028043
2009-02-04   -0.006953
2009-02-05   -0.004524
2009-02-06    0.046023
2009-02-09    0.007073
2009-02-10   -0.036666
```

```
2009-02-11    0.020264
2009-02-12   -0.000946
                ...
2018-11-15    0.010316
2018-11-16    0.001070
2018-11-19   -0.010364
2018-11-20   -0.025850
2018-11-21    0.011689
2018-11-23   -0.011639
2018-11-26    0.020224
2018-11-27    0.003931
2018-11-28    0.024744
2018-11-29   -0.012358
2018-11-30    0.022967
2018-12-03    0.008369
2018-12-04   -0.029607
2018-12-06    0.018997
2018-12-07   -0.036882
2018-12-10    0.014999
2018-12-11   -0.001981
2018-12-12    0.002233
2018-12-13   -0.003549
2018-12-14   -0.006875
2018-12-17   -0.031693
2018-12-18    0.004737
2018-12-19   -0.001886
2018-12-20   -0.029288
2018-12-21   -0.018404
2018-12-24   -0.030377
2018-12-26    0.035512
2018-12-27    0.021456
2018-12-28   -0.006592
2018-12-31    0.005662
Name: IBM, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.036835
2009-01-05   -0.019079
2009-01-06    0.030852
2009-01-07   -0.060508
2009-01-08    0.007618
2009-01-09   -0.027491
2009-01-12   -0.025442
2009-01-13   -0.008702
2009-01-14   -0.043161
2009-01-15    0.016055
2009-01-16    0.033860
2009-01-20   -0.064047
```

```
2009-01-21     0.031105
2009-01-22    -0.033182
2009-01-23     0.023400
2009-01-26     0.019817
2009-01-27     0.032138
2009-01-28     0.014482
2009-01-29    -0.045682
2009-01-30    -0.035153
2009-02-02     0.056589
2009-02-03     0.007336
2009-02-04     0.021339
2009-02-05     0.026657
2009-02-06     0.033684
2009-02-09     0.012220
2009-02-10    -0.055667
2009-02-11     0.000000
2009-02-12    -0.005682
                  ...
2018-11-15     0.021661
2018-11-16     0.014966
2018-11-19    -0.016998
2018-11-20    -0.012708
2018-11-21    -0.007597
2018-11-23    -0.010419
2018-11-26     0.019553
2018-11-27     0.013066
2018-11-28     0.016434
2018-11-29    -0.023741
2018-11-30     0.033753
2018-12-03     0.016629
2018-12-04    -0.047477
2018-12-06     0.012984
2018-12-07    -0.044036
2018-12-10     0.020977
2018-12-11     0.003601
2018-12-12     0.009498
2018-12-13     0.009617
2018-12-14    -0.008905
2018-12-17    -0.016297
2018-12-18     0.014019
2018-12-19    -0.045455
2018-12-20    -0.000658
2018-12-21    -0.015371
2018-12-24    -0.027877
2018-12-26     0.059647
2018-12-27     0.003681
2018-12-28     0.008412
2018-12-31     0.003850
```

```
Name: INTC, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.013706
2009-01-05   -0.009893
2009-01-06   -0.005995
2009-01-07   -0.009382
2009-01-08   -0.001860
2009-01-09    0.000508
2009-01-12   -0.012024
2009-01-13    0.008571
2009-01-14   -0.015126
2009-01-15   -0.005694
2009-01-16   -0.003124
2009-01-20   -0.012012
2009-01-21   -0.006872
2009-01-22    0.009049
2009-01-23   -0.015826
2009-01-26    0.010363
2009-01-27    0.017507
2009-01-28    0.017727
2009-01-29   -0.004782
2009-01-30   -0.010123
2009-02-02    0.000000
2009-02-03    0.015427
2009-02-04   -0.010584
2009-02-05    0.002588
2009-02-06    0.006883
2009-02-09   -0.000170
2009-02-10   -0.030257
2009-02-11    0.010576
2009-02-12    0.007849
                 ...
2018-11-15    0.001733
2018-11-16    0.010311
2018-11-19    0.011918
2018-11-20   -0.008664
2018-11-21   -0.030454
2018-11-23    0.001690
2018-11-26    0.000283
2018-11-27    0.013086
2018-11-28    0.022483
2018-11-29   -0.004029
2018-11-30    0.007199
2018-12-03   -0.004697
2018-12-04   -0.001231
2018-12-06   -0.000822
2018-12-07   -0.003290
```

```
2018-12-10   -0.001169
2018-12-11    0.008537
2018-12-12    0.004096
2018-12-13    0.005030
2018-12-14   -0.100379
2018-12-17   -0.029023
2018-12-18    0.009912
2018-12-19   -0.021546
2018-12-20    0.005172
2018-12-21   -0.001403
2018-12-24   -0.040987
2018-12-26    0.031504
2018-12-27    0.005524
2018-12-28   -0.001099
2018-12-31    0.013986
Name: JNJ, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.006420
2009-01-05   -0.066985
2009-01-06    0.021538
2009-01-07   -0.059906
2009-01-08   -0.030972
2009-01-09   -0.045922
2009-01-12   -0.040816
2009-01-13    0.057808
2009-01-14   -0.016698
2009-01-15   -0.060595
2009-01-16   -0.062448
2009-01-20   -0.207274
2009-01-21    0.250967
2009-01-22    0.020769
2009-01-23    0.051082
2009-01-26    0.009061
2009-01-27    0.022857
2009-01-28    0.103751
2009-01-29   -0.080622
2009-01-30    0.003146
2009-02-02   -0.012152
2009-02-03   -0.045635
2009-02-04   -0.000416
2009-02-05    0.020798
2009-02-06    0.125917
2009-02-09   -0.012667
2009-02-10   -0.097507
2009-02-11    0.059708
2009-02-12    0.003833
                ...
```

```
2018-11-15    0.025529
2018-11-16   -0.000727
2018-11-19    0.007637
2018-11-20   -0.021474
2018-11-21   -0.007469
2018-11-23   -0.009197
2018-11-26    0.024473
2018-11-27    0.004210
2018-11-28    0.011119
2018-11-29   -0.007932
2018-11-30    0.010267
2018-12-03    0.009443
2018-12-04   -0.044636
2018-12-06   -0.019025
2018-12-07   -0.018063
2018-12-10   -0.018685
2018-12-11   -0.009767
2018-12-12    0.006476
2018-12-13    0.000990
2018-12-14   -0.008208
2018-12-17   -0.012763
2018-12-18   -0.004747
2018-12-19   -0.012685
2018-12-20   -0.008634
2018-12-21   -0.023639
2018-12-24   -0.021557
2018-12-26    0.041459
2018-12-27    0.011255
2018-12-28   -0.002164
2018-12-31    0.008159
Name: JPM, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.013916
2009-01-05   -0.010022
2009-01-06   -0.016065
2009-01-07    0.004921
2009-01-08    0.006899
2009-01-09   -0.014147
2009-01-12   -0.019507
2009-01-13    0.006632
2009-01-14   -0.031804
2009-01-15    0.017363
2009-01-16    0.011070
2009-01-20   -0.021898
2009-01-21    0.009561
2009-01-22   -0.003927
2009-01-23   -0.021336
```

```
2009-01-26    0.019668
2009-01-27    0.006972
2009-01-28    0.012231
2009-01-29   -0.007068
2009-01-30   -0.019058
2009-02-02   -0.011236
2009-02-03    0.025568
2009-02-04   -0.021238
2009-02-05    0.006840
2009-02-06    0.020145
2009-02-09   -0.028473
2009-02-10   -0.038762
2009-02-11    0.014753
2009-02-12    0.075600
                 ...
2018-11-15   -0.000402
2018-11-16    0.008645
2018-11-19    0.006777
2018-11-20   -0.022372
2018-11-21   -0.013163
2018-11-23    0.005951
2018-11-26   -0.003060
2018-11-27    0.010231
2018-11-28    0.006887
2018-11-29   -0.006894
2018-11-30    0.028991
2018-12-03   -0.014087
2018-12-04   -0.002214
2018-12-06   -0.004034
2018-12-07   -0.005873
2018-12-10    0.003056
2018-12-11    0.006093
2018-12-12   -0.006459
2018-12-13    0.005079
2018-12-14   -0.002628
2018-12-17   -0.020470
2018-12-18   -0.000207
2018-12-19   -0.008692
2018-12-20   -0.007516
2018-12-21    0.000631
2018-12-24   -0.033845
2018-12-26    0.021323
2018-12-27    0.012569
2018-12-28   -0.006943
2018-12-31    0.003178
Name: KO, Length: 2517, dtype: float64
Date
2008-12-31          NaN
```

```
2009-01-02     0.025085
2009-01-05    -0.002980
2009-01-06    -0.022341
2009-01-07    -0.014483
2009-01-08    -0.011757
2009-01-09    -0.007435
2009-01-12     0.001498
2009-01-13    -0.013963
2009-01-14    -0.033547
2009-01-15     0.011338
2009-01-16     0.029148
2009-01-20    -0.043573
2009-01-21     0.028561
2009-01-22     0.000341
2009-01-23    -0.011921
2009-01-26     0.006549
2009-01-27     0.002055
2009-01-28     0.011620
2009-01-29    -0.017905
2009-01-30    -0.002064
2009-02-02    -0.002068
2009-02-03     0.016926
2009-02-04    -0.017324
2009-02-05     0.008642
2009-02-06     0.001713
2009-02-09     0.009579
2009-02-10    -0.029482
2009-02-11    -0.003491
2009-02-12    -0.002102
                 ...
2018-11-15    -0.001577
2018-11-16     0.021955
2018-11-19    -0.004638
2018-11-20    -0.016120
2018-11-21    -0.005389
2018-11-23    -0.004324
2018-11-26     0.010773
2018-11-27     0.004024
2018-11-28     0.017440
2018-11-29     0.007506
2018-11-30     0.002180
2018-12-03    -0.016657
2018-12-04    -0.001780
2018-12-06     0.002216
2018-12-07    -0.013427
2018-12-10     0.009237
2018-12-11    -0.005741
2018-12-12    -0.000599
```

```
2018-12-13    0.016078
2018-12-14   -0.016843
2018-12-17   -0.013640
2018-12-18   -0.005974
2018-12-19   -0.003061
2018-12-20   -0.030587
2018-12-21    0.002706
2018-12-24   -0.022222
2018-12-26    0.022023
2018-12-27    0.009654
2018-12-28   -0.000854
2018-12-31    0.011449
Name: MCD, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.028676
2009-01-05   -0.011657
2009-01-06    0.011795
2009-01-07   -0.018922
2009-01-08    0.008782
2009-01-09   -0.014339
2009-01-12   -0.011431
2009-01-13   -0.014541
2009-01-14   -0.021511
2009-01-15    0.002362
2009-01-16    0.022657
2009-01-20   -0.044310
2009-01-21    0.005934
2009-01-22   -0.003319
2009-01-23   -0.021458
2009-01-26    0.012477
2009-01-27    0.008029
2009-01-28    0.026486
2009-01-29    0.020390
2009-01-30   -0.048807
2009-02-02   -0.058933
2009-02-03    0.020150
2009-02-04   -0.015492
2009-02-05    0.013966
2009-02-06    0.016295
2009-02-09    0.032831
2009-02-10   -0.055997
2009-02-11    0.004111
2009-02-12   -0.025736
                 ...
2018-11-15    0.034585
2018-11-16    0.019960
2018-11-19   -0.016364
```

```
2018-11-20   -0.024662
2018-11-21   -0.002310
2018-11-23   -0.009512
2018-11-26    0.015549
2018-11-27    0.004153
2018-11-28    0.018187
2018-11-29    0.001077
2018-11-30    0.016425
2018-12-03    0.004040
2018-12-04   -0.031424
2018-12-06    0.002374
2018-12-07   -0.021906
2018-12-10    0.000404
2018-12-11   -0.004336
2018-12-12    0.011901
2018-12-13    0.011611
2018-12-14   -0.029832
2018-12-17   -0.016726
2018-12-18    0.009024
2018-12-19   -0.023643
2018-12-20   -0.013582
2018-12-21   -0.019372
2018-12-24   -0.027918
2018-12-26    0.042772
2018-12-27    0.023838
2018-12-28   -0.006974
2018-12-31    0.006178
Name: MMM, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.019737
2009-01-05   -0.015161
2009-01-06   -0.018343
2009-01-07   -0.016016
2009-01-08   -0.004408
2009-01-09   -0.021458
2009-01-12   -0.008005
2009-01-13   -0.002106
2009-01-14   -0.021800
2009-01-15    0.010784
2009-01-16    0.002489
2009-01-20   -0.010642
2009-01-21   -0.011474
2009-01-22   -0.004352
2009-01-23    0.027323
2009-01-26   -0.014539
2009-01-27    0.020871
2009-01-28    0.014452
```

```
2009-01-29    0.005559
2009-01-30   -0.013476
2009-02-02   -0.004203
2009-02-03    0.063665
2009-02-04   -0.011243
2009-02-05    0.006689
2009-02-06    0.022259
2009-02-09   -0.003900
2009-02-10   -0.053507
2009-02-11    0.024474
2009-02-12   -0.012786
                ...
2018-11-15    0.010123
2018-11-16    0.016301
2018-11-19    0.003813
2018-11-20   -0.020563
2018-11-21    0.000134
2018-11-23   -0.001605
2018-11-26    0.010312
2018-11-27    0.011930
2018-11-28    0.011658
2018-11-29    0.008805
2018-11-30    0.018354
2018-12-03   -0.001512
2018-12-04   -0.012749
2018-12-06    0.002046
2018-12-07   -0.021054
2018-12-10    0.009124
2018-12-11   -0.004004
2018-12-12    0.011672
2018-12-13    0.012819
2018-12-14   -0.025236
2018-12-17   -0.016344
2018-12-18   -0.011963
2018-12-19   -0.007534
2018-12-20   -0.003796
2018-12-21   -0.008028
2018-12-24   -0.024005
2018-12-26    0.040056
2018-12-27    0.018649
2018-12-28   -0.000133
2018-12-31    0.013799
Name: MRK, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.045782
2009-01-05    0.009345
2009-01-06    0.011696
```

```
2009-01-07   -0.060212
2009-01-08    0.031266
2009-01-09   -0.029821
2009-01-12   -0.002561
2009-01-13    0.017977
2009-01-14   -0.036831
2009-01-15    0.007857
2009-01-16    0.024428
2009-01-20   -0.062405
2009-01-21    0.048701
2009-01-22   -0.117131
2009-01-23    0.005260
2009-01-26    0.025000
2009-01-27    0.001702
2009-01-28    0.021517
2009-01-29   -0.024945
2009-01-30   -0.027856
2009-02-02    0.042690
2009-02-03    0.037577
2009-02-04    0.007027
2009-02-05    0.022008
2009-02-06    0.032562
2009-02-09   -0.011190
2009-02-10   -0.032922
2009-02-11    0.021808
2009-02-12    0.002602
                 ...
2018-11-15    0.022006
2018-11-16    0.009415
2018-11-19   -0.033890
2018-11-20   -0.027815
2018-11-21    0.013765
2018-11-23   -0.000388
2018-11-26    0.032987
2018-11-27    0.006293
2018-11-28    0.037148
2018-11-29   -0.008369
2018-11-30    0.006353
2018-12-03    0.010821
2018-12-04   -0.031849
2018-12-06    0.006174
2018-12-07   -0.040022
2018-12-10    0.026426
2018-12-11    0.009295
2018-12-12    0.004512
2018-12-13    0.003392
2018-12-14   -0.031247
2018-12-17   -0.029614
```

```
2018-12-18    0.010497
2018-12-19   -0.002693
2018-12-20   -0.021024
2018-12-21   -0.032312
2018-12-24   -0.041739
2018-12-26    0.068310
2018-12-27    0.006165
2018-12-28   -0.007808
2018-12-31    0.011754
Name: MSFT, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.040392
2009-01-05    0.007162
2009-01-06   -0.020210
2009-01-07   -0.036287
2009-01-08    0.018430
2009-01-09   -0.034637
2009-01-12    0.010280
2009-01-13   -0.012370
2009-01-14   -0.057575
2009-01-15    0.006645
2009-01-16   -0.003407
2009-01-20   -0.056838
2009-01-21    0.034436
2009-01-22   -0.000658
2009-01-23    0.001096
2009-01-26   -0.000219
2009-01-27   -0.003504
2009-01-28    0.045924
2009-01-29   -0.033824
2009-01-30   -0.016090
2009-02-02   -0.018122
2009-02-03    0.042089
2009-02-04   -0.011231
2009-02-05    0.031018
2009-02-06    0.031356
2009-02-09   -0.018694
2009-02-10   -0.056940
2009-02-11   -0.016426
2009-02-12    0.003385
                 ...
2018-11-15   -0.011569
2018-11-16    0.005516
2018-11-19   -0.029703
2018-11-20   -0.019305
2018-11-21    0.017576
2018-11-23   -0.012160
```

```
2018-11-26    0.017065
2018-11-27   -0.008527
2018-11-28    0.035650
2018-11-29   -0.004286
2018-11-30    0.013492
2018-12-03    0.037540
2018-12-04   -0.027585
2018-12-06   -0.003299
2018-12-07   -0.029124
2018-12-10   -0.011317
2018-12-11    0.014619
2018-12-12    0.010194
2018-12-13   -0.018703
2018-12-14   -0.005485
2018-12-17   -0.036261
2018-12-18    0.017883
2018-12-19   -0.030640
2018-12-20   -0.020879
2018-12-21    0.071672
2018-12-24   -0.059002
2018-12-26    0.072100
2018-12-27    0.009040
2018-12-28   -0.004479
2018-12-31    0.010908
Name: NKE, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.031621
2009-01-05   -0.006021
2009-01-06   -0.019824
2009-01-07   -0.017416
2009-01-08    0.009148
2009-01-09   -0.011898
2009-01-12   -0.004587
2009-01-13    0.013249
2009-01-14   -0.019898
2009-01-15    0.008701
2009-01-16    0.006325
2009-01-20   -0.017143
2009-01-21    0.016279
2009-01-22   -0.015446
2009-01-23    0.013946
2009-01-26   -0.103152
2009-01-27    0.010863
2009-01-28   -0.024020
2009-01-29   -0.020725
2009-01-30   -0.035714
2009-02-02    0.021262
```

```
2009-02-03    0.020819
2009-02-04   -0.020833
2009-02-05   -0.004804
2009-02-06    0.023448
2009-02-09   -0.008760
2009-02-10   -0.043508
2009-02-11    0.022032
2009-02-12    0.018776
                 ...
2018-11-15    0.006991
2018-11-16    0.006943
2018-11-19    0.015399
2018-11-20   -0.014713
2018-11-21   -0.009878
2018-11-23    0.000928
2018-11-26    0.004636
2018-11-27    0.016844
2018-11-28    0.018834
2018-11-29    0.013586
2018-11-30    0.015821
2018-12-03   -0.005191
2018-12-04   -0.018482
2018-12-06   -0.003544
2018-12-07   -0.023566
2018-12-10    0.010929
2018-12-11   -0.008784
2018-12-12    0.003408
2018-12-13    0.009284
2018-12-14   -0.017276
2018-12-17   -0.015753
2018-12-18   -0.016470
2018-12-19   -0.010142
2018-12-20   -0.000476
2018-12-21   -0.000477
2018-12-24   -0.032912
2018-12-26    0.040444
2018-12-27    0.015644
2018-12-28    0.002567
2018-12-31    0.016062
Name: PFE, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.015852
2009-01-05   -0.007166
2009-01-06   -0.002887
2009-01-07   -0.017532
2009-01-08   -0.010969
2009-01-09   -0.009104
```

2009-01-12	0.001336
2009-01-13	-0.007841
2009-01-14	-0.027072
2009-01-15	-0.006913
2009-01-16	0.004699
2009-01-20	-0.005197
2009-01-21	0.009469
2009-01-22	-0.010596
2009-01-23	-0.016854
2009-01-26	0.006607
2009-01-27	0.005854
2009-01-28	0.026102
2009-01-29	0.000687
2009-01-30	-0.063895
2009-02-02	-0.026606
2009-02-03	0.016211
2009-02-04	-0.025784
2009-02-05	0.015232
2009-02-06	0.012753
2009-02-09	-0.019630
2009-02-10	-0.028145
2009-02-11	-0.005637
2009-02-12	0.002345
	...
2018-11-15	0.003637
2018-11-16	-0.000107
2018-11-19	-0.005649
2018-11-20	-0.012756
2018-11-21	-0.007492
2018-11-23	0.001422
2018-11-26	0.004370
2018-11-27	0.008484
2018-11-28	0.003128
2018-11-29	-0.002043
2018-11-30	0.018207
2018-12-03	-0.012591
2018-12-04	-0.000107
2018-12-06	0.002572
2018-12-07	-0.011758
2018-12-10	0.006274
2018-12-11	0.009459
2018-12-12	0.001278
2018-12-13	0.026162
2018-12-14	0.001555
2018-12-17	-0.040046
2018-12-18	-0.003018
2018-12-19	-0.007893
2018-12-20	-0.008500

```
2018-12-21   -0.000110
2018-12-24   -0.039683
2018-12-26    0.031250
2018-12-27    0.021423
2018-12-28   -0.009128
2018-12-31    0.008116
Name: PG, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.000000
2009-01-05   -0.014823
2009-01-06   -0.030541
2009-01-07   -0.039611
2009-01-08    0.018572
2009-01-09   -0.005920
2009-01-12   -0.022629
2009-01-13    0.018523
2009-01-14   -0.042833
2009-01-15   -0.000500
2009-01-16    0.026763
2009-01-20   -0.065529
2009-01-21    0.058915
2009-01-22   -0.050714
2009-01-23   -0.016598
2009-01-26   -0.008966
2009-01-27    0.061469
2009-01-28    0.033843
2009-01-29   -0.043889
2009-01-30   -0.020036
2009-02-02    0.003882
2009-02-03    0.010312
2009-02-04   -0.014289
2009-02-05   -0.009060
2009-02-06    0.037617
2009-02-09    0.022407
2009-02-10   -0.043585
2009-02-11    0.054582
2009-02-12    0.019043
                 ...
2018-11-15    0.020725
2018-11-16    0.025321
2018-11-19    0.013590
2018-11-20   -0.016473
2018-11-21   -0.004752
2018-11-23   -0.009080
2018-11-26    0.029542
2018-11-27   -0.005601
2018-11-28    0.008410
```

```
2018-11-29   -0.000536
2018-11-30   -0.001990
2018-12-03   -0.001994
2018-12-04   -0.026286
2018-12-06   -0.010103
2018-12-07   -0.008665
2018-12-10   -0.004532
2018-12-11   -0.016504
2018-12-12    0.008597
2018-12-13   -0.004180
2018-12-14   -0.007819
2018-12-17   -0.005143
2018-12-18   -0.005253
2018-12-19   -0.001174
2018-12-20   -0.015441
2018-12-21   -0.010740
2018-12-24   -0.029554
2018-12-26    0.040309
2018-12-27    0.012802
2018-12-28   -0.003623
2018-12-31    0.012771
Name: TRV, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.037218
2009-01-05   -0.016310
2009-01-06   -0.023582
2009-01-07   -0.007547
2009-01-08    0.015589
2009-01-09   -0.009734
2009-01-12   -0.031380
2009-01-13   -0.010148
2009-01-14   -0.050473
2009-01-15    0.033638
2009-01-16    0.024508
2009-01-20   -0.052549
2009-01-21    0.036838
2009-01-22    0.085429
2009-01-23    0.031261
2009-01-26    0.003923
2009-01-27    0.033038
2009-01-28    0.031293
2009-01-29   -0.043348
2009-01-30   -0.012548
2009-02-02    0.028945
2009-02-03    0.020240
2009-02-04   -0.025555
2009-02-05   -0.006211
```

```
2009-02-06    0.004861
2009-02-09    0.020042
2009-02-10   -0.052507
2009-02-11    0.020737
2009-02-12    0.032574
                ...
2018-11-15   -0.000076
2018-11-16    0.023288
2018-11-19   -0.018664
2018-11-20   -0.017102
2018-11-21   -0.003633
2018-11-23    0.004107
2018-11-26    0.017354
2018-11-27    0.018748
2018-11-28    0.036142
2018-11-29    0.005695
2018-11-30   -0.001030
2018-12-03    0.017664
2018-12-04   -0.027171
2018-12-06   -0.006103
2018-12-07   -0.027705
2018-12-10   -0.009845
2018-12-11    0.002589
2018-12-12    0.012799
2018-12-13    0.005579
2018-12-14   -0.026199
2018-12-17   -0.026224
2018-12-18   -0.019762
2018-12-19   -0.010515
2018-12-20   -0.031441
2018-12-21   -0.016911
2018-12-24   -0.022657
2018-12-26    0.044690
2018-12-27    0.010766
2018-12-28    0.001098
2018-12-31    0.011696
Name: UNH, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.025186
2009-01-05   -0.011829
2009-01-06    0.010682
2009-01-07   -0.024782
2009-01-08   -0.000187
2009-01-09   -0.015138
2009-01-12   -0.006451
2009-01-13   -0.029794
2009-01-14   -0.015157
```

```
2009-01-15   -0.006796
2009-01-16    0.028376
2009-01-20   -0.034051
2009-01-21   -0.002228
2009-01-22   -0.006091
2009-01-23   -0.031461
2009-01-26    0.026577
2009-01-27    0.011712
2009-01-28    0.028838
2009-01-29   -0.039084
2009-01-30   -0.014175
2009-02-02   -0.009377
2009-02-03    0.016197
2009-02-04   -0.016146
2009-02-05    0.010941
2009-02-06    0.020395
2009-02-09    0.012034
2009-02-10   -0.051593
2009-02-11    0.011900
2009-02-12   -0.014910
                 ...
2018-11-15    0.012290
2018-11-16    0.003083
2018-11-19   -0.017521
2018-11-20   -0.014470
2018-11-21   -0.002302
2018-11-23    0.026489
2018-11-26   -0.008214
2018-11-27   -0.041413
2018-11-28    0.000408
2018-11-29   -0.012466
2018-11-30    0.005281
2018-12-03    0.014445
2018-12-04   -0.022087
2018-12-06    0.004799
2018-12-07   -0.016468
2018-12-10   -0.000335
2018-12-11   -0.004020
2018-12-12    0.006138
2018-12-13   -0.003426
2018-12-14   -0.003774
2018-12-17   -0.029377
2018-12-18    0.004076
2018-12-19   -0.017101
2018-12-20   -0.036731
2018-12-21   -0.031381
2018-12-24   -0.038802
2018-12-26    0.038703
```

```
2018-12-27   -0.002358
2018-12-28   -0.003971
2018-12-31    0.010822
Name: UTX, Length: 2517, dtype: float64
Date
2008-12-31          NaN
2009-01-02    0.018875
2009-01-05    0.007111
2009-01-06    0.070420
2009-01-07   -0.021698
2009-01-08   -0.010646
2009-01-09   -0.002511
2009-01-12   -0.047824
2009-01-13    0.003399
2009-01-14   -0.040835
2009-01-15   -0.031195
2009-01-16   -0.039894
2009-01-20   -0.105252
2009-01-21    0.041489
2009-01-22    0.000000
2009-01-23    0.003169
2009-01-26   -0.039034
2009-01-27    0.036628
2009-01-28    0.069535
2009-01-29   -0.020118
2009-01-30    0.066565
2009-02-02    0.012564
2009-02-03   -0.031619
2009-02-04    0.015292
2009-02-05    0.093833
2009-02-06    0.031075
2009-02-09   -0.001624
2009-02-10   -0.026573
2009-02-11    0.028635
2009-02-12    0.026201
                 ...
2018-11-15    0.018673
2018-11-16   -0.011703
2018-11-19   -0.038665
2018-11-20   -0.010315
2018-11-21    0.007873
2018-11-23   -0.011531
2018-11-26    0.023105
2018-11-27   -0.000221
2018-11-28    0.040247
2018-11-29   -0.016127
2018-11-30    0.018763
2018-12-03    0.023216
```

```
2018-12-04   -0.043862
2018-12-06    0.017383
2018-12-07   -0.027933
2018-12-10    0.005616
2018-12-11   -0.007760
2018-12-12    0.007236
2018-12-13   -0.001887
2018-12-14   -0.017813
2018-12-17   -0.027315
2018-12-18    0.009589
2018-12-19   -0.010553
2018-12-20   -0.019046
2018-12-21   -0.034949
2018-12-24   -0.020361
2018-12-26    0.069827
2018-12-27    0.013668
2018-12-28   -0.008105
2018-12-31    0.007637
Name: V, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.021829
2009-01-05   -0.062356
2009-01-06   -0.016010
2009-01-07    0.013679
2009-01-08    0.015361
2009-01-09   -0.007101
2009-01-12   -0.011505
2009-01-13   -0.009122
2009-01-14   -0.029841
2009-01-15   -0.021597
2009-01-16    0.002007
2009-01-20   -0.003004
2009-01-21    0.034483
2009-01-22   -0.023948
2009-01-23    0.009284
2009-01-26    0.018068
2009-01-27   -0.033236
2009-01-28    0.032042
2009-01-29   -0.022316
2009-01-30   -0.011909
2009-02-02    0.024104
2009-02-03    0.031710
2009-02-04   -0.030102
2009-02-05    0.018948
2009-02-06    0.016993
2009-02-09   -0.010404
2009-02-10   -0.044281
```

```
2009-02-11   -0.000667
2009-02-12   -0.004002
                ...
2018-11-15    0.002375
2018-11-16    0.019127
2018-11-19    0.006810
2018-11-20   -0.019136
2018-11-21   -0.005045
2018-11-23   -0.008790
2018-11-26    0.009038
2018-11-27    0.025013
2018-11-28   -0.009728
2018-11-29   -0.010156
2018-11-30    0.014298
2018-12-03   -0.035489
2018-12-04   -0.001204
2018-12-06   -0.000172
2018-12-07   -0.006887
2018-12-10    0.010229
2018-12-11    0.009954
2018-12-12   -0.027188
2018-12-13   -0.002795
2018-12-14   -0.000175
2018-12-17   -0.019797
2018-12-18   -0.005362
2018-12-19    0.003774
2018-12-20   -0.014143
2018-12-21   -0.002724
2018-12-24   -0.034050
2018-12-26    0.026202
2018-12-27    0.013042
2018-12-28    0.002176
2018-12-31    0.017188
Name: VZ, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.019979
2009-01-05   -0.011543
2009-01-06   -0.008847
2009-01-07   -0.008568
2009-01-08   -0.074901
2009-01-09    0.003893
2009-01-12   -0.003684
2009-01-13    0.014205
2009-01-14   -0.010744
2009-01-15   -0.004073
2009-01-16    0.004089
2009-01-20   -0.019395
```

```
2009-01-21   -0.028085
2009-01-22   -0.005494
2009-01-23   -0.010641
2009-01-26    0.005170
2009-01-27    0.003910
2009-01-28   -0.001230
2009-01-29   -0.017853
2009-01-30   -0.015462
2009-02-02   -0.011672
2009-02-03    0.026627
2009-02-04   -0.029074
2009-02-05    0.046101
2009-02-06    0.022035
2009-02-09   -0.007052
2009-02-10   -0.031656
2009-02-11    0.010687
2009-02-12   -0.002073
                 ...
2018-11-15   -0.019600
2018-11-16   -0.018585
2018-11-19   -0.009315
2018-11-20   -0.027072
2018-11-21    0.000106
2018-11-23    0.009876
2018-11-26    0.000526
2018-11-27   -0.001156
2018-11-28    0.025463
2018-11-29   -0.001744
2018-11-30    0.003700
2018-12-03    0.011265
2018-12-04   -0.029772
2018-12-06   -0.005457
2018-12-07   -0.016672
2018-12-10    0.008048
2018-12-11   -0.000958
2018-12-12   -0.007885
2018-12-13   -0.001611
2018-12-14   -0.011941
2018-12-17   -0.011758
2018-12-18    0.003415
2018-12-19   -0.005819
2018-12-20   -0.036113
2018-12-21   -0.001719
2018-12-24   -0.015035
2018-12-26    0.053484
2018-12-27    0.013052
2018-12-28    0.005896
2018-12-31    0.011071
```

```
Name: WMT, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.022673
2009-01-05   -0.000122
2009-01-06   -0.016293
2009-01-07   -0.025529
2009-01-08    0.010734
2009-01-09   -0.019218
2009-01-12   -0.013278
2009-01-13    0.018030
2009-01-14   -0.036191
2009-01-15    0.020772
2009-01-16    0.018784
2009-01-20   -0.023175
2009-01-21    0.038930
2009-01-22   -0.012995
2009-01-23   -0.002429
2009-01-26    0.007176
2009-01-27    0.004072
2009-01-28    0.004181
2009-01-29   -0.028391
2009-01-30   -0.006753
2009-02-02    0.002746
2009-02-03    0.018647
2009-02-04   -0.005889
2009-02-05    0.027298
2009-02-06    0.012094
2009-02-09   -0.010705
2009-02-10   -0.042023
2009-02-11   -0.020489
2009-02-12    0.008581
                 ...
2018-11-15    0.010337
2018-11-16    0.009848
2018-11-19    0.003293
2018-11-20   -0.028402
2018-11-21    0.007665
2018-11-23   -0.026689
2018-11-26    0.019738
2018-11-27    0.000909
2018-11-28    0.018170
2018-11-29    0.007776
2018-11-30    0.005565
2018-12-03    0.021635
2018-12-04   -0.022039
2018-12-06   -0.013093
2018-12-07   -0.009567
```

```
2018-12-10   -0.014168
2018-12-11    0.001829
2018-12-12   -0.008607
2018-12-13    0.012628
2018-12-14   -0.018187
2018-12-17   -0.020376
2018-12-18   -0.027553
2018-12-19   -0.016944
2018-12-20   -0.030376
2018-12-21   -0.007431
2018-12-24   -0.038315
2018-12-26    0.047779
2018-12-27    0.004371
2018-12-28   -0.011169
2018-12-31    0.000293
Name: XOM, Length: 2517, dtype: float64
Date
2008-12-31         NaN
2009-01-02    0.029431
2009-01-05   -0.009054
2009-01-06    0.006949
2009-01-07   -0.027221
2009-01-08   -0.003106
2009-01-09   -0.016389
2009-01-12   -0.014561
2009-01-13   -0.002999
2009-01-14   -0.029404
2009-01-15    0.001506
2009-01-16    0.008369
2009-01-20   -0.040106
2009-01-21    0.035100
2009-01-22   -0.012798
2009-01-23   -0.005569
2009-01-26    0.004763
2009-01-27    0.007233
2009-01-28    0.024554
2009-01-29   -0.027036
2009-01-30   -0.018180
2009-02-02   -0.008013
2009-02-03    0.017842
2009-02-04   -0.015065
2009-02-05    0.013374
2009-02-06    0.026977
2009-02-09   -0.001174
2009-02-10   -0.046185
2009-02-11    0.006420
2009-02-12   -0.000853
                ...
```

```
2018-11-15    0.008324
2018-11-16    0.004901
2018-11-19   -0.015574
2018-11-20   -0.022057
2018-11-21   -0.000039
2018-11-23   -0.007306
2018-11-26    0.014588
2018-11-27    0.004403
2018-11-28    0.024959
2018-11-29   -0.001088
2018-11-30    0.007878
2018-12-03    0.011276
2018-12-04   -0.030951
2018-12-06   -0.003173
2018-12-07   -0.022396
2018-12-10    0.001407
2018-12-11   -0.002171
2018-12-12    0.006443
2018-12-13    0.002859
2018-12-14   -0.020200
2018-12-17   -0.021059
2018-12-18    0.003504
2018-12-19   -0.014867
2018-12-20   -0.019897
2018-12-21   -0.018121
2018-12-24   -0.029100
2018-12-26    0.049846
2018-12-27    0.011381
2018-12-28   -0.003303
2018-12-31    0.011493
Name: ^DJI, Length: 2517, dtype: float64
```

In [146]:
```python
# 1.1 b) Rendements périodiques moyens

average_daily_returns = dict()

for ticker in dow30:
    average_daily_returns[ticker] = stock_returns[ticker].mean()

print('Rendements périodiques moyens')
print(average_daily_returns)
```

```
Rendements périodiques moyens
{'AAPL': 0.0013202448989875118, 'AXP': 0.0009245086451141904, 'BA': 0.0010478188481857058, 'CA
```

In [147]:
```python
# 1.1 c) Écart-type
```

```
std = dict()

for ticker in dow30:
    std[ticker] = stock_returns[ticker].std()

print('Écart-Type')
print(std)
```

```
Écart-Type
{'AAPL': 0.016901961085724504, 'AXP': 0.02044305034571212, 'BA': 0.01659163237842293, 'CAT': 0
```

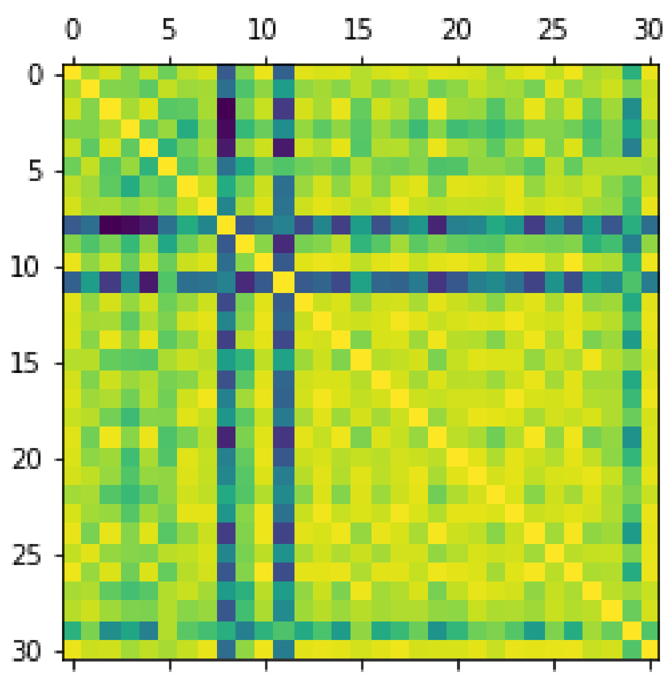
In [148]:
```
# 1.1 d) Matrice de corrélation

correlation_matrix = adj_close.corr()

print("Matrice de Corrélation")
print(adj_close.corr())

plt.matshow(correlation_matrix)
plt.show()
```

```
Matrice de Corrélation
          AAPL       AXP        BA       CAT      CSCO       CVX       DIS  \
AAPL  1.000000  0.886457  0.940398  0.841079  0.924506  0.814177  0.916916
AXP   0.886457  1.000000  0.841334  0.837639  0.787705  0.921416  0.874173
BA    0.940398  0.841334  1.000000  0.888152  0.956490  0.779236  0.787863
CAT   0.841079  0.837639  0.888152  1.000000  0.791758  0.870550  0.675238
CSCO  0.924506  0.787705  0.956490  0.791758  1.000000  0.701869  0.811939
CVX   0.814177  0.921416  0.779236  0.870550  0.701869  1.000000  0.779228
DIS   0.916916  0.874173  0.787863  0.675238  0.811939  0.779228  1.000000
DWDP  0.944624  0.885483  0.887603  0.850573  0.879013  0.841133  0.925164
GE    0.394153  0.462258  0.150735  0.171616  0.213084  0.470999  0.674104
GS    0.838043  0.767769  0.829431  0.719173  0.864278  0.656049  0.813277
HD    0.973714  0.857572  0.930270  0.805834  0.933688  0.805321  0.930904
IBM   0.413996  0.626469  0.299052  0.567939  0.213082  0.768406  0.460797
INTC  0.962610  0.862594  0.943817  0.865475  0.939135  0.813953  0.872114
JNJ   0.949308  0.884464  0.889393  0.788130  0.900043  0.833256  0.940420
JPM   0.954647  0.849707  0.969370  0.860256  0.964638  0.789433  0.858327
KO    0.903809  0.908112  0.799240  0.782777  0.775215  0.896060  0.931485
MCD   0.942664  0.839780  0.935026  0.871551  0.903316  0.830498  0.850430
MMM   0.955274  0.875761  0.900177  0.817789  0.904092  0.818224  0.937450
MRK   0.927891  0.908915  0.823577  0.734298  0.845847  0.842532  0.957833
MSFT  0.957871  0.820078  0.977600  0.848908  0.973469  0.762296  0.829406
NKE   0.952534  0.856513  0.877902  0.739034  0.891121  0.769262  0.958807
PFE   0.944017  0.919496  0.868760  0.769008  0.866861  0.860390  0.956413
PG    0.881345  0.893467  0.772054  0.724056  0.784644  0.858490  0.939230
TRV   0.947679  0.881249  0.870109  0.776781  0.879482  0.832262  0.964331
```

```
UNH   0.971257  0.828795  0.968045  0.844960  0.959863  0.780428  0.866384
UTX   0.921304  0.961009  0.865054  0.845397  0.837817  0.912512  0.922286
V     0.978238  0.868270  0.956263  0.817163  0.955247  0.800133  0.910108
VZ    0.887432  0.900370  0.792064  0.747401  0.779664  0.900540  0.928859
WMT   0.907731  0.935110  0.878864  0.835638  0.833981  0.902576  0.849087
XOM   0.694368  0.833973  0.570132  0.650657  0.522284  0.901413  0.781354
^DJI  0.975649  0.932034  0.939989  0.883088  0.917556  0.889572  0.924914

          DWDP        GE        GS  ...       PFE        PG       TRV  \
AAPL  0.944624  0.394153  0.838043  ...  0.944017  0.881345  0.947679
AXP   0.885483  0.462258  0.767769  ...  0.919496  0.893467  0.881249
BA    0.887603  0.150735  0.829431  ...  0.868760  0.772054  0.870109
CAT   0.850573  0.171616  0.719173  ...  0.769008  0.724056  0.776781
CSCO  0.879013  0.213084  0.864278  ...  0.866861  0.784644  0.879482
CVX   0.841133  0.470999  0.656049  ...  0.860390  0.858490  0.832262
DIS   0.925164  0.674104  0.813277  ...  0.956413  0.939230  0.964331
DWDP  1.000000  0.541012  0.886988  ...  0.921019  0.919624  0.965117
GE    0.541012  1.000000  0.388413  ...  0.543245  0.670487  0.592081
GS    0.886988  0.388413  1.000000  ...  0.780521  0.772276  0.848175
HD    0.955335  0.458698  0.848408  ...  0.956025  0.902782  0.978302
IBM   0.474286  0.527640  0.250259  ...  0.514324  0.556140  0.467986
INTC  0.934535  0.341728  0.824766  ...  0.907686  0.847673  0.930998
JNJ   0.966003  0.535941  0.845419  ...  0.961067  0.956588  0.982816
JPM   0.945471  0.312781  0.914068  ...  0.901242  0.843775  0.928880
KO    0.912218  0.624052  0.709397  ...  0.959828  0.956648  0.951014
MCD   0.930020  0.361525  0.779845  ...  0.914158  0.876636  0.932652
MMM   0.983040  0.523472  0.882192  ...  0.942147  0.936057  0.984696
MRK   0.924059  0.598889  0.786351  ...  0.970549  0.963850  0.952473
MSFT  0.911233  0.237311  0.833406  ...  0.892909  0.814890  0.903283
NKE   0.924402  0.520391  0.796689  ...  0.961858  0.898530  0.965088
PFE   0.921019  0.543245  0.780521  ...  1.000000  0.945904  0.965899
PG    0.919624  0.670487  0.772276  ...  0.945904  1.000000  0.951624
TRV   0.965117  0.592081  0.848175  ...  0.965899  0.951624  1.000000
UNH   0.930527  0.305811  0.837606  ...  0.919919  0.849381  0.932733
UTX   0.946949  0.539801  0.829329  ...  0.948129  0.936096  0.940506
V     0.940564  0.382903  0.841450  ...  0.954989  0.885094  0.959747
VZ    0.886062  0.617529  0.695434  ...  0.969329  0.950398  0.941869
WMT   0.869238  0.381908  0.743434  ...  0.929515  0.894894  0.899904
XOM   0.745167  0.684520  0.517067  ...  0.812992  0.835025  0.773553
^DJI  0.972368  0.453660  0.859468  ...  0.964699  0.927285  0.971684

           UNH       UTX         V        VZ       WMT       XOM      ^DJI
AAPL  0.971257  0.921304  0.978238  0.887432  0.907731  0.694368  0.975649
AXP   0.828795  0.961009  0.868270  0.900370  0.935110  0.833973  0.932034
BA    0.968045  0.865054  0.956263  0.792064  0.878864  0.570132  0.939989
CAT   0.844960  0.845397  0.817163  0.747401  0.835638  0.650657  0.883088
CSCO  0.959863  0.837817  0.955247  0.779664  0.833981  0.522284  0.917556
CVX   0.780428  0.912512  0.800133  0.900540  0.902576  0.901413  0.889572
```

DIS	0.866384	0.922286	0.910108	0.928859	0.849087	0.781354	0.924914
DWDP	0.930527	0.946949	0.940564	0.886062	0.869238	0.745167	0.972368
GE	0.305811	0.539801	0.382903	0.617529	0.381908	0.684520	0.453660
GS	0.837606	0.829329	0.841450	0.695434	0.743434	0.517067	0.859468
HD	0.977645	0.915109	0.991136	0.910498	0.897083	0.701282	0.976883
IBM	0.323445	0.585888	0.355305	0.622244	0.559759	0.763189	0.508070
INTC	0.963351	0.894107	0.964152	0.861843	0.879510	0.669486	0.961348
JNJ	0.948443	0.938598	0.966410	0.930646	0.909079	0.760834	0.972749
JPM	0.979420	0.897316	0.972567	0.831407	0.873573	0.616455	0.965796
KO	0.866101	0.930701	0.900128	0.978538	0.909559	0.857410	0.941017
MCD	0.970839	0.884519	0.961760	0.882294	0.886391	0.670481	0.960674
MMM	0.950140	0.942097	0.962078	0.901916	0.898472	0.726746	0.976974
MRK	0.893079	0.940287	0.926879	0.948924	0.898805	0.810264	0.944015
MSFT	0.989003	0.860906	0.978704	0.824748	0.862073	0.586491	0.948271
NKE	0.935434	0.903916	0.966449	0.921310	0.857108	0.712976	0.947850
PFE	0.919919	0.948129	0.954989	0.969329	0.929515	0.812992	0.964699
PG	0.849381	0.936096	0.885094	0.950398	0.894894	0.835025	0.927285
TRV	0.932733	0.940506	0.959747	0.941869	0.899904	0.773553	0.971684
UNH	1.000000	0.882162	0.987454	0.858192	0.877614	0.621618	0.963657
UTX	0.882162	1.000000	0.910778	0.925239	0.930247	0.834749	0.967548
V	0.987454	0.910778	1.000000	0.896346	0.902106	0.677450	0.975577
VZ	0.858192	0.925239	0.896346	1.000000	0.916740	0.881062	0.929056
WMT	0.877614	0.930247	0.902106	0.916740	1.000000	0.805541	0.940634
XOM	0.621618	0.834749	0.677450	0.881062	0.805541	1.000000	0.767829
^DJI	0.963657	0.967548	0.975577	0.929056	0.940634	0.767829	1.000000

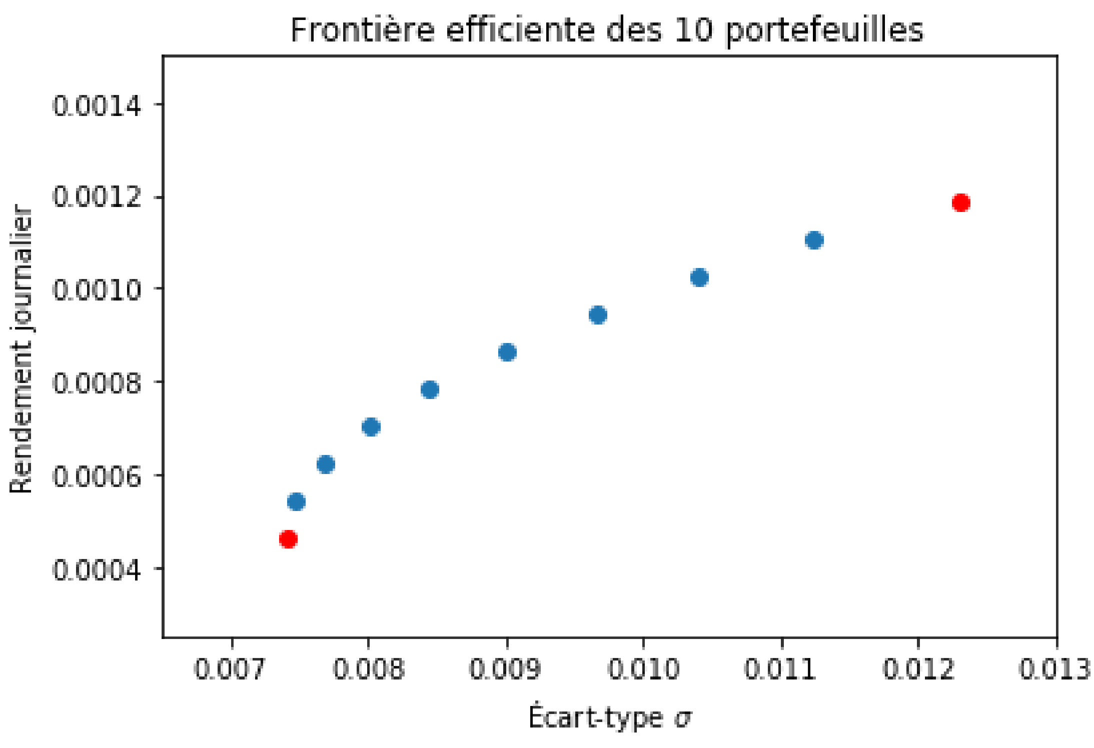
[31 rows x 31 columns]



In [179]:
```python
from scipy.optimize import minimize

# 1.2 Portefeuille à variance minimale

daily_return = adj_close.pct_change(1)
daily_return = daily_return.drop(['^DJI'], axis = 1)
daily_yield_average = daily_return.mean(axis = 0)
cov = daily_return.cov()
initial_weights = np.full((daily_return.shape[1],1), 1 / daily_return.shape[1])


def print_details(weight_sum, yield_porfolio, std_portfolio):
    print('Somme des poids: ', np.sum(weight_sum))
    print('Rendement Portefeuille : ', np.sum(yield_porfolio))
    print('Variance Portefeuille : ', std_portfolio)
    print('\n')

def calculate_portfolio_var(w,cov):
    return np.sqrt(np.dot(w.T, np.dot(cov, w)))

def minimize_var(const, bounds):
    data = minimize(calculate_portfolio_var, initial_weights, args = cov, constraints
    weights_p = data.x
    yield_p = weights_p * daily_yield_average
    std_p = np.sqrt(np.dot(weights_p.T, np.dot(cov, weights_p)))
    return [weights_p, yield_p, std_p]


# Sans contrainte
const = {'type': 'eq', 'fun': lambda x:  np.sum(x) - 1}
bounds = [(0,None) for x in range(daily_return.shape[1])]

data_no_constraints = minimize_var(const, bounds)

print('Portefeuille Minimum Variance Sans Contrainte')
print_details(data_no_constraints[0], data_no_constraints[1], data_no_constraints[2]


# # 1.3 - Avec Contrainte poids max et poids min
const = ({'type': 'eq', 'fun': lambda x:  np.sum(x)-1.0})
bounds = [(0.02,0.20) for x in range(daily_return.shape[1])]

data_constraints = minimize_var(const, bounds)
print('Portefeuille Minimum Variance Avec Contraintes')
print_details(data_constraints[0], data_constraints[1], data_constraints[2])
```

```python
# Calcul 90% du Rendement Maximal
max_yield = np.max(daily_yield_average)
max_yield_ninety = 0.9 * max_yield


# Portefeuille en fonction du Rendement max 90%
const = ({'type': 'eq', 'fun': lambda x:  np.sum(x) - 1.0},{'type': 'eq','fun': lambd
bounds = [(0,None) for x in range(daily_return.shape[1])]

data_max_ninety = minimize_var(const, bounds)
print('Portefeuille Max Rendement 90%')
print_details(data_max_ninety[0], data_max_ninety[1], data_max_ninety[2])


# 1.4 - Calcul des points de la frontière

interval = np.linspace(np.sum(data_no_constraints[1]), np.sum(data_max_ninety[1]), nu
intervals = interval[1:-1]
weights = []

for i in range (0,len(intervals)):

    const = ({'type': 'eq', 'fun': lambda x:  np.sum(x) - 1.0}, {'type': 'eq','fun':
    bounds = [(0, None) for x in range(daily_return.shape[1])]
    data = minimize_var(const, bounds)

    weights.append(data[0])


yield_p = []
volatility_p = []

for i in range (0, len(weights)):
    yield_p.append(np.sum(weights[i] * daily_yield_average))
    volatility_p.append(np.sqrt(np.dot(weights[i].T, np.dot(cov, weights[i]))))

figure = plt.subplot(1, 1, 1)
figure.scatter(volatility_p, yield_p)
figure.plot(data_max_ninety[2], np.sum(data_max_ninety[1]), "or")
figure.plot(data_no_constraints[2], np.sum(data_no_constraints[1]), "or")
plt.xlim(0.0065, 0.013)
plt.ylim(0.00025, 0.00150)
plt.xlabel('Écart-type $\sigma$')
plt.ylabel('Rendement journalier')
plt.title('Frontière efficiente des 10 portefeuilles')
plt.show()
```

```
Portefeuille Minimum Variance Sans Contrainte
Somme des poids:  1.0
Rendement Portefeuille :  0.0004621057599439802
Variance Portefeuille :  0.007416317232996797


Portefeuille Minimum Variance Avec Contraintes
Somme des poids:  1.0000000000000002
Rendement Portefeuille :  0.0005809406947311517
Variance Portefeuille :  0.00866580141455468


Portefeuille Max Rendement 90%
Somme des poids:  1.0000000000000002
Rendement Portefeuille :  0.0011882204090229755
Variance Portefeuille :  0.012307295495245908
```




```
In [178]: from scipy.stats import kurtosis
          from scipy.stats import skew
```

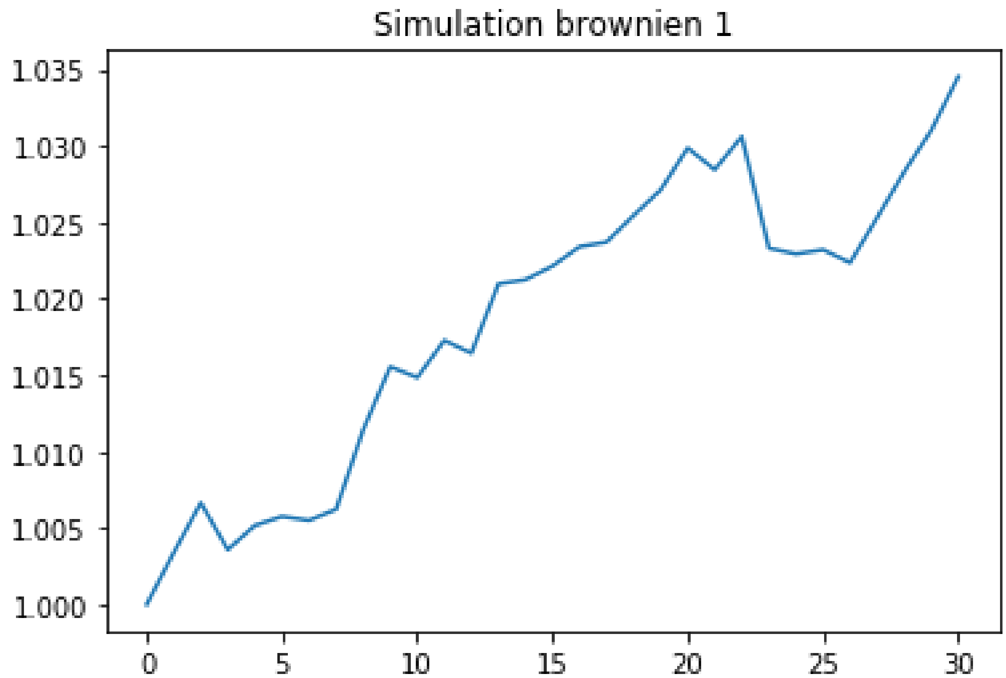
```python
import scipy.stats as sp
import math


#2 - VaR

daily_return = adj_close.pct_change(1)
daily_return = daily_return.drop(['^DJI'], axis = 1)
equal_weigths = np.full((daily_return.shape[1], 1), 1 / daily_return.shape[1])

# 2.1 - VaR historique sur 250 jours

last_250 = equal_weigths.T * daily_return[-250:]
yield_250 = last_250.sum(axis = 1)
ordered_yield_250 = sorted(yield_250)

position = math.ceil(0.05*len(ordered_yield_250))
VaR5 = ordered_yield_250[position]*np.sqrt(50)
print("VaR historique sur 250 jours : ", VaR5)


# 2.2 - VaR paramétrique sur tout l'échantillon

all_values = equal_weigths.T * daily_return
yield_p = all_values.sum(axis = 1)
mu = yield_p.mean(axis = 0)
std = yield_p.std(axis = 0)
VaR_daily_95 = mu - (1,96 * std)
VaR_5_days = VaR_daily_95 * (np.sqrt(5))
print("VaR paramétrique 95% : ", VaR_5_days.mean())

# 2.3 - VaR avec correction Cornish Fisher

zc = sp.norm.ppf(0.99, loc=0, scale=1)
skewness = skew(yield_p)
kurt = kurtosis(yield_p)

zcf = zc + (((zc**2-1)*skewness)/6) + (((zc**3-3*zc)*kurt)/24)- ((((2*zc**3)-5*zc)*s
VaR = (mu - (zcf * std))

VaR_cornish_fisher = VaR * np.sqrt(5)
print('VaR avec correction Cornish Fisher : ', VaR_cornish_fisher)

# 2.4 - VaR RiskMetrics avec alpha = 0.97

alpha = 0.97
daily_yield_6_months = np.array_split(yield_p, 30)
initial_yield_average = daily_yield_6_months[0].mean(axis = 0)
```

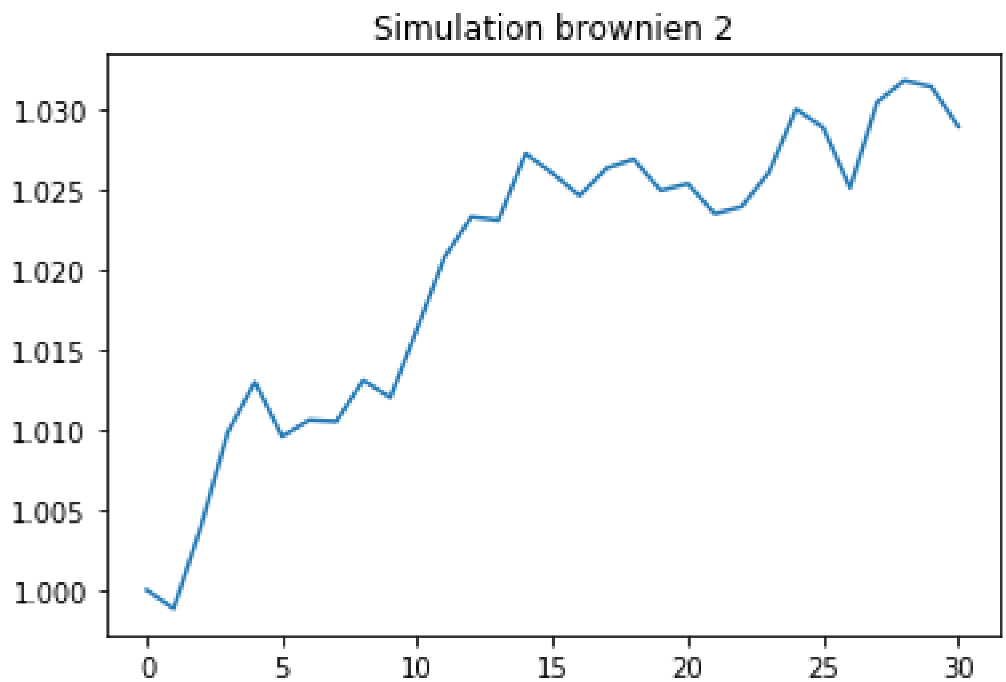
```
initial_std = daily_yield_6_months[0].std(axis=0)

for i in range (1,len(daily_yield_6_months)):
    std = np.sqrt((alpha * initial_std**2) + ((1 - alpha) * initial_yield_average**2)
    initial_std = std
    initial_yield_average = initial_yield_average = daily_yield_6_months[i].mean(axis


nb_periods = (6 * 30) / 5 # Nombre de période de 5 jours au cours de 6 mois
six_month_VaR = (1.96 * std)
VaR_5_days_fischer = six_month_VaR / np.sqrt(nb_periods)
print('VaR à la RiskMetrics : ', VaR_5_days_fischer)
```

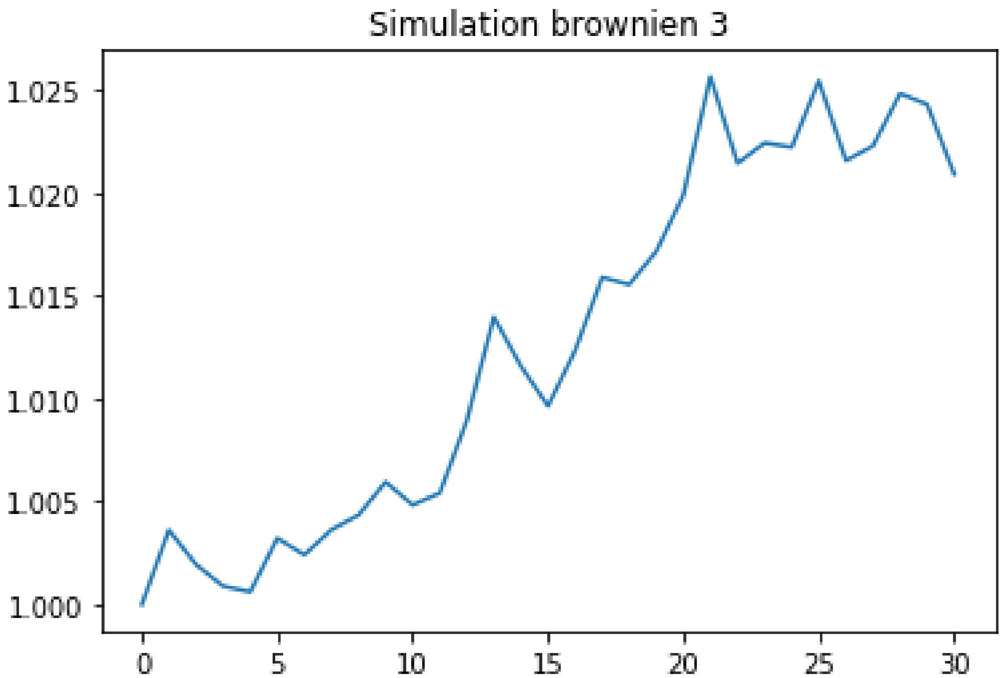
```
VaR historique sur 250 jours :  -0.14810139774727712
VaR paramétrique 95% :  -2.210537176966959
VaR avec correction Cornish Fisher :  -0.08377124558190976
VaR à la RiskMetrics :  0.00541748078113987
```

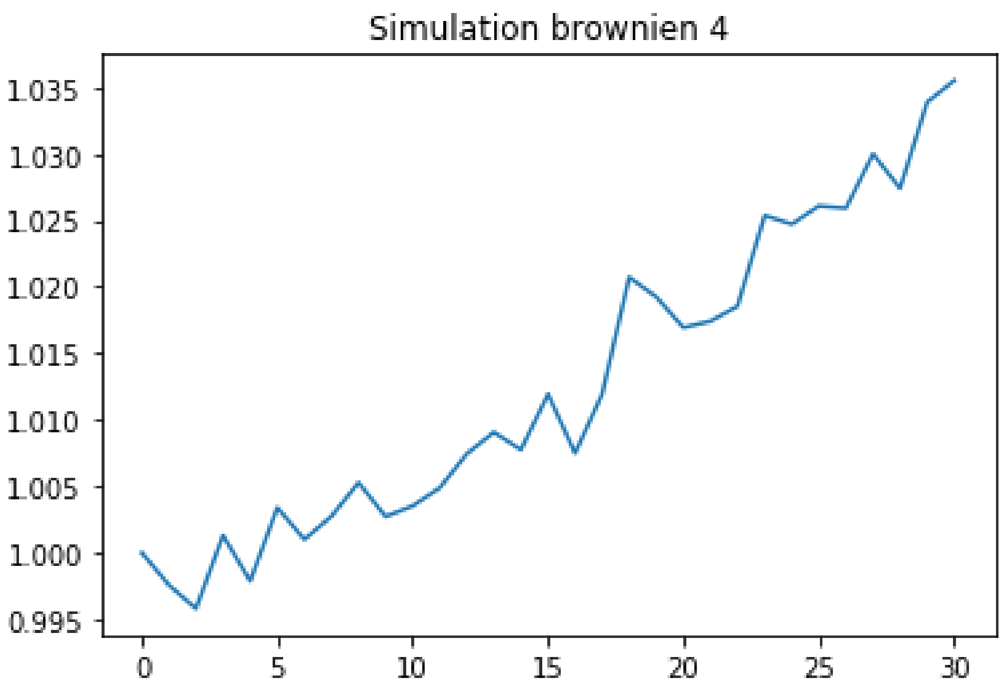
In [141]:
```
#3. Simulation de la valeur d'un portefeuille

import math
from random import randint

std = dict()
for ticker in dow30:
    std[ticker] = stock_returns[ticker].std()

def brownian_movement(s0, mu, sigma, t):
    dz = np.random.normal(0, 1)
    return s0 + s0*(mu*t + sigma*dz)

def generate_brownian(prices):
    next_prices = []
    for i in range(30):
        s0 = prices[i][1]
        ticker = prices[i][0]
        mu = average_daily_returns[ticker]
        sigma = std[ticker]
        t = 1
        next_prices.append((ticker, brownian_movement(s0, mu, sigma, t)))
    return next_prices

def portfolio_value(prices, shares):
    return sum([prices[i][1]*shares[i] for i in range(30)])

def bootstrap_movement(s0, ticker):
    random_index = randint(0, len(stock_returns[ticker]) - 1)
```

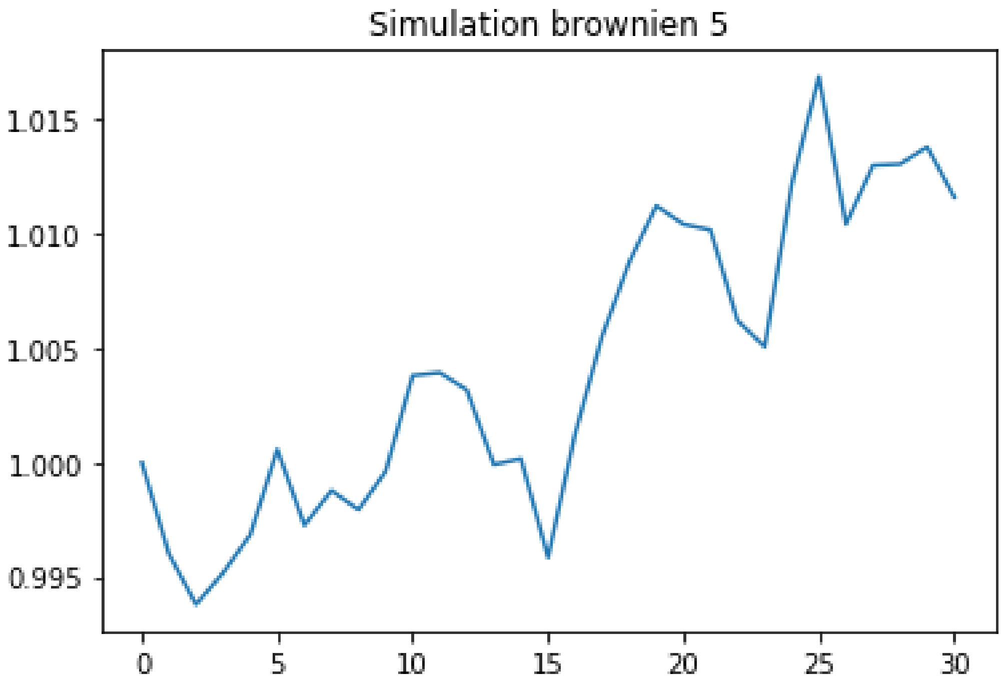
```
    random_return = stock_returns[ticker][random_index]
    return s0 + s0*(stock_returns[ticker][random_index])

def generate_bootstrap(prices):
    next_prices = []
    for i in range(30):
        s0 = prices[i][1]
        ticker = prices[i][0]
        next_prices.append((ticker, bootstrap_movement(s0, ticker)))
    return next_prices

def generate_simulation(is_brownian):
    simulation_nb = 1
    title = ''
    for simulation in range(5):
        dow30_clean = dow30[0:30]
        weight = 1/30
        historical_prices = list()
        historical_prices.append([(ticker, adj_close[ticker][-1]) for ticker in dow3
        historical_values = list()
        historical_values.append(1)
        shares = [weight/price[1] for price in historical_prices[-1]]
        for day in range(30):
            if is_brownian:
                historical_prices.append(generate_brownian(historical_prices[-1]))
                title = 'Simulation brownien '
            else:
                historical_prices.append(generate_bootstrap(historical_prices[-1]))
                title = 'Simulation boostrap '
            historical_values.append(portfolio_value(historical_prices[-1], shares))
        plt.plot(historical_values)
        plt.title(title + str(simulation_nb))
        plt.show()
        simulation_nb = simulation_nb + 1


# Simulation brownian
generate_simulation(True)


# Simulation bootstrap
generate_simulation(False)
```

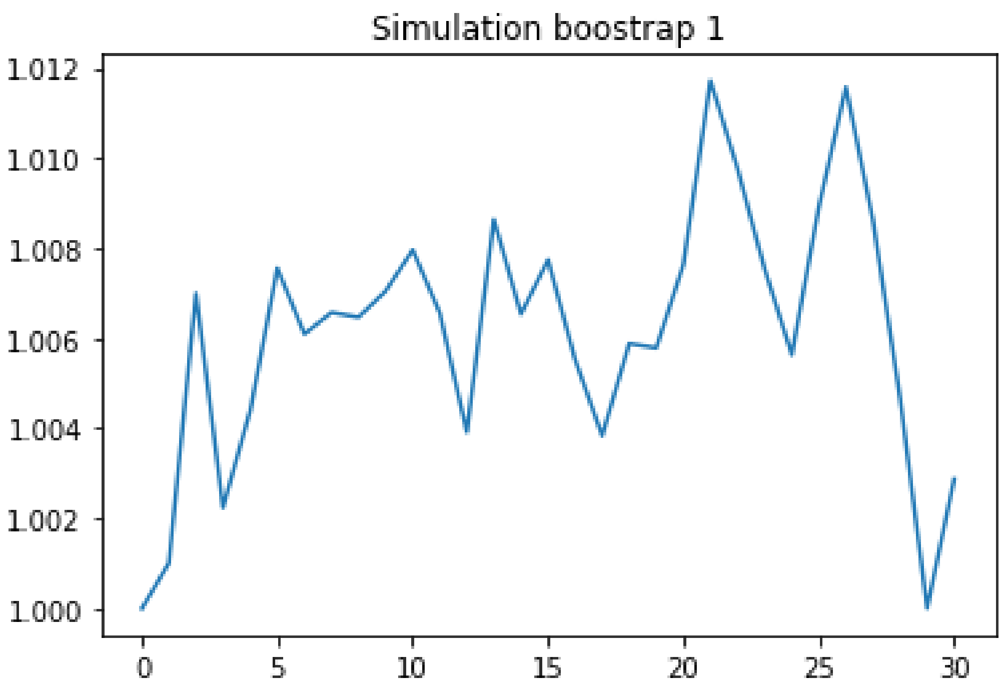

Simulation brownien 1
1.035
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0
5
10
15
20
25
30

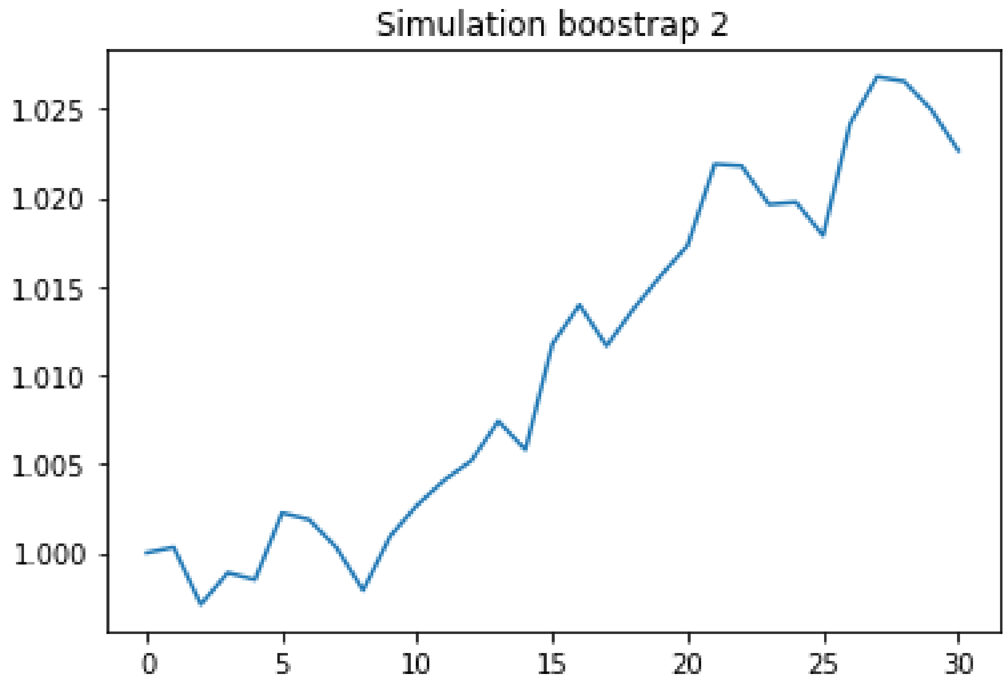

Simulation brownien 2
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0
5
10
15
20
25
30

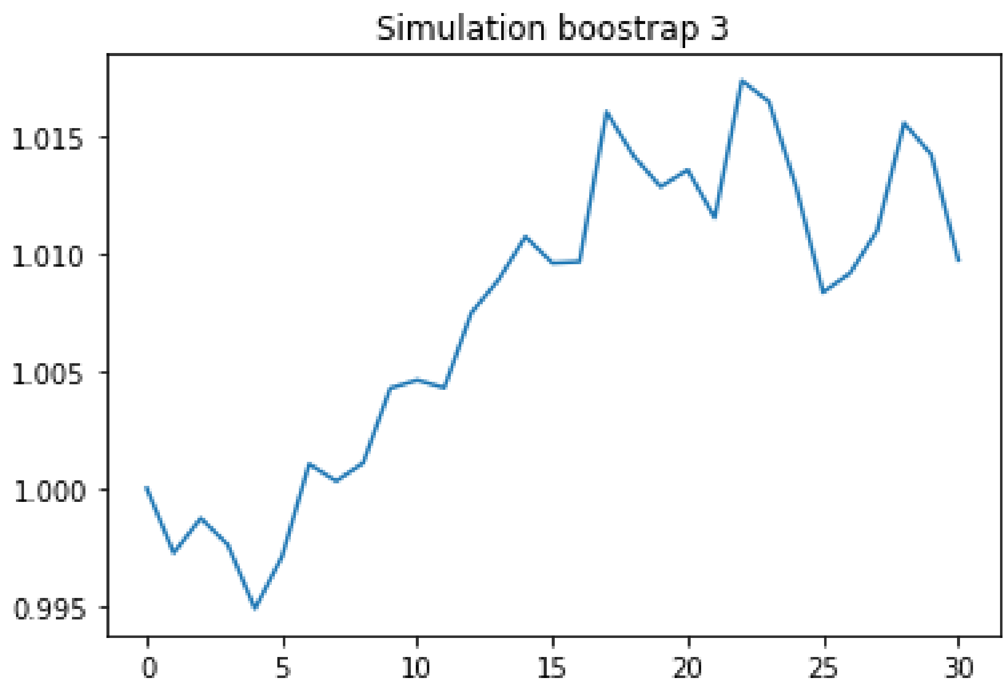

Simulation brownien 3
1.025
1.020
1.015
1.010
1.005
1.000
0
5
10
15
20
25
30

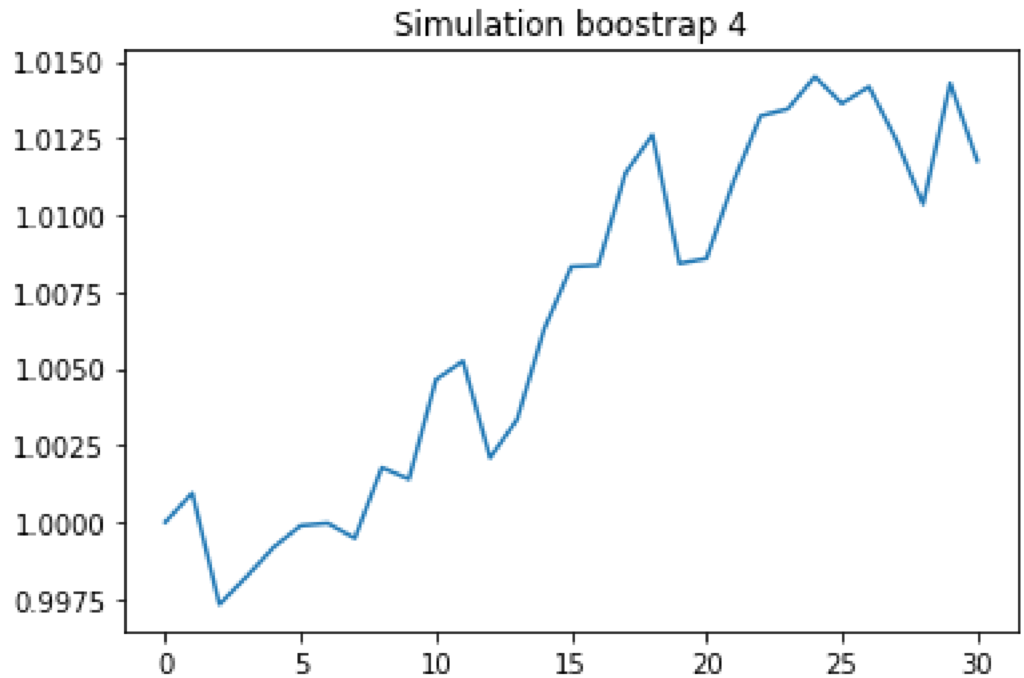

Simulation brownien 4
1.035
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0.995
0
5
10
15
20
25
30

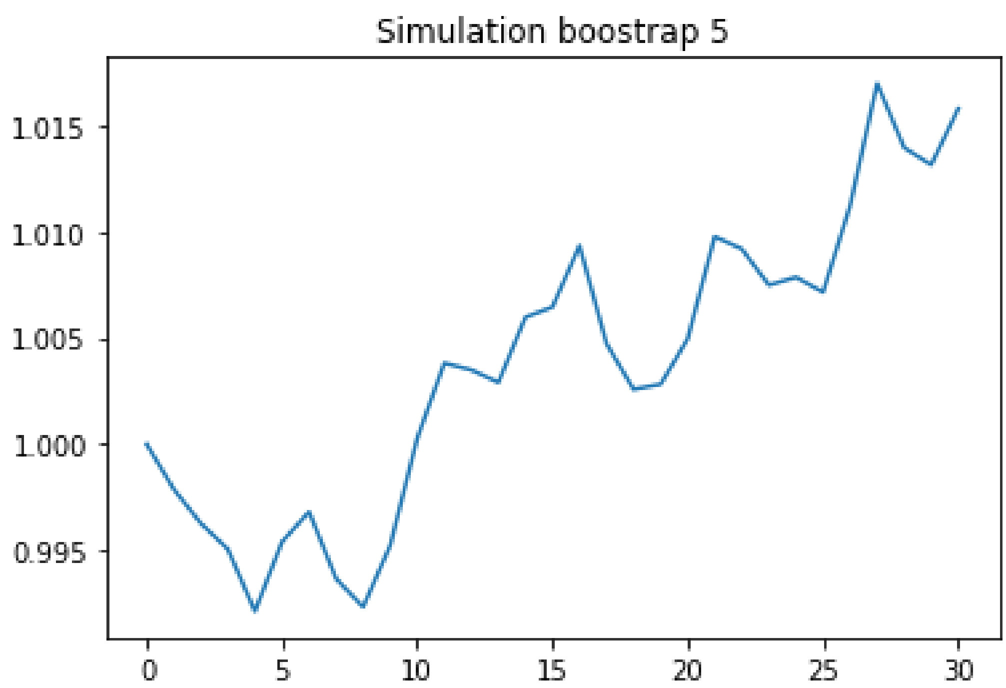

Simulation brownien 5
1.015
1.010
1.005
1.000
0.995
0
5
10
15
20
25
30


Simulation boostrap 1
1.012
1.010
1.008
1.006
1.004
1.002
1.000
0
5
10
15
20
25
30


Simulation boostrap 2
1.025
1.020
1.015
1.010
1.005
1.000
0
5
10
15
20
25
30


Simulation boostrap 3
1.015
1.010
1.005
1.000
0.995
0
5
10
15
20
25
30

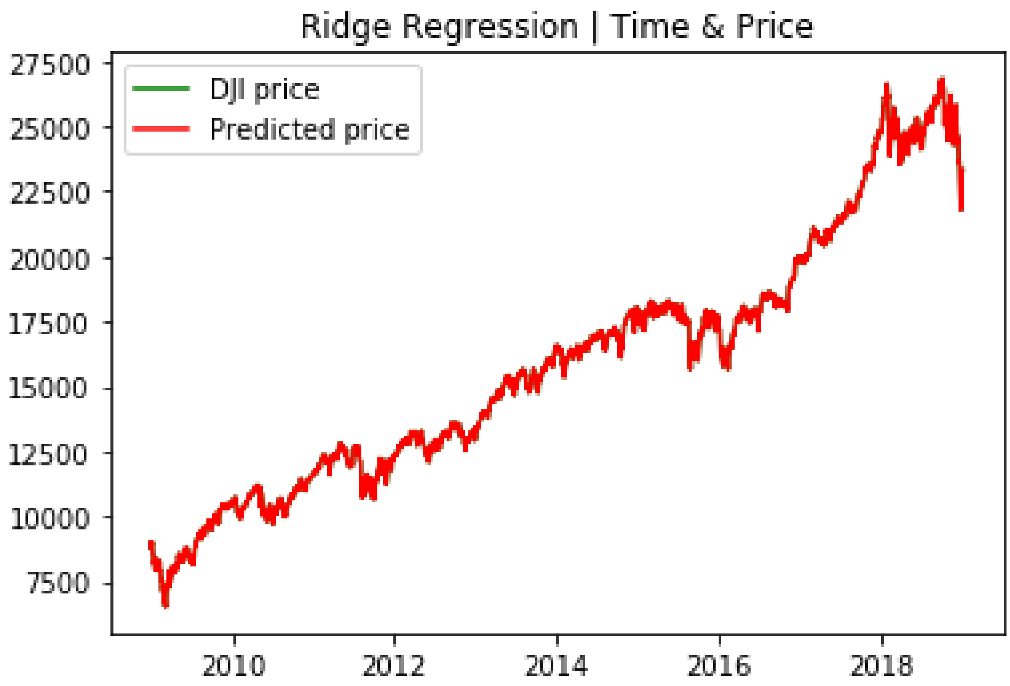





```
In [115]: # Question 4 - Scikit Learn
```

```python
from sklearn.linear_model import Ridge

# Ridge Regression with prices - no optimization

X = adj_close.loc['2008-03-20':]
dowjones = adj_close['^DJI']
Y = dowjones.loc['2008-03-20':]
ridge_regression = Ridge(alpha=1)
ridge_regression.fit(X,Y)
prediction = ridge_regression.predict(X)
dates = Y.index.tolist()

plt.plot(dates, Y.tolist(), color='green', label= 'DJI price')
plt.plot(dates, prediction, color='red', label = 'Predicted price')
plt.title('Ridge Regression | Time & Price')
plt.legend()
plt.show()
```

```
/home/chloe/.local/lib/python3.6/site-packages/pandas/plotting/_converter.py:129: FutureWarning

To register the converters:
        >>> from pandas.plotting import register_matplotlib_converters
        >>> register_matplotlib_converters()
  warnings.warn(msg, FutureWarning)
```



```
In [ ]: # Ridge optimized

        # L'optimization par contrainte n'est pas offerte avec Scikit Learn. De ce fait, il es
        # les contraintes voulues du devoir. On peut se douter qu'avec ces contraintes, les re
        # meilleurs puisque Scikit est concu pour donner les meilleurs resultats selon les don

In [ ]:

In [ ]:
```