In [1]:
```
import pandas as pa
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
eustocks = pa.read_csv(r'C:\Users\SACHIN K M\Desktop\python\data\datasets\EuIndices.csv')
eustocks.head()
```

Out[2]:

	Unnamed: 0	DAX	SMI	CAC	FTSE
0	1	1628.75	1678.1	1772.8	2443.6
1	2	1613.63	1688.5	1750.5	2460.2
2	3	1606.51	1678.6	1718.0	2448.2
3	4	1621.04	1684.1	1708.1	2470.4
4	5	1618.16	1686.6	1723.1	2484.7

In [3]:
```
eustocks_df = pa.DataFrame(data = eustocks.values, columns = ['0', 'DAX', 'SMI', 'CAC', 'FTSE'],
                           index = pa.DatetimeIndex(start='1991-01-01', periods = 1860, freq='B'))

eustocks_df = eustocks_df.drop(columns=['0'])
eustocks_df.head()
```

```
C:\Users\SACHIN K M\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: FutureWarning: Creating a DatetimeIndex by passing range endpoints is deprecated.  Use `pandas.date_range` instead.
```

Out[3]:

	DAX	SMI	CAC	FTSE
1991-01-01	1628.75	1678.1	1772.8	2443.6

	DAX	SMI	CAC	FTSE
1991-01-02	1613.63	1688.5	1750.5	2460.2
1991-01-03	1606.51	1678.6	1718.0	2448.2
1991-01-04	1621.04	1684.1	1708.1	2470.4
1991-01-07	1618.16	1686.6	1723.1	2484.7

In [4]:
```
%matplotlib inline
```

In [20]:
```
eustocks_df.describe()
```

Out[20]:

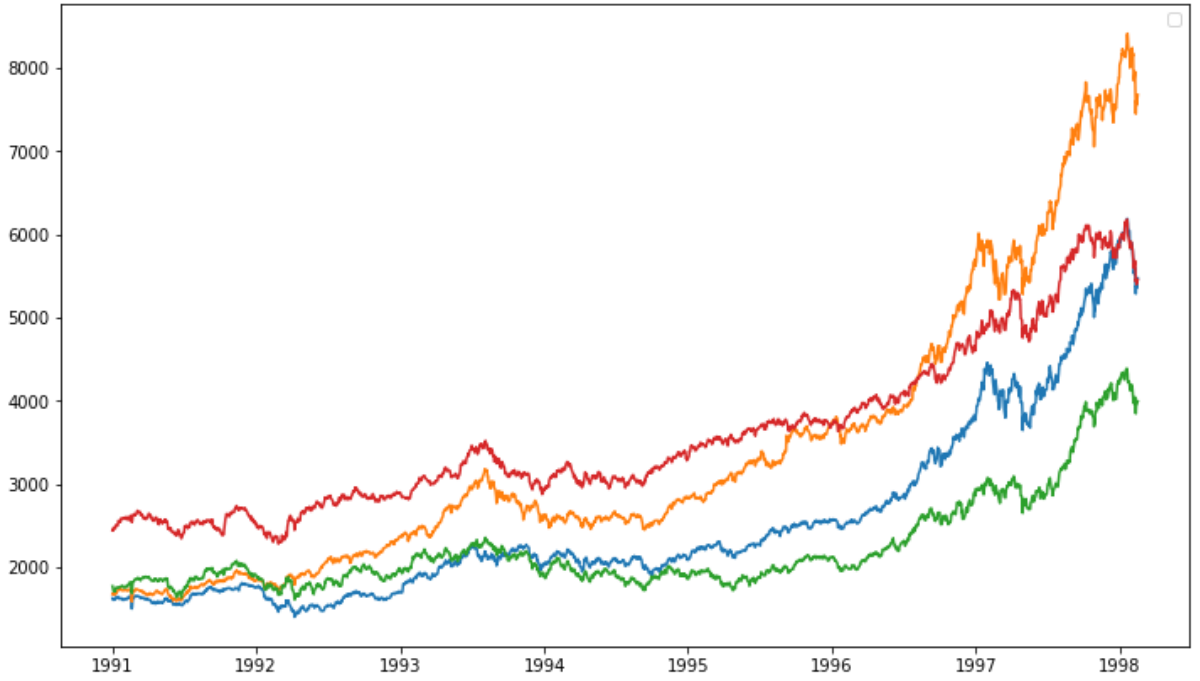
	DAX	SMI	CAC	FTSE
count	1860.000000	1860.000000	1860.000000	1860.000000
mean	2530.656882	3376.223710	2227.828495	3565.643172
std	1084.792740	1663.026465	580.314198	976.715540
min	1402.340000	1587.400000	1611.000000	2281.000000
25%	1744.102500	2165.625000	1875.150000	2843.150000
50%	2140.565000	2796.350000	1992.300000	3246.600000
75%	2722.367500	3812.425000	2274.350000	3993.575000
max	6186.090000	8412.000000	4388.500000	6179.000000

In [5]:
```
#there are no nan-value present in datasets

plt.figure(figsize=(12,7))
plt.plot(eustocks_df)
plt.legend()
```

```
C:\Users\SACHIN K M\Anaconda3\lib\site-packages\pandas\plotting\_converter.py:129: FutureWarning: Using an implicitly registered datetime converter for a matplotlib plotting method. The converter was registered by pandas on import. Future versions of pandas will require you to explici
```

```
tly register matplotlib converters.

To register the converters:
        >>> from pandas.plotting import register_matplotlib_converters
        >>> register_matplotlib_converters()
  warnings.warn(msg, FutureWarning)
No handles with labels found to put in legend.
```

Out[5]: <matplotlib.legend.Legend at 0x2eb90090cf8>



In [6]:
```
#testing for stationarity here we have to check for each ciolumns

from statsmodels.tsa.stattools import adfuller
def stationarity_test(timeseries):
    print("results of Dicky fuller test :")
    dftest = adfuller(timeseries, autolag='AIC')
    df_output = pa.Series(dftest[0:4], index=['test statestics', 'P-val
ue', '#lags_used', 'number of observations'])
```

```
    for key, value in dftest[4].items():
        df_output['critical value (%s)'%key] = value
    print(df_output)
```

In [7]:
```
import functools
eustocks_df.apply(functools.partial(stationarity_test))
```

```
results of Dicky fuller test :
test statestics              2.295811
P-value                      0.998953
#lags_used                  24.000000
number of observations    1835.000000
critical value (1%)         -3.433919
critical value (5%)         -2.863116
critical value (10%)        -2.567609
dtype: float64
results of Dicky fuller test :
test statestics              2.235032
P-value                      0.998910
#lags_used                  22.000000
number of observations    1837.000000
critical value (1%)         -3.433915
critical value (5%)         -2.863115
critical value (10%)        -2.567608
dtype: float64
results of Dicky fuller test :
test statestics              1.286413
P-value                      0.996532
#lags_used                  17.000000
number of observations    1842.000000
critical value (1%)         -3.433905
critical value (5%)         -2.863110
critical value (10%)        -2.567606
dtype: float64
results of Dicky fuller test :
test statestics              0.106116
P-value                      0.966476
#lags_used                  13.000000
```

```
number of observations    1846.000000
critical value (1%)         -3.433897
critical value (5%)         -2.863107
critical value (10%)        -2.567604
dtype: float64
```

Out[7]:
```
DAX     None
SMI     None
CAC     None
FTSE    None
dtype: object
```

the p value should be less than 0.05 if it is more like 0.9 the series is non stationary as in this case

In [8]:
```
eustockdiff = eustocks_df.diff().dropna()
eustockdiff.head()
```

Out[8]:

	DAX	SMI	CAC	FTSE
1991-01-02	-15.12	10.4	-22.3	16.6
1991-01-03	-7.12	-9.9	-32.5	-12.0
1991-01-04	14.53	5.5	-9.9	22.2
1991-01-07	-2.88	2.5	15.0	14.3
1991-01-08	-7.55	-15.0	-8.8	-17.9

In [9]:
```
eustockdiff.apply(functools.partial(stationarity_test))
```

```
results of Dicky fuller test :
test statestics          -8.293747e+00
P-value                   4.193799e-13
#lags_used                1.900000e+01
number of observations    1.839000e+03
```

```
critical value (1%)      -3.433911e+00
critical value (5%)      -2.863113e+00
critical value (10%)     -2.567607e+00
dtype: float64
results of Dicky fuller test :
test statestics           -8.543303e+00
P-value                    9.652044e-14
#lags_used                 1.900000e+01
number of observations     1.839000e+03
critical value (1%)      -3.433911e+00
critical value (5%)      -2.863113e+00
critical value (10%)     -2.567607e+00
dtype: float64
results of Dicky fuller test :
test statestics           -1.015705e+01
P-value                    7.680823e-18
#lags_used                 1.600000e+01
number of observations     1.842000e+03
critical value (1%)      -3.433905e+00
critical value (5%)      -2.863110e+00
critical value (10%)     -2.567606e+00
dtype: float64
results of Dicky fuller test :
test statestics           -1.079549e+01
P-value                    2.080690e-19
#lags_used                 1.200000e+01
number of observations     1.846000e+03
critical value (1%)      -3.433897e+00
critical value (5%)      -2.863107e+00
critical value (10%)     -2.567604e+00
dtype: float64
```

Out[9]:
```
DAX     None
SMI     None
CAC     None
FTSE    None
dtype: object
```

In [10]:
```
from statsmodels.tsa.vector_ar.var_model import VAR
```

```
model = VAR(eustockdiff)
```

In [11]:
```
models = model.select_order(15)
models.summary()

#here we will get the result which will highlight the lowest value from
 all the variables
```

Out[11]:

VAR Order Selection (* highlights the minimums)

	AIC	BIC	FPE	HQIC
0	25.31	25.32*	9.833e+10	25.32
1	25.28	25.34	9.505e+10	25.30*
2	25.28	25.39	9.553e+10	25.32
3	25.27	25.43	9.458e+10	25.33
4	25.26	25.47	9.382e+10	25.34
5	25.26	25.51	9.357e+10	25.35
6	25.26	25.56	9.332e+10	25.37
7	25.26	25.61	9.361e+10	25.39
8	25.26	25.66	9.371e+10	25.41
9	25.26	25.70	9.314e+10	25.42
10	25.26	25.75	9.358e+10	25.44
11	25.26*	25.79	9.303e+10*	25.45
12	25.26	25.85	9.347e+10	25.48
13	25.26	25.89	9.307e+10	25.49
14	25.26	25.94	9.329e+10	25.51
15	25.27	26.00	9.425e+10	25.54

In [12]:
```
results = model.fit(maxlags=15, ic = 'aic')
```

```
results.summary()
```

Out[12]:

```
  Summary of Regression Results
==================================
Model:                         VAR
Method:                        OLS
Date:           Mon, 15, Jul, 2019
Time:                      23:36:11
--------------------------------------------------------------------
No. of Equations:         4.00000    BIC:                    25.7862
Nobs:                     1848.00    HQIC:                   25.4466
Log likelihood:          -33638.3    FPE:                 9.23092e+10
AIC:                      25.2484    Det(Omega_mle):      8.38399e+10
--------------------------------------------------------------------
Results for equation DAX
==========================================================================
====
              coefficient       std. error           t-stat
prob
--------------------------------------------------------------------------
----
const            1.689997         0.772454            2.188
0.029
L1.DAX          -0.002794         0.042406           -0.066
0.947
L1.SMI          -0.106047         0.029764           -3.563
0.000
L1.CAC           0.074580         0.046291            1.611
0.107
L1.FTSE          0.084242         0.036405            2.314
0.021
L2.DAX           0.006051         0.042357            0.143
0.886
L2.SMI          -0.023744         0.029874           -0.795
0.427
L2.CAC           0.082567         0.046370            1.781
0.075
L2.FTSE         -0.082340         0.036647           -2.247
0.025
L3.DAX          -0.070828         0.042131           -1.681
```

```
0.093
L3.SMI           0.005490        0.029829           0.184
0.854
L3.CAC           0.056238        0.046490           1.210
0.226
L3.FTSE          0.034574        0.036766           0.940
0.347
L4.DAX          -0.050557        0.042108          -1.201
0.230
L4.SMI           0.015083        0.029975           0.503
0.615
L4.CAC           0.107053        0.046670           2.294
0.022
L4.FTSE         -0.060486        0.036907          -1.639
0.101
L5.DAX          -0.002764        0.042397          -0.065
0.948
L5.SMI          -0.090774        0.030195          -3.006
0.003
L5.CAC           0.082208        0.046651           1.762
0.078
L5.FTSE         -0.032179        0.036959          -0.871
0.384
L6.DAX          -0.013454        0.042287          -0.318
0.750
L6.SMI           0.027158        0.030250           0.898
0.369
L6.CAC           0.102798        0.046720           2.200
0.028
L6.FTSE         -0.011240        0.036843          -0.305
0.760
L7.DAX           0.060914        0.042345           1.439
0.150
L7.SMI           0.008474        0.030296           0.280
0.780
L7.CAC          -0.057849        0.046792          -1.236
0.216
L7.FTSE         -0.047575        0.036888          -1.290
0.197
```

```
L8.DAX          -0.040198         0.042332           -0.950
0.342
L8.SMI           0.094140         0.030456            3.091
0.002
L8.CAC          -0.109483         0.046762           -2.341
0.019
L8.FTSE          0.051233         0.036867            1.390
0.165
L9.DAX          -0.013915         0.042390           -0.328
0.743
L9.SMI          -0.012519         0.030503           -0.410
0.682
L9.CAC           0.137788         0.046503            2.963
0.003
L9.FTSE          0.001811         0.036969            0.049
0.961
L10.DAX          0.062420         0.042460            1.470
0.142
L10.SMI          0.030617         0.030615            1.000
0.317
L10.CAC         -0.004618         0.046573           -0.099
0.921
L10.FTSE        -0.082541         0.037087           -2.226
0.026
L11.DAX          0.084358         0.042150            2.001
0.045
L11.SMI          0.062522         0.030442            2.054
0.040
L11.CAC         -0.000481         0.046600           -0.010
0.992
L11.FTSE        -0.043432         0.036936           -1.176
0.240
================================================================================

Results for equation SMI
================================================================================
             coefficient       std. error           t-stat
```

```
                prob
-------------------------------------------------------------------------
----
const            2.666518         0.945949            2.819
0.005
L1.DAX           0.015861         0.051931            0.305
0.760
L1.SMI          -0.045199         0.036448           -1.240
0.215
L1.CAC           0.048672         0.056688            0.859
0.391
L1.FTSE          0.140080         0.044582            3.142
0.002
L2.DAX          -0.011278         0.051871           -0.217
0.828
L2.SMI           0.008591         0.036583            0.235
0.814
L2.CAC           0.124562         0.056785            2.194
0.028
L2.FTSE         -0.098270         0.044878           -2.190
0.029
L3.DAX          -0.154551         0.051594           -2.996
0.003
L3.SMI          -0.004518         0.036528           -0.124
0.902
L3.CAC           0.106761         0.056931            1.875
0.061
L3.FTSE          0.122540         0.045024            2.722
0.006
L4.DAX          -0.179588         0.051565           -3.483
0.000
L4.SMI           0.027766         0.036707            0.756
0.449
L4.CAC           0.134131         0.057153            2.347
0.019
L4.FTSE         -0.006755         0.045197           -0.149
0.881
L5.DAX          -0.010278         0.051919           -0.198
0.843
```

```
L5.SMI          -0.081579        0.036977          -2.206
0.027
L5.CAC           0.082653        0.057129           1.447
0.148
L5.FTSE         -0.045753        0.045260          -1.011
0.312
L6.DAX          -0.075441        0.051785          -1.457
0.145
L6.SMI           0.012696        0.037044           0.343
0.732
L6.CAC           0.121670        0.057213           2.127
0.033
L6.FTSE         -0.013926        0.045118          -0.309
0.758
L7.DAX           0.124840        0.051856           2.407
0.016
L7.SMI          -0.001572        0.037101          -0.042
0.966
L7.CAC          -0.101293        0.057302          -1.768
0.077
L7.FTSE         -0.056893        0.045173          -1.259
0.208
L8.DAX           0.002253        0.051840           0.043
0.965
L8.SMI           0.082039        0.037297           2.200
0.028
L8.CAC          -0.087675        0.057265          -1.531
0.126
L8.FTSE         -0.018896        0.045147          -0.419
0.676
L9.DAX           0.090922        0.051910           1.752
0.080
L9.SMI          -0.118136        0.037354          -3.163
0.002
L9.CAC           0.085499        0.056948           1.501
0.133
L9.FTSE          0.077151        0.045272           1.704
0.088
L10.DAX          0.044624        0.051996           0.858
```

```
0.391
L10.SMI          0.044485         0.037491           1.187
0.235
L10.CAC          0.047197         0.057033           0.828
0.408
L10.FTSE        -0.091617         0.045417          -2.017
0.044
L11.DAX          0.091222         0.051617           1.767
0.077
L11.SMI          0.074200         0.037280           1.990
0.047
L11.CAC         -0.002739         0.057067          -0.048
0.962
L11.FTSE        -0.032980         0.045232          -0.729
0.466
================================================================================
====

Results for equation CAC
================================================================================
====
               coefficient       std. error           t-stat
prob
--------------------------------------------------------------------------------
----
const            1.259414         0.629391           2.001
0.045
L1.DAX          -0.004808         0.034552          -0.139
0.889
L1.SMI          -0.075696         0.024251          -3.121
0.002
L1.CAC           0.042553         0.037717           1.128
0.259
L1.FTSE          0.087086         0.029663           2.936
0.003
L2.DAX           0.010514         0.034512           0.305
0.761
L2.SMI          -0.032858         0.024341          -1.350
0.177
```

```
L2.CAC           0.087829         0.037782          2.325
0.020
L2.FTSE         -0.063708         0.029859         -2.134
0.033
L3.DAX          -0.032736         0.034328         -0.954
0.340
L3.SMI           0.026506         0.024304          1.091
0.275
L3.CAC          -0.057546         0.037880         -1.519
0.129
L3.FTSE          0.021721         0.029957          0.725
0.468
L4.DAX          -0.114794         0.034309         -3.346
0.001
L4.SMI           0.044344         0.024423          1.816
0.069
L4.CAC           0.072546         0.038027          1.908
0.056
L4.FTSE         -0.023634         0.030072         -0.786
0.432
L5.DAX          -0.048215         0.034545         -1.396
0.163
L5.SMI          -0.037409         0.024603         -1.521
0.128
L5.CAC           0.048496         0.038011          1.276
0.202
L5.FTSE         -0.011392         0.030114         -0.378
0.705
L6.DAX          -0.013699         0.034455         -0.398
0.691
L6.SMI           0.017909         0.024647          0.727
0.467
L6.CAC           0.055414         0.038067          1.456
0.145
L6.FTSE         -0.006018         0.030019         -0.200
0.841
L7.DAX           0.083216         0.034503          2.412
0.016
L7.SMI          -0.006611         0.024685         -0.268
```

```
0.789
L7.CAC          -0.051019         0.038126          -1.338
0.181
L7.FTSE         -0.061200         0.030056          -2.036
0.042
L8.DAX           0.009058         0.034492           0.263
0.793
L8.SMI           0.024778         0.024815           0.998
0.318
L8.CAC          -0.097555         0.038101          -2.560
0.010
L8.FTSE          0.048158         0.030039           1.603
0.109
L9.DAX           0.026921         0.034539           0.779
0.436
L9.SMI          -0.035057         0.024854          -1.411
0.158
L9.CAC           0.050274         0.037890           1.327
0.185
L9.FTSE         -0.004110         0.030122          -0.136
0.891
L10.DAX          0.040372         0.034596           1.167
0.243
L10.SMI          0.006593         0.024945           0.264
0.792
L10.CAC         -0.019308         0.037947          -0.509
0.611
L10.FTSE        -0.017077         0.030218          -0.565
0.572
L11.DAX          0.058186         0.034343           1.694
0.090
L11.SMI          0.013728         0.024804           0.553
0.580
L11.CAC         -0.015487         0.037970          -0.408
0.683
L11.FTSE        -0.010573         0.030095          -0.351
0.725
================================================================================
====
```

```
Results for equation FTSE
================================================================================
                coefficient       std. error           t-stat
prob
--------------------------------------------------------------------------------
const             1.152197         0.726203            1.587
0.113
L1.DAX            0.024204         0.039867            0.607
0.544
L1.SMI           -0.093526         0.027981           -3.342
0.001
L1.CAC           -0.008986         0.043519           -0.206
0.836
L1.FTSE           0.174825         0.034225            5.108
0.000
L2.DAX            0.017229         0.039821            0.433
0.665
L2.SMI           -0.029392         0.028085           -1.047
0.295
L2.CAC            0.036309         0.043594            0.833
0.405
L2.FTSE          -0.031833         0.034452           -0.924
0.355
L3.DAX           -0.056385         0.039609           -1.424
0.155
L3.SMI            0.007695         0.028043            0.274
0.784
L3.CAC            0.059397         0.043706            1.359
0.174
L3.FTSE           0.007770         0.034565            0.225
0.822
L4.DAX           -0.050778         0.039586           -1.283
0.200
L4.SMI            0.038835         0.028180            1.378
0.168
L4.CAC            0.081026         0.043876            1.847
```

```
0.065
L4.FTSE         -0.091401         0.034697         -2.634
0.008
L5.DAX          -0.018029         0.039858         -0.452
0.651
L5.SMI          -0.034902         0.028387         -1.229
0.219
L5.CAC           0.106804         0.043857          2.435
0.015
L5.FTSE         -0.066915         0.034746         -1.926
0.054
L6.DAX          -0.026199         0.039755         -0.659
0.510
L6.SMI           0.058326         0.028439          2.051
0.040
L6.CAC           0.105054         0.043922          2.392
0.017
L6.FTSE         -0.093175         0.034637         -2.690
0.007
L7.DAX           0.039812         0.039810          1.000
0.317
L7.SMI           0.060004         0.028482          2.107
0.035
L7.CAC          -0.054583         0.043990         -1.241
0.215
L7.FTSE         -0.058763         0.034679         -1.694
0.090
L8.DAX          -0.014377         0.039797         -0.361
0.718
L8.SMI           0.058015         0.028633          2.026
0.043
L8.CAC          -0.068864         0.043962         -1.566
0.117
L8.FTSE          0.015254         0.034659          0.440
0.660
L9.DAX           0.008078         0.039851          0.203
0.839
L9.SMI          -0.025648         0.028677         -0.894
0.371
```

```
L9.CAC           0.073327         0.043718            1.677
0.093
L9.FTSE          0.013886         0.034755            0.400
0.690
L10.DAX          0.048346         0.039917            1.211
0.226
L10.SMI         -0.026559         0.028781           -0.923
0.356
L10.CAC         -0.002653         0.043784           -0.061
0.952
L10.FTSE        -0.036373         0.034867           -1.043
0.297
L11.DAX          0.080742         0.039626            2.038
0.042
L11.SMI          0.038228         0.028620            1.336
0.182
L11.CAC         -0.012021         0.043810           -0.274
0.784
L11.FTSE         0.003188         0.034724            0.092
0.927
================================================================================
====

Correlation matrix of residuals
             DAX       SMI       CAC      FTSE
DAX     1.000000  0.744557  0.742407  0.670121
SMI     0.744557  1.000000  0.638675  0.609294
CAC     0.742407  0.638675  1.000000  0.669407
FTSE    0.670121  0.609294  0.669407  1.000000
```

In [13]:
```
#which variable we should keep in the final model
#Granger test for casality
#here kind f indicates f test
#we can go for chi-sqr test also
grangers = results.test_causality(['SMI', 'CAC', 'FTSE'], ['DAX'], kind
 = 'f')
grangers.summary()
```

Out[13]:

Granger causality F-test. H_0: DAX does not Granger-cause [SMI, CAC, FTSE]. Conclusion: reject H_0 at 5% significance level.

Test statistic	Critical value	p-value	df
1.681	1.438	0.009	(33, 7212)

In [14]:
```
fcast = results.forecast(eustockdiff.values, 50)
```

In [15]:
```
pa.DataFrame(fcast).head()
```

Out[15]:

	0	1	2	3
0	2.741324	0.096875	4.277166	-1.866084
1	-10.667937	1.598237	-3.815663	-8.844529
2	-16.799369	-16.271632	-12.841545	-7.252005
3	-5.835582	-29.049581	-2.570316	-7.261091
4	-42.079109	-27.371264	-17.589227	-18.620932

In [16]:
```
DAXvalues = pa.DataFrame(fcast)[0]
DAXvalues.head()
```

Out[16]:
```
0     2.741324
1   -10.667937
2   -16.799369
3    -5.835582
4   -42.079109
Name: 0, dtype: float64
```

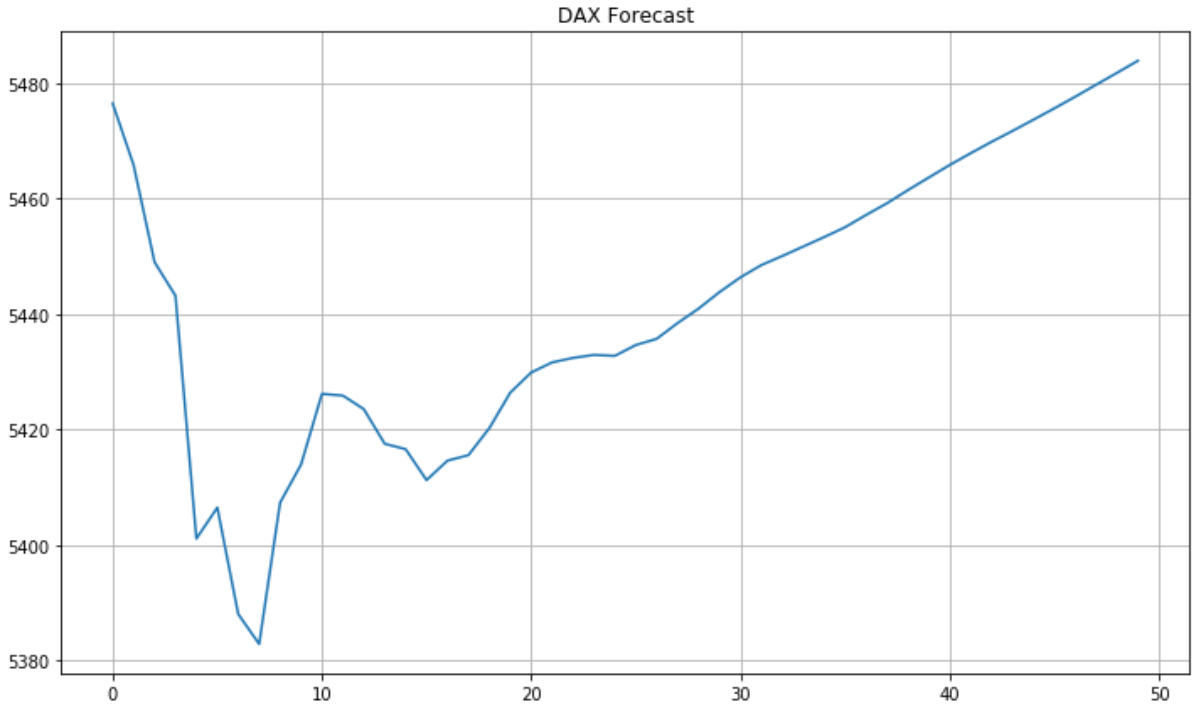
In [17]:
```
eustocks_df.tail(1)
```

Out[17]:

	DAX	SMI	CAC	FTSE
1998-02-16	5473.72	7676.3	3995.0	5455.0

In [18]:
```
dediff = np.cumsum(DAXvalues) + 5473.72
```

In [19]:
```
plt.figure(figsize=(12,7))
plt.plot(dediff)
plt.title('DAX Forecast')
plt.grid()
plt.show()
```



In [ ]:
```

```