Day of the week effect

April 7, 2020

1 Day of the week effect: Indian stock market indices

[1]:
```python
#Importing Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

[2]:
```python
df = pd.read_csv("Index Data.csv",index_col = 'Date',parse_dates = True)
```

[3]:
```python
df.head()
```

[3]:
```
               Auto  Capital Goods  Healthcare  Consumer Durables     FMCG  \
Date
1999-02-01  1000.00        1000.00     1000.00            1000.00  1000.00
1999-02-02   997.29         989.26      993.62             972.13   994.33
1999-02-03  1009.61        1005.18     1008.57             976.90  1008.06
1999-02-04  1001.37         995.89     1016.92             953.25   997.23
1999-02-05   994.08         992.92     1020.40             913.84   990.48

                 IT    Metal  Oil & Gas      PSU
Date
1999-02-01  1000.00  1000.00    1000.00  1000.00
1999-02-02   980.76   984.41     987.35   981.28
1999-02-03  1003.15  1012.54     980.43   982.67
1999-02-04   982.50  1004.54     964.40   965.40
1999-02-05  1170.29   996.95     931.74   939.07
```

[4]:
```python
return_data = np.log(df/df.shift(1)).dropna()
```

[5]:
```python
return_data.head()
```

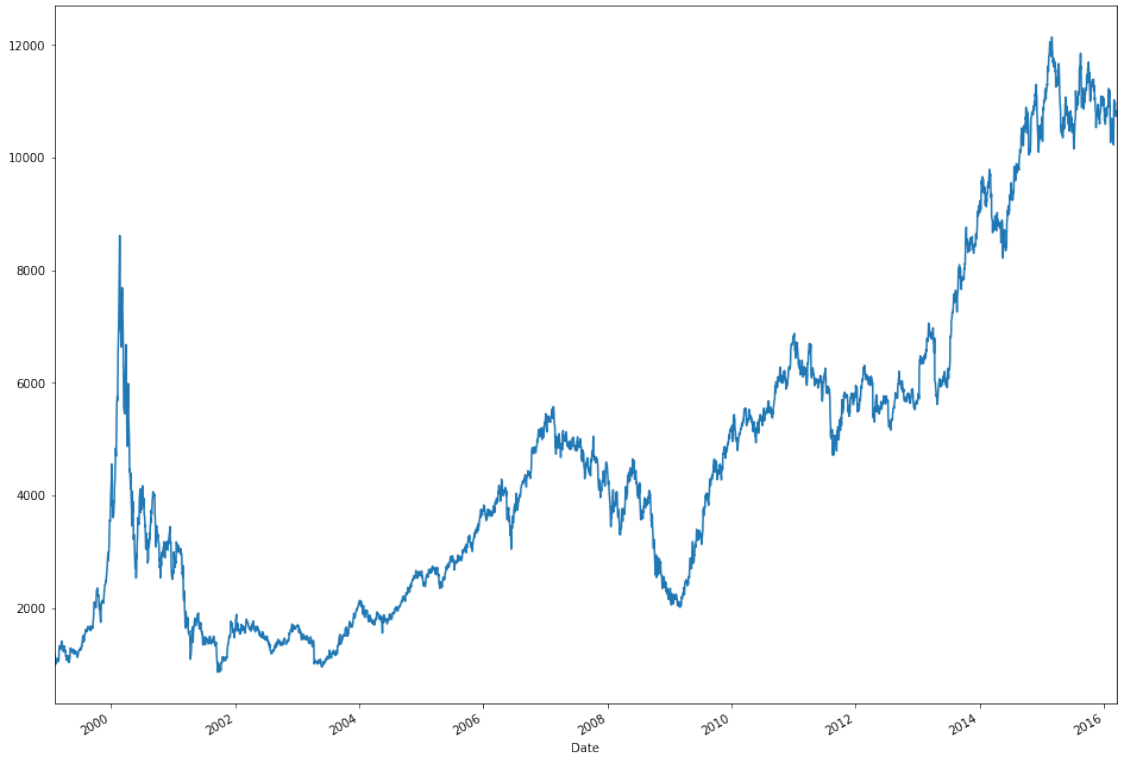
[5]:
```
                Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Date
1999-02-02 -0.002714      -0.010798   -0.006400          -0.028266 -0.005686
1999-02-03  0.012278       0.015965    0.014934           0.004895  0.013714
1999-02-04 -0.008195      -0.009285    0.008245          -0.024507 -0.010802
1999-02-05 -0.007307      -0.002987    0.003416          -0.042222 -0.006792
```

```
1999-02-08  0.001096      -0.006244   -0.006400          -0.018432  0.003799

                 IT     Metal  Oil & Gas       PSU
Date
1999-02-02 -0.019427 -0.015713  -0.012731 -0.018897
1999-02-03  0.022573  0.028175  -0.007033  0.001416
1999-02-04 -0.020800 -0.007932  -0.016485 -0.017731
1999-02-05  0.174907 -0.007584  -0.034452 -0.027652
1999-02-08 -0.161601 -0.015089  -0.036138 -0.027552
```

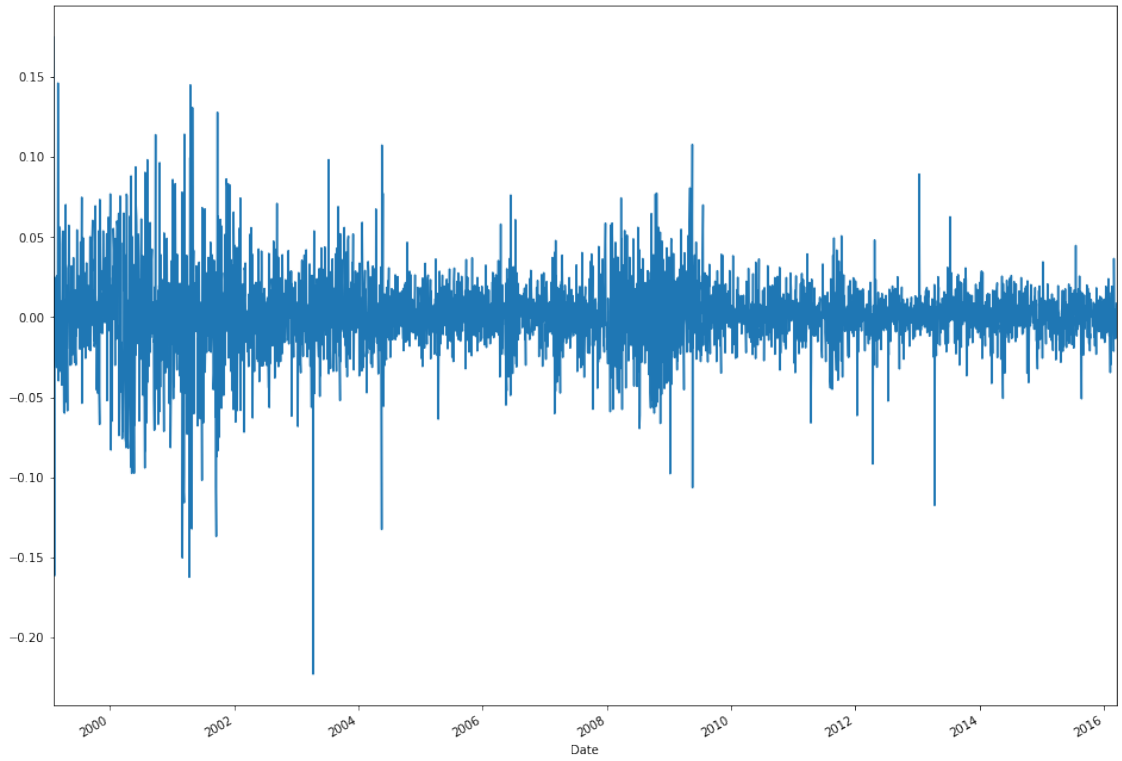
[6]:
```
df['IT'].plot(figsize=(16,12))
```

[6]: <matplotlib.axes._subplots.AxesSubplot at 0x7f1c7a4c3750>



[7]:
```
return_data['IT'].plot(figsize=(16,12))
```

[7]: <matplotlib.axes._subplots.AxesSubplot at 0x7f1c7a1e9790>



[8]:
```
return_data['Weekday'] = return_data.index.weekday
```

[9]:
```
return_data.head()
```

[9]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG	IT	Metal	Oil & Gas	PSU	Weekday
1999-02-02	-0.002714	-0.010798	-0.006400	-0.028266	-0.005686	-0.019427	-0.015713	-0.012731	-0.018897	1
1999-02-03	0.012278	0.015965	0.014934	0.004895	0.013714	0.022573	0.028175	-0.007033	0.001416	2
1999-02-04	-0.008195	-0.009285	0.008245	-0.024507	-0.010802	-0.020800	-0.007932	-0.016485	-0.017731	3
1999-02-05	-0.007307	-0.002987	0.003416	-0.042222	-0.006792	0.174907	-0.007584	-0.034452	-0.027652	4
1999-02-08	0.001096	-0.006244	-0.006400	-0.018432	0.003799	-0.161601	-0.015089	-0.036138	-0.027552	0

[10]:
```
return_data[return_data['Weekday']==0].mean()
```

[10]:
```
Auto                 0.001449
Capital Goods        0.001828
Healthcare           0.001089
Consumer Durables    0.002734
FMCG                 0.000128
IT                   0.000354
Metal                0.001349
Oil & Gas            0.000793
PSU                  0.001072
Weekday              0.000000
dtype: float64
```

[11]:
```
return_data[return_data['Weekday']==1].mean()
```

[11]:
```
Auto                 0.000250
Capital Goods        0.000388
Healthcare           0.000352
Consumer Durables    0.000006
FMCG                 0.000397
IT                   0.001093
Metal               -0.000579
Oil & Gas           -0.000087
PSU                 -0.000424
Weekday              1.000000
dtype: float64
```

[12]:
```
return_data[return_data['Weekday']==2].mean()
```

[12]:
```
Auto                 0.000950
Capital Goods        0.000533
Healthcare           0.001629
Consumer Durables    0.001326
FMCG                 0.001119
IT                   0.001566
Metal                0.001355
Oil & Gas            0.002022
PSU                  0.001278
Weekday              2.000000
dtype: float64
```

[13]:
```
return_data[return_data['Weekday']==3].mean()
```

[13]:
```
Auto                 0.000194
Capital Goods        0.000075
Healthcare          -0.000177
Consumer Durables   -0.000534
FMCG                 0.000583
```

```
IT                  -0.000037
Metal               -0.000021
Oil & Gas           -0.000314
PSU                 -0.000050
Weekday              3.000000
dtype: float64
```

[14]:
```
return_data[return_data['Weekday']==4].mean()
```

[14]:
```
Auto                 0.000368
Capital Goods        0.000010
Healthcare           0.000166
Consumer Durables   -0.001006
FMCG                 0.000117
IT                  -0.000267
Metal                0.000065
Oil & Gas            0.000100
PSU                  0.000099
Weekday              4.000000
dtype: float64
```

[15]:
```
data = return_data.copy()
```

[16]:
```
data.head()
```

[16]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG	IT	Metal	Oil & Gas	PSU	Weekday
1999-02-02	-0.002714	-0.010798	-0.006400	-0.028266	-0.005686	-0.019427	-0.015713	-0.012731	-0.018897	1
1999-02-03	0.012278	0.015965	0.014934	0.004895	0.013714	0.022573	0.028175	-0.007033	0.001416	2
1999-02-04	-0.008195	-0.009285	0.008245	-0.024507	-0.010802	-0.020800	-0.007932	-0.016485	-0.017731	3
1999-02-05	-0.007307	-0.002987	0.003416	-0.042222	-0.006792	0.174907	-0.007584	-0.034452	-0.027652	4
1999-02-08	0.001096	-0.006244	-0.006400	-0.018432	0.003799	-0.161601	-0.015089	-0.036138	-0.027552	0

[17]:
```
#Removing false weekends
data = data[data['Weekday']<5]
data['Backward Diff'] = data['Weekday'] - data['Weekday'].shift(1)
data['Forward Diff'] = data['Weekday'] - data['Weekday'].shift(-1)
data.head()
```

[17]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG
1999-02-02	-0.002714	-0.010798	-0.006400	-0.028266	-0.005686
1999-02-03	0.012278	0.015965	0.014934	0.004895	0.013714
1999-02-04	-0.008195	-0.009285	0.008245	-0.024507	-0.010802
1999-02-05	-0.007307	-0.002987	0.003416	-0.042222	-0.006792
1999-02-08	0.001096	-0.006244	-0.006400	-0.018432	0.003799

Date	IT	Metal	Oil & Gas	PSU	Weekday	Backward Diff	Forward Diff
1999-02-02	-0.019427	-0.015713	-0.012731	-0.018897	1	NaN	-1.0
1999-02-03	0.022573	0.028175	-0.007033	0.001416	2	1.0	-1.0
1999-02-04	-0.020800	-0.007932	-0.016485	-0.017731	3	1.0	-1.0
1999-02-05	0.174907	-0.007584	-0.034452	-0.027652	4	1.0	4.0
1999-02-08	-0.161601	-0.015089	-0.036138	-0.027552	0	-4.0	-1.0

[18]:
```
data.tail()
```

[18]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG
2016-03-10	-0.000893	-0.017105	-0.000070	-0.001333	-0.008386
2016-03-11	0.004203	0.002511	0.005326	-0.000758	0.012291
2016-03-14	0.005978	0.000884	0.001996	-0.002327	0.006923
2016-03-15	-0.007016	-0.002165	-0.030574	0.000211	-0.015551
2016-03-16	-0.005139	-0.000669	0.002993	-0.036819	0.008101

Date	IT	Metal	Oil & Gas	PSU	Weekday	Backward Diff	Forward Diff
2016-03-10	-0.013409	0.003627	-0.010505	-0.006748	3	1.0	-1.0
2016-03-11	-0.000159	-0.006945	0.004976	-0.003983	4	1.0	4.0
2016-03-14	0.000114	-0.020653	0.004646	-0.004886	0	-4.0	-1.0
2016-03-15	-0.008556	0.001932	0.002854	0.003277	1	1.0	
2016-03-16	0.008560	-0.007722	-0.002240	-0.001805	2	1.0	

```
2016-03-15          -1.0
2016-03-16           NaN
```

[19]:
```
data.iloc[-1,-1] = -1.0
```

[20]:
```
data.tail()
```

[20]:
```
                Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Date
2016-03-10 -0.000893      -0.017105   -0.000070          -0.001333 -0.008386
2016-03-11  0.004203       0.002511    0.005326          -0.000758  0.012291
2016-03-14  0.005978       0.000884    0.001996          -0.002327  0.006923
2016-03-15 -0.007016      -0.002165   -0.030574           0.000211 -0.015551
2016-03-16 -0.005139      -0.000669    0.002993          -0.036819  0.008101

                  IT     Metal  Oil & Gas       PSU  Weekday  Backward Diff  \
Date
2016-03-10 -0.013409  0.003627  -0.010505 -0.006748        3            1.0
2016-03-11 -0.000159 -0.006945   0.004976 -0.003983        4            1.0
2016-03-14  0.000114 -0.020653   0.004646 -0.004886        0           -4.0
2016-03-15 -0.008556  0.001932   0.002854  0.003277        1            1.0
2016-03-16  0.008560 -0.007722  -0.002240 -0.001805        2            1.0

            Forward Diff
Date
2016-03-10          -1.0
2016-03-11           4.0
2016-03-14          -1.0
2016-03-15          -1.0
2016-03-16          -1.0
```

[21]:
```
data.head()
```

[21]:
```
                Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Date
1999-02-02 -0.002714      -0.010798   -0.006400          -0.028266 -0.005686
1999-02-03  0.012278       0.015965    0.014934           0.004895  0.013714
1999-02-04 -0.008195      -0.009285    0.008245          -0.024507 -0.010802
1999-02-05 -0.007307      -0.002987    0.003416          -0.042222 -0.006792
1999-02-08  0.001096      -0.006244   -0.006400          -0.018432  0.003799

                  IT     Metal  Oil & Gas       PSU  Weekday  Backward Diff  \
Date
1999-02-02 -0.019427 -0.015713  -0.012731 -0.018897        1            NaN
1999-02-03  0.022573  0.028175  -0.007033  0.001416        2            1.0
1999-02-04 -0.020800 -0.007932  -0.016485 -0.017731        3            1.0
1999-02-05  0.174907 -0.007584  -0.034452 -0.027652        4            1.0
```

```
1999-02-08 -0.161601 -0.015089  -0.036138 -0.027552        0           -4.0

            Forward Diff
Date
1999-02-02          -1.0
1999-02-03          -1.0
1999-02-04          -1.0
1999-02-05           4.0
1999-02-08          -1.0
```

[22]:
```
data['Backward Diff'][0] = 1
```

```
/home/vedant/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:1:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
```

[23]:
```
data.head()
```

[23]:
```
                Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Date
1999-02-02 -0.002714      -0.010798   -0.006400          -0.028266 -0.005686
1999-02-03  0.012278       0.015965    0.014934           0.004895  0.013714
1999-02-04 -0.008195      -0.009285    0.008245          -0.024507 -0.010802
1999-02-05 -0.007307      -0.002987    0.003416          -0.042222 -0.006792
1999-02-08  0.001096      -0.006244   -0.006400          -0.018432  0.003799

                  IT     Metal  Oil & Gas       PSU  Weekday  Backward Diff  \
Date
1999-02-02 -0.019427 -0.015713  -0.012731 -0.018897        1            1.0
1999-02-03  0.022573  0.028175  -0.007033  0.001416        2            1.0
1999-02-04 -0.020800 -0.007932  -0.016485 -0.017731        3            1.0
1999-02-05  0.174907 -0.007584  -0.034452 -0.027652        4            1.0
1999-02-08 -0.161601 -0.015089  -0.036138 -0.027552        0           -4.0

            Forward Diff
Date
1999-02-02          -1.0
1999-02-03          -1.0
1999-02-04          -1.0
1999-02-05           4.0
1999-02-08          -1.0
```

[24]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 4245 entries, 1999-02-02 to 2016-03-16
Data columns (total 12 columns):
Auto                 4245 non-null float64
Capital Goods        4245 non-null float64
Healthcare           4245 non-null float64
Consumer Durables    4245 non-null float64
FMCG                 4245 non-null float64
IT                   4245 non-null float64
Metal                4245 non-null float64
Oil & Gas            4245 non-null float64
PSU                  4245 non-null float64
Weekday              4245 non-null int64
Backward Diff        4245 non-null float64
Forward Diff         4245 non-null float64
dtypes: float64(11), int64(1)
memory usage: 591.1 KB
```

[25]:
```
data = data[(data['Backward Diff']==1) | (data['Backward Diff']==-4)]
```

[26]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 4036 entries, 1999-02-02 to 2016-03-16
Data columns (total 12 columns):
Auto                 4036 non-null float64
Capital Goods        4036 non-null float64
Healthcare           4036 non-null float64
Consumer Durables    4036 non-null float64
FMCG                 4036 non-null float64
IT                   4036 non-null float64
Metal                4036 non-null float64
Oil & Gas            4036 non-null float64
PSU                  4036 non-null float64
Weekday              4036 non-null int64
Backward Diff        4036 non-null float64
Forward Diff         4036 non-null float64
dtypes: float64(11), int64(1)
memory usage: 409.9 KB
```

[27]:
```
data = data[(data['Forward Diff']==-1) | (data['Forward Diff']==4)]
```

[28]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 3837 entries, 1999-02-02 to 2016-03-16
Data columns (total 12 columns):
Auto                 3837 non-null float64
```

```
Capital Goods        3837 non-null float64
Healthcare           3837 non-null float64
Consumer Durables    3837 non-null float64
FMCG                 3837 non-null float64
IT                   3837 non-null float64
Metal                3837 non-null float64
Oil & Gas            3837 non-null float64
PSU                  3837 non-null float64
Weekday              3837 non-null int64
Backward Diff        3837 non-null float64
Forward Diff         3837 non-null float64
dtypes: float64(11), int64(1)
memory usage: 389.7 KB
```

[29]:
```
data.head()
```

[29]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG	IT	Metal	Oil & Gas	PSU	Weekday	Backward Diff	Forward Diff
1999-02-02	-0.002714	-0.010798	-0.006400	-0.028266	-0.005686	-0.019427	-0.015713	-0.012731	-0.018897	1	1.0	-1.0
1999-02-03	0.012278	0.015965	0.014934	0.004895	0.013714	0.022573	0.028175	-0.007033	0.001416	2	1.0	-1.0
1999-02-04	-0.008195	-0.009285	0.008245	-0.024507	-0.010802	-0.020800	-0.007932	-0.016485	-0.017731	3	1.0	-1.0
1999-02-05	-0.007307	-0.002987	0.003416	-0.042222	-0.006792	0.174907	-0.007584	-0.034452	-0.027652	4	1.0	4.0
1999-02-08	0.001096	-0.006244	-0.006400	-0.018432	0.003799	-0.161601	-0.015089	-0.036138	-0.027552	0	-4.0	-1.0

[30]:
```
data.drop(columns=['Backward Diff', 'Forward Diff'], inplace=True)
```

[31]:
```
data.head()
```

[31]:

Date	Auto	Capital Goods	Healthcare	Consumer Durables	FMCG
1999-02-02	-0.002714	-0.010798	-0.006400	-0.028266	-0.005686

```
1999-02-03  0.012278       0.015965    0.014934           0.004895  0.013714
1999-02-04 -0.008195      -0.009285    0.008245          -0.024507 -0.010802
1999-02-05 -0.007307      -0.002987    0.003416          -0.042222 -0.006792
1999-02-08  0.001096      -0.006244   -0.006400          -0.018432  0.003799

                  IT     Metal  Oil & Gas       PSU  Weekday
Date
1999-02-02 -0.019427 -0.015713  -0.012731 -0.018897        1
1999-02-03  0.022573  0.028175  -0.007033  0.001416        2
1999-02-04 -0.020800 -0.007932  -0.016485 -0.017731        3
1999-02-05  0.174907 -0.007584  -0.034452 -0.027652        4
1999-02-08 -0.161601 -0.015089  -0.036138 -0.027552        0
```

[32]:
```
data[data['Weekday']==0].mean()
```

[32]:
```
Auto                0.001212
Capital Goods       0.001441
Healthcare          0.000783
Consumer Durables   0.002599
FMCG               -0.000272
IT                 -0.000665
Metal               0.000802
Oil & Gas           0.000549
PSU                 0.000685
Weekday             0.000000
dtype: float64
```

[33]:
```
data[data['Weekday']==1].mean()
```

[33]:
```
Auto                0.000113
Capital Goods       0.000250
Healthcare          0.000370
Consumer Durables  -0.000073
FMCG                0.000305
IT                  0.000747
Metal              -0.000656
Oil & Gas          -0.000073
PSU                -0.000464
Weekday             1.000000
dtype: float64
```

[34]:
```
data[data['Weekday']==2].mean()
```

[34]:
```
Auto                0.000767
Capital Goods       0.000457
Healthcare          0.001676
Consumer Durables   0.001392
```

```
FMCG                 0.000954
IT                   0.001589
Metal                0.001236
Oil & Gas            0.001981
PSU                  0.001139
Weekday              2.000000
dtype: float64
```

[35]:
```
data[data['Weekday']==3].mean()
```

[35]:
```
Auto                -0.000139
Capital Goods       -0.000178
Healthcare          -0.000136
Consumer Durables   -0.000677
FMCG                 0.000596
IT                  -0.000306
Metal               -0.000362
Oil & Gas           -0.000465
PSU                 -0.000080
Weekday              3.000000
dtype: float64
```

[36]:
```
data[data['Weekday']==4].mean()
```

[36]:
```
Auto                 0.000209
Capital Goods        0.000271
Healthcare           0.000054
Consumer Durables   -0.000892
FMCG                 0.000252
IT                   0.000250
Metal                0.000233
Oil & Gas            0.000164
PSU                  0.000184
Weekday              4.000000
dtype: float64
```

[37]:
```
data.head()
```

[37]:
```
                Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Date
1999-02-02 -0.002714      -0.010798   -0.006400          -0.028266 -0.005686
1999-02-03  0.012278       0.015965    0.014934           0.004895  0.013714
1999-02-04 -0.008195      -0.009285    0.008245          -0.024507 -0.010802
1999-02-05 -0.007307      -0.002987    0.003416          -0.042222 -0.006792
1999-02-08  0.001096      -0.006244   -0.006400          -0.018432  0.003799

                  IT     Metal  Oil & Gas       PSU  Weekday
```

```
Date
1999-02-02 -0.019427 -0.015713  -0.012731 -0.018897        1
1999-02-03  0.022573  0.028175  -0.007033  0.001416        2
1999-02-04 -0.020800 -0.007932  -0.016485 -0.017731        3
1999-02-05  0.174907 -0.007584  -0.034452 -0.027652        4
1999-02-08 -0.161601 -0.015089  -0.036138 -0.027552        0
```

1.0.1 Regression Analysis

[38]:
```
result = pd.DataFrame(data=np.zeros((5,9)),
                      index=['Mon','Tue','Wed','Thur','Fri'],
                     columns=data.columns[:-1])
result.head()
```

[38]:
```
      Auto  Capital Goods  Healthcare  Consumer Durables  FMCG   IT  Metal  \
Mon    0.0            0.0         0.0                0.0   0.0  0.0    0.0
Tue    0.0            0.0         0.0                0.0   0.0  0.0    0.0
Wed    0.0            0.0         0.0                0.0   0.0  0.0    0.0
Thur   0.0            0.0         0.0                0.0   0.0  0.0    0.0
Fri    0.0            0.0         0.0                0.0   0.0  0.0    0.0

      Oil & Gas  PSU
Mon         0.0  0.0
Tue         0.0  0.0
Wed         0.0  0.0
Thur        0.0  0.0
Fri         0.0  0.0
```

[50]:
```
from sklearn.preprocessing import OneHotEncoder
import statsmodels.api as sm
#import pyflux as pf
from arch import arch_model
```

[55]:
```
models = []
garchs = []
for i in range(0,9):
    temp = data.iloc[:,[i,-1]]
    encoder = OneHotEncoder(categorical_features = [1])
    temp_arr = encoder.fit_transform(temp).toarray()
    model = sm.OLS(endog=temp_arr[:,-1],exog=temp_arr[:,:-1]).fit()
    models.append(model)
    result.iloc[:,i]=model.params

    #garch =  pf.GARCH(model.resid,p=1,q=1).fit()
    garch = arch_model(y=model.resid,p=1,q=1,vol='Garch').fit()
    garchs.append(garch)
```

```
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0002441. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0003542. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.
```

```
This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:711:
ConvergenceWarning: The optimizer returned code 8. The message is:
Positive directional derivative for linesearch
See scipy.optimize.fmin_slsqp for code meaning.

  ConvergenceWarning,
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0001829. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:711:
ConvergenceWarning: The optimizer returned code 8. The message is:
Positive directional derivative for linesearch
See scipy.optimize.fmin_slsqp for code meaning.

  ConvergenceWarning,
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
```

```
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0003802. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)

Iteration:      1,   Func. Count:      6,   Neg. LLF: -10808.085733102002
Iteration:      2,   Func. Count:     20,   Neg. LLF: -10810.425406483915
Iteration:      3,   Func. Count:     33,   Neg. LLF: -10810.425743621137
Iteration:      4,   Func. Count:     47,   Neg. LLF: -10810.425910434085
Optimization terminated successfully.    (Exit mode 0)
            Current function value: -10810.425905767017
            Iterations: 5
            Function evaluations: 58
            Gradient evaluations: 4
Iteration:      1,   Func. Count:      6,   Neg. LLF: -10221.468280103236
Iteration:      2,   Func. Count:     20,   Neg. LLF: -10223.525551299155
Positive directional derivative for linesearch    (Exit mode 8)
```

```
            Current function value: -10223.525547340476
            Iterations: 6
            Function evaluations: 20
            Gradient evaluations: 2
Iteration:      1,   Func. Count:      6,   Neg. LLF: -11548.811843464864
Iteration:      2,   Func. Count:     20,   Neg. LLF: -11549.22390852394
Iteration:      3,   Func. Count:     36,   Neg. LLF: -11549.22328179368
Iteration:      4,   Func. Count:     50,   Neg. LLF: -11549.223909714996
Positive directional derivative for linesearch    (Exit mode 8)
            Current function value: -11549.223905377417
            Iterations: 8
            Function evaluations: 50
            Gradient evaluations: 4
Iteration:      1,   Func. Count:      6,   Neg. LLF: -10008.313792767582
Iteration:      2,   Func. Count:     20,   Neg. LLF: -10010.699415793268
Iteration:      3,   Func. Count:     33,   Neg. LLF: -10010.699822764327
Iteration:      4,   Func. Count:     47,   Neg. LLF: -10010.699915389027
Optimization terminated successfully.    (Exit mode 0)
            Current function value: -10010.699911159289
            Iterations: 5
            Function evaluations: 57
            Gradient evaluations: 4
Iteration:      1,   Func. Count:      6,   Neg. LLF: -11250.047114381276
Iteration:      2,   Func. Count:     20,   Neg. LLF: -11250.845347879957
Positive directional derivative for linesearch    (Exit mode 8)
            Current function value: -11250.845336792074
            Iterations: 6
            Function evaluations: 20
            Gradient evaluations: 2

/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0001973. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:711:
ConvergenceWarning: The optimizer returned code 8. The message is:
Positive directional derivative for linesearch
See scipy.optimize.fmin_slsqp for code meaning.

  ConvergenceWarning,
/home/vedant/anaconda3/lib/python3.7/site-
```

```
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0005622. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:711:
ConvergenceWarning: The optimizer returned code 8. The message is:
Positive directional derivative for linesearch
See scipy.optimize.fmin_slsqp for code meaning.

  ConvergenceWarning,
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
```

```
optimizer when
estimating the model parameters. The scale of y is 0.0004869. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.0003432. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning

Iteration:      1,   Func. Count:      6,   Neg. LLF: -9651.429954964591
Iteration:      2,   Func. Count:     21,   Neg. LLF: -9653.954323465128
Iteration:      3,   Func. Count:     37,   Neg. LLF: -9653.953848447441
Iteration:      4,   Func. Count:     50,   Neg. LLF: -9653.954402512973
Iteration:      5,   Func. Count:     66,   Neg. LLF: -9653.954472565656
Iteration:      6,   Func. Count:     82,   Neg. LLF: -9653.954404357883
Positive directional derivative for linesearch    (Exit mode 8)
            Current function value: -9653.954413423951
            Iterations: 10
            Function evaluations: 82
            Gradient evaluations: 6
Iteration:      1,   Func. Count:      6,   Neg. LLF: -9623.226105169515
```

```
Iteration:      2,   Func. Count:     19,   Neg. LLF: -9623.306315094516
Iteration:      3,   Func. Count:     33,   Neg. LLF: -9623.309583432192
Optimization terminated successfully.    (Exit mode 0)
            Current function value: -9623.309579916291
            Iterations: 3
            Function evaluations: 44
            Gradient evaluations: 3
Iteration:      1,   Func. Count:      6,   Neg. LLF: -10304.840992566938
Iteration:      2,   Func. Count:     19,   Neg. LLF: -10304.920632454188
Iteration:      3,   Func. Count:     32,   Neg. LLF: -10304.96663056719
Iteration:      4,   Func. Count:     45,   Neg. LLF: -10305.02683991976
Iteration:      5,   Func. Count:     60,   Neg. LLF: -10305.029331473386
Optimization terminated successfully.    (Exit mode 0)
            Current function value: -10305.029320526675
            Iterations: 6
            Function evaluations: 71
            Gradient evaluations: 5
Iteration:      1,   Func. Count:      6,   Neg. LLF: -10575.44932541482
Iteration:      2,   Func. Count:     20,   Neg. LLF: -10575.542577088414
Positive directional derivative for linesearch    (Exit mode 8)
            Current function value: -10575.542571536342
            Iterations: 6
            Function evaluations: 20
            Gradient evaluations: 2

/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:415: FutureWarning: The handling of
integer data will change in version 0.22. Currently, the categories are
determined based on the range [0, max(values)], while in the future they will be
determined based on the unique values.
If you want the future behaviour and silence this warning, you can specify
"categories='auto'".
In case you used a LabelEncoder before this OneHotEncoder to convert the
categories to integers, then you can now use the OneHotEncoder directly.
  warnings.warn(msg, FutureWarning)
/home/vedant/anaconda3/lib/python3.7/site-
packages/sklearn/preprocessing/_encoders.py:451: DeprecationWarning: The
'categorical_features' keyword is deprecated in version 0.20 and will be removed
in 0.22. You can use the ColumnTransformer instead.
  "use the ColumnTransformer instead.", DeprecationWarning)
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:293:
DataScaleWarning: y is poorly scaled, which may affect convergence of the
optimizer when
estimating the model parameters. The scale of y is 0.000302. Parameter
estimation work better when this value is between 1 and 1000. The recommended
rescaling is 100 * y.

This warning can be disabled by either rescaling y before initializing the
```

```
model or by setting rescale=False.

  data_scale_warning.format(orig_scale, rescale), DataScaleWarning
/home/vedant/anaconda3/lib/python3.7/site-packages/arch/univariate/base.py:711:
ConvergenceWarning: The optimizer returned code 8. The message is:
Positive directional derivative for linesearch
See scipy.optimize.fmin_slsqp for code meaning.

  ConvergenceWarning,
```

[56]:
```
result
```

[56]:
```
           Auto  Capital Goods  Healthcare  Consumer Durables      FMCG  \
Mon    0.001212       0.001441    0.000783           0.002599 -0.000272
Tue    0.000113       0.000250    0.000370          -0.000073  0.000305
Wed    0.000767       0.000457    0.001676           0.001392  0.000954
Thur -0.000139      -0.000178   -0.000136          -0.000677  0.000596
Fri    0.000209       0.000271    0.000054          -0.000892  0.000252

             IT     Metal  Oil & Gas       PSU
Mon  -0.000665  0.000802   0.000549  0.000685
Tue   0.000747 -0.000656  -0.000073 -0.000464
Wed   0.001589  0.001236   0.001981  0.001139
Thur -0.000306 -0.000362  -0.000465 -0.000080
Fri   0.000250  0.000233   0.000164  0.000184
```

[57]:
```
for i in range(0,9):
    print(models[i].summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.001
Model:                            OLS   Adj. R-squared:                 -0.000
Method:                 Least Squares   F-statistic:                    0.9377
Date:                Tue, 07 Apr 2020   Prob (F-statistic):              0.441
Time:                        02:12:47   Log-Likelihood:                 10514.
No. Observations:                3837   AIC:                        -2.102e+04
Df Residuals:                    3832   BIC:                        -2.099e+04
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
x1             0.0012      0.001      2.142      0.032       0.000       0.002
x2             0.0001      0.001      0.201      0.841      -0.001       0.001
x3             0.0008      0.001      1.367      0.172      -0.000       0.002
x4            -0.0001      0.001     -0.246      0.806      -0.001       0.001
x5             0.0002      0.001      0.369      0.712      -0.001       0.001
```

```
==============================================================================
Omnibus:                      385.207   Durbin-Watson:                   1.761
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             1898.380
Skew:                          -0.360   Prob(JB):                         0.00
Kurtosis:                       6.370   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.001
Model:                            OLS   Adj. R-squared:                 -0.000
Method:                 Least Squares   F-statistic:                    0.7789
Date:                Tue, 07 Apr 2020   Prob (F-statistic):              0.539
Time:                        02:12:47   Log-Likelihood:                 9799.3
No. Observations:                3837   AIC:                        -1.959e+04
Df Residuals:                    3832   BIC:                        -1.956e+04
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
x1             0.0014      0.001      2.115      0.035       0.000       0.003
x2             0.0003      0.001      0.370      0.711      -0.001       0.002
x3             0.0005      0.001      0.676      0.499      -0.001       0.002
x4            -0.0002      0.001     -0.260      0.795      -0.002       0.001
x5             0.0003      0.001      0.397      0.692      -0.001       0.002
==============================================================================
Omnibus:                      518.562   Durbin-Watson:                   1.781
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             6768.953
Skew:                          -0.005   Prob(JB):                         0.00
Kurtosis:                       9.507   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.002
Model:                            OLS   Adj. R-squared:                  0.001
Method:                 Least Squares   F-statistic:                    2.177
Date:                Tue, 07 Apr 2020   Prob (F-statistic):             0.0691
Time:                        02:12:47   Log-Likelihood:                 11067.
No. Observations:                3837   AIC:                        -2.212e+04
Df Residuals:                    3832   BIC:                        -2.209e+04
```

```
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
x1             0.0008      0.000      1.599      0.110      -0.000       0.002
x2             0.0004      0.000      0.763      0.446      -0.001       0.001
x3             0.0017      0.000      3.449      0.001       0.001       0.003
x4            -0.0001      0.000     -0.277      0.782      -0.001       0.001
x5          5.385e-05      0.000      0.110      0.913      -0.001       0.001
==============================================================================
Omnibus:                      478.813   Durbin-Watson:                   1.785
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             3580.797
Skew:                          -0.345   Prob(JB):                         0.00
Kurtosis:                       7.682   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.005
Model:                            OLS   Adj. R-squared:                  0.004
Method:                 Least Squares   F-statistic:                     4.440
Date:                Tue, 07 Apr 2020   Prob (F-statistic):            0.00140
Time:                        02:12:47   Log-Likelihood:                 9663.2
No. Observations:                3837   AIC:                         -1.932e+04
Df Residuals:                    3832   BIC:                         -1.929e+04
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
x1             0.0026      0.001      3.681      0.000       0.001       0.004
x2         -7.341e-05      0.001     -0.105      0.916      -0.001       0.001
x3             0.0014      0.001      1.987      0.047    1.82e-05       0.003
x4            -0.0007      0.001     -0.956      0.339      -0.002       0.001
x5            -0.0009      0.001     -1.262      0.207      -0.002       0.000
==============================================================================
Omnibus:                      392.447   Durbin-Watson:                   1.820
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             2495.578
Skew:                          -0.259   Prob(JB):                         0.00
Kurtosis:                       6.917   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
```

specified.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.001
Model:	OLS	Adj. R-squared:	-0.000
Method:	Least Squares	F-statistic:	0.7990
Date:	Tue, 07 Apr 2020	Prob (F-statistic):	0.526
Time:	02:12:47	Log-Likelihood:	10922.
No. Observations:	3837	AIC:	-2.183e+04
Df Residuals:	3832	BIC:	-2.180e+04
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
x1	-0.0003	0.001	-0.535	0.593	-0.001	0.001
x2	0.0003	0.001	0.606	0.545	-0.001	0.001
x3	0.0010	0.001	1.889	0.059	-3.62e-05	0.002
x4	0.0006	0.001	1.167	0.243	-0.000	0.002
x5	0.0003	0.001	0.495	0.621	-0.001	0.001

Omnibus:	370.100	Durbin-Watson:	1.941
Prob(Omnibus):	0.000	Jarque-Bera (JB):	2626.392
Skew:	-0.123	Prob(JB):	0.00
Kurtosis:	7.046	Cond. No.	1.01

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.001
Model:	OLS	Adj. R-squared:	0.000
Method:	Least Squares	F-statistic:	1.080
Date:	Tue, 07 Apr 2020	Prob (F-statistic):	0.365
Time:	02:12:47	Log-Likelihood:	8913.0
No. Observations:	3837	AIC:	-1.782e+04
Df Residuals:	3832	BIC:	-1.778e+04
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
x1	-0.0007	0.001	-0.774	0.439	-0.002	0.001
x2	0.0007	0.001	0.878	0.380	-0.001	0.002
x3	0.0016	0.001	1.864	0.062	-8.24e-05	0.003
x4	-0.0003	0.001	-0.355	0.722	-0.002	0.001

```
x5             0.0002      0.001      0.290      0.771      -0.001       0.002
==============================================================================
Omnibus:                      688.657   Durbin-Watson:                   1.901
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            10109.313
Skew:                          -0.408   Prob(JB):                         0.00
Kurtosis:                      10.910   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.001
Model:                            OLS   Adj. R-squared:                 -0.000
Method:                 Least Squares   F-statistic:                    0.9780
Date:                Tue, 07 Apr 2020   Prob (F-statistic):              0.418
Time:                        02:12:47   Log-Likelihood:                 9188.8
No. Observations:                3837   AIC:                         -1.837e+04
Df Residuals:                    3832   BIC:                         -1.834e+04
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
x1             0.0008      0.001      1.004      0.315      -0.001       0.002
x2            -0.0007      0.001     -0.828      0.408      -0.002       0.001
x3             0.0012      0.001      1.558      0.119      -0.000       0.003
x4            -0.0004      0.001     -0.451      0.652      -0.002       0.001
x5             0.0002      0.001      0.291      0.771      -0.001       0.002
==============================================================================
Omnibus:                      422.248   Durbin-Watson:                   1.818
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             2695.030
Skew:                          -0.315   Prob(JB):                         0.00
Kurtosis:                       7.057   Cond. No.                         1.01
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.002
Model:                            OLS   Adj. R-squared:                  0.001
Method:                 Least Squares   F-statistic:                     1.989
Date:                Tue, 07 Apr 2020   Prob (F-statistic):             0.0934
Time:                        02:12:47   Log-Likelihood:                 9859.7
No. Observations:                3837   AIC:                         -1.971e+04
```

Df Residuals:	3832	BIC:	-1.968e+04
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
x1	0.0005	0.001	0.819	0.413	-0.001	0.002
x2	-7.3e-05	0.001	-0.110	0.913	-0.001	0.001
x3	0.0020	0.001	2.975	0.003	0.001	0.003
x4	-0.0005	0.001	-0.691	0.490	-0.002	0.001
x5	0.0002	0.001	0.244	0.807	-0.001	0.001

Omnibus:	643.869	Durbin-Watson:	1.826
Prob(Omnibus):	0.000	Jarque-Bera (JB):	9198.423
Skew:	-0.342	Prob(JB):	0.00
Kurtosis:	10.554	Cond. No.	1.01

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.001
Model:	OLS	Adj. R-squared:	0.000
Method:	Least Squares	F-statistic:	1.019
Date:	Tue, 07 Apr 2020	Prob (F-statistic):	0.396
Time:	02:12:47	Log-Likelihood:	10105.
No. Observations:	3837	AIC:	-2.020e+04
Df Residuals:	3832	BIC:	-2.017e+04
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
x1	0.0007	0.001	1.089	0.276	-0.001	0.002
x2	-0.0005	0.001	-0.744	0.457	-0.002	0.001
x3	0.0011	0.001	1.823	0.068	-8.6e-05	0.002
x4	-8.013e-05	0.001	-0.127	0.899	-0.001	0.001
x5	0.0002	0.001	0.293	0.770	-0.001	0.001

Omnibus:	623.112	Durbin-Watson:	1.707
Prob(Omnibus):	0.000	Jarque-Bera (JB):	8703.083
Skew:	-0.314	Prob(JB):	0.00
Kurtosis:	10.351	Cond. No.	1.01

Warnings:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[58]:
```
for i in range(0,9):
    print(garchs[i].summary())
```

```
                     Constant Mean - GARCH Model Results
==============================================================================
Dep. Variable:                          y   R-squared:                      -0.001
Mean Model:             Constant Mean       Adj. R-squared:                 -0.001
Vol Model:                      GARCH       Log-Likelihood:                 10810.4
Distribution:                  Normal       AIC:                           -21612.9
Method:            Maximum Likelihood       BIC:                           -21587.8
                                            No. Observations:                 3837
Date:                Tue, Apr 07 2020       Df Residuals:                     3833
Time:                        02:12:32       Df Model:                            4
                            Mean Model
==============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
------------------------------------------------------------------------------
mu         4.6745e-04  2.260e-04      2.068  3.859e-02 [2.453e-05,9.104e-04]
                          Volatility Model
==============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
------------------------------------------------------------------------------
omega      2.4406e-05  4.781e-07     51.051      0.000 [2.347e-05,2.534e-05]
alpha[1]       0.2000  2.468e-02      8.105  5.260e-16     [  0.152,  0.248]
beta[1]        0.7000  2.156e-02     32.465 3.321e-231     [  0.658,  0.742]
==============================================================================

Covariance estimator: robust
                     Constant Mean - GARCH Model Results
==============================================================================
Dep. Variable:                          y   R-squared:                      -0.001
Mean Model:             Constant Mean       Adj. R-squared:                 -0.001
Vol Model:                      GARCH       Log-Likelihood:                 10223.5
Distribution:                  Normal       AIC:                           -20439.1
Method:            Maximum Likelihood       BIC:                           -20414.0
                                            No. Observations:                 3837
Date:                Tue, Apr 07 2020       Df Residuals:                     3833
Time:                        02:12:32       Df Model:                            4
                            Mean Model
==============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
------------------------------------------------------------------------------
mu         5.0283e-04  8.596e-06     58.494      0.000 [4.860e-04,5.197e-04]
                          Volatility Model
==============================================================================
```

```
                 coef    std err          t      P>|t|      95.0% Conf. Int.
-----------------------------------------------------------------------------
omega      7.0840e-06  5.565e-11  1.273e+05      0.000 [7.084e-06,7.084e-06]
alpha[1]       0.1000  1.364e-02      7.329  2.314e-13   [7.326e-02,  0.127]
beta[1]        0.8800  1.154e-02     76.237      0.000     [  0.857,  0.903]
=============================================================================

Covariance estimator: robust
WARNING: The optimizer did not indicate successful convergence. The message was
Positive directional derivative for linesearch.
See convergence_flag.

                     Constant Mean - GARCH Model Results
==============================================================================
Dep. Variable:                          y   R-squared:                 -0.000
Mean Model:             Constant Mean       Adj. R-squared:            -0.000
Vol Model:                      GARCH       Log-Likelihood:            11549.2
Distribution:                  Normal       AIC:                      -23090.4
Method:            Maximum Likelihood       BIC:                      -23065.4
                                            No. Observations:             3837
Date:                Tue, Apr 07 2020       Df Residuals:                 3833
Time:                        02:12:32       Df Model:                        4
                              Mean Model
==============================================================================
                 coef    std err          t      P>|t|       95.0% Conf. Int.
------------------------------------------------------------------------------
mu         1.5519e-04  1.921e-04      0.808      0.419 [-2.213e-04,5.317e-04]
                           Volatility Model
==============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
-----------------------------------------------------------------------------
omega      3.6577e-06  6.231e-14  5.870e+07      0.000 [3.658e-06,3.658e-06]
alpha[1]       0.1000  5.089e-04    196.520      0.000   [9.900e-02,  0.101]
beta[1]        0.8800  4.340e-03    202.770      0.000     [  0.871,  0.889]
=============================================================================

Covariance estimator: robust
WARNING: The optimizer did not indicate successful convergence. The message was
Positive directional derivative for linesearch.
See convergence_flag.

                     Constant Mean - GARCH Model Results
==============================================================================
Dep. Variable:                          y   R-squared:                 -0.001
Mean Model:             Constant Mean       Adj. R-squared:            -0.001
Vol Model:                      GARCH       Log-Likelihood:            10010.7
Distribution:                  Normal       AIC:                      -20013.4
Method:            Maximum Likelihood       BIC:                      -19988.4
```

```
                                     No. Observations:                 3837
Date:                Tue, Apr 07 2020   Df Residuals:                     3833
Time:                        02:12:32   Df Model:                            4
                            Mean Model
============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
----------------------------------------------------------------------------
mu         5.7791e-04  2.674e-04      2.161  3.066e-02 [5.387e-05,1.102e-03]
                          Volatility Model
============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
----------------------------------------------------------------------------
omega      3.8023e-05  2.897e-06     13.124  2.413e-39 [3.234e-05,4.370e-05]
alpha[1]       0.2000  2.128e-02      9.400  5.470e-21     [  0.158,  0.242]
beta[1]        0.7000  2.202e-02     31.794 7.957e-222     [  0.657,  0.743]
============================================================================

Covariance estimator: robust
                  Constant Mean - GARCH Model Results
==============================================================================
Dep. Variable:                          y   R-squared:                  -0.000
Mean Model:                Constant Mean   Adj. R-squared:             -0.000
Vol Model:                         GARCH   Log-Likelihood:             11250.8
Distribution:                     Normal   AIC:                       -22493.7
Method:            Maximum Likelihood   BIC:                       -22468.7
                                        No. Observations:                3837
Date:                Tue, Apr 07 2020   Df Residuals:                    3833
Time:                        02:12:32   Df Model:                           4
                            Mean Model
============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
----------------------------------------------------------------------------
mu         2.3827e-04  7.855e-06     30.332 4.280e-202 [2.229e-04,2.537e-04]
                          Volatility Model
============================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
----------------------------------------------------------------------------
omega      3.9460e-06  1.627e-11  2.425e+05      0.000 [3.946e-06,3.946e-06]
alpha[1]       0.1000  1.904e-02      5.253  1.495e-07   [6.269e-02,  0.137]
beta[1]        0.8800  1.636e-02     53.791      0.000     [  0.848,  0.912]
============================================================================

Covariance estimator: robust
WARNING: The optimizer did not indicate successful convergence. The message was
Positive directional derivative for linesearch.
See convergence_flag.

                  Constant Mean - GARCH Model Results
```

```
================================================================================
Dep. Variable:                          y   R-squared:                       -0.001
Mean Model:                Constant Mean   Adj. R-squared:                  -0.001
Vol Model:                         GARCH   Log-Likelihood:                9653.95
Distribution:                     Normal   AIC:                           -19299.9
Method:              Maximum Likelihood   BIC:                           -19274.9
                                          No. Observations:                  3837
Date:                  Tue, Apr 07 2020   Df Residuals:                      3833
Time:                          02:12:32   Df Model:                             4
                               Mean Model
================================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
--------------------------------------------------------------------------------
mu         6.0762e-04  2.632e-04      2.308  2.097e-02 [9.174e-05,1.124e-03]
                           Volatility Model
================================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
--------------------------------------------------------------------------------
omega      1.1244e-05  5.157e-12  2.180e+06      0.000 [1.124e-05,1.124e-05]
alpha[1]       0.1000  1.981e-02      5.047  4.478e-07   [6.117e-02,  0.139]
beta[1]        0.8800  1.500e-02     58.666      0.000     [  0.851,  0.909]
================================================================================

Covariance estimator: robust
WARNING: The optimizer did not indicate successful convergence. The message was
Positive directional derivative for linesearch.
See convergence_flag.

                     Constant Mean - GARCH Model Results
================================================================================
Dep. Variable:                          y   R-squared:                       -0.000
Mean Model:                Constant Mean   Adj. R-squared:                  -0.000
Vol Model:                         GARCH   Log-Likelihood:                9623.31
Distribution:                     Normal   AIC:                           -19238.6
Method:              Maximum Likelihood   BIC:                           -19213.6
                                          No. Observations:                  3837
Date:                  Tue, Apr 07 2020   Df Residuals:                      3833
Time:                          02:12:32   Df Model:                             4
                               Mean Model
================================================================================
                 coef    std err          t      P>|t|       95.0% Conf. Int.
--------------------------------------------------------------------------------
mu         1.1802e-04  3.094e-04      0.381      0.703 [-4.883e-04,7.244e-04]
                           Volatility Model
================================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
--------------------------------------------------------------------------------
omega      9.7381e-06  5.689e-12  1.712e+06      0.000 [9.738e-06,9.738e-06]
```

```
alpha[1]       0.1000  1.274e-02      7.852  4.110e-15   [7.504e-02,  0.125]
beta[1]        0.8800  1.101e-02     79.942      0.000     [  0.858,  0.902]
================================================================================

Covariance estimator: robust
                    Constant Mean - GARCH Model Results
================================================================================
Dep. Variable:                          y   R-squared:                       -0.000
Mean Model:                Constant Mean   Adj. R-squared:                  -0.000
Vol Model:                         GARCH   Log-Likelihood:                10305.0
Distribution:                     Normal   AIC:                           -20602.1
Method:              Maximum Likelihood   BIC:                           -20577.0
                                          No. Observations:                  3837
Date:                  Tue, Apr 07 2020   Df Residuals:                      3833
Time:                          02:12:32   Df Model:                             4
                                Mean Model
================================================================================
                 coef    std err          t      P>|t|       95.0% Conf. Int.
--------------------------------------------------------------------------------
mu         1.4668e-04  2.461e-04      0.596      0.551 [-3.357e-04,6.291e-04]
                             Volatility Model
================================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
--------------------------------------------------------------------------------
omega      6.8648e-06  7.127e-13  9.633e+06      0.000 [6.865e-06,6.865e-06]
alpha[1]       0.1000  5.383e-03     18.576  4.994e-77   [8.945e-02,  0.111]
beta[1]        0.8800  9.995e-04    880.447      0.000     [  0.878,  0.882]
================================================================================

Covariance estimator: robust
                    Constant Mean - GARCH Model Results
================================================================================
Dep. Variable:                          y   R-squared:                       -0.000
Mean Model:                Constant Mean   Adj. R-squared:                  -0.000
Vol Model:                         GARCH   Log-Likelihood:                10575.5
Distribution:                     Normal   AIC:                           -21143.1
Method:              Maximum Likelihood   BIC:                           -21118.1
                                          No. Observations:                  3837
Date:                  Tue, Apr 07 2020   Df Residuals:                      3833
Time:                          02:12:32   Df Model:                             4
                                Mean Model
================================================================================
                 coef    std err          t      P>|t|       95.0% Conf. Int.
--------------------------------------------------------------------------------
mu         9.5136e-05  2.418e-04      0.393      0.694 [-3.788e-04,5.691e-04]
                             Volatility Model
================================================================================
                 coef    std err          t      P>|t|      95.0% Conf. Int.
```

```
--------------------------------------------------------------------------
omega      6.0401e-06  2.881e-12  2.097e+06      0.000 [6.040e-06,6.040e-06]
alpha[1]       0.1000  5.662e-03     17.662  8.239e-70   [8.890e-02,  0.111]
beta[1]        0.8800  2.400e-03    366.648      0.000     [  0.875,  0.885]
==========================================================================

Covariance estimator: robust
WARNING: The optimizer did not indicate successful convergence. The message was
Positive directional derivative for linesearch.
See convergence_flag.
```

1.0.2 Conclusion

Day of the week effect is pronounced on Mondays and Wednesdays. Most of the sectors yield positive returns on Monday barring IT and FMCG. However, except for the first four sectoral returns for Monday (which are positive), none of them are statistically different from zero. Meanwhile, Wednesdays produce positive returns for all sectoral indices and 5 out of the 9 sectoral indices (excluding Auto, Capital Goods, Metal and PSU) are significant at the 10% level. Mondays and Wednesdays also see the highest returns of the week with Monday being highest in the sectors Auto, Capital Goods and Consumer Durables and Wednesday for the remaining sectors. Thursday, yielded negative returns in almost all indices, however none of them were statistically different from zero.

This study was done for the period 1st Feb 1999 to 16th March 2016.

[ ]: