Test Exercise 3

April 10, 2018

This is a IPython notebook that contains both the answers and the corresponding code for the problems in Test Exercise 3. All code is written is in Python 3 and the text is generated using Markdown.

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
sns.set_style('whitegrid')
%matplotlib inline
```

```
/anaconda/envs/research/lib/python3.5/site-packages/statsmodels/compat/pandas.py:56: FutureWarn
  from pandas.core import datetools
```

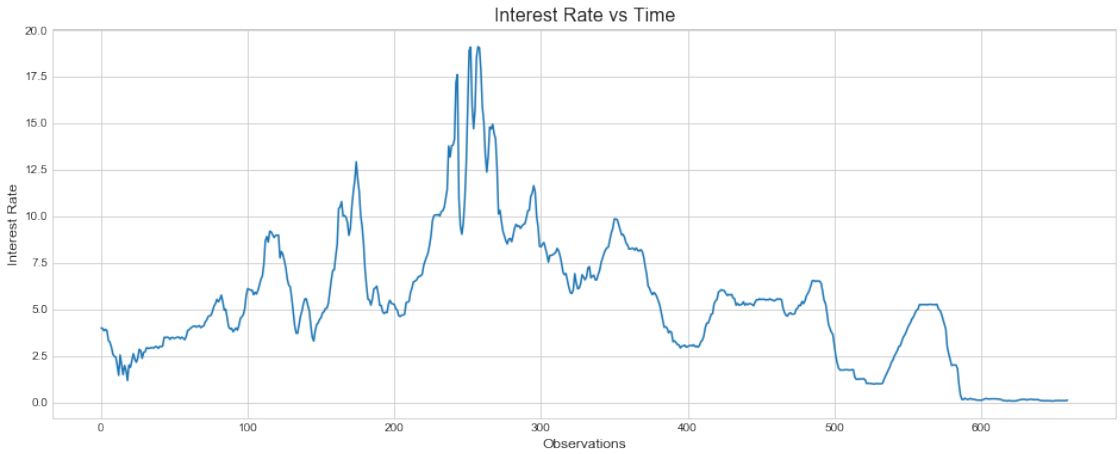
In [2]:
```
df = pd.read_excel('_a367fe65dc319a76cea3558922a4174d_TestExer-3-TaylorRule-round1.xls
```

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

Out[3]:

	OBS	INTRATE	INFL	PROD	UNEMPL	COMMPRI	PCE	PERSINC	HOUST
0	1960:1	3.99	1.24095	10.03653	3.41845	7.95262	5.70962	1.68419	-11.88896
1	1960:2	3.97	1.41379	6.96248	3.46575	-8.55856	5.06452	1.33094	-9.83803
2	1960:3	3.84	1.51881	4.49681	2.71993	-16.83599	5.55733	0.89195	-31.54321
3	1960:4	3.92	1.93237	1.50624	2.79820	-5.03145	7.77351	0.67636	-18.93082
4	1960:5	3.85	1.82507	-0.11398	1.72552	-12.44240	4.39179	0.33667	-15.15354

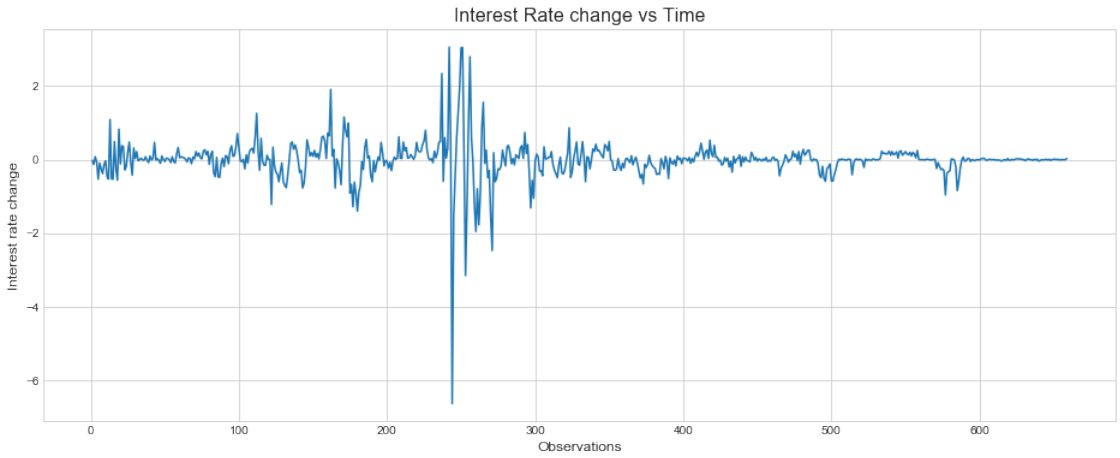
In [4]:
```
plt.figure(figsize=(16,6))
plt.plot(df['INTRATE'])
plt.title('Interest Rate vs Time', fontsize=16)
plt.xlabel('Observations', fontsize=12)
plt.ylabel('Interest Rate', fontsize=12);
```




```
In [5]: df['INTRATE_diff'] = df['INTRATE'].diff()

In [6]: df.head()

Out[6]:       OBS  INTRATE     INFL      PROD   UNEMPL   COMMPRI      PCE  PERSINC  \
        0  1960:1     3.99  1.24095  10.03653  3.41845   7.95262  5.70962  1.68419
        1  1960:2     3.97  1.41379   6.96248  3.46575  -8.55856  5.06452  1.33094
        2  1960:3     3.84  1.51881   4.49681  2.71993 -16.83599  5.55733  0.89195
        3  1960:4     3.92  1.93237   1.50624  2.79820  -5.03145  7.77351  0.67636
        4  1960:5     3.85  1.82507  -0.11398  1.72552 -12.44240  4.39179  0.33667

              HOUST  INTRATE_diff
        0 -11.88896           NaN
        1  -9.83803         -0.02
        2 -31.54321         -0.13
        3 -18.93082          0.08
        4 -15.15354         -0.07
```

0.0.1 Check for stationarity

```
In [7]: plt.figure(figsize=(16,6))
        plt.plot(df['INTRATE_diff'])
        plt.title('Interest Rate change vs Time', fontsize=16)
        plt.xlabel('Observations', fontsize=12)
        plt.ylabel('Interest rate change', fontsize=12);
```



The data distribution appears to be stationary with a few deviations around observations 225 - 275.

1 Part (a)

The AIC and BIC scores increase on dropping `COMMPRI`. So, we keep `COMMPRI` in the model and the final model contains 5 explanatory variables.

`INFL`, `COMMPRI`, `PCE`, `PERSINC`, `HOUST`

```
In [8]: X = pd.concat([df['INFL'], df['PROD'], df['UNEMPL'], df['COMMPRI'], df['PCE'], df['PERS
        y = df['INTRATE']
        X = sm.add_constant(X)
        model = sm.OLS(y, X).fit()
        print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.639
Model:                            OLS   Adj. R-squared:                  0.635
Method:                 Least Squares   F-statistic:                     164.5
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.64e-139
Time:                        00:08:18   Log-Likelihood:                -1449.2
No. Observations:                 660   AIC:                             2914.
Df Residuals:                     652   BIC:                             2950.
Df Model:                           7
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2212      0.245     -0.903      0.367      -0.702       0.260
INFL           0.6961      0.062     11.185      0.000       0.574       0.818
PROD          -0.0577      0.040     -1.447      0.148      -0.136       0.021
```

```
UNEMPL         0.1025      0.097      1.059      0.290      -0.088       0.292
COMMPRI       -0.0055      0.003     -1.857      0.064      -0.011       0.000
PCE            0.3444      0.069      4.958      0.000       0.208       0.481
PERSINC        0.2470      0.061      4.077      0.000       0.128       0.366
HOUST         -0.0194      0.005     -4.155      0.000      -0.029      -0.010
==============================================================================
Omnibus:                       28.142   Durbin-Watson:                   0.101
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               41.034
Skew:                           0.365   Prob(JB):                     1.23e-09
Kurtosis:                       3.980   Cond. No.                         102.
==============================================================================

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

1.0.1 Drop UNEMPL.

```
In [9]: X = pd.concat([df['INFL'], df['PROD'], df['COMMPRI'], df['PCE'], df['PERSINC'], df['HOU
        y = df['INTRATE']
        X = sm.add_constant(X)
        model = sm.OLS(y, X).fit()
        print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.638
Model:                            OLS   Adj. R-squared:                  0.635
Method:                 Least Squares   F-statistic:                     191.7
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.99e-140
Time:                        00:08:18   Log-Likelihood:                -1449.7
No. Observations:                 660   AIC:                             2913.
Df Residuals:                     653   BIC:                             2945.
Df Model:                           6
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2909      0.236     -1.232      0.218      -0.754       0.173
INFL           0.6933      0.062     11.150      0.000       0.571       0.815
PROD          -0.0255      0.026     -0.989      0.323      -0.076       0.025
COMMPRI       -0.0065      0.003     -2.308      0.021      -0.012      -0.001
PCE            0.3686      0.066      5.618      0.000       0.240       0.497
PERSINC        0.2516      0.060      4.162      0.000       0.133       0.370
HOUST         -0.0210      0.004     -4.760      0.000      -0.030      -0.012
==============================================================================
Omnibus:                       21.820   Durbin-Watson:                   0.104
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               30.851
```

```
Skew:                          0.303   Prob(JB):                     2.00e-07
Kurtosis:                      3.868   Cond. No.                         97.1
==============================================================================

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

1.0.2 Drop PROD.

```
In [10]: X = pd.concat([df['INFL'], df['COMMPRI'], df['PCE'], df['PERSINC'], df['HOUST']], axis
         y = df['INTRATE']
         X = sm.add_constant(X)
         model = sm.OLS(y, X).fit()
         print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.637
Model:                            OLS   Adj. R-squared:                  0.635
Method:                 Least Squares   F-statistic:                     229.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          2.03e-141
Time:                        00:08:18   Log-Likelihood:                -1450.2
No. Observations:                 660   AIC:                             2912.
Df Residuals:                     654   BIC:                             2939.
Df Model:                           5
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2401      0.230     -1.042      0.298      -0.692       0.212
INFL           0.7175      0.057     12.555      0.000       0.605       0.830
COMMPRI       -0.0075      0.003     -2.841      0.005      -0.013      -0.002
PCE            0.3405      0.059      5.756      0.000       0.224       0.457
PERSINC        0.2402      0.059      4.048      0.000       0.124       0.357
HOUST         -0.0205      0.004     -4.678      0.000      -0.029      -0.012
==============================================================================
Omnibus:                       23.848   Durbin-Watson:                   0.100
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               31.255
Skew:                           0.354   Prob(JB):                     1.63e-07
Kurtosis:                       3.797   Cond. No.                         94.1
==============================================================================

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

1.0.3 Drop COMMPRI.

```
In [11]: X = pd.concat([df['INFL'], df['PCE'], df['PERSINC'], df['HOUST']], axis=1)
         y = df['INTRATE']
         X = sm.add_constant(X)
         model = sm.OLS(y, X).fit()
         print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.633
Model:                            OLS   Adj. R-squared:                  0.631
Method:                 Least Squares   F-statistic:                     282.3
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          6.18e-141
Time:                        00:08:18   Log-Likelihood:                -1454.3
No. Observations:                 660   AIC:                             2919.
Df Residuals:                     655   BIC:                             2941.
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2136      0.231     -0.923      0.356      -0.668       0.241
INFL           0.7448      0.057     13.149      0.000       0.634       0.856
PCE            0.3110      0.059      5.311      0.000       0.196       0.426
PERSINC        0.2569      0.059      4.327      0.000       0.140       0.373
HOUST         -0.0215      0.004     -4.893      0.000      -0.030      -0.013
==============================================================================
Omnibus:                       27.399   Durbin-Watson:                   0.100
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               33.853
Skew:                           0.416   Prob(JB):                     4.46e-08
Kurtosis:                       3.733   Cond. No.                         62.7
==============================================================================

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

2 Part (b)

The AIC and BIC scores increase on adding PROD and UNEMPL. So, we do not include PROD and UNEMPL in the model and the final model contains 5 explanatory variables.

INFL, COMMPRI, PCE, PERSINC, HOUST

The model is same as the one obtained in Part (a).

```
In [12]: def regression(feature_list):
             X = feature_list
             y = df['INTRATE']
```

```
    X = sm.add_constant(X)
    model = sm.OLS(y, X).fit()
    return model
```

```
In [13]: features = [df['INFL'], df['PROD'], df['UNEMPL'], df['COMMPRI'], df['PCE'], df['PERSI
```

```
for f in features:
    pd.concat([f], axis=1)
    model = regression(f)
    print("\n###############################################################################
    print("###############################################################################
    print(model.summary())
```

```
###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.560
Model:                            OLS   Adj. R-squared:                  0.559
Method:                 Least Squares   F-statistic:                     836.6
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          2.47e-119
Time:                        00:08:18   Log-Likelihood:                -1514.2
No. Observations:                 660   AIC:                             3032.
Df Residuals:                     658   BIC:                             3041.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.6421      0.159     10.352      0.000       1.331       1.954
INFL           0.9453      0.033     28.925      0.000       0.881       1.010
==============================================================================
Omnibus:                        5.019   Durbin-Watson:                   0.063
Prob(Omnibus):                  0.081   Jarque-Bera (JB):                4.841
Skew:                           0.193   Prob(JB):                       0.0889
Kurtosis:                       3.166   Cond. No.                         8.46
==============================================================================

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

###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
```

```
Dep. Variable:                INTRATE   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                 -0.001
Method:                 Least Squares   F-statistic:                    0.2880
Date:                Tue, 10 Apr 2018   Prob (F-statistic):              0.592
Time:                        00:08:18   Log-Likelihood:                -1784.8
No. Observations:                 660   AIC:                             3574.
Df Residuals:                     658   BIC:                             3583.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          5.3942      0.166     32.592      0.000       5.069       5.719
PROD          -0.0159      0.030     -0.537      0.592      -0.074       0.042
==============================================================================
Omnibus:                       87.694   Durbin-Watson:                   0.022
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              136.318
Skew:                           0.880   Prob(JB):                     2.51e-30
Kurtosis:                       4.364   Cond. No.                         6.61
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.059
Model:                            OLS   Adj. R-squared:                  0.058
Method:                 Least Squares   F-statistic:                    41.57
Date:                Tue, 10 Apr 2018   Prob (F-statistic):           2.21e-10
Time:                        00:08:18   Log-Likelihood:                -1764.7
No. Observations:                 660   AIC:                             3533.
Df Residuals:                     658   BIC:                             3542.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.5446      0.185     24.571      0.000       4.181       4.908
UNEMPL         0.4525      0.070      6.447      0.000       0.315       0.590
==============================================================================
Omnibus:                      152.160   Durbin-Watson:                   0.022
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              326.769
Skew:                           1.251   Prob(JB):                     1.10e-71
Kurtosis:                       5.372   Cond. No.                         3.82
```

```
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.011
Model:                            OLS   Adj. R-squared:                  0.010
Method:                 Least Squares   F-statistic:                     7.562
Date:                Tue, 10 Apr 2018   Prob (F-statistic):            0.00613
Time:                        00:08:18   Log-Likelihood:                -1781.2
No. Observations:                 660   AIC:                             3566.
Df Residuals:                     658   BIC:                             3575.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          5.4017      0.142     38.159      0.000       5.124       5.680
COMMPRI       -0.0115      0.004     -2.750      0.006      -0.020      -0.003
==============================================================================
Omnibus:                       84.661   Durbin-Watson:                   0.025
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              129.692
Skew:                           0.861   Prob(JB):                     6.88e-29
Kurtosis:                       4.323   Cond. No.                         34.1
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.420
Model:                            OLS   Adj. R-squared:                  0.419
Method:                 Least Squares   F-statistic:                     476.6
Date:                Tue, 10 Apr 2018   Prob (F-statistic):           6.74e-80
Time:                        00:08:18   Log-Likelihood:                -1605.1
No. Observations:                 660   AIC:                             3214.
Df Residuals:                     658   BIC:                             3223.
Df Model:                           1
Covariance Type:            nonrobust
```

```
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.3361      0.282     -1.194      0.233      -0.889       0.217
PCE            0.8294      0.038     21.832      0.000       0.755       0.904
==============================================================================
Omnibus:                      102.688   Durbin-Watson:                   0.089
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              175.000
Skew:                           0.961   Prob(JB):                    9.98e-39
Kurtosis:                       4.635   Cond. No.                        19.7
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.003
Model:                             OLS   Adj. R-squared:                  0.002
Method:                  Least Squares   F-statistic:                     2.106
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):              0.147
Time:                         00:08:18   Log-Likelihood:                -1783.9
No. Observations:                  660   AIC:                             3572.
Df Residuals:                      658   BIC:                             3581.
Df Model:                            1
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          5.1245      0.208     24.586      0.000       4.715       5.534
PERSINC        0.1043      0.072      1.451      0.147      -0.037       0.245
==============================================================================
Omnibus:                      102.087   Durbin-Watson:                   0.023
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              167.927
Skew:                           0.974   Prob(JB):                    3.43e-37
Kurtosis:                       4.520   Cond. No.                        4.59
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
```

```
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.038
Model:                            OLS   Adj. R-squared:                  0.037
Method:                 Least Squares   F-statistic:                     26.07
Date:                Tue, 10 Apr 2018   Prob (F-statistic):           4.32e-07
Time:                        00:08:18   Log-Likelihood:                -1772.1
No. Observations:                 660   AIC:                             3548.
Df Residuals:                     658   BIC:                             3557.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          5.4036      0.139     38.956      0.000       5.131       5.676
HOUST         -0.0310      0.006     -5.106      0.000      -0.043      -0.019
==============================================================================
Omnibus:                       77.332   Durbin-Watson:                   0.034
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              117.624
Skew:                           0.800   Prob(JB):                     2.87e-26
Kurtosis:                       4.310   Cond. No.                         23.0
==============================================================================

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

2.0.1 Select INFL.

```
In [14]: features = [df['PROD'], df['UNEMPL'], df['COMMPRI'], df['PCE'], df['PERSINC'], df['HOU

         for f in features:
             f1 = pd.concat([df['INFL'], f], axis=1)
             model = regression(f1)
             print("\n###############################################################################
             print("###############################################################################
             print(model.summary())
```

```
###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.575
Model:                            OLS   Adj. R-squared:                  0.573
Method:                 Least Squares   F-statistic:                     443.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.06e-122
Time:                        00:08:18   Log-Likelihood:                -1502.8
```

```
No. Observations:                 660   AIC:                             3012.
Df Residuals:                     657   BIC:                             3025.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.2489      0.176      7.088      0.000       0.903       1.595
INFL           0.9750      0.033     29.785      0.000       0.911       1.039
PROD           0.0947      0.020      4.805      0.000       0.056       0.133
==============================================================================
Omnibus:                       12.297   Durbin-Watson:                   0.065
Prob(Omnibus):                  0.002   Jarque-Bera (JB):               12.444
Skew:                           0.326   Prob(JB):                     0.00199
Kurtosis:                       3.168   Cond. No.                        11.9
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.592
Model:                            OLS   Adj. R-squared:                  0.591
Method:                 Least Squares   F-statistic:                     477.1
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.04e-128
Time:                        00:08:18   Log-Likelihood:                -1488.9
No. Observations:                 660   AIC:                             2984.
Df Residuals:                     657   BIC:                             2997.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.1230      0.169      6.653      0.000       0.792       1.454
INFL           0.9257      0.032     29.300      0.000       0.864       0.988
UNEMPL         0.3358      0.046      7.235      0.000       0.245       0.427
==============================================================================
Omnibus:                       37.124   Durbin-Watson:                   0.066
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               45.150
Skew:                           0.529   Prob(JB):                     1.57e-10
Kurtosis:                       3.722   Cond. No.                        9.90
==============================================================================

Warnings:
```

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

##
##

OLS Regression Results

Dep. Variable:	INTRATE	R-squared:	0.562
Model:	OLS	Adj. R-squared:	0.560
Method:	Least Squares	F-statistic:	420.8
Date:	Tue, 10 Apr 2018	Prob (F-statistic):	2.29e-118
Time:	00:08:18	Log-Likelihood:	-1512.8
No. Observations:	660	AIC:	3032.
Df Residuals:	657	BIC:	3045.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	1.6820	0.160	10.496	0.000	1.367	1.997
INFL	0.9407	0.033	28.715	0.000	0.876	1.005
COMMPRI	-0.0046	0.003	-1.654	0.099	-0.010	0.001

Omnibus:	4.941	Durbin-Watson:	0.063
Prob(Omnibus):	0.085	Jarque-Bera (JB):	4.806
Skew:	0.178	Prob(JB):	0.0904
Kurtosis:	3.219	Cond. No.	58.7

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

##
##

OLS Regression Results

Dep. Variable:	INTRATE	R-squared:	0.604
Model:	OLS	Adj. R-squared:	0.603
Method:	Least Squares	F-statistic:	501.5
Date:	Tue, 10 Apr 2018	Prob (F-statistic):	5.86e-133
Time:	00:08:18	Log-Likelihood:	-1479.1
No. Observations:	660	AIC:	2964.
Df Residuals:	657	BIC:	2978.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]

```
------------------------------------------------------------------------------
const          0.1012      0.234      0.432      0.666      -0.359       0.561
INFL           0.7158      0.041     17.483      0.000       0.635       0.796
PCE            0.3562      0.041      8.590      0.000       0.275       0.438
==============================================================================
Omnibus:                       12.948   Durbin-Watson:                   0.076
Prob(Omnibus):                  0.002   Jarque-Bera (JB):               13.530
Skew:                           0.302   Prob(JB):                      0.00115
Kurtosis:                       3.357   Cond. No.                         23.2
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.613
Model:                             OLS   Adj. R-squared:                  0.612
Method:                  Least Squares   F-statistic:                     519.7
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          4.67e-136
Time:                         00:08:18   Log-Likelihood:                -1471.9
No. Observations:                  660   AIC:                             2950.
Df Residuals:                      657   BIC:                             2963.
Df Model:                            2
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.4472      0.195      2.292      0.022       0.064       0.830
INFL           1.0122      0.031     32.156      0.000       0.950       1.074
PERSINC        0.4360      0.046      9.478      0.000       0.346       0.526
==============================================================================
Omnibus:                        7.956   Durbin-Watson:                   0.102
Prob(Omnibus):                  0.019   Jarque-Bera (JB):                8.138
Skew:                           0.221   Prob(JB):                       0.0171
Kurtosis:                       3.316   Cond. No.                         11.8
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
```

```
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.560
Model:                            OLS   Adj. R-squared:                  0.559
Method:                 Least Squares   F-statistic:                     418.6
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          5.93e-118
Time:                        00:08:18   Log-Likelihood:                -1513.8
No. Observations:                 660   AIC:                             3034.
Df Residuals:                     657   BIC:                             3047.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.6767      0.163     10.278      0.000       1.356       1.997
INFL           0.9383      0.034     27.934      0.000       0.872       1.004
HOUST         -0.0038      0.004     -0.911      0.362      -0.012       0.004
==============================================================================
Omnibus:                        6.328   Durbin-Watson:                   0.063
Prob(Omnibus):                  0.042   Jarque-Bera (JB):                6.229
Skew:                           0.208   Prob(JB):                       0.0444
Kurtosis:                       3.229   Cond. No.                         40.5
==============================================================================

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

2.0.2 Select PERSINC.

```
In [15]: features = [df['PROD'], df['UNEMPL'], df['COMMPRI'], df['PCE'], df['HOUST']]

         for f in features:
             f1 = pd.concat([df['INFL'], df['PERSINC'], f], axis=1)
             model = regression(f1)
             print("\n###############################################################################
             print("###############################################################################
             print(model.summary())
```

```
###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.613
Model:                            OLS   Adj. R-squared:                  0.611
Method:                 Least Squares   F-statistic:                     346.0
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.15e-134
```

```
Time:                        00:08:18   Log-Likelihood:                -1471.9
No. Observations:                 660   AIC:                             2952.
Df Residuals:                     656   BIC:                             2970.
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.4422      0.196      2.257      0.024       0.057       0.827
INFL           1.0130      0.032     32.042      0.000       0.951       1.075
PERSINC        0.4280      0.053      8.030      0.000       0.323       0.533
PROD           0.0064      0.022      0.296      0.768      -0.036       0.049
==============================================================================
Omnibus:                        8.502   Durbin-Watson:                   0.101
Prob(Omnibus):                  0.014   Jarque-Bera (JB):                8.655
Skew:                           0.236   Prob(JB):                       0.0132
Kurtosis:                       3.305   Cond. No.                         14.8
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.617
Model:                            OLS   Adj. R-squared:                  0.615
Method:                 Least Squares   F-statistic:                     351.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          3.79e-136
Time:                        00:08:19   Log-Likelihood:                -1468.4
No. Observations:                 660   AIC:                             2945.
Df Residuals:                     656   BIC:                             2963.
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.4462      0.194      2.298      0.022       0.065       0.828
INFL           0.9916      0.032     30.705      0.000       0.928       1.055
PERSINC        0.3560      0.055      6.480      0.000       0.248       0.464
UNEMPL         0.1425      0.054      2.638      0.009       0.036       0.249
==============================================================================
Omnibus:                       21.055   Durbin-Watson:                   0.091
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               23.143
Skew:                           0.393   Prob(JB):                     9.43e-06
Kurtosis:                       3.473   Cond. No.                         12.6
```

```
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.616
Model:                             OLS   Adj. R-squared:                  0.614
Method:                  Least Squares   F-statistic:                     350.3
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          9.54e-136
Time:                         00:08:19   Log-Likelihood:                -1469.4
No. Observations:                  660   AIC:                             2947.
Df Residuals:                      656   BIC:                             2965.
Df Model:                            3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.4837      0.195      2.479      0.013       0.101       0.867
INFL           1.0071      0.031     32.009      0.000       0.945       1.069
PERSINC        0.4413      0.046      9.611      0.000       0.351       0.531
COMMPRI       -0.0059      0.003     -2.257      0.024      -0.011      -0.001
==============================================================================
Omnibus:                        7.774   Durbin-Watson:                   0.101
Prob(Omnibus):                  0.021   Jarque-Bera (JB):                8.534
Skew:                           0.186   Prob(JB):                       0.0140
Kurtosis:                       3.415   Cond. No.                         76.7
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.619
Model:                             OLS   Adj. R-squared:                  0.618
Method:                  Least Squares   F-statistic:                     356.0
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          3.77e-137
Time:                         00:08:19   Log-Likelihood:                -1466.1
No. Observations:                  660   AIC:                             2940.
Df Residuals:                      656   BIC:                             2958.
```

```
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0212      0.230      0.092      0.927      -0.431       0.473
INFL           0.8754      0.051     17.224      0.000       0.776       0.975
PERSINC        0.3054      0.060      5.129      0.000       0.188       0.422
PCE            0.1812      0.053      3.412      0.001       0.077       0.285
==============================================================================
Omnibus:                        9.545   Durbin-Watson:                   0.088
Prob(Omnibus):                  0.008   Jarque-Bera (JB):                9.664
Skew:                           0.260   Prob(JB):                      0.00797
Kurtosis:                       3.283   Cond. No.                         23.9
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.617
Model:                             OLS   Adj. R-squared:                  0.615
Method:                  Least Squares   F-statistic:                     352.4
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          2.94e-136
Time:                         00:08:19   Log-Likelihood:                -1468.2
No. Observations:                  660   AIC:                             2944.
Df Residuals:                      656   BIC:                             2962.
Df Model:                            3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.4830      0.195      2.482      0.013       0.101       0.865
INFL           0.9957      0.032     31.207      0.000       0.933       1.058
PERSINC        0.4588      0.047      9.861      0.000       0.367       0.550
HOUST         -0.0109      0.004     -2.733      0.006      -0.019      -0.003
==============================================================================
Omnibus:                       17.329   Durbin-Watson:                   0.107
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               20.923
Skew:                           0.303   Prob(JB):                     2.86e-05
Kurtosis:                       3.628   Cond. No.                         51.9
==============================================================================

Warnings:
```

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

2.0.3 Select PCE.

```
In [16]: features = [df['PROD'], df['UNEMPL'], df['COMMPRI'], df['HOUST']]

         for f in features:
             f1 = pd.concat([df['INFL'], df['PERSINC'], df['PCE'], f], axis=1)
             model = regression(f1)
             print("\n###############################################################################
             print("###############################################################################
             print(model.summary())
```

```
###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.621
Model:                             OLS   Adj. R-squared:                  0.618
Method:                  Least Squares   F-statistic:                     268.1
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          2.50e-136
Time:                         00:08:19   Log-Likelihood:                -1465.0
No. Observations:                  660   AIC:                             2940.
Df Residuals:                      655   BIC:                             2962.
Df Model:                            4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.0517      0.235     -0.220      0.826      -0.513       0.410
INFL           0.8383      0.056     14.849      0.000       0.727       0.949
PERSINC        0.3199      0.060      5.308      0.000       0.202       0.438
PCE            0.2243      0.060      3.720      0.000       0.106       0.343
PROD          -0.0369      0.025     -1.506      0.133      -0.085       0.011
==============================================================================
Omnibus:                        7.399   Durbin-Watson:                   0.093
Prob(Omnibus):                  0.025   Jarque-Bera (JB):                7.845
Skew:                           0.193   Prob(JB):                       0.0198
Kurtosis:                       3.370   Cond. No.                         26.4
==============================================================================

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

###############################################################################
```

```
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.620
Model:                             OLS   Adj. R-squared:                  0.618
Method:                  Least Squares   F-statistic:                     267.5
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          3.84e-136
Time:                         00:08:19   Log-Likelihood:                -1465.4
No. Observations:                  660   AIC:                             2941.
Df Residuals:                      655   BIC:                             2963.
Df Model:                            4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0993      0.239      0.415      0.678      -0.371       0.570
INFL           0.8902      0.052     17.013      0.000       0.787       0.993
PERSINC        0.2890      0.061      4.727      0.000       0.169       0.409
PCE            0.1478      0.060      2.458      0.014       0.030       0.266
UNEMPL         0.0722      0.061      1.184      0.237      -0.047       0.192
==============================================================================
Omnibus:                       15.357   Durbin-Watson:                   0.085
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               16.112
Skew:                           0.339   Prob(JB):                     0.000317
Kurtosis:                       3.356   Cond. No.                         25.6
==============================================================================

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

###############################################################################
###############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.625
Model:                             OLS   Adj. R-squared:                  0.623
Method:                  Least Squares   F-statistic:                     273.2
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          5.28e-138
Time:                         00:08:19   Log-Likelihood:                -1461.1
No. Observations:                  660   AIC:                             2932.
Df Residuals:                      655   BIC:                             2955.
Df Model:                            4
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
```

const	-0.0211	0.229	-0.092	0.927	-0.471	0.429
INFL	0.8378	0.052	16.156	0.000	0.736	0.940
PERSINC	0.2841	0.060	4.772	0.000	0.167	0.401
PCE	0.2214	0.054	4.082	0.000	0.115	0.328
COMMPRI	-0.0085	0.003	-3.173	0.002	-0.014	-0.003

Omnibus:	7.556	Durbin-Watson:	0.087
Prob(Omnibus):	0.023	Jarque-Bera (JB):	7.920
Skew:	0.201	Prob(JB):	0.0191
Kurtosis:	3.356	Cond. No.	90.3

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

##
##

OLS Regression Results

Dep. Variable:	INTRATE	R-squared:	0.633
Model:	OLS	Adj. R-squared:	0.631
Method:	Least Squares	F-statistic:	282.3
Date:	Tue, 10 Apr 2018	Prob (F-statistic):	6.18e-141
Time:	00:08:19	Log-Likelihood:	-1454.3
No. Observations:	660	AIC:	2919.
Df Residuals:	655	BIC:	2941.
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.2136	0.231	-0.923	0.356	-0.668	0.241
INFL	0.7448	0.057	13.149	0.000	0.634	0.856
PERSINC	0.2569	0.059	4.327	0.000	0.140	0.373
PCE	0.3110	0.059	5.311	0.000	0.196	0.426
HOUST	-0.0215	0.004	-4.893	0.000	-0.030	-0.013

Omnibus:	27.399	Durbin-Watson:	0.100
Prob(Omnibus):	0.000	Jarque-Bera (JB):	33.853
Skew:	0.416	Prob(JB):	4.46e-08
Kurtosis:	3.733	Cond. No.	62.7

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

2.0.4 Select HOUST.

```
In [17]: features = [df['PROD'], df['UNEMPL'], df['COMMPRI']]

         for f in features:
             f1 = pd.concat([df['INFL'], df['PERSINC'], df['PCE'], df['HOUST'], f], axis=1)
             model = regression(f1)
             print("\n#############################################################################
             print("#############################################################################
             print(model.summary())
```

```
#############################################################################
#############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.635
Model:                             OLS   Adj. R-squared:                  0.632
Method:                  Least Squares   F-statistic:                     227.5
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          1.76e-140
Time:                         00:08:19   Log-Likelihood:                -1452.4
No. Observations:                  660   AIC:                             2917.
Df Residuals:                      654   BIC:                             2944.
Df Model:                            5
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.3126      0.237     -1.321      0.187      -0.777       0.152
INFL           0.6940      0.062     11.125      0.000       0.572       0.817
PERSINC        0.2736      0.060      4.569      0.000       0.156       0.391
PCE            0.3692      0.066      5.610      0.000       0.240       0.498
HOUST         -0.0222      0.004     -5.039      0.000      -0.031      -0.014
PROD          -0.0465      0.024     -1.923      0.055      -0.094       0.001
==============================================================================
Omnibus:                       22.145   Durbin-Watson:                   0.109
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               31.102
Skew:                           0.310   Prob(JB):                     1.76e-07
Kurtosis:                       3.865   Cond. No.                         64.7
==============================================================================

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

#############################################################################
#############################################################################

                            OLS Regression Results
```

```
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.633
Model:                            OLS   Adj. R-squared:                  0.630
Method:                 Least Squares   F-statistic:                     225.5
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.08e-139
Time:                        00:08:19   Log-Likelihood:                -1454.2
No. Observations:                 660   AIC:                             2920.
Df Residuals:                     654   BIC:                             2947.
Df Model:                           5
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2333      0.246     -0.949      0.343      -0.716       0.249
INFL           0.7398      0.060     12.235      0.000       0.621       0.859
PERSINC        0.2596      0.060      4.293      0.000       0.141       0.378
PCE            0.3199      0.069      4.610      0.000       0.184       0.456
HOUST         -0.0218      0.005     -4.745      0.000      -0.031      -0.013
UNEMPL        -0.0150      0.063     -0.239      0.811      -0.138       0.108
==============================================================================
Omnibus:                       25.793   Durbin-Watson:                   0.102
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               31.852
Skew:                           0.398   Prob(JB):                     1.21e-07
Kurtosis:                       3.724   Cond. No.                         67.3
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.637
Model:                            OLS   Adj. R-squared:                  0.635
Method:                 Least Squares   F-statistic:                     229.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          2.03e-141
Time:                        00:08:19   Log-Likelihood:                -1450.2
No. Observations:                 660   AIC:                             2912.
Df Residuals:                     654   BIC:                             2939.
Df Model:                           5
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2401      0.230     -1.042      0.298      -0.692       0.212
INFL           0.7175      0.057     12.555      0.000       0.605       0.830
```

```
PERSINC        0.2402      0.059      4.048      0.000       0.124       0.357
PCE            0.3405      0.059      5.756      0.000       0.224       0.457
HOUST         -0.0205      0.004     -4.678      0.000      -0.029      -0.012
COMMPRI       -0.0075      0.003     -2.841      0.005      -0.013      -0.002
==============================================================================
Omnibus:                       23.848   Durbin-Watson:                   0.100
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               31.255
Skew:                           0.354   Prob(JB):                     1.63e-07
Kurtosis:                       3.797   Cond. No.                         94.1
==============================================================================

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

2.0.5 Select COMMPRI.

```
In [18]: features = [df['PROD'], df['UNEMPL']]

         for f in features:
             f1 = pd.concat([df['INFL'], df['PERSINC'], df['PCE'], df['HOUST'], df['COMMPRI'],
             model = regression(f1)
             print("\n##############################################################################
             print("##############################################################################
             print(model.summary())
```

```
##############################################################################
##############################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                 INTRATE   R-squared:                       0.638
Model:                             OLS   Adj. R-squared:                  0.635
Method:                  Least Squares   F-statistic:                     191.7
Date:                 Tue, 10 Apr 2018   Prob (F-statistic):          1.99e-140
Time:                         00:08:19   Log-Likelihood:                -1449.7
No. Observations:                  660   AIC:                             2913.
Df Residuals:                      653   BIC:                             2945.
Df Model:                            6
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2909      0.236     -1.232      0.218      -0.754       0.173
INFL           0.6933      0.062     11.150      0.000       0.571       0.815
PERSINC        0.2516      0.060      4.162      0.000       0.133       0.370
PCE            0.3686      0.066      5.618      0.000       0.240       0.497
```

```
HOUST         -0.0210      0.004     -4.760      0.000      -0.030      -0.012
COMMPRI       -0.0065      0.003     -2.308      0.021      -0.012      -0.001
PROD          -0.0255      0.026     -0.989      0.323      -0.076       0.025
==============================================================================
Omnibus:                       21.820   Durbin-Watson:                   0.104
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               30.851
Skew:                           0.303   Prob(JB):                     2.00e-07
Kurtosis:                       3.868   Cond. No.                         97.1
==============================================================================

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

################################################################################
################################################################################

                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.637
Model:                            OLS   Adj. R-squared:                  0.634
Method:                 Least Squares   F-statistic:                     191.3
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          3.22e-140
Time:                        00:08:19   Log-Likelihood:                -1450.2
No. Observations:                 660   AIC:                             2914.
Df Residuals:                     653   BIC:                             2946.
Df Model:                           6
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.2460      0.245     -1.006      0.315      -0.726       0.234
INFL           0.7161      0.061     11.792      0.000       0.597       0.835
PERSINC        0.2411      0.061      3.985      0.000       0.122       0.360
PCE            0.3431      0.070      4.937      0.000       0.207       0.480
HOUST         -0.0206      0.005     -4.485      0.000      -0.030      -0.012
COMMPRI       -0.0075      0.003     -2.830      0.005      -0.013      -0.002
UNEMPL        -0.0045      0.062     -0.072      0.943      -0.127       0.118
==============================================================================
Omnibus:                       23.442   Durbin-Watson:                   0.100
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               30.775
Skew:                           0.348   Prob(JB):                     2.08e-07
Kurtosis:                       3.796   Cond. No.                         101.
==============================================================================

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

3 Part (c)

Model using the *Taylor rule of equation*.

Parameters	Model (a)	Taylor rule
R-squared	0.633	0.575
AIC	2919	3012
BIC	2941	3025

Since, the AIC, and the BIC scores of the model in Part (a) are lower than that of Taylor rule, so the model obtained in Part (a) is better. Also, the R-squared of the model in Part (a) is higher.

```
In [19]: X = pd.concat([df['INFL'], df['PROD']], axis=1)
         y = df['INTRATE']
         X = sm.add_constant(X)
         model = sm.OLS(y, X).fit()
         print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.575
Model:                            OLS   Adj. R-squared:                  0.573
Method:                 Least Squares   F-statistic:                     443.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.06e-122
Time:                        00:08:19   Log-Likelihood:                -1502.8
No. Observations:                 660   AIC:                             3012.
Df Residuals:                     657   BIC:                             3025.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.2489      0.176      7.088      0.000       0.903       1.595
INFL           0.9750      0.033     29.785      0.000       0.911       1.039
PROD           0.0947      0.020      4.805      0.000       0.056       0.133
==============================================================================
Omnibus:                       12.297   Durbin-Watson:                   0.065
Prob(Omnibus):                  0.002   Jarque-Bera (JB):               12.444
Skew:                           0.326   Prob(JB):                      0.00199
Kurtosis:                       3.168   Cond. No.                         11.9
==============================================================================

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

4 Part (d)

RESET test
Taking p = 1.

The p value of the γ cofficient is 0.112 and hence it is not significant. So we can conclude that H0 (null hypothesis) is correct. In other words we can consider $\gamma = 0$.

```
In [20]: y_pred = model.predict(X)
         df['y_pred_2'] = y_pred**2

In [21]: X = pd.concat([df['INFL'], df['PROD'], df['y_pred_2']], axis=1)
         y = df['INTRATE']
         X = sm.add_constant(X)
         model = sm.OLS(y, X).fit()
         print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.576
Model:                            OLS   Adj. R-squared:                  0.574
Method:                 Least Squares   F-statistic:                     297.5
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          7.14e-122
Time:                        00:08:19   Log-Likelihood:                -1501.5
No. Observations:                 660   AIC:                             3011.
Df Residuals:                     656   BIC:                             3029.
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.9841      0.242      4.065      0.000       0.509       1.459
INFL           1.1650      0.124      9.418      0.000       0.922       1.408
PROD           0.0999      0.020      5.005      0.000       0.061       0.139
y_pred_2      -0.0137      0.009     -1.593      0.112      -0.031       0.003
==============================================================================
Omnibus:                       10.719   Durbin-Watson:                   0.068
Prob(Omnibus):                  0.005   Jarque-Bera (JB):               10.755
Skew:                           0.301   Prob(JB):                      0.00462
Kurtosis:                       3.170   Cond. No.                         157.
==============================================================================

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

4.0.1 Chow break test

$$F = \frac{(S0 - S1 - S2)/k}{(S1 + S2)/(n - 2k)}$$

```
In [22]: X = pd.concat([df['INFL'], df['PROD']], axis=1)
         y = df['INTRATE']
         X = sm.add_constant(X)
         model = sm.OLS(y, X).fit()
         y_pred = model.predict(X)
         print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.575
Model:                            OLS   Adj. R-squared:                  0.573
Method:                 Least Squares   F-statistic:                     443.9
Date:                Tue, 10 Apr 2018   Prob (F-statistic):          1.06e-122
Time:                        00:08:19   Log-Likelihood:                -1502.8
No. Observations:                 660   AIC:                             3012.
Df Residuals:                     657   BIC:                             3025.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.2489      0.176      7.088      0.000       0.903       1.595
INFL           0.9750      0.033     29.785      0.000       0.911       1.039
PROD           0.0947      0.020      4.805      0.000       0.056       0.133
==============================================================================
Omnibus:                       12.297   Durbin-Watson:                   0.065
Prob(Omnibus):                  0.002   Jarque-Bera (JB):               12.444
Skew:                           0.326   Prob(JB):                      0.00199
Kurtosis:                       3.168   Cond. No.                         11.9
==============================================================================

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

```
In [23]: X1 = X[:240]
         y1 = y[:240]
         X2 = X[240:]
         y2 = y[240:]
```

```
In [24]: model1 = sm.OLS(y1, X1).fit()
         print(model1.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.794
Model:                            OLS   Adj. R-squared:                  0.792
Method:                 Least Squares   F-statistic:                     457.2
Date:                Tue, 10 Apr 2018   Prob (F-statistic):           4.50e-82
```

```
Time:                        00:08:19   Log-Likelihood:                -382.71
No. Observations:                 240   AIC:                             771.4
Df Residuals:                     237   BIC:                             781.9
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.4490      0.182      7.959      0.000       1.090       1.808
INFL           0.7833      0.026     29.781      0.000       0.732       0.835
PROD           0.1160      0.016      7.225      0.000       0.084       0.148
==============================================================================
Omnibus:                        2.436   Durbin-Watson:                   0.146
Prob(Omnibus):                  0.296   Jarque-Bera (JB):                2.351
Skew:                           0.080   Prob(JB):                        0.309
Kurtosis:                       3.458   Cond. No.                         17.7
==============================================================================

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

```
In [25]: y2 = df['INTRATE'][240:]
         model2 = sm.OLS(y2, X2).fit()
         print(model2.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                INTRATE   R-squared:                       0.582
Model:                            OLS   Adj. R-squared:                  0.580
Method:                 Least Squares   F-statistic:                     290.2
Date:                Tue, 10 Apr 2018   Prob (F-statistic):           1.09e-79
Time:                        00:08:19   Log-Likelihood:                -1001.9
No. Observations:                 420   AIC:                             2010.
Df Residuals:                     417   BIC:                             2022.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.7068      0.234      3.022      0.003       0.247       1.167
INFL           1.2330      0.051     24.085      0.000       1.132       1.334
PROD           0.0932      0.031      3.040      0.003       0.033       0.153
==============================================================================
Omnibus:                        5.956   Durbin-Watson:                   0.075
Prob(Omnibus):                  0.051   Jarque-Bera (JB):                4.958
Skew:                          -0.179   Prob(JB):                       0.0838
Kurtosis:                       2.607   Cond. No.                         9.67
```

```
==============================================================================

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

```
In [26]: S0 = sum((df['INTRATE'] - y_pred)**2)
```

```
In [27]: y_pred1 = model1.predict(X1)
         y_pred2 = model2.predict(X2)
```

```
In [28]: S1 = sum((y1 - y_pred1)**2)
         S2 = sum((y2 - y_pred2)**2)
```

```
In [29]: F = ((S0 - S1 - S2)*(660 - 4))/((S1 + S2)*2)
         print("Chow break test = {:.4f}".format(F))
```

```
Chow break test = 43.2343
```

Chow break test = 43.2343

We can safely reject the null hypothesis (H0). We do not reject the alternative hypothesis that the models is a combination of two linear regression model over two sets of data divided at the break date Januray 1980.

4.0.2 Chow Forecast test

$$F = \frac{(S0 - S1)/n_2}{S1/(n_1 - k)}$$

```
In [30]: F = ((S0 - S1)*(240 - 2))/(S1*420)
         print("Chow forecast test = {:.4f}".format(F))
```

```
Chow forecast test = 5.5338
```

Chow forecast test = 5.5338

We can safely reject the null hypothesis (H0). We can say that the alternative hypothesis is true that the 2nd regression line after the break provides a good fit as the coefficient is significant.

4.0.3 Jarque-Bera test

The high JB test value, 12.44 from Taylor equation suggests that the residuals are not normally distributed. This tells us that the model is not good.

The JB test values in the Chow break test gives JB values of 2.31 and 4.96. This indicates that the regression model is a better fit when the data is divided into 2 parts on the basis of time (break date January 1980).